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Medical Continuing Education Committee. Memories for the Future

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In 1910, Abraham Flexner presented his renowned FLEXNER REPORT, which evaluated 155 Medicine Schools in the USA. It criticized a highly lucrative business, to the point of denouncing an overabundance of physicians with bad instruction and worse training.

Flexner asserted: «If medicine was conceived as an art instead of a science, those people practising it would be motivated to act with a clear understanding, but based on superficial empirical sciences. On the contrary, if those people practising medicine were absolutely conscious of their responsibility towards the scientific spirit and method, they would need to make an effort to clarify concepts and proceed systemically on facts and data accumulation, hypothesis formulation, and evaluation of results. If medicine accepts as an aim the achievement of scientific standards in research and professional exercise, medical education must be primarily conceived as education and training of students in the intellectual techniques of inductive science».

I believe that not only did Flexner seek enhancement in hospitals, but he also introduced a key concept: continuing medical education. There are multiple developments that demand competent health professionals: sustained growth in scientific knowledge, increasing availability of diagnostic and treatment technology, impact on social expenditure, and also the new challenges related to ethics and the social responsibility that the medical profession assumes by defending life and fighting disease.

Maybe the most suitable definition for current medicine is the one expressed by the 1985 Nobel Medicine Prize winner Joseph L. Goldstein (2000): «Unlike Mathematics and Physics, Biology and Medicine are *empirical sciences*. Because they lack great unified theories to direct the experiments, conceptual advances in biomedical science deeply depend on technological innovation».

The pandemic striking our planet is putting this tenet to the test. Present-day physicians must know the reasons why they are taught what they are taught. Both the healthy and the sick depend on them.

One of our Nobel Prize winners, Bernardo Houssay, in a conference at the Center of Medicine Students of Buenos Aires in 1927, prophesied the twilight of hospitals in charge of charity workers as «a last refuge for the underdogs and the homeless» in the late 19th century, to be replaced by complex therapeutic institutions in charge of professionals specialized in the art of healing.

He also anticipated Medical Residency as a model to pursue after having obtained a bachelor's degree. We are fully convinced that such practice, together with Programmatic Attendance and fellow associates to the Medical Residency system, are the way forward for a new graduate physician.

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By the 1960s, an innovative method in Medical Education oriented to problem cases is initiated in the University of McMaster, Canada. It demands that the trainees pose questions, develop hypotheses and defend ideas and opinions.

Undoubtedly, motivating the learners to take part on their own training has great value, but it also requires properly formed professors and a certain level of training. This is the reason why we consider such method most suitable for Hospital Athenaeums or Postgraduate Courses.

We are convinced that the students should profit from the first ten years of postgraduate courses in order to acquire a quality training appropriate for a professional specialist. Over that period, efforts must also be made to ensure the completion of the degree with the best standards possible.

Thus, in 2008, under the presidency of Dr. Iván Ayerza, while we were presiding the Continuing Medical Education Committee, we opened the *Curso Oficial Nacional Bianual de Certificación* (National Biannual Official Course of Certification). It consisted in one year of Traumatology and one year of Orthopedics with a Final Monograph. We sought to strengthen the practical training undoubtedly offered by Residency and its incorporated systems with a theoretical reinforcement essential to formation. The course is today mandatory to obtain the Specialty Certification issued by the Asociación Argentina de Ortopedia y Traumatología.

The study program is designed and updated by the Continuing Medical Education Committee, and the speakers are requested and suggested by the Constituents Associations and Societies. The problem cases are selected and coordinated by the Committee. Lectures are given equally across the country, and the final evaluation is performed on the same date and time at the different constituent offices.

At the end of the Residency, the student will be a Specialist in General Orthopedics and Traumatology. After this training, he or she should engage in one of the specialties of our Association. We consider that, in this manner, we are moving closer to a maxim expressed by the founder of the Municipal School for Graduates, Dr. Ricardo Finochietto: «Theory produces information, but not formation. Only surgery practice provides formation».

Since last year, under the conduction of our brand new president, Dr. Jorge Romanelli, we have achieved an even greater enhancement of that stage of theoretical training by establishing a third integrating year. We intend to emphasize on Medical Ethics, following our Code of Ethics and our Guild, and delve into the presentation and solving of Problem Cases, for which the student will be fully prepared at this stage.

Given the changes made, the Course came to be known as *Curso Oficial Nacional Trienal de Certificación* (National Triennial Official Course of Certification). One more step towards academic quality was to establish that the Final Monographs must be done individually and have a stage of oral defence. This will be done over the third year of attendance.

The Course raised high interest, as proven by the amount of enrolled professionals for this year: 324 for the first year, and 301 for the second year.

We have always sought to instill in our associates the concept of Continuing Medical Education. The skills in Distance Education via Zoom acquired as a result of the pandemic have encouraged us to move forward and implement that resource in Intensive Recertification Courses. The associate, already certified as a Specialist, must be imbued with this behavior and it is our duty to support him or her. Recertification every 5 years is also completely necessary, and that is the reason why we offer these courses, which train, update and qualify. We request the Regional Associations or Societies to report the updating syllabi in which they are most interested, and we develop the course based on such reports.

Our first experience will take place on May 31st, and June 1st and 2nd, together with the Asociación Salteña de Ortopedia y Traumatología, in sessions to be initiated at 7 pm and finished at 8:30 pm. Three different topics will be introduced, having been previously published. This format will allow every associate interested in the topics to register in the course.

Another important part of our work is to certify courses according to the number of hours and the syllabi submitted, and to provide sponsorship using the same parameters, without forgetting that we both depend on and have a duty to the Executive Committee of our Association.

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Case Presentation

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See case resolution on page 437.

A 67-year-old patient who consulted for pain in the left gluteal region, of several months of evolution, that altered his quality of life. He reported pain when sitting, when starting to walk and when sleeping on the compromised side. As background, he reported a fall from standing height that had taken place 9 months before, from which he landed on the left gluteal area. Upon physical examination, a slight asymmetry of the folds was observed, with increased volume and tenderness in the area of the left gluteus, which began at the tendinous insertion on the greater trochanter, but was more localized on the belly of the muscle in the central area of the gluteus and coinciding with a palpable hard-stone mass. Radiographs, a CT scan, and MRI with contrast medium of the pelvis were ordered.

FINDINGS AND INTERPRETATION OF IMAGING STUDIES

In the anteroposterior radiographs of both hips, an increase in density was observed in the right and left gluteal regions. Calcifications were also recognized in relation to the right lesser trochanter (Figure 1).

Figure 1. Anteroposterior pelvic radiograph. Increased density in the left gluteal region and calcifications in relation to the right lesser trochanter.

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Magnetic resonance imaging with contrast medium showed small low-signal images in the right lesser trochanter, with slight post-contrast enhancement. A slight edema was observed in the T2-weighted sequences. In the left gluteal region, the signal in the T1-weighted sequence was intermediate. In the T2-weighted sequence, it was high, with marked enhancement of the contrast medium (Figure 2). Computed tomography revealed mature calcifications in relation to the right iliac psoas muscle and small peripheral calcifications in the left gluteal region (Figure 3).

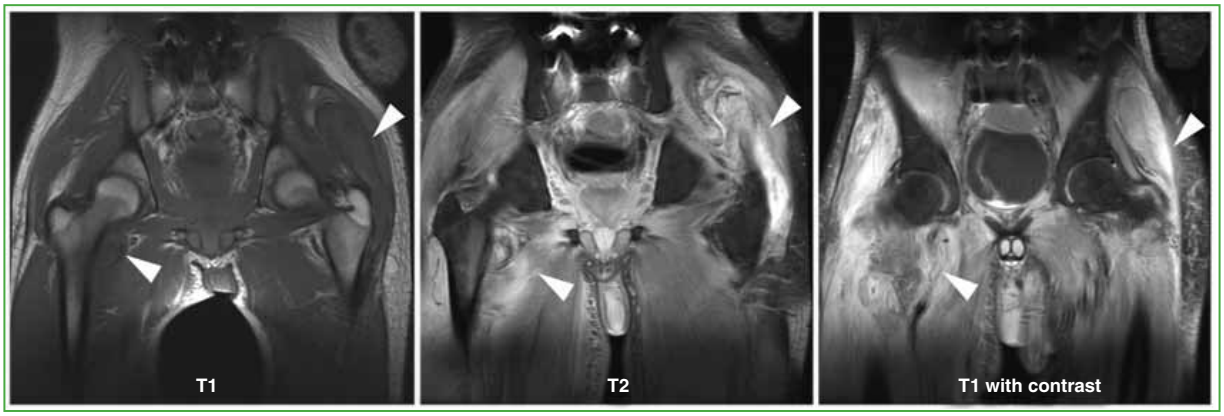

Figure 2. MRI of the pelvis, with contrast medium. In the T1-weighted sequence, low signal images are observed in the right lesser trochanter, with slight post-contrast enhancement. A slight edema was observed in the T2-weighted sequences. In the left gluteal region, the signal in the T1-weighted sequence is intermediate. In the T2-weighted sequence, it is high, with marked enhancement of the contrast medium.

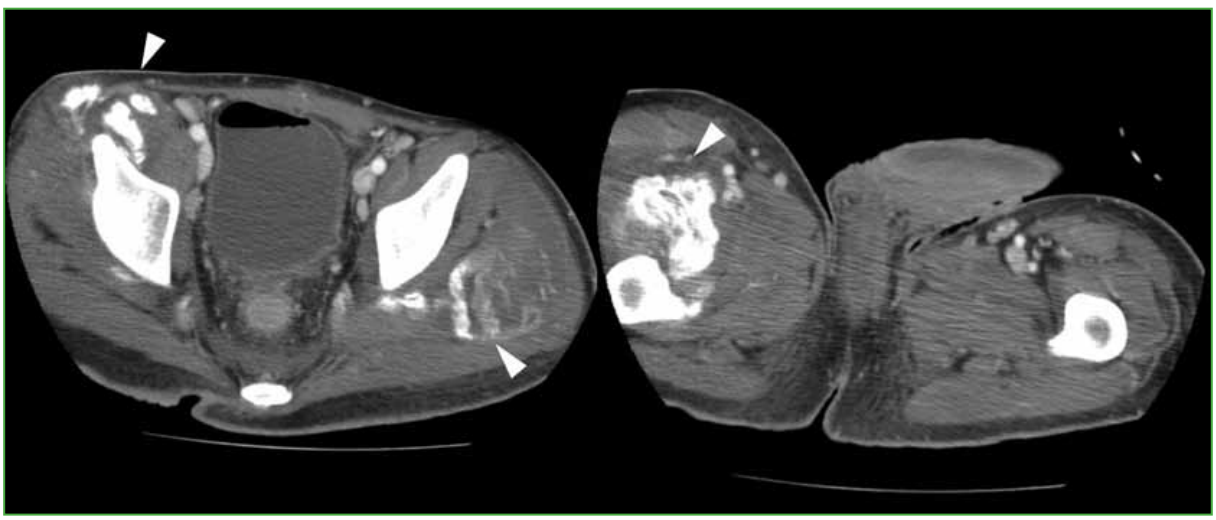

Figure 3. Computed tomography of the pelvis. Mature calcifications in relation to the right iliopsoas muscle and small peripheral calcifications in the left gluteal region.

Tendon Injuries of the Knee Extensor Mechanism: Treatment and Rehabilitation Protocol

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ABSTRACT

Background: The rupture of the extensor mechanism can have its origin at bone or tendon level. Its main cause is patellar fracture, followed by quadriceps tendon rupture, and, finally, patellar tendon rupture. These ruptures can be due to direct or indirect trauma. Tendon ruptures of the extensor mechanism are rare, developing with trauma related to the daily routine, sports, or associated systemic diseases. They represent 3% of all tendon injuries. **Materials and Methods:** We presented 22 tendon ruptures of the knee extensor mechanism, surgically treated between June 2015 and January 2019, from which eight (8) ruptures were of the quadriceps tendon (2 bilateral) and fourteen (14) of the patellar tendon (1 bilateral). The cases were evaluated using the Lysholm score, radiographs, and MRI. **Results:** The minimum follow-up was one (1) year. According to the results of those twenty-two (22) surgeries, thirteen (13) cases had excellent results, seven (7) cases were good and two (2) of them were fair. **Conclusion:** In cases of patellar tendon injury, the primary repair with transosseous suture plus figure-of-eight cerclage as augmentation provides a stable reconstruction, allowing the implementation of an early mobilization post-surgery protocol, thus achieving excellent functional outcomes with low complication levels.

Keywords: Extensor mechanism of the knee; tenorrhaphy; quadriceps; patellar.
Level of Evidence: IV

Lesiones tendinosas del aparato extensor de la rodilla: Protocolo de tratamiento y rehabilitación

RESUMEN

Introducción: La rotura del aparato extensor puede ocurrir a nivel óseo o tendinoso; la principal causa es la fractura de rótula, seguida de la rotura del tendón cuadricipital y la rotura del tendón rotuliano. Estas lesiones pueden deberse a traumas directos o indirectos. La rotura tendinosa del aparato extensor es poco frecuente: representa el 3% de todas las lesiones tendinosas. Se presenta con traumatismos relacionados con la actividad diaria, deportiva o asociada a enfermedades sistémicas. **Materiales y Métodos:** Presentamos una serie de 22 roturas tendinosas del aparato extensor de la rodilla (8 del tendón cuadricipital [2 bilaterales] y 14 del tendón rotuliano [1 bilateral]), tratadas mediante cirugía, entre junio de 2015 y enero de 2019. Todos los pacientes fueron evaluados inicialmente con radiografías y resonancia magnética. Se empleó la escala de Lysholm para la evaluación funcional posquirúrgica. **Resultados:** El seguimiento posquirúrgico fue mínimo de un año (rango 12-24); los resultados fueron excelentes en 13 casos, buenos en 7 casos y regulares en 2 casos. **Conclusión:** La reparación primaria, con sutura transósea de las roturas tendinosas del aparato extensor más cerclaje en 8 como aumento en las lesiones del tendón rotuliano brinda una reconstrucción estable, permite implementar un protocolo posquirúrgico de movilización temprana, y así lograr excelentes resultados funcionales con una tasa baja de complicaciones.

Palabras clave: Aparato extensor de la rodilla; tenorrafia; cuadricipital; rotuliano.
Nivel de Evidencia: IV

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INTRODUCTION

The rupture of the extensor mechanism may be at bone or tendon level;[1] the main cause is the fracture of the patella, secondly, the rupture of the quadriceps tendon and finally the rupture of the patellar tendon.[2,3] These injuries may be due to direct or indirect trauma.[4,5]

Tendon rupture of the extensor mechanism is rare, accounting for 3% of all tendon lesions. It occurs from trauma related to daily- or sports-related activity or systemic disease. Quadriceps tendon injury is observed in people >40 years, with a peak between 60 and 70 years, unlike the patellar tendon injury that is more frequent in individuals <40 years and associated with direct trauma. [1]

Surgery is the gold standard for the treatment of these injuries and its objective is to restore the integrity of the extensor mechanism, reducing the complications associated with this condition, such as loss of range of motion and joint stiffness. [1,6,7]

The aim of this article is to report the outcomes in a series of patients with tendon injuries of the extensor mechanism, treated with tenorrhaphy by transosseous tunneling.

MATERIALS AND METHODS

We present a series of patients with tendon ruptures of the knee extensor mechanism who underwent surgery between June 2015 and January 2019. The inclusion criteria were: patients >18 years of age operated with the transosseous tunneling tenorrhaphy technique. Exclusion criteria were: chronic tendon ruptures (>4 weeks), presence of another associated knee injury, and follow-up <1 year. The series consisted of 20 patients with 22 tendon ruptures of the knee extensor mechanism. Eight had a quadriceps tendon injury (2 bilateral) and 14 had a patellar tendon injury (1 bilateral). The average age of the group with quadriceps tendon rupture was 34 years (range 22-75) and that of the group with patellar tendon injury was, on average, 31 years (range 21-71). Seventeen patients were men and three were women. Thirteen had compromise on the right side and nine on the left.

In all cases, the diagnosis was based on the symptoms, physical examination and radiographs, and was confirmed by magnetic resonance imaging, assessing the discontinuity of the tendon fibers, as well as the location and type of tear (Figure 1).

The results were evaluated using the Lysholm scale, [8] the time elapsed until the return to work was also recorded. The pain was assessed with the Lysholm scale and analog scale. Post-surgical satisfaction was assessed using the Likert scale. [9]

Figure 1. Knee radiograph and magnetic resonance of a patient with a ruptured quadriceps tendon at its insertion in the proximal end of the patella.

Surgical technique

Patellar tendon

Through a longitudinal approach, the distal end of the tear was debrided, as well as the medial and lateral, which made it possible to visualize the extension of the tear and associated retinaculum injuries. The distal end was debrided and the lower pole of the patella was curetted to optimize the healing process. Krackow stitches were placed medially and laterally in the patellar tendon with a Ti-cron™ 5 suture; then three parallel and longitudinal tunnels were created in the patella with a 3.5 mm drill bit, two of the strands were passed through the central tunnel and the other two strands through the medial and lateral, respectively, and knotted over the proximal pole of the patella (Figure 2). Subsequently, a figure-of-eight cerclage with 1.2 mm wire was performed as an augmentation technique and, finally, the retinaculum was repaired using continuous running sutures with Vicryl 1. Once the repair was finished, its resistance was verified by passive flexion up to 90 ° (Figure 3).

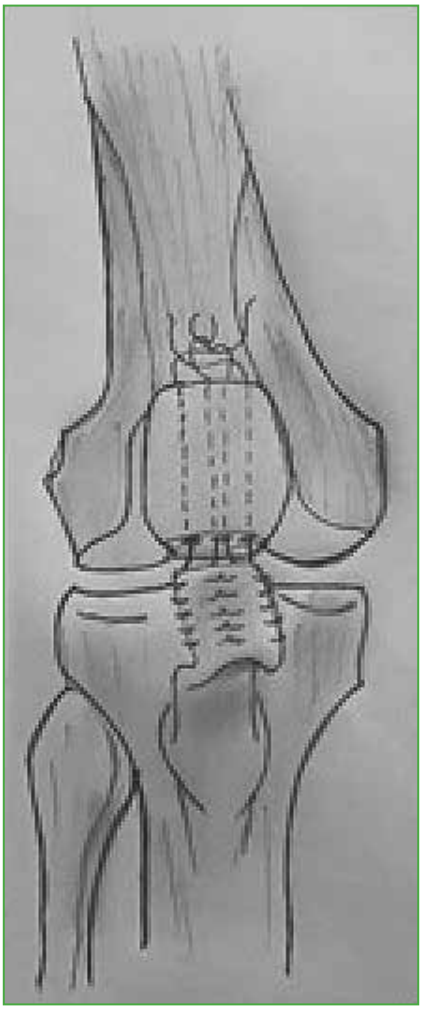

Figure 2. Patellar tendon repair using the transosseous tunnel technique in the patella. The suture (dotted line) passes through three parallel and longitudinal tunnels and is tied over the proximal end of the patella.

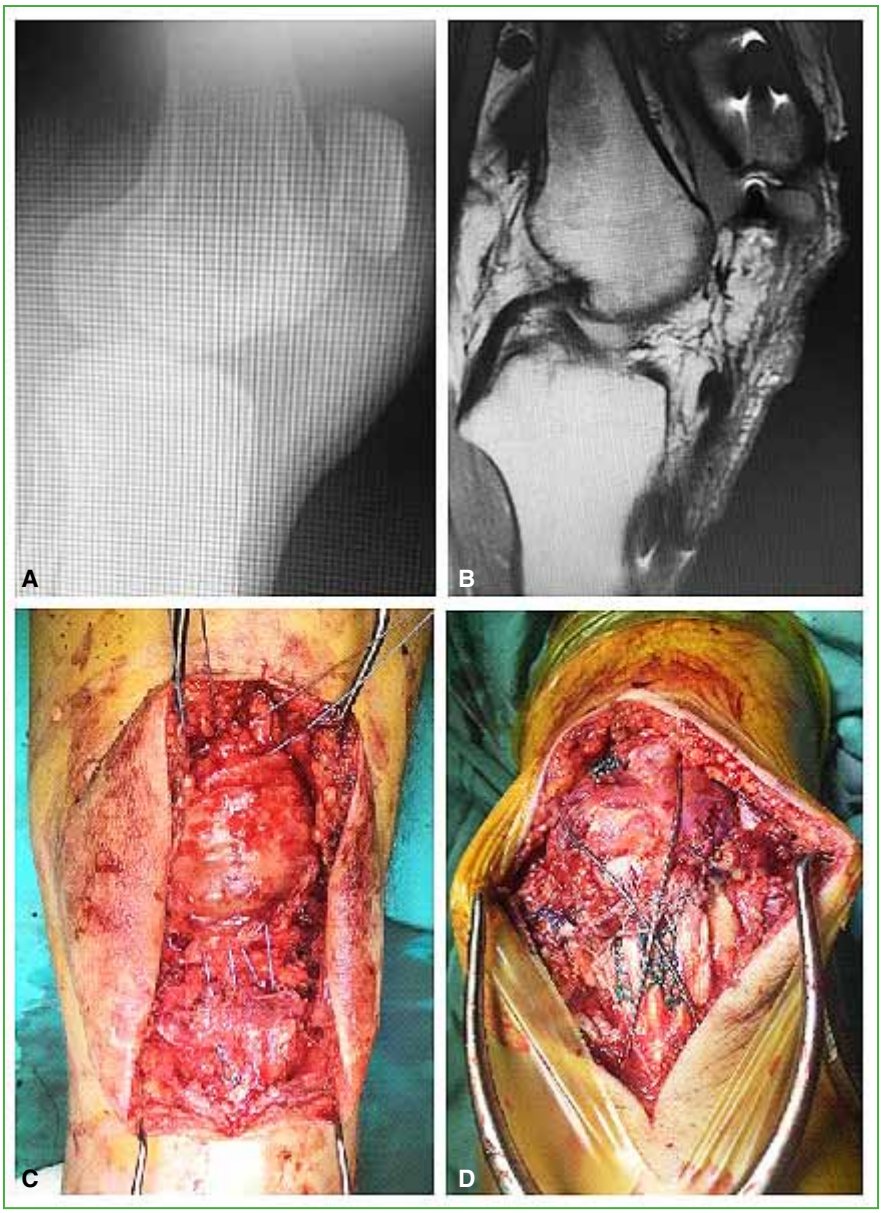

Figure 3. A 43-year-old man with a ruptured patellar tendon, who underwent repair by a transosseous suture in the patella and protection with cerclage. **A.** Lateral knee radiograph showing superior patellar displacement. **B.** Knee MRI, sagittal plane. Note the proximal rupture of the patellar tendon. **C.** Krackow stitches on the tendon and passage of the suture through bone tunnels. **D.** Final assembly with the protective figure-of-eight cerclage wire.

Quadriceps tendon

Through a longitudinal approach, the proximal end of the tear was debrided, as well as the medial and lateral, which made it possible to visualize the extension of the tear and associated retinaculum injuries. Krakow stitches were placed medially and laterally in the quadriceps tendon with a Ti-cron ™ 5 suture. Next, three parallel and longitudinal tunnels were created in the patella with a 3.5 mm drill bit. Two of the strands were passed through the central tunnel and the other two strands medially and laterally, respectively, and knotted over the distal pole of the patella (Figure 4). Finally, the retinaculum was repaired using continuous running stitches with Vicryl 1. Once the repair was completed, its resistance was verified by passive flexion up to 90 ° (Figure 5).

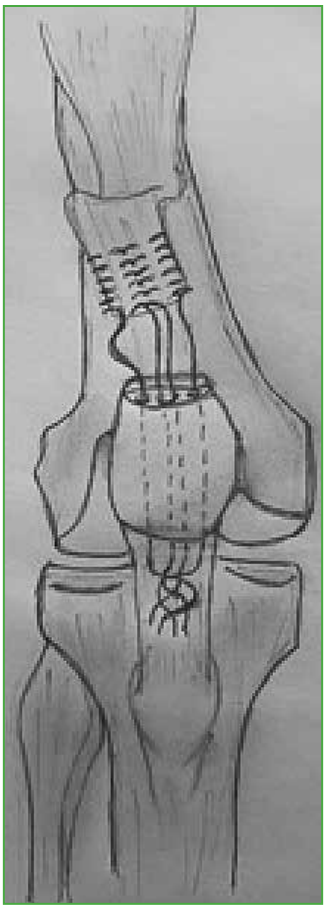

Figure 4. Quadriceps tendon repair using the transosseous tunneling technique in the patella. The suture (dotted line) passes through three parallel and longitudinal tunnels and is tied over the distal end of the patella.

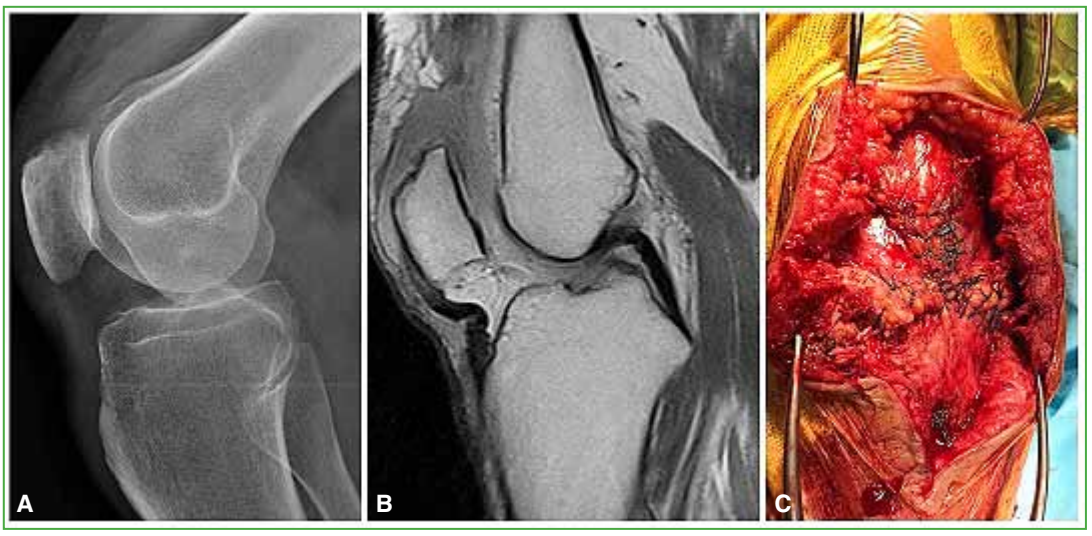

Figure 5. A 74-year-old man with a ruptured quadriceps tendon at its insertion in the patella, who underwent repair by transosseous suture. **A.** Lateral knee radiograph showing inferior patellar displacement. **B.** Knee MRI, sagittal plane. The rupture of the quadriceps tendon is observed at the level of its insertion in the patella. **C.** Immediate postoperative period.

In the immediate postoperative period, a splint was placed in extension and isometric quadriceps contraction exercises were allowed. Weight-bearing with crutches was authorized and the load in extension of the operated limb was accepted. At three weeks, the skin sutures and splint were removed, and active extension and flexion were initiated. A 45° flexion was allowed, gradually increasing to 90° for the first six weeks. In all cases, the protective cerclage was removed at eight weeks, with mobilization of the knee during the same procedure. Then, full range of motion was initiated, authorizing resistance quadriceps strengthening exercises after 12 weeks. Low-impact sports activities were allowed from the fourth month and activities that involved impact or jumping could be resumed after month 9.

FINDINGS

The minimum postoperative follow-up was 12 months (range 12-24); functional evaluation according to the Lysholm method yielded excellent results in 13 patients, good in seven cases and fair in two (Table 1).

Table 1. Outcomes according to the Lysholm method

Outcome	Quadriceps tendon rupture Number of cases	Patellar tendon rupture Number of cases
Excellent	5	8
Fair	2	5
Regular	1	1
Poor	0	0
Total	8	14

When assessing the range of motion of the operated patients, an average range of 0 to 110 ° was found at four months. All returned to their usual activities, on average, within 12 weeks of the injury (Table 2). Only four reported mild pain during sports activity on the analog scale for pain.

Table 2. Ranges of motion and rehabilitation time

Joint range of motion	Quadriceps tendon Number of cases	Patellar tendon Number of cases	Time
45°	8	14	4 weeks
90°	8	14	6 weeks
110°	8	14	12 weeks

One patient (5%) had a superficial infection that was cured with oral antibiotic treatment. One patient required mobilization under anesthesia six weeks after the repair of the quadriceps tendon rupture, because the range of joint motion was 0 to 50°. A flexion of 100° was achieved. 90% of the operated patients reported being satisfied with the results obtained, while 10% expressed dissatisfaction.

DISCUSSION

Tendon rupture of the knee extensor mechanism is a rare injury. The mechanism of injury varies according to age, and the most frequent is the sudden contraction of the quadriceps with the knee in semi-flexion, mainly due to direct trauma in young people and indirect trauma in the elderly. The typical clinical triad consists of pain, functional impairment, and suprapatellar or infrapatellar hiatus. [10,11] Bilateral ruptures of these tendons are even rarer and are associated with systemic diseases—as reported by Rose and Frassica [12] in a systematic literature review—such as systemic lupus erythematosus, chronic kidney disease, rheumatoid arthritis, and primary hyperparathyroidism.

Surgery for knee extensor tendon rupture aims to achieve a stable reconstruction, allowing early rehabilitation. Different techniques have been described, such as end-to-end suture, transosseous suture, and suture with augmentation of peritendinous tissues; the first two are for acute injuries and the last is for chronic injuries.

In a study by Rasul and Fischer [6] with tenodesis of the quadriceps tendon through transosseous points, it was concluded that this technique achieves excellent results, and that age, sex, mechanism and location of the injury do not they have an impact on the long-term outcome. Similarly, Siwek and Rao [1] compared a series of surgical techniques and concluded that tenorrhaphy through transosseous tunnels yielded better results.

It is worth mentioning that, in the national literature, there is only one study, by Costa Paz et al. [13], where tenodesis with suture anchors is proposed for the management of these injuries. These authors point out that it is a valid and effective technique for repairing knee extensor mechanism tears. This technique was proposed by Maniscalco et al. [14] and provides greater stiffness in flexion. However, in a biomechanical study of different surgical techniques for the repair of patellar tendon rupture, Schliemann et al. [15] concluded that the transosseous suture plus augmentation technique, either with cable wire or suture, provides greater firmness and less elongation when subjected to cyclical loads in comparison with a suture-anchor fixation technique.

On the other hand, with regard to rehabilitation, in studies such as that of Benjamin and Kaiser, it was shown that early mobilization is beneficial for tendon healing and also to maintain a healthier joint cartilage and improve joint ranges of motion. They propose to stimulate an early passive flexion from 30 ° to 90 °, starting on the first day after surgery. Meyer and Ricci [5] reported that early repair added to early rehabilitation was effective; the same conclusion was reached by Bhargava et al., [16] who stated that a primary repair plus cerclage and early mobilization provide excellent results in isolated ruptures of the patellar tendon.

We consider that the strengths of our study are the number of patients and the presentation of a surgical technique that has not been published in our country. However, its weaknesses are its retrospective nature and not having a control group undergoing a different surgical repair technique.

CONCLUSION

For the treatment of patellar tendon injuries, the primary repair with transosseous suture of the tendon ruptures of the extensor mechanism and a figure-of-eight cerclage as augmentation provides a stable reconstruction and allow the implementation of an early postoperative mobilization protocol, thus achieving very good functional outcomes with a low rate of complications.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Lateral Unicompartmental Knee Arthroplasty for the Treatment of Lateral Knee Osteoarthritis. Results in 29 Arthroplasties with an Average Follow-up of 6.2 Years

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ABSTRACT

Objective: The purpose of this article is to examine the medium-term functional outcomes and survivorship of lateral unicompartmental knee arthroplasty in the treatment of lateral knee osteoarthritis.**Materials and Methods:** Retrospective report. We selected and analyzed all patients who had undergone a lateral unicompartmental knee arthroplasty for the treatment of lateral knee osteoarthritis between January 1999 and January 2019, with a minimum follow-up of 1 year. The KSS score system 2011, the Kellgren-Lawrence osteoarthritis classification, the Outerbridge femoropatellar chondropathy classification and serial radiographs were used in the evaluation of each patient. The complication and prosthesis survivorship rates were assessed. **Results:** We identified 29 lateral unicompartmental knee arthroplasties in 27 patients with a follow-up of 6.2 years (1-19.5). The clinical and functional KSS improved from 56.5 ± 9.8 to 91.9 ± 5.3 and 33.9 ± 13.7 to 91.4 ± 10.3 respectively (p<0.001). Postoperative maximal flexion improved from 106º ± 6.7º to 124.2º ± 2.4º and flexion contracture improved from 5.2º ± 3.2º to 1º ± 1.6º (p<0.001). The average preoperative alignment was 12.3º ± 4.1º of valgus angulation, which was corrected to 5.2º ± 3.1º of valgus (p<0.001). The survivorship rate was 100% and only one patient showed osteoarthritic changes in the medial compartment (3.4%). **Conclusion:** Lateral unicompartmental knee arthroplasty provides excellent medium-term results. It represents a reliable and definitive option in the treatment of the isolated lateral knee osteoarthritis.

Keywords: Unicompartmental knee arthroplasty; lateral; lateral knee osteoarthritis; knee arthroplasty; unicompartmental replacement.
Level of Evidence: IV

Prótesis unicompartimental lateral de rodilla en el tratamiento del genu valgo artrósico. Resultados en 29 artroplastias con un seguimiento promedio de 6.2 años

RESUMEN

Objetivo: Evaluar, de manera retrospectiva, los resultados funcionales y la supervivencia a mediano plazo de la prótesis unicompartimental lateral de rodilla para tratar el genu valgo artrósico. **Materiales y Métodos:** Estudio observacional retrospectivo. Se analizaron los casos operados con prótesis unicompartimental lateral de rodilla por genu valgo artrósico entre enero de 1999 y enero de 2019, seguimiento mínimo de un año. Se evaluaron los resultados clínicos y funcionales mediante el KSS 2011, el grado de artrosis en el compartimento externo y su progresión en el compartimento contralateral con la clasificación de Kellgren y Lawrence, y la condropatía femorrotuliana mediante la clasificación de Outerbridge modificada. Se determinaron la incidencia de complicaciones y la supervivencia de la prótesis. **Resultados:** Se evaluaron 29 prótesis unicompartimentales laterales de rodilla en 27 pacientes, con un seguimiento promedio de 6.2 años. El KSS clínico y funcional se incrementó de 56,5 ± 9,8 a 91,9 ± 5,3 y de 33,9 ± 13,7 a 91,4 ± 10,3, respectivamente, (p <0,001). La flexión máxima mejoró de 106,6º ± 6,7º a 124,2º ± 2,4º y la

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contractura en flexión, de 5,2º ± 3,2º a 1º ± 1,6º (p <0,001). El eje preoperatorio fue de 12,3º ± 4,1º de valgo, para un posoperatorio de 5,2º ± 3,1º de valgo (p <0,001). La supervivencia de la prótesis fue del 100%, con un caso de progresión artrósica en el compartimento medial (3,4%). **Conclusión:** La prótesis unicompartimental lateral de rodilla representa una alternativa válida y definitiva para tratar la patología artrósica femorotibial externa.

Palabras clave: Prótesis unicompartimental; lateral; genu valgo artrósico; artroplastia de rodilla; reemplazo unicompartimental.
Nivel de Evidencia: IV

INTRODUCTION

Unicompartmental knee arthroplasty (UKA) emerged in the 1970s as a therapeutic alternative in patients with isolated internal or external femorotibial osteoarthritis. [1] Initially, its use was controversial due to unsatisfactory results and high revision rates. [2] However, since the 1980s, several authors, such as Cartier et al. in particular, have widely disseminated its use, perfecting the technique, indications and design of the prosthesis. [3,4] Currently, its use is increasing in a ratio of 3 to 1 with respect to total knee arthroplasty (TKA). [5]

UKA represents an attractive and less invasive alternative, with preservation of bone stock, cartilage, ligament and proprioceptivity, with less operative bleeding, lower risk of infection and lower economic costs in relation to TKA. Other advantages are the greater range of motion obtained postoperatively, the shorter recovery time and sick leave, with a more physiological gait pattern and joint kinematics. [6,7] Furthermore, it is a definitive procedure in the vast majority of cases, with survival rates of over 90% at 10 years. [3,4,8,9]

In 1984, Marmor published the first study focused on the lateral UKA, with excellent results at an average follow-up of 89 months. [10] Isolated external femorotibial osteoarthritis is less frequent than in the internal compartment; it has an incidence of 5-10% of arthritic knees. [11,12] Lateral UKA is 10 times less frequent than medial UKA, representing less than 1% of all arthroplasties. In addition to its lower prevalence, the lateral UKA is technically more demanding and less reproducible, due to the more complex biomechanics of the external compartment. [11,12]

The aim of this study was to evaluate the functional outcomes and the medium-term survival of lateral UKA in the treatment of lateral knee osteoarthritis. We hypothesize that lateral UKA has functional outcomes and survival rates similar to those published in the international literature.

MATERIALS AND METHODS

A retrospective observational study was conducted to evaluate the functional outcomes and medium-term survival of lateral UKA in the treatment of lateral knee osteoarthritis. The cases, which had been operated consecutively by the same surgeon, with the same technique, between January 1999 and January 2019, were analyzed.

The inclusion criteria were: 1) patients with lateral knee osteoarthritis who met the indications for a lateral UKA, 2) age >18 years, 3) follow-up >12 months. The exclusion criteria were: 1) patients with lateral knee osteoarthritis treated with TKA due to not meeting UKA indications, 2) loss of follow-up.

Clinical evaluation

Preoperative data were obtained retrospectively by reviewing the medical records of patients who met the inclusion criteria. The clinical assessment was performed before surgery and at the last postoperative control using the *Knee Society Scoring System* (KSS) 2011 scale. Joint stability was verified using varus-valgus, Lachman, *pivot-shift* and anteroposterior drawer tests, and joint range of motion was evaluated with a goniometer. During the intervention, patellofemoral chondropathy was assessed according to the modified Outerbridge classification as well as the integrity of the anterior (ACL) and posterior cruciate ligaments.

In postoperative follow-up appointments, it was evaluated whether there were both acute (before 3 months) and late complications. Revision was considered to be any new surgical intervention performed on the operated knee, consisting of the removal or replacement of any of the prosthetic components, and reoperation to those with preservation of the components.

Radiographic evaluation

Before surgery, frontal and profile radiographs of both knees with bipedal weight-bearing, axial patella at 30º flexion (Merchant), frontal in 45º semi-flexion (Schuss), and varus and forced valgus radiographs were taken to evaluate the sufficiency of the collateral ligaments, the correction of the misalignment and the impingement of the contralateral compartment (Figure 1). Postoperatively, frontal, profile and axial radiographs of the patella were taken.

The femorotibial axis was measured with a goniometer before and after the operation. The degree of osteoarthritis in the external compartment and the existence of progression in the contralateral compartment were quantified according to the Kellgren and Lawrence scale. The evaluations were carried out by one of the authors who did not intervene in the surgery.

Figure 1. Preoperative right knee radiographs. Kellgren and Lawrence grade 4 lateral knee osteoarthritis with patellofemoral osteoarthritis.

Indications

UKA was indicated due to a clinically and radiographically confirmed symptomatic lateral knee osteoarthritis, localized pain in the external joint interline associated with arthritic changes in the lateral compartment, correctable deformity in varus stress radiographs, with conservation of the joint space in the medial compartment; valgus misalignment of up to 20º, preoperative flexion >90º, preoperative extension deficit <15º and body mass index ≤ 35; clinical ligament sufficiency in the coronal and sagittal planes.

Extended indications: we do not consider symptomatic or asymptomatic arthritic changes at the patellofemoral level, osteophytes or incipient osteoarthritis without clinical repercussion in the medial compartment, degenerative ACL lesion without clinical instability secondary to arthritic progression, nor the age of the patient in the time of surgery as contraindications. Inflammatory arthropathies, such as rheumatoid arthritis, in patients <65 years with inactive disease, under medical treatment and good bone stock, were not considered a contraindication.

Contraindications: lateral knee osteoarthritis with bicompartmental femorotibial involvement, impingement of the medial compartment in knee radiographs with varus stress, valgus misalignments or severe valgus >20º, preoperative flexion <90º, preoperative flexion >15º, body mass index >35, clinical anteroposterior or mediolateral instability, and active systemic arthropathies.

Surgical technique

Patient in dorsal decubitus position under spinal anesthesia. Conventional reduced midline incision and a pure trans-retinacular external parapatellar approach without the involvement of the quadriceps tendon, with a displacement of the patella medially without eversion. The lateral osteophytes of the external femoral condyle that support the femoral component are spared. Resection of anterior tibial, posterior condylar and intercondylar notch osteophytes (notchplasty) to free the ACL, if necessary, and facilitate preoperative flexion recovery.

With regard to the tibial and femoral bone cuts, strict parallelism in extension between the distal femoral cut and the horizontal tibial cut must be achieved in order to achieve correct alignment and centering between both components in gait position. For this, the tibial component must be located as medially as possible, without injuring the insertion of the ACL or the patellar tendon with the cut, which is medialized with a retractor. The femoral component should be hyperlateralized with the knee flexed. In knee flexion, the tibial and femoral components have a divergent orientation, while they align with the extension, due to the femorotibial screwing movement (Figure 2).

A safety laxity of 2-3 mm or forced varus (+ / ++) in flexion of 20-30º should be achieved, in order to avoid overcorrection that leads to deterioration of the contralateral compartment. It is vitally important to preserve the integrity of the lateral collateral ligament and the popliteus tendon, since their injury favors overcorrection of the deformity due to lateral instability. In all cases, a unicompartmental fixed-plate prosthesis was used. Image intensifier was not used.

On the patellofemoral joint, the following surgical gestures are performed on demand: osteophyte resection, cartilaginous shaving, microfractures, patellar external facetectomy or patellofemoral prosthesis. Finally, the subsynovial closure is carried out, leaving the external side open in order to reduce the external patellofemoral hyperpressure and achieve adequate patellar reeling.

Hospital discharge between 24 and 36 h after surgery, with full weight-bearing, isometric quadriceps exercises and oral antithrombotic prophylaxis, for four weeks. Physio-kinesiotherapy from 3-4 weeks and return to normal activities at 6-8 weeks.

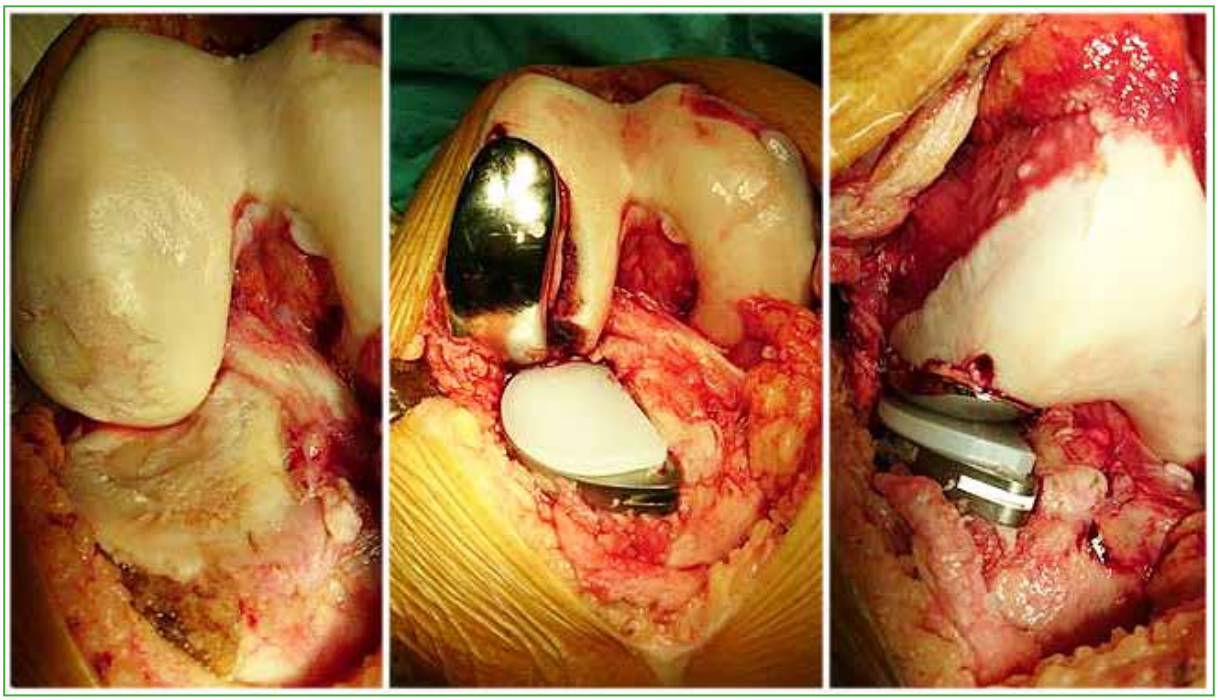

Figure 2. Femorotibial "screwing" phenomenon: divergence of the prosthesis components in flexion and convergence in extension or gait position.

Statistical analysis

The data collected were entered into a Microsoft Excel spreadsheet for subsequent analysis with the R Studio and Tableau Desktop programs. Results were expressed in frequency tables or graphs, as appropriate. Histograms were used for the quantitative variables and the corresponding position measures (average, median and quantiles) and dispersion measures (standard deviation and interquartile range) were calculated. The hypothesis tests were carried out considering a significance level of 5% and the tests used were chosen according to the nature of the data. To compare the characteristics of the individuals before and after treatment, the Wilcoxon rank test was used, in both cases with its adaptation for paired samples. Spearman's nonparametric correlation test was used to study the correlation between variables.

FINDINGS

Of a series of 304 UKAs, 33 were lateral in 31 patients. Four patients were excluded due to death not related to surgery, with loss to follow-up. The sample consisted of 29 lateral UKAs due to lateral knee osteoarthritis in 27 patients, with an average follow-up of 6.2 years (range 1-19.5). In two cases, the procedure was carried out bilaterally and simultaneously in the same surgical stage. Three patients had previous surgeries (arthroscopy). The demographic characteristics are shown in Table 1.

Table 1. Demographic characteristics of the sample

Total of patients Total unicompartmental lateral knee prostheses	27 29
Age (years)	64.3 (range 50- 80)
Body mass index	28.6 (range 25.4- 33.8)
Follow-up (years)	6.2 (range 1- 19.5)
Sex Male Female	 8 (25.9%) 21 (74.1%)
Causes Primary gonarthrosis Osteonecrosis of the external femoral condyle	 28 1

The implants used were: 23 ZUK prostheses (Zimmer®, Warsaw, IN, USA), four Allegretto (Sulzer, Winterthur, Switzerland) and two MG (Zimmer®, Warsaw, IN, USA).

The intraoperative patellofemoral chondropathy according to the modified Outerbridge classification was grade 4 (10 knees), grade 3 (13 knees), and grade 2 (6 knees). In four of the patients with grade 4 chondropathy, who had associated external subluxation and patellofemoral impingement, an external facetectomy was performed. The absence of the ACL was detected in two cases of severe valgus due to the progression of intercondylar osteophytosis, without clinical instability.

Preoperative femorotibial radiographic evaluation: all cases corresponded to stage 4 in the Kellgren and Lawrence classification in the external compartment; two cases of subluxation were observed in the coronal plane. The preoperative axis was 12.3º ± 4.1º valgus, 10 cases of valgus >15º stood out; among them, three severe cases of 20º, reducible in forced varus-valgus maneuvers. Postoperative femorotibial radiographic evaluation: the axis was 5.2º ± 3.1º valgus ($p < 0.001$) (Figure 3). The progression of the osteoarthritic degenerative process was detected in the medial compartment in one patient, who developed grade 2 changes and internal symptoms.

Figure 3. Postoperative right knee radiographs. Correct alignment of the prosthesis and external patellar facetectomy.

The improvement in the KSS was statistically significant in all cases (p <0.001). The clinical KSS increased from 56.5 ± 9.8 before surgery to 91.9 ± 5.3 after surgery and the functional KSS was 33.9 ± 13.7 and 91.4 ± 10.3, respectively. According to the KSS, satisfaction increased from 12.7 ± 4.6 to 38.2 ± 3.6 and expectations went from 12.4 ± 1.4 to 14.9 ± 0.6. A statistically significant improvement was observed in maximum flexion from 106.6º ± 6.7º to 124.1º ± 2.4º (p <0.001) and in flexion contracture from 5.2º ± 3.2º to 1º ± 1. 6th (p <0.001) in the last postoperative control (Table 2).

Table 2. Comparative pre and postoperative results

	Preoperative	Postoperative	P
Clinical KKS	56.5 ± 9.8	91.9 ± 5.3	<0.001
Functional KSS	33.9 ± 13.7	91.4 ± 10.3	<0.001
KSS satisfaction	12.7 ± 4.6	38.2 ± 3.6	<0.001
KSS expectations	12.4 ± 1.4	14.9 ± 0.6	<0.001
Maximum flexion	106.6° ± 6.7°	124.1° ± 2.4°	<0.001
Flexion contracture	5.2° ± 3.2°	1° ± 1.6°	<0.001
Femorotibial axis	12.3° ± 4.1°	5.2° ± 3.1°	<0.001

KSS = Knee Society Score.

The functional results were similar for the unilateral or bilateral procedures and the different implants used (Figure 4). A statistically significant negative correlation was observed between age and postoperative functional KSS (p = 0.04), and between body mass index and postoperative clinical KSS (p = 0.006). No statistically significant relationship was observed between postoperative KSS and degrees of valgus or patellofemoral chondropathy according to Outerbridge (p >0.05).

Survival of the prosthesis was 100% with a follow-up of 6.2 years (range 1-19.5). There was a late complication, with osteoarthritic progression in the internal compartment, 4 years and 6 months after surgery. Before, the patient had undergone an arthroscopic partial meniscectomy by another professional, at 3 years and 6 months after the lateral UKA. Thus, the reoperation rate was 3.4%, with no revisions so far.

Figure 4. A 62-year-old patient with bilateral lateral knee osteoarthritis treated with single-stage bilateral lateral knee unicompartmental arthroplasty, with 7 years of follow-up. Correct alignment of the prosthesis components, with restoration of the primitive valgus and complete function of the knees.

DISCUSSION

The use of medial or lateral UKA in the treatment of unicompartmental knee osteoarthritis has been controversial in past decades, but its use is currently increasing due to the good results reported. [5] Medium-term survival is comparable to that of TKA, while clinical and functional outcomes are superior. [4,6-9,13-15] The lesser frequency of the lateral UKA with respect to the medial UKA (1:10) may be related to the lower incidence of isolated external femorotibial osteoarthritis, as well as the biomechanical characteristics of this compartment, which makes it a more technically demanding procedure. [8,11,12]

Progress in clinical knowledge, surgical technique, and prosthesis design expanded the classic and restrictive indications for UKA, defined by Kozinn and Scott. [15,16] Patellofemoral osteoarthritis, age, obesity, activity level, and LCA integrity are no longer absolute contraindications. [15] In their retrospective study of 1000 medial UKAs, Hamilton et al. found no differences in the failure and reoperation rates between those patients who did or did not meet the classic selection criteria.[16] They reported better functional outcomes in the group where the procedure had been contraindicated, which represented 68% of the sample.[16] In our study, two patients had a degenerative absence of the ACL without preoperative instability; eight, a body mass index between 30 and 35; and 10, grade 4 chondropathy at the patellofemoral level. After the release of the external patellar facet, chondral shaving, microfractures, patelloplasty, and external facetectomy, all reported patellofemoral clinical improvement. Furthermore, after follow-up, 10 patients <60 years did not have signs of prosthesis loosening and only one of them had osteoarthritic progression of the internal compartment. Thus, we consider that a degenerative ACL lesion without clinical instability, a body mass index between 30 and 35, patellofemoral involvement, and age <60 years before surgery do not represent absolute contraindications for lateral UKA.

Our series of 29 knees with a follow-up of 6.2 years showed clinical and functional outcomes according to the KSS that are comparable to those already published (Table 3). Our clinical KSS was 91.9 ± 5.3 and the functional one, 91.4 ± 10.3, as Berend et al. and Lustig et al., and even higher than other reports, such as those by Sah et al. and Argenson et al. [9,13,17,18] Likewise, the satisfaction rate rose to 38.2 ± 3.6, which reveals a high degree of satisfaction. We observed a great improvement in the range of motion, which reached a maximum flexion of 124.1º ± 2.4º, similar to that published by Berend et al., Argenson et al., and Lustig et al. [9,13,17] In our study, the prosthesis survival rate was 100% at the end of follow-up, as reported by Pennington et al., in their series of 29 patients after an average of 12.4 years. [8] In the series by O'Rourke et al., after 25 years of evaluation—the longest published—survival was 72% in 14 lateral UKAs. [14]

Table 3. Comparative outcomes with the published literature

Study	n	Follow-up (years)	Findings	Survival
Marmor [10] (1984)	13	7.4 (range 2.3-9.8)	11 excellent	92.3% (1 review)
Ohdera et al. [19] (2001)	18	8.3 (range 5- 15.7)	89% good and excellent (HSS)	89% (2 reviews)
Ashraf et al. [21] (2002)	83	9 (range 2- 21)	BKS 53.2 preop., 90.1 to 2 years, 83 to 10 years	83% at 10 years, 74.5% at 15 years
Pennington et al. [8] (2006)	29	12.4 (range 3.1-15.6)	100% good and excellent (HSS)	100%
Sah et al. [18] (2007)	48	5.2 (range 2- 15)	KSS, clinical 89 and functional 80	100%
Argenson et al. [9] (2008)	38	12.6 (range 3- 23)	KSS, clinical 88 and functional 78	92% at 10 years and 84% at 16 years
Berend et al. [13] (2012)	100	3.25 (range 2- 6.8)	KSS, clinical 94 and functional 89	97%
Lustig et al. [17] (2014)	46	14.2 (range 10.2- 18)	KSS, clinical 95 and functional 82	94.4% at 10 years and 91.4% at 15 years
Edmiston et al. [20] (2018)	65	6.8 (minimum 2)	Combined KSS 146	94%
Our series (2020)	29	6.2 (range 1- 19.5)	KSS, clinical 92 and functional 91	100%

HSS = Hospital for Special Surgery knee score. BKS = Bristol Knee Score.

The complication rate was 3.4%. There was a late complication that required arthroscopic intervention by another professional at 3 years and 6 months after lateral UKA, with internal partial meniscectomy due to medial symptoms. The last postoperative follow-up showed osteoarthritic progression in the internal compartment, which could be attributed to overcorrection. Thus, the reoperation-free rate was 96.5%. Axis undercorrection is the golden rule to avoid deterioration of the contralateral compartment due to overload during the static and dynamic phase of gait, intending to restoring the primitive axis of the limb. [3,11,12] In our series, similar to that published, the postoperative femorotibial axis was 5.2º ± 3.1º valgus. [17,19]

Osteoarthritic progression in the opposite compartment is rare according to literature reports, in most cases it is asymptomatic. [8,9,20] However, it represents the main cause of prosthetic revision, which can be performed by converting to a TKA or using a medial UKA. [17] According to the literature and our experience in medial UKA revisions, in most cases of conversion to TKA, it can be done relatively easily, and it is necessary to use revision stems and implants in one-third of the cases. [21-23]

Due to the different radius of curvature between both femoral condyles, the *rollback* phenomenon during knee flexion occurs mainly in the external compartment. Numerous biomechanical studies confirmed this external rotation movement of the femur and internal of the tibia during flexion, with subsequent external tibial rotation associated with internal femoral rotation during extension, giving rise to the screw-home mechanism that blocks the knee in extension. [24] This discrepancy in the femoral rollback helps to explain the commonly observed inconsistency in component alignment during flexion, which is corrected in extension or gait position when performing lateral UKA. [12]

Due to the screwing phenomenon, mobile tibial endplate implants are not a valid alternative for the external femorotibial compartment, due to their high rate of dislocation. In their series of 53 lateral UKAs made with Oxford movable-plate prostheses, Gunther et al. reported a prosthesis survival of 82% at 5 years of follow-up, with 11 cases of revision and 10% of dislocation of the polyethylene insert. [25] Consistent with the literature, our series suggests that fixed-plate UKAs can be safely used in the external compartment, with satisfactory and predictable results. [8,9,13]

This study presents the limitations inherent to the observational and retrospective methodology. As for weaknesses, we highlight the relatively small number of patients that make up the sample, which may explain the low frequency of complications. However, we did not find similar national publications and international publications do not, in general, show a large number of patients, so we believe that our analysis can contribute to the literature of our area. Among the strengths, it is important to note that the study population was homogeneous. In addition, all patients were operated on by the same surgical team, with the same type of implant and carried out the same rehabilitation protocol. Studies with a larger sample and a longer follow-up are necessary.

CONCLUSIONS

Lateral UKA represents a valid and definitive alternative in the treatment of external femorotibial osteoarthritis. The conservative nature of the procedure, the quality of the functional outcomes, the rapid recovery and few complications, the best cost-benefit, plus a correct indication and a rigorous surgical technique, make lateral UKA the procedure of choice for a growing number of surgeons. It must be taken into account that it is a technically demanding procedure with a longer learning curve in relation to the medial UKA.

Conflict of interests: Dr. Gabriel Gaggiotti is a Consultant Surgeon for Zimmer Biomet.
The rest of the authors declare they do not have any conflict of interests.

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Is Single-Stage Bilateral Knee Arthroscopy a Safe Option?

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ABSTRACT

Introduction: Single-stage bilateral arthroscopic surgery allows the patient to undergo a single postoperative and rehabilitation period. The aim of this article was to evaluate the functional-clinical outcomes and time to return to work and sports in a series of patients who had undergone single-stage bilateral arthroscopy. **Materials and Methods:** We evaluated a retrospective series of patients who had undergone single-stage bilateral knee arthroscopy from April 2016 to April 2019. Short- and medium-term clinical-functional outcomes, and time to return to work and sports were analyzed. **Results:** The average age of the patients was 41 years (range 18 - 63), with an average follow-up of 18 months (6-37). The average anesthesia time was 105 minutes (range 60 - 170) and the average surgical time was 85 minutes (50 to 150). The average time to return to work was 2 months (range 1-5). Joint range of motion was fully recovered in all patients. **Conclusion:** Although single-stage bilateral arthroscopy has shown good clinical outcomes in selected patients, no relevant comparisons or conclusions can be established due to the low casuistry and the great diversity of the surgeries performed. The main advantage would be in avoiding procedures in two surgical stages, which would imply two operations, twice the anesthesia and two different rehabilitation programs.

Keywords: Bilateral arthroscopy; single-stage arthroscopy; knee arthroscopy.
Level of Evidence: IV

Artroscopia bilateral de rodilla en un solo tiempo quirúrgico, ¿es una opción segura?

RESUMEN

Introducción: La artroscopia bilateral de rodilla en un solo tiempo quirúrgico permite cursar un solo posoperatorio y una única rehabilitación. El objetivo de este estudio fue evaluar los resultados clínico-funcionales y el tiempo hasta el retorno laboral y deportivo en una serie de pacientes sometidos a una artroscopia bilateral en un solo tiempo quirúrgico. **Materiales y Métodos:** Se evaluó a una serie retrospectiva de pacientes desde abril de 2016 hasta abril de 2019, que fueron sometidos a una artroscopia bilateral de rodilla en un solo tiempo quirúrgico. Se analizaron los resultados clínico-funcionales a corto y mediano plazo, y el tiempo para el retorno laboral y deportivo. **Resultados:** La edad promedio fue de 41 años (rango 18-63). El seguimiento promedio fue de 18 meses (rango 6-37). Los tiempos de anestesia y quirúrgico promedio fueron 105 min (rango 60-170) y 85 mi (rango 50-150), respectivamente. El tiempo promedio para el retorno laboral fue de 2 meses (rango 1-5). Todos los pacientes recuperaron el rango completo de movilidad articular. **Conclusión:** Si bien se han obtenido buenos resultados clínicos con la artroscopia bilateral de rodilla en un solo tiempo, en pacientes seleccionados, no se pueden establecer comparaciones ni conclusiones relevantes debido a la baja casuística y a la gran diversidad de las cirugías realizadas. La principal ventaja radicaría en evitar procedimientos en dos tiempos quirúrgicos, lo que implicaría dos operaciones, dos anestesias y dos programas de rehabilitación diferentes.

Palabras clave: Artroscopia bilateral; artroscopia en un tiempo quirúrgico; artroscopia de rodilla.
Nivel de Evidencia: IV

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INTRODUCTION

When a patient requires arthroscopic surgery on both knees, the procedure can be performed in a single surgical stage or planned in two stages. Single-stage bilateral arthroscopy can be performed sequentially, with a single medical team,[1-3] or simultaneously with two different teams.[4,5] This allows the patient to undergo a single postoperative period and a single rehabilitation. In turn, the time to return to work and sports, while depending on the type of surgery, is usually similar to that of surgeries in two different surgical stages.[1,4-6]

Single-stage bilateral procedures involve a lower cost than those that are performed in two stages. In different series, a reduction in costs of between 29% and 64% compared to that of two-stage surgery was reported. This was mainly attributed to surgical and hospitalization charges.[1-3,6]

In none of the reported series was an increased risk of complications between single-stage and two-stage surgeries observed.[1-3,6]

At present, few published articles report on the clinical or return-to-work outcomes following bilateral arthroscopic surgery.

The main aim of this study was to evaluate a number of patients who had undergone single-stage bilateral knee arthroscopy, from a clinical and functional point of view, as well as to analyze the time to return to work and sports.

MATERIALS AND METHODS

A series of cases that included 11 patients who had undergone arthroscopic surgery of both knees in a single surgical time, either sequentially or simultaneously, between April 2016 and April 2019, was retrospectively analyzed. The minimum follow-up was six months.

All procedures were performed in the Orthopedics and Traumatology Service of our hospital. The search was conducted in the institution's electronic medical records database.

The following data were recorded: type of surgical procedure, pre-surgical risk by the classification of the American Society of Anaesthesiologists (ASA),[7] anesthesia time and surgical time.

The pain was evaluated before and after surgery, using the visual analog scale, and the degree of postoperative satisfaction was determined with the Likert scale.[8] The range of motion of the joint was determined by a goniometer in the last appointment. It was considered complete in the range of 0-10º extension and >120º flexion.

The time until the return to work and sports was analyzed. Surgical complications were recorded according to Dindo-Clavien's classification.[7]

Surgical technique

The patient was placed in supine decubitus position. The surgeries were performed under general and locoregional anesthesia. Both lower limbs were placed within the same sterile field. Operations were performed by surgeons specializing in knee arthroscopy. We have a single arthroscopy tower and two surgical teams, so in single-stage arthroscopies, the procedures were performed sequentially. Conversely, in those that included arthroscopy and open surgery, while one of the teams performed arthroscopy on one knee, the other team performed open surgery on the other. The hemostatic cuff (in cases of anterior cruciate ligament surgery) was used only for the arthroscopic stage (Figure).

Surgical procedures are summarized in Table 1. Regarding the plastic of the anterior cruciate ligament, in all cases, a technique involving hamstring grafting, cortical button fixation on the femur and interference screw in the tibia was performed.[8]

Rehabilitation protocols were individualized according to the type of surgery.

Figure. Reconstruction surgery of the anterior cruciate ligament. On the right knee, the arthroscopic stage ended and the graft was fixed. On the left knee, the graft was taken during the arthroscopic stage on the right (in preparation at the surgical table) and the arthroscopic stage was advanced.

FINDINGS

Five women and six men were evaluated, with an average age of 41 years (range 18-63) and an average follow-up of 18 months (range 6-37). The surgical risk was ASA 1 (6 patients), ASA 2 (4 patients) and ASA 3 (1 case). The average anesthesia time was 105 min (range 60-170). The average surgery time was 85 min (range 50-150). Seven procedures were day-case and four required hospitalizations: three anterior cruciate ligaments and one avascular bone necrosis (Tables 1, 2 and 3).

The average pain score on the visual analog scale was 7/10 (range 3/10 to 10/10) before the intervention and 2/10 (range 0/10 to 6/10) afterward. According to Likert's satisfaction scale, nine patients reported being "very satisfied" and two "satisfied" with postoperative results. Faced with the question "would you undergo the same single-stage bilateral procedure?" they all replied that they would.

In the last follow-up appointment, all patients had regained the range of joint motion.

The time until return to work and sports is described in Tables 1 and 2.

In the immediate postoperative period, two minor complications were recorded: one patient with persistent pain and one with hemarthrosis.

DISCUSSION

Regardless of underlying conditions, satisfactory results have been achieved with single-stage bilateral knee arthroscopy.[1-3,6] Larson et al. did not find statistically significant differences for complication rates, instability tests or functional outcomes between patients with bilateral anterior cruciate ligament insufficiency operated in a single stage and those operated on in two stages.[2]

Table 1. Summary of surgical procedur

Patient	Diagnosis	Bilateral arthroscopic treatment	Anesthesia time	Surgical time	Time until return to work (weeks)	Time until return to sport (weeks)
1	Patellar OCL	Microperforations + PRP	60 min	50 min	20	12
2	ACL rupture + IMS	ACL reconstruction + meniscal suture	170 min	140 min	16	32
3	OCL in femoral condyle + IMS	Microperforations + partial meniscectomy	70 min	50 min	12	12
4	OCL in femoral condyle + IMS	Microperforations in femoral condyle + partial meniscectomy	75 min	60 min	8	8
5	ACL rupture + IMS	ACL reconstruction + partial meniscectomy	110 min	75 min	8	32
6	ACL rupture + IMS	ACL reconstruction + partial meniscectomy	150 min	105 min	8	36
7	IMS	Partial meniscectomy	90 min	80 min	1	6
8	Avascular necrosis in femoral condyle	Microperforations in femoral condyle + bone marrow concentrate	85 min	75 min	The patient does not work.	8
9	Trochlea OCL	Mosaicplasty + bone marrow concentrate	165 min	150 min	8	12
10	IMS	Partial meniscectomy	80 min	60 min	3	8
11	Patellar OCL	Mosaicplasty	110 min	90 min	8	12

OCL - osteochondral lesion, ACL - anterior cruciate ligament, IMS - internal meniscal syndrome, PRP - platelet-rich plasma.

Table 2. Average anesthesia and surgical times, and time until return to work and sports.

n = 11	Average	SD	Minimum	Maximum
Anesthesia time (min)	106	± 38.38	63	169
Surgery time (min)	88	± 42.02	49	181
Time until return to work (weeks)	9	± 5.61	1	20
Time until return to sport (weeks)	16	± 11.26	6	36

SD = Standard Deviation

Knee arthroscopy does not usually require hospitalization; however, in single-stage bilateral proceedings, there is no clear consensus.[2,3,9,10] Some authors recommend a hospital stay of at least one day, due to the difficulty to walk and lower range of motion of these patients,[2,3,9]whereas others prefer day-case management.[3,10] In our series, patients undergoing bilateral anterior cruciate ligament reconstruction were hospitalized due to the regional block of both lower limbs. The remaining patient was hospitalized due to the high surgical risk (ASA3) from his history of pulmonary transplantation. The rest of the surgeries were day-case, as they were performed under local and general anesthesia.

Table 3. Number of day-case and inpatient surgeries, and ASA score

Type of intervention	Total
Day-case	7
Inpatient	4
	n = 11
ASA score	
1	6
2	4
3	1
	n = 11

An important factor to consider when performing a single-stage bilateral arthroscopy is the understanding and desire of the patient, as this is of paramount importance for good evolution and rehabilitation. Lack of conviction can be a limiting factor in performing single-stage bilateral arthroscopy.[4,5]

The return to work and sports after a simple arthroscopy depends not only on the initial diagnosis and the type of treatment proposed, but also on intraoperative factors, such as the treatment of joint cartilage, the need for osteotomies or ligament reconstructions, which could even extend the time return to work to more than three months. In the series published by Jari et al.,[1] no significant differences were found in time until return to work between patients who had undergone single-stage surgery and those with surgeries in more than one stage.

Table 4, compares the average time to return to work and sports based on the type of surgery when it is unilateral or bilateral. While lapses may be slightly larger when operating both knees in a single stage, the patient does not require a second procedure, although the time until return to work and sport would be longer. The advantage of operating both knees in a single stage lies in having a single postoperative period.

While the period until return to work was similar to that of other published series,[1,4] we should emphasize that it depends to a large extent on the type of intervention and the type of activity each patient engages in.

The published complication rate for single-stage simple and bilateral arthroscopies are similar, between 1% and 6%. The most common complications in bilateral surgeries are pain and hemarthrosis,[9-12] which coincides with the two complications observed in our series.

Table 4. Comparison of the average time to return to work and sports in single-stage unilateral and bilateral surgeries, according to each pathology, expressed in weeks.

	Unilateral		Bilateral	
	Return to work	**Return to sport**	**Return to work**	**Return to sport**
Plastic of anterior cruciate ligament	8	32	11	32
Partial meniscectomy	2	6	2	7
Mosaicplasty	7	12	8	12
Microperforations	5	8	10	9

Several publications indicate that single-stage bilateral arthroscopy represents a lower hospital cost.[2,6,13] In the series published by Sajovic et al., which compares the costs of single-stage and two-stage bilateral reconstruction of the anterior cruciate ligament, the total savings are 2925 euros.[6] In their retrospective series, Larson et al. reported savings of more than US$3750 and attribute the higher percentage of this figure to day-case surgery and the possibility of a single postoperative rehabilitation.[2]

At our institution, the costs of operating room inputs, as well as surgical, rehabilitation and hospitalization time for bilateral knee arthroscopy, were compared, and the amount saved for the healthcare system was US$750.[13]

The main limitation of our study is that, as this is a series of retrospective cases, without a control group, with great heterogeneity in surgical procedures and a low casuistic, it is not possible to establish relevant comparisons or conclusions. However, it reports on the safety and outcomes of single-stage bilateral knee arthroscopy, a subject with few reports in the international literature and without publications in the national literature.

CONCLUSIONS

While single-stage bilateral knee arthroscopy has achieved good outcomes from a clinical point of view and is a cost-effective procedure in selected patients, no relevant comparisons or conclusions can be established due to low casuistics and the great diversity of surgeries performed in this study. The main advantage would lie in avoiding two-stage procedures, which would involve two surgeries, twice the amount of anesthesia and two different rehabilitation programs.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Supracondylar Subtraction Wedge Osteotomy for the Treatment of Adult Cubitus Valgus

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ABSTRACT

Objective: to report the results of a series of adult patients with a valgus malunion of the elbow treated with a supracondylar subtractive monoplanar wedge osteotomy. **Materials and methods:** 5 patients were included. The surgical technique consisted of a posterior paratricipital approach, with resection of a subtractive wedge and the anterior transposition of the ulnar nerve. The average follow-up was 17 months. **Results:** 4 patients were men and 1 was a woman with an average age of 27 years. The preoperative range of motion was 138°-7° and the postoperative range of motion was 138-6°. Pain according to VAS was 4 and 1, MEPS was 71 and 97, and DASH 6 was 26 and 8, respectively. The preoperative radiological evaluation showed an average valgus of 30º with a contralateral valgus of 11°. The final valgus obtained was 13º. The final correction was, on average, 2° less than the contralateral side. All osteotomies healed and the medial prominence was on average 32% more than before surgery. According to the Oppenheim scale, the results were excellent in 4 patients and good in 1. Personal satisfaction was, on average, 8.6. **Conclusions:** Supracondylar subtractive wedge osteotomy is a good option for the treatment of adult cubitus valgus, with a recovery of angular values similar to the contralateral side and a high satisfaction rate. As it is a simpler technique, compared to the multiplanar osteotomies, it is our treatment of choice for adult cubitus valgus.

Keywords: Cubitus valgus; osteotomy; subtractive wedge; malunion; supracondylar humeral fracture.

Level of Evidence: IV

Osteotomía en cuña sustractiva supracondílea para el tratamiento del codo valgo del adulto

RESUMEN

Objetivo: Comunicar los resultados de una serie de adultos con consolidaciones en valgo del codo tratados con una osteotomía en cuña sustractiva monoplanar. **Materiales y Métodos:** Se incluyeron 5 pacientes. Se describe la técnica quirúrgica que consistió en un abordaje posterior paratricipital, resección en cuña sustractiva y transposición anterior del nervio cubital. El seguimiento promedio fue de 17 meses. **Resultados:** Se trató a 4 hombres y una mujer, con una edad promedio de 27 años. La movilidad preoperatoria promedio fue de 138°-7° y la posoperatoria, de 138-6°, el puntaje de dolor en la EAV fue de 4 y 1, el MEPS de 71 y 97, y el DASH de 26 y 8, respectivamente. La evaluación radiográfica preoperatoria arrojó un valgo promedio de 30° con un valgo contralateral de 11º. La corrección radiográfica demostró un valgo de 13°. Se obtuvo una corrección promedio de 2° menos que del otro lado. Todas las osteotomías consolidaron, y la medición de la prominencia medial fue, en promedio, un 32% mayor que en el preoperatorio. Según la escala de Oppenheim, el resultado fue excelente en 4 pacientes y bueno en uno. La satisfacción personal fue, en promedio, de 8,6. **Conclusiones:** La osteotomía en cuña sustractiva para tratar un codo valgo es una buena opción terapéutica, con recuperación de valores angulares comparables con el lado contralateral, y alta tasa de satisfacción de los pacientes. Como es una técnica menos compleja que las osteotomías multiplanares, es nuestra elección ante una consolidación viciosa en valgo del codo del adulto.

Palabras clave: Codo valgo; osteotomía; cuña sustractiva; consolidación viciosa; fractura supracondílea de codo.

Nivel de Evidencia: IV

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INTRODUCTION

Angular deformities of the elbow are common complications of supracondylar fractures in children. These alter joint orientation in a mono or multiplanar manner.[1] Cubitus varus is the most frequent complication, it has an average incidence of 30% (range 0-60%).[2-4]In contrast, cubitus valgus, caused by a nonunion of the lateral humeral condyle or premature physeal closure, is rare.[5]

This valgus deformity rarely compromises the function of the elbow, it presents as an aesthetic alteration. In many cases, it goes unnoticed, because it implies an increase in the physiological position of the elbow. However, there may be medial instability and irritation of the ulnar nerve induced by its stretching in complex cases.[3]

There are different types of osteotomies for the treatment of the cubitus valgus.[6-8] However, there is no consensus on which one achieves the best final outcome. Therefore, the choice of the surgical technique depends on the surgeon's preference.

Monoplanar osteotomy is a controversial procedure because it does not allow a multiplanar correction that often accompanies valgus deformity.

The objective of this study is to report the results of a series of adult patients with valgus consolidations of the elbow treated with a monoplanar subtractive wedge varizing osteotomy.

MATERIALS AND METHODS

A retrospective observational study was designed that included all patients who had undergone a corrective elbow osteotomy to correct a deformity, at our institution, between 2007 and 2019. 10 patients were identified. The inclusion criteria were: patients >18 years of age (skeletally mature), with vicious consolidations of the distal humerus with pathological valgus deviation (> 20º),[7] treated with a medial subtractive wedge varizing osteotomy, with complete pre and postoperative radiological studies and a follow-up >1 year.

The final group encompassed five patients. The remaining five were excluded because they had varus consolidations (3 cases) and their age was <18 years (2 cases).

All preoperative and postoperative evaluations were carried out by one of the authors (GG).

The radiographic evaluation was performed in the regular anteroposterior and profile elbow views of both upper extremities, and they were analyzed comparatively.

To measure the deformity, the humerus-elbow-wrist angle[8] was used in the anteroposterior projection with the elbow extended and in maximum supination, drawing two transverse lines perpendicular to the humeral axis (one proximal and one distal) and two lines perpendicular to the axis of the forearm (one proximal and one distal). Then a line was drawn perpendicular to the midpoint of the humeral lines and another connecting the midpoint of the forearm lines. The intersection between these two lines forms the humerus-elbow-wrist angle. The necessary correction angle was determined using the healthy contralateral side as a guiding parameter.

Medial prominence was measured with the Wohn scale[9] (Figure 1).

Four patients had a history of a supracondylar fracture in childhood. One (Case 3) had suffered a posterolateral dislocation of the elbow at the age of 11 and, three years before our surgery, suffered a new trauma with dislocation. From that moment on, he had multiple episodes of subluxation.

Two patients had a nonunion of the humeral condyle due to a type 2 fracture of the Milch classification.[10] Two patients had paresthesias in the ulnar territory and one (Case 1) had undergone a tendon transfer due to ulnar paralysis and anterior nerve transposition.

All were operated on by the same surgeon (GG).

Surgical technique

The patients were placed in the prone position with the arm resting on a radiolucent surgical table. A posterior approach was performed and the ulnar nerve was identified and transposed anteriorly and in the subcutaneous plane in four of the five cases. The remaining patient was the one who had already undergone surgery. In the osteotomy surgery, the nerve was only identified, no surgical gesture was performed on it.

The paratricipital approach was used in all cases. The wedge to be resected had been previously measured and made in a plastic template and, with it, the osteotomy was performed. Previously, a hole had been created in the apex of the wedge 2 mm from the external cortex of the humerus to try to make the osteotomy incomplete and facilitate compression. It was temporarily fixed with two 2 mm Steinmann nails and then definitive osteosynthesis was carried out with two locking plates.

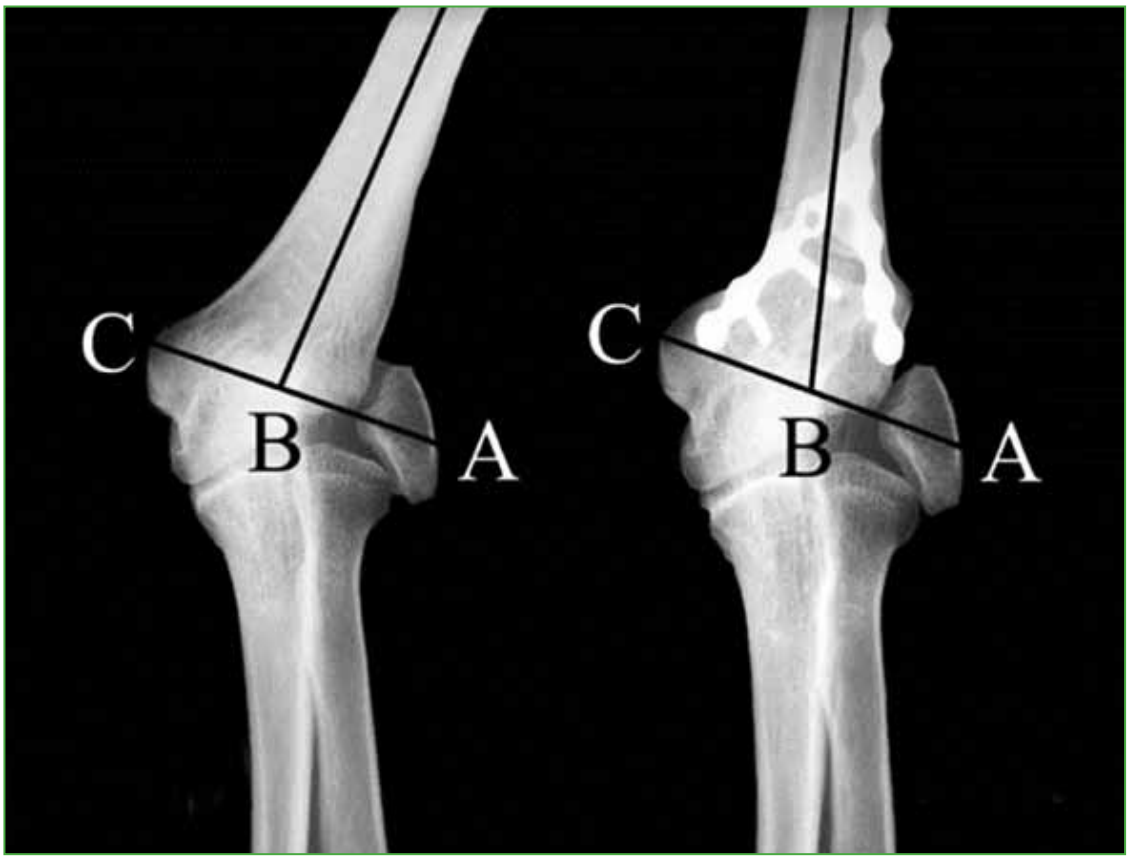

Figure 1. Medial prominence index measurement (%) = (CB - BA)/CA × 100.

One of the patients had posterolateral elbow instability so the distal approach was prolonged and, through the interval between the anconeus and the posterior ulna, the joint capsule was accessed and reconstruction of the lateral ligament was carried out with a triceps slice.

The closure was performed with a drain in all cases and postoperative immobilization was carried out with a plaster cast at 90° for one week. In the case of ligament reconstruction, immobilization lasted for six weeks.

The final clinical evaluation consisted of an objective examination measuring the range of motion with a goniometer and a subjective one using the DASH (*Disabilities of the Arm, Shoulder and Elbow*),[11] MEPS (*Mayo Elbow Performance Score*)[12] and visual analog scale (VAS) scores for pain in activity and patient satisfaction.

To analyze the clinical outcomes of the correction of the deformity, the Oppenheim criteria scale[13] was used, based on the measurement of the humerus-elbow-wrist angle, the active range of motion and the presence of complications. The result is considered excellent if the humerus-elbow-wrist angle correction has a difference <5º with respect to the contralateral side, the loss of range of motion is <5º and there are no complications; good if the difference of the humerus-elbow-wrist angle is 6º to 10º and the loss of the range of mobility is <6º-10º with respect to the contralateral elbow, accompanied by slight deformity, and poor if the difference is> 10º and the loss of the range of mobility is> 10º in relation to the contralateral elbow.

The average follow-up was 19 months (range 12–37).

FINDINGS

The group consisted of four men and one woman, with an average age of 27 years (range 18-42) (Table 1). The right side was affected in four cases and the dominant limb in another four. The average preoperative range of motion was 138-7 ° whereas the postoperative one was 138-6 °, the pain score according to the VAS was 4 and 1, the MEPS score was 71 and 97, and the DASH was 26 and 8. respectively (Table 2).

In two patients with ulnar paresthesias, the symptoms reappeared.

Table 1. Demographic data

Patient	Age	Sex	Associated lesions	Valgus (°)	Valgus Contralateral (°)	Resected Wedge (°)	Final valgus (°)	Correction (°)	Medial prominence			Follow-up (months)
									Preop.	Postop.	%	
1	23	M	Pseudocondyle	29	6	23	8	-2	22	34	54	37
2	42	M	No	34	15	19	19	-4	52	59	13	16
3	20	F	Posterolateral instability	40	20	20	20	0	46	54	17	12
4	18	M	No	22	5	17	6	-1	50	61	22	13
5	34	M	Pseudocondyle	25	8	17	11	-3	24	37	54	18
Average	27			30	11	19	13	-2	39	50	32	19

M = male, F = female.

Table 2. Findings

Patient	Flexion-extension (°)		MEPS		DASH		Pain		Satisfaction	Oppenheimen scale	Complications
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.			
1	145-0	145-5	65	100	24	2	5	0	9	Good	Ulnar neuritis and implant extraction
2	135-10	135-10	70	100	34	5	5	1	9	Excellent	No
3	135-0	135-0	65	85	34	13	5	2	9	Excellent	No
4	140-10	140-10	85	100	9	6	2	1	8	Excellent	No
5	135-15	135-5	70	100	27	12	3	1	8	Excellent	No
Average	138-7	138-6	71	97	26	8	4	1	8.6%		

MEPS = *Mayo Elbow Performance Score, DASH = Disabilities of the Arm, Shoulder and Elbow.*

The preoperative radiographic evaluation showed an average valgus of 30º (range 22-40 °), with a contralateral valgus of 11º (range 5-20 °). Radiographic correction showed a valgus of 13º. Therefore, the correction obtained was, on average, 2° less than on the contralateral side. All osteotomies healed and the medial prominence measurement was, on average, 32% (range 13-54%) higher than preoperatively (Figures 2 and 3).

According to the Oppenheim scale, the results were excellent (4 cases) and good (1 case). Personal satisfaction with the outcome was, on average, 8.6 (range 8-9).

Figure 2. A. Patient with cubitus valgus (Case 1). **B and C.** Anteroposterior and lateral radiograph of the elbow, showing humeral condyle nonunion and a valgus deviation of 29°. **D.** Paratricipital approach. **E.** Subtraction wedge osteotomy. **F.** Osteotomy osteosynthesis. **G.** Radiograph showing an 8° postoperative valgus. **H-J.** Final range of motion.

Figure 3. **A.** Patient with valgus deviation (Case 4). **B.** Intraoperative image of the subtraction wedge. **C.** Final range of motion.

DISCUSSION

We reported the results of monoplanar wedge osteotomy for the treatment of elbow valgus and have obtained good functional outcomes. This type of osteotomy is widely criticized in the literature, because the deformity is often multiplanar, which is why, for many authors, so should be its correction. The osteotomy that we present is monoplanar, and it would not allow correction in all planes.[6,7,14,15] Weaknesses of this osteotomy include: that it does not allow a rotary correction, it provides less stability because it is a linear osteotomy, and it increases medial prominence, since it does not allow the translation of the distal fragment.

The three most frequently published osteotomies are the closing wedge, the step-cut "V", and the dome-shaped. The step cut osteotomy has some advantages, such as providing intrinsic stability from the V-shape of the cuts and allowing multiplanar correction. Kin et al.[8] published the results of 13 patients treated with this technique. They achieved good angular correction, with an average final valgus of 9.1º and an improvement in medial prominence. However, four patients required an additional osteotomy to correct a flexion contracture.

The dome-shaped osteotomy is less complex than the previous one, but the correction, in our opinion, is less precise than with the resection of a wedge. Hahn et al.[8] reported 13 patients who underwent this osteotomy, with a valgus correction from 24º to 11º, with improvement in functional clinical scores and medial prominence.

Although these types of osteotomies would have the advantage of multiplanar correction, no published studies compare the results with monoplanar osteotomies. In our series, the increase in medial prominence was 32%. Although this is one of the criticisms of this technique, the clinical satisfaction of the patients has been high and none reported discomfort regarding this point.

Therefore, we consider that, except in exceptional cases, such as with a very marked deformity in other planes, in addition to the coronal one, monoplanar correction allows achieving similar results to those of other multiplanar techniques and with a simpler technique.

Humeral condyle nonunions were not treated because they were not symptomatic. Although some authors recommend osteosynthesis for nonunions,[14,16]others have obtained good results without surgical treatment.[17]

This study has many limitations. First of all, its retrospective nature. Second, the series consisted of a small number of patients with limited follow-up. Third, the final functional evaluation was done by the surgeon in charge. However, this type of deformity is a poorly reported condition in our literature and vindicates this often-criticized type of osteotomy.

The subtractive wedge varizing osteotomy for the treatment of adult cubitus valgus is a good therapeutic option, the angular values achieved are comparable with those of the contralateral side, and the patient satisfaction rate is high. As it is a less complex technique than multiplanar osteotomy, it emerges as our choice when faced with a valgus malunion of the elbow.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Traumatic Acute Spinal Cord Injury Associated with Ossification of the Cervical Posterior Longitudinal Ligament without Tomographic Evidence of Bone Trauma. Case Series and Literature Review

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ABSTRACT

Objectives: to present a case series of traumatic acute spinal cord injury associated with ossification of the cervical posterior longitudinal ligament (OPLL) without tomographic evidence of bone trauma and to perform a narrative review of the literature on its treatment and postoperative prognosis. **Materials and methods:** We described a case series of patients with traumatic spinal cord injury and association of cervical OLLP, treated by our team during the period January 2012 - December 2019. We excluded patients with an association of vertebral fractures and/or dislocations, and those referred to another center before treatment and with incomplete records. Additionally, a narrative review of the literature on postoperative treatment and prognosis of this association was carried out. Ten articles were obtained with our search strategy for the narrative review. **Results:** A sample of 5 cases was formed, all males, with an average age of 62.2 (+/- 9.36), 4 cases were surgically treated by a posterior approach and 1 case was conservatively treated. **Conclusion:** we presented a case series of a rare association in our region, preceded only by an isolated case report. The review of the current literature suggests timely surgical treatment over conservative treatment, but controversies persist in this regard.

Keywords: Ossification; posterior longitudinal ligament; spinal cord injury; cervical trauma.
Level of Evidence: IV

Trauma medular cervical en pacientes con osificación del ligamento longitudinal posterior sin evidencia de fractura. Serie de casos y revisión bibliográfica

RESUMEN

Objetivos: Presentar una serie de casos de lesión medular aguda traumática asociada a osificación del ligamento longitudinal posterior cervical sin evidencia tomográfica de trauma óseo y realizar una revisión narrativa de la bibliografía sobre su tratamiento y pronóstico posoperatorio. **Materiales y Métodos:** Descripción de una serie de pacientes con lesión medular aguda traumática y osificación del ligamento longitudinal posterior cervical, tratados por nuestro equipo, entre enero de 2012 y diciembre de 2019. Se excluyó a pacientes con fracturas o luxaciones vertebrales asociadas, aquellos derivados a otro centro antes del tratamiento y con registros incompletos. Además, se llevó a cabo una revisión narrativa de la bibliografía sobre el tratamiento y el pronóstico posoperatorio de esta asociación en la última década. Con nuestra estrategia de búsqueda, se obtuvieron 10 artículos, a partir de los cuales se desarrolló la revisión narrativa. **Resultados:** Se conformó una muestra de 5 casos, todos hombres, con una edad promedio de 62.2 años (DE ± 9,36), 4 pacientes fueron operados por vía posterior y uno recibió tratamiento conservador. **Conclusión:** La lesión medular aguda traumática asociada a osificación del ligamento longitudinal posterior cervical es infrecuente en países no asiáticos, precedida, en nuestra región, por un reporte de caso aislado. La revisión de la bibliografía actual sugiere al tratamiento quirúrgico oportuno por sobre el tratamiento conservador, pero persisten las controversias al respecto.

Palabras clave: Osificación; ligamento longitudinal posterior; lesión medular aguda; trauma.
Nivel de Evidencia: IV

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INTRODUCTION

Traumatic spinal cord injury still represents a challenge in the care of polytraumatized patients due to the controversies associated with diagnostic-therapeutic aspects and because, once established, it constitutes a "devastating" injury with great morbidity and mortality and socioeconomic impact.[1,2]

We know that a timely diagnostic evaluation conditions the therapeutic opportunity, in which the finding of unstable vertebral fractures or elements that compress the neuraxis alerts the team of spinal surgeons to the possibility of operating to release neurological elements and to perform reduction and stabilization of spinal injuries.[3]

Within the spectrum of traumatic spinal cord injuries in adults, there are those without evidence of fracture or vertebral dislocation on radiographs and tomography, called SCIWORA, SCIWOCTET or SCIWORET.[4-9] The term SCIWORA is an acronym for Spinal Cord Injury Without Radiological Abnormality and it was coined in 1982 by Pang in pediatric patients evaluated with radiographs and defines traumatic spinal cord injury without radiographic or tomographic evidence of bone injury.[4,5] Computed tomography and magnetic resonance imaging (MRI) evidenced, in adult patients, the association of non-traumatic injuries linked to the injury mechanism (ligament calcification, degenerative changes, central disc herniation, spinal canal stenosis), suggesting that the acronym SCIWORA was a "misnomer".[6,7] In fact, authors with similar considerations proposed alternative terms, such as SCIWOCTET (*Spinal Cord Injury Without CT Evidence of Trauma*) and SCIWORET (*Spinal Cord Injury Without Radiographic Evidence of Trauma*).[8,9]

The ossification of the posterior longitudinal ligament (OPLL) is a pathological process of lamellar bone deposition in the aforementioned structure.[10] It has a high prevalence in Asian countries, affecting 2% of the Japanese, and represents one of the main causes of narrow cervical canal. For this reason, the publications on acute traumatic spinal cord injury complicated by OPLL are mostly of Asian origin.[11-21]

According to our literature search in journals indexed in national and international biomedical databases, we found a single reported case of Hispanic-American origin.[22] Consequently, we consider our contribution a relevant experience in the treatment of this serious injury in a non-Asian country.

Our objective is to present a series of cases of cervical spinal cord trauma associated with OPLL without tomographic signs of vertebral fractures and dislocations.

The secondary objective is to carry out a narrative review of the literature on the treatment and postoperative prognosis of this group of patients.

MATERIALS AND METHODS

Case series

We conducted a descriptive study of a series of cases of cervical spinal trauma associated with OPLL, treated by the same surgical team, in two centers: a hospital of the public health system of the Autonomous City of Buenos Aires and a referral center of the same area. The study lasted from January 2012 to December 2019.

As inclusion criteria, we considered patients with acute traumatic spinal cord injury observable on MRI and tomographic evidence of calcification of the posterior vertebral common ligament closely related to the affected spinal area. Patients with evidence of vertebral fractures or dislocations, those referred to another center after the primary revision, and those with incomplete medical records were excluded.

The following study variables were described: age, sex, comorbidities, traumatic history, preoperative time (> 72 h or <72 h), initial neurological status according to the American Spinal Injury Association (ASIA) scale,[23] type of OPLL according to the morphological classification: (A) continuous, (B) segmental, (C) combined, and (D) limited to the disc space (Figure 1),[24]extent of myelopathy according to cervical levels (hyperintense image in MRI T2-weighted sequence), treatment performed (surgical or conservative), type of surgery (technique and approach), post-therapeutic neurological evolution (stable, neurological improvement or deterioration) and complications (related to trauma and intervention).

In the description, the individual data, their respective summary and dispersion measures were included. The average and standard deviation were considered for the numerical variables, and the absolute value and the percentage for the nominal ones.

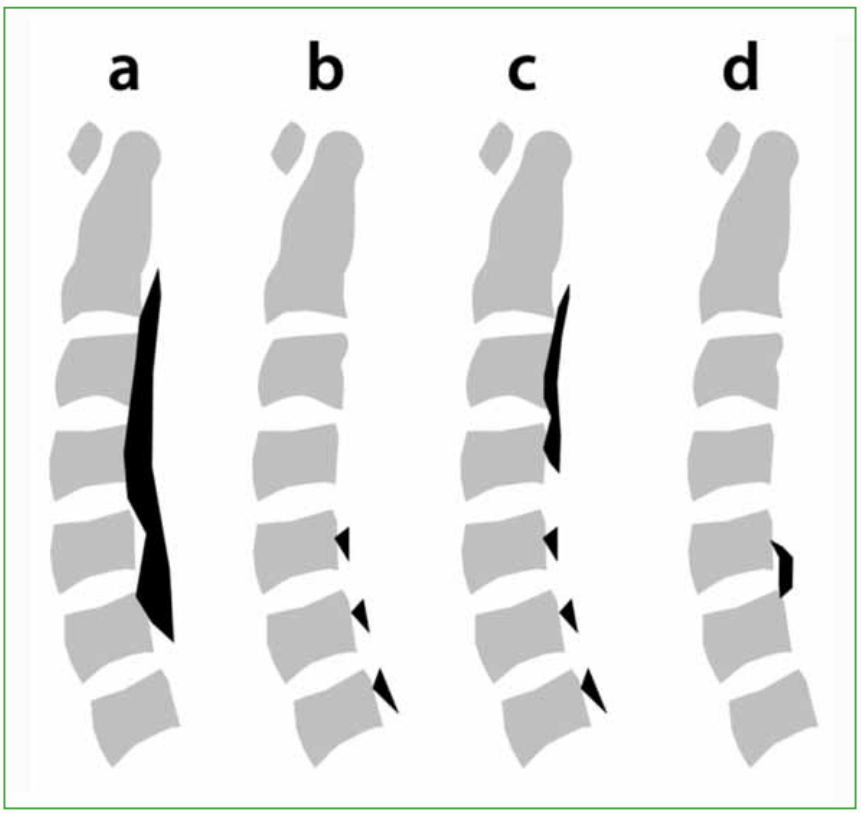

Figure 1. Morphological classification of the ossification of the posterior longitudinal ligament into 4 types: type A or continuous (extended along several vertebrae), type B or segmental (areas of segmented ossification in the posterior wall of the vertebral body), type C or mixed (combination of continuous and segmented) and type D (limited to the disc space).

Narrative review of the literature on the treatment and postoperative prognosis of acute spinal cord injury complicated by OPLL

A literature review was carried out in the main biomedical databases MEDLINE, EMBASE, LILACS, Cochrane Library through the PubMed search engines, VHL portal and Google Scholar, considering articles published between January 2010 and September 2020, using the following keywords and search strategies:

- Strategy 1: ((((“cord injury”) AND (“ossification of the posterior longitudinal ligament”)) AND (cervical)) AND (trauma)) AND (treatment)

- Strategy 2: ((((“cord injury”) AND (“ossification of the posterior longitudinal ligament”)) AND (cervical)) AND (trauma)) AND (“outcomes”)

In the PubMed search engine, 22 articles were collected (strategy 1: 20; strategy 2: 10; coincidences: 8). Case reports, studies of patients with associated vertebral fractures or dislocations, and expert opinions (13 articles) were excluded. Nine of all the articles obtained were selected.[11,18-20,25-29] An additional article was obtained through Google Scholar with the same keywords.[30]Finally, 10 articles were included in the review. The following variables were recorded: lead author, year of publication, country of origin, study design and level of evidence.

FINDINGS

Case series

During the study period, seven patients with acute traumatic spinal cord injury and OPLL were included. Two patients were excluded: one due to referral to another center after initial care and one due to death in the first 24 h before treatment, with no data being recorded in the clinical record. A sample of five patients was formed. All were men, with an average age of 62.2 years (standard deviation, 9.36).

As a traumatic history, two (40%) had suffered a fall from their own height; two (40%), a motor vehicle collision and one (20%), an equestrian accident.

All had a severe initial neurological deficit according to the ASIA scale: four (80%) ASIA A and one (20%) ASIA C (central cord syndrome).

As relevant antecedents, three (60%) patients had comorbidities (obesity: 2 cases, high blood pressure and diabetes: 2 cases) and one (20%), had injuries associated with trauma (closed chest trauma); none had a history of myelopathy.

According to the OPLL morphological classification, one case (20%) was type A or continuous (case 1); one (20%), type B or segmental (case 2); one (20%), type C or combined (case 5); two (40%), type D or limited to the disc space (cases 3 and 4) (Figures 2 and 3).

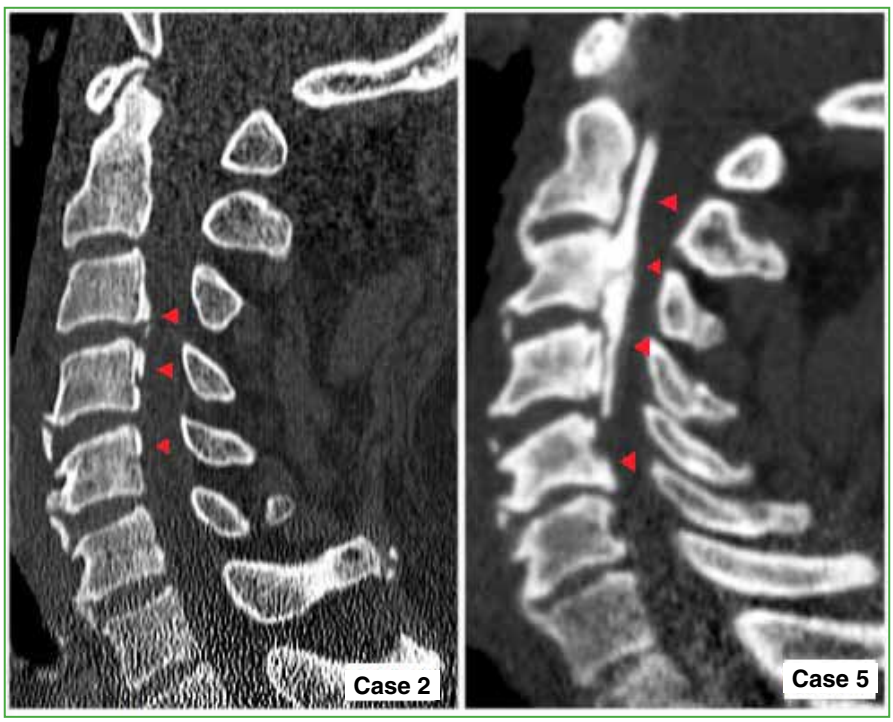

Figure 2. Computed tomography, sagittal plane. Characteristic images of ossification of the posterior longitudinal ligament (arrows), segmental (Case 2) and mixed (Case 5) are observed.

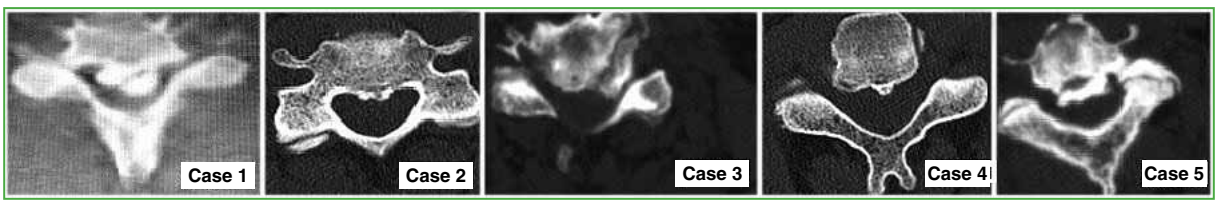

Figure 3. Computed tomography, axial plane. Cases 1-5. Images compatible with ossification of the posterior longitudinal ligament.

All patients had hyperintense spinal topography images on large-area MRI T2-weighted sequence, with involvement of multiple cervical levels (Figure 4).

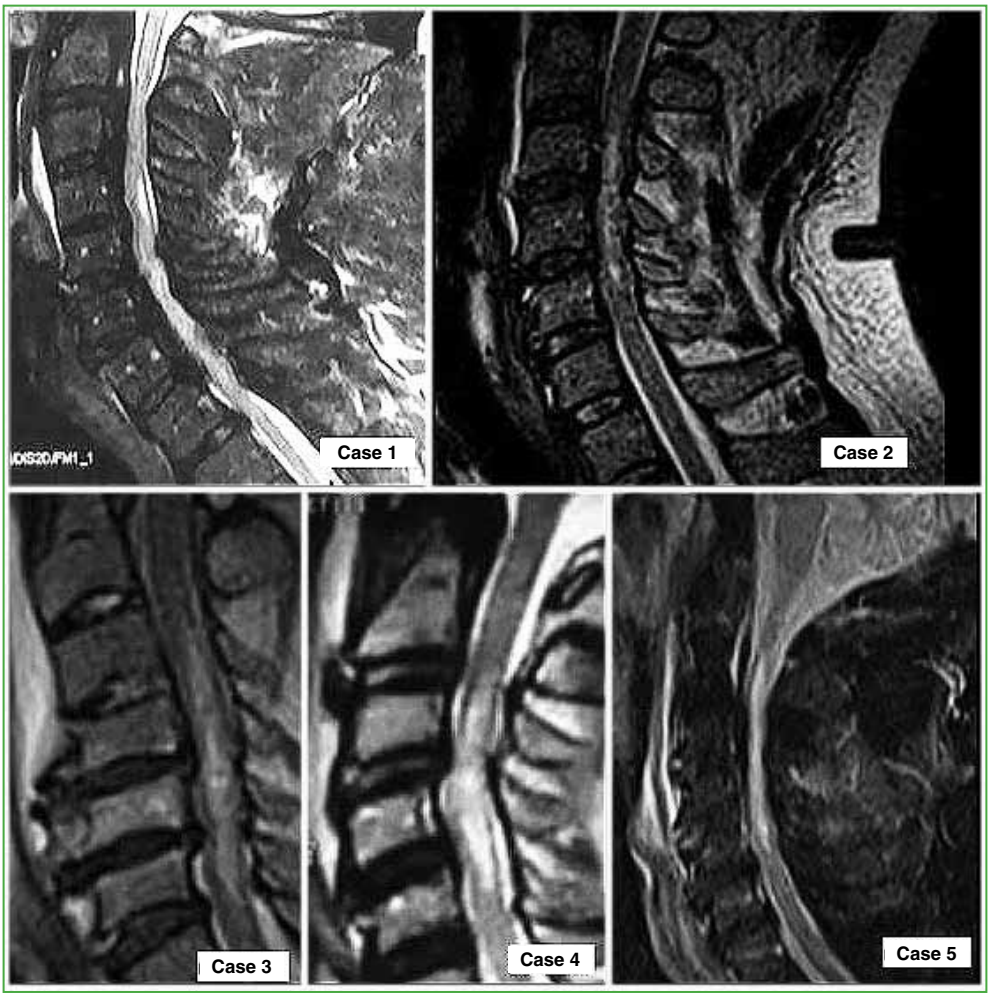

Figure 4. Initial MRI. Cases 1-5. Increased medullary signal in T2-weighted (Case 2) and STIR (Cases 1, 3, 4 and 5) sequences.

Four (80%) patients treated by surgery and one (20%) who received conservative treatment were described. Three were operated on before 72 h and, in the remaining patient, it was necessary to postpone surgery beyond this period due to associated respiratory distress complicated by nosocomial infection. All surgeries were posterior. The surgical techniques implemented were laminoplasty (1 case), laminectomy and arthrodesis (2 cases) and laminectomy without fixation (1 case). The choice of surgical technique was based on the analysis of complementary studies, the availability of implants as soon as possible in the emergency room, and the surgeon's preference (Figure 5).

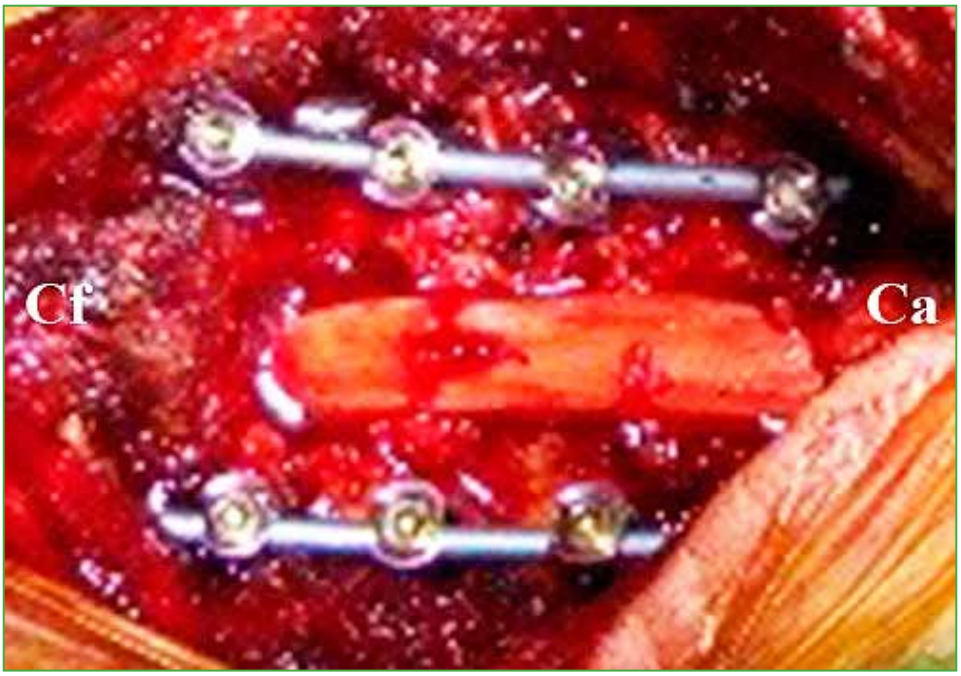

Figure 5. Intraoperative image. Laminectomy and arthrodesis. Cf = cephalic, Ca = caudal.

One patient decided to receive conservative treatment given the risks of surgery and the prognosis of spinal cord injury (case 5, ASIA A).

During the immediate postoperative period, two patients presented significant hemodynamic compromise (neurogenic shock) that caused the death of one of them 48 hours after surgery and the other one week later.

One patient died at six months from a gastrointestinal condition not associated with trauma (perforated diverticulum and fecal peritonitis). The total mortality rate was 60%, 40% (2 cases) died in the immediate postoperative period. Two patients continue in rehabilitation and follow-up to date.

The neurological status did not improve in any case, in an average follow-up time of 3.9 years (± 3.78), in three of the five cases.

All received an intravenous corticosteroid regimen with methylprednisolone upon admission, according to the NASCIS II protocol.

Table 1 summarizes the description of the variables and Table 2, the patient data.

Narrative literature review

Table 3 lists the articles included in the literature review.

Risk factors for acute traumatic spinal cord injury in OPLL patients

Wu et al. conducted a retrospective cohort study of patients with OPLL treated conservatively versus a control group without OPLL over an 8-year follow-up period. The incidence of cervical spinal cord injury was significantly higher in the OPLL patient cohort than in the control group, with an incidence of 4.81 versus 0.18 patients per 1000 people-year. This study did not assess the risk of myelopathy associated with specific aspects of OPLL (type, canal diameter, age of the patients).[29]

Onishi et al. retrospectively estimated a greater association between OPLL and acute spinal cord injury in elderly patients, those with a mixed or segmental ossification pattern and the additional presence of ossification of the anterior common vertebral ligament.[20]

Table 1. Series description

Average age (SD)	62.2 (± 9.36)
Sex, n (%)	
Male	5 (100)
Female	0 (0)
Traumatic history	
low energy, n (%)	2 (40)
high energy, n (%)	3 (60)
Initial neurological injury, n (%)	
ASIA A	4 (80)
ASIA B	0 (0)
ASIA C	1 (20)
ASIA D	0 (0)
OPLL classification, n (%)	
Type A	1 (20)
Type B	1 (20)
Type C	1 (20)
Type D	2 (40)
Extension of the spinal cord image on magnetic resonance imaging (T2-weighted), n (%)	
From C4 to T1	1 (20)
From C3 to C5	2 (40)
From C2 to C5	1 (20)
From C3 to C6	1 (20)
Surgical treatment, n (%)	
Yes	4 (80)
No	1 (20)
Surgery, n (%)	
Laminoplasty	1 (20)
Laminectomy	1 (20)
Laminectomy and arthrodesis	2 (60)
Neurological evolution, n (%)	
Improvement	0 (0)
Stable	5 (100)
Deterioration	0 (0)

OPLL = Ossification of Posterior Longitudinal Ligament.

Table 2. Patient data

Case	Age	Sex	Trauma	Initial ASIA	OPLLC	MRI extension (T2) (levels)	Treatment	Surgery	Neurological evolution
1	54	M	Fall from own height	A	A	C4 to T1	Surgical	Laminoplasty	Stable
2	55	M	Fall from own height	A	B	C3-C5	Surgical	Laminectomy and arthrodesis	Stable
3	65	M	Traffic	C	D	C3-C6	Surgical	Laminectomy	Stable
4	77	M	Equestrian	A	D	C3-C5	Conservative	-	Stable
5	60	M	Traffic	A	C	C2-C5	Surgical	Laminectomy and arthrodesis	Stable

COLLP =Ossification of Posterior Longitudinal Ligament Classification, MRI = magnetic resonance imaging, M = male.

Table 3. Articles on the ossification of the posterior longitudinal ligament and acute traumatic spinal cord injury.

Year	Author	Origin	Type of study	Level of evidence
2011	Yan et al.[25]	China	Case series	IV
2011	Chikuda et al.[11]	Japan	Retrospective observational analysis. Multicenter	III
2012	Onishi et al.[20]	Japan	Retrospective observational analysis. Comparison of 3 groups. 1) acute spinal cord injury and OPLL, 2) myelopathy and OPLL, and 3) control	III
2012	Wu et al.[29]	Taiwan	Retrospective observational analysis.	III
2014	Choi et al.[28]	South Korea	Retrospective observational analysis, correlation.	III
2014	Gu et al.[18]	China	Retrospective observational analysis, comparison of 2 groups.	III
2015	Kwon et al.[26]	South Korea	Retrospective observational analysis, multivariate analysis.	III
2016	Gu et al.[19]	China	Retrospective observational analysis.	III
2020	Li and Jiang[30]	China	Retrospective observational analysis, multivariate analysis.	III
2020	Hollenberg and Mesfin[27]	United States	Retrospective observational analysis, comparison	III

Surgical versus conservative treatment

The treatment of acute traumatic spinal cord injury associated with OPLL remains controversial. There are no published studies with a high level of evidence to guide its therapy.

In a retrospective multicenter study of 34 centers in Japan, Chikuda et al. evaluated 94 patients. Neurological improvement was greater in patients treated with surgery; however, it was not statistically significant. They emphasize that, when the sample was segmented according to the existence of compromise of the gait prior to the trauma (previous myelopathy), in this subgroup, the improvement with surgical treatment was significant.[11]

In a retrospective study of 60 patients, Gu et al. obtained a higher proportion of cases with neurological recovery in the follow-up of patients treated with surgery compared to those who received conservative treatment.[18]

Yang et al. published a series of 25 patients with improved neurological status in 21 of the 25 cases. Twenty patients in the series had Frankel C or D neurological conditions.[25]

Prognostic factors for the outcome of surgical treatment

In the last decade, five retrospective studies have been published which estimate the prognostic factors of surgical treatment in patients with spinal cord injury complicated by OPLL.

Kwon et al. retrospectively evaluated the factors associated with postoperative neurological recovery in a series of 38 patients treated posteriorly (laminoplasty or laminectomy) over a seven-year period. Using a multivariate analysis, they estimated that advanced age, a lower motor score on the ASIA scale upon admission, the severity of spinal cord hyperintensity in the T2-weighted sequence of the preoperative MRI and a smaller space available for the spinal cord (SAC) were associated with worse neurological outcomes.[26]

In a study of similar design with 36 patients operated on using different approaches, Gu et al. estimated the presence of an area of hyperintensity of the medullary signal in the T2 sequence of the MRI as the main factor associated with worse outcomes in the postoperative neurological recovery.[19]

In a retrospective multivariate analysis of 69 patients with acute traumatic spinal cord injury without evidence of vertebral fracture or dislocation that included 10 patients with OPLL, Li and Jiang did not demonstrate a relationship between the prognosis of spinal cord injury and the presence of OPLL. The significant association factors with postoperative prognosis were: 1) baseline ASIA score (patients with ASIA C and D scores on admission had a higher rate of neurological recovery), 2) length of spinal cord injury on MRI (≥45 mm was associated with worse neurological outcomes), 3) the Pavlov relationship (<0.65 was associated with poor results) and 4) the type of spinal cord injury on MRI (the coexistence of bleeding and edema was associated with worse outcomes).[30]

Choi et al. compared the results obtained with posterior release surgery (laminectomy or laminoplasty) in patients with chronic cervical myelopathy and those with a history of low-energy trauma as a trigger. In their sample, a traumatic history was not significantly associated with worse outcomes. The factors that had a significant association were: preoperative neurological status, magnitude of spinal cord compression, diabetes mellitus, and increased spinal signal on the initial MRI.[28] Recently, Hollenberg et al. conducted a similar study in a cohort of North American patients and reported, as a significant finding, worse initial and postoperative motor neurological values in patients with acute spinal cord injury compared with those with myelopathy.[27]

DISCUSSION

We presented a series of five cases of cervical spinal cord trauma associated with OPLL that, although it represents a low number of patients compared to previous publications, has as its only precedent a case report of this association by Spanish-speaking authors.[22] As an additional noteworthy antecedent, Rendó et al. published a case of OPLL-associated myelopathy.[31]

In our setting, the prevalence of OPLL in acute traumatic spinal cord injury without evidence of fracture is unknown. According to Asian publications, 34% of these injuries are associated with OPLL.[10] Bazan et al. reported a series of 13 patients with acute traumatic spinal cord injury without radiographic and tomographic signs of trauma, none of them had OPLL.[32]

The clinical profile of this condition includes elderly patients with a minor traumatic history.[11] Two of our cases had suffered falls from their own height as a traumatic event.

According to the literature consulted, patients with OPLL have a higher risk of suffering a traumatic spinal cord injury, in addition to the possible development of chronic myelopathy.[29] The traumatic history would not have a direct impact on the results compared to other factors that are known to have a significant association, such as the severity of the initial neurological state, advanced age, increased intensity of the spinal cord signal on MRI and magnitude of compression.[19,26-29] The suggested treatment is early surgical release, and reports of the posterior approach (laminectomy or laminoplasty) predominate.[11,18-20,25-30]

In our series, emergency surgical treatment did not provide benefits based on neurological recovery and the mortality rate in the immediate postoperative period was high. It should be noted that all the included cases had a high ASIA score upon admission (4 ASIA A and 1 C). Clinically, four patients had a complete spinal cord injury and one had a central cord syndrome. Likewise, in accordance with the factors associated with worse outcomes in the literature, all of our cases were associated with extensive hyperintense spinal cord images on preoperative MRI and evidence of significant spinal canal stenosis.

The main weaknesses of our study are its descriptive nature and the low number of cases, which is why the contribution of the data of the series is limited. However, we consider it a novel report in the Hispanic-American literature on a rare association in our region.

CONCLUSION

We presented a series of patients with cervical spinal cord trauma associated with OPLL, which is rare in our setting; there is only one case report registered in the Spanish-American literature. The recent literature considers surgical release via the posterior route in time as the predominant treatment. Severe initial neurological injury, advanced age, increased intensity of the spinal cord signal on MRI, and high spinal cord compression are associated with poor postoperative outcomes.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Catastrophic Spinal Cord Injuries in Argentine Rugby. Impact of the Measures Implemented and Their Relative Reduction in Time

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ABSTRACT

Introduction: A catastrophic injury is defined as any serious trauma that involves the head, brain, spine, or spinal cord. They are life-threatening or may leave a permanent or semi-permanent disability. In Argentina, there is a high incidence of injuries. **Materials and Methods:** Data obtained from a telephone survey carried out in the collaborative framework between the *Union Argentina de Rugby* and the *Fundación para la Lucha de Enfermedades Neurológicas de la Infancia* (Fleni, by its acronym) were analyzed. We carried out a qualitative analysis of the data and their relationship to progressive changes in sports regulations. **Results:** It was observed that the number of injuries remained stable year after year. When associating this fact with a sustained increase in the number of players per year, we can see a relative decrease in the risk of injury. **Conclusion:** Catastrophic injuries have a great impact on the quality of life of the player and his environment. They must be considered inadmissible and the efforts must be increased to achieve zero risk. In recent years, multiple preventive measures have been implemented and regulations have been modified in order to avoid catastrophic injuries.

Keywords: Rugby; spinal cord; scrum.

Level of Evidence: IV

Lesiones medulares catastróficas en el rugby argentino. Impacto de las medidas implementadas y su reducción relativa en el tiempo

RESUMEN

Introducción: Se entiende por lesión catastrófica a cualquier trauma grave que comprometa la cabeza, el cerebro, la columna vertebral o la médula espinal, que pone en riesgo la vida o puede dejar una discapacidad permanente o semipermanente. En la Argentina, la incidencia de lesionados en el ámbito del *rugby* es alta comparada con la de otros países. En los últimos años, se han implementado múltiples medidas de prevención y se han modificado normas con el objetivo de evitar las lesiones catastróficas. **Materiales y Métodos:** Se analizaron datos obtenidos de una encuesta telefónica realizada en el marco de colaboración entre la Unión Argentina de Rugby y la Fundación para la Lucha de Enfermedades Neurológicas de la Infancia (Fleni). Se realizó un análisis descriptivo de los datos. Se recopilaron los cambios en las normativas del deporte, que pudieran tener impacto en las futuras lesiones. **Resultados:** Se observa que el número de lesiones se mantiene estable año tras año. Al asociar este dato con un aumento sostenido de la cantidad de jugadores por año, impresiona haber una disminución relativa del riesgo de lesionarse. **Conclusiones:** Las lesiones catastróficas generan un gran impacto en la calidad de vida del jugador y de su entorno. Deben considerarse inadmisibles y se deben incrementar los esfuerzos para lograr eliminar los riesgos de lesionarse. El esfuerzo de las entidades reguladoras impresiona tener un impacto positivo al haberse logrado una reducción relativa de las lesiones en relación con el aumento de jugadores año tras año.

Palabras clave: *Rugby*; médula; lesión; catastrófica; *scrum*.

Nivel de Evidencia: IV

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INTRODUCTION AND OBJECTIVES

Over the past 10 years, the professionalization and diffusion of rugby have led to an increase in the number of fans in Argentina; it currently has a base of more than 65,000 players.

Rugby is a team sport in which there is a strong exposure to physical contact. It has game-specific situations (*scrum*, *tackle*, *ruck*, and *maul*) where there is a dispute between two or more players to determine the position of the ball, and high-impact collisions can be generated. Such situations may pose a risk of injury that can have serious consequences. In the last 20 years, the focus has been on risk factors related to the origin of serious injuries, and this led to deepening education and prevention of these injuries.

Catastrophic injury means any serious trauma involving the head, brain, spine, or spinal cord, which requires urgent admission to the hospital and must be resolved immediately, as it poses a risk to life or may leave a permanent or semi-permanent disability.[1] These injuries represent a very low percentage of the total rugby-related injuries, but, due to the severity and potential risk of disability, they tend to have a significant impact on the general population, who perceive the risk qualitatively.[2]

Fundación Unión Argentina de Rugby (FUAR) is a non-profit non-governmental organization founded in 2015. Its aim is to provide comprehensive assistance to players who have suffered serious injuries within the playing field. Along with the development of the "Rugby Insurance" program in 2016, they have been the two most representative actions in all aspects of spinal cord injury prevention. They have a comprehensive database and an important organizational structure focused on minimizing the obstacles generated by the inability to acquire a good quality of life.

The aim of this article is to retrospectively analyze the history of catastrophic spinal cord injuries in Argentina, according to the players who suffered them and to mention the measures implemented in order to minimize these tragic injuries.

MATERIALS AND METHODS

Within the framework of collaboration between the Argentine Rugby Union (UAR) and the Foundation for the Control of Neurological Diseases of Childhood (Fleni), we sought to update and analyze new data on *rugby* players who suffered catastrophic spinal cord injuries between 1965 and 2017. To achieve this aim, a telephone survey was conducted to all players included in the FUAR records, who had suffered catastrophic spinal cord injuries. Fleni and CEBES members (both scholars and doctors) were in charge of telephone communication with players to conduct a standardized and semi-structured survey that allowed the collection of both specific data and subjective data provided by each individual. The verbal consent of each player was requested for the use of the data provided, but no information that could identify the respondents is mentioned. As it was a personal survey, players who had died before the study were excluded. In turn, statistical data recorded since 1996 on the number of players registered in the UAR were used.

In the personal survey of players, data such as age, technical parameters of the game (position, hours of training) and details of the injury (game situation, biomechanical details of the injury, spinal location of the lesion) were obtained. Medical care received (in the field, medical care, type of surgery required, hospital stay) and chronic evolution (sequelae, social reintegration, current relationship with *rugby*) were recorded. It was decided to avoid statistical analysis, since, due to the low number of injured players, it would not have a representative value. We chose to perform a descriptive and qualitative analysis of catastrophic spinal cord lesions. We collected some of the changes in sports regulations that could have an impact on future injuries.

FINDINGS

Thirty-two out of 33 injured players were surveyed between 1965 and mid-2017. The missing injured player was the only one who had died of causes indirectly related to his spinal cord injury. The registry was created 52 years ago and injuries have been recorded in 33 players, i.e. a minimum of one case per year and a maximum of three cases per year (2016).

All players surveyed were over 18 years of age when they were injured. The median age when injured was 19.5 years (range 15-28). All injured players were amateur. 75% of injured players performed specialized training for an average of 7 hours per week (between 2 and 18 h). As for the position, 23 of the 32 athletes played as forward (74%), of whom 11 occupied the *hooker* position, the riskiest position (Figure 1).

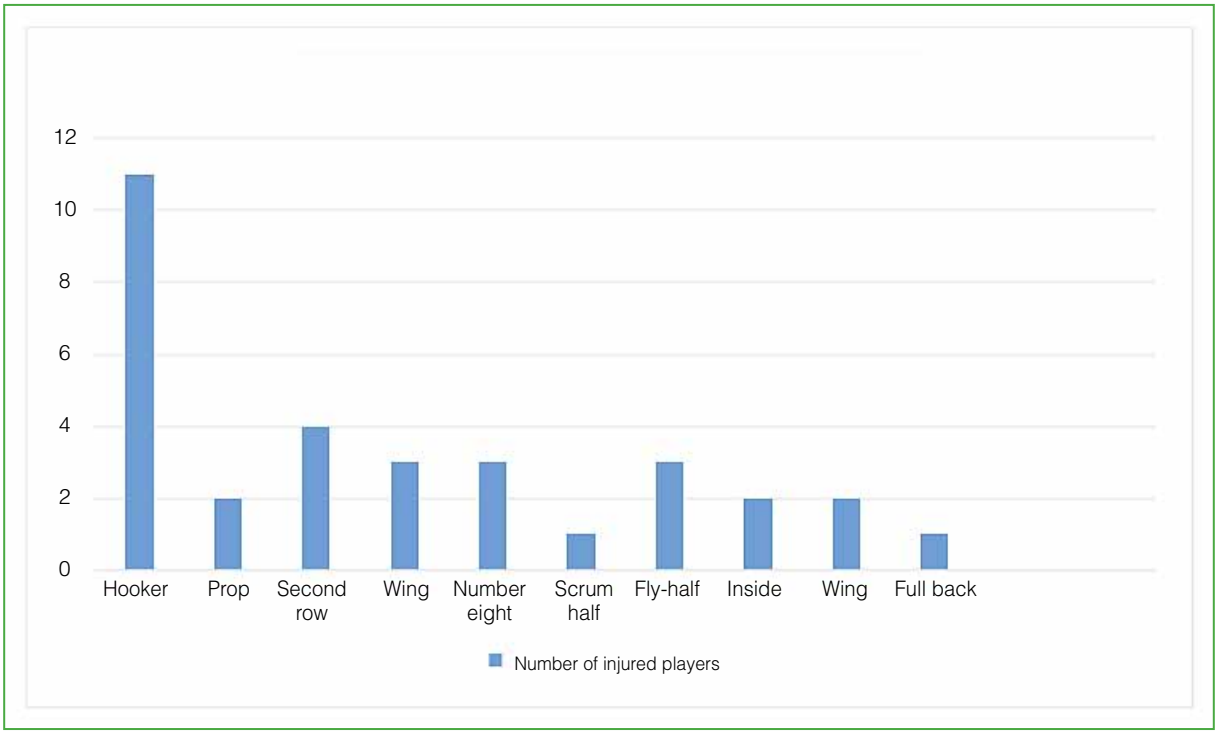

Figure 1. Bar chart showing the number of injured persons based on position. It highlights the huge prevalence of the first row of strikers, specifically the *hooker* position.

Among the game situations, 50% of the injuries occurred during the *scrum*, 22% in *tackle* situations, 19% during *ruck* and the remaining 9% in other unspecified situations.

As the mechanism of injury, cervical hyperflexion with rotation or without rotation was identified in 59% of cases. The most frequently affected spinal sector was between levels C4-C5 and C6-C7; the compromise of more than one level is possible (Figure 2). Spinal lesions are divided into complete or incomplete section, and the first is the most frequent.

75% of players received medical attention on the pitch. The transfer to hospital facilities was carried out within 30 min in 41% of cases, 30-60 min in 40% and after 60 min in the rest (19%). In 84% of cases, the spine was immobilized for the player's transfer. The majority of the injured players (93%) required emergency surgery to prevent the progression of the injury.

Concerning the evolution of players, 97% suffered motor sequelae that included motor, sensory or autonomic deficit. The most frequent neurological sequela was quadriparesis with different levels of severity. 87% achieved an adequate return to the workforce and that same percentage remains linked to *rugby* in some way. Outside the statistical analysis, a large number of injured players felt that the main factor to improve is the change of standards and education for the prevention of such injuries. Concerning the measures taken by the UAR, those who expressed their opinion considered that they were appropriate and that changes could be observed in the management of such catastrophic situations. Their first-person experience provides useful data that is beyond the reach of experts on the subject.

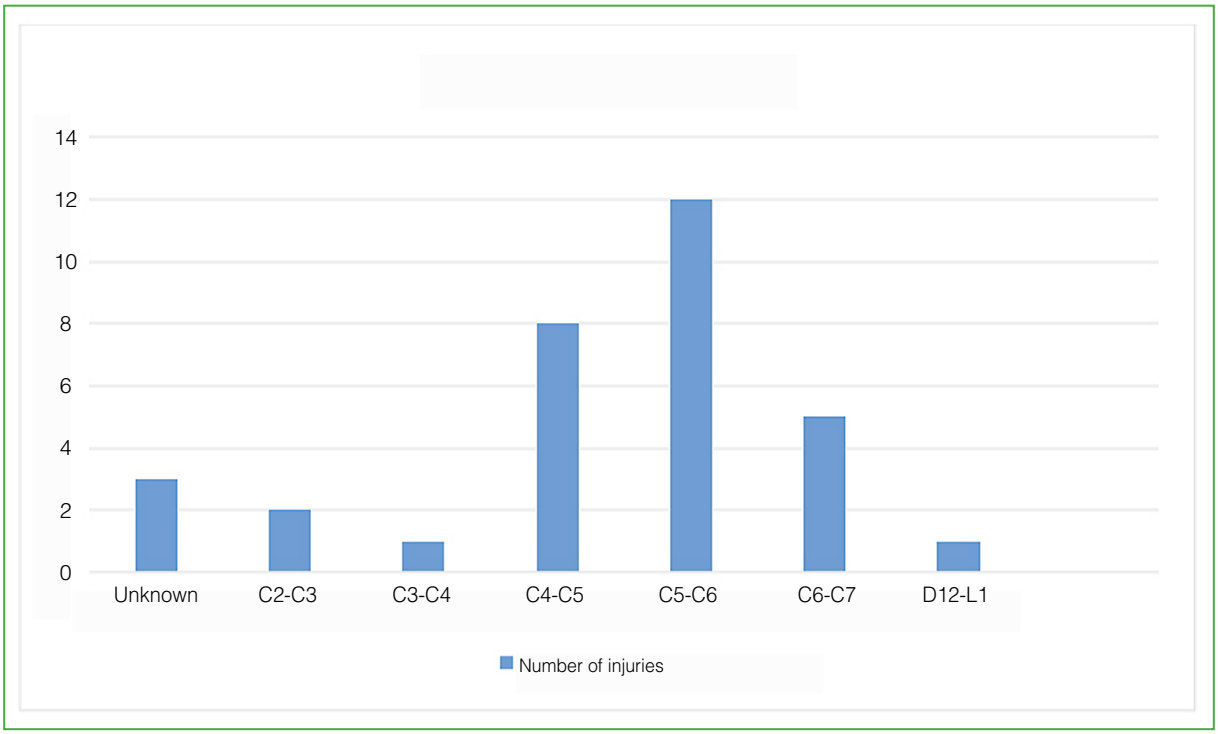

Figure 2. Bar chart showing the spinal cord levels where the injuries occurred. The prevalence of the proximal half of the cervical spine is highlighted.

DISCUSSION

Currently, in Argentina, there are no official statistics on the extent of spinal cord injuries associated with sport, and the economic impact these injuries generate on both individuals and society is unknown. Chan et al. conducted a review of population data provided by each country. Only 25 countries conducted epidemiological studies on sports-related spine injuries, accounting for 13% of spinal cord injuries. [4] Among other sports, rugby is considered to have a moderate to high risk of spinal cord injury. In 1999, Secin et al. described the first series of cases of catastrophic and almost catastrophic injuries in Argentina. [4] In the period we analyzed, the incidence of injuries was 1.4-5.1 cases per 100,000 players per year. In countries with the highest number of *rugby* players, the different series report the following incidence of cases every 100,000 players, per year: England 0.48-1.5; France 1.4-2.1 and South Africa 1.04-1.8. [5,6]

According to current statistics, there are more than 65,000 UAR-affiliated *rugby* players. There is a steady growth in the number of registrants; in the last 20 years, the number of players registered in the different unions that depend on the UAR has doubled.

The average age when injured was 19.5 years, a time of transition between the youth leagues and the upper squad. The literature is contradictory regarding the relationship between age and catastrophic lesions. There is no reported case series comparing the dispersion of age in spinal cord lesions within the highest age category, nor is there evidence to support that the musculoskeletal immaturity observed in younger players or the different fitness levels are related to the frequency of injuries. [6] In turn, in Argentina, there are no reports of professional players who have suffered this type of injury, implying that proper technique and specific training are mitigating factors.[5]

In our series, about three-quarters of the injured were playing in striker positions. In this outstanding difference between the strikers and defenders, players on the front lines are the ones who are exposed to greater risk. In concordance with historically reported data, the hooker position, especially when forming the *scrum*, remains the riskiest. These data coincide with international statistics and are reflected in the Argentine population. [4] As a general rule, there is a tendency to avoid a large disparity in both technical and physical training between teams, as this would put both sides at risk.[7] The general recommendation remains to encourage the generation of an appropriate physical framework for the position and that specific training be carried out for players participating in the *scrum* (especially the front lines). *Scrum* is the training in which the largest number of catastrophic injuries occurs, reaching half the total among the players surveyed. A systematic review published in 2015 on scrum-related spinal lesions concluded that the percentage of spinal lesions may be similar in *tackle* and *scrum*, but those caused by the latter tend to be more severe and produce permanent sequelae. Different series have reported that the lesions associated with *scrum* cause a permanent deficit in 60% of the injured, while those in *tackles* cause 29%.[8] In the *scrum* is where the most prevention measures were taken. Reboursiere et al. demonstrated the effectiveness of the rules concerning *scrum*, implemented in France and how the incidence of spinal cord injuries decreased.5 In Argentina, specific measures related to the prevention of *scrum* injuries were taken, including:

- Amendments to the referee's orders. Currently, "Crouch - Bind - Set". Minimizing the onslaught between rival front blocks.
- Limitation in juvenile divisions to push more than 1.5 meters when a *scrum* is formed.
- Assistant referee's entry to control, along with the referee, both sides of the scrum.
- Generation of the FRA (Front Row Accreditation) with training for players who occupy those positions.

It should be noted that the vast majority of serious and non-serious injuries are related to *tackle*, as it is the individual action that is most observed in a rugby match. In our Argentine experience, we identified that 22% of the lesions were tackle-related, representing a lower percentage than in other series. There are specific types of *tackle* that increase the risk of injury (e.g., a high *tackle*, more than a player involved or tackling a player who is not standing), so they are considered illegal in modern rugby. The risk of tackle-related spinal cord injury remains low and the rules set by regulators tend to reduce those risks. Year after year, training is strengthened for players and referees on the appropriate techniques to avoid serious injuries.

Concerning the mechanisms of trauma, it is believed that injuries occur at the time when the player undergoes an exaggerated flexion of the neck, which causes a fracture of the anterior wall of the cervical vertebra and dislocation of the said vertebra into the medullary canal. [8] In our series, this was the mechanism reported as most frequent. According to the literature, lesions with catastrophic results are generated in the most mobile parts of the cervical spine, especially between the C4-C5 and C5-C6 levels. [9] In our series, the mechanism of the lesion was identified as cervical hyperflexion with or without rotation in 59% of cases and more than 90% were between C3-C4 and C6-C7 levels. This kinetic mechanism was most often observed in the *scrum*, especially when the scrum collapsed or when one team rammed the other before it was properly formed.

Initial medical care represents a vital point in the evolution of catastrophic lesions. Our series shows a high heterogeneity in the type of medical treatment, probably related to the temporal dispersion of the analysis. In 2017, Badenhorst et al. reported a large variability of health care in different regions of South Africa and that lower socioeconomic levels were more vulnerable to these conditions, which was associated with a worse prognosis.[10] While there is currently no regulation for medical care on the pitch of amateur rugby matches**,** online and face-to-face training is encouraged for club physicians and those attending matches within the UAR orbit. Adequate transfer conditions and urgent referral to high-complexity centers specialized in the management of neurosurgical pathologies may be the difference between complete recovery and permanent sequelae. Within the orbit of the BokSmart program in South Africa, the "Spineline" program was developed to facilitate the injured player's access to a facility trained to quickly resolve the injury and thus prevent its progression.[6] In our series, virtually all patients required some kind of surgical instrumentation to achieve stabilization of the cervical spine and thus prevent the progression of spinal cord injury.

The analysis of the prognosis of these lesions remains overwhelming. Although 87% of patients achieved some degree of reintegration into the workforce, they all have some kind of motor, sensory or autonomic sequelae. 70% require some kind of urinary tract instrumentation, which generates a serious compromise in daily-life activities. It should be noted that most players who suffered catastrophic injuries continue to be related to *rugby*, demonstrating the importance of the emotional and economic support provided by the rugby community to such events. Badenhorst et al. made an interesting contribution in assessing the quality of life of rugby players with spinal cord injuries in South Africa. Among the conclusions, it is noted that the support of the sports group is a factor that improves the social reintegration of injured persons.[11] Concerning the opinion of injured players, there is a general consensus that intensive work is being done on the issue and that the measures implemented are adequate.

Countries such as South Africa and New Zealand have developed programs for the prevention and treatment of rugby-related injuries (BokSmart and RugbySmart, respectively) that require constant training of coaches, physicians and referees.[11,12] In Argentina, the "Rugby Seguro" program was designed to identify and remove players who suffer an injury during training or on the day of the match. This initiative was launched in 2016 with the main focus on player and medical staff education and training to increase awareness and decrease the number of injuries.

Both training programs and numerous regulatory changes have been implemented to promote the safety of players, for example,

- Regular pre-competitive medical examinations and the generation of the pre-competitive medical electronic card.
- More severe penalties for dangerous play, such as aggravated yellow card.
- Generation of specific training programs for players, authorities and physicians.
- Encouraging the "IDENTIFY AND WITHDRAW" premise on suspicion of a major injury.

These changes have strengthened the idea of safe play and shown their short-term results, as a low number of spinal cord injuries has maintained, despite a significant increase in the number of players. This can be interpreted as a relative decrease in catastrophic injuries as the number of players increases each year. This relative decrease in the annual risk of catastrophic injuries is associated with the intensification and promotion of continuing education programs combined with less flexible regulations. In turn, the result of these changes resulted in the absence of new catastrophic lesions from 2017 to date.

Our study has certain limitations, such as the temporary extension of registration, the fact that rules have changed multiple times and the transition from amateur to professional rugby. In turn, long-term follow-up and the difficulty in grouping all the injured may mean that not all patients have been included in the survey. The calculated incidence corresponds to the number of players injured by the number of players per year. By not calculating the risk according to hours of exposure, the results may be inaccurate. We believe that this should be the starting point for a prospective analysis of the impact of prevention measures, and the initiation of collaborative and multidisciplinary work that will reduce this type of injury to a minimum, while keeping the spirit of rugby intact.

CONCLUSIONS

Over the past four decades, the number of patients with rugby-related spinal cord injuries in Argentina remained stable. When compared with the increase in the total number of players, a relative decrease in the ratio between injured players and the total number of players each year has been achieved. This shows that efforts to improve standards and constant education are key factors in prevention. *Tackle* and *scrum* are the riskiest situations of the game and where more emphasis has been placed on minimizing the risks of this type of injury. Especially the front rows of all divisions should receive supervised theoretical and practical education in order to achieve an appropriate technique that reduces risks. It is essential to deepen the learning of the correct approach techniques in training, especially in the area of youth divisions.

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Patient-reported Outcomes of Calcaneonavicular Coalitions Treated With Surgical Excision and Fat Graft Interposition: A Two-Center Experience

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ABSTRACT

Background: The purpose of the present study was to evaluate clinical/radiographic outcomes, and complications for calcaneonavicular coalition (CNC) excision and fat graft interposition in patients under the age of 18. **Materials and Methods:** A retrospective review of all pediatric patients surgically treated with symptomatic CNC at two institutions was performed. Demographic data and postoperative complications were recorded. Functional results were evaluated with AOFAS Ankle-hindfoot Scale and Visual Analog Scale (VAS). Radiographic assessment of coalition recurrence was performed on the most recent oblique radiograph (resected gap remaining <50%). **Results:** Between January 2008 and January 2018, 52 patients (65 feet) with CNC were surgically treated. Forty patients (48 feet) met the inclusion criteria and were available for evaluation. The average age at surgery was 11.9 years old (range 9-17 years old). The average follow-up was 43 months. The average AOFAS score improved from 58.9±8 points preoperative to 92.9±7.8 points postoperatively (p<0.001). Preoperative pain scores averaged 6.9 ± 2.5 points. At the last follow-up, the VAS score was 0.49 ±1.1 points (p<0.001). Most patients (87.5%) were painless at the last follow-up and five patients (6 feet) had occasional pain with strenuous activities. Five complications were recorded: wound dehiscence (N=3) and superficial infection (N=2). Two feet (4.2%) had coalition regrowth on the postoperative radiographs without requiring further surgery. **Conclusion:** Calcaneonavicular coalition excision with fat graft interposition can improve function and relieve pain with a low rate of complications in the pediatric-adolescent population.
Keywords: Foot, adolescent, calcaneonavicular, coalition resection.
Level of Evidence: IV

Resultados funcionales del tratamiento de coaliciones calcáneo-escafoideas con resección e interposición de grasa autóloga: Experiencia de dos centros

RESUMEN

Objetivo: Evaluar los resultados clínico-radiográficos y las complicaciones en pacientes <18 años con coaliciones calcáneo-escafoideas (CCE) sintomáticas tratados con resección e interposición de grasa autóloga de la región glútea. **Materiales y Métodos:** Se analizó retrospectivamente a los pacientes con CCE sintomáticas operados con dicha técnica, en dos instituciones, y un seguimiento mínimo de 2 años. Se analizaron los datos demográficos y las complicaciones posoperatorias. Los resultados funcionales fueron evaluados con la escala AOFAS y la EAV. Se determinó la presencia de recidiva en la radiografía oblicua más reciente (defecto remanente <50%). **Resultados:** Entre enero de 2008 y enero de 2018, se operó a 52 pacientes (65 pies) con CCE. Cuarenta (48 pies) cumplían con los criterios de inclusión. La edad promedio al operarse era de 11.9 años. El seguimiento promedio fue de 43 meses. El puntaje AOFAS promedio mejoró significativamente de 58,9 ± 8,2 precirugía a 92,9 ± 7,8 después (p <0,001). El puntaje promedio preoperatorio de la EAV era de 6,9 ± 2,5 y de 0,49 ± 1,1 (p <0,001) en el último seguimiento. El 87,5% no tenía síntomas en el último control y 5 pacientes (6 pies) sufrían molestias ocasionales con la actividad física intensa. Hubo 5 complicaciones posoperatorias: dehiscencia de la herida e infección superficial. Dos pies (4,2%) presentaron recidiva radiográfica de la coalición aunque ningún paciente requirió revisión. **Conclusión:** La resección de CCE y la interposición de grasa autóloga permiten aliviar el dolor y mejorar la función con una baja tasa de complicaciones en la población pediátrico-adolescente.
Palabras clave: Pie; adolescentes; coalición calcáneo-escafoidea; resección.
Nivel de Evidencia: IV

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INTRODUCTION

Calcaneonavicular coalitions (CNC) are congenital anomalies in which there is a fibrous, cartilaginous, or osseous connection between the calcaneus and the navicular. [1] This condition is believed to be due to an alteration in differentiation and segmentation, resulting in a failure in the normal formation of this joint. [2] The estimated incidence varies from 1% to 13%, which makes it one of the most common foot and ankle pathologies in children. [3,4] The abnormal connection between the navicular and the calcaneus can cause significant morbidity. The typical patient with symptomatic CNC is an adolescent with persistent pain, limited range of motion, and repeated sprains or fractures of the ankle or foot.[5]

Persistent symptoms, despite nonsurgical measures, may lead to the need for surgical treatment. CNCs are usually treated by resection and soft tissue interposition to prevent recurrences. Jayakumar and Cowell[6] were the first to publish the use of the extensor digitorum brevis muscle for the interposition. Other authors have alternatively proposed the use of autologous fat from the gluteal fold or abdominal region, bone wax or fibrin glue. [7-9] It remains controversial which interposition material can provide the best functional outcome and the lowest recurrence rate.

Since 2008, the authors of this study have used a technique that involves a very careful resection and a free fat graft taken from the gluteal region as interposing tissue. This study aims to evaluate the clinical-radiographic outcomes and complications in patients <18 years with symptomatic CNC treated with this procedure and a minimum follow-up of two years.

MATERIALS AND METHODS

This study was approved by the ethics committee of both participating institutions. All patients with a diagnosis of CNC treated with the same surgical technique over a period of 10 years (from January 2008 to January 2018) were retrospectively analyzed. All surgeries were carried out in two reference centers and were in charge of four surgeons specializing in Children's Orthopedics. Those patients with associated bars, severe deformity requiring realignment in the same surgical time, revision surgeries and a follow-up <24 months were excluded from the analysis.

Surgical technique

After general anesthesia and antibiotic prophylaxis during anesthetic induction, a hemostatic cuff is placed on the thigh and antiseptic measures are taken. The patient is placed in the dorsal decubitus position with an enhancement in the lateral gluteal region. A 3-4 cm oblique lateral approach is performed, centered on the coalition. The aponeurosis of the extensor digitorum brevis muscle is incised. It is carefully disinserted from its proximal origin with an electrosurgical knife and marked with Vicryl 0. The coalition is identified clinically and the resection margins are identified by fluoroscopy. As a guide, the calcaneocuboid joint is used for the proximal limit and the joint between the cuboid and the lateral wedge for the distal limit. The resection is performed with 10 mm chisels to initiate the cut and then 5 mm in the plantar area of the bar to avoid injuring the cuboid or the head of the talus. [5] If a portion of the bar remains in the plantar area, Kerrison-type forceps can be used. The periosteum in the plantar region of the coalition is completely resected. Complete resection of the fusion is confirmed clinically and radiographically (Figures 1 and 2). Next, we proceed to take the fat graft from the gluteal region. In nine

Figure 1. Resection margins.

Figure 2. A. Approach. **B.** Intraoperative image. **C.** Coalition. **D.** Image of the defect after completing the resection. **E.** Fat harvesting from the posterointernal gluteal fold. **F.** Button fixation of the fat graft.
A = talus, Ca = calcaneus, E = navicular, Cu = cuboid.

cases, it was taken from the most posterior region of the gluteus. As two patients presented dehiscence, it was decided to modify the incision to a posteromedial position. To do this, the ipsilateral hip is flexed and abducted. The fat is prepared with Vicryl 0 sutures, introduced into the defect and button-fixated on the sole of the foot (*pull-out*). The extensor digitorum brevis muscle is repositioned with separate Vicryl 1 stitches, attaching it to the extensor retinaculum. Subcutaneous cellular tissue is then closed with Vicryl 2.0 and the skin with Monocryl 4.0. A sterile bandage and a plaster splint are placed below the knee without standing for two weeks. After this period, the splint and plantar button are removed. Progressive standing and physical therapy are indicated to improve range of motion and strength and to retrain gait. A progressive return to sports activities is usually allowed after three months.

Patient evaluation

The information analyzed included demographic data (age, sex, side), type of bar,[10] symptoms that led to the consultation, previous treatment and postoperative complications (infection, wound dehiscence, recurrence, etc.). CNCs were classified according to Upasani[10] into four types: frustrated, fibrous, cartilaginous, and bone. Before surgery, anteroposterior, lateral, and oblique radiographs of the foot were taken, and a computed tomography (CT) scan was performed to rule out associated coalitions and assess foot alignment.

Functional results were evaluated with the *Ankle-Hindfoot Scale* of the AOFAS (*American Orthopedics Foot and Ankle Society*)[11] and the visual analog scale (VAS)[12,13] through a telephone survey. The *Ankle-Hindfoot Scale* analyzes subjective and objective parameters, with values from 0 to 100 points, considering optimal results directly proportional to the number of points. The VAS is a one-dimensional measurement tool for calculating pain intensity, in which the response corresponds to a level of agreement by defining a position on a continuous line between two points (from 0 to 10). It was defined as radiographic recurrence of the bar when the intraoperative resection margin decreased to less than 50% on the last oblique radiograph.[7] A patient was considered to have a symptomatic recurrence if they presented the aforementioned characteristics, but with pain that limited their usual activities.

Statistical analysis

Descriptive statistics (average and standard deviation) were used for the description of quantitative variables, and absolute frequencies were used for qualitative variables. The preoperative and postoperative differences of the AOFAS functional scale were evaluated with the paired Student's t-test. The alpha value was set at 0.05. All statistical analyses were performed with the SPSS v.19.0 program (IBM Corp., Armonk, NY, USA).

FINDINGS

Between January 2008 and January 2018, 52 patients (65 feet) with CNC underwent surgery. Forty (48 feet) met the inclusion criteria and could be identified for evaluation. The average age at the time of surgery was 11.9 years (range 9-17). The demographic characteristics of the patients and the results according to the *Ankle-Hindfoot Scale* and the VAS are described in the Table.

Table. Demographic data and functional outcomes

Patients (feet)	40 (48)
Age	11.9 years (range 9-17)
Upasani Classification (10) #	I: 12.5% (n = 6), II: 50% (n = 24), III: 20.8% (n = 10), IV: 16.7% (n = 8)
Average follow-up (months)	43 (range 24 - 132)
AOFAS-*Ankle-Hindfoot Scale* (preoperative-postoperative)	58.9 ± 8.2 - 92.9 ± 7.8 (p <0.001) *
Visual analog scale	0.49 ± 1.1 (range 0-4)
Radiographic recurrence	4.2% (2/48)
Clinical recurrence	0% (0/48)

* Student's paired t-test.
# Upasani Classification: I (forme fruste), II (fibrous), III (cartilaginous), IV (osseous).

87.5% of the patients were completely asymptomatic at the last follow-up. Six feet (5 patients) had occasional discomfort that did not interfere with activities of daily living. Two feet (4.2%) had a radiographic recurrence of the coalition (Figure 3). One of these patients presented pain, for which he was treated with rehabilitation and the symptoms improved. Neither patient required revision surgery.

There were five postoperative complications (10.4%). Three patients suffered wound dehiscence: two in the area where the interposition material (fat) was taken and one on the lateral aspect of the foot. One of them, located in the gluteus, was treated with debridement and secondary closure. The other two dehiscences were treated with curings. Two superficial infections were reported and cured with oral antibiotics (first-generation cephalosporin).

Figure 3. Radiographic recurrence image.

DISCUSSION

Surgical resection of symptomatic CNCs represents the gold standard for treatment.[14,15] Among the options, one of the most popular is resection through a dorsal approach and interposition of the extensor digitorum brevis muscle.[6] Good to excellent results have been reported with this technique, between 69% and 88%,[6,16-19] with reossification rates that vary from 0% to 38%, according to the definitions used by the authors.[16-19] A cadaver study refutes the use of the extensor digitorum brevis as an interposition material.[7] Due to anatomical restrictions, the extensor digitorum brevis muscle would not be of sufficient length and volume, leaving more than a third of the defect unfilled on the plantar aspect of the resection. Another disadvantage is that osteoprogenitor cells reside in muscle[20] and as such may not be the best option when the goal of surgery is to minimize the risk of recurrence. On the other hand, the use of the extensor digitorum brevis generally results in a large and cosmetically unattractive cleft in the tarsal sinus.

For this reason, some authors[5,7] recommend using autologous fat from the gluteal fold or abdomen. Free autologous fat has been used as an interposition material in the resection of physeal arrests, posttraumatic synostoses, CNCs and talocalcaneal coalitions.[7,8,21-23] Tachdjian[24] was the first to describe its application in CNC. Although there are very few series that describe the outcomes of this technique,[7,8] the reossification rate would appear to be lower. Mubarak et al.[7] evaluated 55 patients (78 feet) treated with resection and fat graft interposition. The result was excellent in 48 patients (87%), fair in four (8%), and poor in three (5%). Although 10 feet presented radiographic reossification, only three of them (5%) caused symptoms. Masquijo et al.[8] compared the functional

outcomes and the reossification rate in 56 feet treated with resection and interposition with bone wax (n = 18), autologous fat (n = 23) and extensor digitorum brevis muscle (n = 15). Patients treated with fat graft interposition had better functional outcomes and a significantly lower reossification rate (p = 0.004). Although the few patients treated with bone wax obtained results comparable to those with autologous fat, wax is a synthetic material that can produce foreign body reactions and wound dehiscence; therefore, it should be used with caution.[25]

The results of the series evaluated in this study are a confirmation of those already reported. The low recurrence rate (4.2%) after a minimum follow-up of two years allows us to affirm that the autologous fat graft taken from the gluteal area is an excellent interposition material, since it covers the defect in its entirety and has a better consistency than locally obtained fat, thus avoiding the reossification of the bar. Another advantage of using fat and repositioning the extensor digitorum brevis muscle to its original insertion is that it avoids the formation of an umbilication (in the resection area) and a bony prominence (anterior portion of the calcaneus) that often bothers patients when wearing footwear. . In our series, there were three wound dehiscences. Two were located in the graft harvesting area. In the first nine patients in the series, the graft was taken from the posterior gluteal fold. After the aforementioned complication, we decided to modify the graft harvesting area using the posterointernal crease of the gluteus, because it is an area with less skin tension, better healing, and is more aesthetic. Since we introduced this modification, we have not observed complications like the one described. The remaining dehiscence occurred in the foot wound. The disadvantage of the lateral approach to the foot is that it presents little subcutaneous cellular tissue, so the closure must be very careful to avoid such a complication.

Our study has some limitations related to the methodological design and retrospective data collection. The AOFAS scale has not been validated in the pediatric population, although it has been used in other similar studies.[8,23] Despite these limitations, we consider that the results with a minimum follow-up of two years are encouraging, since most of the patients had no symptoms and were able to return to their activities without difficulties.

CONCLUSION

The resection of symptomatic CNCs with the interposition of a free fat graft taken from the gluteal region allows to improve function and relieve pain with a low rate of complications.

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Versatility of the Tibia Long Retrograde Intramedullary Nail for Tibiotalocalcaneal Arthrodesis in Patients with Associated Lesions in the Same Segment

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ABSTRACT

Background: The joint condition that leads to the need for a tibiocalcaneal arthrodesis may be accompanied by a second injury in the same bone segment, and design nails for arthrodesis are not of adequate length to cover both injuries. We have not found therapeutic options for this type of injury in the literature. **Objective:** To present a series of cases where a single tibia nail (antegrade placement) was used retrogradely, with the dual objective of performing a tibiotalocalcaneal arthrodesis added to the treatment of an associated injury in the same surgical stage. **Materials and methods:** We retrospectively evaluated a group of 12 patients who required a tibiotalocalcaneal arthrodesis as well as to simultaneously resolve a local secondary defect from September 2009 to June 2019. The average age was 43.7 (27-61) years, and the global follow-up was 43.9 months. **Results:** All patients achieved a tibiocalcaneal arthrodesis confirmed in antero-posterior and lateral radiographs, and 83.3% of the patients recovered their bone stock completely. **Conclusion:** Faced with the lack of osteosynthesis in the market to resolve associated pathologies in the same patient, we propose the use of a long tibial intramedullary nail placed in a retrograde manner as a treatment option since it has proven to be efficient in achieving tibiocalcaneal arthrodesis. In addition, it could be used as a rail for bone lengthening and transport, and as stabilization to treat simultaneous injuries.

Keywords: Tibiotalocalcaneal arthrodesis; bone lengthening; bone transport; retrograde nail; tibial fracture.
Level of Evidence: IV

Versatilidad del clavo endomedular retrógrado largo de tibia para artrodesis tibio-talo-calcánea en pacientes con lesiones asociadas en el mismo segmento

RESUMEN

Introducción: La afección articular que lleva a la necesidad de una artrodesis tibio-calcánea puede estar acompañada de una segunda lesión en el mismo segmento óseo, y los clavos de diseño para artrodesis no tienen la longitud adecuada para cubrir ambas lesiones. No hallamos opciones terapéuticas para este tipo de lesiones en la bibliografía. **Objetivo:** Presentar una serie de casos en los que se utilizó un único clavo de tibia (de colocación anterógrada) de forma retrógrada, con el doble objetivo de efectuar una artrodesis tibio-talo-calcánea, sumada al tratamiento de una lesión asociada en un mismo tiempo quirúrgico. **Materiales y Métodos:** Se evaluó, en forma retrospectiva, desde septiembre de 2009 hasta junio de 2019, a un grupo de 12 pacientes que requirió una artrodesis tibio-talo-calcánea sumada a la necesidad de resolver simultáneamente un defecto secundario local. La edad promedio fue de 43.7 años, y el seguimiento global fue de 43. 9 meses. **Resultados:** Todos los pacientes lograron una artrodesis tibio-calcánea constatada en radiografías de frente y de perfil, y el 83,3% recuperó el capital óseo de manera completa. **Conclusión:** Ante la ausencia en el mercado de osteosíntesis para resolver las patologías asociadas en un mismo paciente, proponemos el uso del clavo endomedular largo de tibia colocado de manera retrógrada como una opción de tratamiento, porque se ha demostrado que es eficaz para lograr la artrodesis tibio-calcánea. Además, se lo pudo utilizar como riel en el alargamiento y el transporte óseo, y como estabilización para tratar lesiones simultáneas.

Palabras clave: Artrodesis tibio-talo-calcánea; alargamiento óseo; transporte óseo; clavo endomedular retrógrado; fractura de tibia.
Nivel de Evidencia: IV

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INTRODUCTION

Tibiotalocalcaneal arthrodesis is a procedure indicated for patients with post-traumatic osteoarthritis, rheumatoid arthritis, sequelae of infections, neuromuscular symptoms and ankle arthroplasty failure.[1] Its goal is to achieve a solid and painless fusion in a biomechanically stable position that allows the person to ambulate unaided.[2] For this, retrograde intramedullary fixation is the implant of choice.[3]

The procedure described refers to the tibiotalocalcaneal fixation in the context of a lesion at this level, an element that motivates the use of nails of adequate lengths for this purpose; however, the joint involvement may be accompanied by an extension or a second bone lesion at the diaphyseal level of the same bone segment, and design nails for arthrodesis are not of adequate length to cover both lesions; therefore, it is necessary to add an implant or apply a tactic that allows a single osteosynthesis to be adapted for the management of added injuries.

We have not found therapeutic options for this type of injury in the literature, so we have implemented a strategy that is tailored to the needs of the possible combination of injuries that the patient may present. For this reason, we present a series of cases in which a traditional antegrade tibial nail was used, placed in a retrograde manner, with the main objective of performing a tibiotalocalcaneal arthrodesis adding the function of treating associated injuries with a single osteosynthesis as a secondary objective.

At the same time, we tried to outline a way to classify the possible indications.

MATERIALS AND METHODS

Our case series was evaluated retrospectively from September 2009 to June 2019. We included patients >18 years of age with an indication for tibiotalocalcaneal arthrodesis, who presented a concomitant condition in said bone segment where the use of a conventional-length arthrodesis nail was not possible. They also had to have complete medical records. Those who did not meet any of these three conditions were excluded.

Using the data provided by the electronic medical record of our institution, demographic variables, the type of initial trauma and the number of previous surgeries upon admission to our institution were evaluated.

Likewise, the length of the bone defect, if it existed, and the correction achieved at the end of the treatment were evaluated, as well as the presence or absence of concomitant infection and the type of germ, if applicable. After collecting the information, a group of 12 patients was formed, who were classified according to bone defects and therapeutic needs, namely:

1. Limb with conservation of segment length
   A. With segmental defect
   B. Without segmental defect
2. Limb that does not preserve segment length

As an example, the treatment of each of the possible sequelae was described, showing the versatility of the technique according to the problem in each case.

Problem 1.A. Limb with length conservation plus segmental defect

This group was made up of five patients with a bone stock deficit in the tibia, whose main reconstructive strategy, in most cases, was bone transport.

In these situations, the same intramedullary nail was used for the tibiotalocalcaneal arthrodesis and as a mechanical axis to guide the transported bone segment for bone reconstruction.

A 35-year-old man with a history of exposed distal tibia fracture with joint involvement and bone loss. He was treated at another center and progressed to an infected nonunion (Figure 1A-B).

Upon entering our institution, he underwent debridement (Figure 1C), then a cement spacer with antibiotics was placed and stabilized with a retrograde tibia nail at the tibio-talo-calcaneus level (Figure 1D).

Faced with a favorable evolution and after control of the local septic process, the defect was reconstructed with bone transport on a nail (Figure 1E).

After transporting, it was decided to protect the area with plating and screws (Figure 1F).

Figure 1. **A and B.** Anteroposterior and lateral leg radiographs. The focus of nonunion is observed in the distal tibia. **C.** Anteroposterior leg radiograph after initial debridement. The bone stock deficit is observed. **D.** Anteroposterior leg radiograph after the placement of an antibiotic-loaded cement spacer and the stabilization with a retrograde tibia nail at the tibiocalcaneal level. **E.** Anteroposterior leg radiograph. The reconstruction of the defect with bone transport on a nail is observed. **F.** After transporting, it was decided to protect the area with a plate and screws.

Problem 1.B. Limb with length conservation and without segmental defect

This group included two patients with two or more injuries to the tibia, who preserved limb length and did not have a segmental bone defect.

A 46-year-old woman with a right pilon fracture associated with a fibula fracture (Figure 2A-B). Reduction and osteosynthesis were carried out. The postoperative outcome is shown in Figure 2C-D. Four months after surgery, she suffered from a surgical site infection, requiring multiple cleanings over four months. In a tomographic control (Figure 2E-F), a joint with important degenerative changes was observed; therefore, it was decided to remove the osteosynthesis. At the time of reimplantation, due to post-traumatic osteoarthritis and an infectious history, it was decided to perform retrograde tibiotalocalcaneal arthrodesis with a nail coated with antibiotic-loaded cement. The postoperative outcome is shown in Figure 2G-H.

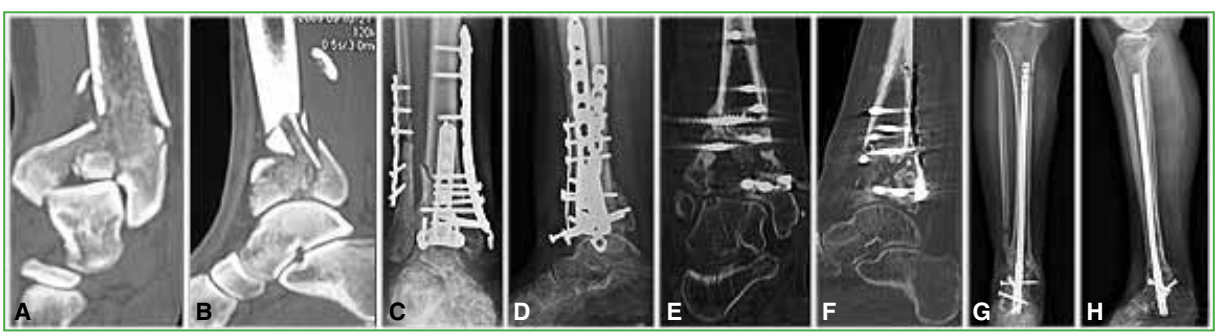

Figure 2. Ankle computed tomography, coronal (**A**) and sagittal (**B**) planes. A 46-year-old woman with a right pilon fracture associated with a fibula fracture. **C and D.** Anteroposterior ankle radiographs after reduction and osteosynthesis. **E and F.** Ankle computed tomography, coronal and sagittal planes. Follow-up after the treatment of the focus of infection. Important degenerative joint changes are detected. **G and H.** Anteroposterior and lateral leg radiographs, after a retrograde tibiocalcaneal arthrodesis using a nail coated with antibiotic-loaded cement.

Problem 2.B. Limb that does not preserve the length of the segment plus segmental bone defect

This group comprised five patients who had a length discrepancy due to a bone defect in the affected lower limb. In patients with defects that could not be compensated for with enhancement, callotasis lengthening was performed on the same retrograde intramedullary nail that was used for ankle arthrodesis.

A 59-year-old man with a history of peripheral vascular disease, who suffers an open pilon fracture. He was initially treated in another center, required multiple bone and soft tissue surgical procedures, and progressed with loss of bone stock at the joint level (Figure 3A-B) and the failure of two covering flaps. At that time, an infrapatellar amputation was indicated, which was rejected by the patient.

He was referred to our institution with a soft tissue defect on the lateral aspect of the right ankle, in addition to long-standing bone and joint exposure. Reconstruction was performed through a bone resection of the tibia and distal fibula with acute shortening of the limb and tibiotalocalcaneal arthrodesis with a long nail. (Figure 3C-D). Given the improvement of the soft tissues, we proceeded with callotasis lengthening according to the technique (Figure 3E). The final outcome can be observed in Figure 3F-G.

Figure 3. A and B. Anteroposterior and lateral ankle radiographs. The sequela of an open fracture of the tibial pilon is observed which, after multiple surgeries, evolved with loss of joint bone stock. **C and D.** Anteroposterior and lateral ankle radiographs, after reconstruction through a bone resection of the tibia and distal fibula with acute shortening of the limb and tibiocalcaneal arthrodesis with a long nail. **E.** Scanogram of both lower limbs at the beginning of the lengthening due to callotasis according to the technique. **F.** Scanogram of both lower limbs. **G.** Anteroposterior leg radiograph. Final outcome.

FINDINGS

A series of 12 patients (8 men and 4 women) was presented. The average age was 43.7 years (range 27-61); the average age of the patients in group 1 was 40.8 years (range 27-61) and the average age of the patients in group 2 was 47.6 years (range 31-59).

The global follow-up was 43. 9 months from September 2009 to June 2019.

Regarding the initial trauma, the exposed fractures of the tibia and fibula and the pilon fractures were the most frequent (4 patients each), followed by the exposed fracture of the femur, ankle fracture, isolated fracture of the fibula and exposed talus dislocation (1 patient each).

Regarding the number of surgeries before entering our institution, three patients did not have surgeries or had up to two previous interventions, the remaining nine patients had more than two interventions in other centers.

Regarding the analysis of the length of the bone defects in centimeters, we observed that, in the group of patients with conservation of limb length, in those who had a segmental defect (subgroup A), the average defect was 6.02 cm. Subgroup B did not have an associated segmental bone defect. Finally, patients without preservation of limb length had an average shortening of 4.07 cm.

The final correction achieved in patients without preservation of limb length was complete in two of the five cases, a residual shortening of 2 cm in one patient and 4 cm in the remaining two.

As seen in Table 1, in most cases, the first step was the infectological staging of the patients. 91.6% suffered a concomitant infection, and the most frequent germ was *Staphylococcus aureus* (Table 2). For this reason, all the nails used for arthrodesis were coated with antibiotic cement. In addition, all the patients had a multidisciplinary follow-up together with the doctors of the Infectious Diseases Service who determined the indicated antibiotic, according to the results of the cultures. The patients underwent intravenous or oral treatment for at least 6 weeks, depending on the microorganism isolated in surgery, and were periodically monitored with laboratory tests that included white blood cell count, erythrocyte sedimentation and C-reactive protein, as well as a trauma control to assess the evolution of the surgical site.

At the time of surgery, all patients were placed in the dorsal decubitus position on a radiolucent surgical table, and the conventional plantar entry point was used.

Regarding complications, those that required surgical treatment were documented. These complications were mainly associated with an infectious history rather than with the retrograde arthrodesis technique with a tibial nail. (Table 3).

In the 12 patients, a satisfactory tibiocalcaneal arthrodesis was achieved, confirmed in the anteroposterior and lateral radiographs, and 83.3% recovered their bone stock completely.

Table 1. Initial surgery performed at our institution.

Initial surgery	+/N° patients
Puncture biopsy	9/12
External tutor	3/12
Reduction and osteosynthesis	1/12

Tablae 2. Microorganism detected in the samples taken at the initial surgery.

Microorganism	Number of patients
Staphylococcus aureus	8/12
Enterococcus faecalis	7/12
Pseudomonas aeruginosa	3/12
Staphylococcus epidermidis	3/12

Table 3. Complications that required a new procedure.

Complications/Procedure	Number of affected patients
Infection/Surgical debridement	8/12
Infection/Intramedullary nail replacement x1	4/12
x2	2/12
several	2/12
Misalignment/Osteotomy	5/12

DISCUSSION

It is a known fact that, when faced with a tibial shaft fracture, the standard treatment is the intramedullary nail.[4] Regarding tibiotalocalcaneal arthrodesis, although internal fixation with screws and other devices has been described, satisfactory outcomes have been reported with the use of an intramedullary nail to achieve arthrodesis. Biomechanical studies demonstrate superior strength with an intramedullary nail than with screw fixation.[5] Implants up to 465 mm long are marketed for tibia fractures, but not for ankle arthrodesis, where the designed nails do not exceed 300 mm.

The problem arises in patients who need ankle arthrodesis associated with a pathology that requires proximal fixation.

No method has been published to solve both pathologies simultaneously with the same implant, nor have we found implants designed to treat them together.

Biomechanical studies demonstrate that an area susceptible to stress is located immediately proximal to fixation with short nails. This occurs because after the arthrodesis of the tibio-calcaneal joint and the subtalar joint, a decrease in the range of motion is generated and, without the ability to accommodate the forces of both joints, a bending moment is generated along the tibia.[6] Another factor that contributes to tibial stress fractures after arthrodesis is the increased flexion forces transmitted to the distal tibia by a longer lever arm in a stiffer foot, associated with a decrease of the mechanical strength of the bone.[6] On the other hand, over the years, it has been shown that the proximal point of the nail coincides with a stress point in the tibia, the isthmus (transition between metaphysis and diaphysis), the place where the proximal locking screw is located, and the site where fatigue fractures occur.[6] Thordarson and Chanq identified a radiolucent area proximal to the tip of the standard retrograde nail, used in ankle arthrodesis, which is correlated with episodes of pain, manifested by patients in this area. Their theory states that this area is the area with the highest concentration of stress.[5]

In a biomechanical study, Noonan et al.[6] stated that, compared to the standard 15 cm nail, a longer nail would bring the stress concentration to the proximal tibia, thus avoiding potential fatigue. Other authors suggest that the nail should reach the anterior tibial tuberosity.[8] Burns and Dunse[9] found that the standard length of the short nail increases the force in the posterior cortex of the tibia at the proximal lock by 5.3 times more than a long locking nail. For this reason, many use a long intramedullary nail for better fixation and stability in the shaft, reducing stress and the possibility of fracture.

Another potential benefit of the retrograde intramedullary nail is the early weight-bearing, this becomes a fundamental aspect when performing an arthrodesis in elderly patients with low functional demand, since it has been demonstrated that early mobility reduces mortality in this age group.[8] According to the literature, long femoral nails have been used in a retrograde manner, but in scenarios different from ours, as well as tibia nails in a retrograde manner, but in patients who only presented a defect secondary to oncological disease. Baker et al.[8]studied the use of a long retrograde femoral nail for unstable ankle fractures in 16 elderly patients (average age 73 years). With an average follow-up of 21 months, they demonstrated that the use of the retrograde femoral intramedullary nail is a safe and effective option, there were no cases of osteosynthesis failure, no fractures around the implant or wound infections. Pinzur et al.[7] evaluated nine patients with type 2 diabetes plus Charcot arthropathy who underwent ankle arthrodesis using a retrograde femoral nail. The average age was 52 years. Consolidation was confirmed on radiographs, in all patients, in an average time of 10.5 weeks. No patient sustained a fracture or had evidence of stress. With an average follow-up of 32 months, all patients walked wearing orthopedic shoes. Xu et al.[10] evaluated five patients with tibial osteosarcoma who underwent resection plus allograft in addition to arthrodesis with a retrograde tibial intramedullary nail. With a 42-month follow-up, four of the five patients were satisfied with the results. By the sixth month of follow-up, all had radiographic signs of consolidation.

One strength of our work is that we present a novel way to resolve multiple concomitant conditions in the same bone segment, with the same implant and in a single surgical time. Our case series had a follow-up time similar to that of the published series, with the exception that none of those described is the same as the one we present here.

As for weaknesses, we mention its retrospective nature, with a series of heterogeneous cases.

CONCLUSIONS

In our series of cases, the retrograde tibial nail has not only achieved its main objective (the tibiotalocalcaneal arthrodesis), but has also made it possible to treat a wide range of associated conditions, which demonstrates the great versatility of this technique. As we reported, the same osteosynthesis allowed, in turn, to carry out bone transport, to be a guide for lengthening, and to help local infectological control, as has been presented in the different cases.

We consider that, in the future, it would be necessary to develop an osteosynthesis designed specifically for this type of technique. Given the current absence in the market, we suggest the use of tibia nails placed in a retrograde manner, with which, in our cases, we have obtained good results, safely and with minimal complications.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Acute Achilles Tendon Injury Treatment Using a Minimally Invasive Knotless Technique. Rehabilitation and Immediate Weight Bearing

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ABSTRACT

Introduction: Modern surgical techniques seek to rehabilitate early for recovery in less time. Minimally invasive techniques are one option to accomplish this. **Objective:** To evaluate the ability to start rehabilitation and weight bearing in the immediate postoperative period and the evolution at 6 months postoperative using a minimally invasive knotless technique. **Materials and Methods:** 10 surgical repairs of acute Achilles tendon injuries were performed with a minimally invasive technique. The original Arthrex combination system (PARS - SpeedBridge™) was used. After 48 hours, weight bearing was progressively allowed according to tolerance. The final outcome at 6 months was evaluated using the ATRS score. **Results:** On average, patients took 14 days to walk without crutches. All began rehabilitation with active and passive ankle range of motion during the first postoperative week. The average ATRS score was 79 points (between 60 and 90 points). **Conclusion:** This technique has proven to be an excellent surgical option in acute midsubstance Achilles tendon injuries. The patients were able to start rehabilitation within the first postoperative week, whereas immediate weight bearing was not possible, due to the patients' pain or fear.

Key words: Achilles tendon; minimally invasive technique; knotless technique; early rehabilitation.
Level of Evidence: IV

Tratamiento de la lesión aguda del tendón de Aquiles mediante una técnica mínimamente invasiva sin nudos. Rehabilitación y carga de peso inmediata

RESUMEN

Introducción: Las técnicas quirúrgicas modernas buscan rehabilitar en forma temprana para una recuperación en menor tiempo. Las técnicas mínimamente invasivas son una opción para lograrlo. **Objetivo:** Evaluar la capacidad de comenzar una rehabilitación y la carga de peso en el posoperatorio inmediato utilizando una técnica mínimamente invasiva sin nudos y la evolución a los 6 meses de la cirugía. **Materiales y Métodos:** Se realizaron 10 reparaciones quirúrgicas de lesiones agudas del tendón de Aquiles con una técnica mínimamente invasiva sin nudo. Se utilizó el sistema combinado (PARS – SpeedBridge™ original. A las 48 h se permitió la carga completa de forma progresiva, según tolerancia. Se evaluó el resultado final a los 6 meses utilizando el puntaje ATRS. **Resultados:** En promedio los pacientes tardaron 14 días en deambular sin muletas. Todos comenzaron la rehabilitación con movilidad activa y pasiva del tobillo durante la primera semana posoperatoria. El puntaje ATRS promedio fue de 79 (rango 60-90). **Conclusión:** Esta técnica ha demostrado ser una excelente opción quirúrgica en las lesiones agudas del tendón de Aquiles de media sustancia, pero no fue posible comenzar con la carga de peso inmediata debido al dolor o temor del paciente, pero sí con la rehabilitación dentro de la primera semana posquirúrgica.

Palabras clave: Lesión de Aquiles; técnica mínimamente invasiva; técnica sin nudos; rehabilitación temprana.
Nivel de Evidencia: IV

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INTRODUCTION

The incidence of acute non-insertional Achilles tendon injury is increasing in patients aged 30 to 50 years, and more than 50% of cases occur during recreational sports.[1]

The choice of treatment remains a controversial topic, it can be surgical or conservative.[2] During the last decade, surgical treatment has been considered the first option,[3] especially in high-performance athletes.

The incidence of re-rupture has been shown to be higher in conservatively treated patients, but the risk varies between different studies.[4] However, operated patients are at higher risk of infections and soft tissue problems.[5] According to the *American Academy of Orthopedic Surgeons* (AAOS) practice guidelines, minimally invasive techniques cause fewer overall complications than traditional open repair.[6] Modern surgical techniques seek to rehabilitate early, to achieve recovery and return to daily activities and sports in less time.

OBJECTIVE

To assess the ability to start rehabilitation and weight bearing in the immediate postoperative period using a minimally invasive knotless technique and the evolution six months after the intervention.

MATERIALS AND METHODS

A retrospective study was conducted in a healthcare facility in the province of Buenos Aires. 10 patients operated between January and March 2019 to treat an acute Achilles tendon rupture were included.

The inclusion criteria were: 1) age between 18 and 55 years, 2) acute midsubstance Achilles tendon injury, and 3) surgery using the same percutaneous knotless technique. The exclusion criteria were: 1) age >55 years and <18 years, 2) injuries of more than three weeks of evolution, 3) previous surgeries or conditions of the Achilles tendon.

All patients were operated on by the same leg, ankle and foot surgeon, with the same surgical technique. The original PARS - SpeedBridge ™ (Arthrex) combined system was used, with a minimally invasive knotless technique.

Surgical technique

The patient was placed face down with the leg in neutral rotation. Both feet were left hanging at the end of the table to allow the control of the plantar flexion of the ankle during surgery.

A 2 cm wide transverse skin incision was made on the proximal aspect of the palpable defect in the midsubstance Achilles tendon (Figure 1). The paratenon was opened, the proximal tendon stump was secured with an Allis clamp, and gentle distal traction was applied. A Percutaneous Achilles Repair System jig (Arthrex) was then inserted into the incision and advanced proximally into the paratenon. A passing needle was placed through the jig and tendon for preliminary fixation (Figure 2). Suture needles and No. 2 FiberWire sutures (Arthrex) were passed using numbered holes along the side of the jig (Figure 3). The jig was removed through the incision with all the sutures to ensure fixation and control of the proximal tendon (Figure 4). Then, two 5 mm longitudinal incisions were made on the posterior aspect of the heel, medial and lateral to the insertion of the Achilles tendon in the calcaneus. The drill (3.5 mm) and the drill guide were used through each incision, oriented slightly towards the midline (Figure 5). Each hole was drilled to receive the 4.75mm SwiveLock® Anchor (Arthrex). The Banana SutureLasso ™ (Arthrex) with inner nitinol wire was passed through the distal stump of the Achilles tendon distally (heel incision) to proximally (transverse incision), to retrieve a side of the proximal sutures (Figure 6). The sutures were passed through the distal stump of the Achilles tendon and the process was repeated for the other side. Ankle plantar flexion was performed to adequately tighten the Achilles tendon. Sutures were passed through the eyelet of the SwiveLock® anchor (Arthrex), and the anchor was gently inserted into the calcaneal drill hole up to bone level (Figure 7). The process was repeated for the insertion of another SwiveLock® anchor. The repair of the paratenon with absorbable sutures was followed by subcutaneous and skin closure. After the final repair, plantar flexion of the ankle at rest was assessed and the Thompson test was performed (Figure 8).

Figure 1. 2 cm transverse skin incision on the proximal aspect of the palpable defect in the midsubstance Achilles tendon.

Figure 2. Percutaneous Achilles tendon Repair System (Arthrex) in the incision, advanced proximally into the paratenon. A passing needle is placed through the jig and tendon for preliminary fixation.

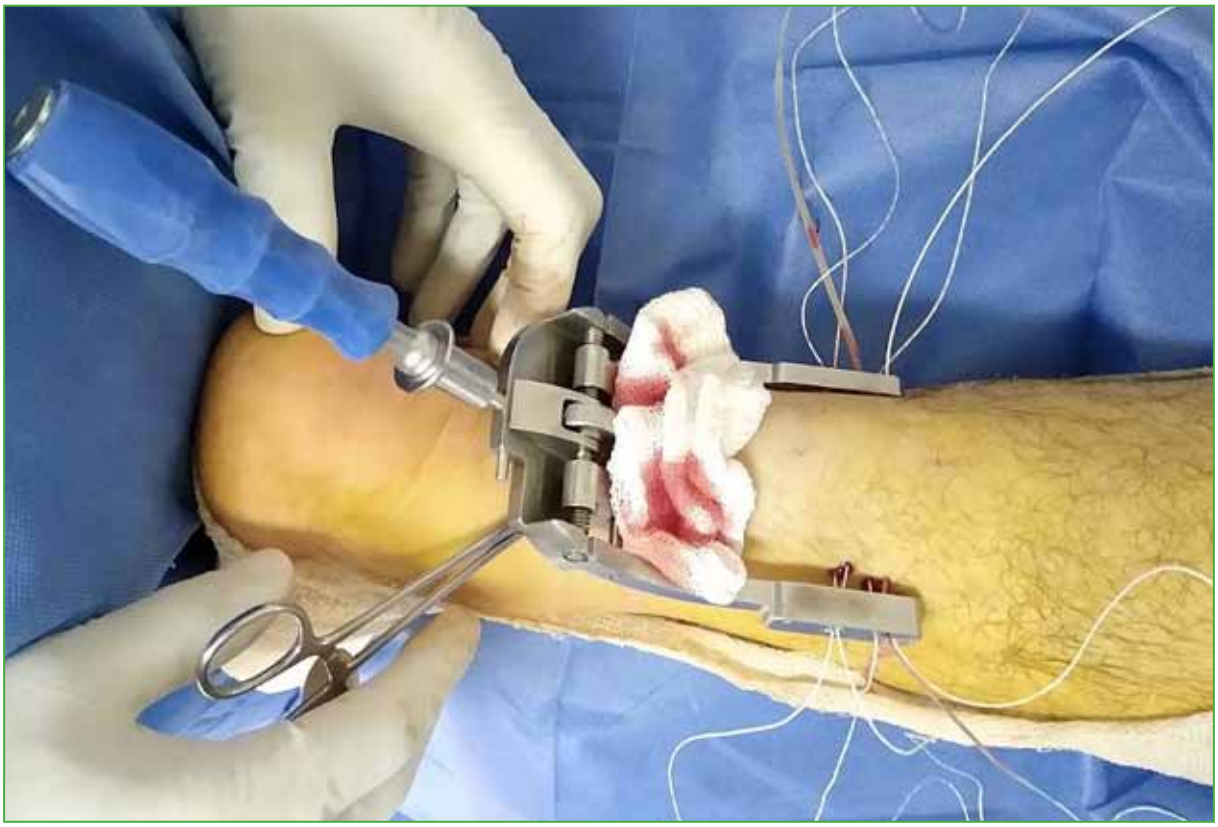

Figure 3. Suture needles and No. 2 FiberWire® (Arthrex) are passed using numbered holes along the side of the jig.

Figure 4. The clamp and jig are removed through the incision, and all pairs of sutures are pulled distally to ensure fixation and control of the proximal tendon.

Figure 5. Two 5 mm longitudinal incisions are made along the posterior aspect of the heel along the sides of the Achilles tendon insertion. The drill (3.5mm) and drill guide are used through each incision oriented slightly toward the midline.

Figure 6. The Banana SutureLasso ™ (Arthrex) with inner nitinol wire is passed through the distal stump of the Achilles tendon and through a proximal incision to retrieve one side of the proximal suture.

Figure 7. The ankle is plantar flexed to properly tighten the Achilles tendon and an assistant holds it in place. Sutures are passed through the eyelet of the SwiveLock® Anchor (Arthrex), and the anchor is gently inserted into the calcaneal drill hole and hand-tightened until it reaches bone level.

Figure 8. After the final repair, the plantar flexion of the ankle at resting position is evaluated and the Thompson test is performed.

A plantar flexion splint was placed for immobilization. After 48 h, the splint was removed and a walker boot with 2 heel wedges, each 1.5 cm high, was placed. Full weight bearing was allowed, progressively, according to tolerance. Rehabilitation was indicated, with a kinesiologist familiarized with the surgical technique used.

Follow-up visits took place weekly during the first month, every two weeks during the second month and once a month until six months. The final outcome was assessed at six months using the ATRS (*Achilles tendon Total Rupture Score*). It is a patient-informed instrument with high reliability, validity, and sensitivity to measure the outcome after treatment in patients with total Achilles tendon rupture.[7]

FINDINGS

Ten surgical repairs of acute Achilles tendon injuries were performed using a minimally invasive knotless technique in 10 patients (8 men and 2 women), of an average age of 40 years (range 21-50). Six procedures were on the right side and four on the left side. The minimum follow-up was 6 months (range 6-9). All patients had been injured during recreational sports (9 soccer and 1 volleyball).

A postoperative follow-up of up to 6 months was conducted in 9 of the 10 operated patients. A patient moved abroad a month after the surgery and it was not possible to contact him.

The average time elapsed between injury and surgery was 7.5 days (range 5-9). There were no intraoperative complications. The evolution of the wounds was very good and free of complications (infection, dehiscence or adhesion). There were no neurological injuries.

All patients had their splint removed 48 h after surgery, a walker boot with a 3 cm heel wedge was placed, and they were allowed to begin weight bearing progressively with assistance of crutches according to tolerance. They were told that they could leave the crutches the same day the splint was removed. A heel pad was removed after three weeks.

The patients took 14 days on average to walk without crutches (range 7-20). None of them did full weight bearing before day 7 after surgery, due to pain or fear of rupture of the fixation system of the tendon to the calcaneus. All patients began rehabilitation with active and passive ankle range of motion during the first postoperative week. They began walking without a walker boot, on average, at 6.6 weeks (range 6-8). The return to normal work activities occurred, on average, at nine weeks (range 4-12). One patient resumed sports activity (skiing) at three months and 10 days. The remaining eight did not start sports activity until five months after surgery.

Nine patients were discharged at 6 months. The average ATRS score was 79 (range 60-90). All patients said they were satisfied with the procedure and that they did not regret the decision of undergoing surgery. Two patients experienced mild to moderate pain at the SwiveLock® placement site when rubbing with footwear until the last follow-up appointment at 6 months.

DISCUSSION

Many minimally invasive techniques that achieve good functional outcomes and a low complication rate have been described. In a meta-analysis of 800 patients, percutaneous techniques reduced the rates of re-rupture and overall complications when compared to open surgical techniques.[5]

Compared to open techniques, the advantages of minimally invasive techniques in terms of complication rate are clear. However, in all of these techniques, knots are used to hold both ends of the Achilles tendon together and do not allow rehabilitation to begin immediately.

After a minimally invasive procedure using Dresden instruments, Amlang et al.[8] allowed patients to start physiotherapy at two weeks. Using the same technique, Joannas et al.[9] allowed active dorsiflexion of the ankle at three weeks and Arzac et al.[10] authorized physiotherapy and 50% weight bearing at five weeks.

In a prospective randomized study, De la Fuente et al. concluded that patients operated using a minimally invasive technique with Dresden instruments and who begin aggressive and immediate rehabilitation have better clinical outcomes and better Achilles tendon function at 12 weeks without increasing complications.[11]

A biomechanical study comparing the original Arthrex PARS (minimally invasive technique with knots without fixation to the calcaneus) with the open Krackow repair did not find significant differences in load and work, but did find a higher initial linear stiffness for open repair, which could potentially reduce the gap formation during postoperative rehabilitation.[12]

Tendon lengthening is a recognized complication of Achilles tendon rupture repair. This can worsen the functional outcome and has been shown to be more common with minimally invasive procedures than with open techniques.[13]

Using the technique presented in this study, the suture passes through the distal stump of the tendon in its entire length, before anchoring directly to the calcaneus at the anatomical insertion point; this avoids the risk of knot failure and cutting of the suture at the distal end of the tendon.[14] This can be contrasted to other minimally invasive techniques that do not anchor in the bone, which would allow rehabilitation and weight bearing to begin in the immediate postoperative period, with less risk of elongation and re-breakage.

The clinical outcomes of this technique are mainly limited to case reports,[15] but, like the results of this study, the initial reports are promising and support early rehabilitation and early return to sports. A preliminary report of 34 patients operated on with the same technique indicates that there were no complications and that the results were satisfactory.[16]

CONCLUSIONS

The minimally invasive knotless technique described and used in the nine patients monitored for six months was an excellent surgical option for acute midsubstance Achilles tendon injuries. There were no complications from the wounds nor neurological injuries. Weight bearing could not start until after 48 h after surgery, due to pain or fear of the patient, but rehabilitation started within the first week after surgery.

More studies with a larger number of patients operated with this technique are needed to compare it with other minimally invasive and open techniques in order to draw meaningful conclusions.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Mazabraud Syndrome: A Case Report

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ABSTRACT
Mazabraud's Syndrome is a rare association of lesions to the musculoskeletal system. It results from the combination of one or more intramuscular myxomas and fibrous dysplasia. We present a case of a 46-year-old man with bone lesions compatible with fibrous dysplasia associated with intramuscular myxoma, configuring Mazabraud's Syndrome, and a review of the literature.
Keywords: Mazabraud's syndrome; fibrous dysplasia; intramuscular myxoma.
Level of Evidence: IV

Síndrome de Mazabraud: reporte de un caso

RESUMEN
El síndrome de Mazabraud es una rara asociación de lesiones del sistema musculoesquelético. Resulta de la combinación de uno o varios mixomas intramusculares y displasia fibrosa. Presentamos a un hombre de 46 años con lesiones óseas compatibles con displasia fibrosa asociada a mixoma intramuscular configurando un síndrome de Mazabraud y una revisión de la bibliografía.
Palabras clave: Síndrome de Mazabraud; displasia fibrosa; mixoma intramuscular.
Nivel de Evidencia: IV

INTRODUCTION

Fibrous dysplasia is a developmental skeletal abnormality of unknown etiology; it is characterized by the replacement of the medullary cavity by fibrous tissue. It can present as a single lesion (monostotic) or multiple lesions (polyostotic).[1] It produces bone fragility with deformity, pain, pathological fractures, and functional impairment. Fibrous dysplasia is usually located in the pelvis and femur. On radiographs, it is visualized as lytic or dense diaphyseal-metaphyseal lesions, localized or diffuse, which can expand the bone and generate a trabeculated appearance, like "ground glass".[2]

The association between fibrous dysplasia and intramuscular myxomas is called Mazabraud syndrome. The first case was described by Henschen in 1926[3] and named by Mazabraud in 1957.[4] Approximately 100 cases have been reported to date.[1]

Intramuscular myxoma is a rare lesion, with difficult radiological and clinical diagnosis. Its incidence is 1: 1,000,000. It is a benign soft tissue neoplasm of mesenchymal origin.[5] It typically involves muscles, thighs, buttocks, shoulders, and the upper arm. Clinically, intramuscular myxomas present as a slow-growing, ovoid, painless mass.[6-9]

CLINICAL CASE

A 46-year-old man, with no pathological history, who consulted a general practitioner in another center, in October 2019, for localized mechanical low back pain during physical activity, of several months of evolution. An MRI of the spine and pelvis was requested, in which a doubtful image was observed in the proximal femur, so it was decided to extend the study to the thigh and complement it with radiographs and computed tomography of the entire right lower limb.

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In February 2020, the patient consulted a traumatologist at our center. On physical examination, full range of motion of the hip and knee was observed, with no pain in the right lower limb. In addition, a tumor was palpated in the proximal anterolateral area of the right leg, of approximately 8 cm, deep, elastic, not painful (Figure 1). The patient expressed that he had had the tumor since the age of 17 and its growth had been slow. New radiographs and an MRI of the hip and leg were requested, as well as an ultrasound of the soft tissue mass in the leg (Figure 2).

Figure 1. Clinical image of the lesion.

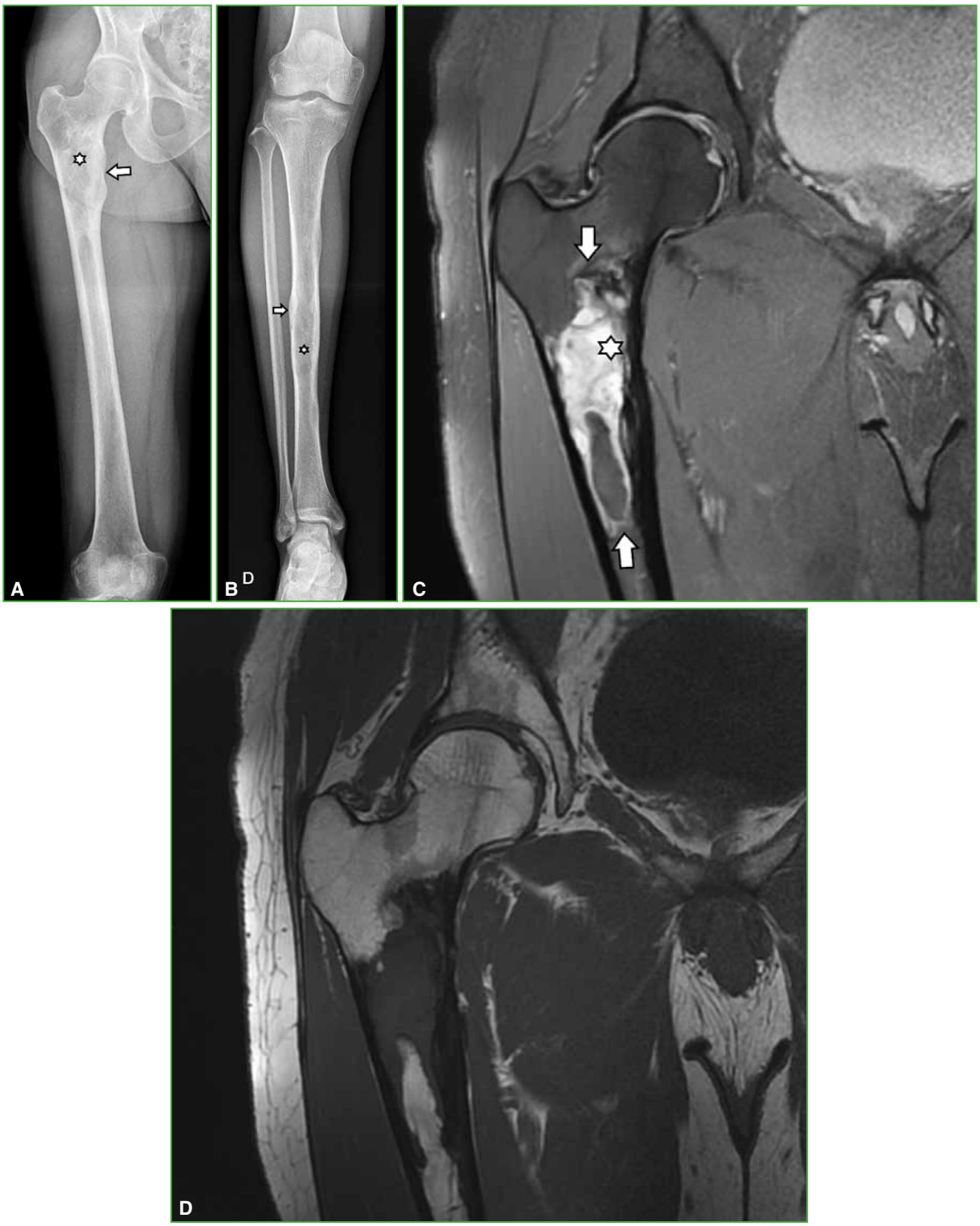

Figure 2. **A.** Frontal radiograph of the right femur. Bulging (asterisk) of the femoral neck adjacent to the lesser trochanter, cortical thinning (arrow), with loss of trabecular pattern. **B.** Radiograph of the right leg showing three lesions with similar characteristics to those described in the femur, endosteal involvement (arrow) and "ground glass" appearance (asterisk). **C.** Right hip MRI, coronal plane, STIR sequence. Marked hypersignal, endosteal compromise (asterisk), bone bulging and defined limits (arrows). **D.** Right hip MRI, coronal plane, T1-weighted sequence with marked hyposignal.

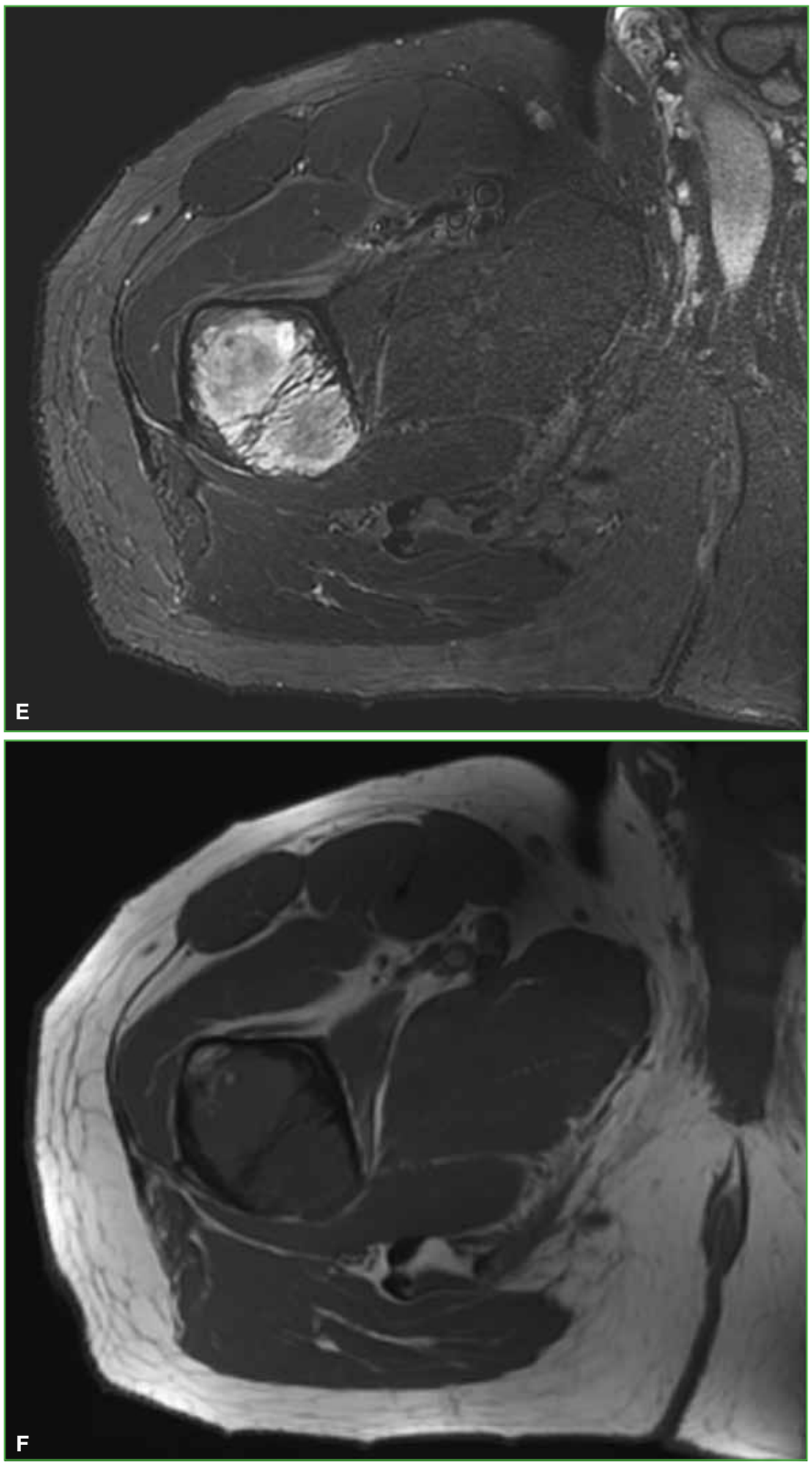

Figure 2. **E.** Right hip MRI, axial plane, STIR sequence with hypersignal. Bone bulging and thin interior septa. **F.** Right hip MRI, axial plane, T1-weighted sequence with hyposignal.

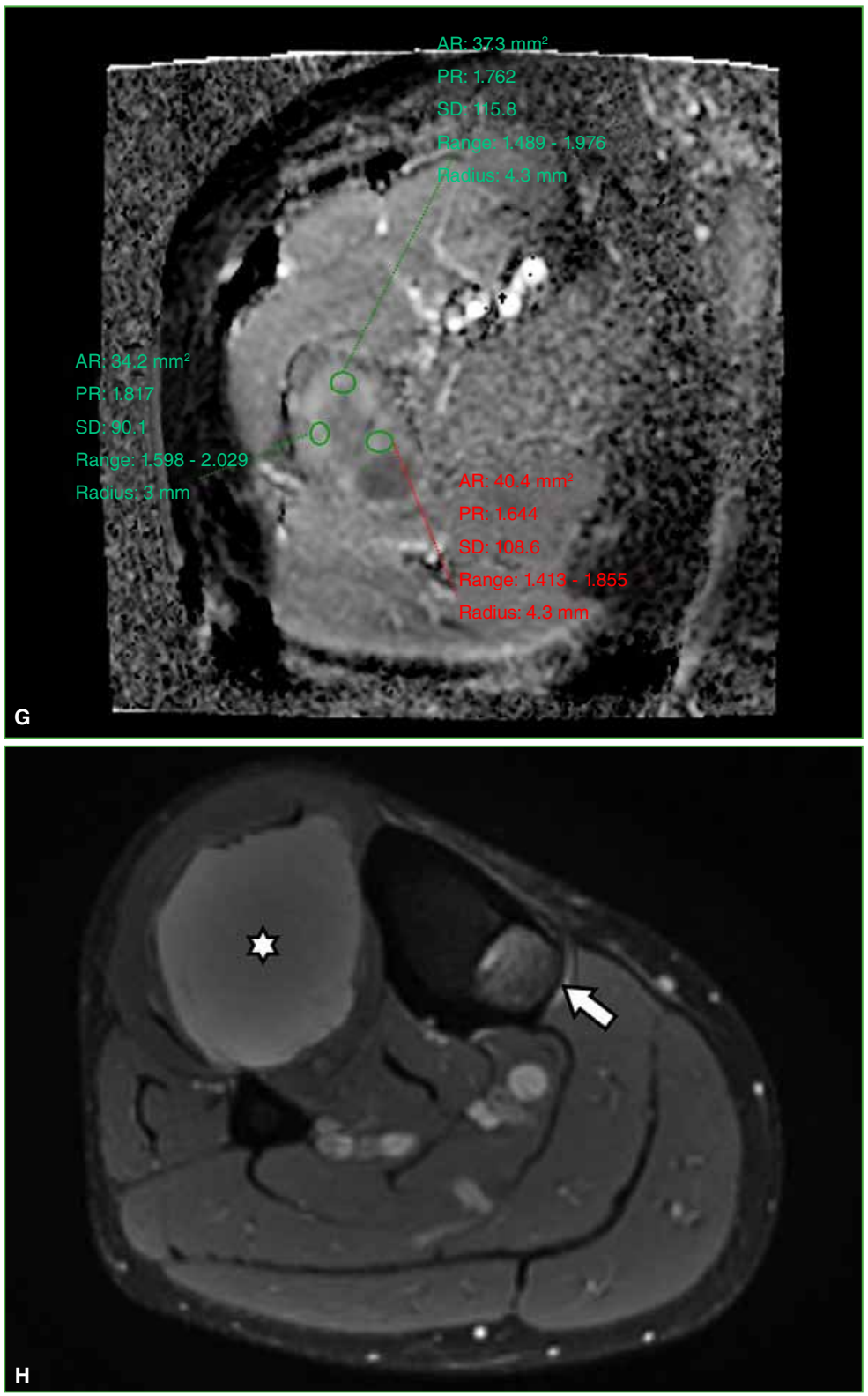

Figure 2. G. Map of the apparent diffusion coefficient with an average value of 1.7 x 10^{-3} mm^2/s, marking a facilitated diffusion. **H.** Right leg MRI, axial plane, STIR sequence. Hyperintense lesion in the proximal tibia (arrow) and markedly hyperintense lesion in soft tissue, in the anteroexternal muscle plane (asterisk).

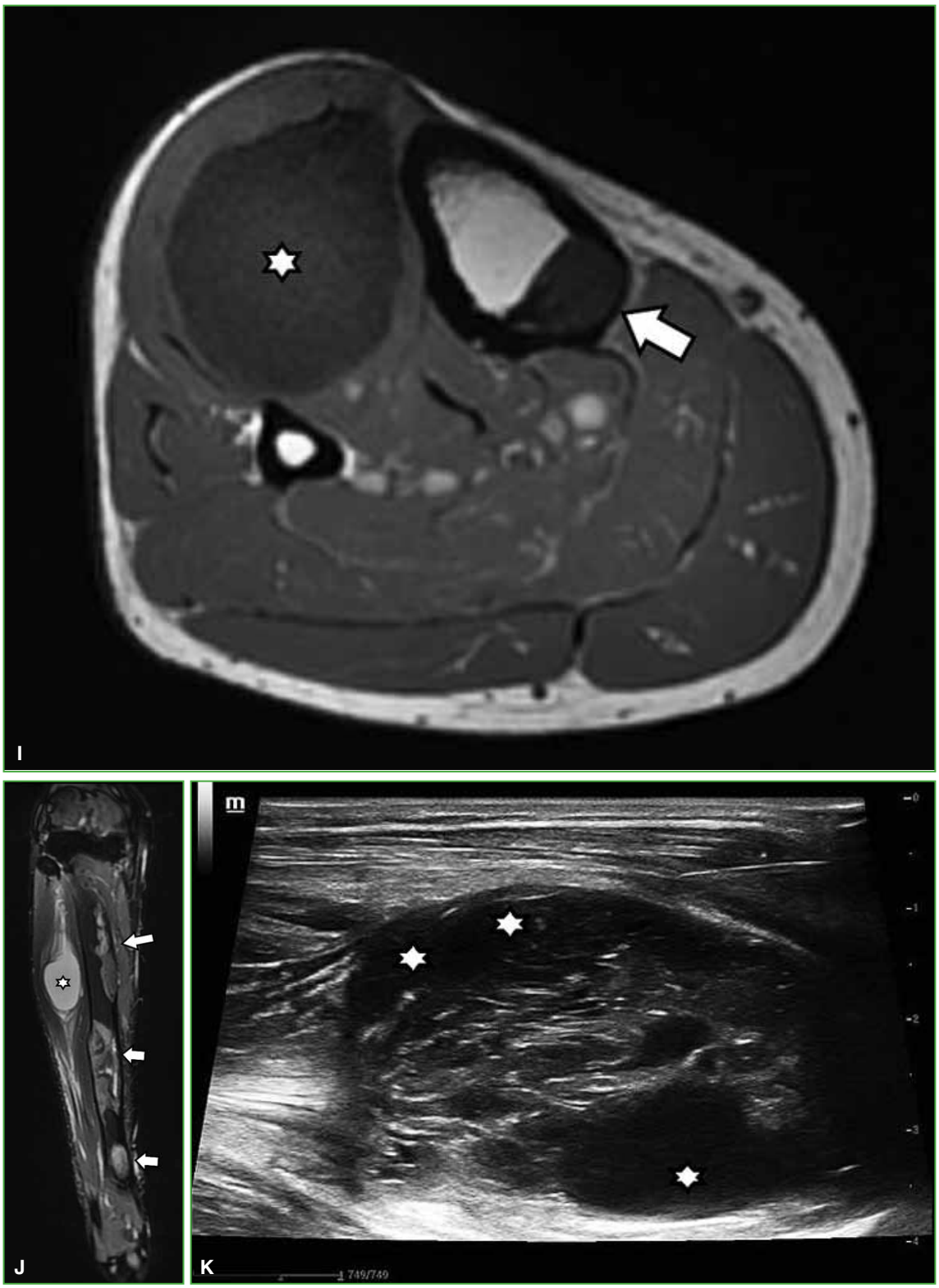

Figure 2. **I.** Right leg MRI, axial plane, T1-weighted sequence. Hypointense lesion in the proximal tibia (arrow) and markedly hypointense lesion in soft tissue (asterisk). **J.** Right leg MRI, coronal plane, STIR sequence. Multiple hyperintense bone lesions (arrows) and hyperintense soft tissue lesions (asterisk). **K.** Ultrasound of the soft tissue injury. Ovoid morphology, with partially defined borders, heterogeneous, with small peripheral cystic areas (asterisks).

Given the suspicion of an association between bone lesions, interpreted as fibrous dysplasia and soft tissue lesion, a biopsy of the soft tissue mass was requested (Figure 3). The histological analysis confirmed the intramuscular myxoma (Figure 4), which configures a Mazabraud syndrome.

The patient will continue under observation with radiological and clinical evolution studies.

Figure 3. Ultrasound-guided cutting-needle biopsy of the soft tissue lesion (arrow).

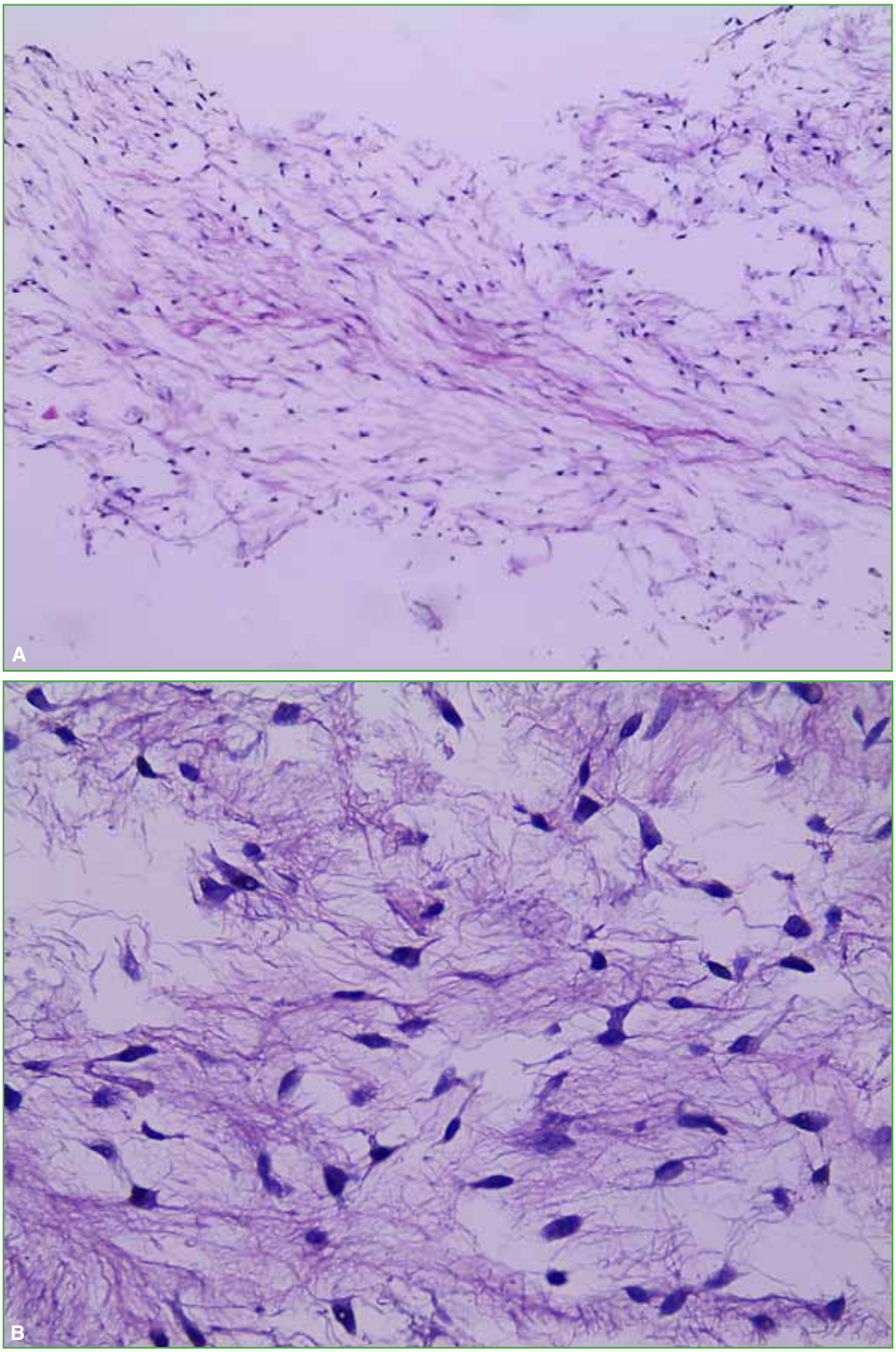

Figure 4. Pathological anatomy analysis with hematoxylin-eosin staining. Medium (**A**) and high magnification (**B**). A mesenchymal tumor with spindle cell myxoid stroma is seen. There are no atypia, mitosis, necrosis, or other significant alterations.

DISCUSSION

Fibrous dysplasia is a rare benign lesion caused by a genetic mutation in the GNAS gene, located in chromosome 20q13.2-q13.3.[10] It is characterized by the presence of non-ossified areas in the bone. It can be monostotic or polyostotic, and is more common in women (68%).[1,2,10] In general, it is diagnosed between the first and third decade of life. The most affected sites are the proximal femur, tibia, skull, ribs and, to a lesser extent, the humerus, forearm and pelvis. Often there are several conditions in the same bone.

The monostotic variant has an asymptomatic presentation; it appears as an incidental finding. The polyostotic variant can present with intermittent pain, stress fractures, expansion masses in palpable bones, or pathological fractures. The association of polyostotic fibrous dysplasia with intramuscular myxoma configures Mazabraud syndrome.[1,2,9,10]

Imaging of fibrous dysplasia is important for proper diagnosis and follow-up, to detect and treat possible complications.

On radiographs, it is visualized as radiolucent intramedullary diaphyseal lesions with a "ground glass" appearance and loss of the normal trabecular pattern, endosteal compromise and cortical thinning with spared areas. The margins are defined. A periosteal reaction is not observed. Computed tomography images confirm the presence of homogeneous lesions with a "ground glass" appearance. There may be cystic areas and calcifications. On magnetic resonance imaging, lesions with low signal on T1-weighted sequences and high signal on T2-weighted sequences are observed. There may be a hypointense halo around it in the T1- and T2-weighted sequences. As it is a benign lesion, it has facilitated diffusion with apparent diffusion coefficient values above 1.1×10^{-3} mm ^{2} / s.[1,2,10]

Radiographs are normal, although intramuscular myxomas may present with non-specific soft tissue calcifications. On ultrasound, intramuscular myxomas are visualized as ovoid masses, poorly defined and hypoechoic, with possible cystic areas. On computed tomography, they appear as hypointense lesions with a wall that separates them from muscle tissue. On MRI, they are visualized as hyperintense lesions on T2-weighted, gradient echo, or STIR sequences. T1-weighted sequences show low signal.[2,6-9]

CONCLUSIONS

Although the association between fibrous dysplasia and intramuscular myxomas is rare, it is probably underestimated due to misdiagnosis. Fibrous dysplasia is usually diagnosed earlier than intramuscular myxomas or at the same time, as findings on routine radiographs or MRI.

Symptoms are rare, they can manifest as pathological fractures or palpable masses.

The treatment of intramuscular myxomas is surgical excision. Fibrous dysplasia is controlled with imaging tests. The possibility of malignant transformation is low.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Retrograde Femoral Intramedullary Nail Extraction Techniques. Report of Three Cases

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ABSTRACT
Background: The indication for osteosynthesis with a retrograde intramedullary nail in femur fractures has increased in recent years and with it, the number of complications. Three surgical techniques are described for the management of the proximal fragment of the broken intramedullary osteosynthesis. From March 2001 to January 2019, 321 osteosyntheses with retrograde femoral intramedullary nails were performed at our institution. The implant rupture rate associated with nonunion was 0.9%. Minimally invasive techniques were performed to remove the implant, preserving the soft tissues. Definitive reosteosynthesis was achieved with the consequent consolidation in an average time of 140 days. **Conclusions:** The techniques used were simple, safe, minimally invasive, and reproducible.
Keywords: Broken; nail; retrograde; femur; extraction.
Level of Evidence: IV

Técnicas de extracción de clavos endomedulares retrógrados de fémur rotos. Presentación de tres casos

RESUMEN
Introducción: La indicación de colocar un enclavado endomedular retrógrado en las fracturas de fémur se ha incrementado en los últimos años y, con ello, la cantidad de complicaciones. Presentamos la descripción de las técnicas quirúrgicas para el manejo del fragmento proximal de la osteosíntesis endomedular rota. Desde marzo de 2001 hasta enero de 2019, se realizaron 321 enclavados endomedulares retrógrados de fémur en nuestra institución. La tasa de rotura del implante asociadas a una seudoartrosis fue del 0,9% (3 casos); se realizaron técnicas mínimamente invasivas y diferentes para la extracción del implante. En tres pacientes, se extrajeron los clavos rotos satisfactoriamente, sin complicaciones asociadas a la técnica quirúrgica. Se logró la reosteosíntesis definitiva con la consiguiente consolidación en un tiempo medio de 140 días. **Conclusiones:** Las técnicas utilizadas fueron simples, seguras, mínimamente invasivas y muy reproducibles.
Palabras clave: Rotura; clavo retrógrado; fémur; extracción.
Nivel de Evidencia: IV

INTRODUCTION

The use of antegrade intramedullary osteosynthesis is considered the treatment of choice for diaphyseal femur fractures; union rates close to 99% are obtained. [1] The indication for retrograde intramedullary nails has gained ground, expanding the initial indications for this technique and achieving similar consolidation results. [2-4]

However, some risk factors predispose to implant failure and rupture, such as exposed fractures, intramedullary nail diameter, unreamed nail placement, surgical technique, osteosynthesis design, etc. [5-7]

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In the case of a nonunion, the osteosynthesis material is subjected to an increased stress that predisposes it to fatigue and breakage.[8]

Different surgical techniques have been described to extract the broken intramedullary nail, to preserve the soft tissues through minimally invasive approaches, without causing greater damage.

The aim of this article is to describe the techniques used to extract the osteosynthesis, without opening the focus of the nonunion, using minimally invasive techniques.

MATERIALS AND METHODS

321 retrograde intramedullary nailings of the femur were performed at our institution, between March 2001 and January 2019. 57.9% (186 cases) were diaphyseal fractures and 42% (135 cases) were supracondylar fractures. In this series, there were only three cases (0.9%) of implant rupture in the presence of a nonunion. We describe the different surgical techniques used for the management and extraction of the proximal fragment of the nail that has been broken.

Case 1

A 17-year-old male was admitted due to polytrauma after a motorcycle collision accident against a car, in which he suffered a transyndesmal fracture of the left ankle and a fracture of the right femur (type 32A2 of the AO classification) associated with thorax trauma (Figure 1).

Figure 1. Anteroposterior and lateral radiographs of the femur. A 32A2 femur fracture is seen.

Initially, the femoral fracture was stabilized with an external fixator and the ankle fracture, with a plaster cast. On the eighth day, the external tutor was replaced with an unreamed 9 mm x 350 mm retrograde femoral intramedullary nail (Figure 2).

Figure 2. Anteroposterior and lateral radiographs of the femur in the immediate postoperative period. Reduction and osteosynthesis were performed with an unreamed retrograde intramedullary nail.

In the fourth month after surgery, the patient reported a sudden increase in pain in the operated limb, during walking, without previous trauma. In the radiological control, nonunion and implant rupture were observed. A series of combined conditions were identified that led to the failure of osteosynthesis. First, the choice of a smaller diameter intramedullary nail due to a history of chest trauma. Second, the faulty design of the osteosynthesis material, which presented a locking hole in the middle third and, added to this, the proximity of the fracture site to the area of weakness of the osteosynthesis material.

These were the determining conditions for nonunion, material fatigue and implant rupture (Figure 3).

Figure 3. Anteroposterior and lateral radiograph of the femur. Note the small diameter of the intramedullary nail, the nonunion over an area of implant weakness, and the breakage.

The surgical plan consisted of the extraction of the intramedullary nail fragments and the new osteosynthesis with a larger diameter nail to provide the necessary stability and achieve consolidation over time.

The blocks were extracted percutaneously. Through the transpatellar approach, the distal end of the nail was removed with the specific extractor.

A 3 cm approach proximal to the greater trochanter was used to extract the proximal fragment. A threaded 3.8 mm guide pin was placed and, under fluoroscopic control, a correct entry point was made. The guide pin was removed and then the olive-tipped guide wire was inserted through its non-olive end. The aim of this technique is to thread and secure the olive tip at the proximal end of the implant (Figure 4). The olive-tipped guide wire should be advanced from the greater trochanter to the distal femur approach to make the extraction in a retrograde and safe way, through the transpatellar approach.

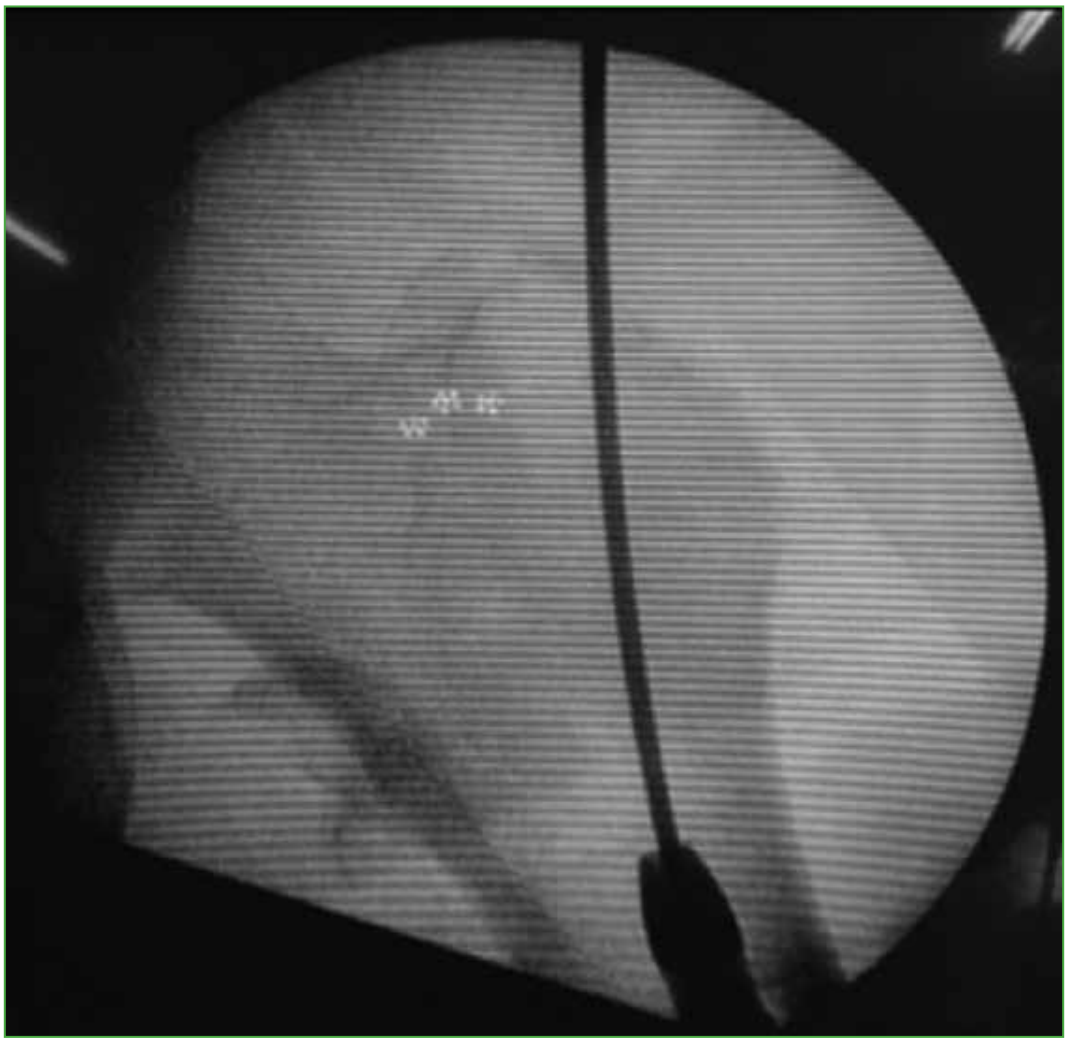

Figure 4. Intraoperative image showing the antegrade placement of the olive-tipped guide by threading the proximal fragment of the broken nail.

Next, a reamed 11mm x 380mm intramedullary retrograde nail was placed. Consolidation was achieved at four months (Figure 5).

Figure 5. Radiographic control 4 months after surgery. Consolidation of the fracture is observed.

Case 2

A 79-year-old woman with a history of smoking and use of alendronate was admitted to the Emergency Service with pain and functional impairment plus deformity of the lower right limb, after a fall from her own height. On radiographs, a femoral shaft fracture, type 32A2 of the AO classification, was detected (Figure 6).

Figure 6. Anteroposterior and lateral radiographs of the right femur upon admission. A 32A2 diaphyseal femur fracture is observed.

Reduction and osteosynthesis with a reamed 11 mm x 340 mm intramedullary nail were carried out on the fourth day of admission (Figure 7).

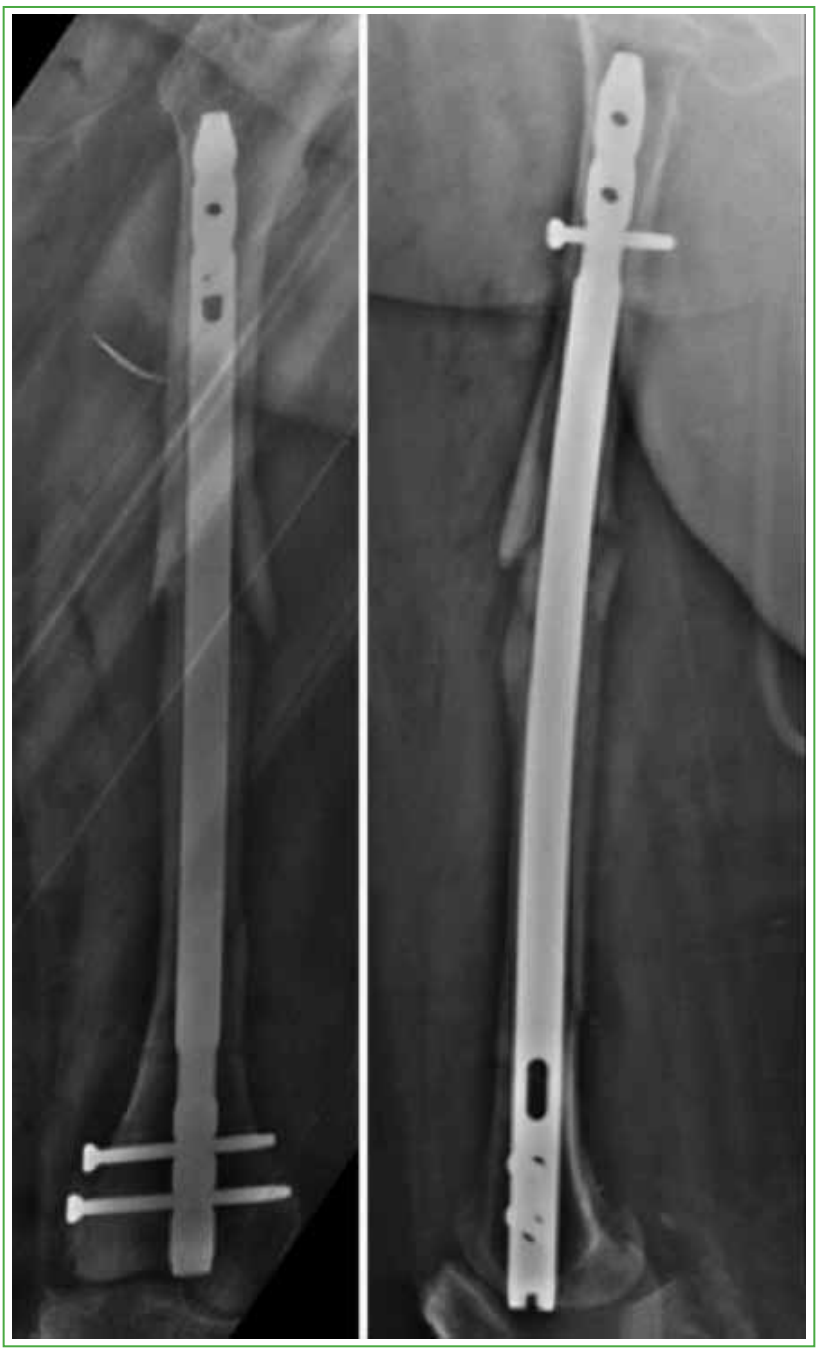

Figure 7. Immediate postsurgical radiographic control.

On radiological controls, a delay in union and its subsequent evolution to nonunion were observed, as well as the inherent fatigue of the intramedullary nail, which presented a blocking hole close to the fracture focus. But, as there were no symptoms or pain, the patient did not accept a second intervention. A year after the intervention, she was admitted to the Emergency Service with pain and functional impairment, after a fall from her own height. Implant rupture was observed (Figure 8).

Figure 8. Anteroposterior and lateral radiographs of the right femur upon admission to the Emergency Service. Note the breakage of the intramedullary nail and the nonunion.

The surgical plan consisted of removing the broken intramedullary nail to perform reosteosynthesis with a larger diameter retrograde intramedullary nail. After removing the distal blocks percutaneously, the surgery continued with the extraction of the distal nail fragment with a specific extractor through the transpatellar approach. The non-olive guide wire was then introduced retrogradely and impacted up to the greater trochanter. A 3 cm approach was made proximal to the trochanter in order to place a 3.8 mm guide pin and then drill with an 8 mm cannulated drill bit. The guide was then removed and a "hook" bend was made at the tip (Figure 9).

Figure 9. Proximal approach to the greater trochanter through which the olive-tipped guide was advanced and a "hook"-shaped bend was made.

The purpose of this technique is to "hook" the proximal fragment of the broken nail with the hook-shaped guide, in order to be able to extract it retrogradely through the patellar approach (Figure 10).

Figure 10. Retrograde extraction of the hook-shaped guide once the proximal fragment of the broken nail has been engaged.

Increased reaming and placement of the 14 mm x 340 mm retrograde intramedullary nail were carried out without complications.

In the following radiological controls, consolidation was confirmed at 5 months (Figure 11).

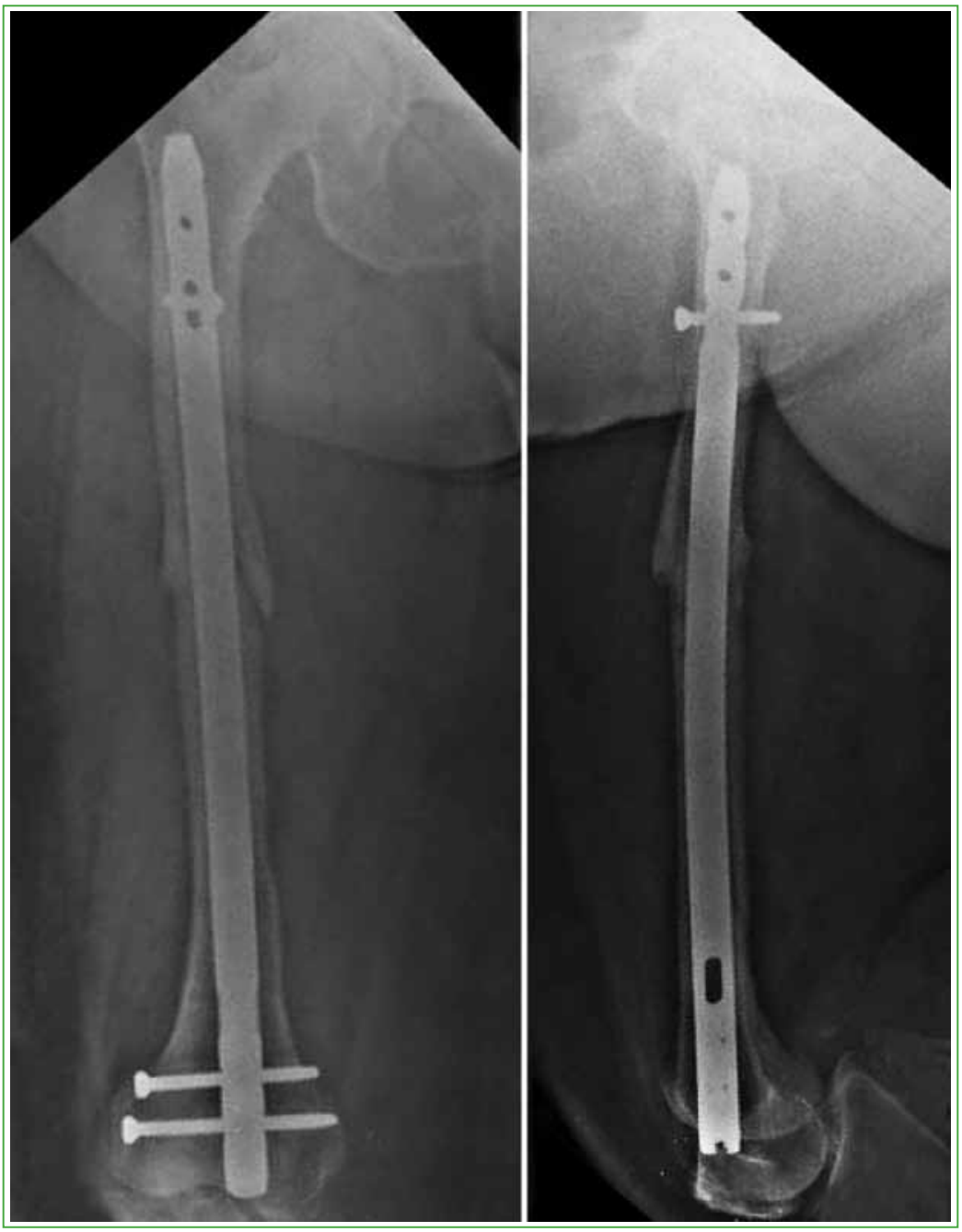

Figure 11. Radiographic control 5 months after surgery. There are signs of bone consolidation.

Case 3

A 52-year-old woman, smoker, obese with a body mass index of 42, and diabetic. She was admitted with polytrauma due to a motorcycle-car collision, in which she suffered a cranioencephalic traumatism, rib fractures, fractures in both forearms and left humerus, a severe exposed dislocation-fracture of the right ankle and a diaphyseal fracture of the left femur, type 32A2 of the AO classification.

Initial stabilization with an external tutor was carried out for the ankle and femur dislocation-fracture, and immobilization with a plaster cast for the upper limbs. On the ninth day of hospitalization, the external tutor was replaced with a 10 mm x 340 mm reamed retrograde intramedullary nail.

Two years after the accident, she was admitted to the Emergency Service with pain and difficulty walking, without previous trauma. A nonunion associated with the breakage of the intramedullary nail was observed (Figure 12).

Figure 12. Radiographic control upon admission to the Emergency Service. Implant rupture associated with nonunion is observed.

It was decided to remove the material and perform reosteosynthesis with a retrograde intramedullary nail using a single approach.

The blocks were removed percutaneously and the distal nail fragment was removed through the patellar approach with the specific extractor. A non-olive intramedullary guide was then introduced retrogradely through the proximal nail fragment until it passed the nail tip at approximately 6 cm (Figure 13A).

The aim of this technique is to introduce and impact another non-olive guide of a smaller diameter until the two guides are obstructing each other (Figure 13B).

Once the "obstruction" had been achieved, the first guide that was initially placed was pulled, to later extract the proximal nail fragment (Figure 13C), using a single approach and without complications (Figures 13D). In Figure 13E, the effective obstruction of both guides is seen.

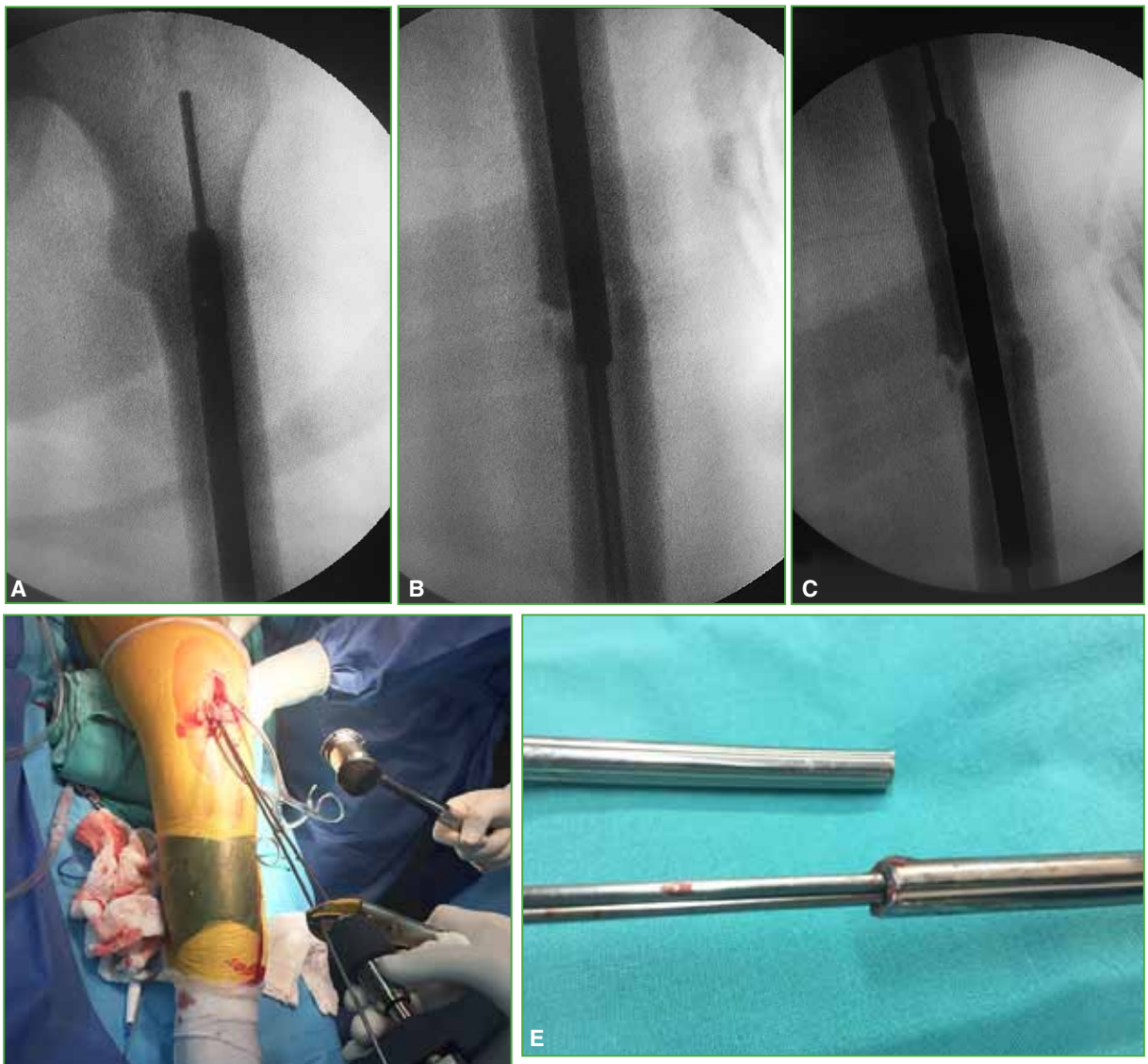

Figure 13. A. Intraoperative image in which the correct placement of the intramedullary guide is evaluated until it surpasses the tip of the nail. **B.** Placement of the second guide of smaller diameter, achieving the obstruction of both guides to the proximal fragment of the broken nail. **C.** Extraction of the proximal fragment by pulling the first intramedullary guide. **D.** Correct retrograde extraction of the fragment of the broken nail, through a single approach. **E.** Image showing the effective locking of guides of different sizes.

The nail with the largest diameter was reamed and placed according to the technique (Figure 14).

The patient evolved favorably and consolidation was confirmed at six months in radiological controls (Figure 15).

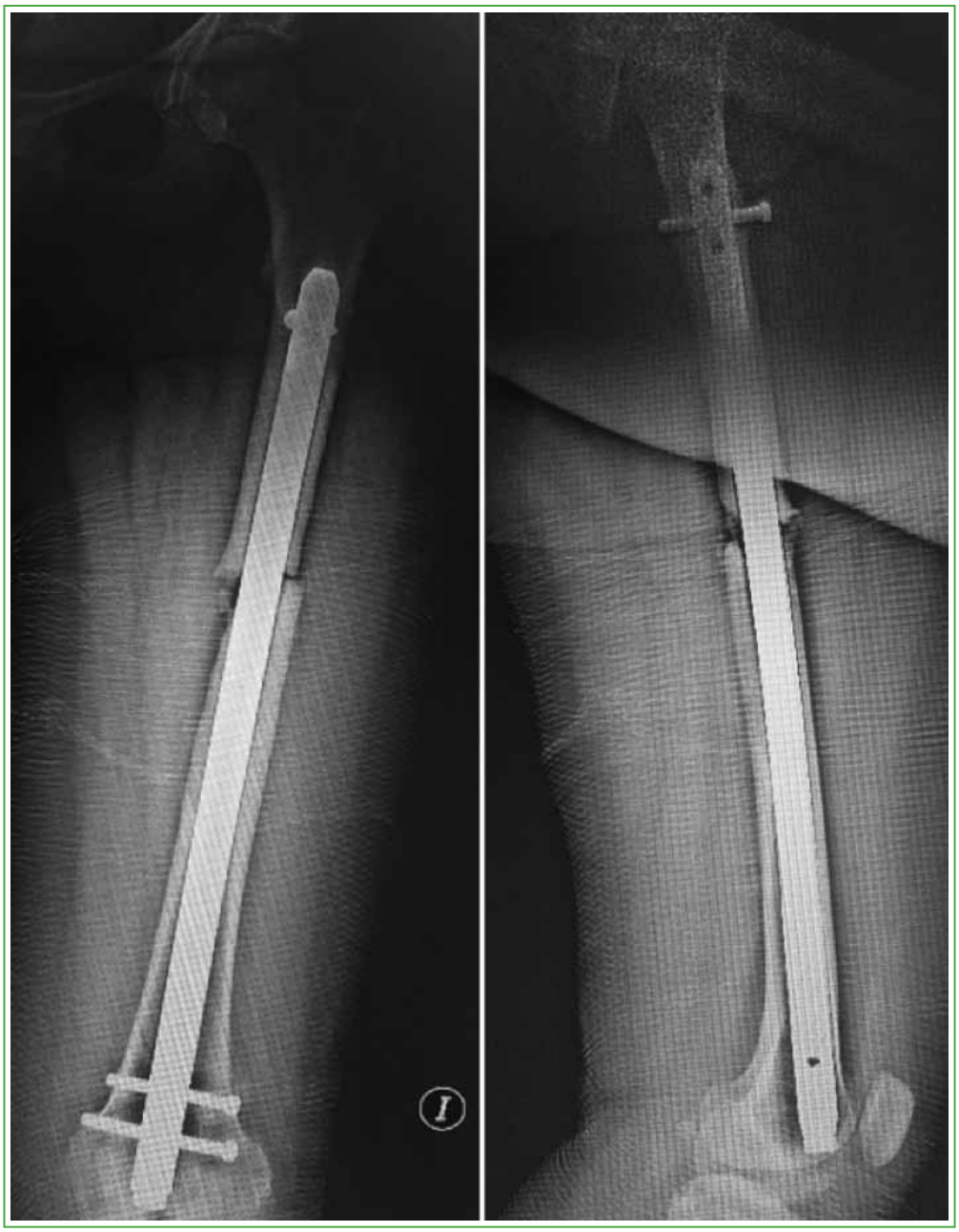

Figure 14. Immediate postoperative follow-up with a larger diameter retrograde nail.

Figure 15. Follow-up 6 months after surgery. Signs of bone consolidation are observed.

DISCUSSION

Many techniques to extract the distal fragment of a broken antegrade femur nail have been described, but there is scant literature on this type of complication in retrograde femoral nails.

We described three techniques to extract the proximal fragment of a broken retrograde nail. The decision to perform one technique or another was based on its practicality and effectiveness, trying to protect the soft tissue and gradually increasing the complexity of the techniques as needed.

Initially, we attempted extraction using a single approach, placing two intramedullary guides through the transpatellar approach, looking for their obstruction in the proximal fragment. If this technique was not effective, as a second option, we placed the olive-tipped guide wire, by its non-olive end, through a new approach on the greater trochanter, to perform the retrograde extraction. The next technique consists of placing the intramedullary guide through the patellar approach, extracting it through the greater trochanter, and creating a hook over the tip of the guide to "hook" the nail fragment.

In 1988, Franklin et al. [9] described a revolutionary technique for the extraction of broken nails. They used 50 cm long osteotomes to make a hook-shaped bend 2 cm from the tip. This technique achieves a change in osteosynthesis rescue surgeries, since it allows to preserve the soft tissues without raising the periosteum, which happens when the nonunion focus is opened to extract the distal fragment of the broken nail using basic instruments, such as forceps, clamps or forceps. In conclusion, they report that this technique is extremely safe and effective, and eliminates the need to open the focus to extract the nail fragment.

Authors such as Brewster et al., [10] Hak et al., [11] and Blake [12] described techniques for the extraction of the broken osteosynthesis using two intramedullary guides. A hook-shaped guide and another smaller olive-tipped guide, which had to be inserted beyond the tip of the broken nail, to then impact the other intramedullary guide and thus increase the binding forces to be able to extract more efficiently. In their series, they do not describe complications and, as an advantage, they mention the simplicity of the technique, which does not require new approaches.

In 2004, Magu et al. [13] described an innovative technique to extract antegrade nails using an olive-tipped intramedullary guide together with a washer through a transpatellar approach, seeking the obstruction of the latter on the tip of the nail. The advantage of this technique over the others is that it generates a greater grip when performing the extraction. This technique is easy to reproduce and is performed in an antegrade manner for retrograde nail removal.

In 2006, Karladani[14] published an extraction technique in which, in a first step, the olive-tipped intramedullary guide was placed beyond the fragment of the broken nail, then a 12 mm long 3.5 mm screw was placed in the locking hole crossing the first cortex, and was fixed only to the nail. Then, the olive-tipped intramedullary guide was removed, looking for the olive to bind to the screw. In the literature review and case report published by Abdelgawad and Kanlic, [15] in 2013, the authors mentioned this technique as their first option, since it was easily reproducible and one of the safest. In our opinion, it is a risky and highly demanding technique, and a possible complication is that the screw comes out of the locking hole of the nail and remains lodged in the intramedullary cavity with the possibility of injuring the internal cortices of the femur during extraction.

In 2008, Acharya et al. [16] published a series of two cases of antegrade nail breakage, using an intramedullary guide bent in the form of a hook to extract the distal fragment. They concluded that the technique could be used to extract any intramedullary nail, but, in order to extract a retrograde nail, we have modified this technique by making an approach on the greater trochanter to be able to extract the guide, make the fold in the shape of a hook and thus be able to "hook" the broken proximal fragment and carry out the retrograde extraction in a satisfactory and uncomplicated manner.

In the meta-analysis by Whalley et al., [17] 35 articles with 11 techniques were cited. They did not reach a conclusion about which is the most effective technique and referred to the surgeon's ability to choose the technique that best suits each situation and the need to change techniques as the procedure is carried out.

CONCLUSION

The techniques we described are effective, simple, with minimal soft tissue aggression, and do not require sophisticated instruments. For this reason, we recommend considering these techniques when planning the extraction of a broken retrograde nail, using materials and instruments that any operating room can have.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Spinal Needle Removal in the Thoracolumbar Spine. Case Report

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ABSTRACT
The presence of foreign elements within the spinal canal is rare and there is no clear consensus regarding its treatment. The publications on intracanal firearm projectile fragments recommend exeresis of the fragments due to the possibility of migration, especially when they are in an area close to the medullary cone. The same procedure should be applied to a needle inside the spinal canal. We present a patient with disabling radicular pain caused by a needle fragment within the spinal canal after cesarean section.
Key words: Epidural anesthesia; broken needle; intradural anesthesia.
Level of Evidence: IV

Retiro de aguja intradural en la columna toracolumbar. Reporte de un caso

RESUMEN
La presencia de elementos extraños dentro del canal raquídeo es infrecuente y no hay claro consenso respecto de su tratamiento. Las publicaciones sobre fragmentos de proyectil de arma de fuego intracanal recomiendan la exéresis de los fragmentos ante la posibilidad de migración, sobre todo, cuando están en una zona próxima al cono medular. Se debería proceder del mismo modo ante una aguja dentro del canal espinal. Presentamos a una paciente con dolor radicular invalidante provocado por un fragmento de aguja dentro del canal espinal luego de una cesárea.
Palabras clave: Punción espinal; anestesia epidural; anestesia intradural; rotura de aguja.
Nivel de Evidencia: IV

INTRODUCTION

The anesthesia of choice for a cesarean section is subarachnoid block, for which increasingly fine spinal needles are used to reduce the incidence of postdural puncture headache, the most frequent complication of this type of anesthesia.[1] However, the use of smaller and smaller needles carries the risk of another complication: fracture of the spinal needle, a rare but serious situation.[2] Technique, needle type, and patient characteristics may contribute to the potential risk of needle fracture. There is considerable consensus that broken spinal needle fragments should be removed as soon as possible to prevent serious symptoms or complications. However, few reports focus on the mediate management of this complication and there are even fewer cases that prove the migration of the intracanal fragment.[3]

We present the case of a woman who had undergone a cesarean section under subarachnoid anesthesia and who, months later, began to suffer radicular pain in the right lower limb from a needle fragment lodged within the thoracolumbar spinal canal.

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CLINICAL CASE

A 36-year-old woman, with a body mass index of 31, who consulted for right radicular pain from a spinal puncture, after a cesarean delivery six months before. She referred that, at the time of anesthesia, she felt severe lacerating pain radiating from the lumbar area to the lower right limb, in the thigh area up to the knee. After that episode, the pain set in, and was more severe during activity and in certain positions. It decreased when resting.

During consultation, the patient reported lumbar pain with projection to the right thigh, with a score of 8/10 on the visual analog scale. Sensory compromise was detected in the thigh, without motor compromise.

On radiographs and magnetic resonance imaging (MRI) and three-dimensional computed tomography (3D CT) of the dorsolumbar spine, a foreign body was observed in T12-L1, right paracentral, close to the ipsilateral foramen, which was interpreted as a remnant of the needle that had been broken at the time of the spinal puncture for the cesarean section, six months before (Figure 1).

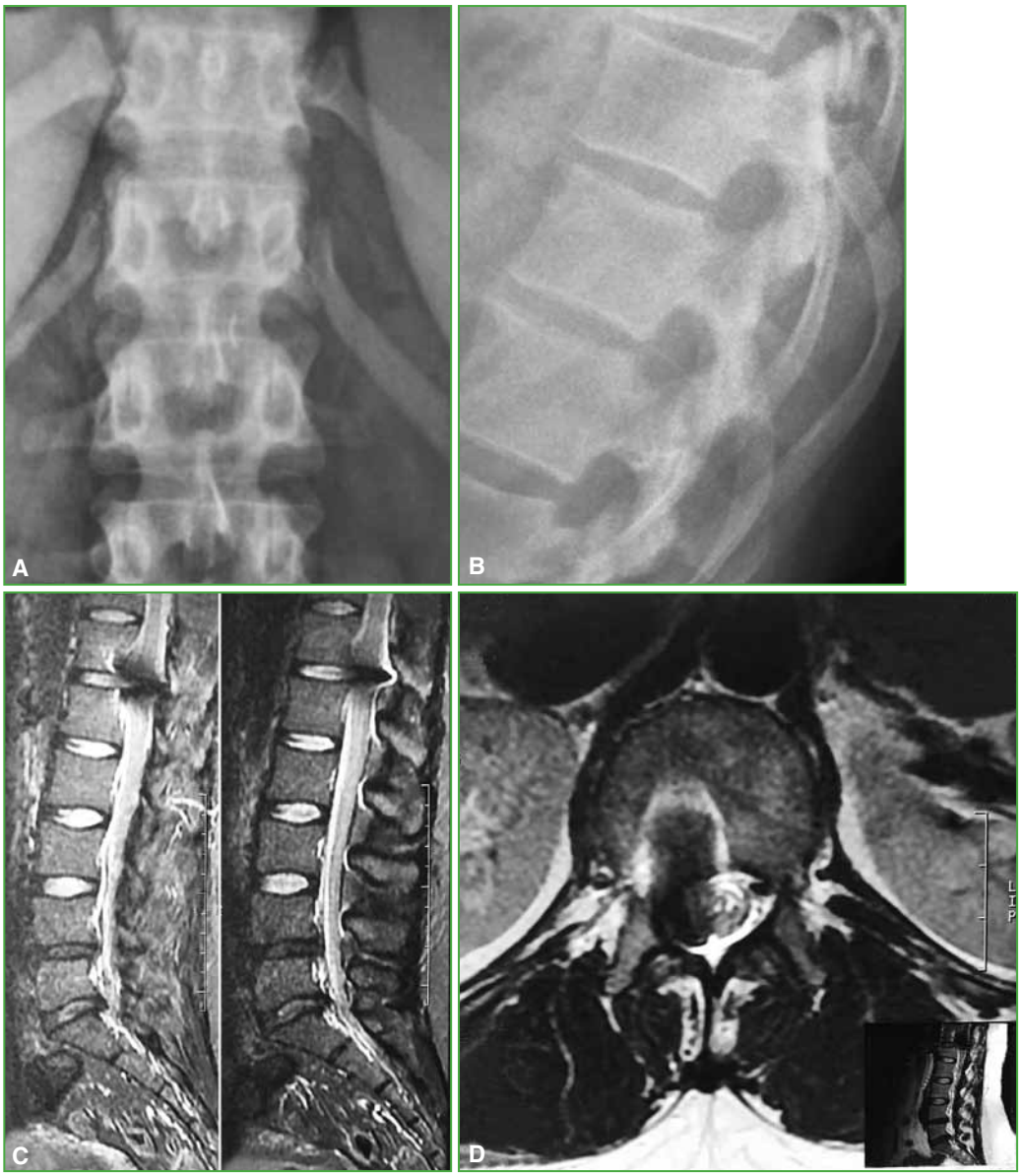

Figure 1. A and B. Thoracolumbar spine radiograph. An intracanal spinal needle fragment is visualized. **C and D.** Lumbar spine magnetic resonance, sagittal and axial planes. The artifact generated by the intracanal needle is observed.

Surgical treatment was indicated to remove the needle. Surgery was planned through the posterior dorsolumbar approach, through the midline between T12 and L1, with divulsion of the muscle on the right side. By means of hemilaminectomy, the epidural space was accessed and no element was found compatible with what was visualized in the studies by images. Therefore, we decided to perform a transdural exploration under microscope, and the fragment of the needle was found, fixed in the T12-L1 disc on the right side. The fragment was removed with a pituitary forceps (Figure 2). After the exploration with fluoroscope and verifying that the rest of the needle had been completely extracted, the closure was carried out with 6.0 suture and dural sealant, with a negative Valsalva maneuver. The closure of the wound by planes was completed in a hermetic manner.

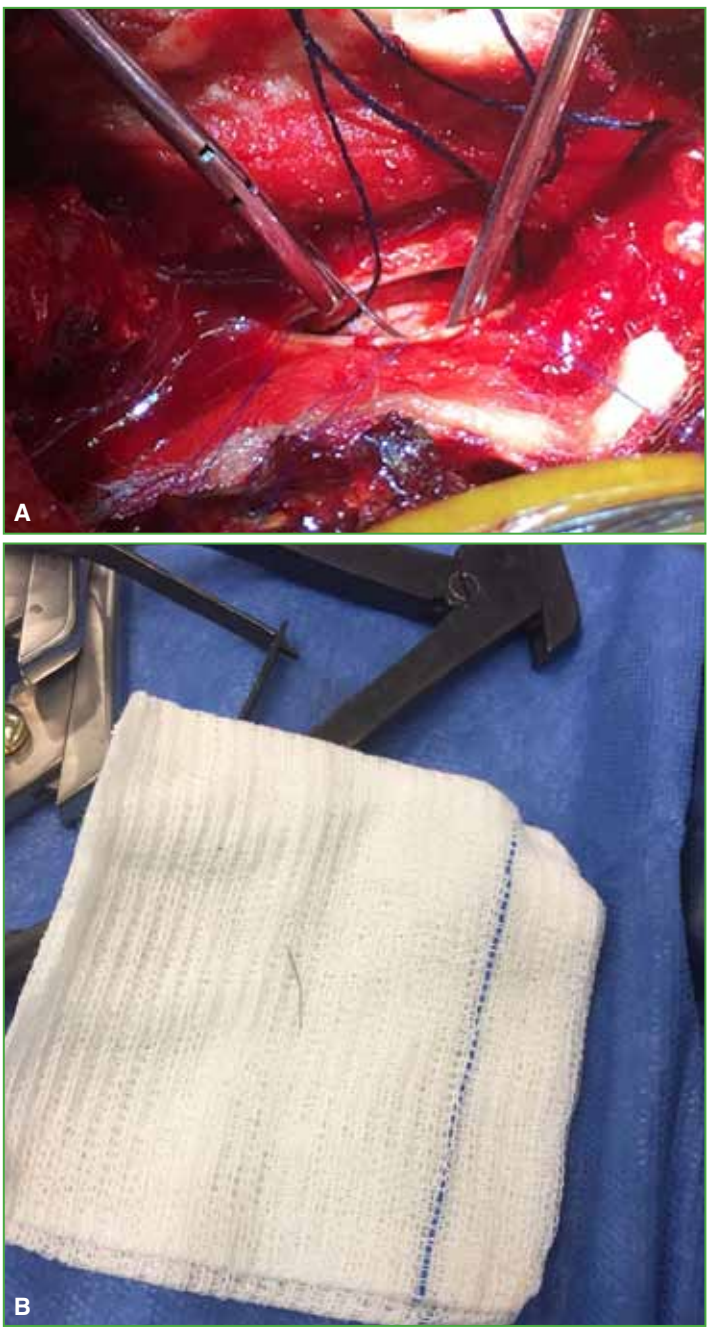

Figure 2. A. Removal of the needle after dural opening. The needle was fixed on the T12-L1 disc. **B.** Broken needle fragment, sent to regulatory authorities.

Surgery was carried out with somatosensory and motor evoked potentials, and no alterations were observed. After extraction, imaging studies were performed in order to verify and document the absence of the needle fragment (Figure 3).

Figure 3. Control radiographs. No remains of the intracanal fragment are observed.

At 48 h after surgery, she was allowed to walk. The patient manifested pain in the area of the surgical wound that had a good response to analgesics. She did not have radicular pain radiating to the right as before surgery (score 0/10 on the visual analog scale). On the third postoperative day, she was discharged from the hospital; initial care was indicated during the first week and, after the removal of the stitches, at 10 days, she continued with her normal life. At present, with 24 months of follow-up, the patient has no symptoms.

DISCUSSION

Subarachnoid anesthesia used for cesarean section is a safe procedure, with a low rate of complications, among them, the most frequent is postdural puncture headache. In order to reduce this complication, small-caliber pencil-point needles are used. However, with their use, the risk of another complication of this technique increases, such as deformity or broken needles.[2,4] This complication, although it occurs and it has been described, is very rare. According to Abou-Shameh et al., the incidence rate is 1/5000.[5]

Various risk factors are mentioned, such as the type of needle, the technique used and factors associated with the patient.[1,6] Regarding the type of needle, the use of fine, long Quincke-type needles and the use of an alternative introducer to that recommended by the manufacturer have an influence on the outcome.[7] Regarding the technique, the most likely practices that can break or cut fragments of the needle are: a) redirecting the needle without withdrawing it to the superficial subcutaneous tissues, b) withdrawing and redirecting the needle while keeping the introducer in place and c) manipulating the needle after removing the stylet. Finally, among the factors associated with the patient and that can generate a difficult puncture—either due to the direction of the needle or the effectiveness of the puncture—we can mention obesity, short stature, severe vertebral deformity or a history of spinal surgeries. In the same way, acting urgently in a cesarean section can involve risks.[2] In our case, when the spinal operation was performed, the patient had a body mass index of 31; this can be considered a risk factor.

From a clinical point of view, the symptoms generated by an intracanal foreign body are usually unusual, with nonspecific pain, with a radicular pattern and without a specific position of relief. Previous studies show unusual pain patterns.[7,8] Our patient remained with insidious right radicular pain for several months after cesarean section, which did not disappear with conservative treatment.

Blanchard et al. mention that the consequences of a broken spinal needle in the spine include its migration as a foreign body, infection or fibrosis of the surrounding tissue, and possible neurological complications. In our patient, the migration of the fragment was verified with subsequent neurological compromise generated by disabling right radicular pain.[7,9]

The most useful diagnostic studies are radiographs and CT scans that show the metal fragment of the needle. Staats et al. published a case of an intracanal needle that had not been clearly observed in the initial magnetic resonance images, so the diagnosis had to be completed with a computed tomography.[9] In our patient, the MRI showed an artifact in the area of the spinal canal, compatible with a foreign body, which was confirmed by the tomographic study.

Management of spinal needle fracture

Immediate diagnosis and management

There is consensus when the immediate diagnosis is made:

Continue with the scheduled surgery: if the patient does not have neurological symptoms associated with the needle fragment, the surgeon can proceed with the scheduled surgery, under spinal or general anesthesia, depending on the type of surgery to be performed. If it ruptures in a cesarean section, most publications recommend proceeding to the lumbar puncture at a higher level (the risk factors for needle fracture are the same as for difficult intubation and general anesthesia should be avoided in these patients).[3,10]

Plan the extraction of the fragment: during surgery or immediately afterwards. Intraoperative fluoroscopy can be used to locate the fragment. And, depending on the location and type of surgical procedure being performed, the presence of a general surgeon or a spine specialist should be guaranteed.

Inform the patient: the patient should be informed and explained that removal of the fragment does not usually cause long-term neurological sequelae.

Extract the fragment as soon as possible: it should be treated immediately, usually in the same surgical shift, although, according to some articles, it has been deferred up to two weeks, without complications.[1,3,11]

Sending of material to the regulatory authority and control by diagnostic imaging.

Mediate diagnosis

In cases of mediate diagnosis, there is not enough evidence on how to proceed and we opted for the removal of the needle. This article proves that it can be done without complications, even in symptomatic cases.

In our case, the location of the needle fragment was very striking, since spinal punctures should always be performed below L2, ideally the L3-L4 or L4-L5 spaces. Therefore, we affirm that the needle migrated, which reinforces the indication to extract all fragments, as soon as the diagnosis is confirmed. The needle fragments have stiff, sharp ends and can migrate into the spinal cord.

We also recommend surgery as soon as possible in asymptomatic patients, given the possibility of intracanal migration, something that was verified in this patient.

The patient should always be examined before and after extraction using imaging studies.

CONCLUSIONS

We believe that the deformity or breakage of the needle in a spinal puncture is a rare complication with a low incidence according to the studies evaluated. We consider that it is essential to perform a subarachnoid puncture with the appropriate technique and, if there are risk factors, such as obesity, consider the use of thicker needles to avoid this complication.

Finally, we believe that, if such a complication occurs, whether it was diagnosed immediately or months later, surgery to remove the broken fragment is the procedure of choice, as it is very effective and very well tolerated.

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Acute Paraparesis due to Aggressive Vertebral Hemangioma. Report of Two Cases and Literature Review

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ABSTRACT

Introduction: Aggressive hemangiomas make up 1% of all vertebral hemangiomas. They can produce pain, fractures, deformity and slowly progressive neurological compromise. Different treatment approaches have been described, but optimal management remains unclear. We report two cases of acute paraparesis secondary to aggressive thoracic hemangioma, we describe their treatment and evolution. We carry out a narrative review of the literature on vertebral hemangiomas. **Conclusion:** Through early decompression and arthrodesis followed by local adjuvant radiotherapy, we obtained complete neurological recovery and disease control in a medium-term follow-up.

Keywords: Aggressive hemangioma; benign tumor; spine; radiotherapy; paraparesis.

Level of Evidence: IV

Paraparesia aguda por hemangioma vertebral agresivo. Reporte de dos casos y revisión bibliográfica

RESUMEN

Introducción: Los hemangiomas agresivos constituyen el 1% del total de los hemangiomas vertebrales. Pueden producir dolor, fracturas, deformidad y compromiso neurológico, generalmente de larga evolución. Se han descrito diferentes opciones terapéuticas, pero el manejo óptimo sigue sin estar claro. Comunicamos dos casos de paraparesia aguda secundaria a un hemangioma torácico agresivo, describimos su tratamiento y evolución. Realizamos una revisión narrativa de la bibliografía. **Conclusión:** Mediante la descompresión y la artrodesis tempranas seguidas de radioterapia, se logró la recuperación neurológica completa y el control de la enfermedad en un seguimiento a mediano plazo.

Palabras clave: Hemangioma agresivo; tumor benigno; columna vertebral; radioterapia; paraparesia.

Nivel de Evidencia: IV

INTRODUCTION

Vertebral hemangiomas (VH) are the most frequently diagnosed benign tumors in the axial skeleton, they have an incidence of 10-12% between the fourth and fifth decades of life.[1,2] Histologically, they are made up of vascular spaces lined with endothelium separated by bone stromal septa.[3,4] In general, they are asymptomatic and quiescent, most are discovered incidentally when performing an MRI indicated for other reasons. They mainly affect the vertebral body and, rarely, spread to the posterior components.[5]

On imaging studies, "typical" VHs exhibit a characteristic pattern, lithic foci with trabeculae reminiscent of a honeycomb with large and long vertical streaks on plain radiography. In the computed tomography, irregularly distributed punctate calcifications are observed, product of the coalescence of the vertical trabeculae described. Magnetic resonance imaging (MRI) highlights a hyperintense image in both T1 and T2 sequences (due to the predominance of fat content), as well as in fluid-sensitive sequences, STIR, due to vascular components.[5-7] However,

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VHs may not show these distinctive characteristics when there is a lower fat content and more vascular content. These are called "atypical" VHs.[5]

The "aggressive" VHs are the third category of these lesions that—despite being benign from the histological point of view—have a locally aggressive behavior, corresponding to grade 3 of the Enneking classification.[8] They are rare, representing 1% of all VHs,[9] and can cause symptoms, such as pain in 54% of cases, pathological fractures, spinal deformity and neurological compromise in up to 40% of cases.[10-13] They are most frequently located in the thoracic spine and the male: female ratio is 1: 1.5.[14]

The aim of this article is to present two cases of acute paraparesis due to aggressive thoracic hemangiomas and to conduct a narrative review of the literature on the subject.

CLINICAL CASE 1

A 22-year-old male patient who consulted for progressive loss of strength in the lower limbs associated with back pain secondary to a fall from his own height, seven days before. On physical examination, he presented 2/5 muscle strength for muscle groups innervated by L2, L3, L4, L5, and S1; hypoesthesia below the umbilical area; and hyper-reactive patellar and Achilles reflexes. The score on the Nurick scale[15] was 5 and on the modified Japanese Orthopedic Association scale[16] (mJOA) was 9/18. A Frankel C incomplete spinal cord syndrome with severe paraparesis was diagnosed.

The radiographic analysis showed an alteration of the bone tissue in the vertebral body of T9 (Figure 1). A computed tomography scan was performed, in which the classic punctate pattern of hemangiomas was not observed, which made the initial diagnosis difficult. The MRI showed an isointense image in the T1 and T2 sequences with extravertebral extension and involvement of the medullary canal, while, in the STIR sequence, the lesion was evidently hyperintense (Figure 2).

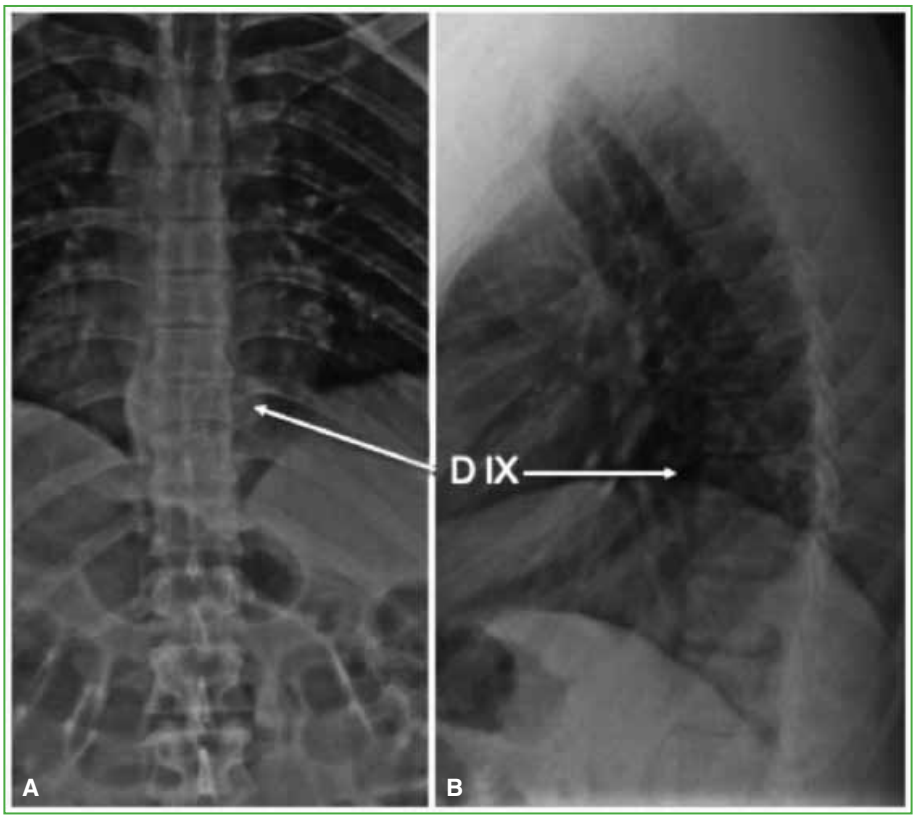

Figure 1. Case 1. A 22-year-old man. Anteroposterior (**A**) and lateral (**B**) radiographs of the thoracic spine. An alteration in the bone tissue at the T9 level and a slight collapse of the vertebral body are observed.

Figure 2. Case 1. A 22-year-old man. Computed tomography of the thoraco-lumbar spine. **A.** Coronal plane, **B.** Sagittal plane, **C.** Axial plane. Heterogeneous lytic lesions with a permeative pattern are observed, altering the bone tissue of the vertebral body of T9 with compromise of the cortices and extending to the paravertebral and epidural spaces. The compromise of both pedicles is evidenced, mostly on the right side, with involvement of the pars and ipsilateral facets. Magnetic resonance imaging of the dorsal spine. **C.** Sagittal plane, STIR sequence. The hyperintensity of the lesion that affects the entire vertebral body is highlighted, generating a pathological fracture, with compromise of the posterior wall and invasion of the medullary canal. **E.** T1-weighted sequence, **F.** T2-weighted sequence. Isointense images show a greater right paravertebral extension.

Due to the acute and progressive neurological condition, a decompression was performed by means of a T9 laminectomy and an emergency arthrodesis of T7-T11 via the posterior approach (Figure 3). Samples were sent for histopathological analysis of the lesion, which informed the diagnosis of VH (Figure 4).

Five weeks after surgery, the patient began radiation treatment with a total dose of 4000 cGy divided into sessions of 150-200 cGy, every 24-48 h, according to tolerance, with the aim of preventing recurrences.

At 36 months after the intervention, after intensive progressive rehabilitation, the patient presented neurological improvement, with scores of 17/18 on the mJOA, Nurick 3 and Frankel E scale, with no signs of tumor recurrence.

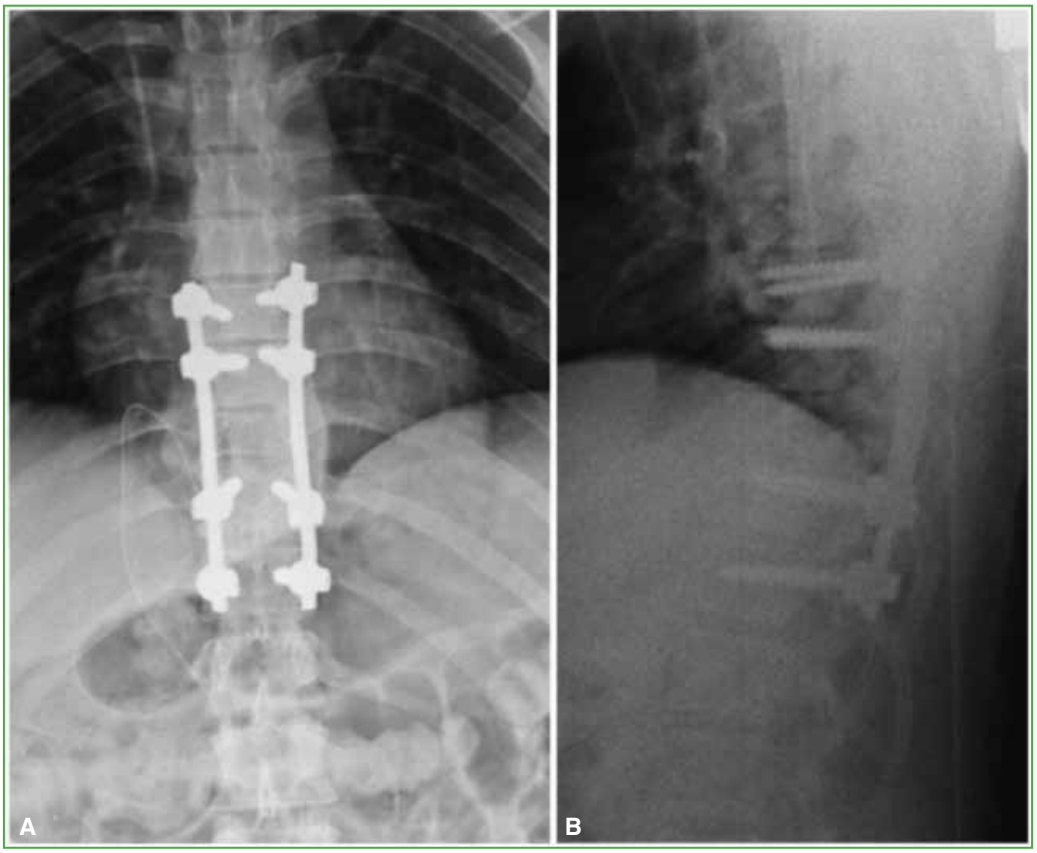

Figure 3. Case 1. A 22-year-old man. Postoperative anteroposterior (**A**) and lateral (**B**) radiographs of the thoracic spine. Pedicle screw fixation from T7 to T11 is visualized.

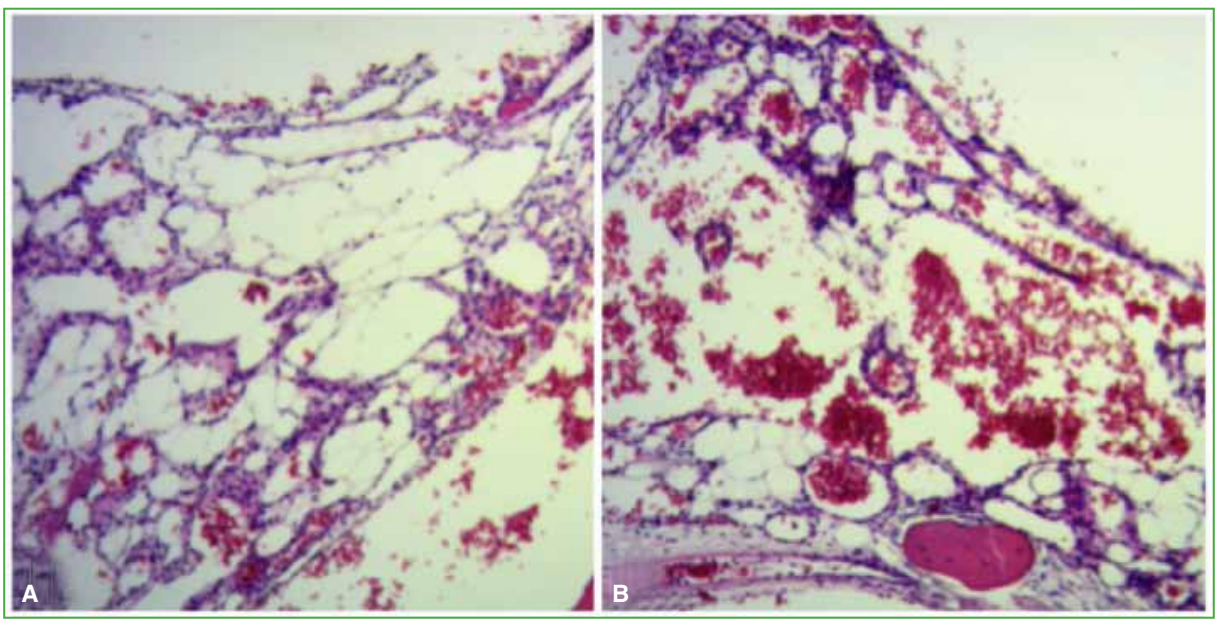

Figure 4. Case 1. A 22-year-old man. Histological analysis under x20 (**A**) and x40 (**B**) microscopy and hematoxylin-eosin staining showed the lining of the spaces created within the collagenous matrix stroma by thin layers of flat endothelial cells that form capillary-sized cavernous blood vessels, consistent with the diagnosis of hemangioma.

CLINICAL CASE 2

A 23-year-old female patient who consulted at the emergency room for progressive back pain and paraparesis of 24 h of evolution, with no relevant traumatic history. As a relevant antecedent, the patient reported previous episodes of back pain, with imaging studies and vertebral biopsy puncture compatible with VH, treated conservatively. On physical examination, she presented 3/5 decreased muscle strength from L2 to distal, bilateral patellar hyperreflexia, and positive Babinski. Neurological scores were 4/5 for Nurik, 14/18 for mJOA, and Frankel C. An emergency MRI revealed complete involvement of the vertebral body of T11, with altered bone structure, extension through the right pedicle towards the posterior apophyseal ring and invasion of the medullary canal (Figure 5). Given the previous diagnosis of VH, a selective embolization of the nutrient artery of the lesion was performed, followed by decompression of T10-T12 and arthrodesis of T9-L1 via the posterior approach (Figure 6). Four weeks after surgery, she began radiation therapy at a dose of 4500 cGy. After 60 months of follow-up, the patient was pain-free, and her scores were Frankel E, Nurik 1, and 17/18 on the mJOA scale. No signs of recurrence of the lesion were observed.

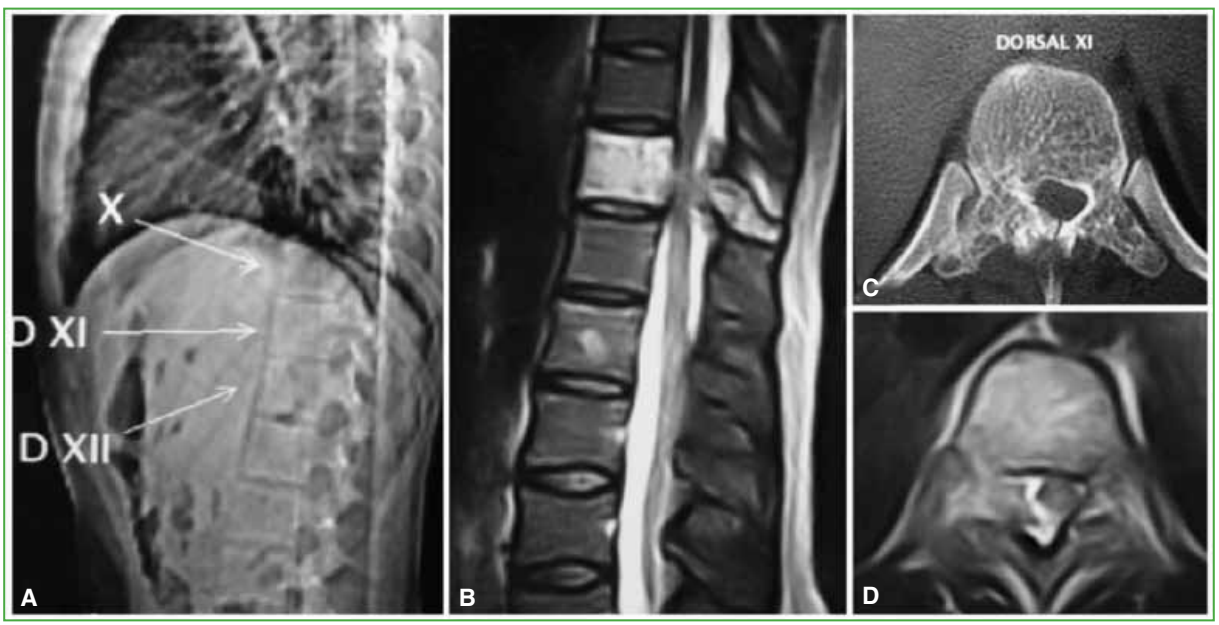

Figure 5. Case 2. A 23-year-old woman. **A.** Lateral radiograph of the thoracic spine with marking of the level involved without relevant findings. MRI. **B.** Sagittal plane, T2-weighted sequence. Hyperintensity of the vertebral body is observed, with extension towards the right pedicle and invasion of the medullary canal, displacing the marrow to the left (**D**). **C.** Computed tomography, axial plane. The alteration of the bone structure in the vertebral body is observed, with insufflation of the right components of the apophyseal ring.

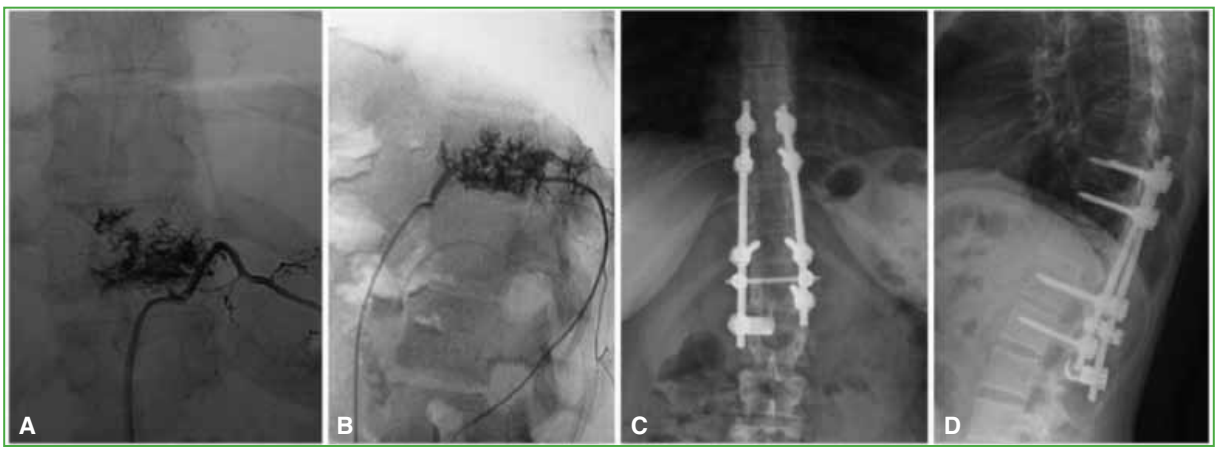

Figure 6. Case 2. A 23-year-old woman. Anteroposterior (**A**) and lateral (**B**) fluoroscopy images of the dorsal spine lesion at the T11 level during the selective arterial embolization procedure of the nutrient artery. Anteroposterior (**C**) and lateral (**D**) radiographs of the thoracic spine at 5 years of follow-up. Decompression and dorsolumbar arthrodesis from T9 to L1 are visualized.

DISCUSSION

We have described two cases of aggressive dorsal hemangioma with severe acute paraparesis that required urgent surgical intervention. Aggressive VH represent less than 1% of the total, can cause pain, pathological fractures and neurological compromise. Most aggressive hemangiomas show a typical polka-dot sign[17] or honeycomb pattern on images; however, in up to a third of them, the patterns may be atypical.[18] Acosta et al.[19] describe six peculiarities in imaging studies, which are associated with "symptomatic" or "aggressive" VH: 1) thoracic location (particularly T3-9); 2) involvement of the entire vertebral body; 3) involvement of the neural arch (particularly pedicles); 4) an irregular appearance without a honeycomb shape, 5) an expanded, insufflated and poorly defined cortex and 6) involvement of the adjacent paravertebral soft tissue. Diagnosing "atypical" and "aggressive" VHs by images can be difficult, regardless of the imaging modality used, as they can mimic malignant bone tumors or primary metastases.[5] Our two patients presented all these atypical characteristics, which made diagnosis by imaging difficult. Therefore, it was necessary to resort to the pathological anatomy of the lesion for an accurate diagnosis.

Optimal treatment strategies and adjuvant therapy options remain controversial, as large randomized studies are difficult to conduct due to the low prevalence of this condition.[1,19,20] Different options have been described, such as intralesional ethanol injection,[21] arterial embolization,[22] vertebroplasty[23] or kyphoplasty,[24] total *en bloc* spondylectomy[19] or partial spondylectomy plus stabilization,[25,26] radiotherapy[27,28] or a combination of them. Kaoudi et al.[29] have recently described a robot-assisted radiofrequency thermal ablation in an aggressive hemangioma of the sacrum, with good results at one year of follow-up.

Preoperative intra-arterial embolization offers the advantages of controlling bleeding and reducing perioperative morbidity.[30] In some cases, slowing or growth arrest of the lesion has been observed when performed in isolation.[3,31] In the first case presented, embolization was not considered due to the lack of a specific diagnosis and the urgency of the condition. However, in the second case, there was prior histological confirmation, so it was possible to perform an emergency embolization followed by decompression surgery and arthrodesis.

The use of adjuvant radiation therapy after intralesional excision surgeries with the aim of reducing the recurrence rate is controversial. While some authors have reported good long-term results in series of patients treated in this way,[1,11,32] Qiu et al.[20] reported having carried out radiotherapy in only three of 10 patients, and they also did not detect recurrences at the average 11-month follow-up, so the real benefit of this treatment is questioned.

Both of our patients received radiotherapy at the fourth and fifth week after surgery. This delay reduces the rate of wound complications, such as dehiscence and infection. No postoperative complications were detected and both patients had a progressive and complete neurological recovery without signs of tumor recurrence at the end of follow-up.

We described two cases of a rare pathology with an infrequent presentation. There are few reports of acute spinal syndromes due to aggressive hemangiomas, most of which are cases of slow progression over time. In a retrospective analysis, Qiu et al.[20] reported 10 cases of aggressive hemangiomas over a 13-year period, five of them with progressive neurological deterioration and one Frankel D at the time of treatment. Our patients presented with a Frankel C developed in a short period. We obtained good results after emergency decompression and stabilization surgery followed by radiation treatment. It is worth noting that the success of this type of surgery depends on the speed of detection, diagnosis and treatment, since the delay can cause a less marked or absent neurological improvement.

A postoperative recurrence rate of 0% to 30% has been published,[20] regardless of treatment with or without adjuvant radiation therapy. It is worth highlighting the particular aggressiveness of this injury in pregnant women, in whom the recurrence rate is greater than 20%.[19,33] This is the product of the influence of gestational progesterone on the tumor, which would also be related to the higher incidence in women.[14]

According to our search, these are the first two cases published in the Latin American literature on acute neurological compromise in young patients caused by aggressive VH. We believe that it is important to be aware of this diagnosis, its typical and atypical images, as well as its forms of treatment in order to provide our patients with the best results. At present, there is no consensus on the optimal treatment and each case must be particularly evaluated taking into account all the factors listed above.

CONCLUSION

We presented two cases of severe acute paraparesis secondary to aggressive thoracic VH. By means of early decompression and arthrodesis followed by radiation therapy, a complete neurological recovery and disease control were achieved in a medium-term follow-up.

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Surgical Variants in the Treatment of Proximal Hamstring Avulsion

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ABSTRACT

Proximal tendon avulsion of the hamstring insertion is a rare entity. The therapeutic approach is different in contrast to the treatment in common muscle tears. The greater benefit of surgical treatment has been widely verified in the literature, and given the low frequency of this type of injury, few orthopedic surgeons are used to both diagnosis and surgical procedures in this anatomical region. The aim of this article is to report four patients with insertional hamstring rupture and describe the surgical technique used in each case. We present the surgical variants as well as the outcomes achieved.

Keywords: Hamstrings; surgical treatment; functional outcome; sports.

Level of Evidence: IV

Variantes quirúrgicas en el tratamiento de la desinserción proximal de isquiotibiales.

RESUMEN

Las lesiones por avulsión isquiática o rotura tendinosa en la inserción proximal de los isquiotibiales son infrecuentes. El abordaje terapéutico es diferente del de los desgarros. Se ha comprobado ampliamente un mayor beneficio con el tratamiento quirúrgico y, dada la baja frecuencia de este tipo de lesiones, son pocos los cirujanos ortopédicos habituados tanto al diagnóstico como al procedimiento quirúrgico. El objetivo de este estudio es reportar cuatro casos de pacientes con rotura insercional de isquiotibiales y describir la técnica quirúrgica utilizada. Exponer las variantes quirúrgicas y sus resultados.

Palabras clave: Isquiotibiales; reparación quirúrgica; resultado funcional; deporte.

Nivel de Evidencia: IV

INTRODUCTION

Hamstring muscle injury is one of the most common injuries in athletes.[1,2] However, ischial avulsion or tendon rupture in its proximal insertion is infrequent, it has an incidence of less than 5% of all sports injuries.[3,4]

The therapeutic approach is varied; tears tend to be treated conservatively, whereas, for insertional hamstring rupture, the greater benefit of surgical treatment has been widely proven.[5-8] Given the low frequency of this type of injury, few orthopedic surgeons are used to surgical procedures in this anatomical region.[9]

The complications of not treating an insertional hamstring rupture range from chronic pain, [10] significant decline in sports performance [4,11] to sciatic nerve irritation. [10] The latter occurs due to the intimate relationship of said muscle mass with this nerve, where, when the muscle fibers retract, fibrosis occurs that could irritate it, thus causing a "hamstring syndrome", a differential diagnosis within sciatica. [12]

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The aim of this article is to report four cases of patients with insertional hamstring rupture and to describe the surgical technique used with its variants. The long-term results obtained are presented.

CLINICAL CASES

Case 1

A 44-year-old man, with no relevant medical history, a recreational athlete who, during a soccer game, felt a sudden pain in his right thigh after a sweep on the playing field. By ultrasound, he was diagnosed with a 34-mm fibrillar disruption of the semitendinosus muscle with an adjacent 21 mm hematoma. After three months, he returned to consult due to the persistence of pain with functional limitation and without neurological deficit. Magnetic resonance imaging (MRI) was performed showing proximal hamstring avulsion with a retraction of approximately 50 mm. Surgical repair was indicated.

Surgery: Posterior longitudinal thigh approach. Primary anchor repair of the conjoint tendon.

Three years after surgery, after an eccentric contraction while unloading weight at work, he suffered a new ischial injury. Ultrasound revealed an incomplete injury to the semitendinosus muscle. The reoperation was decided.

Surgery: Posterior longitudinal approach extended over the previous scar. A lesion of the semitendinosus muscle was found at the myotendinous junction. A proximal release of the muscle was performed and the anchoring surface in the ischium was prepared. Said anchorage was carried out with two 5 mm double suture anchors. By this means, the distal end of the myotendinous tear was sutured, bringing it closer to the enthesis and the ischium, thus generating a recovery of muscle tension.

Case 2

A 54-year-old woman, with no relevant medical history, a recreational athlete who, during a tennis match, suffered sudden pain in the right gluteus after a sprint start. She was immediately admitted to the Emergency Department, where an extensive hematoma was found on the back of the thigh, with pain on palpation of the ischium without a visible or palpable gap. On radiographs, no associated bone lesions were seen. Ultrasound showed a complete proximal insertional tear of the right hamstring tendons, with distal retraction of approximately 4 mm. The MRI at four days revealed a tendon avulsion of 47 mm. Surgical intervention was decided.

Surgery: Transverse approach on the gluteal fold. Primary repair with conjoint tendon anchors.

Case 3

A 52-year-old woman, with a history of total colectomy due to colon cancer, without residual disease. She arrived at the consultation with a diagnosis of complete avulsion of the proximal right hamstring tendon. She had suffered an indirect sports trauma one week before the consultation. Both the musculoskeletal ultrasound and the MRI of the right thigh revealed a tendon retraction in caudal direction of 6 cm. It was decided to perform a surgical treatment.

Surgery: Posterior longitudinal thigh approach. Primary repair with anchors of both tendons.

Case 4

A 43-year-old woman, with no relevant medical history, a marathoner who suffers a fall from her own height with her right lower limb in knee extension and hip flexion. She consulted for posterior thigh pain radiating to the leg that was exacerbated by extending the knee. A musculoskeletal ultrasound was performed, which showed a complete rupture of the proximal myotendinous junction of the semimembranosus and a total tear of the conjoint tendon. The MRI of the right thigh showed a tendon retraction in caudal direction of approximately 6 cm (Figure 1). Surgical treatment was decided.

Surgery: Transverse approach on the gluteal fold. Primary anchor repair of the conjoint tendon.

Figure 1. Magnetic resonance imaging of the right thigh. **A.** Coronal plane, **B.** axial plane, **C.** sagittal plane. Tendon injury and retraction.

General surgical technique

The patient is placed in the prone position, protecting the bony prominences. The approach depends on the characteristics of the patient. In slim people with acute injuries without tendon retraction, we opted for an approach in the gluteal fold (Figure 2A). This approach poses difficulties for reinsertion, but is more aesthetic. In overweight patients or patients with chronic tendon retraction, we opted for a posterior approach perpendicular to the gluteal fold with a distal extension of 12-15 cm (Cases 1 and 3) (Figure 2B).

In the deep plane, the greater sciatic nerve; the ischium, detached from the tendon insertions; and the detached tendon end are identified by blunt dissection. The fibrosis is resected until an adequate surface is achieved in the ischium for the placement of the anchors. Between two and five anchors are placed, as needed, until the tendon assembly is supported on the bone. We recommend placing at least three anchors in the ischium (distal, medial and proximal). The most distal is sutured 5 cm from the end of the tendon assembly, while the most proximal, close to the tendon end, allowing the tendon to be placed equidistant on its bone insertion. The tendon suture is performed using the Krackow technique (Figure 3). The lower limb is positioned in 90° knee flexion to relax the muscular structures of the posterior compartment.

Once the tendon reinsertion is finished, the closure is carried out by planes maintaining the knee flexion. This position should be maintained postoperatively using a splint.

Rehabilitation protocol

In our institution, the postoperative rehabilitation protocol consisted of immobilization with a splint in knee flexion, avoiding load on the operated limb. The first two weeks at 90°, the third and fourth weeks at 60°, the fifth and sixth weeks at 45° with partial support (Figure 4).

Figure 2. **A.** Posterior thigh hematoma and outline of the incision through the gluteal fold. **B.** Outline of the longitudinal incision.

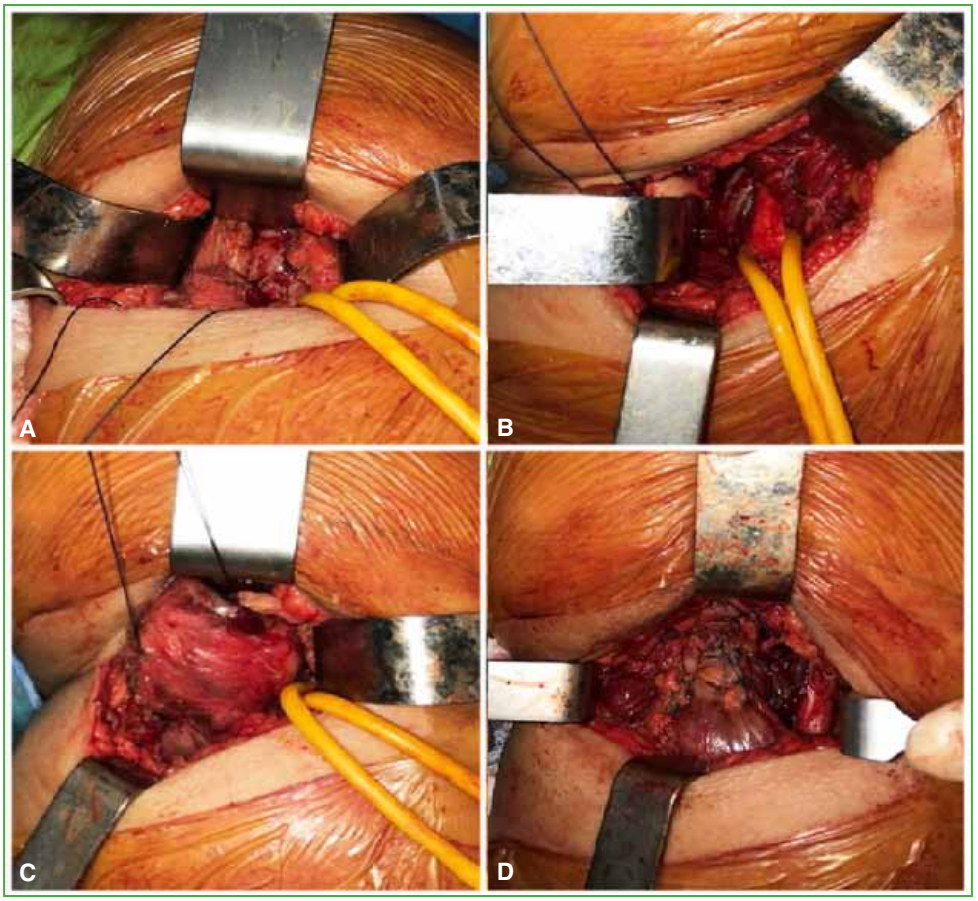

Figure 3. Clinical intraoperative images. **A.** Ischium detached from tendon insertions. **B.** Common sciatic nerve repair. **C.** Conjoint tendon on its anatomical position. **D.** Final anchor repair.

Figure 4. Clinical image of the patient during the postoperative period. Variable fixed-angle splint.

According to published recommendations, at six weeks, total weight bearing begins on the affected limb. [13] After six weeks, we indicate the removal of the immobilizer and allow full weight bearing on the operated limb. From the sixth week onwards, the specific rehabilitation begins. It is indicated to begin with exercises of extension and active and passive flexion of the hip and knee through isotonic exercises and closed chain exercises. This is followed by open-chain exercises that allow the patient to improve and begin to regain strength. [13] It should be noted that strengthening is a necessary factor not only for rehabilitation, but also for the prevention of injury recurrence.

At 12 weeks, the protected sports activity begins, on firm ground and with a linear gait.

FINDINGS

There were no intraoperative complications associated with the procedure. No patient had wound-related complications or had to be reoperated before 12 months after surgery. There were no cases of postoperative pain (visual analog scale: 0/10).

The range of motion of the limb compared to the contralateral was complete. All patients were satisfied with the functional outcomes obtained at the end of the rehabilitation. Although none were high-performance athletes, all engaged in recreational physical activity (tennis and soccer) more than four times a week. Within eight months after surgery, they resumed sports activity. Three of the four patients returned to full sports activity without deficit, as before the injury. The minimum follow-up was six months.

DISCUSSION

The hamstring muscle mass is comprised of three muscles, the semimembranosus, the semitendinosus, and the biceps femoris with its two portions (long and short). It is inserted proximally in the ischium by means of two tendons (Figure 5). A conjoint tendon between the semitendinosus and the long head of the biceps femoris forms an oval insertion.[9] These are separated into two individualized strands at approximately 9 cm. Lateral to this oval complex, there is an independent insertion of the tendon of the semimembranosus. Lateral to the hamstring attachments and 5 cm proximal to the distal border of the gluteus maximus, is the inferior gluteal nerve bundle. The sciatic nerve should be identified 1.5 cm on average from the lateral ridge of the ischial tuberosity. Its function involves two joints, the hip and the knee. The semitendinosus and semimembranosus extend the hip when the torso is fixed. They flex the knee and intra-rotate the leg when the knee is flexed. The long head of the biceps femoris extends the hip when walking, and both the short and long heads flex the knee and extra-rotate the leg when the knee is flexed.

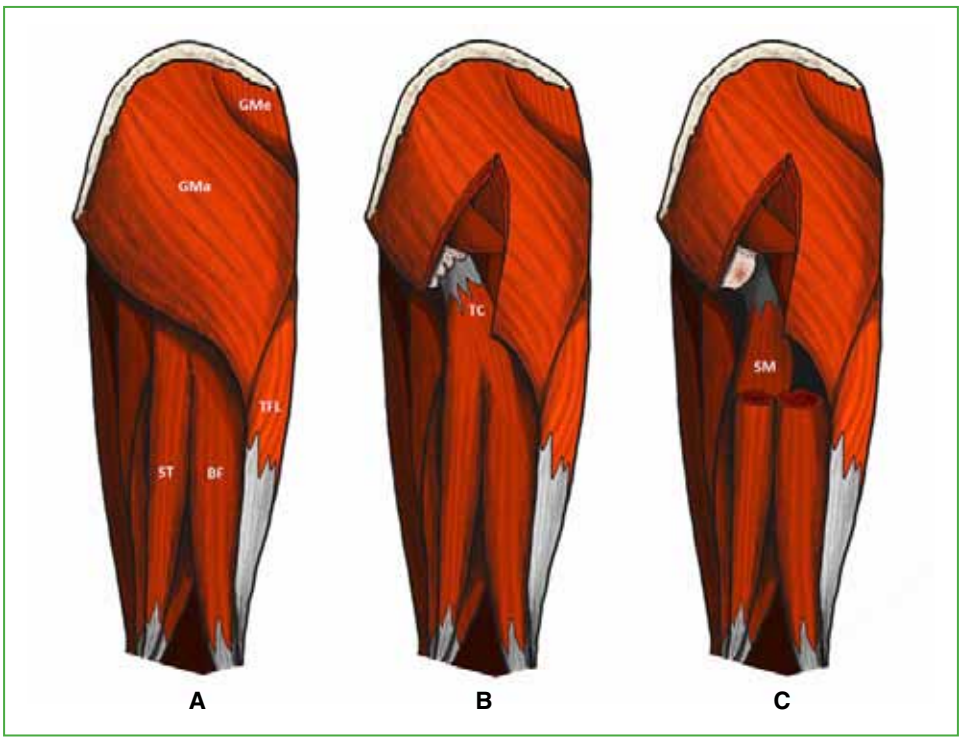

Figure 5. Anatomical diagram by planes of the posterior region of the thigh. Gluteus medius muscle (GMe), gluteus maximus muscle (GMa), tensor fasciae latae muscle (TFL), biceps femoris muscle (BF), semitendinosus muscle (ST), semimembranosus muscle (SM), and conjoint tendon (CT).

There are risk factors for proximal injuries, among them, previous injuries of the hamstring muscles are the main factor, as well as muscle weakness and fatigue, muscle imbalances and lumbopelvic dysfunctions.[14]

The injuries result from excessive stretching at the level of the myotendinous junction. They are generated by contractions with eccentric overload, hip hyperflexion, and knee hyperextension. In contrast, muscle belly tears are caused by a concentric contraction, for example, in a sprint.[15]

The main indication for imaging studies in acute hamstring injuries is the diagnosis of proximal insertion tears.

Radiographs, although limited, allow us to observe bone avulsions at the level of the ischial tuberosity. Computed tomography has been relegated by MRI and ultrasound.[16] Although the latter does not have the precision of MRI, its practicality, low cost, and absence of contraindications and adverse effects make it the gold standard. It allows muscle and tendon analysis, especially in superficial injuries, in a static and dynamic way. It has its limitations for mild injuries with little perilesional fluid or in patients with a lot of body tissue, especially in the proximal portion of the tendon, where the gluteus maximus muscle, which is multi-fasciculated and fatty, makes visualization difficult.[16]

MRI makes it possible to detect injuries ranging from subtle to the most serious and to define their extension, a relevant factor, because it has implications for rehabilitation time.[17] In acute injuries, T2-weighted or fat suppression (STIR) sequences show high-intensity images as a result of edema or hemorrhage surrounding the damaged muscle. Whereas, in the T1-weighted sequences, areas of intermediate intensity are observed that are confused with muscle mass. The insertional hamstring tear can be complete or affect only the semimembranosus portion or the conjoint tendon of the semitendinosus and the biceps femoris. In these circumstances, we find a discontinuity between the bone and the remaining tendon (either partial or complete) that will be surrounded by hematoma or inflammatory fluid that also infiltrates the muscle, to a variable degree, giving it a "feather" appearance.[18]

It is essential to quantify the extent of the tendon retraction when opting for surgical treatment and its immediate relationships with the sciatic nerve.

Lesions can be classified according to their clinical presentation into three grades: grade 1 (mild): excessive stretching with minimal loss of enthesis integrity; grade 2 (moderate): partial detachment and grade 3 (severe): total rupture of the enthesis.[1]

Wood et al. proposed a new classification (Table) in which the lesions are divided into five stages, according to their anatomical location, the degree of detachment (complete or incomplete), the degree of muscle retraction and the presence or absence of irritation of the sciatic nerve.[18]

Table. Wood Classification[18]

Type	Characteristic
1	Bone avulsion
2	Injury to the myotendinous junction
3	Partial detachment
4	Complete detachment without retraction
5	Complete detachment with retraction
5B	Type 5 + sciatic nerve irritation

Most of these lesions respond to conservative treatment with cryotherapy, rest, stretching, and gradual return to normal activities. But, in cases of detachment, greater importance is given to surgical treatment[1,10,15] in athletes who perform speed races and need explosive muscular actions.

Taking this into account, there are two main cornerstones for these injuries: the type of treatment (surgical vs. conservative) and when to perform it (acute vs. chronic).

Historically, surgical treatment to repair hamstring injuries received little attention. Over time, this changed thanks to the understanding of injuries and orthopedic training.[19]

Conservative treatment is the main therapeutic option for partial injuries and insertional tendinopathies.[10,15] However, in athletes, the results are not optimal, therefore surgical treatment is considered. This is recommended for injuries of two tendons and detachments with retractions >2 cm.[4,15] The formation of retracted scar tissue can

inhibit the innervation of the muscle regeneration tissue and reduce its contractility and range of motion, as well as irritate the sciatic nerve in the face of perineural scarring. Fat atrophy has been observed at the margins of avulsed muscle as well as a generalized reduction in muscle volume.[20]

Hofmann et al. evaluated patients who preferred conservative management for complete proximal hamstring tears, and observed deficits in the strength of the affected limb and failure to return sports at their previous level.[11]

In systematic reviews carried out by other authors, it was concluded that surgery improves outcomes in terms of athletic return, strength and endurance.[8,21,22]

Piposar et al. also obtained positive functional outcomes with a significant improvement when comparing patients treated surgically vs conservatively, except in strength where they found no significant differences.[8,23]

However, there are special situations, including partial detachments that usually occur due to repetitive and chronic injuries. Traditionally, these lesions are conservatively treated and surgery is indicated if there is no improvement after six months of non-surgical treatment.[8,23]

Regarding rehabilitation, sports activities can be resumed once the functionality of the lower limb reaches 80% compared to the contralateral one when measured by an isokinetic study. In addition, a return to sports can be considered if there is no pain, the patient can perform sports activities without fear, the strength and elongation of the affected muscle have been recovered and, finally, if the patient is in optimal condition and is self-confident enough to carry out the specific activity. On average, this is achieved between 6 and 10 months after surgery.[13,24]

On the other hand, Hofmann et al. stated that, in cases of conservative treatment, rehabilitation is necessary for a minimum period of 16 weeks before returning to sport. In our case series, no patient received conservative treatment. It should be noted that, with conservative treatment, the reported satisfaction rates are low and a third of the patients are unable to return to their sports activity at the level they had before the injury.[11]

Regarding when to perform a surgical procedure, in some studies, it is argued that surgery in the acute stage improves the evolution of patients with these injuries, determined by strength, pain, return to sports and satisfaction.[22] On the other hand, other authors did not find differences related to the time of surgery.[6]

The study by Blakeney et al. supports the recommendation of surgical treatment in the acute stage.[7,25] However, they consider that favorable results are achieved with surgery in both acute and chronic injuries. The patient in case 1 is an accurate reflection of this.

Differences in surgical technique between acute and chronic injuries mainly depend on tendon retraction, fibrosis around the injury, and the need for augmentation of the remaining tendon. The use of Achilles tendon allograft or fascia lata autograft has been described.[6]

FINAL CONSIDERATIONS

Proximal hamstring detachment is an infrequent condition and there are very few cases in the national literature. Surgical treatment should be considered a valid option. In agreement with the literature, our patients obtained favorable results through surgical treatment.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Evaluation of Clinical and Surgical Proficiency at a Residency of Child Orthopedics and Traumatology

Use of the Mini-CEX (*Mini-Clinical Evaluation Exercise*) and DOPS (*Direct Observation of Procedural Skills*)

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ABSTRACT

Purpose: To assess professional competencies in a Pediatric Orthopedic and Traumatology Residency Program by the implementation of two performance-assessment instruments: Mini-Clinical Evaluation Exercise (Mini-CEX) and Direct Observation of Procedural Skills (DOPS) for clinical and surgical skills. Both tools aim to assess the top of Miller's pyramid, for its reliability and validity. **Materials and Methods:** Prospective observational cohort study of six medical trainees in the first, second and third year of their residency program (R1-R2-R3) who were randomly assessed by six examiners during their daily training at outpatient clinics, emergency room, inpatients unit, operating room, and plaster room. The statistical analysis was carried out with the Chi-Square and Wilcoxon-Rank paired test for univariate variables. The residents' relationship cohorts were compared using the Kruskal-Wallis test. The reliability of the methodological tool was determined by the psychometric test of Crombach. Alfa was set at ≤ 0.05. Diagnostic study: level IV. **Results:** We performed 65 assessments. Each resident was evaluated 10 times on average by 3 to 6 examiners. The oldest residents had better performances in overall clinical competencies. However, the R1 group achieved satisfactory results whereas the R2-R3 groups had the most outstanding scores. There were no statistical differences in general surgical competencies, but the R3 group was outstanding in cases of unforeseen surgical situations. The Alfa Crombach coefficient was over 0.90. **Conclusion:** The Mini-CEX, DOPS, and interactive feedback were powerful tools to provide high-quality assessment and were widely accepted by residents and examiners. The statistical analysis allowed us to identify the weaknesses and strengths of the trainees. The Crombach coefficient had a high psychometric impact.

Keywords: Residency; assessment; competencies; Mini-CEX; DOPS.
Level of Evidence: IV

Evaluación de competencias clínicas y quirúrgicas de una Residencia de Ortopedia y Traumatología Infantil. Utilización del Mini-CEX (*Mini-Clinical Evaluation Exercise*) y del DOPS (*Direct Observation of Procedural Skills*)

RESUMEN

Objetivo: Evaluar competencias profesionales de una residencia de Ortopedia y Traumatología Infantil. Instrumentos pedagógicos utilizados: *Mini-Clinical Evaluation Exercise* (Mini-CEX) y *Direct Observation of Procedural Skills* (DOPS) para competencias clínicas y quirúrgicas, respectivamente. Ambas evalúan la cúspide de la pirámide de Miller; se precisaron su confiabilidad y validez. **Materiales y Métodos:** Estudio observacional prospectivo de una cohorte de seis residentes de primero, segundo y tercer año quienes fueron evaluados por seis docentes en diversos contextos y situaciones reales: consultorio externo y de guardia, sala de internación, interconsultas, quirófano y sala de yesos. **Resultados:** Se realizaron 65 observaciones. Cada residente fue evaluado como media en 10 oportunidades por entre 3 y 6 docentes. Para las variables clínicas, en general, los residentes más antiguos obtuvieron valores sobresalientes y los residentes de primer año, valores satisfactorios. No hubo diferencias significativas para las competencias quirúrgicas globalmente, pero los residentes de tercer año fueron más competentes para resolver situa-

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ciones inesperadas. El coeficiente de Cronbach fue superior a 0,90. **Conclusiones:** Ambos instrumentos de evaluación tuvieron una elevada confiabilidad. El método estadístico permitió individualizar exactamente las fragilidades y fortalezas de la residencia. El coeficiente de Cronbach obtuvo un valor de alto impacto psicométrico.

Palabras clave: Residencia; evaluación; competencias; Mini-CEX; DOPS.
Nivel de Evidencia: IV

INTRODUCTION

Medical education in Child Orthopedics and Traumatology consists of the development and acquisition of specific competencies, the purpose of any curriculum planned and included in the official program of a residency. Competence is defined as the set of knowledge, skills and attitudes that provide excellent medical practice in continuous improvement and appropriate to the social context in which it takes place. It includes cognitive aspects (knowing and understanding), psychomotor skills (knowing how to act), and training in values and attitudes (knowing how to be).[1,2]

Determining whether resident physicians meet the expectations of achievement requires the use of structured, adaptable and relevant assessment tools in relation to the content and objectives included in the training curricula. The fundamental purpose of an assessment is to analyze the learning process, something we do *with* and *for* the residents—not *to* the residents.[1,3,4]

In 2010, the Consensus Group at the Ottawa Conference defined the criteria for proper evaluation: validity, reliability, fairness and equity, equivalence, feasibility, educational and catalytic effect, and acceptability. A tool is valid when it effectively evaluates what it intends to evaluate, and is consistent with teaching strategies and content. Reliability is a statistical concept that defines the stability or reproducibility of a test; it is expressed by a correlation coefficient, in which 1 is perfection and 0 is nullity. Justice and equity respond to the social principle of education. Equivalence is the probability of application of the same assessment methodology in subsequent meetings or different institutions. Feasibility is the availability of physical, human and financial resources. Every evaluation affects the educational strategy and the future of the professional. The catalytic effect is the ability to imitate or spread an assessment methodology.[5]

In 1990, Miller presented a four-step pyramid of assessment (Figure). The lower two tiers are formed by theoretical knowledge *(knows)* and its application in specific cases *(knows how).* The upper tiers refer to behavior: the third expresses competence in simulated or *in vitro* environments (*shows how*), whereas the fourth tier or pinnacle of the pyramid is the reference pattern of professionalism or the practice of medicine in real situations *(does).* It is feasible to evaluate each item by specific instruments. The framework for the assessment at the pinnacle of the pyramid includes: *Clinical Evaluation Exercise* (CEX), *Mini-Clinical Evaluation Exercise* (Mini-CEX), *Direct Observation of Procedural Skills* (DOPS), feedback or *multi-source feedback* 360, portfolio, case-based studies, video recordings, peer evaluations, audits and others. All can be used for formative or summative assessment, or both (Figure).[6,7]

The direct observation of the clinical and surgical skills of resident physicians is essential. To this end the *American Board of Internal Medicine* developed the Mini-CEX in 1995.[8-11] This is a structured assessment tool that involves patients and real situations in varied contexts and with diverse difficulties. The DOPS tool was introduced in 2005, in the United Kingdom, by the *United Kingdom Foundation Programme*, as a resource for assessing specific surgical and technical competencies. It also uses patients and real-world situations in scenarios of varying complexity.[12-18] It is important to note that it is not designed to assess *in vitro* situations in animals or in anatomical theatre.[9] The Mini-CEX has received more support from the literature, probably because the publication and application of DOPS are newer.[4,8]

These assessments can be conducted at the request of the observer or resident, which significantly reduces psychic stress or anxiety from the experience.[8] Both include a systematic return or feedback.[8,9,16]

The purpose of this research was to determine the validity and reliability of the Mini-CEX and DOPS tools in *a training assessment* of specific clinical, surgical and orthopedic practices at a residency of Child Orthopedics and Traumatology.

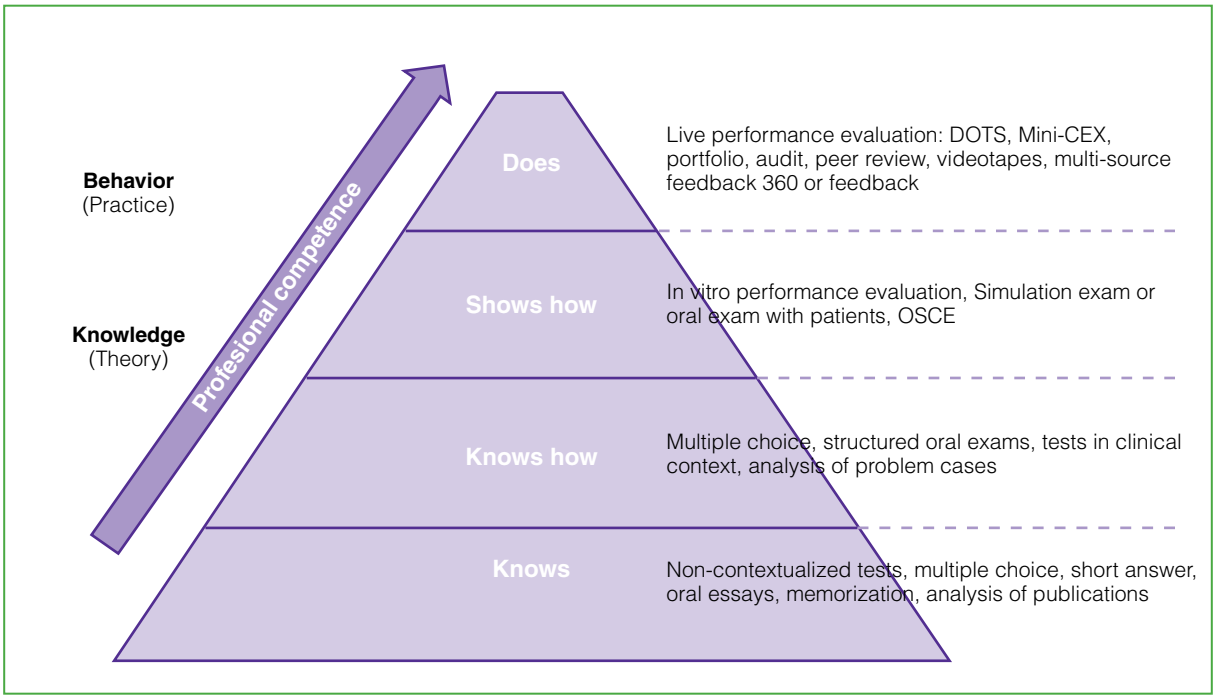

Figure. Miller's pyramid of knowledge and correlation with evaluation tools.

MATERIALS AND METHODS

It is an observational and prospective cohort study, of the diagnostic category. Between November 2018 and April 2019, doctors from a residency of Child Orthopedics and Traumatology—accredited by the *Asociación Argentina de Ortopedia y Traumatología* and the *Sociedad Argentina de Ortopedia y Traumatología Infantil*—were evaluated. It is a second-stage residency, the *sine qua non* requirement of which is to have undergone and passed a general Orthopedics and Traumatology residency, as well as a multiple-choice question examination. It is the only education system developed in a purely pediatric hospital of maximum complexity in the province. The program lasts for two years, with the option of a third year as head of residents. For the data collection and statistical processing, we will refer to first- and second-year resident physicians, and heads of residents, as R1, R2 and R3, respectively.

The body of evaluators consisted of staff physicians, who randomly chose both the resident to interview and the competence to assess. Conversely, some residents requested to be evaluated at a given activity. Mini-CEX was used for clinical competencies in various contexts: external and on-call practice, interconsultations and inpatient rooms. The complexity of the procedure was classified as low, medium or high. The following variables were included: anamnesis and physical examination, ethics or professionalism, clinical judgment, organization and efficiency. Each competence was valued according to the following scale: 1 to 3 or unsatisfactory, 4 to 6 or satisfactory and 7 to 9 or outstanding. The time of observation and feedback was allocated. Both evaluator and resident were able to express their satisfaction with the encounter on a scale of 1 to 10. The observer was able to point out in writing the positive aspects of the experience and those that could be improved (Table 1).

Table 1. *Mini-Clinical Evaluation Exercise* (Mini-Cex) structured form.

Mini-Cex (Mini Clinical examination) Structured observation of clinical practice

Evaluator: Date
Resident R1 ( ) R2 ( ) R3 ( )
Environment Outpatient office ( ) Emergency ( ) Room ( ) Referral ( )
Patient First time ( ) Follow-up ( ) Age Gender
Diagnosis:
Complexity Low ( ) Medium ( ) High ( )
Observer Staff Physician ( ) Professor ( )

1. **Anamnesis** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
2. **Physical examination** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
3. **Profesionalism** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
4. **Clinical judgement** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
5. **Communication skills** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
6. **Organization/ Efficiency** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**
7. **Global score** 1 2 3 Unsatisfactory 4 5 6 Satisfactory 7 8 9 Superior	**Not evaluated**	**Observation**

- Particularly positive aspects:
- Aspects that need to be improved:
- Resident's satisfaction with the MiniCex 1 2 3 4 5 6 7 8 9 10
- Observer's satisfaction with the MiniCex 1 2 3 4 5 6 7 8 9 10
- Time (minutes) used for observation:
- Time (minutes) used for feedback:
- Comments:
- Date: .....
- Resident's signature: ..... • Observer's signature: .....

DOPS was chosen to evaluate competencies in scheduled and on-call surgeries, as well as in the orthopedic treatment of clubfoot with the Ponseti technique. The residents were assigned a role as surgeon or assistant. The complexity of the procedures was classified into: less than usual, usual and more than usual. The variables evaluated were: specific informed consent, therapeutic indication, anatomy, procedure and complications, preparation of the procedure according to protocol, demonstration of good asepsis and proper use of the instruments, orderly development of the technique, respect for anatomical structures, behavior in an unexpected situation, communication with the surgical team, preparation of surgical protocol, demonstration of professional behavior in all instances and indications of post-surgical care. Each observation was awarded the following score: 0 = Not observed, 1 = lower-than-expected development, 2 = satisfactory or desired level and 3 = outstanding. Just as in the Mini-CEX, immediate feedback was given; the evaluator and the resident were able to express their satisfaction with the test, and comment on aspects to be considered and modified (Table 2). For both situations, the patient's diagnosis, age and sex were needed.

Table 2. *Direct Observation of Procedural Skills* (DOPS) structured form.

Direct observation of procedural skills. (Surgery and bot foot) (**DOPS**: Direct Observation of Procedural Skills)
Evaluator: Date
Resident: R1 ( ) R2 ( ) R3 ( )
Environment: Operating room ( ) Bot foot Clinic ( ) Plaster room ( )
Surgeon ( ) Assistant ( )
Patient First time ( ) Follow-up ( ) Age Gender
Diagnosis:
Complexity of the procedure: Less than usual ( ) Usual ( ) More than usual ( )
Name of the procedure:
Elective surgery ( ) Emergency ( ) Closed reduction of fractures / dislocations ( )
Observer Staff Physician ( ) Professor ( ) Other ( )

0 = Not observed, 1 = Lower-than-expected development, 2 = Satisfactory or desired level 3 = Outstanding

Competencies	**Score**	**Comment**
1. Obtains informed consent and lists possible complications		
2. Describes the indication, anatomy, procedure and complications		
3. Prepares the procedure according to protocols		
4. Demonstrates good asepsis and uses instruments safely		
5. Develops the technique in an orderly manner, respects the anatomical structures		
6. Behaves appropriately in unexpected situations		
7. Communicates clearly with the surgical team and staff		
8. Fulfills the surgical protocol		
9. Behaves professionally at all times		
10. Indicates post-surgical care		

Comments
• Particularly positive aspects:
• Aspects that need to be improved:
• Recommendations:
• Resident's satisfaction with the DOPS 1 2 3 4 5 6 7 8 9 10
• Observer's satisfaction with the DOPS 1 2 3 4 5 6 7 8 9 10
• Time (minutes) used for observation:
• Time (minutes) used for feedback:
• Comments:
• Date: .....
• Resident's signature: ..... • Observer's signature: .....

An explanation of the tests to be used, their objectives and importance, as well as the structured files, were sent in advance by email, both to residents and the body of evaluators. Subsequently, a face-to-face explanatory meeting was held with evaluators and residents, in order to train them with the methodology and resolve doubts, emphasizing the concept that an evaluation is not an exam, it does not grant grades or certifications.

The data collected were transferred to Microsoft Windows 10 Excel spreadsheets for further analysis. The SPSS 17 program was used for statistical processing.[17] A significance level of $p \leq 0.05$ was established. The chi-square test sensitized to the Wilcoxon rank sum test for paired samples was used for the univariate analysis. The comparative analysis between groups of residents was performed with the Kruskal-Wallis test. The reliability of the assessment tools was determined by Cronbach's coefficient α.

FINDINGS

65 observations were made in six residents, by six staff physicians. Four of them are professors of a National University and all of them completed a medical residency (or equivalent) in Child Orthopedics and Traumatology. The average age of graduation was 25 years (range 13-38).

Mini-CEX: comprised 40 evaluations of 40 patients with an average age of 7.2 years (range6 months-14 years), without predominance of any sex. The observations corresponded to: 47.5% to R1, 22.5% to R2 and 30% to R3. Each evaluator made an average of 6.66 observations (range 5-10). The average time of the encounter was 16.4 min (range 10-30) and the time spent for feedback, 7 min (range 5-15). Each resident underwent an average of 6.66 assessments (range 3-10), in charge of 3 to 6 evaluators. Table 3 shows the number of observations made in each clinical scenario. The complexity of the consultation was: low (37.5%), moderate (32.5%), high (30%). 22.5% of consultations were "first-time"; 35.7% were "follow-up" and 42.5% were not recorded. Of all the competencies evaluated, the maximum score corresponded to professionalism and the lowest was related to clinical judgment and effective organization. R1s scored lower on the physical examination; R2s, in professionalism and R3s, in anamnesis (Table 4). However, there was no statistically significant difference in the observations of the residency as a whole. Evaluator satisfaction averaged 8.37 (range 4-10) and resident satisfaction averaged 8 (range 2-10) ($p < 0.003$).

Table 3. Mini-CEX. Frequency of evaluations for each clinical scenario

Scope of observation (n = 40)	Frequency	%
Outpatient office	15	37.5
Emergency	3	7.5
Room	16	40
Referral	6	15

Table 4. Scores by year of residence and scope of evaluation

Scope	1st year resident	2nd year resident	3rd year resident	p
Room	42	104	240	0.023
Referral	74	84	105	0.031
Outpatient office	502	349	217	0.027
Emergency	40	49	51	0.5

Inferential statistics: when specific competencies were analyzed by year of residency, R1s had lower overall scores, except in professionalism. R2s had lower scores in professionalism and R3s had slightly lower scores in anamnesis, although the difference between groups was not significant ($p = 0.31$). In assessing all competencies between groups, the R3s obtained significantly higher scores over the other groups ($p < 0.05$). Still, the R1s achieved a satisfactory average score; whereas the R2s and R3s were outstanding. Compared according to the field of observation, R1 and R2 obtained better scores in the outpatient clinic ($p < 0.02$) and R3, in the hospitalization room and interconsultations ($p < 0.03$). Cronbach's coefficient α was 0.92 for the Mini-CEX and 0.85 to 0.97 for the intrinsic relationship between variables (Tables 5 and 6).

Table 5. Mini-CEX. Competencies evaluated by scope, average values ($\bar{x}$)

Variables	Outpatient office	Emergency	Room	Referral	p
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	
Global score	54.9	49	48.25	37.57	0.5
Observation time (min)	16.5 (5-22)	15 (5-30)	16.4 (15-20)	16.25 (5-20)	0.4
Time used for feedback (min)	6.8 (5-10)	5 (3-8)	14.5 (10-30)	10 (5-15)	0.5
Resident's satisfaction	8.5 (6-10)	7.6 (6-10)	7 (4-10)	8.8 (5-10)	0.03
Evaluator's satisfaction	8.3 (4-10)	9 (6-10)	7.5 (4-10)	9.8 (7-10)	0.03

Table 6. Mini-CEX. Competences by year of residency

Evaluated area		R1		R2		R3		
Competencies	**n**	**Average**	**n**	**Average**	**n**	**Average**	**Average**	**p**
Anamnesis	95	5	80	7.2	70	7	19.2	0.3
Physical examination	92	4.8	76	6.9	80	8	19.7	0.3
Professionalism	119	6.2	83	4.5	79	7.9	18.6	0.3
Clinical judgement	114	6	89	8.09	78	7.8	21.8	0.3
Cognitive abilities	109	5.7	83	7.5	81	8.1	21.3	0.3
Effective organization	112	5.8	65	5.9	80	8	19.7	0.3
Global score	116	6.10	79	7.9	70	7	21	0.05

DOPS: over 25 observations, 40% corresponded to R1; 28% to R2; and 32% to R3. The evaluation included 23 patients, 78% were male, and the average age was 6.76 years (range 6 months-14 years). The average time of evaluation was 1 h and 21 min (range 10 min-5 h 50 min), the average feedback took 8.8 min (range 5-15). The complexity of the procedure was considered usual at 68% and more than usual at 32%. Residents performed as surgeons in 72% of the procedures and as assistants in the remaining procedures. On 19 occasions, trauma and orthopedic surgeries of various aetiologies were evaluated. In six cases, the evaluation included the treatment of bot foot with Ponseti technique, including manipulations, plasters and, in some patients, Achilles tendon tenotomy, as well as expertise with the use of the abduction splint. Each resident was evaluated, on average, 4.16 times (range 3-6) by 2.8 evaluators (range 2-4). Overall, 72% had a satisfactory score, and 28% did so outstandingly. None of them had a lower-than-expected result. Evaluator satisfaction with observation averaged 8 (range 7-10) and resident satisfaction averaged of 8.63 (range 6-10) ($p < 0.03$).

Inferential statistics: comparing resident groups, we see a statistically significant difference in overall competencies in favor of R3 ($p < 0.05$). Similarly, the latter group was more competent in resolving unexpected situations during the surgical act ($p < 0.005$). Cronbach α coefficient was 0.90 for DOPS, but for internal correlation between variables fluctuated between 0.89 and 0.93 (Tables 7 and 8).

Table 7. DOPS. Relationship between competencies in the surgical setting

Competencies	R1	R2	R3	Average	p
Global score	16.8	17	21	18.2	0.05
Number of observations	9	8	7	4.16	0.5
Average observation time (min)	66.1	60.8	49.2	58.7	0.5
Time used for feedback (min)	13 (5-15)	10 (5-15)	10.71 (5-15)	8.8	0.5
Resident's satisfaction	8	9	9	8.6	0.03
Evaluator's satisfaction	9	9	9	9	0.03

Table 8. Relationship between the years of residency and the surgical competencies analyzed.

Competencies	Scores (n)	R1	R2	R3	p
1. Obtains informed consent and lists possible complications	58	13	18	27	0.01
2. Describes the indication, anatomy, procedure and complications	47	13	16	18	0.5
3. Prepares the procedure according to protocols	56	10	16	30	0.01
4. Demonstrates good asepsis and uses instruments safely	65	17	18	30	0.01
5. Develops the technique in an orderly manner, respects the anatomical structures	68	18	20	30	0.02
6. Behaves appropriately in unexpected situations	68	18	20	30	0.005
7. Communicates clearly with the surgical team and staff	60	18	20	22	0.5
8. Fulfills the surgical protocol	65	18	20	27	0.5
9. Behaves professionally at all times	60	10	20	30	0.01
10. Indicates post-surgical care	68	18	20	30	0.05

DISCUSSION

The purpose of a residency program is the professionalization of the physician through the progressive acquisition of specific competencies. It is imperative to determine whether teaching strategies have been adequate and expectations of achievement have been met. This requires a process of systematic evaluation, diagnosis or data collection, by means of the application of various tools. Depending on the case, the evaluation can be diagnostic or initial, summative or final and formative, when it is desired to monitor the process and progress of learning. In our specialty, the task is arduous, because we must include very heterogeneous competencies. In *Civilization and Its Discontents,* Sigmund Freud ironically defined as impossible professions those in which the results are never completely satisfactory: psychoanalysis, government and education.[18]

We have already proposed that every tier of Miller's pyramid should be evaluated with relevant or specific instruments. Seeking to evaluate professionalism or even more, suitability, by means of a multiple-choice exam or written assignments, which refer exclusively to theoretical knowledge or, at most, to the "know-how", is irrelevant. They say nothing about "demonstrating" or "doing." The risk is evident. With theoretical knowledge, memory, correct answer recognition and prior practice, an individual can obtain excellent qualifications, even if this does not guarantee the quality of his/her professional practice at all. This is a false positive, which gives

professional credit to those who do not deserve it. We usually call this *Funes the Memorious Complex*, after the famous Jorge Luis Borges short story, in which he tells us the vicissitudes of Ireneo Funes, a young Uruguayan from Fray Bentos who, crippled as a result of an equestrian accident, develops hypermnesia or extraordinary memory, although lacking rational competencies. Insightful, Borges writes: "I suspect, however, that he was not very capable of thinking. To think is to forget differences, it is to generalize, to abstract."[19]

The practice of medicine is closely related to philosophy. Thus, when we reason we apply logic; by considering the patient as a real subject and external to our consciousness, we invoke naive realism; when we accept the existence of genes, microbes, technology and surgical techniques, we employ scientific realism; by rejecting the hypothesis of the mythical origin of diseases, we subscribe to naturalistic principles and, when we help beyond our own interests, we practice humanistic moral philosophy. We philosophize unknowingly, but, as Mario Bunge warns, "The implicit philosophy of the good doctor is that which he practices and not necessarily that which he professes." And it is, at this point, where evaluation is crucial and imperative.[20]

The stable and teaching medical team, in conjunction with the institution, has an undeniable moral and legal responsibility in the evaluation. As well as the State, given that 70% of the medical residencies of our specialty are under its aegis.[21] Evaluation involves *a process of* self-assessment of methodological learning or metacognition strategies. A recent survey by the Argentine Association of Orthopedics and Traumatology, conducted with resident physicians, has identified and alerted the deficit in academic activity as one of the main concerns of young people in training.[21]

The two instruments used in our study, Mini-CEX and DOPS, evaluated "do" or professional excellence. They were chosen *ex profeso*, by virtue of previous experiences that enhance them as of greater educational impact in relation to many others.[8,9,11,15,18] They allowed us to observe the competencies of residents in real situations and various contexts, both clinical and surgical, as well as behavioral factors and horizontal-vertical incorporation of knowledge. At first glance, the observation of the overall results obtained was satisfactory, but the statistical analysis of multivariate regression allowed to identify, precisely, strengths and weaknesses in each year of the residency, as well as to discriminate between different levels of experience. The first corollary for academic leaders of a residency seems obvious: to work to correct these weaknesses. It is also worth noting how misleading descriptive inferences can be in contrast to the power of the scientific method. On the other hand, it is important to note that achieving an optimal skill in one area does not predict success in another, even if they are related. Compared to other publications, we have spent a longer time evaluating surgeries, due to the full observation of procedures.[12,14] However, and similarly to other investigations, there was a high acceptance or satisfaction, both from observers and residents.[11,12,14,18,22,23] Cronbach's α coefficient was 0.90 and 0.92 for DOPS and Mini-CEX, respectively; from a psychometric point of view, factors considered to have the greatest impact on educational measurement.[18] Increasing or sustaining reliability is possible by holding 4 to 10 annual meetings.[9,13,15,22,23] In addition, the increase in observations is also justified by the need to mitigate, statistically, the potential pathology of evaluators: intraobserver variations linked to changes in attention, perspective or mood. We must also recognize interobserver variations: differences in criteria, accuracy, and empathy.[15]

Feedback is the main quality of both instruments, especially *positive feedback,* as it promotes reflection and self-criticism on the part of the resident, helps to identify their weaknesses and strengths. Alves de Lima argues that residents want and need constructive feedback, as they relate them to quality teaching.[24] Feedback must be immediate, since the delay in its implementation leads to evaluation errors. Many researchers, including us, think it is part of our teaching responsibility to influence the professional future of the resident through constant feedback. This is part of socratic teaching, which, despite certain current tensions, we have always professed.[9,22] The time assigned for feedback with Mini-CEX and DOPS was 7 and 8.8 min, respectively, but in future evaluations we will allocate more time, due to the reasons already mentioned. Suggested recommendations for proper feedback are: establishing a respectful learning environment, communicating goals and objectives, comment from direct observation, provide timely feedback on a regular basis, start the session with the self-assessment of the resident, reinforce and correct observed performances, use neutral language to focus on specific knowledge or procedures, confirm understanding and facilitate acceptance, conclude with an action plan, reflect on feedback skills, create opportunities for personal development and make this procedure part of the institutional culture.[18]

This study has several limitations: execution errors related to our first experience with these evaluation tools. On the other hand, given the prevailing culture in our environment, it was unconvincing that the resident did not perceive the review as an exam whose outcome could affect their self-esteem or final qualification. Like other authors, we believe that, given the specific context of each institution, it does not seem advisable to extrapolate, unthinkingly, findings from one residency to another.[23] Finally, we should increase the number of observations in order to sustain or increase the reliability of the evaluation instruments and reduce potential abnormal biases of some observers. The strength of this study was the use of evaluation tools structured in a specific medical residency, inspired by the following thought said by Horace and made known by the excellent German philosopher Immanuel Kant: *Dimidium facti, qui coepit habet, sapere aude. Incipe*.[25]

In conclusion, Mini-CEX and DOPS proved to be relevant and reliable tools for assessing the professionalism of a residency in Pediatric Orthopedics and Traumatology, but this does not imply that they are exclusive. A portfolio that includes various forms of valuation, structured or not, would appear to be the ideal instrument. The quality of the evaluation depends primarily on the relevance to the observed object, the type of prioritized cognitive operations and the subjects involved.

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Total Elbow Arthroplasty in the Context of a Nonunion of the Olecranon. Surgical Technique and Report of 3 Cases

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ABSTRACT
The integrity of the extensor apparatus is essential for the correct functioning of an elbow prosthesis. Triceps deficiency has been considered a relative contraindication for arthroplasty, because it produces a flexion contracture and an active extension deficit. These limitations can significantly affect the functional improvement that total elbow arthroplasty produces. Faced with an olecranon nonunion, the placement of a total elbow prosthesis is presented as a complex problem to be solved. The objective of this article is to describe the surgical technique for the placement of a total elbow prosthesis in the context of an olecranon nonunion, and to report three cases.
Keywords: Total elbow prosthesis; olecranon nonunion; triceps deficiency; absorber-traction system.
Level of Evidence: IV

Prótesis total de codo en el contexto de una seudoartrosis de olécranon. Técnica quirúrgica y reporte de tres casos

RESUMEN
La indemnidad del aparato extensor es fundamental para un correcto funcionamiento de una prótesis de codo. Se ha considerado que la deficiencia del tríceps es una contraindicación relativa para la artroplastia, porque produce una contractura en flexión y un déficit de extensión activa. Estas limitaciones pueden afectar significativamente la mejora funcional que la artroplastia total de codo produce. Ante una seudoartrosis de olécranon, la colocación de una prótesis total de codo se presenta como un problema complejo que resolver. El objetivo de este artículo es describir la técnica quirúrgica para la colocación de una prótesis total de codo en el contexto de una seudoartrosis de olécranon, y comunicar tres casos.
Palabras clave: Prótesis total de codo; seudoartrosis de olecranon; deficiencia del tríceps; sistema de absorbe-tracción.
Nivel de Evidencia: IV

INTRODUCTION

Total elbow arthroplasty (TEA) is an effective option for the treatment of various post-traumatic and degenerative diseases.[1-8] The integrity of the extensor apparatus is essential for a correct functioning of the prosthesis.[9] Triceps deficiency has been considered a relative contraindication for TEA, because it produces a flexion contracture and a deficit of active extension. These limitations can significantly affect the functional improvement that total elbow arthroplasty produces.[10,11]

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Thus, if a patient has osteoarthritis or elbow arthritis associated with an olecranon nonunion (ON), the placement of a TEA as a salvage procedure is presented as a complex problem to solve.

Although some alternatives for the management of an ON have been described in this context, the literature remains scarce. Some of the proposed treatments include resection of the proximal end of the ulna, osteosynthesis and conservative treatment in the case of fractures without great displacement and with strong fibrous junctions.[12,13]

The objective of this article is to describe the surgical technique for the placement of a TEA in the context of an ON and to report three cases.

Surgical technique

All patients were operated on by the same surgeon. The surgery was carried out with the patient in the dorsal decubitus position under regional anesthesia. After placing a pneumatic tourniquet cuff, a posterior elbow approach was performed and the ulnar nerve was identified, which, after neurolysis, was transposed anteriorly in all cases. The ON focus was identified (Figure 1A) and, through it, the joint was entered, resecting all the fibrous tissue. The proximal end of the ulna, in conjunction with the triceps tendon, was repaired proximally (Figure 1B).

In all patients, the triceps was contracted and strongly attached to the posterior aspect of the humerus, so it was necessary to release it to allow subsequent coaptation of the ulna ends.

Cases 1 and 2 were sequelae of Monteggia dislocated fractures with a subsequent evolution to ON and joint degeneration. Case 3 was a woman with a periprosthetic fracture due to an inverted shoulder arthroplasty who, a year earlier, had presented an olecranon fracture treated conservatively and, in this context, suffered a distal humerus fracture AO C3.

In patients 1 and 2, the entire distal humerus was exposed and the corresponding cuts were made preserving both columns. In the case of the supracondylar fracture, the fractured distal humerus was resected.

At the ulnar level, the medullary canal was reamed until the corresponding implant could be placed. All patients received a Coonard-Morrey semi-constrained prosthesis (Zimmer, Warsaw, IN, USA) in two cases and a Discovery (Biomet, Warsaw, IN, USA) in the remainder.

The pre-assembled trial prosthesis was then placed. This surgical step is important, because placing the implant in this way avoids the possibility of malrotation of the components, which is common when there is a bone deficit at the level of the proximal ulna or distal humerus. To place the prosthesis, the elbow was placed in maximum flexion and both components were introduced, at the same time, into the medullary canals (Figure 1C). The proximal ulna should then be trimmed to better fit the distal ulna.

Before cementing the prosthesis, a transverse hole was drilled in the ulna and a 1.6 mm wire was inserted for the traction-absorber system. A plug was placed in the humeral canal and the final prosthesis was cemented with a gun. In all cases, cement with antibiotics (vancomycin 1 g / dose) was used. Before setting the cement, the proximal ulna fragment was reduced and two 1.6 mm Kirschner pins were placed from the posterior aspect of the ulna to the anterior or intramedullary aspect, attempting to place them on each side of the prosthesis stem. The pins were placed into the cement to prevent their extrusion, and a bone graft was placed in the area of nonunion obtained from the cuts and fracture fragments of the distal humerus (Figure 1D).

Osteosynthesis was carried out at 45° extension of the elbow and was complemented with a non-absorbable thread suture (Ti-Cron® 2-0) from the triceps tendon to the orifice of the absorber-traction system with the intention of reducing the tendon traction.

During the surgery, the complete range of motion of the elbow was verified and the patients were immobilized with a plaster cast in 45° extension, which was left for 15 days, then a sling was placed and an active mobilization plan was started.

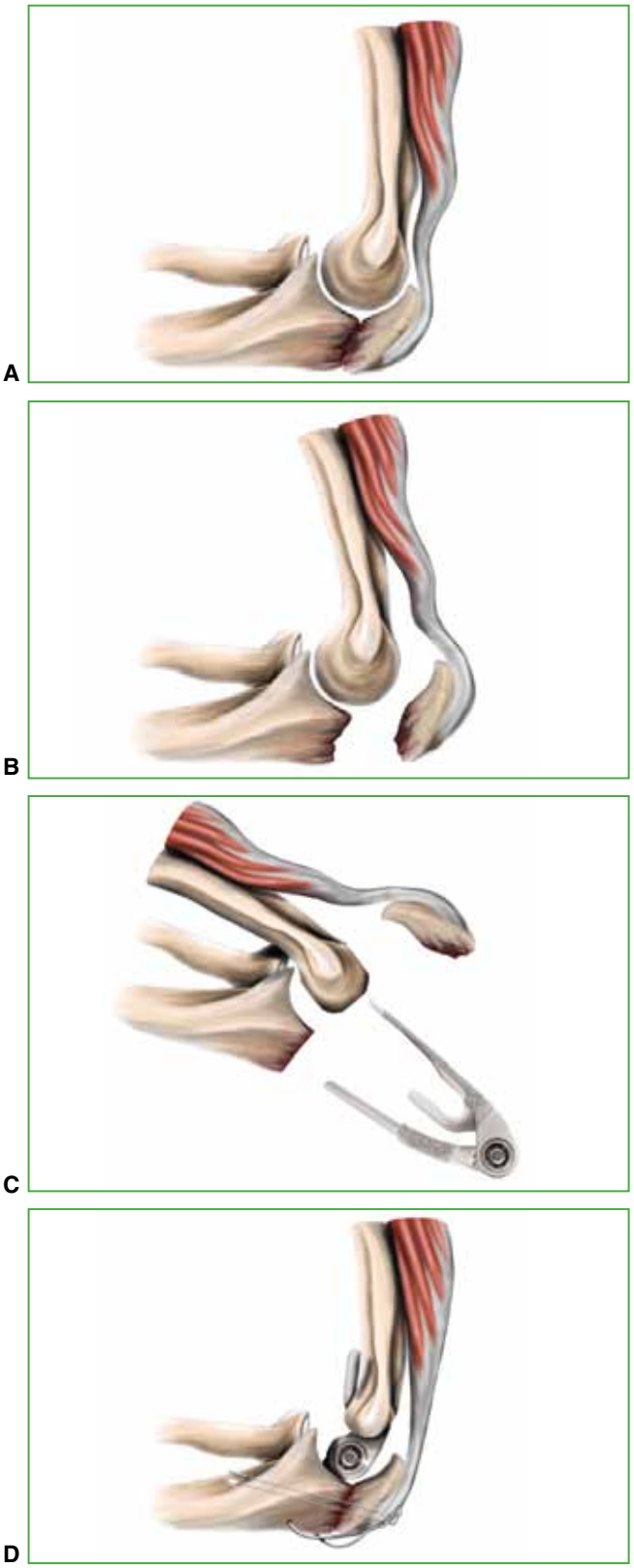

Figure 1. Surgical technique. **A.** Image with olecranon nonunion. **B.** We entered through the nonunion focus. **C.** The cuts are made and the assembled prosthesis is placed. **D.** The proximal olecranon is carved and osteosynthesis is performed with the traction-absorber system.

CLINICAL CASES

From 2007 to date, 115 TEAs have been placed in our service. Only three TEAs were placed in the context of a degenerative pathology, associated with an ON.

Case 1

A 70-year-old woman who consulted for pain and instability in her left elbow. As background, she presented a Monteggia fracture-dislocation of three years of evolution, for which she underwent surgery on three occasions. In the first surgery, the osteosynthesis of the olecranon was performed; in the second, the head of the radius was excised and, in the third, the osteosynthesis material was extracted. Flexion-extension was 90° -30°, with a pain score of 8 on the visual analog scale (VAS), a MEPS score of 40, and a DASH score of 56. On radiological images, the ON and advanced joint degeneration were evident. After puncture to rule out infection, the patient was operated on with the described technique. A Coonrad-Morrey prosthesis was fitted. Five years after surgery, the pins were removed due to discomfort; final flexion-extension was 125° -25°, with a VAS score of 2, a MEPS score of 75, and a DASH score of 32. The nonunion was consolidated and the prosthesis showed no signs of loosening (Figure 2).

Case 2

A 27-year-old man who consulted for pain and instability in his left elbow. As background, he presented a Monteggia fracture-dislocation of three years of evolution, for which he underwent surgery four times. In the first surgery, the osteosynthesis of the olecranon was performed; then, a subluxation traction absorber was placed, the head of the radius was resected and, finally, the entire osteosynthesis was removed. Flexion-extension was 110° -40°, with a pain score of 5 on the VAS, a MEPS score of 35, and a DASH score of 46. Radiographic images showed joint wear and ON. After puncture to rule out infection, the patient was operated on with the described technique. A Coonrad-Morrey prosthesis was fitted. At four years of follow-up, flexion-extension was 120° -35°, with a VAS score of 2, a MEPS score of 75, and a DASH score of 27. The nonunion was consolidated and the prosthesis showed no signs of loosening (Figure 3).

Case 3

A 81-year-old woman who consulted for a C3 supracondylar fracture according to the AO classification. She had undergone surgery for a shoulder fracture and an inverted prosthesis had been placed. She then suffered a periprosthetic fracture that was treated with a plate. A year before our surgery, she had had an olecranon fracture treated in a conservative way. In our surgery, some distal implant screws were removed and a Discovery prosthesis was placed. Three months after the intervention, it was necessary to remove the pins due to protrusion. At one year of follow-up, flexion-extension was 135° -40°, with a VAS score of 2, a MEPS score of 80, and a DASH score of 29. The nonunion was consolidated and the prosthesis had no signs of loosening (Figure 4).

DISCUSSION

The most common indications for prosthetic replacement in the elbow are post-traumatic sequelae and degenerative diseases. Post-traumatic pathology is associated with a greater number of complications compared to rheumatic ones.[3,4] Among them, triceps insufficiency is one of the most published[9,14] and when the patient has previous infections, the results are even worse. Duquin et al.[15] reported that 55% of 91 patients with a history of infection in the elbow had an elbow extension deficit at the end of reconstruction. Therefore, the correct and careful handling of the extensor apparatus is essential to try to prevent complications.

Faced with a proximal ulna without bone deficit, a relative success of reconstruction with bank Achilles tendon grafts and rotational anconeus flap has been reported. Sanchez-Sotelo and Morrey reported seven patients with these types of reconstruction and a good recovery of extension strength in six of them.[9]

In cases with more severe bone deficits, the solution is complex.[16-18]

The ON alters the continuity of the extensor apparatus and, therefore, we consider that it should be solved at the same time the prosthesis is placed. ON is rare in the context of a fracture treated with osteosynthesis.[19,20]

Papagelopoulos and Morrey[12] published a series of 16 ONs treated with autologous bone graft and osteosynthesis; consolidation was achieved in 15 cases. However, in Monteggia fracture-dislocations or transolecranon fractures, it tends to occur more frequently.[21,22]

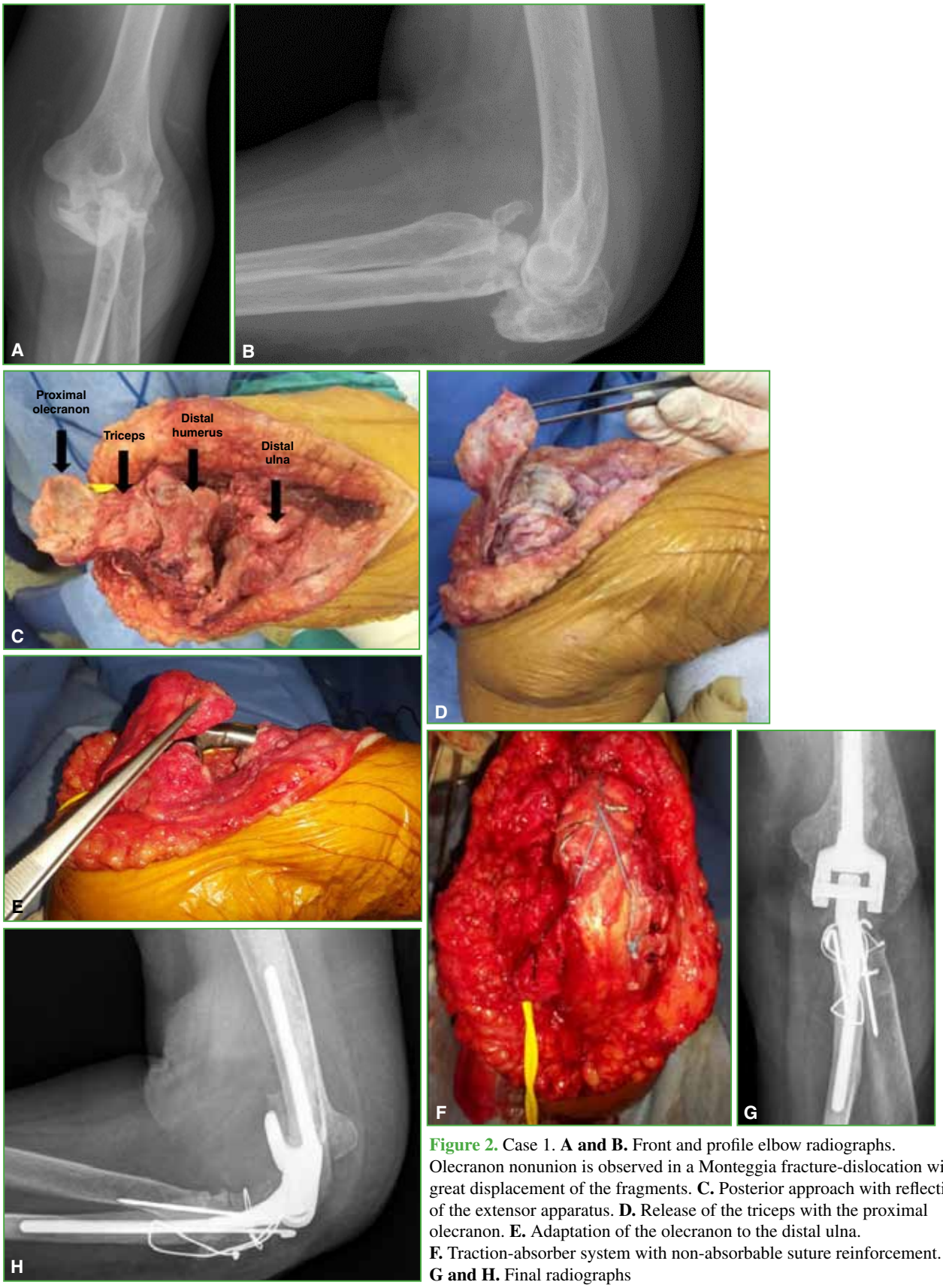

Figure 2. Case 1. **A and B.** Front and profile elbow radiographs. Olecranon nonunion is observed in a Monteggia fracture-dislocation with great displacement of the fragments. **C.** Posterior approach with reflection of the extensor apparatus. **D.** Release of the triceps with the proximal olecranon. **E.** Adaptation of the olecranon to the distal ulna. **F.** Traction-absorber system with non-absorbable suture reinforcement. **G and H.** Final radiographs

Figure 3. Case 2. **A and B.** Front and profile elbow radiographs. Olecranon nonunion is observed in a Monteggia fracture-dislocation. **C and D.** Final radiographs.

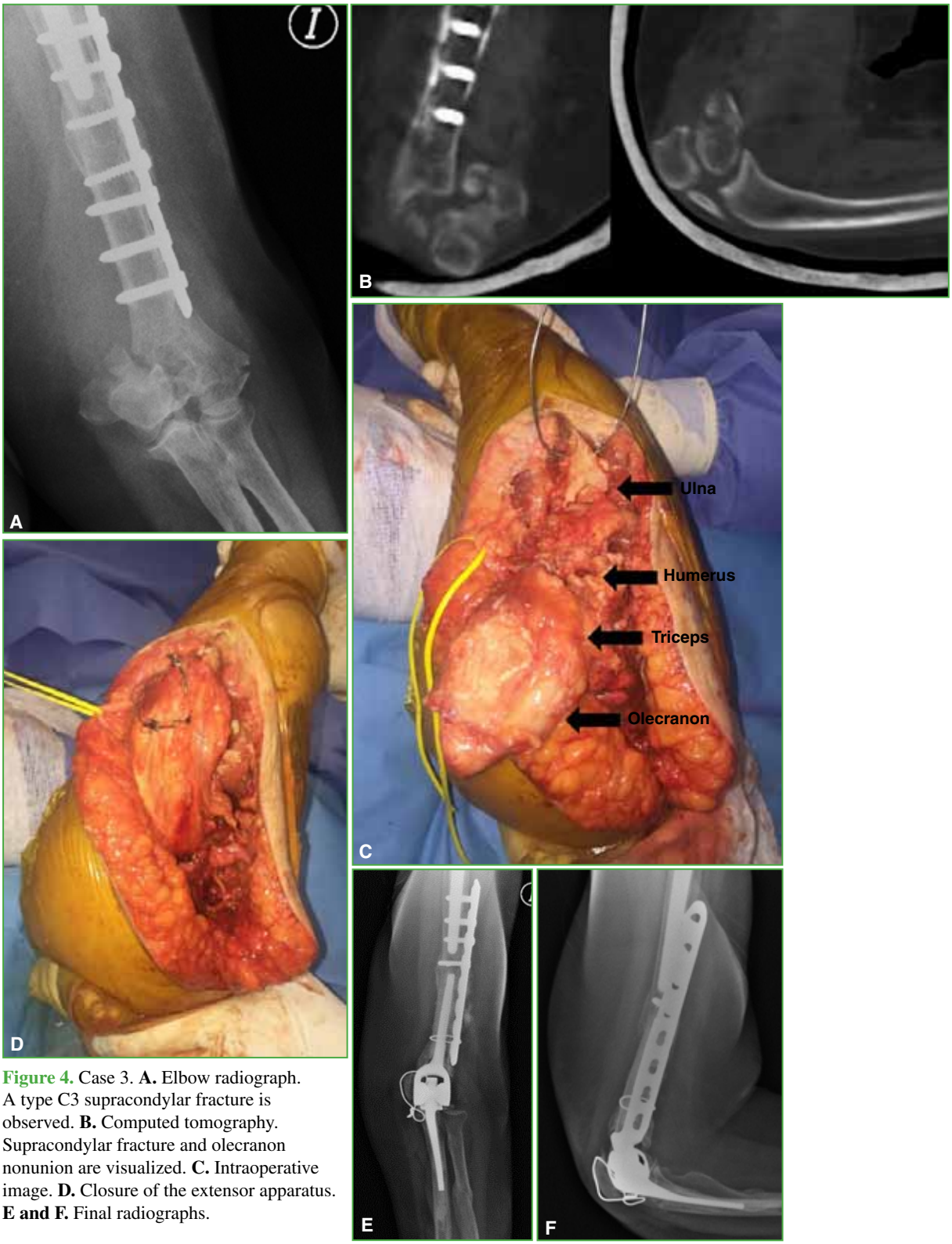

Figure 4. Case 3. **A.** Elbow radiograph. A type C3 supracondylar fracture is observed. **B.** Computed tomography. Supracondylar fracture and olecranon nonunion are visualized. **C.** Intraoperative image. **D.** Closure of the extensor apparatus. **E and F.** Final radiographs.

The described technique allows the prosthesis to be placed while maintaining the continuity of the extensor apparatus by means of its osteosynthesis with a traction absorber system.

Marra et al.[13] published a series of seven patients with post-traumatic pathologies and ON who underwent the placement of a TEA and, in four of them, consolidation was achieved. Two of the three remaining cases without consolidation required a new intervention with plate and screw osteosynthesis. Therefore, the consolidation of the ON is difficult to obtain. In some cases, a strong fibrous union of the nonunion focus can yield good results while maintaining an acceptable function of the extensor apparatus.[13]

In this series, we have added a bone graft taken from the distal humerus in all three cases and consolidation was achieved in all of them.

Chronic triceps retraction can also lead to lack of consolidation. Therefore, we consider that reinforcement with non-absorbable sutures and immobilization at 45° of extension are useful alternatives to reduce the muscle traction force and allow the consolidation of the nonunion.

The placement of Kirschner pins before the cement sets should be quick and accurate, with little chance of repositioning. For this reason, the length of the pins must be previously measured so that they do not extend beyond the anterior cortex of the ulna. However, we had to remove the pins in two of the cases due to protrusion or discomfort. The placement of the traction absorber system once the cement has set instead of with the fresh cement, is possibly useful to achieve a better positioning of the pins, which has been a complicated step in our patients.

CONCLUSIONS

When there is joint wear and an ON, treatment with a previously assembled TEA placed through the nonunion focus, releasing the entire extensor apparatus, an osteosynthesis with an absorbent-traction system and the addition of bone graft can yield good results. This technique allows us to achieve a stable elbow, with little pain, and to maintain the continuity of the extensor apparatus. Obtaining excellent results in this type of reconstruction is difficult and patient follow-up is essential, because complications are very frequent.

Conflict of interests: The authors declare they do not have any conflict of interests.

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Case Resolution

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See case presentation on page 289.

DIAGNOSIS: Myositis ossificans

DISCUSSION

Myositis ossificans is the most common form of heterotopic ossification, usually within large muscles. Its importance stems in large part from its ability to mimic more aggressive pathological processes. In more than 75% of cases, this disease is associated with trauma or a history of repetitive microtrauma. To a lesser extent, it is related to surgical procedures. It is also detected in patients with long ICU stays for head trauma, spinal trauma or neurological disorders, even patients with severe burns. The most common presentation sites are: elbow, shoulder, pelvis and thighs. It can also involve muscles, tendons, ligaments and aponeurosis.

Some conditions are related to myositis ossificans or share a similar name, including:

- Circumscribed myositis ossificans: it refers to new bone that usually appears after trauma (Figures 4 and 5).

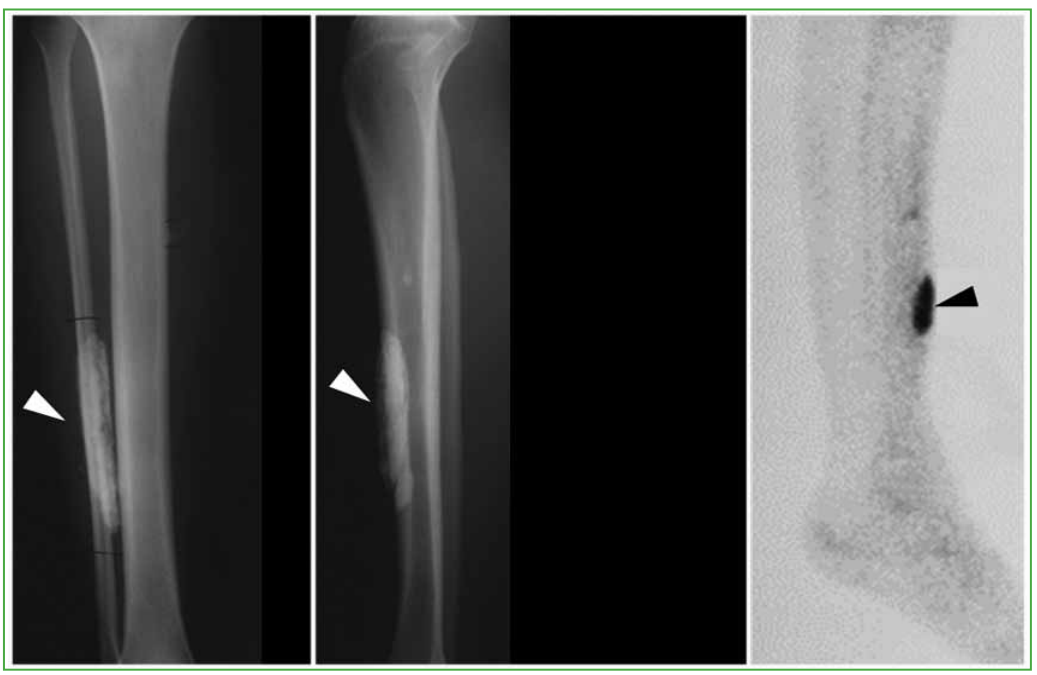

Figure 4. Myositis ossificans in the mature phase. Leg radiographs show tibial calcification adjacent to the shaft and bone scan uptake.

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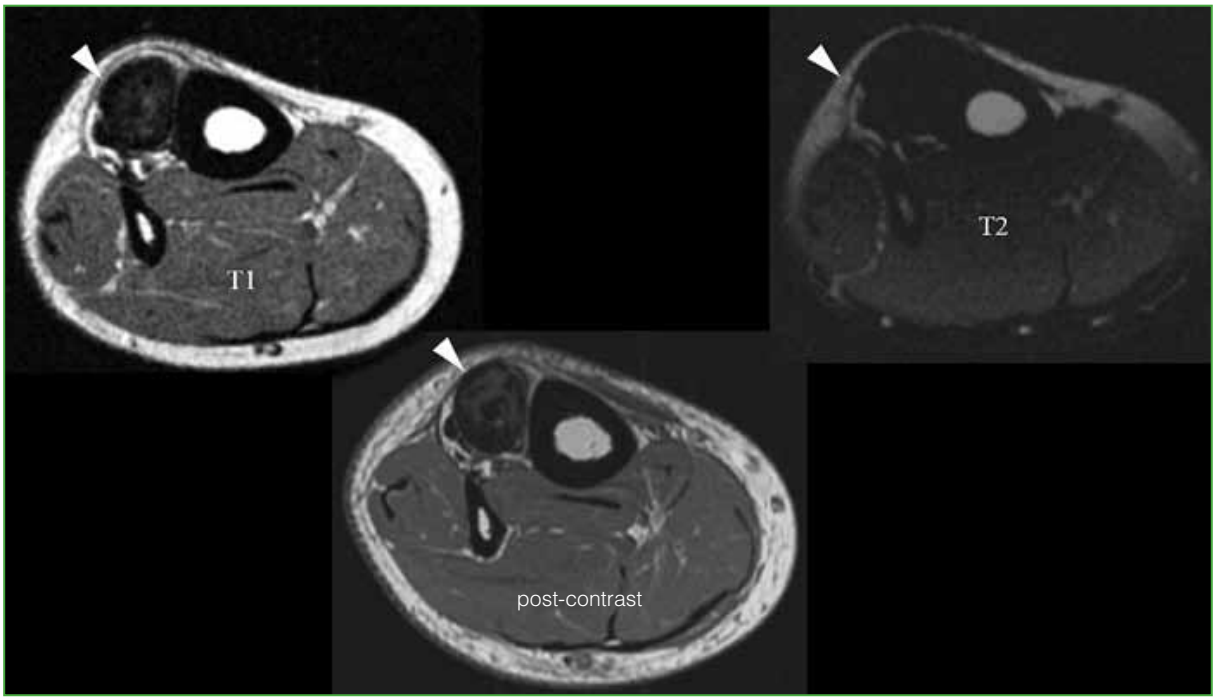


Figure 5. MRI of the leg with contrast medium. In the T1- and T2-weighted sequences, a low signal image is observed adjacent to the tibial shaft with little post-contrast enhancement.

- Myositis ossificans progressiva: it is a rare inherited disorder characterized by fibrosis and ossification of muscles, tendons and ligaments at multiple sites; it is disabling and ultimately fatal (Figure 6).
- Panniculitis ossificans: similar to myositis ossificans, but affects the subcutaneous tissues.

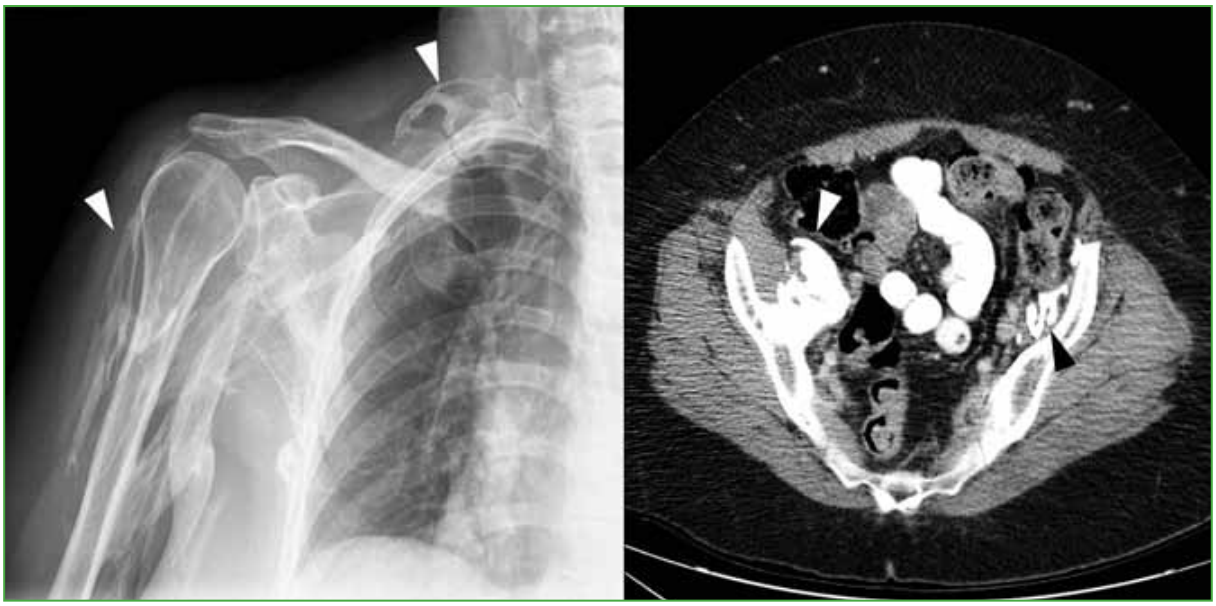


Figure 6. Myositis ossificans progressiva. On the right shoulder radiograph, multiple soft tissue calcifications are recognized, and on computed tomography, progressive calcifications are seen in the psoas.

Most cases of myositis ossificans occur as a result of trauma, and therefore the primary demographic is young adults. Another group especially prone to myositis ossificans are paraplegic patients, generally without evidence of trauma.

It typically presents as a painful, tender, enlarging mass, which in 80% of cases is located in the large muscles of the extremities, often following recognized local trauma, although a definite traumatic event is not always recalled. In paraplegic patients, recognized traumatic events are often absent, and the disease occurs especially around the knees and hips. Myositis ossificans is essentially a metaplasia of the intramuscular connective tissue that results in extraosseous bone formation (without inflammation).

There are three well-described histopathological stages:

1. First month: the tissue injury causes organizing granulation tissue with fibroblastic and osteoblastic differentiation and osteoid formation.
2. Second month: mineralized osteoid matrix develops with immature lamellar bone.
3. Third month: immature bone progresses to mature lamellar cortical and trabecular bone.

Unfortunately, the histological appearance of myositis ossificans may appear similar to that of osteosarcoma and therefore can lead to inappropriate management.

The typical radiographic appearance of myositis ossificans is a circumferential calcification with a lucent center and a radiolucent cleft that separates the lesion from the cortex of the adjacent bone. On plain radiographs, initially, there is no calcification, but there may be soft tissue inflammation. Calcification usually manifests within 2-6 weeks, and the lesion reaches the classic well-circumscribed peripherally calcified appearance by two months. Over the following four months or so, the calcifications usually become smaller and denser. The radiolucent cleft can be difficult to see on plain radiographs.

The appearance on computed tomography images is similar to that of conventional radiography, demonstrating mineralization proceeding from the outer margins towards the center. The cleft between the calcifications and the subjacent bone is usually visible. The peripheral rim of mineralization is visible within 4-6 weeks.

The appearance on MRI changes with the age of the lesion. Early features can be misleading because the peripheral calcification is poorly visualized and soft tissue edema can extend beyond the often inapparent calcific rim.

- T1: ill-defined isointense to muscle mass.
- T2: periphery: high signal (edema) observed up to eight weeks; central: heterogeneous high signal, due to high proliferating cellularity and cartilaginous components. Fluid-fluid levels have been reported and attributed to previous hemorrhage.
- T1 with contrast medium: enhancement is often present.

Late features mimic bone:

- T1
  - periphery: low signal (mature lamellar bone)
  - central: intermediate to high signal (bone marrow)
- T2
  - periphery: low signal (mature lamellar bone)
  - central: intermediate to high signal (bone marrow)
- T1 with contrast medium: generally none in mature lesions.

In the early stages of lesion development, nonspecific increased bone scan uptake is observed, gradually decreasing as the lesion matures.

FDG PET can demonstrate intense uptake mimicking high-grade lesions.

Myositis ossificans is benign and there is no compelling evidence that malignant degeneration ever occurs. As such, treatment is reserved for symptomatic lesions, and surgical resection is usually curative.

DIFFERENTIAL DIAGNOSIS

In imaging studies, the differential diagnosis should include:

- soft tissue sarcomas, including malignant histiocytoma or synovial sarcoma. There is no traumatic history (Figure 7).
- Paraostal osteosarcoma: it calcifies in the center and continues towards the periphery, and affects the metaphyseal region more (Figure 8).

Treatment of this disease seeks to improve symptoms and may include radiation therapy, non-steroidal analgesics that inhibit the formation of calcifications, and surgery. It is important to clarify that, when indicating surgery, it is necessary to add the three strategies mentioned.

Radiotherapy: This treatment is essential to control and even reduce the masses related to myositis ossificans. It is used both in the prevention of surgeries that could potentially generate myositis ossificans, and in the surgical treatment of the extraction of masses of myositis ossificans to prevent their recurrence. There is no consensus on the dose, but, in general, it depends on the size, the location, and if it is preventive or adjuvant.

Nonsteroidal anti-inflammatory drugs: They are the drugs most used in the prophylaxis of myositis ossificans. Indomethacin is the gold standard, 25 mg are given 3 times a day for 6 weeks.

New studies show good results with COX-2 inhibitors, such as celecoxib, for the prophylaxis of myositis ossificans.

The surgical indication to remove myositis ossificans is directly related to the symptoms and how these affect the quality of life of the patient.

Figure 7. MRI of the pelvis with contrast medium. In the T1-weighted sequence, an expansive lesion with an intermediate signal is observed in the inner region of the proximal third of the right thigh. In the T2-weighted sequence, the lesion is evidently hyperintense. Following the injection of the contrast medium, a marked enhancement is seen with central areas of low signal not taking up the contrast medium.

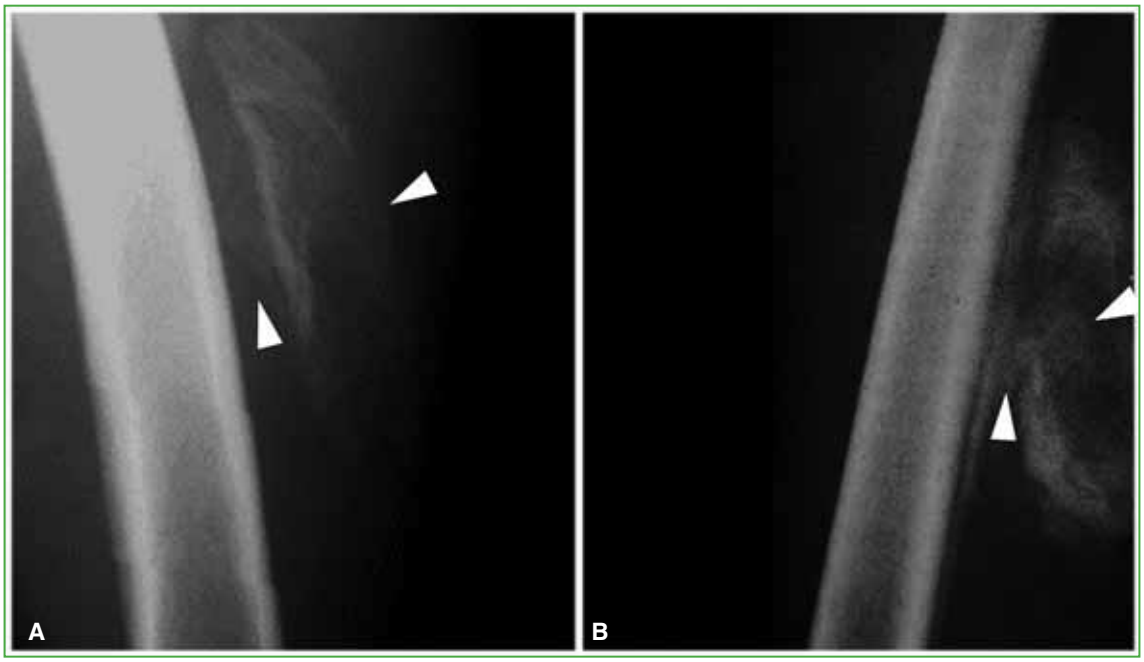
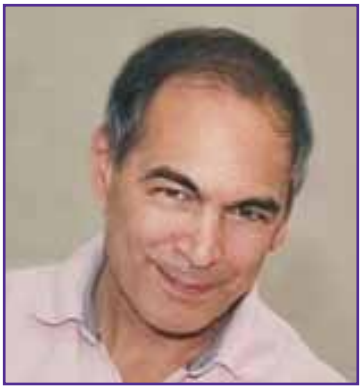


Figure 8. Radiographs of the femur in different patients showing the difference between myositis ossificans (**A**) and paraostal osteosarcoma (**B**). In myositis, the calcification is peripheral and radiolucency (cleft) is recognized with the adjacent bone. In sarcoma, the calcification is central and there is continuity with the neighboring bone structure.

An important point to clarify is that surgery must be performed 6 months after the appearance of myositis ossificans, that is, it must "mature" before the procedure. The recurrence rate is high when the surgery is carried out earlier. It is important to remember that the surgical procedure must be accompanied by prophylactic radiation therapy and non-steroidal anti-inflammatory drugs.

The patient presented was treated with a single dose of radiotherapy, physiotherapy and indomethacin 25 mg, 3 times a day, for 6 weeks, with a good restoration of quality of life, but the volume of myositis ossificans was not significantly reduced.

Dr. Aníbal Julio Acuña
Goodbye Aníbal!



On May 7th, 2021, a pandemic Friday, I found myself reading in the WhatsApp group of Residents about the news of the death of Medical Colonel Aníbal Julio ACUÑA, nicknamed by his friends "the Monk", for he was tall, thin, always with the right word and a frank smile; a man without evil. All of us orthopedists feel enormous grief over the early death of this extraordinary colleague. A great expectation for his great medical qualities was lost. Noted for his reasoning abilities and sagacity to solve the most complicated clinical-surgical issues, of prodigious memory, original, a creator and artist at times. He was born on July 3rd, 1968, in Córdoba, the eldest son of six siblings, one of them stands out: his graceful sister. They moved to Salta where their physician father practiced our profession as an anesthetist. After graduating, he entered the Military Health System with the rank of First Lieutenant Medical Resident of Traumatology and Orthopedics and was discharged on December 31st, 1992. Being the first of his generation, his colleagues were Maxi RODRIGUEZ, Marcelo COTARELO, Pablo RUIZ, Roberto CASTELLI, Fernando GALLO. They attended the residency with two civilian medical colleagues, Gustavo CAPURRO and Víctor DÍAZ MARTINEZ, Colombian. His Chief of Residents and instructor—because he was already a staff member—was the then Medical Captain Carlos Eugenio MARTINEZ. Let us remember that, at that time at the Central Military Hospital, there were two well-characterized teams, represented by two prestigious specialists, Doctors Carlos Manuel Osvaldo VILARIÑO and Ariel Darío BARRERA ORO. A Hand Surgery Service, created by Dr. León A. POCHAT in 1954, separated from the rest of the Department, and was presided by the author of this piece, who allows himself to interpret this man and his circumstances.

In 1995, Dr. Aníbal Julio ACUÑA had his first mission abroad, UNPROFOR CROATIA, former Yugoslavia, where he had his Baptism by Fire on May 31st, when he took part during the offensive of the Serbian Army. He was a member of the Health section of Ca A. He was a member of the mission of "safe passage" of the civilian population to areas out of conflict. All operations were life-threatening, for which he received the UNPROFOR Decoration. His second mission was in 1998 by the UN UNFICYP, in the armed conflict between GREECE and TURKEY on the island of Cyprus. There, he was the first SMO (Senior Medical Officer) of the UNPA (United Nation Protection Area) and he also received a decoration. In 1997, he entered the Hand Surgery Service of the Central Military Hospital, which already had Dr. Fredy Aponte Arrazola as a consultant. He showed his special interest in the specialty studying in parallel with Dr. Carlos ZAIDENBERG, who nicknamed him "the soldier" and with whom he perfected his knowledge for a year. On that occasion, he established a strong friendship with Dr. Álvaro Muratore, current President of the Asociación Argentina de Cirugía de la Mano (Argentine Association of Hand Surgery). In 2000, he married Luciana in Salta, with whom he had four children: Máximo, 18; Augusto, 17; Victoria, 14; and Octavio, 11. In 2003 he was appointed Head of the Hand Surgery Service of the Central Military Hospital, during which time he presented outstanding works, until he became a full member, after having worked in several commissions. In 2006, due to his leadership virtues, he was appointed Chief of Traumatology and Orthopedics at the Campo de Mayo Military Hospital, continuing his career to date, in various positions of increasing hierarchy, until he became the Director of the Campo de Mayo Military Hospital. I must emphasize that he never left his teaching activity for the UBA and the Barceló University. On Sunday, May 9th, we said farewell to him at the Chacarita Cemetery with all the military honors, always accompanied by Denise, his children, all his family, colleagues and friends. Personally, it is very sad to see the loss of a younger colleague; it is not natural to say goodbye to someone who started his first years in the specialty. Many of those named express themselves through my words. Goodbye Aníbal! You will always be in our hearts.

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