Ulnocarpal Impaction

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ABSTRACT
The purpose of this article is to provide updated knowledge about ulnocarpal impaction syndrome (UCIS) and its treatment. Classic studies on biomechanics of the ulnar side of the wrist have shown that millimetrical changes in the relative lengths of the ulna and the radius significantly alter the load transmission between the carpal bones, the radius, and the ulna. Thus, an increase in the relative length of the ulna will generate an excessive load on the ulnocarpal joint, which will produce a spectrum of progressive degenerative changes in the ulnar dome, lunate, triquetrum, and the triangular fibrocartilage complex (TFCC), that will lead to ulnocarpal and distal radioulnar-joint (DRUJ) osteoarthritis. In its various degenerative stages, UCIS can be treated with osteotomies that seek to decompress the ulnocarpal load. These can be extra-articular or intra-articular. Within the extra-articular osteotomies, we find the diaphyseal, metaphyseal without joint exposure (subcapital), and the distal metaphyseal with joint exposure. Within the intra-articular ones, we find the wafer procedure, which resects the cartilage and subchondral bone of the ulnar dome, and can be performed either openly or arthroscopically. If there is associated DRUJ osteoarthritis, it can only be treated with salvage surgeries such as the Darrach, Sauvé-Kapandji, and Bowers procedures, or a DRUJ arthroplasty. These osteotomy techniques will be analyzed in detail in order to define their advantages and disadvantages. Finally, we propose a way to typify the UCIS to guide the reader towards the best possible treatment supported by current literature.
Keywords: Ulnar impactation syndrome; positive variance; osteotomy; shortening; wafer.
Level of Evidence: V

Impactación cubitocarpiana

RESUMEN
El objetivo de este artículo es actualizar los conocimientos sobre la impactación cubitocarpiana y su tratamiento. Estudios clásicos sobre la biomecánica del borde cubital de la muñeca han demostrado que los cambios milimétricos en la relación de longitud entre el cúbito y el radio alteran significativamente la transferencia de cargas entre los huesos del carpo, el radio y el cúbito. Así, un aumento relativo en la longitud del cúbito generará una carga excesiva sobre la articulación cubitocarpiana que producirá un espectro de cambios degenerativos progresivos en el domo cubital, el semilunar, el piramidal y el complejo del fibrocartílago triangular que finalizarán con artrosis cubitocarpiana y radiocubital distal. La impactación cubitocarpiana, en sus diversos estadios degenerativos, se puede tratar mediante osteotomías que buscan descomprimir la carga cubitocarpiana. Las osteotomías pueden ser extrarticulares o intrarticulares. Entre las extrarticulares, están las diafisarias, las metafisarias sin exposición articular (subcapitales) y las metafisarias distales con exposición articular y, entre las intrarticulares, la cirugía de resección en oblea (*wafer*), que reseca cartílago y hueso subcondral del domo cubital, y puede ser un procedimiento abierto o artroscópico. Si hay artrosis radiocubital distal, solo se podrá tratar con cirugías de rescate, como Darrach, Sauvé-Kapandji, Bowers, o una prótesis radiocubital distal. Estas técnicas de osteotomía se han analizado detalladamente para lograr definir sus ventajas y desventajas. Finalmente se propone una forma de tipificar la impactación cubitocarpiana, cuyo objetivo es orientar al lector hacia el mejor tratamiento posible, avalado por la bibliografía actual.
Palabras clave: Impactación cubitocarpiana; cúbito plus; osteotomía; acortamiento; procedimiento tipo *wafer*.
Nivel de Evidencia: V

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INTRODUCTION

The objective of this article is to present a review of the literature published in English on ulnocarpal impaction syndrome (UCIS), from the classics to date, in order to update knowledge and generate a guide for the choice of treatment.

BIOMECHANICS

One of the characteristics of evolution, from primates to man, is the increase in range and precision in the mobility of the wrist and hand. In the hand, this is given by the opposition of the thumb and, in the wrist, it is the result of two skeletal modifications: the distal ulna moves away from the triquetral and pisiform bones, and begins to articulate with the distal radius increasing ulnar deviation and pronosupination. In this way, the evolution of the distal radioulnar (DRUJ) and ulnocarpal joints in humans allows a marked range of motion of the forearm and wrist, without interfering with the grip function of the hand.[1] During the pronosupination movement, the radius and carpus rotate around an axis that is the ulna and, taking into account the DRUJ ratio, the head of the ulna moves towards the dorsal and distal side in pronation, and towards the volar and proximal side in supination.[1]

In 1984, Palmer and Werner showed that the radius normally receives 82% of the axial load transmitted from the carpus, and the ulna, 18% through the triangular fibrocartilage complex (TFCC). Millimetric changes in the DRUJ length ratio substantially alter the load transfer. Thus, a length discrepancy of +2.5 mm (ulna plus) will increase the load from the carpus to 42%, whereas -2.5 mm (ulna minus) will reduce it to 4%. This concept of small changes in length associated with large alterations in loads is fundamental to understand the biomechanics of this condition and the principles of its treatment.[2]

A direct relationship has been described between the increase in ulnar length with respect to that of the radius and age. This could be associated with the asymmetrical wear of the articular cartilage at the level of the elbow, which is greater in the radial head.[3] On the other hand, Orbay et al. argue that the progressive elongation of the central band of the interosseous membrane would be, among others, the cause of the change in the anatomical relationship between the ulna and the radius, generating a positive ulnar variance acquired by age.[4]

Based on previous research conducted by Werner on load transmission through the TFC, Harley et al. conducted a cadaveric study in which they found that, when there is a constitutional ulna minus, the articular disc of the TFCC has a greater thickness, and, conversely, it is thinner when the relationship is inverse (ulna plus). In this way, the load transmission from the wrist to the forearm is not influenced by constitutional ulnar variance. They hypothesize that the higher incidence of UCIS observed in positive ulnar variance is related to a thinner central disk and therefore a greater tendency to perforate.[5]However, this can also occur in neutral and even negative variances. Friedman et al. have shown that the clenched fist and pronation maneuver produces a relative shortening of the radius, revealing a dynamic UCI, which, repetitively, over time, can generate erosion, then perforation of the articular disc and chondromalacia in the ulna, lunate and triquetral bones.

DEFINITION

UCIS is a condition caused by an excessive load on the ulnocarpal joint that produces a spectrum of progressive degenerative changes at the distal end of the ulna, lunate and triquetral bones, and the TFCC.[6,7] The usual alterations are degenerative tear of the TFC; chondromalacia in the lunate, triquetral and head of the ulna; instability or tear of the lunotriquetral ligament; and, finally, osteoarthritis of the ulnocarpal and DRUJ joints.[7,8] Palmer designed a classification system for TFCC lesions based on the mechanism of injury, its location, and the structures involved, which helps us guide clinical management (Table 1).

When osteoarthritic changes occur, they are usually treated by rescue procedures. However, when UCIS is diagnosed early, there are different types of treatments proposed to stop its progression. The main goal of treatment is to unload the ulnocarpal compartment, but also to restore the congruence of the DRUJ joint and adjust the stress of the TFCC.[6]

Table 1. Classification of triangular fibrocartilage complex (TFCC) injuries according to Palmer et al.

Class I - Traumatic injury	A. Central perforation
	B. Ulnar avulsion
	C. Ulnocarpal ligament avulsion
	D. Radial avulsion
Class II - Degenerative injury	A. Central wear of the triangular fibrocartilage complex
	B. IIA + lunate or ulnar head chondromalacia, or both.
	C. Perforation of the triangular fibrocartilage complex and chondromalacia of the lunate, ulnar head, or both
	D. IIC + lunotriquetral ligament perforation
	E. IID + ulnocarpal osteoarthritis

This condition is usually associated with a positive ulnar variance, either congenital or acquired. Ulnar variance is defined as the difference in relative length between the ulnar corner of the lunate fossa of the radius, and the most distal point of the dome of the ulnar head. This is measured by drawing two lines perpendicular to the longitudinal axis of the forearm in an anteroposterior radiograph of the wrist in neutral rotation, these lines must be tangential to the proximal end of the lunate fossa of the radius, and to the distal end of the articular surface of the ulnar head (Figure 1).[9] The variance is positive when the dome of the ulnar head is more distal than the medial corner of the lunate fossa.[8,10] The value is expressed in millimeters and is independent of the length of the ulnar styloid process.[8]

Figure 1. Measurement of distal radioulnar discrepancy on a wrist radiograph.

The overload between the carpus and the ulnar head brings pain at the ulnar corner of the wrist and restricts ulnar deviation and pronosupination. Along with the degenerative changes already mentioned, there may be instability of the DRUJ due to ligament injuries following the rupture or avulsion of the TFCC.[10] It usually occurs in cases of vicious consolidation of the distal radius, excision of the radial head, premature closure of the radius physis, Essex-Lopresti injury, congenital positive ulnar variance, Madelung deformity or in any condition that causes an increase in the relative length of the ulna.[11]

As already mentioned in the biomechanics section, Friedman and Palmer demonstrated that UCIS can be a dynamic condition due to the intermittent changes in ulnar variance with activities of daily living and in occupations that require repetitive grasping movements and forearm pronation. Thus, clenching the fist with maximum force in pronation results in an average increase of 1.95 mm in the ulnar variance. Therefore, certain repetitive activities would generate increases in the ulnar load of the carpus, developing long-term secondary changes.

CLINICAL PRESENTATION AND DIAGNOSIS

The clinical presentation usually has an insidious and progressive beginning. Patients report feeling pain at the ulnar corner of the wrist, with occasional episodes of edema and decreased wrist mobility. These symptoms can be exacerbated during activities that involve forceful fist clenching, pronation, or ulnar deviation, and are relieved by rest.

The diagnosis of UCIS is mainly based on physical examination, and is complemented by imaging studies.[12] A thorough evaluation should be performed to rule out other sources of pain at the ulnar corner of the wrist, such as pisotriquetral arthritis, DRUJ osteoarthritis, extensor carpi ulnaris (ECU) tendonitis, or dorsal ulnar cutaneous nerve neuritis, among others.

Nakamura et al. described the ulnocarpal stress test,[13] where the patient is seated with the elbow resting on the table and the forearm in neutral rotation, the wrist is placed at maximum ulnar deviation and rotated in pronosupination, while an axial load is applied. This test is considered positive when it reproduces the painful symptoms for which the patient consults (Figure 2).

Figure 2. Nakamura maneuver.

The ulnar fovea sign is also usually positive, although it is not specific to UCIS. It aims at eliciting pain when pressing the soft spot between the ulnar styloid process, the flexor carpi ulnaris tendon (FCU) and the pisiform bone with the thumb. If the lunotriquetral ligament is compromised, provocative maneuvers, such as the Reagan and Kleinman tests, may be positive. Finally, it is also important to evaluate the DRUJ joint.

IMAGING STUDIES

Given the suspicion of UCIS, the first study that should be requested is an anteroposterior comparative radiograph of the wrist. It is performed with the shoulder in 90º abduction, the elbow in 90º flexion and the forearm in neutral rotation. A lateral and anteroposterior radiograph in maximum pronation with the fist clenched should also be taken.[8] This is how both static and dynamic ulnar variance is evaluated.

Typical radiographs may show subchondral sclerosis or cystic changes in the ulnar head, the posteromedial corner of the lunate, or the posterolateral border of the triquetral.[8] In severe cases, osteoarthritis with osteophyte formation can be observed in the ulnocarpal joint. If the possibility of performing a shortening osteotomy is being evaluated, the DRUJ joint and its anatomical inclination should also be examined. In the profile, a dorsal subluxation of the ulna should be searched for.[14]

Given a high clinical suspicion of UCIS without radiographic signs, magnetic resonance imaging is very useful. In the early stages, fibrillation may be observed at the level of the articular cartilage of the carpus and the head of the ulna. The condition progresses to bone edema (Figure 3) and then to sclerotic changes.[8] In patients with radiographic signs of UCIS, MR arthrogram is useful for assessing the integrity of the TFC and the lunotriquetral ligament.[7,9]

UCIS should be differentiated from other conditions that affect the lunate bone. Radiological changes in the structure of the lunate are fundamental to distinguish other etiologies, such as Kienböck's disease or intraosseous cysts. In the first case, the images are more diffuse, affecting the radial side of the lunate, and there is no compromise of the triquetrum or the ulnar head. Intraosseous cysts appear as an image of defined edges, without affecting neighboring bones.[8]

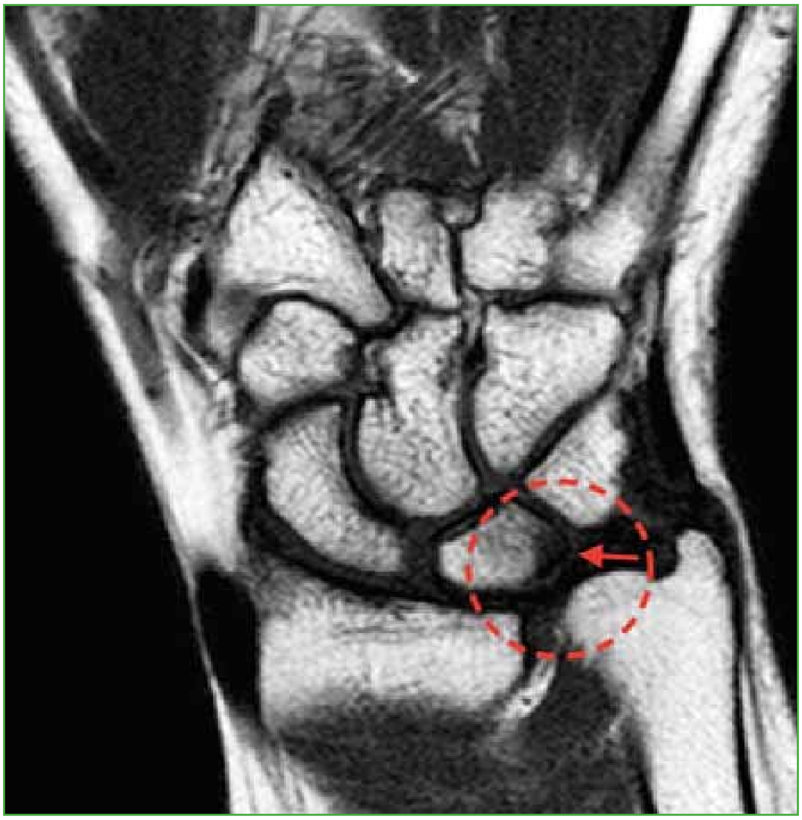

Figure 3. MRI of the wrist with ulnocarpal impaction. Edema in the lunate.

TREATMENT

There is agreement that UCIS, especially in idiopathic cases, should initially be treated with non-surgical resources for three to six months. This includes immobilization splints, modification of daily activities, nonsteroidal anti-inflammatory drugs, local infiltrations with corticosteroids, and physical therapy.

If the symptoms do not improve, surgical treatment is indicated, whose main objective is to unload the ulnocarpal joint, shortening the length of the ulna with respect to the radius and, in this way, decreasing the pressure in the articular disc of the TFC.

If the cause is the vicious consolidation of a fracture of the distal radius in the sagittal plane, we should consider a corrective osteotomy of the radius.[15]

The ulnocarpal joint can be unloaded by extra-articular or intra-articular shortening osteotomies. Extra-articular osteotomies comprise those that are diaphyseal, those that are metaphyseal without articular exposure (subcapital), and those that are distal metaphyseal with articular exposure. Among the intra-articular osteotomies, there is the surgery described by Feldon in 1992, which became known as the *wafer procedure* and in which the cartilage and subchondral bone of the ulnar head are resected. It can be an open or arthroscopic procedure. If UCIS coexists with osteoarthritis in the DRUJ joint, the indication is a rescue surgery that annuls or replaces the latter with a prosthesis. These procedures are the Darrach or Bowers surgeries (resective), Sauvé-Kapandji (arthrodesis) or distal ulna prosthesis in its different variants (Figures 4 and 5).[10]

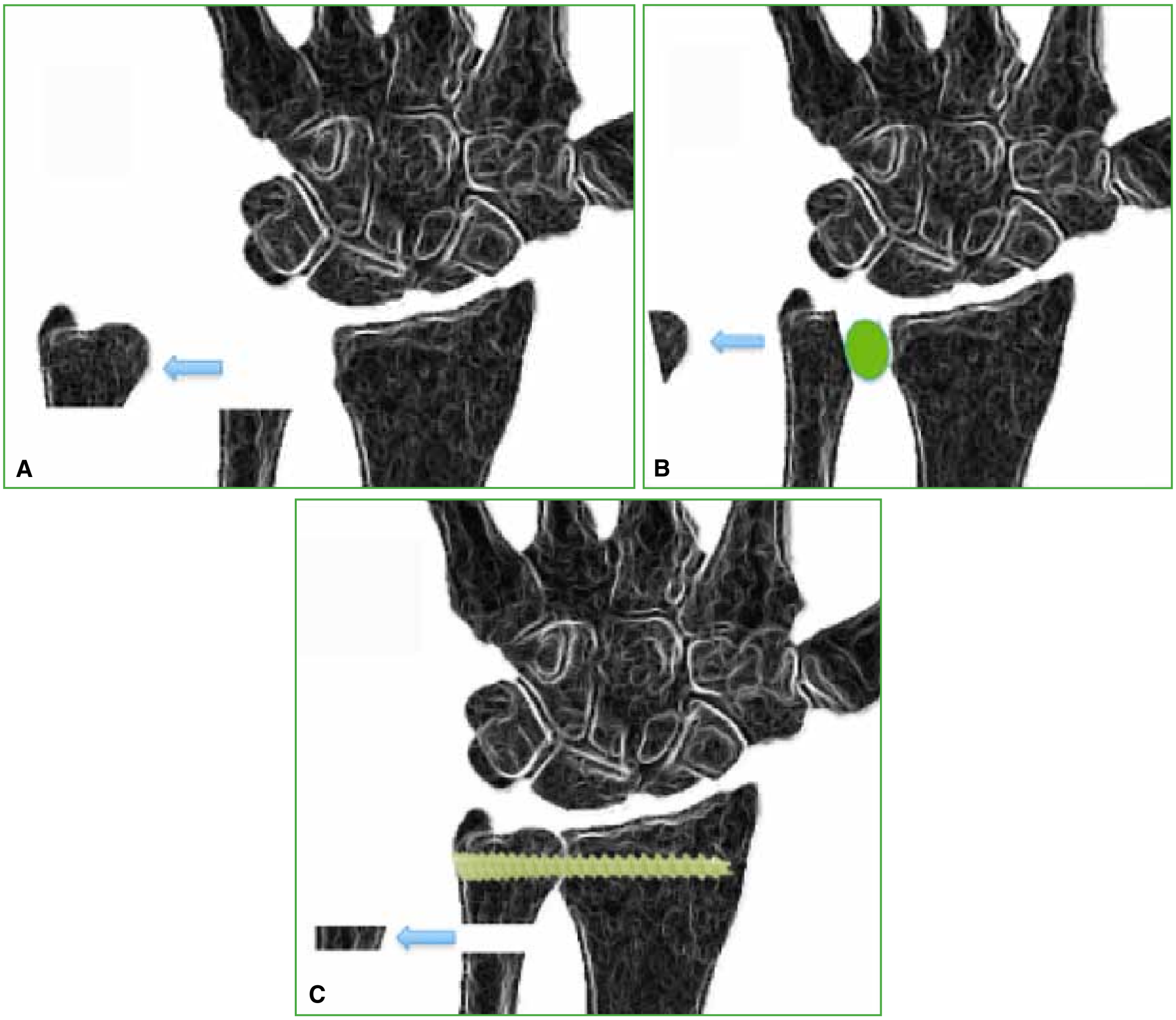

Figure 4. A. Darrach resection. **B**. Bowers resection. **C.** Sauvé-Kapandji.

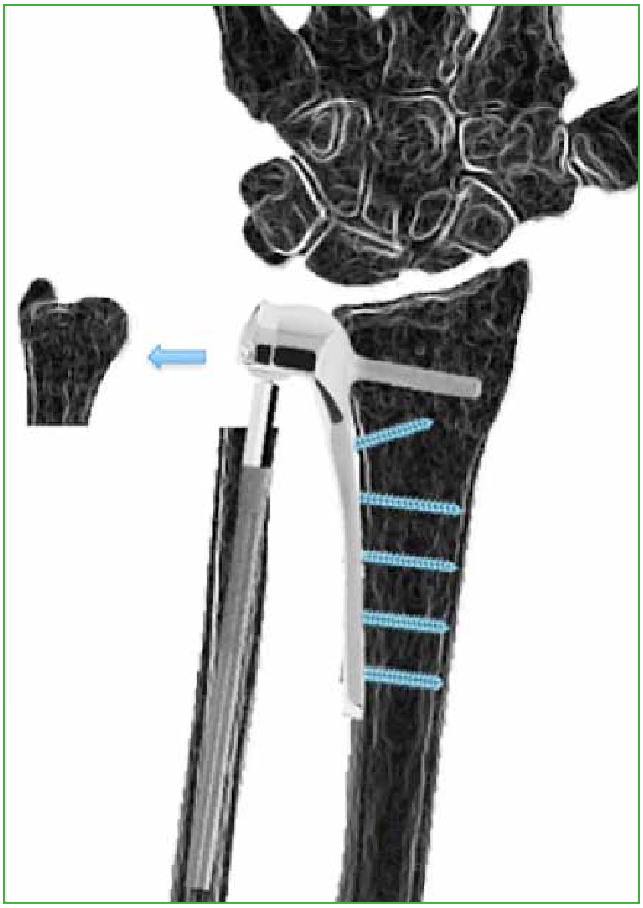

Figure 5. Scheker prosthesis.

Diaphyseal osteotomies

Milch first described a diaphyseal ulnar shortening osteotomy in 1941. He performed this procedure on a patient with UCI as a consequence of the vicious consolidation of a distal radius fracture.

Over time, the accuracy of the shortening and osteosynthesis systems improved, and today, ulnar shortening is considered the golden standard in the treatment of this condition.[10,16] The plate and screw fixation of transverse ulnar osteotomy was first described by Cantero in 1974 (Figure 6A). Subsequently, oblique osteotomies were described that allowed a trans-osteotomy compressive screw to be placed in order to improve the stability of the system and the consolidation rate (Figure 6B).

Darlis described a step-cut diaphyseal shortening osteotomy whose execution is much more complex, but with the advantages of being able to place a trans-osteotomy compressive screw and providing a larger contact surface and better control of rotation. Using a 3.5 mm volar neutralization plate, he achieved 100% consolidation in his series of 29 patients (Figure 6C).

The goal of the shortening osteotomy in an ulna plus is to achieve a variance of 0 or -1 mm. In the event of neutral or negative variance, the magnitude of the shortening will be determined by dynamic radiographs in pronation and with the fist clenched.

Minami and Kato had noticed that some patients with TFC injury after arthroscopic debridement continued to be in pain. The common factor was a positive ulnar variance that could be associated with a lunotriquetral ligament injury. For this reason, they proposed to treat TFC injuries with ulna plus by means of an ulnar shortening osteotomy.[9]

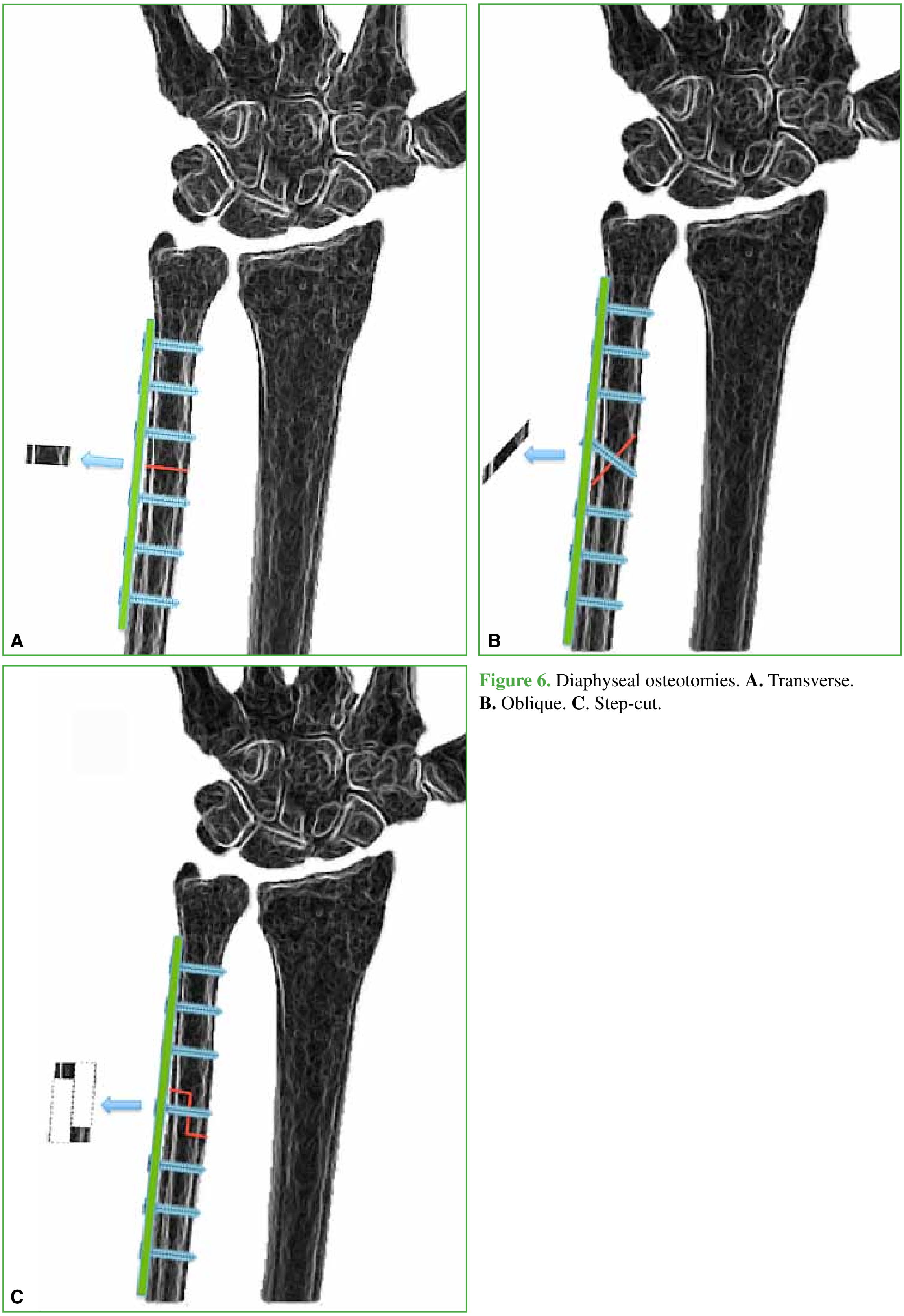

Figure 6. Diaphyseal osteotomies. **A.** Transverse. **B.** Oblique. **C**. Step-cut.

In a series of 31 patients, Baek et al. found a positive correlation between the magnitude of ulnar variance and a dorsal subluxation of the DRUJ joint. In these cases, shortening surgery tends to correct such subluxation. This could be related to the retention of the ulnocarpal ligaments.[14] This same author also observed that 16% of patients undergoing shortening osteotomies tend to develop osteoarthritic changes in the DRUJ joint in the long term. These changes usually appear three years after surgery and could be linked to the magnitude of the discrepancy and preoperative radioulnar dorsal subluxation. However, the occurrence of osteoarthritis was not associated with pain or other clinical and functional changes. Other authors observed osteoarthritic changes in 38% of cases.[17]

The TFCC can be interpreted as a three-dimensional structure that stabilizes the entire ulnar corner of the wrist. When performing an ulnar shortening, there is a traction of this entire structure, generating greater ligament tension and, therefore, stabilizing the DRUJ and ulnocarpal joint. In a cadaveric biomechanical study, Nishiwaki et al. showed that the greater the magnitude of the shortening, the greater the stabilizing effect if the foveal insertion was intact or only partially injured. They calculated that, for a partial injury, a shortening of 3 mm regains the original stability; on the other hand, if there is a complete foveal disinsertion, there is no stabilizing effect.[18] In another anatomical study, Arimitsu et al. investigated the role played by the interosseous membrane in DRUJ stability, and found that osteotomies performed from just one millimeter of shortening have a stabilizing effect when they are performed proximal to the insertion of the distal oblique bundle (present in 40% of the specimens used). They also stressed that the presence of this bundle can be a factor of difficulty in carrying out the desired shortening and even achieving consolidation.[19]

Increased ligament tension of the ulnar corner of the wrist due to ulnar shortening has two direct effects. On the one hand, the stabilizing effect already mentioned and, on the other, an increase in pressure at the level of the DRUJ that could be a generator of pain and osteoarthritis in the future. This increased pressure would also correlate with joint incongruence caused by shortening.

Isa et al. conducted a cadaveric biomechanical study in which they evaluated, in a dynamic way, pressure changes in the ulnocarpal joint with different degrees of shortening and in different positions (flexion, ulnar deviation, dart-throwing and pronation). They concluded that, in idiopathic UCIS (not associated with fracture), a 2 mm shortening is a sufficient measure to decompress the ulnocarpal joint, without generating excessive tensile forces due to ligament distension.

Tatebe et al. evaluated the evolution of TFC articular disc injuries detected by arthroscopy during a shortening osteotomy and after several years, through a second arthroscopic exploration. 50% of the injuries had healed, and circular injuries had greater potential than linear ones. Therefore, the unloading of the articular disc and the DRUJ stability obtained after shortening osteotomy would facilitate this scarring process.

The advantages of the diaphyseal ulnar shortening osteotomy are: it effectively decompresses the ulnocarpal joint; it is an extra-articular procedure that preserves and re-tensions the radioulnar and ulnocarpal ligaments, restoring DRUJ and ulnocarpal stability; it preserves the articular cartilage of the ulnar head and, in cases of radius fracture sequela without sagittal deformity, it restores DRUJ anatomy.

The disadvantages are the delay in or lack of consolidation that oscillates in a 4%, which has been related to smoking and that improves markedly with specific shortening systems that allow a very good stability and compression of the focus of osteotomy. Likewise, the rate of implant removal due to local irritation ranges between 11% and 44%, according to different publications. This local irritation is determined by the surface of the ulna on which the implant is placed, the volar surface is the one that has shown the best tolerance. The increase in the DRUJ trans-articular pressure would carry the potential risk of generating osteoarthritis, especially in the inverted oblique form described by Tolat.[16]

To evaluate the contraindications of shortening osteotomy, we must pay attention to the DRUJ joint. The main contraindications include osteoarthritis, sagittal deformity of the minor sigmoid cavity of the radius as a fracture sequela, the inverse oblique configuration of the aforementioned Tolat classification or the need for excessive shortening.

Wafer procedure

In 1992, Feldon described this procedure for the treatment of TFC lesions associated with UCI. It is based on the resection of the cartilage and subchondral bone of the ulnar head (between 2 and 4 mm thick), preserving ligament inserts in the fovea and ulnar styloids and DRUJ joint. The goal is to decompress the ulnocarpal joint and the articular disc of the TFC (Figure 7).[20]

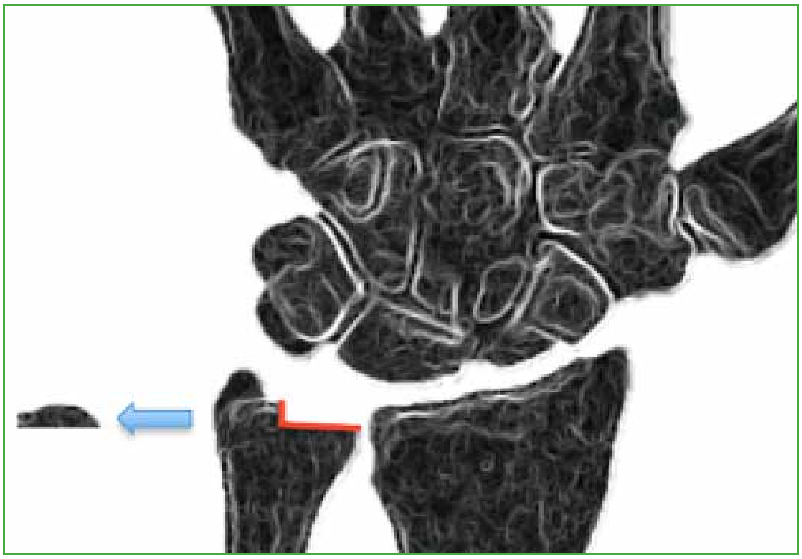

Figure 7. Wafer procedure.

Based on cadaveric studies, Wnorowsky et al. proposed to perform this procedure completely arthroscopically. By means of a perforation in the central disc of the TFC, a motorized reamer is introduced with which the cartilage of the ulnar head and the subchondral bone are resected until a shortening of 2-3 mm is achieved. In subsequent publications on this arthroscopic technique, it has been recommended to use intraoperative radioscopic control to verify the amount of resected subchondral bone, due to poor visualization. Tomaino and Weiser treated a group of 12 patients with TFC (traumatic and degenerative) and UCI injuries by debridement of the TFC articular disc plus the arthroscopic wafer procedure. All outcomes were satisfactory in terms of pain relief.[21]

The advantages of this procedure are: it decompresses the ulnocarpal joint, it does not require a period of consolidation or osteosynthesis material, the surgical approach is limited, and it allows to treat TFC injuries simultaneously. It can be performed in a minimally invasive way if the arthroscopic technique is chosen. Since the ligaments are not tensed, the trans-articular DRUJ pressure does not increase, thus reducing the predisposition to osteoarthritis. It can be performed in a Tolat reverse oblique configuration.

The disadvantages are that it generates an irreversible injury of the articular cartilage of the ulna pole; it is more technically demanding than a diaphyseal osteotomy; the shortening is limited to 3 mm; the recovery time to achieve pain relief is prolonged (3-6 months); since there is no ligament retention, it does not correct DRUJ or lunotriquetral instabilities; it can generate a hemarthrosis with potential arthrofibrosis and it does not resolve the stylocarpal impaction.[22] The arthroscopic technique, although minimally invasive, does not adequately show the amount of resected subchondral bone.

Metaphyseal Osteotomies with Joint Exposure

In 2007, Slade and Gillon proposed technique for a wedge resection shortening osteotomy of subchondral and metaphyseal location, which involved exposing the DRUJ joint which are then fixed with two headless cannulated screws.[23] Hammert et al. described this same technique in more detail, but using only a cannulated screw and preferred to call it distal metaphyseal ulnar shortening osteotomy, as it more accurately describes the anatomical site involved (Figure 8).

Barry and Macksoud described a technique that consists of a metaphyseal subchondral resection osteotomy very similar to the one proposed by Slade, but incomplete, leaving the most ulnar cortical intact, and then fracturing it in a controlled way, thus obtaining a shortening that, due to its stability, does not require osteosynthesis (Figure 9).[24]

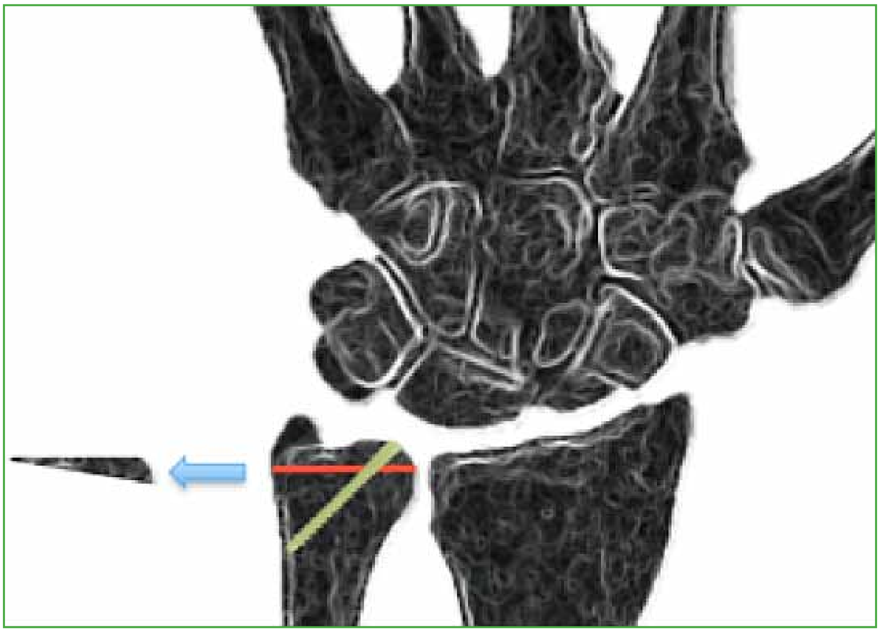

Figure 8. Slade's subchondral osteotomy, modified by Hammert.

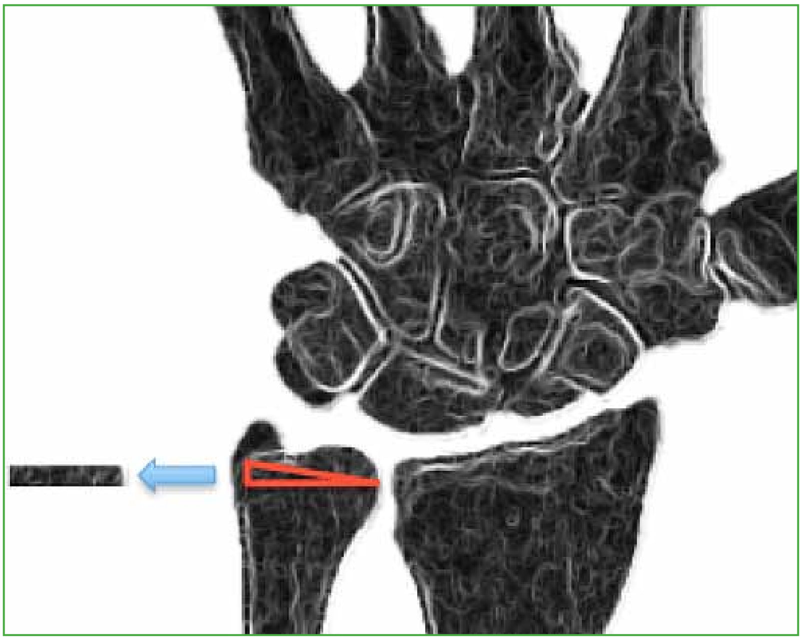

Figure 9. Barry's subchondral osteotomy.

In all these techniques, the articular cartilage of the ulnar head, the DRUJ joint, and the ligament inserts of the TFC are preserved. Likewise, they look for an osteotomy site with greater consolidation potential. The authors report that their patients had little postoperative pain, so they mobilized them early and achieved excellent mobility in a period of two months. In contrast to classic diaphyseal osteotomies, these authors emphasize that the approach is limited and that they do not need a second surgery to remove the osteosynthesis material.

The disadvantages of these arthrotomy techniques are that capsular healing can generate joint stiffness and that they are demanding techniques due to the great precision required to avoid vicious consolidation.[24]

Greenberg et al. conducted a cadaveric study to evaluate the biomechanics of this type of distal metaphyseal osteotomies and concluded that they effectively decrease the ulnocarpal load in static and dynamic evaluations. They also found that, unlike diaphyseal osteotomies, changing the geometry and position of the ulnar head did not increase the pressure forces in the DRUJ joint and, therefore, would not generate osteoarthritis.[25]

Metaphyseal Osteotomy without Joint Exposure

Nunez et al. proposed a subcapital transverse osteotomy without the need to expose the DRUJ joint. They stabilize it with a low-profile distal ulna osteosynthesis locking plate with distal hooks that allow the ulnar styloid to be taken and proper compression of the osteotomy site to be performed. Due to its low profile, it generates less conflict with the surrounding soft tissue, less skin prominence and, therefore, less need for a second surgery to remove it (Figure 10).

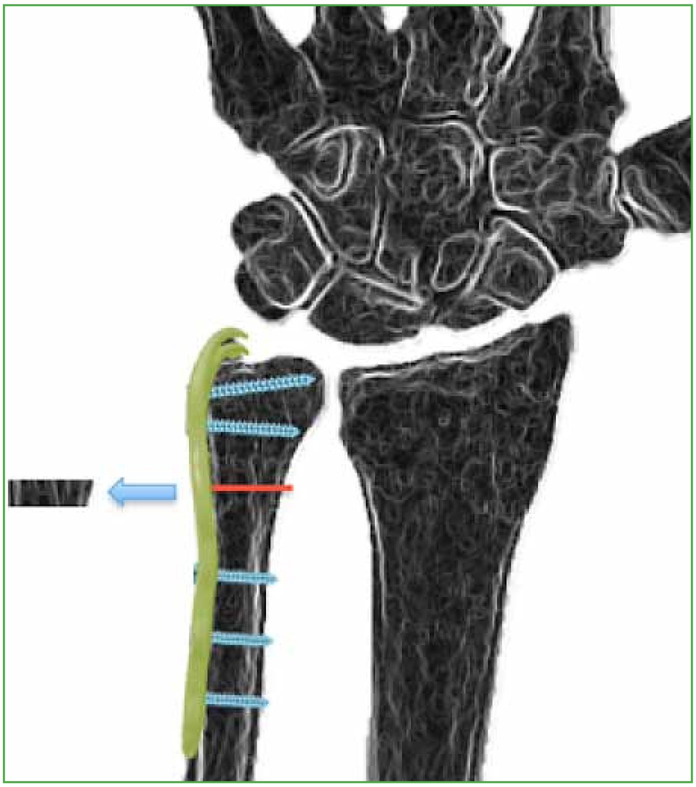

Figure 10. Nunez's subcapital metaphyseal osteotomy.

This procedure has an effect of retention of the TFC ligament, thus stabilizing the DRUJ and lunotriquetral joints. But, due its anatomical location, it does not interfere with the tension of the distal oblique band of the interosseous membrane.

Due to its irrigation and bone characteristics, the anatomical site where it is performed has better consolidation potential and less risk of thermal osteonecrosis than a conventional diaphyseal osteotomy.[6]

Future Directions

The question arises as to which of all these techniques is the best and should be used for the treatment of UCI. We believe that there is no ideal technique to treat all cases of this condition; therefore, we propose its classification according to the following table to guide the best form of treatment (Table 2).

Table 2. Ulnocarpal impaction (UCI) classification

Characteristics of the UCI	Implication in the treatment
DRUJ Osteoarthritis	Advanced DRUJ osteoarthritis is a contraindication to perform any type of ulnar shortening and rescue procedures should be considered.
Magnitude of DRUJ discrepancy	If it is >3 mm, the wafer procedure (open or arthroscopic) is contraindicated, as well as the subtractive osteotomy as described by Slade and Barry.
Sagittal deformity of the radius	In sequelae of fractures of the distal radius, if there is a deformity in the orientation of the lesser sigmoid notch of the radius, an osteotomy of the radius should be thought of, since an ulnar shortening would correct the discrepancy, but would also generate a DRUJ joint incongruence.
DRUJ or lunotriquetral instability	Diaphyseal and metaphyseal subcapital ulnar shortening osteotomies have the property of recovering stability by ligament retention if the foveal insertion is preserved.
Tolat configuration	Tolat's reverse oblique configuration is a contraindication for subcapital diaphyseal and metaphyseal osteotomies, because they could considerably increase DRUJ pressure and worsen the pain.
Functional demand	A wafer procedure will leave a bloody and irregular surface below the TFC that, in the face of repetitive effort tasks, will result in damage. The conservation of the ulnar head cartilage is essential to continue having a glide with minimal friction
Smoking	Smoking is a predisposing factor for pseudo-osteoarthritis in diaphyseal osteotomies

DRUJ = distal radioulnar joint, TFC = triangular fibrocartilage.

We believe that in the future, prospective, randomized, multicenter studies should be carried out in groups of patients with defined characteristics, comparing the efficacy and complications of the different surgical techniques that we have described. In this way, we would be able to assign, with greater scientific rigor, an exact use for each of them.

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

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