Total knee arthroplasty in severe knee valgus deformity
5- to 14- year follow-up

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Abstract

Introduction: Knee valgus misalignment is a complex deformity, with bone and soft tissues alterations. There are numerous surgical techniques that describe the sequence of the release of the posterior-lateral structures and state the need to use constrained prosthesis. Total prosthetic replacement in valgus knee deformity comes as a challenge for the orthopedist. The aim of this study is to assess our results in the surgical treatment of the severe valgus deformity of the knee, and describe the surgical technique we use.
Materials and methods: We developed a medical-radiologic classification and set aside the cases of severe knee valgus deformity. We evaluated 42 total knee replacements in 39 patients (average follow-up of 9.2 years). As medical evaluation standard we used the *Knee Society Score*. For radiologic evaluation we used the best quality X-ray taken in the last follow-up consultation. Survival analysis considered the need for revision for any reason and revision for mechanic failure.
Results: The *Knee Society Score* was, on average, 83.3, with clear improvement in pain and range of motion. We used constrained implants in 16.7% of the cases. The average post-operative angle was 5.9º. There were two revisions, with prosthetic survival for mechanic failure of 97.6%. There were no revisions due to infection.
Conclusions: It is necessary to perform thorough pre-operative physical examination and X-rays evaluation. The decision to use a constrained implant is made during the surgery. It is important to release soft tissues appropriately. Independently of the surgical technique used, the requirement for constrained prosthesis is low. We recommend our technique, because it is a procedure scarcely demanding with encouraging medium- and long-term results.

Key words: knee valgum deformity; severity; knee total replacement; release; surgical technique
Level of evidence: IV

Artroplastia total de rodilla en genu valgo severo. Seguimiento de 5 a 14 años

Resumen

Introducción: El deseje en valgo es una deformidad compleja, con alteración ósea y de partes blandas. Se han descrito numerosas técnicas quirúrgicas que detallan la secuencia de liberación de las estructuras posterolaterales y la necesidad de utilizar implantes constreñidos. El reemplazo total de rodilla para el genu valgo es un desafío para el ortopedista. Los objetivos fueron evaluar nuestros resultados en el tratamiento quirúrgico del genu valgo severo y detallar la técnica quirúrgica empleada.

Conflict of interests: The authors have reported none.

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Materiales y Métodos: Se estableció una clasificación clínico-radiológica y se discriminaron los casos con genu valgo severo. Se evaluaron 42 reemplazos totales de rodilla en 39 pacientes (seguimiento promedio 9.2 años). Se utilizó el *Knee Society Score* como parámetro de evaluación clínica. Para la evaluación radiográfica, se contó con la radiografía de mejor calidad del último control. El análisis de supervivencia contempló la necesidad de revisión por cualquier causa y por falla mecánica.
Resultados: El *Knee Society Score* fue, en promedio, de 83,3, con franca mejoría en los parámetros dolor y rango de movilidad. Se utilizaron implantes constreñidos en el 16,7% de los casos. El ángulo posoperatorio promedio fue de 5,9°. Hubo dos revisiones, con una supervivencia protésica por falla mecánica del 97,6%. No hubo revisiones por causa infecciosa.
Conclusiones: Se requiere de un minucioso examen físico y radiografías preoperatorias. La decisión de utilizar implante constreñido se toma durante la cirugía. Es importante la apropiada liberación de partes blandas. Al margen de la técnica quirúrgica empleada, el requerimiento de prótesis constreñida es bajo. Recomendamos nuestra técnica, pues se trata de un procedimiento poco demandante con resultados alentadores a mediano y largo plazo.

Palabras clave: Genu valgum; grave; reemplazo total de rodilla; liberación; técnica quirúrgica.
Nivel de Evidencia: IV

Introduction

Knee valgus misalignment is a complex and mutiplanar deformity associated with abnormalities not only in the bone of the distal femur and the proximal tibia, but also in the peri-articular soft tissues. Although most cases of osteoarthritis with misalignment that will require total knee replacement (TKR) stem from varus deformity, valgus misalignment represents approximately 10% of all arthroplasties.[1,2]

As regards the bone component, there is distal femur distorted anatomy involved, with remarkable hypoplasia of the lateral femoral condyle, whereas the tibia shows defects in the lateral tibial plate. Moreover, as a consequence of these disorders, there can be inappropriate patellar alignment. Regarding problems in the soft tissues, there is muscle contracture in the tensor fasciae latae, the popliteus and the gastrocnemius muscles, retraction of the lateral collateral ligament (LCL) and the posterior-lateral capsule, with or without association with medial ligament laxity depending on the misalignment and the time of disease progression.[1-6]

One of the classifications most used to describe this deformity is Krackow's (1990),[2,7-9] which divides the deformity into three types:

Type 1: Minimal valgus deformity with lateral bone defect and retraction, together with unharmed medial soft structures

Type 2: >10º fixed valgus, with medial laxity.

Type 3: Severe deformity, consecutive to tibial anti-varus osteotomy, requiring constrained implant

There are numerous reports about surgical techniques that describe thoroughly the different posterior-lateral structures involved in the deformity and the sequence of their release, depending on the magnitude of the misalignment, and also about specific pre- and post-operative maneuvers to establish the degree of joint instability, what is most helpful when it comes to deciding the degree of prosthetic constraint to use.[2,4,6,7,9-12]

Given the importance of getting a stable knee both in flexion and extension for the patient to do well, the TKR for knee valgus deformity still represents a challenge for the orthopedic surgeon.[3,4,6-8,10,13,14]

The aim of this work is to assess our medium- and long-term results in the surgical treatment of the severe osteoarthritic knee valgum deformity, and provide details about the surgical technique that we use.

Materials and methods

Between 1997 and 2008, at our center we performed 681 primary TKRs, out of which 201 (29.5%) were given to patients with knee valgum deformity (Figure 1). We developed a medical-radiologic classification with the aim of sub-dividing the population taking into account the radiologic magnitude of the misalignment and the degree of competence of the medial ligaments. This way, we outlined three groups:

Type 1 (mild): <10º knee valgum deformity with competent medial collateral ligament (MCL)

Type 2 (moderate): 10º-20º knee valgum deformity
- with competent MCL
- with incompetent MCL

Type 3 (severe): >20º knee valgum deformity (Figure 2)
- with competent MCL
- with incompetent MCL

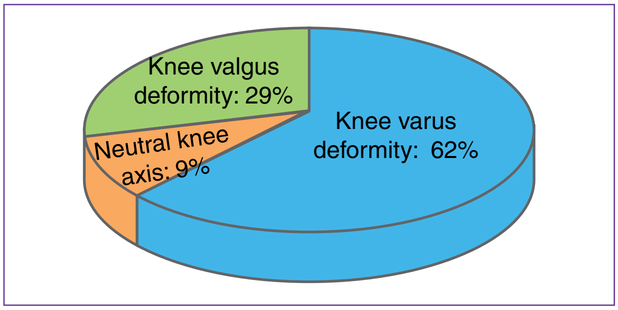

Figure 1. Total Knee Replacements.

The degrees of misalignment were assessed in a knee X-ray in monopodal support. We performed the valgus stress maneuver to establish the magnitude of the MCL incompetence, and we considered it as positive when there was no medial stoppage or when the knee went beyond medical or radiologic 30º valgus. We set aside the cases included in type 3 (severe knee valgum deformity), and this way we got 45 TKRs in 42 patients. Three patients were lost for follow-up for different reasons (two of them because they failed to attend the following medical check-ups, and the other one because of death due to other causes).

The assessment criteria for this analysis were: >20º knee valgum misalignment, primary TKR and minimal follow-up of five years. This way, the series was made up of 42 TKRs in 39 patients (35 knees were type 3A and 7 knees were type 3B). Thirty five patients (89.7%) were women and 4 (10.2%) were men; on average, they were 68.1 years old (from 23 to 87 years old). We performed 25 right replacements and 17 left replacements, with three bilateral replacements in two surgical times. The average follow-up was of 9.2 years (ranging from 5 to 14.3). (Table 1).

Figure 2. X-ray showing >20° knee valgus deformity (type 3).

As regards the pre-operative diagnosis, 26 patients (61.9%) suffered osteoarthritis; 10 patients (23.8%), rheumatoid arthritis; three patients, post-traumatic osteoarthritis, and the remaining three patients represented sequels to femoral or tibial overcorrected anti-varum osteotomies. Moreover, it is worth mentioning that four patients had been subject to arthroscopic surgery, with plastic surgery of the anterior cruciate ligament in one of them. One patient showed extra-articular femoral deformity due to mal-union in a diaphyseal fracture, with varum (10º) and antecurvatum (20º) misalignment in the distal femur, what asked for an unusual bone intra-articular cut.

Physical examination and X-rays played a key role at the time of deciding what kind of prosthesis we would use, having as alternatives posterior-stabilized knee prosthesis and constrained prosthesis. Knees with radiologic evidence of moderate or severe misalignment were assessed pre-operatively with the aim of identifying MCL incompetence (Figure 3). Later on, during the surgery itself, after releasing the soft tissues and performing the bone cuts we assessed the patients further verifying the degree of medial-lateral stability in knee flexion and knee extension with the trial components and, at that moment, we decided what the definite components would be. This way, the implants we used were posterior-stabilized prosthesis in 35 cases and constrained prosthesis in the remaining seven cases (16.7%).

The posterior-stabilized prosthesis that we used were: the PFC® SIGMA® model (Johnson & Johnson) in 12 TKRs (28.6%), the national Insall® model (FICO and Villalba) in 11 knees (26.2%), the All Poly® model (Johnson & Johnson) in nine knees (21.4%) and the Scorpio® model in three knees (7.1%). The most frequently used model of constrained prosthesis was the TC3 PFC® SIGMA® in five cases (11.9%), followed by one Scorpio® knee and one IP Magna knee.

Surgeries were performed at a laminar flow operating room with hypotensive spinal anesthesia. Pneumatic tourniquet cuff was used systematically. We performed an anterior approach with medial para-patellar arthrotomy. As antibiotic prophylaxis patients received 1 g of a first-generation cephalosporin (caphazolin) one hour before the procedure and, later on, two 1 g post-operative doses every 8 hours. As prophylaxis of deep venous thrombosis and pulmonary thromboembolism we prescribed low-weight molecular heparin during 20 days after the surgery.

To assess the series objectively we used the *Knee Society Score* as pre- and post-operative medical standard. To assess functional progress in the patients, we applied the *Functional Knee Society Score*.

For radiologic assessment, we relied on the best quality X-ray taken on the last follow-up consultation. We evaluated the femoral-tibial anatomic axis, the coronal angle in the femoral cut, the coronal and sagittal angles in the tibial cut, patellar inclination, the degree of femoral-patellar congruence, the thick of the remaining bone, and both radiolucence and osteolysis in any of the two components.

Table 1 Patients' characteristics*

Patient	Pre-operative axis	Type	Post-operative axis	Score	Follow-up (years)	Implant	Infection	Delimitation	Revision
1	21°	3A	6°	76	13.5	Estabilizado a posterior	No	No	No
2	30°	3A	4°	76	12.5	Estabilizado a posterior	No	No	No
3	32°	3A	8°	88	14.3	Estabilizado a posterior	No	No	No
4	33°	3A	8°	88	12.5	Estabilizado a posterior	No	No	No
5	29°	3A	6°	75	14	Estabilizado a posterior	No	No	No
6	27°	3A	10°	72	13.2	Estabilizado a posterior	No	Sí	No
7	22°	3A	8°	90	12.8	Estabilizado a posterior	No	No	No
8	21°	3A	7°	78	12.7	Estabilizado a posterior	No	No	No
9	21°	3A	5°	88	12.2	Estabilizado a posterior	No	No	No
10	25°	3A	5°	76	12	Estabilizado a posterior	No	No	No
11	21°	3A	8°	83	11	Estabilizado a posterior	No	No	No
12	25°	3A	5°	86	11	Estabilizado a posterior	No	No	No
13	21°	3A	6°	77	11.2	Estabilizado a posterior	No	No	No
14	23°	3A	5°	85	10.9	Estabilizado a posterior	No	No	No
15	23°	3A	4°	88	10.9	Estabilizado a posterior	No	No	No
16	21°	3A	7°	82	9.9	Estabilizado a posterior	No	No	No
17	21°	3A	6°	72	9.9	Estabilizado a posterior	No	Sí	Sí
18	21°	3A	7°	92	9.8	Estabilizado a posterior	No	No	No
19	25°	3A	6°	84	9.8	Estabilizado a posterior	No	No	No
20	21°	3A	4°	90	9.6	Estabilizado a posterior	No	No	No
21	25°	3B	8°	83	9	Constreñido	No	No	No
22	22°	3A	7°	85	8.8	Estabilizado a posterior	No	No	No
23	24°	3A	8°	84	8.8	Estabilizado a posterior	Yes	No	Yes
24	30°	3B	4°	88	8.5	Constreñido	No	No	No
25	22°	3A	6°	87	8.5	Estabilizado a posterior	No	No	No
26	22°	3B	3°	70	7.7	Constreñido	No	No	No
27	22°	3B	2°	88	7.7	Constreñido	No	No	No
28	22°	3A	4°	86	7.6	Estabilizado a posterior	No	No	Sí
29	21°	3B	7°	84	7.4	Constreñido	No	No	No
30	21°	3A	2°	74	7	Estabilizado a posterior	No	No	No
31	45°	3B	8°	87	7	Constreñido	No	No	No
32	25°	3A	7°	86	6.7	Estabilizado a posterior	No	No	No
33	21°	3A	5°	86	6	Estabilizado a posterior	No	No	No
34	35°	3B	6°	81	6.6	Constreñido	No	No	No
35	24°	3A	9°	83	6.6	Estabilizado a posterior	No	No	No
36	21°	3A	4°	87	6.6	Estabilizado a posterior	No	No	No
37	25°	3A	7°	70	6.1	Estabilizado a posterior	No	No	No
38	21°	3A	8°	89	5.9	Estabilizado a posterior	No	No	No
39	23°	3A	9°	84	5.6	Estabilizado a posterior	No	No	No
40	21°	3A	5°	92	5.5	Estabilizado a posterior	No	No	No
41	22°	3A	3°	87	5	Estabilizado a posterior	No	No	No
42	22°	3A	4°	90	5	Estabilizado a posterior	No	No	No

*39 patients (42 Total Knee Replacements)

Figure 3. Pre-operative physical examination to identify instability in the medial collateral ligament.

We defined osteolysis as the presence of a ≥1 cm-diameter area of focal radiolucency; we considered there was loosening when we verified circumferential radiolucency in the bone-cement or cement prosthesis interfaces.

Survival analysis considered the need to perform revision surgery for any reason. We carried out a second assessment that included only revision for mechanical reasons (loosening or instability).

Pre-operative planning

The pre-operative planning included:

1) Orthopedic physical examination, with assessment of range of motion and anterior-posterior and medial-lateral stability, looking for incompetence of the MCL by means of the knee valgus stress test.

2) A conventional radiologic evaluation, with anterior-posterior X-rays (with and without weight bearing) of the knee about to be operated on, plus lateral and patellar tangential X-rays, all of them in real size. We determined the longitudinal femoral and tibial axes, what makes it possible to assess the anatomic misalignment and draw the cut lines involved with the femoral bone (with 3º to 4º valgus inclination) and the tibial bone (orthogonal to the tibial longitudinal diaphyseal axis). Later on, it is required to estimate in templates the size of the components to be used, both in anterior-posterior and lateral views.

3) Dynamic radiologic assessment, in an anterior-posterior X-ray under knee valgus stress to establish and document whether or not the MCL is competent. Incompetence is assumed when the gap is greater than 30º (Figure 4).[6,14,15]

During the planning stage, one of the aims is to determine the presence of dorsal osteophytes in the lateral X-ray; osteophytes have to be surgically removed because they go against the post-operative range of motion and the appropriate balance of the soft tissues.

Figure 4. **A.** Anterior-posterior X-ray that shows severe knee valgus deformity
B. Knee X-ray in the same patient showing incompetence in the medial collateral ligament in the X-ray under stress, what suggests that a constraint implant is required.

Surgical technique

Once the surgical approach has been initiated and before performing the incision of the extensor apparatus, the first approach to releasing the soft tissues is developed—dissection and the localization of the tendon of the tensor fasciae latae is carried out at the level of the proximal pole of the patella. Then complete tenotomy comes, with special care about total fibers cut off on the dorsal aspect of the tendon (Figure 5). Later on, arthrotomy follows; so, the medial para-patellar approach is carried out, with removal of the cruciate ligaments (preference for the posterior-stabilized implant) and the meniscus. Then, the second approach to releasing the soft tissues is developed, what consists of releasing the proximal (femoral) attachment of the LCL by complete osteotomy of the lateral femoral epicondyle. This is performed by spotting the anterior and distal edges of such insertion with a laminar chisel, separating with the same chisel the lateral epicondyle in the form of a bone tablet of approximately 2 cm in diameter and 3-4 mm in thick (Figure 6). If some degree of retraction remains, the procedure needs to be supplemented with popliteus muscle tenotomy and, if necessary, release of the posterior-lateral capsule.

The release of the soft tissues is always carried out first, before moving on to the bone cuts. It is worth emphasizing that the release maneuvers are performed on demand,

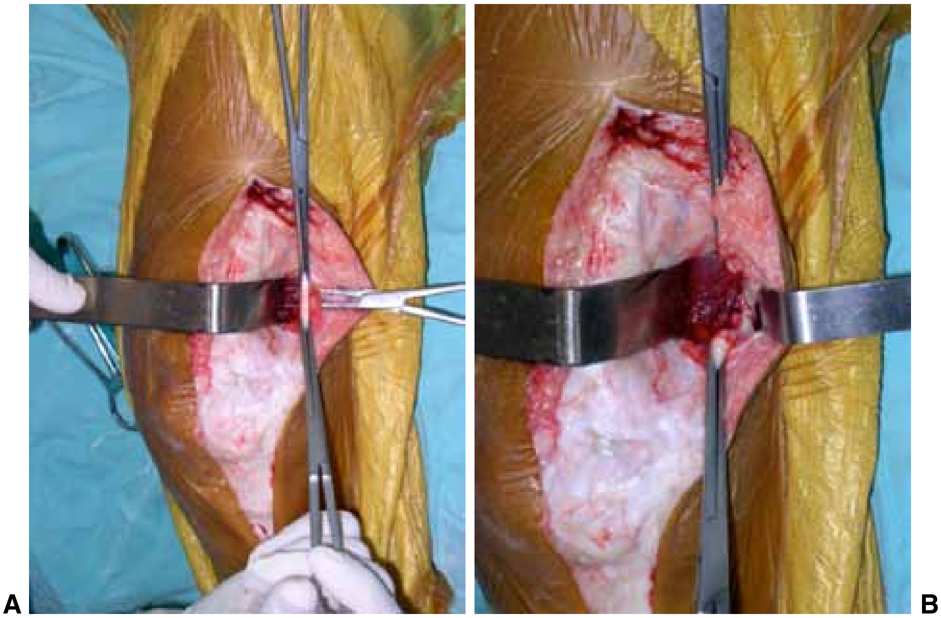

Figure 5. Complete tenotomy of the tensor fasciae latae at the level of the proximal pole of the patella.

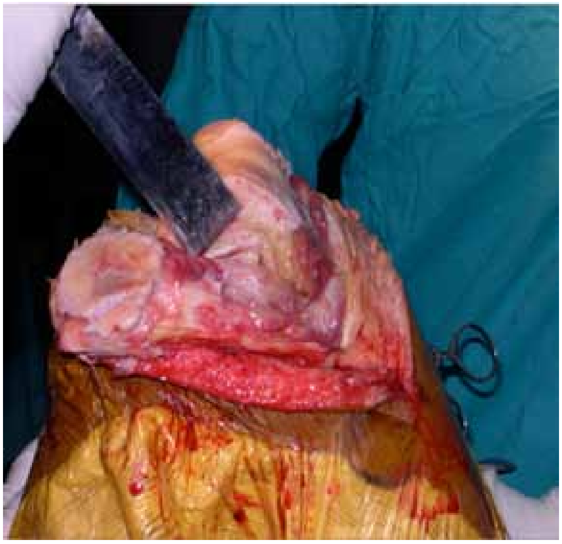

Figure 6. The lateral collateral ligament is being proximally unattached by complete osteotomy of the epicondyle.

what makes this a dynamic and sequential procedure, since the different lateral structures are cut as required.

After such lateral release, the tibial and femoral cuts are carried out, trying to do as planned pre-operatively, realizing the importance of getting an appropriate rotation of the components due to the risk of patellar misalignment and ligament instability.

With appropriate removal on all the planes, it is possible to get a rectangular gap in knee extension and flexion, with a stable joint at knee varus-valgus stress maneuvers. This is the moment when some degree of instability can be detected, after releasing the soft tissues and removing the bone. When the aforementioned maneuver shows medial knee instability, constrained implants have to be chosen.

Results

Medical results

The 39 patients (42 TKRs) underwent an average follow-up of 9.2 years (ranging from 5 to 14.3). The *Knee Society Score* showed average pre-operative values of 23.2 (ranging from 17 to 38), whereas its post-operative average values were of 83.3 (ranging from 70 to 92). Likewise, the pre-operative *Functional Knee Society Score* was, on average, 27.5 (ranging from 0 to 45), while its post-operative values were 82.5 (ranging from 65 to 100) (Figure 7).

At the time of assessing knee pain before the surgery, it was seen that 88% of the patients suffered moderate or

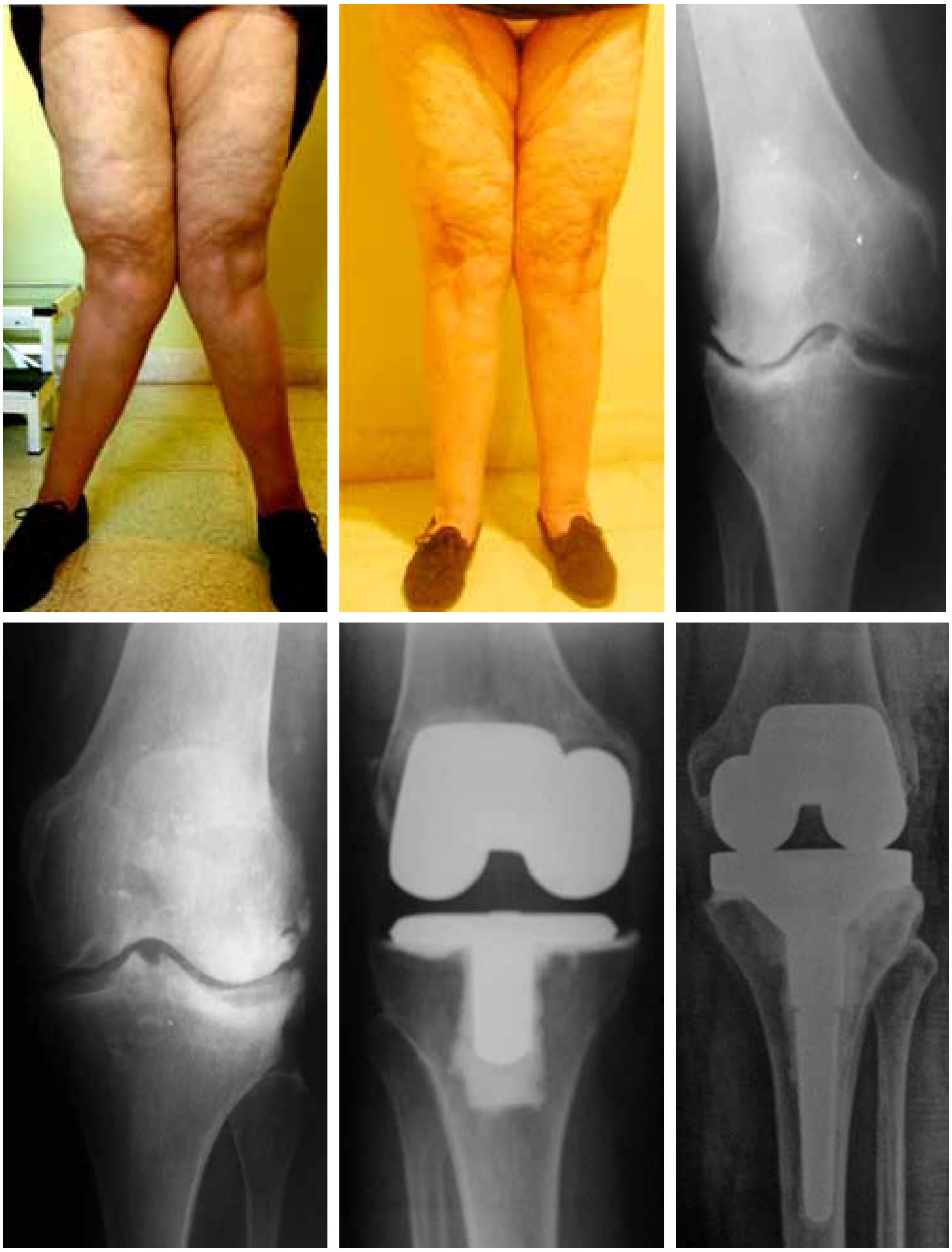

Figure 7. Patient with bilateral severe knee valgus deformity (28º on the left and 35º on the right), with 9-year and 10-year follow-up respectively. Favorable results at the time of the last follow-up consultation.

severe pain while doing activity, and 70%, at rest. In the last post-operative follow-up consultation, 79% of the patients showed no knee pain. Six percent of them reported mild pain at rest, whereas 15% of them showed mild or moderate pain while doing activity.

In the pre-operative stage, range of motion was limited in the great majority of the patients. Average flexion was 95º (ranging from 55º to 115º); on the other hand, there was no >5º complete extension in 13 patients (33.3%) and > 15º in four patients (10.2%) before the surgery. Average post-operative flexion was 105º (ranging from 80º to 125º); 96% of the patients showed complete extension or no <5º complete extension after the surgery, and we verified 5º-10º flexion contracture in two patients (5.1%). None of the patients required mobilization under anesthesia (Figure 8).

We detected pre- and intra-operative medial ligament instability in seven knees in the series (16.7%), in which we used constrained implants. After the medial-lateral and anterior-posterior stress maneuvers in the last post-operative follow-up consultation, 41 knees (97.6%) were stable. We detected one case (2.4%) of moderate medial instability during physical examination in the first post-operative follow-up consultation. This patient required immobilization during six weeks and, in the last follow-up consultation (9.2 years), there was medial stability. The "post-operative instability" variable was not associated with high range of motion before the surgery (p=0.17), neither was it associated with pre-operative instability (p= 0.8) nor with the degree of the pre-operative knee valgus deformity (p= 0.3).

Radiographic results

The pre-operative knee valgus angle in the series was, on average, 24.3º (ranging from 21º to 45º). After the surgery, we corrected such misalignment in almost all the patients—we got an axis in between 3º and 8º in 88.1% of the cases, with an average knee valgus angle of 5.9º (Figure 9). Two patients showed post-operative varus (2º) and one patient showed post-operative valgus (10º); both had favorable medical results as seen 6, 7 and 12.2 years after the surgery. In the Table 2 there is a detail of the values of the rest of the angles. At the time of evaluating post-operative X-rays in the last follow-up consultation, we saw that 92.9% of the knees did not show radiolucency in any of its components. One patient showed both femoral and tibial global delimitation from the second post-operative year on, with no symptoms until the last follow-up consultation, with a general follow-up of 13.2 years. In another case, we saw a <1mm radiolucent line in two zones of the femoral component, without medical symptoms. One patient showed progressive tibial loosening with simultaneous medical symptoms; that is why here it was necessary to perform revision eight years after the surgery. There were no signs of osteolysis in any of the components.

Complications and revision surgeries

As intra-operative complication, we underwent a proximal tibial fracture while working into the canal; this drawback was overcome with the use of a 4.5 mm-thick interfragmentary cannulated screw, with no interference in the tibial component.

As a post-operative complication, one patient suffered a septic arthritis consecutive to a phlebitis process in the contralateral lower limb (by *Staphylococcus aureus*) four years after the surgery, which was treated with arthroscopic lavage plus antibiotics (with previous consultation with Infectology); so far, this patient has shown no further complications—nowadays, nine years after the primary surgery and five years after the arthroscopic surgery, the patient walks unaided, with no pain, and showing an acceptable range of motion.

There were neither cases of cutaneous necrosis or tegument defects, deep vein thrombosis or pulmonary thromboembolism, extensor apparatus injuries, patellar fracture or necrosis, patellar misalignment, nor were there cases of neurovascular injuries.

Figure 8. Appropriate post-operative range of motion in a patient operated on due to severe knee valgum deformity.

Figure 9. Five degrees axis in the post-operative X-ray.

Table 2. Coronal angle in the femoral bone cut plus coronal and sagittal angles in the tibial bone cut

Values	Degrees (on average)	Range
Femoral angle	5.7°	3°-8°
Tibial angle	88°	82°-97°
Post. Tibial fall	4.7°	3°-8°

In our series, we performed two revision surgeries: one of them due to mechanic loosening, and the other one because of peri-prosthetic femoral fracture. We did not perform revision due to infection.

In the first case, the patient showed early signs of loosening of the tibial component, which worsened in the consecutive medical check-ups with progressive increase in the patient's symptoms; this is why it was decided to revise the prosthesis eight years after the primary TKR. In this case, it is worth emphasizing the defective insertion of the tibial component on the coronal plane (with a 6º-varus angle in the immediate post-operative X-ray). In the last follow-up consultation, the patient's medical status

Figure 10. Tibial component in varus; revision of TKR eight years after the primary surgery, with good results so far.

was acceptable, with no pain in the knee and ambulation aided by cane on the contra-lateral side (Figure 10).

The second revision was necessary due to a traumatic event: The patient suffered a peri-prosthetic femoral fracture which was unsuccessfully subject to two osteosynthesis attempts (pins plus cast immobilization and locked plating in the distal femur) with progression to non-union in both cases. This is why it was decided to insert a non-conventional prosthesis in the distal femur. This procedure was performed seven months after the primary surgery. Nowadays, the patient develops aided ambulation at home with no pain in the knee (Figure 11).

Survival

As suggested by the survival analysis, the prosthetic survival rate was of 95.2% at 9.2- year post-operative follow-up, if the need of revision for any reason is considered as reference. Survival rate increases, though, reaching 97.6% at 9.2-year post-operative follow-up if only mechanic reasons are considered as reference.

Discussion

It is widely acknowledged that, in order to get complete and painless knee mobility after a TKR, it is essential to correct the misalignment and get a stable joint. In those patients with severe knee valgus deformity, one of the main challenges is to get an appropriate ligament balance; this is why procedures to the soft tissues are extremely important.

There are numerous reports about surgical techniques for the release of the soft tissues, with acceptable results.[3,6,8,9,13,15-17] The first one of them was described by Insall et al.[13] in 1979, and consists of the transverse section of the tendon of the tensor fasciae latae at the level of the joint itself, followed by the sequential release of the posterior-lateral capsule, the popliteus muscle and the LCL, which are unattached proximally from the lateral femoral condyle. It is worth mentioning that, at that time, these authors did not have femoral components differentiated into left and right; therefore, it was necessary to release

Figure 11. Failed attempts at osteosynthesis in peri-prothetic fracture; non-conventional prosthesis in the distal femur six years after the primary surgery, with good results.

longitudinally the patellar lateral retinaculum in all cases, with the aim of getting an appropriate patellar alignment.

In 1985, Ranawat et al.[1-3] modified such surgical technique, encouraged by the relatively high rates of late instability described by Insall. Here, they performed a less extensive release of the soft tissues, what decreased the need for constraint implants. Bone cuts, contrarily to the Insall's technique's, are performed in the first place; later on, the release of the soft tissues comes, what includes the intra-articular release of the posterior-lateral capsule and the tensor fasciae latae by multiple transverse incisions immediately proximal to the joint itself, with release of the popliteus tendon and the LCL in the cases of the most severe knee valgus deformities.

The latest suggestions emerge as from the 1990s on, reported by Buechel, Fiddian et al., and Keblish. [16, 18, 19] These authors, contrarily to the ones mentioned previously, who performed an anterior approach with medial parapatellar arthrotomy, suggest a lateral capsule approach for the treatment of the knee valgus deformity. On the other hand, Whiteside[6] recommends the sequential release of the tensor fasciae latae, the LCL, and the proximal end of the lateral gastrocnemius muscle (as required); moreover, he transfers the anterior tibial tubercle when the Q angle is altered (>26º). Lastly, Krackow et al.[9,20] and Healy et al.[7] reported encouraging results by LCM reconstruction, proximal or distal advance technique, as the surgeon prefers to carry it out.

As regards the results reported in literature by the aforementioned different authors, Ranawat et al.[3] reports good results in 42 knees in 35 patients, with average follow-up of nine years. Physical examination in post-operative assessment showed that the *Knee Society Score* increased from 30 to 93, whereas the functional score increased from 34 to 81. Average post-operative knee flexion was 110º, and the post-operative stability score increased from 17 to 24. In the X-rays, the average pre-operative knee valgus misalignment was of 15º (ranging from 10º to 32º), and it was possible to get a post-operative anatomic-physiologic axis of 5º (ranging from 0º to 10º). There were neither radiologic signs of loosening, nor was there osteolysis in the femoral and tibial components that could be seen. One patient developed aseptic loosening, and treatment consisted of revision in two surgical times. The prosthetic survival reported was of 92.9% in the medium term.

Krackow et al.[9] in a retrospective work on 99 TKRs in 81 patients with knee valgum deformity (67 of type 1 and 32 of type 2), analyzed medium-term follow-up (2 to 10 years) after performing their release technique plus MCL plication. The *Knee Society Score* increased 53.2 marks, whereas the functional score increased 17.9 marks. The average post-operative range of motion was of 103º, with 20 cases (20.2%) that required mobilization under anesthesia. There were 42 TKRs (42.4%) with complications: 11 (11.1%) superficial infections of the surgical wound, 2 (2%) patellar sub-dislocations, 3 (3%) post-surgical disorders of the common fibular nerve, three deep vein thrombosis and two reflex sympathetic dystrophies. They performed three revision surgeries with diagnosis of mechanic loosening, with short- and medium-term survival of 97%. Likewise, Healy et al.,[7] by a similar surgical technique in eight patients, published their results with a follow-up of almost six years on average, with post-operative increase in medical and functional scores compared to the pre-operative ones, with no evidence of medial-lateral instability, and an increase in the average range of motion from 87º to 112.5º; the average anatomic axis was of 5.4% for a pre-operative anatomic axis of 22.4%; they did not make any report about complications, taking into account the small size of the population and the short time of follow-up in this series.

For this work we assessed 42 TKRs in 39 patients, with a follow-up slightly higher than nine years, using a surgical technique developed by Insall et al.[13] and implemented at the institution we work at as from 1997. Like those of the aforementioned authors', our different medical and functional results were favorable, with appropriate knee range of motion and no pain in the knee; we got a proper axis after the prosthetic surgery in the vast majority of the patients.

Although release required by severe knee valgus deformity is extensive, we got appropriate joint stability (anterior-posterior and medial-lateral stability) in all the patients that we assessed, and the need of constraint implants was scarce (7-16.7%). These results are similar to the ones reported by Ranawat et al.[3] even though the lateral structures that we release are not the same as the ones they work with.

Similarly to the Ranawat et al.'s work's[3] our complications rate was low. In our series, however, there were neither cases of septic loosening requiring surgical revision, nor were there patients with tegument necrosis around the surgical wound, deep venous thrombosis and pulmonary thromboembolism. As regards disorders in the femoral-patellar biomechanics, we did not detect patellar alignment disorders.

Taking as reference the need of revision for any reason, the prosthetic survival rate in our series (95.2% at 9.2-year follow-up) was quite similar to those obtained by the aforementioned authors, with no disregard for the fact that all the studies that we consulted report the follow-up of patients subject to surgery for any degree of knee valgus deformity as pre-operative diagnosis, whereas for our study, we set aside the cases with severe knee valgus deformity (of type 3 or misalignment >20º) (Table 3).

The approach to the surgical treatment of the severe knee valgus deformity asks for thorough pre-operative physical examination and an appropriate X-ray with stress, what establishes the MCL competence and the degrees of knee valgus. When there is MCL incompetence or knee valgus in stress is >30º, it is necessary to have a constraint implant and its use will be decided during the surgery, after the release of soft tissues and the bone cuts we describe in this work.

Table 3. Comparative figures in the different publications

	n	Follow-up (years)	Score	Functional Score	Post-operative range of motion	MUA	Treatment due to instability	Anatomic axis	Complications	Revision	Survival
Our institution	42	9.2	83.8	82.5	105°	No	2.4%	5.9°	4.8%	4.8%	97.6%
Ranawat (2004)	42	9	93	81	110°	No	No	5°	11.9%	7.1%	92.9%
Krackow (1991)	99	From 2 to 10	87.6	52.3	103°	20%	No	5.2°	42.4%	3%	97%
Healy (1998)	8	6	87.1	70.6	112.5°	No	No	5.4°	No	No	100%

MUA = mobilization under anesthesia.

Conclusions

We emphasize the importance of soft tissues appropriate release in the treatment of the knee valgus deformity, taking into account that, independently of the chosen surgical technique, when it is performed appropriately, both the post-operative instability rate and the need for a constraint implant are low, getting a stable and aligned knee. We believe that, by getting soft tissues balanced before performing the femoral and tibial bone cuts, less bone tissue gets sacrificed, what is important when it comes to the possibility of a future revision surgery. We recommend our technique in the management of the severe knee valgus deformity, because it is a procedure scarcely demanding with encouraging medium- and long-term results. In our study, further follow-up keeps pending, what will allow us to establish the true prosthesis survival.

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