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.

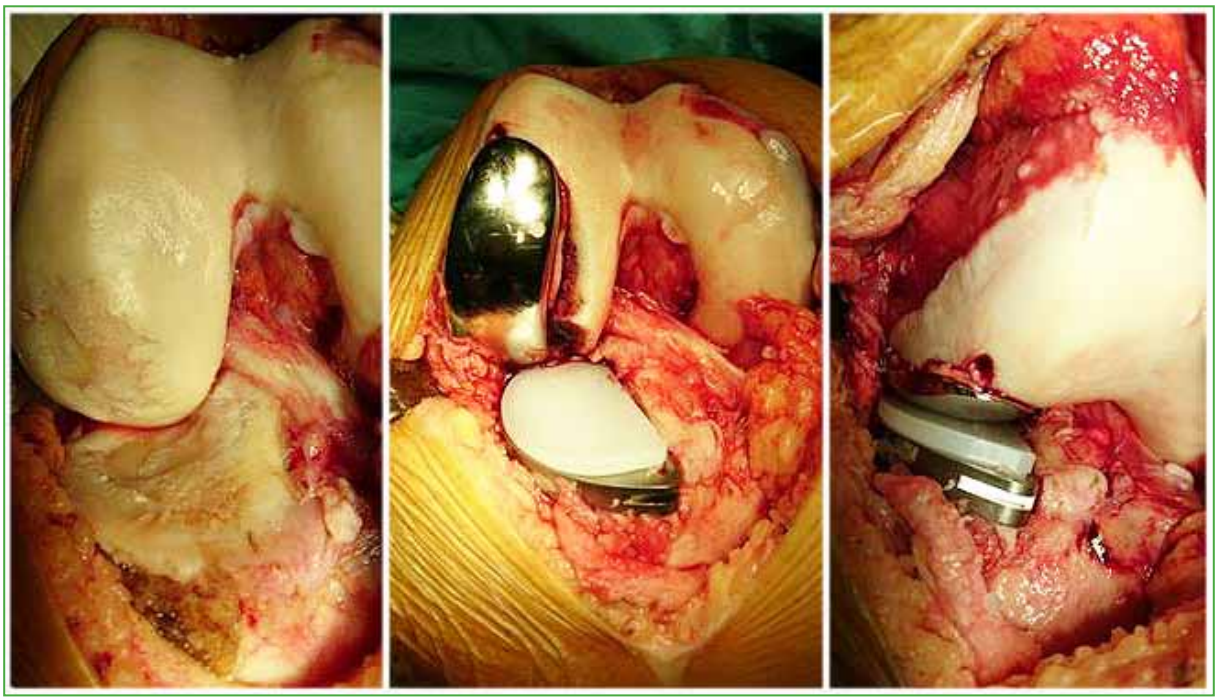

Figure 2. Femorotibial "screwing" phenomenon: divergence of the prosthesis components in flexion and convergence in extension or gait position.

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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