Unicompartmental Knee Arthroplasty. Clinical-Radiographic Results and Analysis of Implant Survival

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ABSTRACT

Objective: To assess the clinical and radiological outcomes of patients who underwent a unicompartmental knee arthroplasty (UKA), as well as the complication rate and implant survival. **Materials and Methods:** We present a retrospective descriptive study of 68 consecutive patients (70 knees) who underwent UKA between 2013 and 2020, with an average follow-up of 57.7 months (range 24-105) and an average age of 61 years (range 34-79). 46.5% of the patients were male. The average BMI was 29.9 (range 20-39). The most frequent etiology was osteoarthritis of the medial femorotibial compartment with a varus >7°. To assess the outcomes, the visual analog scale (VAS) for pain and the Knee Society Score (KSS) were used. The complication and implant survival rates were evaluated. **Results:** The average decrease in the VAS pain scale was 4.4 ± 1.9. The average score on the postoperative KSS functional and clinical scales were 77.4 ± 13.7 and 70.2 ± 17.7, respectively. The postoperative complication rate was 7% (5 cases). The surgical reoperation rate was 15.5% (11 patients): nine cases for persistent pain, one case for joint stiffness, and one case for aseptic loosening. **Conclusions:** UKA is an effective therapeutic option for patients with unicompartmental knee osteoarthritis, providing good clinical results with an acceptable rate of complications; however, it provides a considerable implant revision rate.

Keywords: Unicompartmental prosthesis; knee; unicompartmental involvement; survival.
Level of Evidence: IV

Prótesis unicompartimental de rodilla. Resultados clínico-radiográficos y análisis de la supervivencia del implante

RESUMEN

Objetivo: Evaluar los resultados clínicos y radiográficos en pacientes sometidos a artroplastia unicompartimental de rodilla, así como la tasa de complicaciones y la supervivencia del implante. **Materiales y Métodos:** Estudio descriptivo retrospectivo de 68 pacientes consecutivos (70 rodillas) sometidos a artroplastia unicompartimental de rodilla entre 2013 y 2020, con un seguimiento medio de 57.7 meses (rango 24-105) y una media de la edad de 61 años (rango 34-79). El 46,5% eran hombres. El índice de masa corporal medio era de 29,9 (rango 20-39). El diagnóstico más frecuente fue la artrosis del compartimento femorotibial medial con un varo <7°. Los resultados se evaluaron con la escala analógica visual para dolor y el *Knee Society Score* (KSS). Se evaluó la incidencia de complicaciones y la tasa de supervivencia del implante. **Resultados:** La disminución media en la escala analógica visual para dolor fue de 4,4 ± 1,9. Las puntuaciones medias posoperatorias en las escalas funcional y clínica del KSS fueron de 77,4 ± 13,7 y 70,2 ± 17,7, respectivamente. La tasa de complicaciones posquirúrgicas fue del 7% (5 casos). La tasa de reintervención quirúrgica fue del 15,5% (11 pacientes): nueve casos por persistencia del dolor, uno por rigidez articular y otro por aflojamiento aséptico. **Conclusiones:** La artroplastia unicompartimental de rodilla es una opción terapéutica eficaz para pacientes con gonartrosis unicompartimental de rodilla; se logran buenos resultados clínicos con una aceptable tasa de complicaciones; sin embargo, la tasa de revisión del implante es considerable.

Palabras clave: Prótesis unicompartimental; rodilla; compromiso unicompartimental; supervivencia.
Nivel de Evidencia: IV

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INTRODUCTION

The surgical treatment of degenerative disease of a single compartment of the knee continues to be a subject of controversy that varies depending on the schools of thought and the experience of the surgeon.[1]Likewise, the annual demand for gonarthrosis arthroplasties is expected to increase considerably in the near future due to the aging of the population.[2,3]

Among the current therapeutic options, we can highlight unicompartmental knee arthroplasty (UKA), total knee arthroplasty (TKA),[4] arthroscopic lavage, alignment osteotomies[5] and, very recently, osteochondral grafting and cultured cartilage cell transplants.[6] Specifically, UKA is a procedure that preserves bone stock and cruciate ligaments, which allows good kinematics, while preserving knee proprioception.

Although the scientific evidence indicates that functional outcomes in the medium and long term are favorable in patients undergoing UKA,[7] there are studies that report a considerable rate of implant revision. In addition, it is a technically demanding procedure and its indication remains a controversial issue.[8]

The aim of this study was to evaluate the clinical and radiographic results in patients undergoing UKA, as well as the rate of complications and implant survival.

MATERIALS AND METHODS

Study design

A retrospective descriptive study of 70 knees (68 patients) operated on by the same surgical team at our institution between September 2013 and March 2020 using a fixed polyethylene cemented UKA was performed. The minimum follow-up was two years. Inclusion criteria for UKA were the involvement of a single compartment of the knee, the presence of competent cruciate ligaments, <10º flexion or none at all, and <7º varus-valgus deformity on preoperative anteroposterior and lateral radiographs.

The exclusion criteria were: involvement of more than one compartment, inflammatory arthritis, and ligamentous instability. Body mass index (BMI), age and level of physical activity of the patient were not considered exclusion criteria.

Surgical technique

All patients underwent the placement of a fixed-bearing Triathlon® PKR (Stryker®, NJ, USA) unicompartmental prosthesis according to the usual technique. The patient is placed in the supine position. Under aseptic and ischemic conditions, a medial parapatellar approach is performed, dislocating the patella laterally. All patients were administered antibiotic prophylaxis with cefazolin, and a redon drain and a compression bandage were placed at the end of the intervention.

The tibial component is always approached first, pinning the assembly to the proximal end of the tibia, just anterior to the anterior cruciate ligament insertion. In this way, the assembly is anterior to the tibial crest and centered in the ankle joint, ensuring parallelism with the tibia and, therefore, the tibial inclination of the implant. Afterwards, the varus/valgus adjustment of the prosthesis is performed by modifying the adjustment knob that regulates the mounting medially or laterally. Varus deformity should not be overcorrected, because this approach will place undue stress on medial soft tissue structures, causing pain and increased contact forces in the contralateral compartment, predisposing to further wear. Then, the vertical tibial resection is performed at the tibial spine, just medial to the insertion of the anterior cruciate ligament to avoid damaging its fibers, and reaching up to the upper surface of the tibial resection guide. The transverse tibial resection is continued to the posterior part of the joint. The flexion gap is checked, the minimum component of which comprises a thickness of 8 mm, the tibial cut can be increased if this spacer does not fit and then the extension gap is determined and, by subtracting both gaps, the distal resection guide for femoral preparation is determined. The distal resection guide is attached to the spacer with the leg in extension, this assembly is below the distal femoral bone; before performing the distal femoral osteotomy (using the 2-in-1 cutting block system, in extension and in flexion), the good alignment of the assembly is verified. Tibial rotation and knee flexion are adjusted so that the spacer block rests on the tibial resection and the posterior part of the 2-in-1 cutting block rests on the resected distal femur. The tibial size is then calculated using a caliper, the knee is placed at 90º of flexion and the trial femoral component is placed, which is considered adequate when it leaves 2-3 mm of exposed bone above its anterior edge. If the femoral component is between two

sizes, the smaller one is chosen in order to promote better patellar tracking. The tibial trial is then placed. Stability, placement, and alignment in all axes of the knee are verified.

Then, the femoral and tibial pivots are prepared by drilling. The tibial and femoral components are cemented, and both final components are impacted. Finally, the insert is inserted by pushing it posteriorly until it engages with the tibial tray in the posterior part, impacting it after its placement.

All patients were immobilized with a compression bandage. As of the second post-surgical day, active range of motion exercises of the joint began, at which time the redon and bandage were removed.

Demographic data

The study included 37 women (52.9%) and 33 men (47.1%), with a mean age of 60.8 years (range 34-79). The diagnoses were: gonarthrosis (grade III or IV of the Ahlbäck classification) (48 cases, 68.6%), osteonecrosis (13 cases, 18.6%), osteochondritis (5 cases, 7.1%) and post-traumatic osteoarthritis (4 cases, 5.7%).

91.4% (64 cases) had involvement of the medial compartment and 8.6% (6 cases) of the lateral compartment. In 31 cases (44.3%), the operated knee was the left and, in the remaining 39 cases (55.7%), the right.

The mean BMI was 29.9 (range 20-39). Twenty-nine patients (41.4%) had been infiltrated with intra-articular corticosteroids before surgery, without clinical improvement; four (5.7%), with intra-articular platelet-rich plasma, without improvement; and five (7.1%) had received both treatments on different occasions. The rest (32 cases; 45.7%) had no previous infiltrations.

Half of the patients had already undergone knee arthroscopy and, in all, a partial meniscectomy of the affected compartment had been performed. Two had been operated on for a post-traumatic lateral tibial plateau fracture, by open reduction and internal fixation with screw-retained plates; and another had undergone patellar realignment.

Assessment methods

The cases were retrospectively analyzed by three surgeons—different from the main surgeon—who reviewed the medical records. The clinical and radiographic follow-up was carried out in outpatient offices of the center at one month, three, six and 12 months, and then annually after surgery.

The pre- and post-surgical radiographic anatomical axes were determined and the presence or absence of radiolucencies in the last clinical follow-up was evaluated using anteroposterior weight-bearing and lateral radiographs at 45º, taking into account the method proposed by Kalra et al.[9] Pre- and postoperative pain was assessed using the visual analog scale (VAS). In the last follow-up visit, the clinical result was evaluated by measuring the joint balance of the operated knee with a goniometer and the use of the Knee Society Score (KSS), and these values were compared with those of the preoperative period.[10]

In addition, applying the multiple linear regression model, we analyzed whether age, BMI, and sex affected the functional outcome.

A survival study of the implant was carried out with the Kaplan-Meier survival analysis, associating the survival curve of the series presented and assuming as "rescue" all those patients who required a new surgery for the replacement of some component of the prosthesis or the entire implant. We evaluated whether implant survival was significantly modified by any of the factors measured (sex, BMI, and age) separately, using the logarithmic order test, which takes into account the differences in survival between the different groups in all the follow-up stages. In addition, these factors were analyzed using a multivariable analysis with the Cox regression model, in order to determine the effects of these variables over time until prosthesis salvage.

The incidence of intra- and postoperative complications was determined, as well as the implant revision rate.

Statistical Analysis

The descriptive analysis of the categorical variables is expressed as absolute and relative frequency; quantitative variables are described with mean and standard deviation (SD). The normality of both quantitative and qualitative variables was verified using the Kolmogorov-Smirnov test. In all statistical analyses, the significance level was set at 5%. Data were analyzed with the statistical programs SPSS 22 and XLSTAT for MAC OS.

RESULTS

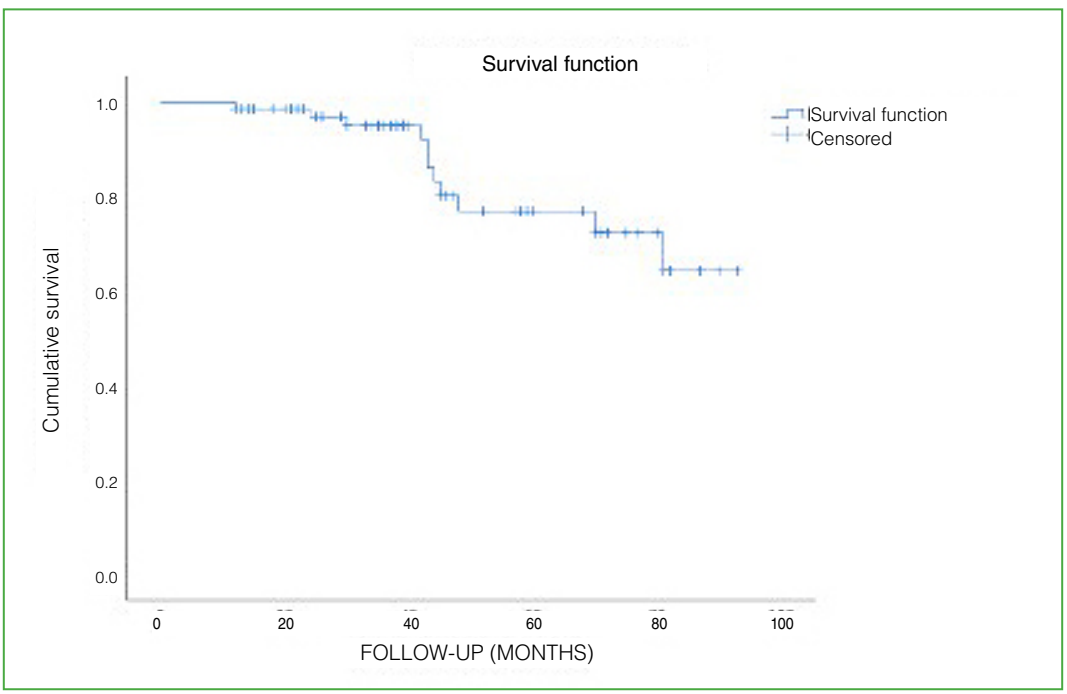
Mean follow-up was 57.7 months (range 24-105). The functional outcomes are shown in Table 1.

In the analysis using the multiple linear regression model of the age, sex and BMI variables and their influence on the functional result in the KSS, statistically significant differences were observed in terms of sex: the results were better in men (CI95% of -14.25 to -1.6, p = 0.014). There were no significant differences in terms of age and BMI. The implant survival rate was 84.3% (Figure 1).

Table 1. Clinical-functional outcomes of the series

	VAS	KSS	Anatomical axis
Preoperative	6.8 ± 1.2	56.8 ± 16.3	5.2 ± 7.5º
Posoperative	2.3 ± 1.8	77.4 ± 13.7	4.1 ± 7.7º
p	**28**	**1**	**7**

Results are expressed as mean and standard deviation. VAS = visual analog scale, KSS = Knee Society Score.



Means and medians for survival time

	Median				Median			
			95% confidence interval				95% confidence interval	
	Estimate	Standard error	Limit inferior	Limit superior	Estimate	Standard error	Limit inferior	Limit superior
	78.645	3.738	71.319	85.971	.	.	.	.

a. If censored, the estimate is limited to the longest survival time.

Figure 1. Implant survival rate. Kaplan-Meier survival curve.

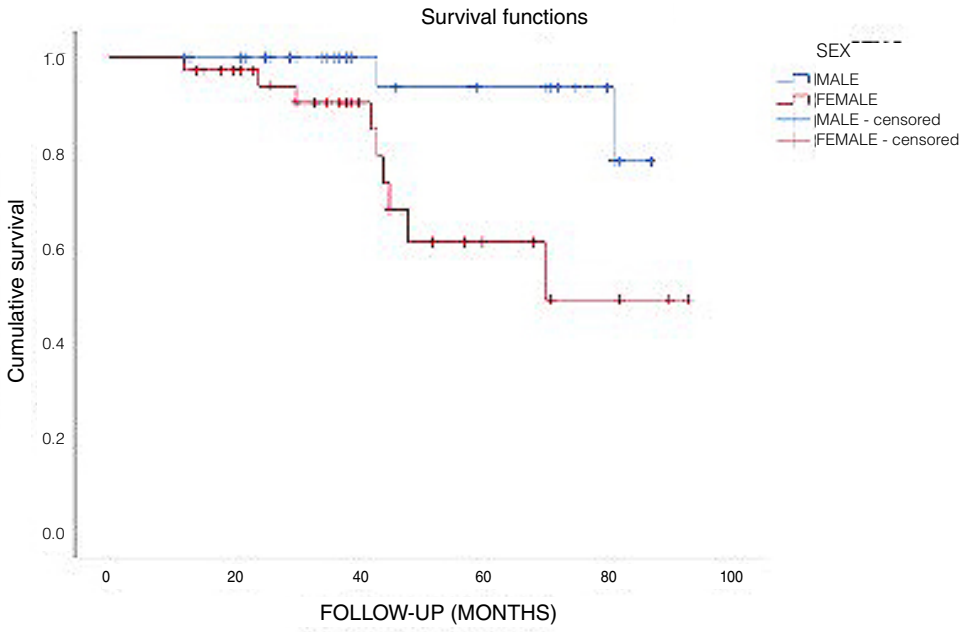
Taking into account that our study is limited to the maximum follow-up period (specifically, a maximum follow-up of 105 months), the median survival time is 78.7 months (CI95% 71.3-85.9) (Table 2). If the 5-year survival time is calculated, the result is 88.6%.

Table 2. Implant survival time.

Mean estimation	Standard deviation	Inferior limit CI95%	Superior limit CI95%
78.6	**3.7**	**71.3**	**85.9**

CI95% = 95% confidence interval.

The results of the univariate log-rank survival analysis test were not statistically significant for the BMI and age variables. However, significant differences were obtained in the sex variable for implant survival ($X^2(1) = 6.04$; $p = 0.014$) (Figure 2).



Variables in the equation

	B	SE	Wald	df	Sig.	Exp(B)
AGE	-.022	.027	.648	1	.421	.978
SEX	1.936	.804	5.793	1	.016	6.929
BMI	-.134	.076	3.120	1	.077	.875

Figure 2. Kaplan-Meier survival curve by sex.

B = coefficient, SE = standard error of B, Wald = Wald test, df = degrees of freedom. Sig. = p value (significance level $p<0.05$), Exp(B) = estimated odds ratio

The results in the multivariable analysis according to the Cox regression model (Table 3) were not significant for the variables age (p = 0.421) and BMI (p = 0.077); while, for the sex variable, the differences were significant (p = 0.016), the revision rate was higher in women.

Table 3. Cox regression for the variables age, sex and body mass index*

	B*	SE*	Wald*	df*	Sig.*	Exp (B)*
Age	-22	27	648	1	421	978
Sex	1936	804	5793	1	16	6929
Body mass index	-134	76	3120	1	77	875

*Significant for the sex variable.
B = coefficient, SE = standard error of B, Wald = Wald test, df = degrees of freedom. Sig. = p value (significance level p<0.05), Exp(B) = estimated odds ratio.

The complication rate in the series was 7% (5 cases): a hematoma that was resolved by conservative treatment; a surgical wound dehiscence that was treated with the Friedrich method and closure of the wound; a surgical wound infection healed with antibiotic treatment; one case of joint stiffness and another of aseptic loosening of the prosthesis, in which it was necessary to replace the prosthesis to TKA.

The implant revision rate was 15.7% (11 cases), there were complete conversions from unicompartmental arthroplasty to TKA. All revision surgeries were in patients with UKA of the medial compartment. The causes of the reinterventions were: persistent postoperative pain that did not improve with conservative treatment (9 cases); aseptic loosening of the implant detected by radiolucency in control radiographs (1 case) and joint stiffness that did not improve with rehabilitation treatment (1 case).

DISCUSSION

The treatment of single compartment gonarthrosis continues to be a subject of study, and UKA occupies a prominent place. In fact, recent research has shown the profitability of this implant when the surgical indication is adequate.[11] On the other hand, a wrong indication can generate a higher revision rate and worse clinical outcomes.[12]

In this sense, in 1989, Kozinn and Scott established the indications and the inclusion and exclusion criteria to select UKA candidate patients, which are the same as those taken for this study.[13] However, these indications have expanded, as can be seen in a review of five cohort studies carried out by van der List et al., in which good clinical outcomes were obtained in patients with mild to moderate patellofemoral involvement, without any differences in functional outcomes or in the risk of implant revision.[14] Likewise, Johal et al., and Jennings et al. obtained good clinical outcomes in patients >60 years and BMI >30.[8,11] The absence of an anterior cruciate ligament as a contraindication to UKA has recently been questioned. Several studies show acceptable results in patients who underwent ACL and UKA reconstruction at the same surgical stage, without increased revision rates, when compared to patients with competent ACL and knee kinematics similar to those of patients with an intact anterior cruciate ligament.[8]

The affected compartment is usually the medial one, while the lateral one is involved in 10% of the cases, according to some studies.[15] In our series, the incidence of lateral involvement was 8.6% (6 cases).

Regarding the implant, UKA is characterized by its minimal replacement design of the affected joint compartment. It is necessary to take into account that, when implanting this prosthesis, an elasticity gradient is created between the operated compartment and the non-operated compartment, which can affect the transmission of forces in the joint. While TKA imposes its own biomechanics on the operated knee, UKA should resemble the native knee anatomy as closely as possible to maintain patient-specific force patterns with improved dynamic proprioception and postural control in comparison to that of TKA.[16] In this regard, it should be noted that, in our specific case, the mean post-surgical anatomical axis was 4.1 ± 7.7º; while the mean pre-surgical axis was 5.2 ± 7.5º. A mean undercorrection of 1.1º was obtained, preserving the elasticity gradient and allowing a clinical-functional improvement of up to 20.6 points in the KSS.

As described by Schaafer et al., overcorrections of 5° in the operated compartment can increase mechanical forces by 88% over the other compartment, so this type of implant should be placed with an undercorrection of 3° to 5°, thus preserving the tibial epiphyseal bone stock and the good functionality and proprioception of the intervened joint.[7]

Regarding implant revision rates, UKA has been associated with higher revision rates when compared to the TKA since its introduction in 1970.[17] In a systematic review by Arirachakaran et al.,[4] three studies were included that compared the functional outcomes and revision rate of patients undergoing UKA or TKA. The authors found that there were no significant differences in terms of short-term functional outcomes; however, UKA patients had a 5.4 times higher revision rate than TKA patients.

The implant revision rate in our series was 15.7% (11 cases) and the calculated 5-year survival rate was 88.6%. There is considerable discrepancy between cohort studies and national prosthetics records on UKA implant survival, a mean survival rate of 90.5% was observed in cohort studies and 84.1% in national records. Wilson et al. conducted a systematic review of 60 studies divided into three groups: seven publications from six randomized clinical trials, 17 joint national records and national database studies, and 36 cohort studies. The 5-year revision rates were higher for UKA than TKA in all three study groups (hazard ratio 5.95 (1.29-27.59), 2.50 (1.77-3.54) and 3.13 (1.89-5.17), respectively).[18] Similarly, a systematic review of cohort studies and national records found that the mean 10-year UKA survival was 90.5% in the cohort studies, but only 84.1% in the national records. The 15-year survival was 87% and 69.6%, respectively.[19] The revision of a UKA with another UKA obtains a worse survival than the revision with TKA.[20]

Revision rates in national records are the highest overall, because surgeons who perform the most surgeries tend to publish their own series, while surgeons who perform fewer UKAs annually are included in national records.[2]Regarding the most frequent causes of revision, the most common are aseptic loosening (43-30%), disease progression (29-20%), unexplained pain (23-10%), instability (6%), infection (5%) and polyethylene wear (4%).[11,19,22-24] In our series, the most frequent reason for revision was persistent pain (9 cases), which coincides with other research, such as a systematic review of 39 studies carried out by Thienpont, which describes that UKA revision rate for unexplained pain was 6.76 times higher than that for TKA.[15]

From this study, we highlight the need for further research to clarify the probable cause of this persistent pain.

There are different risk factors that influence an earlier UKA revision. According to the Australian registry of prosthetics, which includes 46,094 UKAs, the risk factors are female gender and young age, with a 10- and 15-year revision rate of 14.6% and 21%, respectively.[11] In our study, the female gender was a risk factor that significantly influenced implant survival, but the same did not occur with age and BMI.

Other factors that influence UKA revision are the surgeon's preference and the difficulty perceived by the surgeon for the conversion to total knee replacement.[22] Thus, if UKA revision is perceived as an easy procedure, surgeons may be more inclined to revise implants in patients with unexplained pain, thus increasing revision rates.[24] In a systematic review of five studies and 536 patients carried out by Sun et al. to compare the clinical outcomes of UKA converted to TKA and primary TKA, the primary TKA group outperformed the revised UKA group in terms of scores on the WOMAC, KSS, and active joint balance scales.[1] However, although revision from UKA to TKA may not have similar results to primary TKA, morbidity has been shown to be lower than with revision TKA.[25]

In addition, the number of UKAs that the surgeon performs per year is a factor to take into account in implant revision.[26] As reported in some studies, the revision rate may be higher if surgeons perform fewer than 15 UKAs per year.[15] In a meta-analysis by Sun et al., UKA revision rates increased from 8.3% in surgeons who placed one unicompartmental implant per year to 1% in those who performed more than 12 UKAs per year.[1] In addition, these less experienced surgeons can increase the inclusion of total knee replacements in patients who are candidates for unicompartmental replacements (usage phenomenon) due to the high revision rate that they can cause due to the low volume of annual surgeries, which reaches 11% according to national records.[21] As described in the study by Hamilton et al., this fact has been associated with a lower revision rate.[27] It should be noted that one of the advantages of our study is that all the implants were placed by the same surgical team from the knee unit

of the same hospital and that the number of UKAs per year is higher than the minimums reflected in published studies.

The type of implant in all cases was a fixed polyethylene cemented unicompartmental prosthesis. A recent systematic review of cohort studies and national registries found higher rates of aseptic loosening in mobile polyethylene implants than in fixed ones, but higher rates of disease progression in fixed ones. In contrast, medium-term survival for cemented and uncemented implants was comparable between groups with survival rates greater than 95%.[11]

The limitations of this study are that it does not have a control group of patients who underwent TKA to compare results between groups and that more specific complementary tests, such as computed tomography or magnetic resonance imaging, were not performed to more accurately assess the outcome and the presence of loosening of the implant, as well as for preoperative planning.

CONCLUSION

UKA is a therapeutic option that provides good clinical results with an acceptable rate of complications in patients with unicompartmental gonarthrosis of the knee; however, the implant revision rate is higher than with TKA.

Conflict of interest: The authors declare no conflicts of interest.

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