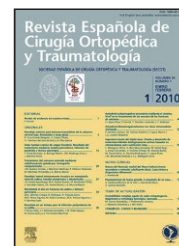


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REVIEW ARTICLE

Implantation of the patellar component in the total arthroplasty of the knee: current situation

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KEYWORDS

Knee;
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Abstract

Introduction: Implanting or not implanting the patellar component (PC) in knee prosthesis (TKP) is a controversial subject.

Material and method: In an attempt to clarify this controversy, we have reviewed grade 1 and 2 scientific evidence articles.

Results: The percentage of anterior knee pain without PC ranges from 17% to 69% versus 5.3-37% when the PC is placed. Without PC, the percentage of reoperation goes from 0% to 20%, this being from 0% to 13% when the PC is implanted. A prospective study has demonstrated that the Outerbridge classification serves to decide on whether to perform a PC implant or not.

Conclusions: The controversial is still unsolved. For some authors, it is better to always place a PC. However, others state that it is not necessary to do so in Outerbridge grades I, II and III, being recommendable to do so in grade IV.

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PALABRAS CLAVE

Rodilla;
Artroplastia;
Componente rotuliano

Implantación del componente rotuliano en la artroplastia total de rodilla: situación actual

Resumen

Introducción: Implantar o no el componente rotuliano (CR) en prótesis de rodilla es un tema controvertido.

Material y método: Para intentar clarificar esta controversia hemos revisado artículos de evidencia científica grados 1 y 2.

Resultados: Sin CR, el porcentaje de dolor anterior de rodilla oscila entre 17-69% frente al 5,3-37% cuando se coloca el CR. Sin CR, el porcentaje de reoperación va de 0-20%, y es de 0-13% cuando se implanta el CR. Un estudio prospectivo ha demostrado que la clasificación de Outerbridge sirve para decidir si implantar o no el CR.

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Conclusiones: La controversia sigue sin estar resuelta. Para algunos autores es mejor colocar siempre el CR. Sin embargo, otros señalan que no es necesario colocar el CR en los grados I, II y III de Outerbridge, y es aconsejable hacerlo en los grados IV.
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Introduction

Total knee arthroplasty (TKA) is one of the most frequent procedures in the field of adult reconstructive surgery. The treatment of the joint surface of the knee during TKA is controversial and consists of three options: never replace the patella, always replace it, or make the choice to replace it or not according to symptoms and findings during the operation.

The first designs for total knee prosthesis (TKP) did not take into account the patellofemoral joint, which provoked anterior knee pain in 40-58% of patients. Furthermore, the higher incidence of pain in patients with rheumatoid arthritis contributed to the incorporation of a patellar component in later designs.

Initially, an anterior shield was used in the femoral component without replacing the patellar surface, although this was not sufficient to improve the results: the shield used was flat, provoking instability of the patella. Subsequently, the anterior femoral shield was given a concavity in which a polyethylene component was implanted in the patella. The first patellar replacement was performed in 1974; this was a polyethylene dome used for a total chondylar prosthesis (Zimmer®, Warsaw, IN).¹

The improved results obtained with a patellar replacement led many surgeons to defend the systematic replacement of the patella. Subsequently, reports on the complications of patellar substitutions began to be published, highlighting fractures, wear of the polyethylene, loosening of the patellar component, or patellar tendon rupture, which led to the concept of selective patellar replacement in TKA. Table 1 shows the traditional indications for replacement or conservation of the patellar joint surface.

In spite of the large number of studies performed to classify the indications for patellar replacement in TKA, these have not been able to demonstrate a clear superiority in using patellar replacement over not replacing it, leading to the current controversy. The objective of this update

report is to clarify this controversy in light of current knowledge based on scientific evidence.

Prior considerations

Before performing a patellar replacement, one must consider the biomechanical implications. The patella acts as a dynamic fulcrum that transmits the forces generated in the quadriceps to the knee, such that a patellectomy results in a 50% loss in extension force of the knee. Furthermore, quadriceps contraction increases pressure in the patellofemoral joint, which can reach 6.5 times the actual body weight.²

Thinning of the patella in cases of replacement, as well as osteopenia and devascularisation associated with freeing of the retinaculum all increase the risk of fracture. Another element to keep in mind is the origin of anterior pain in the knee following TKA. It is normal to associate this pain with the patellofemoral joint, but other causes must also be considered, such as tendonitis, bursitis, synovial plica, neuromas, osteonecrosis, patellar clunk syndrome, and other less frequent conditions.

The design of the femoral prosthetic component turns out to be vital when deciding whether or not to change the patellar surface. The original designs were associated with an elevated rate of patellar subluxations due to an incongruence in the femoropatellar joint. Different studies show that a more medial localization of the patellar component and a deeper and more lateral groove in the femoral component with implantation in external rotation all favour a more anatomical movement of the patella in the femoral trochlea.³

Meta-analysis

Several meta-analyses compiled of randomised comparative studies have been done on patients who received TKA with and without patellar replacement (table 2). Nizard et al⁴

Table 1 Traditional indications for implantation/no implantation of the patellar component in a total knee arthroplasty

Traditional indications for the implantation of the patellar component, conservation of the original patella	
Advanced age	Thin and low stature patients
Anterior knee pain or femoropatellar symptoms	Young age
Femoropatellar radiographic changes	Osteoarthritis or non-inflammatory arthropathy
Inflammatory arthropathy	Well-preserved femoropatellar cartilage
Obesity	Congruency of the femoropatellar joint
Intraoperative femoropatellar incongruence	Thickness or size of the patella insufficient for placement of the prosthetic implant
History of patellar dislocation or subluxation	Femoral component with anatomical patellar shield for the patella
Femoral component with non-anatomical patellar shield	
High loss of femoropatellar cartilage	

Table 2 Meta-analysis

Author	No. of studies	No. of arthroplasties	Percent reoperated		Functional scales		Anterior knee pain		Pain while climbing stairs	
			Patella yes	Patella no	Patella yes	Patella no	Patella yes	Patella no	Patella yes	Patella no
Nizard et al ⁴	12	1,490	2.3	6.5	Analysis impossible		7.6%	22.3%	12.7%	26.4%
Pakos et al ⁵	10	1,223	0-13	0-20	No differences		6.4%	21.2%		
Parvizi et al ⁶	14	1,519	No differences (8.7)		No differences		11%	23.8%		

reviewed 12 randomised studies that complied with the necessary requirements, with a total of 1,490 knees diagnosed with rheumatoid arthritis or osteoarthritis intervened with knee arthroplasty between the years of 1996 and 2003: 753 individuals in the group of no patellar replacement and 737 with replacement.

The relative risk of a second operation was lower in the group with patellar replacement; the frequency of new surgeries for femoropatellar problems was 6.5% when the original patellar surface was left intact, and 2.3% when replaced ($p = 0.0008$). When the analysis of these studies is limited to the three with highest levels of quality, the difference continues to be statistically significant with reoperation frequencies of 7.9 and 3.1%, when conserving or replacing the original patellar surface, respectively. The relative risk for anterior knee pain was lower in the group with patellar replacement ($p = 0.005$). Patients complained of anterior knee pain in 22.3% of cases with conservation of the original patellar surface and 7.6% of cases with replacement. These values were upheld only when analysing the three highest quality studies.

The clinical/functional scales from the Knee Society Score (KSS) and Hospital for Special Surgery (HSS) are not fit for statistical analysis due to the heterogeneity of the studies. Twelve point seven percent of knees with patellar replacement and 26.4% of those with conservation of the patellar surface presented with pain upon walking up stairs. Seven point nine percent of patients from the first group were unsatisfied with the results of the surgery, while this percentage rose to 10.7% in cases where the original patella was conserved. As a result, this meta-analysis demonstrates that the rate of reoperation for femoropatellar problems, anterior knee pain, and pain when walking up stairs is lower when the patellar joint surface is replaced. We must also note that the follow-up period for many of these studies is insufficient for observation of adverse effects attributable to the presence or absence of the patellar component.

Pakos et al⁵ performed a different meta-analysis using a total of 10 randomised studies involving 1,223 knees that received arthroplasty with and without replacement of the patellar surface, and analyzed the frequencies of reoperation and anterior pain in the knee, as well as KSS and HSS score evaluations.

Once all of the studies that complied with the required criteria were analysed, a 48% lower reoperation frequency became apparent in the group that received a patellar surface replacement. Upon analysis of only those studies

with less than a 5 year follow-up period, no statistically significant differences were found, but when the analysis was limited to studies with more than 5 years follow-up time, the difference was more evident (3.6% in the group with patellar replacement as opposed to 9.8% in the group with the original patella left intact).

The presence of anterior knee pain following arthroplasty was 3 times lower in the group with patellar replacement, with a total reduction in risk of 13.8% (6.4 as opposed to 21.2%).

For the analysis using functional scales, only 4 studies complied with the necessary requirements for inclusion, and the available data were very heterogeneous. This led to an absence of statistically significant differences observed in the KSS and HSS functional scales between the two groups in the study.

Parvizi et al⁶ performed yet another meta-analysis to evaluate the results of TKA with and without patellar surface replacement, with special attention to patient satisfaction, the incidence of anterior knee pain, patellar complications, and frequency of reoperations. Fourteen articles were compiled under the inclusion criteria, with a total of 1,519 knee arthroplasties. Eleven percent of the patients in the group with patellar replacement presented with some level of anterior knee pain, and 23.8% presented in the group with the original patella ($p = 0.00001$).

No significant differences were observed in the level of satisfaction or frequency of revision surgery between the two groups, although 8.7% of the group with the original patella required later surgery for the implantation of a patellar component (PC). Nor were there statistically significant differences in the risk of patellar fractures, avascular necrosis, lesions in the patellar ligament, or other complications of the extensor apparatus. They observed a significant improvement in the functional scales following knee arthroplasty, independent of the treatment of the patella (no functional differences between the two study groups). The group with patellar replacement averaged a postoperative score of 84.11 and 104.48 on the KSS and HSS scales, respectively, while in the group with no patellar replacement, the scores were 80.16 and 103.16 ($p > 0.05$).

Prospective comparative studies between patellar replacement and conservation

Many surgeons prefer not to replace the patella and only do so in select cases, but these criteria are highly variable and

generally are based on intraoperative findings. Patelloplasty is an alternative to replacement using a prosthetic component. Some authors remove the osteophytes or make perforations in the ivory bone; other authors perform a soft tissue release of the lateral section of the patella, a patellofemoral ligament section, electrocoagulation of the patellar ring in order to achieve partial denervation, or perform multiple perforations with the objective of decompressing the subchondral bone.

Several prospective studies exist in the medical literature that use randomised designs to compare TKA results with and without patellar replacement (table 3).

Mayman et al⁷ commenced a prospective double blind study in 1991 of 100 patients with primary gonarthrosis to determine the efficacy of patellar replacement in TKA. Fifty patients were randomly assigned to a group that received patellar surface replacement, while the patella was conserved in the other 50%. In all cases, the same prosthetic model was used (Anatomic Medullary Knee®, DePuy, Warsaw, IN). With a 10-year follow-up, no significant differences were observed on the KSS clinical scale between the 2 groups. The rate of anterior knee pain while walking or climbing stairs was significantly lower in the group with patellar replacement. Eighty percent of patients with PC were very satisfied with the results of the surgery, while this percentage declined to 48% in the group where the patellar surface was conserved. Upon grouping the very satisfied and satisfied patients, no significant differences were found between groups.

Seven of the 100 patients required a second surgical procedure, 5 of which were in the patellar conservation group and 2 were in the group of patellar replacement, although 3 cases were due to femoropatellar problems. In the first group, 2 patients received a delayed replacement in the patellar surface due to anterior knee pain, while in the second group one case produced a failure in the secondary extensor mechanism in a fall that required surgical treatment.

Barrack et al⁸ performed a prospective double blind study on 118 knees that received arthroplasty with the same prosthetic model (Miller-Galante II®, Zimmer, Warsaw, IN), and were randomised to receive either replacement or conservation of the patellar surface. The mean follow-up time was 70.5 months (range: 60-84). At the end of the follow-up period, no statistically significant differences were observed on the KSS clinical and functional scales or in frequency of anterior knee pain between patients with and without patellar surface replacement. Ninety two percent of patients were satisfied with the knee arthroplasty, and this value was similar in both groups.

The rates of reoperation due to femoropatellar problems was 0% in the groups with patellar replacement, and 12% in the groups with conservation of the patella due to the presence of anterior knee pain that required delayed patellar arthroplasty. Obesity, level of femoropatellar degeneration, and preoperative anterior knee pain did not show a predictive value for lower scores on the KSS scale or frequency of anterior knee pain after the knee arthroplasty.

Table 3 Prospective comparative studies on total arthroplasty of the knee with and without replacement of the patellar surface of patients with gonarthrosis

Author	No. of arthroplasties	Follow-up (years)	Implant	Percent reoperated		Anterior knee pain		KSS		Satisfaction	
				Patella yes	Patella no	Patella yes	Patella no	Patella yes	Patella no	Patella yes	Patella no
Mayman et al ⁷	100	10	Anatomical Medullary Knee (DePuy)	2	4	10%	47%	156.5	146.8	100%	96%
Barrack et al ⁸	118	6	Miller-Galante II (Zimmer)	0	12	9%	17%	169	161	93%	91%
Campbell et al ⁹	100	10	Miller-Galante II (Zimmer)	2	4	51%	69%	137.6	135.5		
Burnett et al ¹⁰	90	10	Anatomical Medullary Knee (DePuy)	2	6	37%	25%	145.6	144.5	94.2%	89.2%
Waters et al ¹¹	514	5.3	Press-Fit Chondylar (Johnson and Johnson)	1.2	4.7	5.3%	25.1%	152	163	73.2%	86.6%
Smith et al ^{12,14}	181	4	Profix Total Knee System (Smith and Nephew Richards Inc.)	0	0	30.1%	20.9%	152	163	73.2%	86.6%
Wood et al ^{13,15}	220	2	Miller-Galante II (Zimmer)	9	12	16%	31%			100%	100%

KSS: Knee Society Score.

Several different prospective studies exist that have been performed in different geographical areas with similar results. Campbell et al⁹ in Australia and Burnett et al¹⁰ in London used prospective and comparative studies on 100 and 90 knees, respectively, with a mean follow-up period of 10 years on patients who received TKA with and without patellar surface replacement, showed that no statistically significant differences existed between the two groups in the functional and clinical KSS scales, incidence of revision surgery, patient satisfaction, anterior knee pain, and postoperative radiographic findings.

In a level ii evidence prospective study, Rodríguez-Merchán and Gómez-Cardero showed that the Outerbridge classification,¹¹ which measures the level of damage to the patellar cartilage, is useful for predicting the need (or lack thereof) for PC implantation in the TKP NexGen PS[®] cemented model (Zimmer, Warsaw, USA).¹² The most important evaluation parameter in this study was the need for a second intervention for PC placement when it had not been inserted in the primary procedure. The principal conclusion of the aforementioned authors was that it is not recommendable to implant PC in grade I, II, and III Outerbridge levels, but that it is recommended in grade IV cases. Their study makes reference to a prosthetic model (NexGen) that is considered to be patella-friendly.

Comparative studies of bilateral knee arthroplasties

Several studies have been performed on patients with bilateral knee arthroplasties, both with and without patellar joint surface replacement.

Barrack et al⁸ performed a randomised study on 86 patients with 118 knee arthroplasties that included 32 bilateral cases. They found that no differences existed in functional scale scores, pain, or satisfaction between the two knees. A survey of the patients revealed that 21% preferred the side with patellar replacement, 29% preferred the side with conserved original patella, and 50% expressed no preference for either.

Thirty-five patients received a bilateral knee arthroplasty with patellar replacement on only one side in the study performed by Waters et al.¹³ Fifty-one percent of these preferred the side with patellar replacement, 11% preferred the side with the patella conserved, and 37% showed no preference. Only 4 of the 35 patients presented with anterior knee pain in the knee with patellar replacement as opposed to 9 cases with patellar conservation. These differences, both in preference and anterior knee pain, were statistically significant ($p < 0.001$).

In a study of 30 patients treated with bilateral TKP with a mobile platform and patellar replacement on one side, Keblish et al¹⁶ found no differences between the two sides with respect to their capacity to climb stairs or the incidence of anterior knee pain, and patients showed no preference for either side. The radiographs also showed no differences between the two sides in alignment, joint congruency, or joint line positioning. The authors conclude that with the use of an adequately designed prosthesis and a careful surgical technique, one can achieve results as positive

as with knee arthroplasty with and without patellar replacement.

Levitsky et al¹⁷ performed a 66 patient study, treating gonarthrosis with knee arthroplasty; in 13 of these, the prosthetic replacement was bilateral with patellar changes on only one side. In order to conserve the original patella, the authors followed several criteria based on intraoperative findings, such as the existence of a satisfactory joint cartilage, the absence of ivory bone, a congruent patellofemoral displacement, a patella with normal anatomy, and the absence of an inflammatory condition. Six of the 13 patients preferred the side with patellar replacement and no differences existed in the KSS scales, pain, range of movement, or patient satisfaction. According to the authors, knee arthroplasty without patellar replacement provides satisfactory long-term results with no complications as long as the aforementioned selection criteria are adhered to.

Studies in patients with rheumatoid arthritis

Rheumatoid arthritis is a systemic inflammatory disease characterised by symmetrical polyarthritis that typically affects the neck, shoulders, elbow, wrist, and small joints of the hands. The damage to the knee is infrequent in initial stages, but can rise to 90% in long-term evolution of cases.

Inflammatory arthritis has been classically considered as an indication for patellar replacement during knee arthroplasty. Frequently, patients with rheumatoid arthritis are sedentary, with periarticular osteopenia, poor quality subchondral bone, and deformities in soft tissues surrounding the joint, and increased risk of infection. The patella can be thin, which hampers replacement and promotes associated complications, such as fractures, aseptic loosening, disruption of the extensor mechanism, osteonecrosis, patellar instability, or clunk patellar syndrome.¹⁸

Synovitis that affects the extensor mechanism can contribute to peripatellar pain and the remnants of articular cartilage can act as antigenic stimulants for a persistent synovitis and can cause an immune response. However, upon review of the medical literature, it is not clear whether or not rheumatoid arthritis serves as an absolute indication for patellar replacement.

Shoji et al¹⁹ studied 35 patients with rheumatoid arthritis without severe deformities in the patella who received bilateral knee arthroplasty with patellar surface replacement on one side. With a minimum follow-up of 2 years, the results in terms of pain, muscular strength, arc of movement, and functional improvement showed no significant differences between the two groups. Furthermore, Holt et al¹⁸ observed similar clinical and functional results in patients with seropositive rheumatoid arthritis with replacement or conservation of the patellar surface; when the bone reserve is satisfactory, no large deformity exists, and the patellar displacement in the femoral trochlea during surgery is appropriate, leading to the recommendation in these type of patients not to replace the patella in order to avoid the potential complications associated with its prosthetic replacement.

In a similar study of 26 patients with rheumatoid arthritis receiving bilateral knee arthroplasty with randomised one-side patellar replacement and a mean follow-up time of 6.6

years, Kajino et al²⁰ found no significant differences in function, range of motion, muscular strength, or instability. In contrast, pain while walking or climbing stairs at the patellofemoral scale was only observed in knees with conservation of the original patella. The authors of this study indicate that patients with rheumatoid arthritis should have patellar replacement surgery for the alleviation of anterior knee pain.

Certain controversy also exists surrounding the field of patellar surface replacement in function of patient sex, height, and weight. Feller et al²¹ studied 40 patients with primary gonarthrosis who received TKA (PCA Modular, Howmedica®) without patellar replacement. The clinical/functional evaluation was performed using the HSS scale with a mean follow-up period of 38.4 months. Results were statistically significantly lower in female and obese patients. In a similar manner, Picetti et al²² studied a total of 100 knee arthroplasties (Total Chondylar Knee®, Johnson and Johnson) both with and without patellar replacement and a minimum 2 year follow-up period. They found that the results on the HSS scale were inferior in patients with height greater than 160cm, weight over 60kg, or advanced degenerative changes in the patellofemoral joint. As such, they recommend a systematic replacement of the patellar surface in patients with these anthropometric characteristics.

Decision-making tree

Currently, the indications for patellar replacement continue to be a point of controversy. In an attempt to determine the surgical attitude regarding the patella in patients receiving TKA, Helmy et al²³ developed a decision-making tree based on 7 randomised and controlled studies in which patients were specifically asked about previous knee pain. These decision trees constitute a methodological tool that permits a quantitative analysis of the results derived from a decision through expected values.

This decision tree has the objective of answering 2 questions: the first is whether or not to systematically replace the patella during TKA, and the second is whether or not to replace the patella in a secondary approach. This tree with sensitivity analyses shows that the best strategy in knee arthroplasties is the placement of the PC primarily, and that a delayed replacement leads to poorer results in most patients. The results of this tree are represented in figure 1.

Conclusions

The indications for patellar replacement during TKA continue to be a point of controversy in the orthopaedic

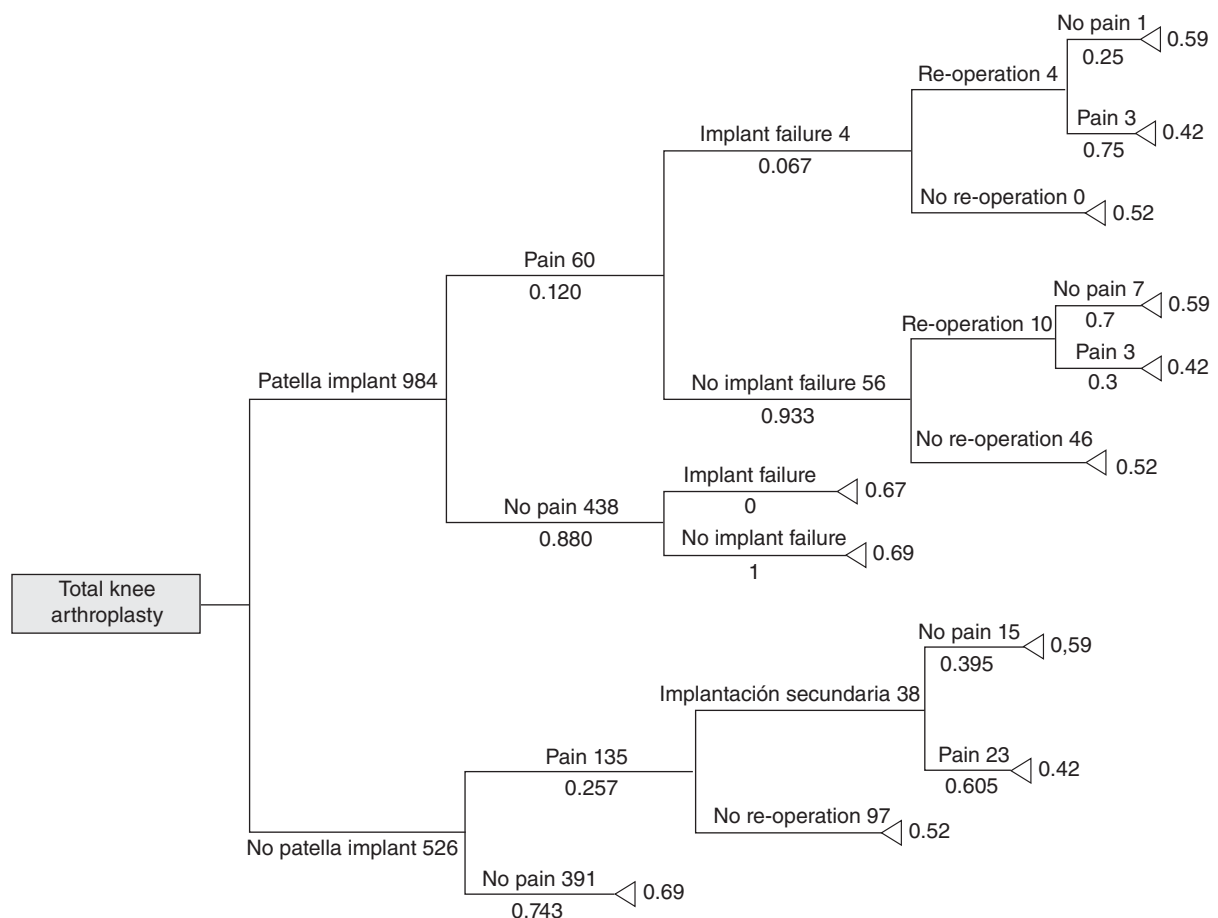


Figure 1 Helmy et al² decision-making tree. Shows the probabilities calculated from controlled randomised studies using the modified McKnee index. The number of patients in each path is detailed, as well as its inherent probability.

community. Generally, upon performing a knee arthroplasty without patellar replacement, a 10% prevalence of anterior knee pain can be expected, often requiring a second surgical procedure. When knee arthroplasty is performed with a primary PC implantation, the rate of femoropatellar complications is less than 10%. The traditional indications for patellar replacement, such as inflammatory arthritis and obesity, as well as the possible benefits to be gained, such as increased capacity to climb stairs and lower incidence of anterior knee pain, could be related to more than just the replacement or not of the original patella. Other factors related to the implant are also important, such as the design and rotation of the components, or joint congruency. Furthermore, not all cases of anterior knee pain following TKA originate in the femoropatellar joint.

Therefore, studies with a longer follow-up time are required with proper randomisation and controls in order to achieve the total comprehension of the role the patella and patellar component play in TKA.

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