

Original article

Long-term analysis of minimally invasive surgery in knee arthroplasty

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ABSTRACT. *Background:* Knee arthroplasty is the treatment of choice for gonarthrosis. The development of minimally invasive surgery (MIS) requires assessing results based on the classical approaches and this is the purpose of our study. *Methods:* Randomized, prospective study comparing two groups; one underwent MIS (45 patients) and the second one a classical approach (51 patients); both groups were comparable. The following variables were assessed in the immediate postoperative period and at 4 and 8 years: blood loss, pain according to the VAS, flexion and extension and quality of life measured with the SF-36. *Results:* In the immediate postoperative period we observed statistically significant differences ($p < 0.05$) in favor of the MIS approach in pain, hospital stay and blood loss. However, this was not observed at 4 and 8 years concerning pain, quality of life and range of motion. We observed an improvement in the functional scale and quality of life compared with the preoperative status, without any differences when both groups were compared. *Conclusions:* The MIS technique results in a better immediate postoperative period, but no differences were seen in the choice of the approach 4 and 8 years after surgery.

Key words: arthroplasty, knee, gonarthrosis, aged, utility.

RESUMEN. *Antecedentes:* La artroplastía de rodilla es el tratamiento de elección en la gonartrosis. El desarrollo de la cirugía mínimamente invasiva (MIS) obliga a evaluar los resultados en relación a los abordajes clásicos, siendo éste el propósito de nuestro estudio. *Métodos:* Estudio randomizado y prospectivo en el que comparamos dos grupos, uno vía MIS (45 pacientes) y otro vía clásica (51 pacientes), siendo los dos grupos comparables. Se evaluó en el postoperatorio más inmediato, a los 4 y 8 años la pérdida sanguínea, el dolor según la escala EVA y los grados de flexión y extensión, así como la calidad de vida por el SF 36. *Resultados:* En el postoperatorio inmediato observamos diferencias estadísticamente significativas ($p < 0.05$) a favor del abordaje MIS en cuanto al dolor, estancia hospitalaria y pérdida sanguínea, no así en el seguimiento a los 4 y 8 años en cuanto al dolor, calidad de vida y rango de movilidad. Apreciamos una mejora del estado funcional y calidad de vida con respecto al estado preoperatorio, sin haber diferencias al comparar los dos grupos. *Conclusiones:* La técnica MIS demuestra proporcionar un mejor postoperatorio inmediato, pero no se ven diferencias en la elección del abordaje a los 4 y 8 años de la cirugía.

Palabras clave: artroplastía, rodilla, gonartrosis, ancianos, utilidad.

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Introduction

Gonarthrosis is present in 10.2% of the adult population; its peak prevalence occurs at 78 years of age and it is more frequent in females.^{1,2} This represents an important burden for health care and accounts for 10% of the total first-time visits in primary care and 30% at Orthopedics Services.²

Total knee arthroplasty (TKA) is the treatment of choice at the final stage of disease, with excellent long-term results.³

During the evolution of TKA attempts have been made to avoid the tissue damage resulting from the classic parapatellar approach; during the 1990's the unicondylar Repicci approach and the advances in minimally invasive surgery (MIS) emerged as an attempt to minimize these damages and achieve better patient recovery.³⁻⁶

Multiple trials comparing the classic parapatellar approach with MIS have been published and, even though short-term results are similar, there is a better postoperative and functional recovery with MIS. However, all of them coincide on the need to perform long-term prosthetic survival assessments due to the risk of improper component placement or fixation in the MIS approach.⁷⁻⁹

This study intends to respond to these needs proposed in the literature by means of long-term results of the comparison between TKA with the classic approach and the minimally invasive subvastus approach.

Material and methods

We conducted a prospective randomized trial comparing the 4- and 8-year results of patients who underwent total knee arthroplasty with a medial parapatellar approach and with the MIS technique.

Patients underwent surgery from January 2000 to January 2001 and were randomly divided, prior to surgery, into two groups: 51 in the classic approach and 45 in the MIS group. They were informed personally about the trial and they all gave their consent.

The recorded preoperative data were similar for both groups (*Table 1*), without statistically significant differences between the groups in age ($p = 0.143$), sex ($p = 0.694$), personal history ($p = 0.999$), body mass index (BMI) ($p = 0.699$), preoperative hemoglobin ($p = 0.07$), side of the surgery ($p = 0.522$) and preoperative mobility [flexion ($p = 0.216$) and extension ($p = 0.412$)].

The SF-36 quality of life questionnaire was applied to all patients; it summarizes the data in two parameters (physical and psychic assessment), in a scale from 0 to 100, with 0 being the worst health status and 100 the best. A visual analog scale (VAS) was also used for subjective pain assessment at that time, ranging from 0 to 100, with 0 being no pain and 100 the most unbearable pain as perceived by the patient.¹⁰⁻¹² No significant differences were found between both groups in the SF-36 physical scale ($p = 0.863$), the SF-36 psychic scale ($p = 0.256$), and the VAS ($p = 0.132$).

The same anesthetic technique was used in all of them; it consisted of placing an epidural catheter for postoperative pain control, which was removed 48 hours after surgery. Antibiotic and thromboembolic prophylaxis was the same for all patients, with a first-generation cephalosporin and low molecular weight heparin, respectively.

A natural knee (Zimmer®) total knee prosthesis was placed in all cases, with all the components mentioned, including the patellar one. Surgeries were always performed by the same surgeon, who had ample experience in implanting such prosthesis using both approaches.

The classic approach used was the medial parapatellar one, with a 5 cm skin incision above the proximal knee pole all the way to the tibial tubercle; then arthrotomy was performed with a medial patellar incision, longitudinally sectioning the quadriceps tendon and the ligament tissue located medial to the patellar tendon in order to laterally dislocate the patella and thus expose the entire knee.

The MIS technique consisted of a subvastus approach with a skin incision <10 cm from the medial proximal pole of the patella to the tibial tubercle; this was followed by en bloc resection of the skin, subcutaneous tissue and superficial fascia to detach them from the vastus medialis fascia and create a «mobile window» of supraaponeurotic tissues that may be easily displaced to avoid excessive compression with retractors; the medial alar ligament was sectioned and a medial parapatellar arthrotomy was performed and extended, making a 90° curve at the superomedial aspect of the patella, under the vastus medialis without opening its fascia until it was released. The entire bottom of the subquadricepsal sac was detached and the synovial plicae were removed to freely move the patella with the quadriceps.¹³⁻¹⁷

After surgery all patients began rehabilitation during the immediate postoperative period and the drain was removed at 48 hours, at which time crutch-assisted walking was allowed.

Patient pain was assessed daily with a visual analog scale (VAS) and the mean for the hospital stay was recorded.

Blood loss was assessed considering the postoperative hemoglobin at 24 hours and the number of blood transfusions (autologous and allogeneic).

Table 1. Preoperative data.

| | Classic TKP | MIS TKP |
|------------------------|---------------|---------------|
| Number of cases | 51 | 45 |
| Female/Male | 37/14 | 31/14 |
| Age (years) | 69.3 (SD 6.4) | 71.2 (SD 6.5) |
| BMI (mean) | 27.9 (SD 5.1) | 28.4 (SD 5.4) |
| Side (right/left) | 25/26 | 25/20 |
| Flexion (degrees) | 97.3 (SD 4.7) | 98.5 (SD 4.2) |
| Extension (degrees) | -2.9 (SD 3.5) | -3.5 (SD 3.0) |
| Hemoglobin (g/dl) | 13.7 (SD 1.4) | 14.3 (SD 1.6) |
| Physical SF-36 (0-100) | 53.3 | 52.6 |
| Psychic SF-36 (0-100) | 17.4 | 17.5 |
| VAS (0-100) | 62.3 | 58.4 |

Patient follow-up consisted of a protocol of postoperative visits: at one month, at 3 months, at 6 months and once a year thereafter. At each visit the degrees of flexion and extension were recorded, the SF-36 was filled-out again, as well as the pain VAS, and the postoperative month when the patient achieved complete functional mobility for activities of daily living was recorded (*Table 2*). Anteroposterior, lateral and axial X-rays were taken at each visit to assess prosthetic mobilization or component misplacement.

Data were processed using a spreadsheet and they were statistically analyzed with ANOVA, chi square, the Student t test, and regression analysis at the immediate postoperative period, and at 4 and 8 years. All analyses were performed with a 5% alpha error.

Three patients in the classic approach group were lost to follow-up, and 2 in the MIS group.

Results

Immediate postoperative period

Operative time was 107.8 minutes (SD 22.7) for the classic approach and 131 minutes (SD 16.9) for the MIS approach, with significant differences ($p < 0.05$). An increase of 23.3 minutes was observed with the MIS approach.

The length of stay at the Recovery Unit was similar, without significant differences ($p = 0.623$).

Blood loss was 4.3 g/dl (SD 1.0) in the classic approach and 3.4 g/dl (SD 1.1) in the MIS approach, with significant differences ($p < 0.05$). The classic approach involved a loss of 0.9 g/dl more than MIS.

The regression analysis assessed the influence of sex, age, BMI, and autotransfusion on blood loss. Significant differences were found only in BMI and autotransfusion. Moreover, more autotransfusions were necessary in the classic approach (33 units) than in MIS. Concerning transfusions performed after 24 hours, 30 were performed with the classic approach, and 6 with MIS. Only in the standard approach was more than one transfusion prescribed (4 times).

The mean postoperative pain VAS during the hospital stay was 45.8 (SD 11.5) for the classic group and 26.9 (SD

10.2) for MIS; length of stay was 6.5 days (SD 1.5) for the standard approach and 5.3 days (SD 1.1) for MIS, with statistically significant differences ($p < 0.05$).

X-rays showed proper placement of all the implants.

Four-year follow-up

Pain assessed by means of the VAS was 9.7 (SD 8.9) with the classic approach and 11.2 (SD 7.7) with MIS, without significant differences ($p = 0.01$). When it was compared with the preoperative VAS assessment, a statistically significant difference was seen ($p < 0.05$), with a decrease of 50 points. Still no differences were found in this comparison when patients were grouped based on the type of approach ($p = 0.117$).

As regards functional capacity, flexion was 106.3° (SD 7.2) with the classic approach and 108.3° (SD 7.5) with MIS; extension was -1.4° (SD 2.1) with the standard approach and -0.93° (SD 1.9) with MIS, without any statistical significance ($p = 0.307$). But if we compare it with the preoperative range of motion, we do see significant differences ($p < 0.05$), with an increased mobility of 9.6° in flexion and 2° in extension.

Quality of life assessment with the SF-36 questionnaire did not show differences when the physical and mental components were compared between the classic and the MIS approaches; however, when it was compared with preoperative quality of life, significant differences were observed ($p < 0.05$), with an increase of 5 points in the physical scale and 3 points in the mental scale.

When these values were compared with the reference values for the Spanish population > 60 years,^{10,18} an increase of 8 points, with a 95% confidence interval (95% CI, 7.7-8.8) was observed in the physical scale as compared to the general population, and an increase of 6.9 points (95% CI, 6.5-7.3) in the psychic scale, with statistically significant differences ($p < 0.05$). When they are compared by approach groups no differences were found for any of the two scales ($p = 0.544$; $p = 0.149$).

The X-rays did not show any sign of loosening (*Figure 1*).

Eight-year follow-up

The mean pain VAS was 8.7 (SD 6.3) for the classic approach and 9.8 (SD 5.4) for MIS, without any statistically significant differences ($p = 0.401$). When compared with the VAS at 4 years, a significant decrease of 1.15 points was observed as a result of time. No differences were found when both approaches were compared ($p = 0.614$).

The range of motion was 107.8° of flexion (SD 7.4) and -1.2° of extension (SD 2.1) for the classic group, and 109.6° of flexion (SD 6.8) and -0.7° of extension (SD 1.7) for the MIS group, without any significance ($p = 0.228$; $p = 0.274$).

When the differences in mobility were compared with the 4-year follow-up, an increase of 1.4° in flexion was ob-

Table 2. Data recorded during the follow-up.

| Recorded data |
|---|
| Postoperative VAS (mean) |
| Postoperative hemoglobin (g/dl) |
| Operative time (minutes) |
| Recovery time (minutes) |
| Autotransfusion (number) |
| Transfusion (number) |
| Flexion at 4 and 8 years (degrees) |
| Extension at 4 and 8 years (degrees) |
| Physical and psychic SF-36 at 4 and 8 years |
| Pain VAS at 4 and 8 years (0-100) |
| Time to functional mobility (months) |

served, with a significant difference ($p < 0.05$) and an increase of 0.2° in extension, which was not significant ($p = 0.139$). No differences were found in flexion and extension between both approaches.

Concerning the physical and mental quality of life assessments, no significant differences were seen between the two approaches for each level of the SF-36. Only a 4.2-point improvement in the physical scale was observed with time. When results were compared with the population reference values, a difference of 12.5 points was found (95% CI) in the physical scale, and a difference of 6.7 points (95% CI) in the mental scale; these were significant differences, but when the results are analyzed by approach groups no significant differences were observed.

The X-rays did not show any signs of loosening (*Figure 2*).

Functional recovery

We also assessed the number of months required for patients to achieve optimal functional mobility for activities of daily living (0° a 100°); the classic approach group required

15.6 months (SD 2.1), and the MIS group 13.5 months (SD 1.9), with significant differences ($p < 0.05$).

Table 3 summarizes the results.

Discussion

Given the need reflected in the literature^{7,9,19} of obtaining and comparing long-term results of minimally invasive knee surgery, we proposed to conduct this study, as there are many short- and long-term analyses (*Table 4*), but very few long-term published papers. Our study assessed the results in the immediate postoperative period, and at 4 and 8 years.

The MIS approach involves a longer operative time because it requires a more careful dissection until the «mobile window» is achieved together with an appropriate exposure to perform osteotomies and place implants in a small space; however, this can be offset by a reduction in the length of stay in the recovery room. Even though we have not found any differences between the two approaches, we could reduce the operative time in MIS patients, as the reduced blood loss decreased the transfusion rate of blood products,

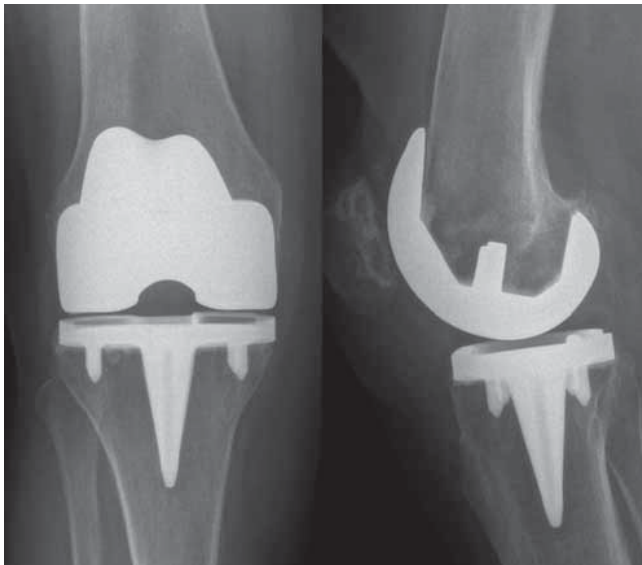


Figure 1. X-rays at 4 years without evidence of loosening.

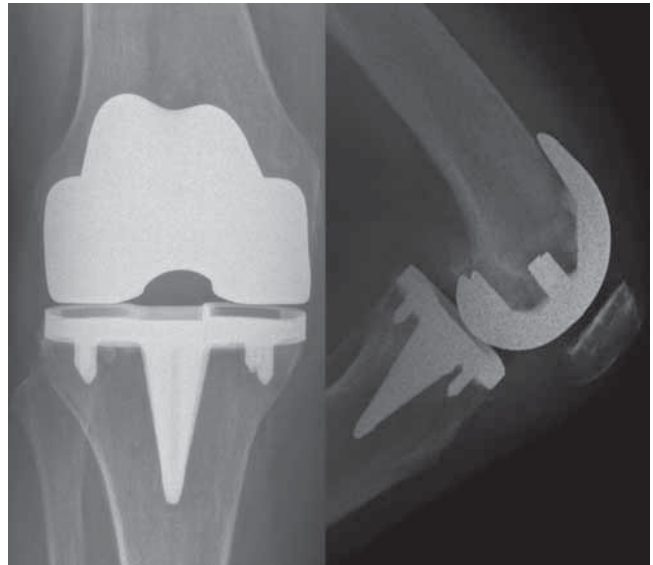


Figure 2. X-rays at 8 years without evidence of loosening.

Table 3. Summary of results.

| Table 3. Summary of results. | | | | | |
|------------------------------|-------------|-------------------|---------------------|----------------|--------------|
| Preoperative assessment | | | | | |
| | VAS | Flexion (degrees) | Extension (degrees) | Physical SF-36 | Mental SF-36 |
| Classic | 62.3 (13.7) | 97.3 (4.7) | -2.9 (3.5) | 17.4 (1.6) | 53.3 (3.2) |
| MIS | 58.4 (11.2) | 98.5 (4.2) | -3.5 (3.0) | 17.5 (1.7) | 52.6 (2.8) |
| Assessment: 4 years | | | | | |
| Classic | 9.7 (8.9) | 106.3 (7.2) | -1.4 (2.1) | 51.6 (2.2) | 55.7 (1.6) |
| MIS | 11.2 (7.7) | 108.3 (7.5) | -0.93 (1.9) | 51.9 (2.8) | 56.3 (2.2) |
| Assessment: 8 years | | | | | |
| Classic | 8.7 (6.3) | 107.8 (7.4) | -1.2 (2.1) | 55.7 (1.6) | 54.3 (1.5) |
| MIS | 9.8 (5.4) | 109.6 (6.8) | -0.7 (1.7) | 56.3 (2.3) | 55.7 (1.9) |

Table 4. Studies by duration.

| Author/Year | Number of months |
|-----------------------------------|------------------|
| Watanabe T. (2009) ²⁰ | 48 |
| Barrack R. (2009) ²¹ | 36 |
| Schroer W. (2008) ²² | 24 |
| Shen H. (2007) ²³ | 17 |
| Tanavalee A. (2005) ²⁴ | 14 |
| Yu J. (2008) ²⁵ | 6 |
| Hernández D. (2010) ¹⁹ | 6 |
| Cheng T. (2010) ²⁶ | 6 |
| Wohlrab D. (2008) ²⁷ | 3 |
| Laskin R. (2004) ²⁸ | 3 |

which is the main determinant of the length of recovery after knee arthroplasty.

Given that blood loss is less in the MIS approach due to the reduced tissue damage, we were also able to reduce the complications resulting from acute anemia. This, together with significantly less postoperative pain, leads to quicker recovery with early and intensive rehabilitation and contributes to reduce the length of hospital stay and the resulting health expense,^{4,19,27,29,30} an aspect that improves patient satisfaction.²⁹

In summary, immediate postoperative results are better with the MIS approach, which coincides with those published in numerous studies conducted prior to this one.^{3,4,19,23,27,28,30-33}

There is no doubt that total knee arthroplasty is the treatment of choice to relieve pain and recover the function of this joint when other treatments have failed. In this study we showed that 4 and 8 years after prosthetic surgery, the type of approach used, whether classic or MIS, makes no difference from the perspective of pain, and this could not be otherwise, as after the immediate postoperative period the tissues damaged by the surgical insult are repaired. For the same reason, we did not see any differences either between both groups regarding mobility, as the only surgical difference is the treatment of soft tissues, as osteotomies and the implants were the same. No implant malposition resulting from the surgical technique was observed.

The SF-36 questionnaire has proven validity to measure patient quality of life including both physical and mental aspects.¹⁰⁻¹² Upon applying it to the patients in our study we proved the improvement that occurred with time in both aspects, but mainly in the physical scale. This is understood because pain and the patient's functional status are two of the items assessed by the questionnaire and, as we have already said, total knee arthroplasty is able to improve them thus fulfilling its final goal. This was already shown in medium-term studies.²⁰⁻²¹

Lastly, functional patient recovery for activities of daily living, assessed subjectively by them, showed that patients who underwent the MIS approach recovered earlier their functional independence, so we believe that this may lead to a decrease in indirect costs, mainly social-related costs (return to work, walking aids, and etcetera).

In conclusion, we did not see any medium- and long-term differences between the two approaches. MIS yielded better results in the immediate postoperative period, with better patient recovery and a reduction in direct and indirect health care costs. We therefore consider that this approach should be used, as the postoperative period is clearly beneficial for the patient, the economic resources, which are currently scarce, are better utilized, and long-term results are the same as for the standard approach.

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