Cemented all polyethylene tibial insert unicompartamental knee arthroplasty: A long term follow-up study

S. Lustig, J.-L. Paillot, E. Servien, J. Henry, T. Ait Si Selmi, P. Neyret

Knee Surgery Department, centre Livet, Albert Trillat Center, North Hospitals Group, 8, rue de Margnolles, 69300 Caluire, France

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Summary Unicompartmental knee arthroplasty outcome is sometimes compared to total knee arthroplasty but various implant parameters might greatly influence this outcome. The objectives of this study were to report the results of a consecutive series of 172 all-polyethylene unicompartamental knee arthroplasies (UKAs) and to detail possible factors of success and failure.

Hypothesis. — It is possible to outline implant and technique factors determining success or failure in unicompartamental knee arthroplasty.

Materials and methods. — One hundred seventy-two HLS-type cemented resurfacing UKAs, with the femoral implant made of chrome-cobalt and the tibial implant tibial entirely in polyethylene (without anchorage studs) were consecutively implanted between 1988 and 2004 in 134 patients (111 females and 23 males) in our center according to the indications established in 1988, using the same technique for each surgery. The patients’ mean age was 72.2 years (range, 25—90 years). The review rate was 83.7% (144 UKAs), with a mean follow-up of 62.3 months (range, 24—160 months). The series included 84 medial UKAs and 60 lateral UKAs. The clinical data were analyzed using the IKS criteria and the patients had a complete radiological evaluation before surgery and at the last follow-up.

Results. — The rate of satisfied or very satisfied patients was 97.2%. No pain or slight pain was found in 81% of the cases. The mean flexion was 133° (range, 85—150°). The mean knee score varied from 63.6 before surgery to 91.5 (90.4 for medial UKAs and 92.9 for lateral UKAs) and the function score from 63.6 to 83.8 (84.7 for medial UKAs and 82.6 for lateral UKAs). The mean range of motion was 133° (range, 85—150°), better than the medial UKAs for osteonecrosis.
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The mean residual deformity was 4° varus for the medial UKAs and 2° valgus for the lateral UKAs. A radiolucency was found in 23% of the cases (20% tibial and 3% femoral), nonprogressive in all cases. In 87.2% of the cases, the opposite femorotibial compartment remained radiologically normal. No progression to osteoarthritis in the femoropatellar joint required additional surgery. Sixteen patients required revision surgery: in six cases, the implant was removed and a total prosthesis implanted (one late infection, one case of involvement of the opposite compartment, and four cases of tibial component loosening). In the other cases, one tibial baseplate was changed, five arthroscopies were done, and four unicompartmental knee replacements were done on the opposite compartment. The Kaplan-Meier survival rate (taking into account the revisions with implant change) was 95.6. The results of this series were very satisfactory and were similar to recent series in the world literature that showed survival rates between 90 and 98% at 10 years, rates that are equivalent to those found for total knee replacements. The mean flexion range of motion found was higher than the majority of other recent series, probably because of the precise patient selection in the present study, a minimally invasive approach, and the femoral implant design with an ascending condylar posterior cut. The deterioration of the contralateral compartment is frequently reported, but was perhaps prevented by the absence of overcorrection and patient selection. In this series, none of the UKAs was revised for wear. We explain this by the systematic preservation of a moderate undercorrection, particularly for medial UKAs, the quality of the polyethylene, and a selection based on patient weight and age.

Conclusions. — The option of an all-polyethylene tibial implant, with minimal bone cuts (femoral resurfacing), makes excellent long-term results possible.

Level of Evidence: Level IV. Therapeutic Study.

Introduction

Unicompartmental knee arthroplasties (UKAs) were introduced at the end of the 1960s by Marmor [1] and a little later in France by Cartier et al. [2]. Several authors reported the first UKA results [3,4]. Compared to total knee replacements, the UKAs were reputed to have inferior and less reliable results, mainly because of the problems related to defining the best indications or technical problems. The failure rates reported were caused by patient selection errors as well as design and surgical technique problems Insall and Aglietti [3,4].

Currently there is renewed interest in the use of UKAs in light of the results published from the Swedish registry [5], which have provided a better understanding of the causes for failure. A less invasive approach, lower morbidity, quicker recovery, and the frequency of a perfect functional result (“forgotten knee”) [6,7] also support this technique. Following the example of the total knee prostheses, many surgeons have evolved toward the metal back trays, i.e., with a metallic baseplate topped by an insert in polyethylene. Since 1988, we have chosen a resurfacing implant with a cemented all-polyethylene tibial tray. The objective of this study was to evaluate our results based on a consecutive single-center series of 144 UKAs with a minimal follow-up of two years, so as to demonstrate the factors involved in the failures or successes observed in our series.

Material and methods

The implant

We used a unicompartmental HLS implant from Tornier (Grenoble, France) (Fig. 1). The femoral implant is a resur-
Material

One hundred seventy-two UKAs were implanted in our department between January 1988 and December 2004. This is a retrospective series (excluding the three implants in titanium during the study period that were removed from the series). One hundred forty-four implants had a clinical and radiological follow-up lasting at least 24 months. Twelve patients had died (for reasons independent of the surgery) and 28 (16%) were lost to follow-up. The study investigated these remaining 144 UKAs implanted in 134 patients (ten bilateral replacements): 111 women (82.8%) and 23 men (17.2%). UKAs were implanted in 80 right knees and 64 left knees. The population’s characteristics are reported in Table 1.

The mean age at the time of surgery was 72.2 ± 1.5 years (range, 25–90 years). A total of 84 medial UKAs and 60 lateral UKAs were done. From an etiological point of view, 100% of the lateral UKAs were implanted for lateral osteoarthritis (three cases of which posttraumatic osteoarthritis); 63% of the medial UKAs (n = 53) were implanted for medial osteoarthritis, 36% (n = 30) for spontaneous osteonecrosis of the medial condyle, and 1.5% (n = 1) for necrosis of the medial tibial plateau. One hundred and eleven knees had never been operated on before; 27 had undergone minor surgery (14 open meniscectomies, 12 arthroscopies, one medialization of the anterior tibial tuberosity [ATT], excision of a bone cyst), and three had been instrumented for lateral tibial plateau fracture.

The inclusion criteria were established in 1987 and were reported in 1991 at the 7th Journées Lyonnaises du Genou. The first criterion was joint involvement: osteonecrosis of the medial condyle or isolated unicompartmental femorotibial osteoarthritis including nearly complete or complete femorotibial narrowing (excluding bone loss greater than 5 mm) were potentially good indications. We took into account the reducibility judged on stress view and the amount of preoperative deformity on the frontal plane: the limit was set at a 170° femorotibial angle for the medial UKAs (i.e., overall varus less than 10°) and 194° for the lateral UKAs (i.e., overall valgus less than 14°). The anterior cruciate ligament had to be healthy [9,10] and evaluated clinically as well as on the frontal and lateral X-rays taken with the patient standing on one foot. Thus, an anterior translation greater than 10 mm, a posterior saucer-shaped indentation, or a hooked aspect of the anterior intercondylar tubercles, reflecting ACL involvement, contraindicated UKA. Finally, the preoperative range of motion had to be normal or nearly normal, with flexum less than 10° and flexion greater than 100°. Weight alone was not an absolute contraindication, but we did not perform a UKA in patients weighing more than 80 kg. The only absolute contraindications were rheumatoid involvement (rheumatoid arthritis, etc.), bi- or tricompartmental osteoarthritis, or associated ligament involvement (chronic ligament laxity, involvement of the medial collateral ligament).

The mean preoperative International Knee Society (IKS) score [11] was 63.6 (range, 30–100 points), with a mean range of motion of 130.5° (range, 80–150°) and a mean flexum of 1.5° (range, 0–10°). The mean IKS function score was 63.6 points (range, 0–100 points).

From a radiological point of view, the mean femorotibial mechanical angle before the intervention was 179.5° (range, 166–194°) considering the entire series. It was 175.3° (range, 166–186°) for the medial UKAs and 183.3° (range, 172–194°) for the lateral UKAs. On the axial view of the patella, with the knee at 30° of flexion, the patella appeared centered in all the patients, with lateral femoropatellar osteoarthritis in three patients (2.2%) and medial femoropatellar osteoarthritis in 13 patients (9.6%). The opposite femorotibial compartment appeared normal in 138 patients (87.6%) and six patients (4.2%) presented joint space loss without bone-on-bone contact of the opposite compartment. A medial UKA was implanted in one patient with rheumatoid arthritis (diagnosed after the surgery).

All the patients were operated on following the same surgical principles established since 1988, with a medial approach for the medial UKA implants and a lateral approach for the lateral UKAs. A tourniquet was used in all cases except one patient with severe arterial vessel disease. Since 1996, we have limited exposure and since 1998 we no longer expose the ATT for the lateral approaches [12]. The ATT was exposed in the lateral approach for eight patients. Moreover, a lateral partial vertical patellectomy was also performed in two patients. The anterior cruciate ligament was normal in 139 patients and fragile or ruptured in five patients (evaluation noted during the surgical procedure). All implants were cemented. The polyethylene tray was 8 mm thick in 7% of the cases (n = 10), 9 mm thick in 75.6% of the cases (n = 109), 10 mm thick in 11% of the cases (n = 16), 11 mm thick in 4.9% of the cases (n = 7), and 12 mm thick in 1.4% of the cases (n = 2).

All patients received antibiotic treatment (second-generation cephalosporin) and an anticoagulant treatment (low-molecular-weight heparin). Weightbearing mobilization of the knee was begun the day after surgery.

Method

The clinical results were studied using the IKS scores [11]. During the review, all patients were asked if they had forgotten the presence of the prosthesis during daily activities, a positive response classifying them into the ‘’forgotten knee’’ category. The radiological results were evaluated based on standardized images taken at the last follow-up: standing frontal and lateral images, frontal standing long leg films, and an axial view of the patella at 30°. We were thus able to measure the preoperative femorotibial mechanical angle at the last follow-up and search for radiolucencies (Fig. 2) (noting any progression if necessary) or joint deterioration of the opposite compartment or femoropatellar

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Finaly, detectable wear of the polyethylene was sought on the standard X-rays using a metallic landmark on the tibial baseplate. We studied the results of the entire series, but also looked at lateral and medial UKAs as two separate subgroups and medial UKAs performed for osteoarthritis or necrosis as two other subgroups. We also specifically analyzed the UKAs where overcorrection was observed (femorotibial mechanical angle (mFTA) greater than 180° for the medial UKAs and less than 180° for the lateral UKAs).

The statistical analysis was done using Minitab software. The chi-square test was used to compare the quantitative variables, with significance set at \( p < 0.05 \). The survival curves were calculated using the Kaplan-Meier method with a 95% confidence interval based on the following endpoints: (1) implant removal and (2) implant removal or a second UKA performed for osteoarthritis progression in the opposite compartment.

Results

Mean follow-up

The 144 implants had a clinical or radiological follow-up equal to or greater than 24 months. The mean follow-up at the last review was 62.3 months (range, 24–160 months).

Complications

Early (during the first few months)

General complications were rare. We noted three cases of distal phlebitis and two cases of pulmonary embolism (clinically suspected and demonstrated on scintigraphy or thoracic spiral CT), all of which were resolved with appropriate anticoagulation therapy.

Late

Of the 144 UKAs, 16 underwent a second surgery: six conversions to TKA (one late infection, one progression of the osteoarthritis to the opposite compartment, four cases of tibial tray loosening), one tibial tray change (for loosening), four revisions for UKA in the second compartment (Fig. 3), and five arthroscopies.

Eleven patients complained of pronounced unexplained pain during recovery. Five of them had a diagnostic arthroscopy that corrected a meniscus lesion or fibrous involvement; in the six others, the pain resolved progressively. Other minor complications (one case of tendinitis, one case of internal gemellus muscle rupture, two cysts, and one case of hamstring tear) were reported. No revision surgery was necessary for wear of either of the two components.

Functional results

All of the 144 UKAs were evaluated (the six cases of conversion to TKA were considered before revision).

Overall series

The mean IKS knee score was 89.5 points (range, 42–100), with mean range of movement 132° (range, 85–150) and a mean IKS function score totaling 81.8 points (range, 44–100). The gain was 25.9 points for the IKS knee score and 18.2 points for the IKS function score (statistically significant gain; \( p < 0.05 \)). Therefore, 92.9% of the patients were very satisfied or satisfied (very satisfied 55.4%; satisfied 37.5%) and 7.1% were dissatisfied.

No pain or occasional pain was reported by 76.8% of the patients, with the walking test results unlimited or greater than 1 km in 76%. Limping was found in only 12.7% of the patients and cane use remained necessary for 19%, often related to multiple joint involvement or general health status.

Medial and lateral UKAs

No statistical difference was found for pain, IKS knee score, or IKS function score.
Medial osteoarthritis and osteonecrosis
No statistically significant difference was found for pain, IKS knee score, IKS function score, and mobility (Fig. 4). The number of patients reporting “forgotten knee” was statistically higher in cases of UKA for necrosis (80% in cases of necrosis and 55% in cases of osteoarthritis; \( p = 0.04 \)).

Radiological results

Residual deformity
For the medial UKAs, the mFTA at the last follow-up was 176.2° (175.5° before surgery) (Fig. 5).

For the lateral UKAs, it was 181.8° (185.4° before surgery).

Radiological overcorrection
For six of the cases of medial UKA, the mFTA value was greater than 180°, with a mean of 185.3° (range, 182—193°). The mean follow-up was 45.5 months (range, 27—95 months). Two cases of femorotibial compartment deterioration were reported, as asymptomatic joint space narrowing for one patient and complete joint space loss requiring a lateral UKA 61 months after the medial UKA.

For the 14 lateral UKAs, the mFTA value was less than 180°, with a mean of 177.2° (range, 174—179°). The mean follow-up was 75 months (range, 33—155 months). Four cases of femorotibial compartment deterioration were reported, as an asymptomatic joint space narrowing in two patients and two cases of complete joint space loss requiring a medial UKA 49 and 84 months after the lateral UKA (Fig. 6).

Radiolucency
A radiolucency was found in 26.5% of the cases (23.5% at the tibia and 3% at the femur). These radiolucencies were noted in the first postoperative year. They were progressive for the five cases of tibial detachment that had required revision and remained nonprogressive in the other cases. They were more frequent in the medial UKAs (25 cases out of 84; 29.8%) than in lateral UKAs (seven cases out of 60; 11.7%).

Figure 4 Unicompartmental knee arthroplasties for medial osteonecrosis. (A) Preoperative radiograph; (B) AP postoperative radiograph.

Figure 5 Pre- and postoperative HKA axis. (A) Medial unicompartmental knee arthroplasties; (B) lateral unicompartmental knee arthroplasties.
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Figure 6 Subsequent medial Uni after degenerative changes of the opposite compartment (49 months after lateral UKA).

Opposite compartment
In 87.2% of the cases studied, the opposite femorotibial compartment remained radiologically normal. In 9.2% of the cases, joint space narrowing appeared in 5% of the cases in whom total loss of joint space required revision surgery (one conversion to TKA and four UKAs of the nonimplanted femorotibial compartment).

To date, we have not observed arthritic progression of the femoropatellar joint that would warrant additional surgery in this series of 144 UKAs. Of the three patients with lateral femoropatellar osteoarthritis, only one did not have a patella lateral facetectomy and remained clinically asymptomatic with no radiological progression at 61 months of follow-up.

The patient with rheumatoid polyarthritis presented a good radiological and clinical result with a short follow-up of 35 months.

Survival curves
Implant survival was 95.6% at five years and 93.5% at 10 years, taking as the end point removal of the prosthesis (Fig. 7). Considering medial UKAs, survival was 95.3% at five years and 90.4% at 10 years. Considering lateral UKAs, survival was 98.3% at five years and at 10 years.

If failure is also defined as decompensation of the contralateral compartment (total loss of joint space), implant survival was 93.6% at five years and 89.1% at 10 years (Fig. 8). For medial UKAs, survival was 91.8% at five years and 84.5% at 10 years. For lateral UKAs, survival was 96.2% at five years and 96.2% at 10 years.

Discussion
Functional results
The recent series in the literature [13–16] show results that are favorable and generally similar to those of our series, with a survival rate between 90 and 98% at 10 years, equivalent to the survival rates observed with total replacements [17]. In a series of 62 Miller-Galante UKAs, with a mean follow-up of 12 years, Berger et al. [18] found 80% excellent results, a 120° mean flexion, no significant loosenings, and 18% contralateral compartment involvement, for a 98% survival rate at 10 years. With the same type of implant but only for lateral arthroses, Pennington et al. [19] reported 100%

Figure 7 Kaplan Meier survivorship curve (failure = unicompartmental knee arthroplasties revision). (A) All unicompartmental knee arthroplasties; (B) medial unicompartmental knee arthroplasties; (C) lateral unicompartmental knee arthroplasties.
good and excellent results in a series of 29 lateral UKAs at 12 years of follow-up. Tabor and Tabor [15] reported a 90% survival rate at 10 years for a series of 100 medial Marmor-type UKAs, with involvement of the contralateral compartment in 20% of the cases.

The mean flexion for this series was 133°, which was higher than the majority of the results from recent series (121° for Berger et al. [18], 128° for Argenson et al. [20], 125° for Naudie et al. [13]). Even though it was measured clinically, this difference can also undoubtedly be explained by our patients being precisely selected (with high preoperative flexion), the use of less invasive approaches (possible because of the progress made in ancillary instrumentation), and the design of the femoral implant with a posterior ascending cut (associated with an anatomical design favoring flexion of the posterior part of the condyle).

Dejour et al. [21] reported results from a first series of 110 HLS UKAs implanted between 1987 and 1991, with 2—9 years of follow-up. They found slightly less flexion, with a mean of 120°, but the approaches used at that time were more extensive, notably with systematic raising of the ATT for lateral UKAs. As for these lateral UKAs, the results were similar to the results of our series, with 97.5% survival at five years. However, the results of the medial UKAs were less satisfactory, with 74% survival at five years; nearly all the failures were explained by technical errors during surgery, notably a certain number related to pronounced undercorrection (postoperative varus greater than 7°).

Etiology
With 20% necrosis and 80% medial osteoarthritis, the distribution of the indications in our series is similar to the distribution of the recently published series by Berger et al. [18], who found 15% necrosis, and Argenson et al. [20], with slightly less than 10%. The results reported herein are excellent for the cases of unicompartmental osteoarthritis in both medial and lateral compartments. We did not find significant differences between the medial and lateral UKAs in terms of functional results. These excellent lateral UKA results have also been reported by Pennington et al. [19], Ashraf et al. [22], and Kobayashi and Ohdera [23]. The results also seem excellent in cases of medial UKA for osteonecrosis of the condyle, at least equivalent to the results observed in cases of medial unicompartmental osteoarthritis, particularly for flexion, which was greater than a mean 135°. This can be explained by the fact that the initial disease results in less capsule and ligament retraction than in cases of osteoarthritis (because this is more painful and operated on before the capsule retractions appear), making spontaneous osteonecrosis of the medial condyle an ideal indication for medial UKA.

Alignment of the operated limb
The pitfalls to avoid are different in medial and lateral UKAs. It should be remembered that undercorrection is often defined in relation to an axis assumed to be perfect at 180°. Actually, when assessing unicompartmental implants, it should be defined in relation to the constitutional bone deformity (before wear), with the unicompartmental prosthesis acting as a wedge aiming to compensate for joint wear but never changing the limb’s original alignment [24].

For lateral UKAs, the main risk is overcorrection, becoming more frequent as the physiological joint laxity in the lateral compartment increases. Even more than for the medial compartment, in this case a consequential (2 mm) laxity must be left in the lateral compartment at the end of surgery. In addition, any overcorrection is even less well-tolerated if the patient is overweight because the extrinsic and intrinsic varizing distances [25] combine, which is responsible for an increase in the medial stresses, with
a risk of medial compartment deterioration. On the other hand, in cases of undercorrection, the extrinsic varus axial distances is subtracted from the intrinsic varus axial distances, limiting the stresses on the lateral compartment.

For the medial UKAs, the risks are different. The dangers of excessive tibial cutting are great, because undercorrection may result in excessive residual varus, or, as in the overcorrections in lateral UKAs, the extrinsic and intrinsic varus axial distances combine to increase the stresses in the medial compartment, possibly producing failures. However, if this is compensated by a thicker tibial tray, there nevertheless remains a risk of excessive stress because the weightbearing surface and the bone quality are progressively less optimal the lower the osteotomy of the medial tibia. Therefore, an osteotomy to remove a minimal amount of bone is required, taking into account a sufficiently thick polyethylene. As for lateral UKAs, overcorrection also risks deteriorating the opposite compartment.

Complications

Excessive wear of the polyethylene is often cited as a cause of failure after UKA [26—28]. In our series, none of the UKAs was revised for wear at a mean follow-up of five years and a maximum of 13 years. Thus, contrary to metal back implants, although the use of an all-polyethylene tray precludes a simple tray change without recutting the bone, wear seems exceptional, provided that the proper indications are respected and a moderate undercorrection is taken into account. The weightbearing surface and the bone quality are progressively less optimal the lower the osteotomy of the medial tibia. Therefore, an osteotomy to remove a minimal amount of bone is required, taking into account a sufficiently thick polyethylene. As for lateral UKAs, overcorrection also risks deteriorating the opposite compartment.

Selection criteria

All the recently reported series seem to agree that patient selection greatly influences the UKA survival rate [20,18]. Limiting the degenerative involvement to a single compartment, moderate axial deviation, and joint range of movement that is not highly restricted are the classic indications. In our opinion, a moderate BMI is also an important factor, particularly on the medial side. Tolerance of the medial UKA in overweight patients is theoretically not as good because overcorrection and overweight combine to increase the stresses on the implant and the medial tibial plateau (although the present study did not analyze results in patients with a high BMI because our selection criteria limited the indications to patients weighing less than 80 kg). Some authors maintain the indication up to 125 kg [18], which we believe is excessive, even if good results in obese patients have been reported [37]. Like Świenckowski et al. [38], we believe that age should not be an absolute limiting factor, and in certain indications (posttraumatic, for example), a UKA can be proposed to patients who are less than 60 years old, particularly for lateral UKAs (given the excellent survival curve in lateral UKAs). Similarly, we feel that UKA remains an excellent option in the very aged population (85 years and over).

Conclusion

The long-term results of HLS UKA using an all-polyethylene cemented tibial tray seem to validate this surgical option.
for cases of unicompartmental osteoarthritis and necrosis, provided that strict selection criteria are respected. All positioning errors must also be prevented, notably overcorrection, which may lead to deterioration in the nonimplanted compartment at the medium term (optimal correction can be planned on the contralateral nonoperated lower limb). Nevertheless, on the medial side, undercorrection can be the source of residual pain. The small zone of tolerance in positioning the medial UKA may very well explain a slightly less satisfactory survival curve than for lateral UKAs. The reliable and sustainable results of the lateral UKA motivate us to extend our criteria for this indication (younger and slightly overweight patients).

References


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