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ORIGINAL STUDY

Does a minimally invasive approach affect positioning of components in unicompartmental knee arthroplasty ? Early results with survivorship analysis

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Fifty unicompartmental knee arthroplasties (UKAs) were performed through a minimally invasive approach and were reviewed with an average follow-up of 3.7 years. This technique leads to reduced access to surgical landmarks. The purpose of this study was to evaluate whether correct component positioning is possible through this less invasive approach. Component positioning, femorotibial alignment and early outcomes were evaluated.

We observed perfect tibial component position, but femoral component position was less consistent, especially in the sagittal plane. Femorotibial alignment in the coronal plane was within 2.5° of the desired axis for 80% of the cases. Femoral component position in the sagittal plane was within a 10° range of the ideal for 70% of the cases.

The mean IKS Knee Function Score and Knee Score were 89/100 and 91/100 respectively.

We observed two polyethylene dislocations, and one revision was performed for progressive patellofemoral arthrosis.

According to our data, minimally invasive UKA does not conflict with component positioning although a learning curve needs to be respected, with femoral component positioning as the major obstacle.

Keywords : minimally invasive ; knee arthroplasty ; unicompartmental.

INTRODUCTION

Unicompartmental knee arthroplasty (UKA) was developed in the early 1970s as an alternative treatment for unicompartmental osteoarthritis of the knee.

Multiple arguments in favour of UKA have been reported : lower postoperative morbidity (*16, 27, 30*), less blood transfusion needed (*27*), less reoperations (*27*), quicker recovery (*16*), better subjective outcome, better kinematics (*16, 18, 22*), greater range of motion (*16, 18, 22, 27*), more bone stock preserved (*18*).

The main argument against UKA is its reportedly lower survivorship compared to total knee arthroplasty (*11, 12, 17, 30*). For this reason UKA remains a controversial procedure for the treatment of unicompartmental osteoarthritis of the knee. Three major causes for early failures of UKA are prosthetic design, surgical technique and patient selection. The cause of late failure is progression of arthrosis in the patellofemoral compartment or the contralateral femorotibial compartment (*2*).

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Metal-backed porous coated unicompartmental replacement showed poor results with early designs (*4, 6*). Increasing conformity of the femorotibial articulation in fixed bearing designs and thin tibial polyethylene correlated with failure (*1, 19, 28*).

Regarding surgical technique, impingement of meniscal bearings causes polyethylene wear and osteolysis (*25*). Overcorrection into valgus of the femorotibial alignment is associated with an increased risk of degenerative changes in the lateral compartment (*14, 32*). Severe undercorrection into varus (< 170°) has an increased risk of PE wear (*9*). Too far anterior placement of the femoral component is associated with patellofemoral impingement (*10*). Component on component malalignment results in edge loading (*28*).

Recently, good long term results of UKA by standard open technique have been described (*3, 5, 21, 29*) and the interest in UKA has been fuelled by minimally invasive surgery (MIS). Romanowski and Repicci (*26*) pioneered the possibility to perform UKA through a minimally invasive approach aiming at fast and complete rehabilitation. Minimally invasive UKA avoids damage to the suprapatellar pouch and the quadriceps tendon, and patellar dislocation. Faster recovery and less impairment of proprioceptive capabilities and gait patterns were expected when compared with the standard technique for UKA (*26*). According to Price *et al* (*24*), patients with a minimally invasive approach for UKA recover twice as fast as patients with a standard open technique for UKA.

The combination of UKA and a minimally invasive approach has raised some concern about component position because of the limited exposure.

The purpose of this study was to evaluate if correct component positioning in UKA is possible through a minimally invasive approach. We also report our early clinical results with UKA through a minimally invasive approach.

MATERIAL AND METHODS

The review is based on a prospectively collected database. From January 2000 the MIS approach was used to perform UKA. As such, this series represents the learning curve of the senior author. Fifty UKA's were performed through a minimally invasive incision on 49 patients (14 male, 35 female). Indications were isolated medial compartment osteoarthritis in 46 knees, avascular necrosis in 3 and posttraumatic osteoarthritis in 1.

Surgical technique

All procedures were performed under general anaesthesia with the patient's leg secured via a moveable thighholder (Maquet®) and dropleg. The tourniquet was inflated at 350 mm Hg ; the other leg was positioned in abduction. The incision was made from the medial pole of the patella to the tibial tuberosity, 1/3 below, 2/3 above the joint line. The arthrotomy was performed following the same parapatellar incision. The Oxford unicompartmental knee (Biomet, Bridgend, UK) with the Phase 3 instruments was used. The tibial cuts were made using an extramedullary tibial guide, perpendicular to the mechanical axis in the coronal plane ; in the sagittal plane, the natural slope of the medial compartment was reproduced. The femoral cuts were referenced from the flat tibial base cut. No intramedullary femoral guides were used. The posterior cut was made in the frontal plane parallel to the tibial base cut at 90°. The distal femur was prepared with a mill until flexion and extension space were equalised. No ligaments were released. After cementing, a varus force (with a trial insert in place) was exerted for pressurisation of the cement with the knee in 45° flexion.

Patients were invited to the clinic and examined by an independent reviewer (S. C.).

The accuracy of implant positioning was determined using standard anteroposterior and lateral radiographs (fig 1). Measurements in the coronal and sagittal plane were made as shown in fig 2. The percentage of component positions out of the optimal range in the coronal and sagittal plane (determined by the manufacturer) was determined (table I).

Additionally, alignment was measured preoperatively and postoperatively as the hip-knee-ankle angle on standing full leg radiographs of the entire limb.

Patients were evaluated clinically with the IKS Knee Score, the IKS Knee Function Score and a Pain Score.

A life table was used to determine survival rate with the 95 % confidence interval (*26*).

RESULTS

All patients were contacted by phone. Forty-three of them were reviewed at the consultation,

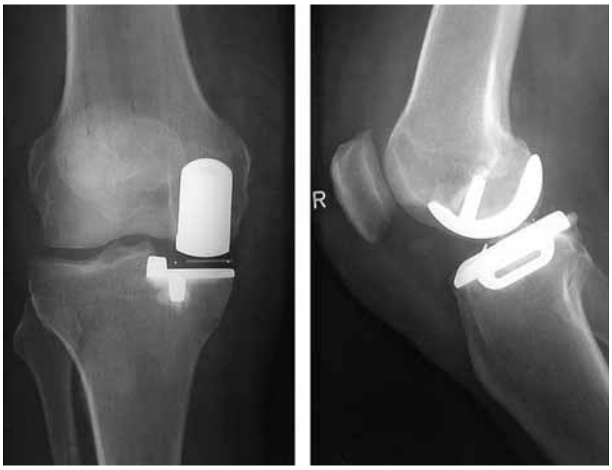

Fig. 1. — Anteroposterior and lateral postoperative radiographs.

5 were interviewed by phone (radiographs were sent by mail) and one patient died (last radiographs were reviewed).

The mean age of the patients was 66 years (range : 45 to 90). The mean weight was 84.2 kg (range : 53 to 115) with a mean BMI (kg/m^2) of 27.5. Mean follow-up was 3.7 years (range : 2.6 to 5.0). Mean preoperative femorotibial alignment was 4.5° (range : 0 to 11). Table II shows the study group demographics.

Alignment of femoral component

A. Coronal plane position : mean absolute value 4.8° (range : 12° varus to 18° valgus), 4% out of optimal range.
B. Sagittal plane position : mean absolute value 4.3° (range : 14° flexion to 9° extension), 30% out of optimal range.
C. Medial – lateral position : 100% central fit with maximal deviation of 1 mm.
D. Posterior fit : mean 1.2 mm (range : 0 to 3), 4% out of optimal range.

Table I. — Measurements of implant position

Measurement	Position	Optimal Range
Femoral Component		
A/A	Varus-valgus angle	< 10° varus-< 10° valgus
B/B	Flexion-extension angle	< 5° flexion-< 5° extension
C/C	Medial-lateral position	central
D	Posterior fit	< 2 mm
Tibial component		
E/E	Varus-valgus angle	< 10° varus-< 5° valgus
F/F	Slope	7° + or -5°
G	Medial fit	< 2 mm
H	Posterior fit	< 2 mm
J	Anterior fit	< 3 mm
K	Lateral fit	Accurate – without space
Meniscal Implant		
L	Marker central and parallel to tibial component	
Bone adjunction		
M	Posterior femoral	Parallel, cement ok
N	Tibial	Parallel, cement ok
Others		
O	Posterior osteophytes	None
P	Depth of tibial cut	Minimal mass of cement
Q	Intact posterior cortical substance of bone	Posterior, no cement
R	No anterior impingement of bone	Adequately removed bone substance

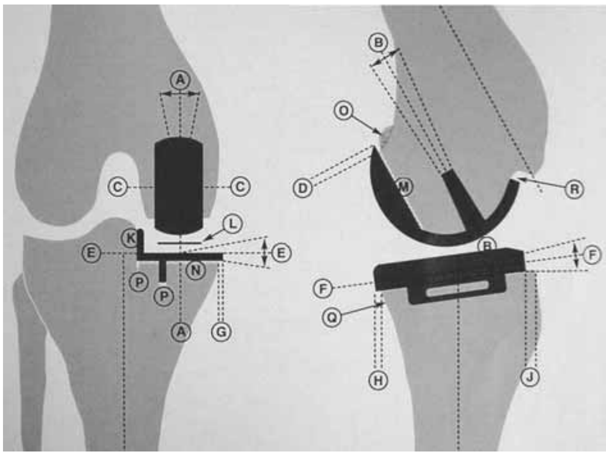

Fig. 2. — Measurements of implant position (instructions from the manufacturer).

Table II. — Study Group Demographics

No. of knees	50
No. of patients	49
Average age	66 years (range : 45 to 90)
Average weight	84.2 kg (range : 53 to 115)
Average follow-up	3.7 years (range : 2.6 to 5.0)

Alignment of tibial component

E. Coronal plane position : mean absolute value 1.5° (range : 1° varus to 5° valgus), 0% out of optimal range.
F. Slope : mean 5°, 0% out of optimal range.
G. Medial fit : mean 0.4 mm (range : 0 to 2), 0% out of optimal range.
H. Posterior fit : mean 0.8 mm (range : 0 to 3), 2% out of optimal range.
I. Anterior fit : mean 1 mm (range : 0 to 3), 0% out of optimal range.
J. Lateral fit : all accurate, 0% out of optimal range.

Others

O. Posterior osteophytes : 6% minimal dorsal osteophytes.
Q. Intact posterior cortex : 6% posterior cement on the femoral side (fig 3).
R. No anterior impingement of bone : all accurate.

Fig. 3. — Remaining cement in the posterior part of the knee joint.

The postoperative average hip-knee-ankle (HKA) angle was 177° (range : 185 to 170). Eighty percent had a HKA-angle between 175° and 180° (fig 4). Eight percent had an undercorrection between 170° and 175°. Ten percent had a valgus overcorrection between 180° and 183°. Two percent had an overcorrection of 185°.

There were no infections or wound complications.

The mean IKS knee score was 91/100 (range : 53 to 100).There were two poor results (< 70/100) with an IKS knee score of 53 and 64 respectively, one because of progressing patellofemoral osteoarthritis, the other because of anterior laxity with recurrent joint effusion. The mean IKS function score was 89/100 (range : 40 to 100). The mean pain score was 44/50 (range : 10 to 50). All patients obtained full extension and the mean flexion was 126° (range : 90 to 140).

One patient had an anterior dislocation of the meniscal bearing at one year postoperatively, which was reduced by closed manipulation under general anaesthesia. The knee functioned well afterwards. One patient needed a polyethylene exchange after a posterior dislocation. A polyethylene size 3 was replaced by a polyethylene size 5.

Fig. 4. — Adequate undercorrection of femorotibial alignment.

The knee functioned well afterwards. This is recorded as a success in the survival table (endpoint : revision). One revision was performed for patellofemoral osteoarthritis three years postoperatively.

Table III shows the number of knees at risk for each year, the number revised and the cumulative survival. In the life table with revision as the endpoint, the cumulative survival was 98%.

DISCUSSION

Concern about component position is justified because a minimally invasive approach reduces access to surgical landmarks. Pressure from the patella during operation may push instruments and components into an incorrect position. Poor positioning of the component may lead to early PE wear, poor functional results and a high revision rate (*24*).

For the femoral component, 30% of the components were out of the optimal range in the sagittal plane position. We observe hereby the same results as Muller *et al* (*20*) who used the same evaluation criteria. Muller *et al* (*20*) compared the component position in UKA performed through a standard open approach and a minimally invasive approach. In their series, they observed that both groups had a high number of femoral component positions in the sagittal plane out of the optimal range, but even then, femoral component position was superior by minimally invasive implantation.

Excellent tibial component position according to the described references was found.

There were three patients with minor posterior osteophytes. This may be related with reduced intraoperative accessibility and view, and can cause flexion deficit. In this series, posterior osteophytes are considered as pure radiological findings as all patients reached full flexion.

Incomplete cement removal can also accelerate PE wear due to impingement. In 6% of the patients, posterior cement was observed. We consider this as a direct consequence of the minimally invasive technique and see this as an important downside. Cement debris is a cause of pain over the posterior aspect of the knee and cement removal (arthroscopically) may be necessary (*15*). We advise to use the tibial plateau as a mirror to remove posterior cement with adapted instrumentation (*24*).

Similar to Price *et al* (*24*) and Muller *et al* (*20*), we obtained good radiological results after minimally invasive UKA.

We observed femorotibial alignment between 0 to 5° varus in 80%. Undercorrection of the femorotibial alignment is crucial to avoid advancing disease in the contralateral compartment. Severe

Table III. — Survival of 50 unicompartmental arthroplasties. At 5 years, the 95% CI by the method of Peto *et al* (23) is 89.2% to 100%

Year	Number	Failures	Withdrawn	Number at risk	Failure rate (%)	Cumulative Survival (%)	95% confidence interval
1	50	0	0	50	0	100	92.9-100
2	50	0	1	49.5	0	100	92.8-100
3	49	0	0	49	0	100	92.7-100
4	49	0	0	49	0	100	92.7-100
5	49	1	0	49	2	98	89.2-100

undercorrection can however be a cause of increased polyethylene wear, loosening or bony collapse. Overcorrection is a significant cause of osteoarthritis in the opposite compartment (*9*). Femorotibial alignment is dependent of the thickness of the polyethylene insert. The amount of passive correction possible at time of surgery is limited because no ligamentous releases are performed. Too thin a polyethylene insert, if used with the purpose to achieve undercorrection, is a risk for bearing dislocation.

The clinical results presented here are short term after the surgery with an average of 37 months follow-up. A 4% rate of bearing dislocation is too high. We attribute this high number to the learning curve because it concerns the sixth and seventh patient of this series. Consequences of technical errors are expected during the first two postoperative years while revisions for advancing disease occured in the series of Romanowski and Repicci (*26*) from 37 till 90 months postoperatively. Failures due to technical errors are not expected in these series any more. Comparing our survival rate with the survival rate of Murray *et al* (*21*) (using standard open technique), we obtain a similar percentage at the same period of follow-up. Similar functional scores following UKA through a minimally invasive approach are described by Gesell and Tria (*8*).

Excellent short term evaluations are described, with functional results in the range of healthy joints (*7*), especially in active patients with good general condition (*13*).

In summary, UKA through a minimally invasive technique allows perfect tibial component position. Femoral component position in the sagittal plane was suboptimal in this study. The variability in component alignment can be attributed to the learning curve. Reduced exposure of the anatomical landmarks and soft tissue tension on the instruments play a role in this process (*21, 31*). Attention should be paid to removing all posterior cement.

According to our data and to the literature, minimally invasive implantation of a unicompartmental knee prosthesis does not conflict with component positioning and allows for acceptable early clinical results.

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