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Navigated Shorter Incision or Smaller Implant in Knee Arthritis?

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Minimally invasive approaches for unicompartmental knee arthroplasty are well-accepted for treating knee arthritis because of the smaller implant size, shorter operative time, and tissue-sparing nature of the procedure. With the introduction of computer alignment systems, a well-aligned and balanced total knee arthroplasty (TKA) can be achieved even with smaller surgical exposures. We hypothesized a unicompartmental knee arthroplasty would provide better midterm outcomes than a computer-assisted minimally invasive TKA in patients with isolated medial compartment knee arthritis. We matched (preoperative arthritis severity, age, gender, and preoperative range of motion) 64 knees that had a medial unicompartmental knee arthroplasty or a mini-incision computer-assisted TKA. All patients had a varus deformity no greater than 8° and a body mass index lower than 30 kg/m^2. Patients were followed a minimum of 48 months. In the mini-incision computer-assisted TKA group, all the implants were positioned within 4° of ideal alignment. The surgical time and hospital stay were longer in the computer-assisted TKA group. A unicompartmental knee arthroplasty was estimated to cost at least 3100 euros (approximately US $4100) less. The clinical assessment showed higher functional and Italian Orthopaedic UKA Users Group scores for the unicompartmental knee arthroplasty group.

Level of Evidence: Level III, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Less invasive reconstructive surgery has generated considerable interest in recent years. In particular, minimally invasive total knee replacement is growing in popularity because the procedure ostensibly reduces blood loss, hastens recovery, and lowers costs.[8,17,23,24,42] Recently, several authors[4,6,18–20,28,30,43] have recommended caution with minimally invasive techniques in total joint arthroplasty. Dalury and Dennis[12] reported that although TKA through a small incision may provide some early advantages, these incisions can also obscure a surgeon's vision, may influence component alignment, and potentially compromise long-term outcome.

Unicompartmental knee arthroplasty (UKA) is a well recognized minimally invasive procedure for treating knee arthritis. Well-defined indications for UKA were first documented by Kozinn and Scott[22] in 1989 and continue to be refined. Several authors report high short-term success rates for the procedure with newer designs and materials.[31,41]

In comparison with TKA, UKA allows for smaller implants, shorter operative time, preservation of both cruciate ligaments, and minimal bone resection.[3,29,35] Maintenance of the anterior cruciate ligament and its mechanoreceptors may produce a better functional result in UKA.[5,15,16] After UKA, knee kinematics during flexion more closely resemble those of the intact knee.[5,16] Biomechanical studies of TKA, however, suggest persistently abnormal kinematics.[2,5,15,16,40] Weale et al[44] documented a superior functional recovery with a higher performance in descending stairs and better patient satisfaction with UKA compared with TKA. In a cadaveric study, Patil et al[33] demonstrated normal joint biomechanics after UKA implantation in a knee.

Despite the advantages of UKA, some authors[34] still believe the most reliable results in 60-year-old nonobese patients with unicompartmental knee arthritis are obtained with TKA. Furthermore, with the introduction of computer-guided joint replacement, correct implant alignment of TKA can be achieved with smaller surgical exposures.[14] Computer-assisted TKA (CA-TKA) may therefore offer a compromise with a total joint arthroplasty through a smaller surgical exposure.[38]

Few studies in the literature compare the clinical outcomes of UKA with TKA. In a prospective, randomized study comparing UKA with TKA, Newman et al[29] reported greater range of motion after UKA but no difference in the Bristol scoring system. The authors did not analyze or match for the grade of tibiofemoral or patellofemoral arthritis and they performed patella resurfacing in all patients in the TKA group. The degree of patellofemoral degeneration may have adversely affected the results in the UKA group.

We hypothesized the UKA implant would provide better clinical scores than the computer-assisted mini-incision at midterm followup. We further asked whether there were differences in alignment, hospital costs, and hospital stay.

MATERIALS AND METHODS

We retrospectively reviewed 32 patients with isolated medial compartment knee arthritis who underwent a medial UKA from February to September 2001. All patients had an asymptomatic patellofemoral joint. In all 32 knees, the arthritic change was graded according to the classification of Ahlbäck.[1] Arthritic change should not exceed Grade IV in the medial compartment and Grade II in the patellofemoral compartment. Other inclusion criteria were a varus deformity lower than 8°, a body mass index lower than 30 kg/m^2, and no clinical evidence of anterior cruciate ligament laxity or flexion deformity with a preoperative range of motion of a least 110°. Every patient in the UKA group was matched with a patient who had undergone a CA-TKA performed with a less invasive approach (shorter than 12 cm) for isolated medial compartment knee arthritis between August 1999 and September 2002 (mini-incision computer-assisted group). All patients included in the CA-TKA group had a stable knee, asymptomatic patellofemoral joint, and range of motion of at least 110°. No patient in the mini-incision computer-assisted group had a preoperative flexion deformity or varus deformity greater than 8°. Like with the UKA group, all patients had a body mass index less than 30 kg/m^2. In the mini-incision computer-assisted group, we excluded the first 15 cases to avoid bias associated with the learning curve and patients with an incision longer than 12 cm. Patients were matched in terms of preoperative arthritis severity, age, gender, and preoperative range of motion. Patients were matched with a maximum age difference of 3 years and maximum range of motion difference of 10°. The minimum followup was 48 months (mean, 54.7 months; range, 48–67 months) and 49 months (mean, 57.3 months; range, 49–73 months) for the UKA group and mini-incision computer-assisted group, respectively.

The mean preoperative age was 69.1 years (range, 60–82 years) for the UKA group and 70.7 years (range, 60–83 years) for the mini-incision computer-assisted group. There were 18 women and 14 men in each group. The mean preoperative flexion was 120° (range, 110°–130°) and 117.8° (range, 110°–127°) for the UKA group and the mini-incision computer-assisted group, respectively. The mean preoperative hip-knee-ankle angle was 174.5° (range, 171°–178°) and 173.9° (range, 170°–176°) for the UKA group and the mini-incision computer-assisted group, respectively. Preoperatively, the mean Knee Society score[20] was 45.1 (range, 39–50) in the UKA group and 43.9 (range, 40–49) in the mini-incision computer-assisted group. The preoperative functional score was 49.7 (range, 44–56) for the UKA group and 48.5 (range, 44–55) for the mini-incision computer-assisted group. There were no differences in the preoperative factors for the two groups (Table 1).

The unicompartmental implant used in the UKA group was the UC-Plus Solution (Plus Orthopedics, Rotkreuz, Switzerland), and in the mini-incision computer-assisted group, a posterior cruciate-retaining TKA (Search; Aesculap, Tuttlingen, Germany) was used. A total computer-assisted computed tomography-free alignment system (Orthopilot 3.0; Aesculap) was used for all TKA procedures. All the implants had a fixed tibial bearing. In the UKA patients, an approximate 9-cm incision and anteromedial approach with arthrotomy was used. In the mini-incision computer-assisted group, we adopted a short approach predrawn on the skin midpatellar ranging between 10 cm and 12 cm with an anteromedial mini parapatellar arthrotomy and lateral patellar retraction. The average incision length was 9.3 cm (range, 7.9–9.8 cm) in the UKA group and 11.2 cm (range, 10–12 cm) in the mini-incision computer-assisted group. All the components in both groups were cemented. In the UKA group, an all-polyethylene tibial component was used in all cases. The patella was not resurfaced in any patient from the mini-incision computer-assisted group. Full weightbearing was allowed as soon as tolerated in all patients.

TABLE 1. Demographic and Preoperative Patient Data

Variable	UKA Group (32 knees)	MICA Group (32 knees)	p Value
Age (years)	69.1 (range, 60–82) SD, 5.9	70.7 (range, 60–83) SD, 6.2	0.3
Followup (months)	54.7 mo (range, 48–67) SD, 6.5	57.3 mo (range, 49–73) SD, 7.6	0.07
Flexion	120° (range, 110°–130°) SD, 4.9	117.8° (range, 110°–127°) SD, 4.8	0.08
Deformity—HKA	174.5° (range, 171°–178°) SD, 1.7	173.9° (range, 170°–176°) SD, 1.2	0.1
Knee Society score	45.1 (range, 39–50) SD, 3.1	43.9 (range, 40–49) SD, 3.1	0.08
Functional score	49.7 (range, 44–56) SD, 3.59	48.5 (range, 44–55) SD, 3.2	0.17

UKA = unicompartmental knee arthroplasty; MICA = computer-assisted minimally invasive total knee arthroplasty; HKA angle = hip-knee-ankle angle; SD = standard deviation

Two authors (AM, CP) who were not involved in the original surgery evaluated all patients at latest followup. We used the Knee Society score[20] and a dedicated UKA score developed by the Italian Orthopaedic UKA Users Group (GIUM).[11,25] The GIUM score is based on a sum of positive and negative values.[11]

We (AM, CP) determined the hip-knee-ankle (HKA) angle and the frontal tibial component (FTA) angle at latest followup on long-leg standing anterior-posterior radiographs and the mean values between the two surgeons assessments were used as final values. The frontal tibial component angle is the angle between the mechanical axis of the tibia and the medial transverse axis of the tibial component. We considered as ideal HKA angle and FTA angle of 180° and 90°, respectively.

We recorded the surgical time and hospital stay. During the hospital stay, we recorded when each patient was standing and comfortably bearing full weight according to a self-answered questionnaire. We estimated costs by implant and hospital charges; we did not consider other costs such as longer surgical time or extra costs typical of innovative surgical procedures like computer-assisted surgery.

Statistical analysis of the results (Knee Society, functional and GIUM score, HKA and FTA angles) was performed using the parametric Student's t-test. A comparison of the percentage of results for the GIUM score was performed using the chi square test. A significant result was assumed at $p \leq 0.05$.

RESULTS

No implant was revised and there were no intra- or postoperative complications related to implant selection. No major signs of radiographic loosening were seen in either group.

We observed no difference in the Knee Society score of the two groups (Table 2). However, the UKA group had a higher ($p = 0.02$) functional score. Furthermore, the UKA group had a higher ($p = 0.02$) GIUM score (Table 2). All the knees in the UKA group had a range of motion greater than 120° compared with only 25 knees (78.1%) in the mini-incision computer-assisted group. Twenty-six patients (81.2%) in the UKA group could walk for more than 1 km without any problem compared with 24 patients (75%) in the mini-incision computer-assisted group. No low scores were seen in either group. The two groups had similar percentages of knees with high scores (Table 2).

At latest followup, the mean hip-knee-ankle angle was lower ($p < 0.001$) for the UKA group (mean, 176.8°) than for the mini-incision computer-assisted group (mean, 179.3°). The mean frontal tibial component angle was also lower ($p < 0.001$) for the UKA group (mean, 86.9°) compared with the mini-incision computer-assisted group (mean, 89.4°). All TKA implants were positioned within 4° of a hip-knee-ankle angle of 180° and frontal tibial component angle of 90°.

Costs were approximately 3100 euros (approximately US $4100) greater in the mini-incision computer-assisted group. This consisted of an increased TKA implant cost of 1600 euros (approximately US $2100), and the costs of an increased mean hospital stay of 1500 euros (approximately US $2000) (500 euros each day). Furthermore, 11 patients in the mini-incision computer-assisted group required postoperative blood transfusions. Hospital stay and operative time were longer (both $p < 0.001$) in the mini-incision computer-assisted group (Table 2).

DISCUSSION

A number of surgical options are available to the orthopaedic surgeon for patients with isolated medial compartment knee arthritis. In patients older than 60 years, the operative treatment of choice in most cases is arthroplasty using either a unicompartmental or total joint replacement.[32] Excellent results have been reported for both implant types with followups longer than 10 years.[27,31,34,41] Unicompartmental knee arthroplasty has the added benefit of being less invasive, allowing for preservation of bone stock and soft tissues.[5,35] Likewise, many approaches have been proposed for new, more conservative surgical approaches in TKA to soft tissues such as the midvastus or

TABLE 2. Postoperative Patient Data

Variable	UKA Group (32 knees)	MICA Group (32 knees)	p Value
Surgical time	51.5 minutes (range, 36–75) SD, 9.5	108.8 minutes (range, 80–132) SD, 13.5	< 0.001
Hospital stay	5.1 days (range, 3–7) SD, 1.08	8.2 days (range, 4–16) SD, 2.85	< 0.001
Full weightbearing	3.1 days (range, 2–5) SD, 0.9	4.6 days (range, 2–7) SD, 1.1	< 0.001
Deformity—HKA	176.8° varus (range, 174°–182°) SD, 2.1	179.3° varus (range, 177°–182°) SD, 1.2	< 0.001
Deformity—FTC	86.9° (range, 84°–90°) SD, 2.1	89.4° (range, 87°–92°) SD, 1.2	< 0.001
Knee Society score	80.5 (range, 70–100) SD, 5.1	78.4 (range, 70–87) SD, 4.7	0.08
Functional score	83.5 (range, 73–100) SD, 9.3	78.8 (range, 59–90) SD, 7.8	0.02
GIUM score	76 (range, 67–89) SD, 4.9	73.03 (range, 66–85) SD, 4.8	0.01
GIUM results distribution	25 normal (78.1%) 7 almost normal (21.9%)	23 normal (71.8%) 9 almost normal (28.2%)	

UKA = unicompartmental knee arthroplasty; MICA = computer-assisted minimally invasive total knee arthroplasty; HKA = hip-knee-ankle angle; FTC = frontal tibial component angle; GIUM = Italian Orthopaedic UKA Users Group; SD = standard deviation subvastus.[24] At the beginning of the last century, Bizozzero[26] discouraged aggressive surgery that damaged muscles owing to its highly differentiated nature that could heal only with scarring. More recently in 2006, Chen et al[10] demonstrated only perioperative advantages with a quadriceps-sparing approach over a standard parapatellar approach but with a lower accuracy in radiographic outcomes.

Although this was a retrospective matched paired study, we used strict criteria for patient selection and matching. These criteria included body mass index, limb deformity, an efficient anterior cruciate ligament, preoperative range of motion, and grade of patellofemoral arthritis, none of which have been documented in previous studies. Other study limitations were observers who assessed the results were not blind to the groups and we did not consider the intraobserver or interobserver error in the radiographic assessment.

In TKA, proper axial alignment has a major impact on the longevity of the implant.[36,37] Berend et al[7] showed alignment with a relative hazard of failure after 2 years minimum followup was 17.2 times greater in a tibial component with greater than 3° varus alignment. Computer-assisted systems have been recently developed to improve the alignment of components and soft tissue balancing. Despite the initial skepticism, recent trials have demonstrated computer-guided TKA allows greater implantation accuracy and better soft tissue balancing.[9,13,39] No study has considered the critical importance to knee performance of correct alignment of the implant in TKA compared with a relatively more forgiving UKA implant.

We compared UKA with computer-assisted minimally invasive TKA. Differences between the two procedures should therefore be lessened because computer guidance allows for smaller exposures and more accurate alignment. Alignment of all the TKA prostheses in this study in the frontal plane was within 4° of ideal for the HKA angle, reducing any influences of malalignment on the final outcome. This meant the influences of malalignment were minimized in comparisons of the matched UKA and TKA groups.

At the latest followup, we observed no difference in the postoperative Knee Society scores for the two groups. However, differences were seen between the two groups in the functional results and in the GIUM score. The UKA group had better results because all UKA patients achieved a range of motion greater than 120° and could walk for longer distances. The UKA patients also reported earlier full weightbearing during their hospital stay. This was despite less accurate limb alignment. In addition to inferior results for the computer-assisted minimally invasive TKA group, the costs of that procedure were greater because of the expensive implants and technology along with longer surgical times and hospital stays.

Although longer followup is required, we believe joint arthroplasty for isolated primary medial compartment knee arthritis in patients older than 60 years is best achieved by UKA rather than computer-assisted minimally invasive TKA. Despite using a computer-assisted alignment system for TKA to achieve more accurate implant positioning and smaller exposures, the functional and GIUM scores were still inferior to those of UKA. Use of a UKA also had financial benefits. Perhaps in the future, a place for computer navigation may be as an attractive adjunct in UKA in this patient population.[21]

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