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ORIGINAL PAPER

Unicompartmental versus computer-assisted total knee replacement for medial compartment knee arthritis: a matched paired study

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Abstract Patients older than 60 with unicompartmental knee arthritis can be treated with total or unicompartmental knee replacement. The aim of this study was to compare the results of matched paired groups of patients with isolated medial compartment knee arthritis replaced with either UKR (group A) or computer-assisted TKR (group B). The results included 68 knees at a minimum follow-up of 3 years. All patients had a varus deformity no greater than 8º and a BMI lower than 30. Patients were matched in terms of preoperative arthritis severity, age, gender and preoperative range of motion. In the computer-assisted TKR group, all the implants were positioned within 4º of the correct hip-knee-ankle angle and frontal tibial component angle. The surgical time and hospital stay were statistically longer in the CA TKR group. During the study no implant required revision. The results showed higher scores for a UKR in the treatment of isolated primary unicompartmental knee arthritis in patients older than 60 compared to a computer-assisted TKR. In this study a computer-assisted alignment system for TKR with optimal implant positioning did not produce equivalent clinical results compared to a UKR, but did increase the financial costs.

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Résumé Les patients âgés de plus de 60 ans, présentant une arthrose unicompartimentale du genou ont été traités soit par une prothèse totale, soit par une prothèse unicompartimentale. Le but de cette étude est de comparer les résultats de patients présentant une arthrose fémoro tibiale interne traités par une prothèse unicompartimentale (groupe A), ou par prothèse totale du genou mise en place par chirurgie assistée par ordinateur (groupe B). Les résultats incluent 68 genoux avec un suivi minimum de 3 ans. Tous les patients avaient une déformation en varus inferiure à 8 degrés et un BMI inférieur à 30. Les patients ont été comparés en fonction du degré d'arthrose, de l'âge, du sexe et de la mobilité pré opératoire. Dans la série prothèse totale, tous les implants ont été positionnés avec une marge de 4° par rapport à l'angle hanche cheville. Le temps opératoire et la durée d'hospitalisation ont été statistiquement plus importants dans le groupe prothèse totale. Aucun implant n'a nécessité de révision. Les résultats montrent que le score est bien meilleur dans les prothèses unicompartimentales pour le traitement des arthroses unicompartimentales, chez ces patients âgés de plus de 60 ans, comparé au traitement par prothèse totale avec chirurgie assistée par ordinateur. Cette étude montre que la mise en place par chirurgie assistée par ordinateur d'une prothèse totale du genou avec un positionnement optimal des implants peut donner un résultat équivalent à celui des prothèses unicompartimentales mais augmente le coût financier du traitement.

Introduction

Recent trends in knee reconstructive surgery have included less invasive surgical approaches along with preserving bone stock and soft tissues [12]. Unicompartmental knee replacement (UKR) is a well-accepted minimally invasive surgical procedure for the treatment of knee arthritis. New designs and materials have resulted in improved implants with high reliability [17, 19]. Well-defined indications for the use of a UKR first documented by Kozinn and Scott have been refined by several authors, resulting in a high success rate for this procedure [11, 24]. Recently, a high survivorship, greater than 90% at the 10-year follow-up, has been shown even in patients less than 60 years old [24]. Weale et al. (2001) documented a superior functional recovery with a higher performance and better patient satisfaction with UKR compared with TKR [25]. In a cadaveric study, Patil et al. demonstrated normal joint biomechanics after a UKR implantation in a knee [15].

Despite the advantages of UKR, some authors still feel the most reliable results in 60-year-old non-obese patients with unicompartmental knee arthritis are obtained with TKR [6]. With the introduction of computer-guided TKR, correct implant alignment can be achieved with smaller surgical exposures [22]. Computer-assisted TKR may therefore offer a compromise with a total joint arthroplasty through a smaller surgical exposure.

The aim of this study is to compare the results of UKR and TKR for medial compartment knee arthritis in matched paired groups at a minimum 3 years of follow-up. A UKR was used in group A and a TKR was used in group B using a computer-assisted alignment system (Ct-less).

Materials and methods

From January 2001 to October 2002, 34 patients with isolated medial compartment knee arthritis who underwent a UKR were included in the study (group A). In all 34 knees the arthritic change was graded according to the classification of Älback [1]. Arthritic change did not exceed grade IV in the medial compartment and grade III in the patello-femoral compartment. All patients had an asymptomatic patello-femoral joint. All patients had a varus deformity lower than 8° and a body mass index lower than 30. No patient had any clinical evidence of ACL laxity or flexion deformity, and all had a preoperative range of motion of a least 110°.

At a minimum follow-up of 3 years, all patients in group A were matched with a patient who had undergone a computer-assisted TKR for medial compartment knee arthritis between July 1999 and November 2002 (group B). All patients included in the computer-assisted TKR group had a stable knee, asymptomatic patello-femoral joint and range of motion of at least 110°. No patient in group B had a preoperative flexion deformity or varus deformity greater than 8º. As with group A, all patients had a body mass index less than 30. In group B the first 15 cases were excluded to avoid the bias associated with the learning curve. Patients were matched in terms of preoperative arthritis severity, age, gender and preoperative range of motion. Patients were matched with a maximum difference with respect to age of 3 years and motion of 10º. Preoperatively, all the knees were evaluated according to the Knee Society Score [9].

The unicompartmental implant used in group A was the UC-Plus Solution (Endoprothetik, Rotkreuz, Switzerland), and in group B a posterior cruciate retaining TKR (Search, Aesculap, Tuttelingen, Germany) was used. A total computer-assisted CT-free alignment system (Orthopilot 3.0, Aesculap, Tuttelingen, Germany) was used for all TKRs. All the implants had a fixed tibial bearing. In group A an approximately 9-cm incision and anteromedial approach with arthrotomy were used. In group B an approximately 12-cm parapatellar approach with an anteromedial arthrotomy and lateral patellar retraction was used. All the components in both the groups were cemented. In group A an all poly tibial component was used in all the cases. The patella was not resurfaced in any patient from group B. Full weight bearing was allowed as soon as tolerated in all patients.

At the latest follow-up, the clinical outcome was evaluated using both the Knee Society Score and a dedicated UKR score developed by the Italian Orthopaedic UKR Users Group (GIUM) [5]. The GIUM score is based on a sum of positive and negative values and indicates normal, almost normal, abnormal and poor results. Two independent orthopaedic surgeons not involved in the original surgery evaluated all patients. The hip-knee-ankle angle (HKA) and the frontal tibial component angle (FTC) were measured at the latest follow-up on long leg standing anterior-posterior radiographs. The FTC angle is the angle between the mechanical axis of the tibia and the medial transverse axis of the tibial component. The surgical time and hospital stay were recorded and compared.

Statistical analysis of the results was performed using the parametric test (Student's t-test). A statistical comparison of the percentage of results for the GIUM score was performed using the chi-square test. A statistically significant result was given at $P \leq 0.05$.

Results

The demographic and preoperative data are shown in Table 1. The mean preoperative age was 69.08 years (range: 60–82) for group A and 70.7 (range: 60–83) for group B. There were 20 females and 14 males for each group. The mean preoperative flexion was 120º (range: 110–130) and 117.8º (range: 110–127) for group A and group B, respectively. The mean preoperative HKA angle

Table 1 Demographic and preoperative data

	Group A (34 knees) (UKR)	Group B (34 knees) (CA-TKR)
Age (years)	69.08 (range: 60–82) SD 5.7	70.7 (range: 60–83) SD 6.06 *P=0.2*
Follow-up	45.2 months (range: 37–58) SD 6.3	49 months (range: 36–62) SD 7.3 *P=0.061*
Preoperative flexion	120° (range: 110–130) SD 4.8	117.8° (range: 110–127) SD 4.6 *P=0.063*
Preoperative deformity (HKA angle)	174.5° (range: 171–178) SD 1.6	173.8° (range: 170–176) SD 1.2 *P=0.061*
Preoperative KS score	45.1 (range: 39–50) SD 3.01	43.9 (range: 40–49) SD 3.01 *P=0.067*
Preoperative functional score	49.7 (range: 44–56) SD 3.59	48.2 (range: 44–55) SD 5.6 *P=0.063*

UKR: unicompartmental knee replacement; CA-TKR: computer assisted total knee replacement; HKA angle: hip-knee-ankle angle; SD: standard deviation; KS score: Knee Society score

was 174.5º (range: 171–178) and 173.8º (range: 170–176) for group A and group B, respectively. Preoperatively, the mean Knee Society score was 45.1 (range: 39–50) in group A and 43.9 (range: 40–49) in group B. The preoperative functional score was 49.7 (range: 44–56) for group A and 48.2 (range: 44–55) for group B. There were no statistically significant differences in the preoperative data for the two groups. The mean follow-up was 45.2 months (range: 37–58) and 49 months (range: 36–62) for groups A and B, respectively. No implant was revised, and there were no intra- or postoperative complications related to implant selection.

Both the hospital stay and operative time were obviously longer in the TKR group. In the UKR group the mean surgical time was 51.5 min (range: 36–75), while in the computer-assisted TKR group, it was 108.8 min (range: 80–132). In the UKR group the patients remained in the hospital for a mean of 5.1 days (range: 3–7) and in the computer-assisted TKR group 8.2 days (range: 4–16). The mean increased financial costs for each patient in group B were approximately 3,100 Euros. This consisted of an increased TKR implant cost of 1,600 Euros and the cost of an increased mean hospital stay of 1,500 Euros (500 Euros each day). In addition, 12 patients in group B required postoperative blood transfusions.

The postoperative Knee Society, functional and GUIM scores are shown in Table 2. At the latest follow-up the mean Knee Society score was 80.58 (range: 70–100) and 78.9 (range: 70–87) for group A and B, respectively. No statistically significant difference was seen for the Knee Society score between the two groups. The mean functional score was 83.5 (range: 73–100) for group A and 78.79 (range: 59–90) for group B. A statistically significant difference was seen for the functional score with superior results for group A (P=0.01).

A statistically significant difference was seen for the GIUM score with better results for group A (P=0.02). The mean GIUM score was 78 (range: 67–90) and 73.02 (mean: 65–85) for group A and B, respectively. All the knees in the UKR group had a range of motion greater than 120° compared to 27 knees (79.5%) in the computer-assisted TKR group. Twenty-eight patients (82%) in group A could walk for more than 1 km without any problem compared with 25 patients (73%) in group B. No poor or abnormal results were seen in either group. However, in group A 26 knees (76.4%) were normal, while in group B there were 24 normal knees (70.5%) with no statistically significant difference in terms of percentage of results (P=0.38).

At the latest follow-up the mean HKA angle was 177.4° for group A (range: 175–182°) and 179.3° for group B (range 177–182°). The mean FTC angle was 87.4° (range: 84–91°) and 89.4° (range: 87–92°) for group A and B, respectively. All TKR implants were positioned within 4º of a HKA angle of 180° and FTC angle of 90°. No major signs of radiological loosening were seen in either group.

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 [11]. Excellent results have been described for both these implant types [11]. A higher survivorship rate of the current generation of TKR has been an often quoted advantage of these implants compared with UKR [16]. However, recently several authors have documented similar results for survivorship of UKR with follow-up longer than 10 years [3, 18]. Unicompartmental knee replacement has the added benefits of being less invasive, allowing the preservation of bone stock and soft tissues.

In comparison with a TKR, UKR allows the use of smaller implants, shorter operative time, preservation of both the cruciate ligaments and minimal bone resection [7, 14]. Maintenance of the anterior cruciate ligament and its mechanoreceptors may produce a better functional result in UKR [2, 7, 24]. Knee kinematics during flexion following UKR has been shown to more closely resemble the intact knee [2, 7, 24]. On the other hand, biomechanical studies of TKR have yielded results far from that of a normal knee [2].

Table 2 Postoperative data

	Group A (34 knees) (UKR)	Group B (34 knees) (CA-TKR)	T-test P value
Surgical time	51.5 min (range: 36–75) SD 9.5	108.8 min (range: 80–132) SD 13.5	
Hospital stay	5.1 days (range: 3–7) SD 1.08	8.2 days (range: 4–16) SD 2.85	
Postoperative deformity (HKA angle)	177.4° varus (range: 175–182) SD 2.0	179.3° varus (range: 177–182) SD 1.2	
Postoperative KS score	80.58 (range: 70–100) SD 4.9	78.9 (range: 70–87) SD 4.59	*0.06*
Postoperative functional score	83.5 (range: 73–100) SD 9.0	78.79 (range: 59–90) SD 7.6	*0.01*
Postoperative GIUM score	78 (range: 67–89) SD 4.77	73.02 mo (range: 65–85) SD 4.74	*0.02*
GIUM results distribution	26 normal (76.4%) 8 almost normal (23.6%)	24 normal (70.5%) 10 almost normal (19.5%)	

UKR: unicompartmental knee replacement; CA-TKR: computer-assisted total knee replacement; HKA angle: hip-knee-ankle angle; SD: standard deviation; KS score: Knee Society score; GIUM score: Italian UKR Users Group

Few studies in the literature have compared the clinical outcomes of UKR with TKR. Newman et al. (2001) presented a randomised study comparing UKR to TKR, showing a greater range of motion following UKR. This difference was not shown to be statistically significant using the Bristol scoring system [14]. The authors did not, however, analyse the grade of patello-femoral arthritis in each group and performed a patella resurfacing in all patients in the TKR group. The degree of patello-femoral degeneration may have adversely affected the results in the UKR group. Weale et al. in another comparative study showed only better capacity in descending stairs in the UKR group [24]. However, this retrospective study was not based on patients with matched grades of arthritic change.

No study has considered the critical importance to knee performance of correct alignment of the implant in TKR compared to a relatively more forgiving UKR implants. In TKR proper axial alignment has a major impact on the longevity of the implant [20, 21]. Malpositioning in any anatomical plane can cause significant complications with varus or valgus malalignment being the most common cause of early loosening, and this may lead to limited movement [8, 13]. Computer-assisted systems have been recently developed in order to improve the alignment of components and soft tissue balancing. Despite the initial scepticism, recent trials have demonstrated that computer guidance of TKR allows component implantation with greater accuracy and better soft tissue balancing [4, 6, 23].

In this study, UKR was compared with computer-assisted TKR. Differences between the two procedures should therefore be lessened because computer guidance allows for smaller exposures and more accurate alignment. Alignment of all the TKR prostheses in this study in the frontal plane was within 4° of ideal for the hip-knee-ankle angle, reducing any influences of malalignment upon the final outcome. This meant that the influences of malalignment were minimised in comparisons of the matched UKR and TKR groups. In the study strict criteria were used for patient selection and matching. These criteria included bone mass index, preoperative range of motion and grade of arthritis, which have not been documented in previous studies. In addition, both the Knee Society score and a dedicated UKR outcome score (GIUM) were used to evaluate the results.

No statistically significant difference was seen in the post-operative Knee Society score for either group. However, significant differences were seen between the two groups in the functional results and in the GIUM score. In the UKR group all patients achieved a range of motion greater than 120° and could walk for longer distances. This was despite less accurate limb alignment in the UKR group. In addition to inferior results for the computer-assisted TKR group, the costs of the procedure were obviously greater because of the expensive implants and technology along with longer surgical times and hospital stay. A UKR in our study was estimated to be approximately at least 3,100 Euros cheaper with no need of blood transfusions.

In conclusion, our study showed superior results using a UKR in the treatment of isolated primary medial compartment knee arthritis in our patients older than 60 compared to a computer-assisted TKR. Despite using a computer-assisted alignment system for TKR to achieve more accurate implant positioning and smaller exposures, the functional and GIUM scores were still inferior to those for UKR. Use of a UKR also had significant financial benefits. Whilst longer follow-up is required, we believe based on this study, that joint arthroplasty for isolated primary medial compartment knee arthritis in patients older than 60 is best achieved by UKR rather than computer-assisted TKR. Perhaps in the future a place for computer navigation may be found as an attractive adjunct in UKR in these patients [10].

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