Functional and radiological outcome after total knee replacement performed with mini-midvastus or conventional arthrotomy: controlled randomised trial

Robertinas Juosponis · Sarunas Tarasevicius ·
Alfredas Smailys · Romas Jonas Kalesinskas

Received: 16 May 2008 / Revised: 28 May 2008 / Accepted: 29 May 2008 / Published online: 25 July 2008
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Abstract The results of minimally invasive techniques used for total knee replacement are controversial. Despite reported advantages such as faster recovery, there are some concerns regarding component positioning. We compared mini-midvastus versus medial parapatellar arthrotomy with respect to component position and functional results. We included 70 osteoarthritis total knee replacement patients in our study. Patients were randomised for the approach. We recorded Knee Society scores before and after the surgery and radiological component position. Patients were followed up to 12 weeks after the surgery. We found that the mini-midvastus approach was associated with better Knee Society scores six weeks after surgery; after 12 weeks the difference was not statistically significant. We found no difference related to the approach in radiological component position. The mini-midvastus approach is associated with faster recovery and reproduces the same accuracy in component positioning as the medial parapatellar approach.

Résumé Les techniques de chirurgie mini-invasives sont controversées dans les prothèses totales du genou. En dépit d'une récupération plus rapide, il est nécessaire de bien observer la position des implants. Nous avons comparé un abord mini-midvastus versus à un abord parapatellaire médian sur les critères position des implants et sur les résultats fonctionnels. Matériel et méthode: 70 approches du genou avec remplacement total ont été étudiés. Les

patients ont été randomisés selon la voie d'abord. Le score de la Knee Society et l'étude radiologique ont permis l'évaluation de ces prothèses. Les patients ont été suivis 12 semaines après l'intervention chirurgicale. Résultats: nous avons trouvé que l'abord mini-midvastus était associé à un meilleur score fonctionnel 6 semaines après l'intervention. Après 12 semaines, la différence n'est pas statistiquement significative. Nous n'avons pas trouvé de différence en ce qui concerne la position des implants. En conclusion: l'abord mini-midvastus est associé à une récupération plus rapide et, permet de positionner les implants de façon aussi efficace que lors d'un abord parapatellaire médian.

Introduction

Total knee replacement (TKR) has been under development since its introduction in 2003 [13]. Several minimally invasive (MIS) TKR techniques have been described in the literature: mini-midvastus, medial quad-sparing and mini-subvastus [1, 4, 10, 12, 13]. Many advantages such as faster functional recovery, shorter hospital stay and better early knee range of motion have been reported with different MIS techniques. However, several problems associated with MIS have been described. Kim et al. [8] analysed 120 bilateral knee replacements using standard and quadriceps-sparing techniques and reported an increased rate of complications such as notching of the anterior femoral condyle and a supracondylar fracture in the MIS group and stated that these complications were related to limited visualisation. Kolisek et al. [9] investigated 80 TKR knees and compared MIS with the standard approach with respect to surgery time, early functional results and complication rates. They found that the MIS approach was associated with wound healing problems and longer operation time.

R. Juosponis (✉) · S. Tarasevicius · A. Smailys ·
R. J. Kalesinskas
Department of Orthopaedics, Orthopaedic and Trauma Clinic,
Kaunas Medical University,
Eiveniu 2,
50009 Kaunas, Lithuania
e-mail: rjuosponis@gmail.com

Table 1 Patient-related data, means and standard deviations (SD)

	MMV (SD)	MPP (SD)	<i>p</i>
Female/male	30/5	30/5	0.9
Age	72 (5.5)	71.4 (5.04)	0.54
BMI	27.95 (3.2)	29.08 (2.7)	0.15

The MIS technique has become a selling point for the patients recently. However, only a few surgeons offering MIS to patients are presenting information describing failures associated with the technique [14, 15].

It is known that the long-term outcome after TKR is related to component position and ligament balance [6, 10, 11]. There is a lack of evidence in the literature that MIS can achieve the same results as the standard TKR approach in terms of component alignment precision [3, 7, 8, 10]. The smaller incision in MIS might be associated with increased risk of malalignment of components due to limited visualisation.

This encouraged us to perform a randomised controlled trial to compare the mini-midvastus (MMV) with the conventional medial parapatellar approach (MPP) in terms of component alignment and knee function up to three months after the surgery.

Material and methods

We included in our study 70 osteoarthritis (OA) patients older than 65, admitted for primary total knee replacement. The inclusion period was from October 2005 to March 2007; 425 OA patients were admitted for TKR in our institution during this period. Only patients who signed an

informed consent and met inclusion criteria were included in the analysis.

Patients with a body mass index (BMI) more than 35, valgus deformation more than 10°, varus deformation more than 20°, flexion contracture more than 15°, active flexion less than 70° or previous history of major knee surgery were not included in the analysis. We excluded obese and extremely deformed patients due to limitations of visualisation in the MIS technique. Excluded patients were operated upon using the conventional or MMV approach but they received different implants. We recorded knee function according to the Knee Society score (KSS) [5] before surgery. Anterior, lateral and axial X-rays were performed before surgery for all included patients. We measured varus, valgus deformation and radiographic grade of severity of OA according to Burnett et al. [2].

Patients were randomised for the choice of approach (envelope was extracted). The randomisation process was performed one hour before the surgery by the person not directly related to the procedure.

All patients were operated on without tourniquet with the cemented DePuy PFC Sigma PS prosthesis without

Fig. 1 Axial X-ray view (*ct* centre of the trochlea, *cp* centre of the patella). **a** Normal patella position. **b** Lateralised patella

Fig. 2 Lateral X-ray view (γ femoral component angle, δ tibial component angle)

patellar component, using a different instrumentation set for MIS. Thus, 35 patients were operated on using the standard approach (MPP) with conventional instruments for implantation and 35 patients were operated on with the MMV approach [4, 10] using special MIS instrumentation (Table 1).

Fig. 3 Long standing X-rays and component position measurements (*FH* centre of the femoral head, *CA* centre of the ankle, α femoral component angle, β tibial component angle)

All TKR replacements were performed by two experienced orthopaedic surgeons with the same type of spinal-epidural anaesthesia. The epidural catheter was used for a period of 72 hours; the patients were drained for a period of 24 hours after the TKR. All included patients received three weeks in-hospital rehabilitation. The length of incision and operating time were recorded. All included patients were followed up to three months postoperatively. After the operation conventional anterior, lateral and axial as well as anterior long standing X-rays were performed. For conventional axial X-rays we investigated the position of the patella (Fig. 1), and for lateral X-rays we measured the tibial slope and femoral component position (Fig. 2). For long standing X-rays we analysed the accuracy of component position with respect to the anatomical references. We recorded the alignment of the tibial component with respect to the centre of the ankle and femoral component alignment where a mid part of the femoral head was used as a reference point (Fig. 3). A radiologist, blinded to randomisation results, performed all measurements. We recorded postoperative range of motion two to six days and also six and 12 weeks after the TKR.

KSS (Knee Society objective and functional scores) were recorded six and 12 weeks after TKR. Range of motion measurements and KSS scores were done by one of the authors (RJ), who was not blinded to the randomisation process. Range of motion measurements we made using a goniometer.

The study was approved by the Institutional Ethics Committee.

Statistics

The primary effect variable, used for power calculation analysis, was active flexion after the TKR. With an assumption of a difference in means of 10° , and an SD of 10° for both groups, and aiming at a power of 0.95 and a risk of 0.05 for type 1 error, 27 patients were required in each group.

The *t*-test was used to calculate the differences between the numerical variables in the groups. SPSS software was used for calculation and $p < 0.05$ was considered statistically significant.

Table 2 Postoperative radiological axis data measured on X-rays, means and standard deviations (SD)

	MMV (SD)	MPP (SD)	<i>p</i>
Femoral anterior	89.1° (1.2)	89.4° (0.9)	0.2
Tibial anterior	89.2° (1.1)	89° (1.1)	0.5
Femoral lateral	90.5° (1.1)	90.1° (1.2)	0.15
Tibial lateral	85.7° (1.2)	85.4° (0.9)	0.38

Table 3 Postoperative range of motion, means 2–6 days and standard deviations (SD)

	2-day mean (SD)	3-day mean (SD)	4-day mean (SD)	5-day mean (SD)	6-day mean (SD)
MMV flexion	71.2° (10.5)	76.5° (8.8)	80.7° (7.8)	90.8° (2.7)	98.7° (4.0)
MPP flexion	61.7° (7.5)	69° (8.0)	72.2° (5.6)	85.3° (6.7)	89.1° (5)
<i>p</i>	<0.001	<0.001	<0.001	<0.001	<0.001
MMV extension	2.14° (3.7)	1° (2.03)	0.28° (1.2)	0.28° (1.2)	0.28° (1.2)
MPP extension	8.85° (3.8)	5.42° (3.7)	3.14° (3.2)	1.71° (3.2)	1° (2.4)
<i>p</i>	<0.001	<0.001	<0.001	0.016	0.11

Results

The 34 patients in the conventional approach group had a varus deformation of 12.5° (SD 4.5); one patient had 6° valgus deformation. For MMV 33 patients had a varus deformation of 12.1° (SD 3.6), $p=0.7$; two patients had 3° valgus deformation. The mean OA grade for MPP TKR was 16.6 (SD 1.5) and for MMV TKR 16.6 (SD 1.9), $p=0.9$. The mean KSS score for MPP preoperatively was 36 (SD 11.5) and for the MMV group 40.1 (SD 9.7), $p=0.2$. The mean KSS functional score for MPP preoperatively was 37.0 (SD 9.3) and 36 (SD 10.1), respectively, $p=0.6$. The preoperative mean flexion for the MPP group was 89.1° (SD 7.0) and for the MMV group 86.4° (SD 8.9), $p=0.16$. The preoperative mean deficit of extension for the MPP group was 6° (SD 5.4) and for MMV 8° (SD 4.9), $p=0.1$. The mean length of incision for the MPP group was 17.1 cm (SD 0.7) and for the MMV group 10.6 cm (SD 0.8), $p<0.001$. The mean operation time for TKR with MPP was 86 min (SD 6.9) and for MMV 93 min (SD 8.7), $p<0.001$.

Postoperative radiological data are presented in Table 2. Postoperative range of motion is presented in Table 3 and Fig. 4. We observed four lateralised patellae in the MPP TKR group (Fig. 1). Range of motion and KSS objective and functional scores six and 12 weeks after TKR are presented in Table 4.

We did not observe wound healing problems, fractures or implant notching in either of the groups studied.

Discussion

The reports of MIS use in TKR are controversial. There are well-established and proven advantages such as less blood loss, less postoperative pain, smaller scar and faster recovery of knee function [4, 7, 10, 12, 13]. However, all these advantages apply only to the early period after TKR. The patients after TKR surgery expect a long-lasting and pain-free knee. Thus, component alignment problems associated with MIS, related to limited visualisation, might be a major disadvantage of this technique. Dalury et al. [3] compared 30 TKR mini incision patients with 30 standard TKR approaches and found that mini incision TKR were associated with tibial component malposition. The authors used the same conventional instruments for both the standard approach and mini incision TKR. This might be the reason for the problems with component alignment. In our study we used a special MIS instrument set for implantation and detailed radiological analysis showed no component alignment problems associated with the MMV technique. Alignment problems also were previously reported by Karachalios et al. [7]. They investigated technical errors related to MIS and found that the MMV approach had three times more malalignment problems than MPP TKR. However, the authors analysed conventional X-rays only and that can influence the results of radiological assessment. Jeffery et al. [6] reported that short conventional radiographs are accurate only to 5°, compared to full-

Fig. 4 Range of motion 2–6 days after TKR. **a** Flexion. **b** Extension

Table 4 Postoperative data on KSS scores, means and standard deviations (SD)

	MMV mean (SD)	MPP mean (SD)	<i>p</i>
Range of motion 6 weeks	119.8 (3.9)	110.4° (4.9)	<0.001
KSS objective 6 weeks	84.5 (7.2)	64.5 (7.2)	<0.001
KSS functional 6 weeks	75.6 (7.8)	58.6 (6.9)	<0.001
Range of motion 12 weeks	124.7° (3.1)	123.3° (3.1)	0.075
KSS objective 12 weeks	91.2 (4.9)	89.2 (3.6)	0.055
KSS functional 12 weeks	89.5 (4.6)	89.1 (6.6)	0.77

length long standing radiographs that are accurate to 2°. The accuracy of measurements when analysing the component position is of importance. Long standing X-rays in our series showed no difference in component alignment between our TKR groups.

We found a statistically significant difference in KSS scores when comparing MMV and MPP six weeks after the TKR. This is in concordance with other reports. Laskin et al. [10] compared 32 MMV with 26 MPP TKR and found significantly better postoperative range of motion and KSS scores six weeks after TKR; 12 weeks after TKR the difference disappeared. We observed a similar functional outcome 12 weeks after TKR.

The mean operation time for MPP TKR was 86 min compared to 93 min, $p < 0.001$. The MMV approach requires more surgical steps to achieve sufficient visualisation of anatomical landmarks to insure secure implantation. All these steps are time consuming and directly related to the technique. A precise operation technique is of importance in MMV TKR and might reduce the risk of component malposition, which was the case in our study. We observed no complications related to prolonged operation time in the MMV group.

We observed four patella lateral displacements in the MPP TKR group. All these patients had no complaints related to this radiological finding. This radiological finding might be due to malrotation of the components. Another explanation of radiologically observed patella lateralisation could be due to damage of the quadriceps tendon in MPP TKR. We assume that preserving the quadriceps tendon and extensor mechanism in the MMV approach ensures better patellar tracking after TKR.

In our material we did not observe fractures, component notching and wound healing problems, which was the case in other reports [7–9]. This might be related to the instrumentation used for the implantation and sufficient visualisation of the operating field.

We conclude that the MMV technique is associated with better early functional results after TKR. The MMV approach according our data can reproduce results similar to MPP in respect to component position. A precise operation technique and adequate visualisation of anatomical landmarks during implantation are the key points of success in MMV TKR.

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