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Comparison of early postoperative rehabilitation outcome following total knee arthroplasty using different surgical approaches and instrumentation

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ABSTRACT

Purpose. To assess early postoperative rehabilitation outcome following computer-assisted total knee arthroplasty (TKA) or standard instrumentation TKA using a medial parapatellar or subvastus approach.
Methods. A prospective controlled trial of 70 consecutive patients undergoing TKA with a low contact stress rotating platform prosthesis was conducted. Patients were randomised to receive surgery with either computer navigation or standard instrumentation. A medial parapatellar or subvastus approach was used according to the surgeons' preference. Outcome measures included preoperative knee function, intra-operative factors, and postoperative rehabilitation.
Results. Duration of surgery was significantly longer when using computer navigation; however, operating time decreased with greater experience. A higher incidence and duration of early postoperative quadriceps dysfunction was associated with computer-assisted TKA through the medial parapatellar approach than through the subvastus approach or TKA performed with standard instrumentation. No patient who received surgery through the subvastus approach had a lag of more than 20 degrees, at 48 hours postoperatively, regardless of the instrumentation used.
Conclusion. Computer-assisted TKA through a medial parapatellar approach was associated with delayed recovery of the quadriceps during early postoperative rehabilitation. This was due to the additional quadriceps dissection required to place the femoral tracking array. The subvastus approach is therefore recommended for computer-assisted TKA.

Key words: *arthroplasty, replacement, knee; instrumentation; rehabilitation; surgery, computer-assisted; surgical procedures, operative*

INTRODUCTION

Computer-assisted total knee arthroplasty (TKA) provides better reproducibility in implant positioning

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than standard instrumentation, and may potentially improve the durability of the implant.[1–7] Prosthetic malposition has been associated with early failure of TKA; however, the incidence of malposition may be reduced with the use of intra-operative computer navigation systems with or without preoperative computed tomographic scans.[4,8–14] Computer-assisted TKA has been demonstrated to result in improved femoral component alignment in rotation and flexion, tibial component posterior slope, and matching of the femoral and tibial components in rotation.[15–17] Computer navigation, however, increases surgery cost and operating time. Although gaining popularity, it has not won universal acceptance as presently only surrogate outcome measures demonstrate its advantages.[9,15,18]

Computer-assisted TKA requires rigid application of tracking arrays as reference points for preparation of bone surfaces and prosthetic implantation by acquisition of data describing the anatomical landmarks and surface topography of the knee joint. Tracking arrays must be rigidly applied to bone in order to reduce instrumentation error associated with movement, and be positioned as not to obstruct the further conduct of surgery, in particular the application of resection blocks and trial prostheses. When performing computer-assisted TKA via a medial parapatellar approach, the attachment pin is drilled into the anteriomedial cortex at the apex of the quadriceps incision or via a separate stab incision. Additional proximal extension of the quadriceps incision is often required for placement of the femoral array into a position suitable to achieve the clearance required to place cutting guides and prosthetic trials. This additional dissection of the extensor is not required when surgery is performed with standard instrumentation.

This study aimed to assess early postoperative rehabilitation following computer-assisted TKA performed via a medial parapatellar or subvastus approach.

MATERIALS AND METHODS

We studied 70 consecutive patients who underwent TKA between November 2002 and November 2003 at the Queen Elizabeth II Jubilee Hospital in Brisbane, Australia. Patients were randomly selected to undergo TKA with computer navigation (CT-free Knee 1.1; BrainLAB, Munich, Germany) or TKA with conventional instrumentation using intramedullary femoral and extramedullary tibial alignment guides. The low contact stress rotating platform prosthesis (DePuy, Johnson & Johnson, Warsaw [IN], US) was used in all patients.

Operating approaches were determined by the surgeons' preference and not randomly assigned. One surgeon used the medial parapatellar approach with application of an arterial tourniquet inflated to 350 mm Hg. The other surgeon used the subvastus approach. No minimally invasive surgical techniques were performed. Patients who underwent computer-assisted TKA and had distal femoral and proximal tibial arrays attached using a single bicortical 5.0-mm Schanz pin (without a toothed-nut attachment) predrilled to 3.5 mm. If additional clearance for placement of the femoral array was required, the incision of the superior apex of the quadriceps was extended by approximately 1 to 2 cm. Separate stab incisions for placement of the femoral tracking array were not performed.

Antibiotic prophylaxis consisted of intravenous cephalothin 1 g on induction, followed by 3 postoperative doses of 1 g at 6-hour intervals. The use of epidural catheters and other regional anaesthetic techniques was at the discretion of the attending anaesthetist. Reinfusion drains were placed according to the surgeons' preference. Duration of surgery from incision to closure of the wound was recorded. Any procedural difficulty was recorded by the surgeons in a postoperative datasheet.

Blood collected in reinfusion drains was transfused according to an established protocol whereby transfusion was undertaken if a volume of >200 ml was collected at postoperative 6 hours. Wound drains were removed on postoperative day 1, and catheters used for the administration of regional anaesthesia (femoral nerve block or epidural) were removed on day 2. The criteria for allogeneic blood transfusion was symptomatic anaemia: haemoglobin level of <80 g/l on blood test taken the morning after surgery, or <100 g/l in patients with pre-existing significant cardiovascular disease. Chemical thromboprophylaxis (enoxaparin 40 mg) was administered subcutaneously once daily starting on the day of surgery.

Postoperative rehabilitation included a 'drop and dangle' protocol commencing on postoperative day 1. Continuous passive motion machines were not used. Goniometer measurements of knee range of motion and quadriceps lag were made preoperatively and postoperatively on a daily basis until discharge by 2 ward physiotherapists who were blinded to the surgical approach and instrumentation used. Postoperative quadriceps dysfunction was defined as a knee joint lag of $\geq 25^{o}$ when performing a supine straight leg raise test, or an inability to perform active straight leg raise regardless of knee joint lag. Criteria

Table 1
Comparison between standard instrumentation and computer-assisted groups

	Standard instrumentation	Computer navigation
No. of patients	31	39
Mean age (years)	70.42	67.92
Cause of surgery		
Osteoarthritis	29 (93.5%)	37 (94.9%)
Rheumatoid arthritis	2 (6.5%)	2 (5.1%)
Approach		
Medial parapatellar	21	21
Subvastus	10	18
Preoperative condition		
Varus	0.5º	3.4º
Maximal flexion	108.1º	109.6º
Fixed flexion deformity	4.8º	6.8º
Haemoglobin level (g/l)	137.0	137.6
Low contact stress rotating platform	31 (100%)	39 (100%)
Both components cemented	31 (100%)	36 (92.3%)
Regional anaesthesia	28 (90.3%)	32 (84.6%)
Reinfusion drain	25 (80.6%)	33 (84.6%)
Hospital stay (days)	6.94	7.23
Transfusion (units)	0.54	0.36
Postoperative haemoglobin level (g/l)	105.7	103.2

Table 2
Comparison between medial parapatellar and subvastus approaches

	Medial parapatellar	Subvastus
No. of patients	42	28
Mean age (years)	68.8	69.2
Cause of surgery		
Osteoarthritis	38 (90.5%)	28 (100%)
Rheumatoid arthritis	4 (9.5%)	0 (0%)
Instrumentation used		
Standard	21	10
Computer-assisted	21	18
Preoperative condition		
Varus	0.8º	2.4º
Maximal flexion	108.6º	109.6º
Fixed flexion deformity	6.1º	5.7º
Haemoglobin level (g/l)	137.0	137.9
Low contact stress rotating platform	42 (100%)	28 (100%)
Both components cemented	42 (100%)	25 (89.3%)
Regional anaesthesia	37 (88.1%)	23 (82.1%)
Reinfusion drain	42 (100%)	16 (57.1%)

for discharge included safe mobility, adequate quadriceps control, and knee flexion to 90º.

Data were analysed using either parametric or non-parametric tests, and frequencies were compared using one- or 2-tailed Fisher's exact test where appropriate. A p value of <0.05 was considered significant.

RESULTS

Characteristics of the 2 groups were equivalent with respect to age, pathology, preoperative function, the use of polymethyl methacrylate cement, regional anaesthesia and reinfusion drains, hospital stay, transfusion requirement, and postoperative haemoglobin level (Tables 1 and 2). Of the subvastus approach, more patients underwent TKA with computer navigation than standard instrumentation but this was not significant (p=0.10).

The mean duration of surgery was 77.4 minutes for standard instrumentation TKA and 113.1 minutes for computer-assisted TKA (p<0.001, Mann Whitney *U* test). There was no significant difference in duration of surgery between medial parapatellar and subvastus approaches using either computer-assisted TKA or standard instrumentation TKA. With increasing experience in using computer navigation, operating times decreased, demonstrating a learning curve associated with the use of computer navigation (Fig. 1).

Comparison of mean preoperative and early postoperative knee flexion angles following computer-assisted TKA or standard instrumentation TKA is shown in Figure 2. Knee flexion was similar, regardless of operative approach or instrumentation used.

Regional anaesthesia was administered to 60 (85.7%) of the 70 patients: epidural catheters (n=44, 73%), combination of spinal and epidural anaesthesia (n=9, 15%), spinal anaesthesia (n=5, 8.3%), and other regional anaesthesia techniques (n=4, 6.6%). The frequency and type of anaesthetic techniques used were not significantly different regardless of the surgical approach or instrumentation used. Catheters inserted for the administration of continuous postoperative regional anaesthesia were removed on postoperative day 2. The type of anaesthetic technique used did not significantly influence the quadriceps dysfunction; nevertheless, there was a trend for the 10 patients who had general anaesthesia without adjunctive regional anaesthesia to have less quadriceps dysfunction on postoperative day 2 (p=0.06, Fisher's exact test) and day 3 (p=0.07, Fisher's exact test).

The results of postoperative quadriceps dysfunction are shown in Figures 3 to 5. Patients who underwent standard instrumentation TKA rehabilitated faster, but not significantly, than those

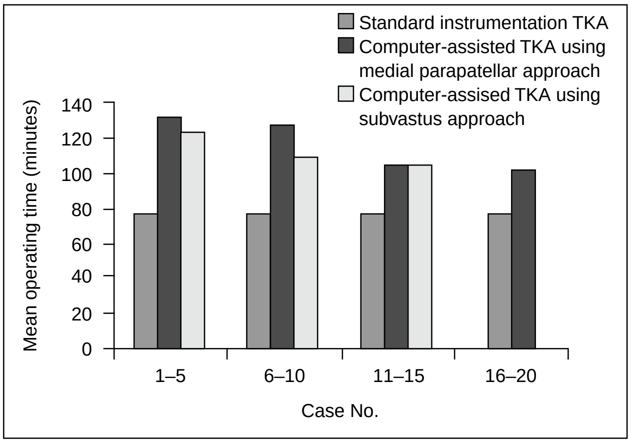
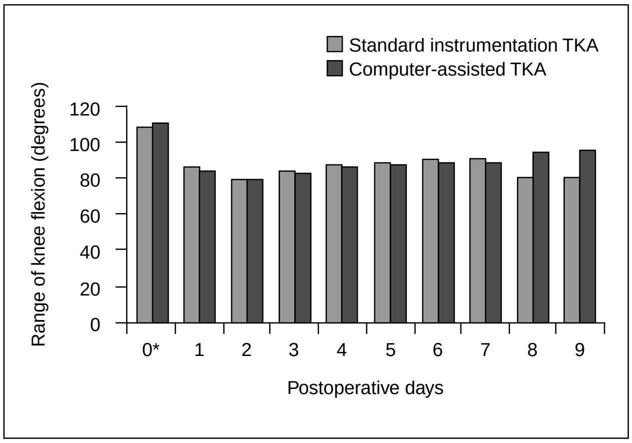


Figure 1 The mean operating time of patients performed with different approaches (the case number is arranged in chronological order).



* 0 denotes preoperative day

Figure 2 Range of knee flexion of preoperative and postoperative days.

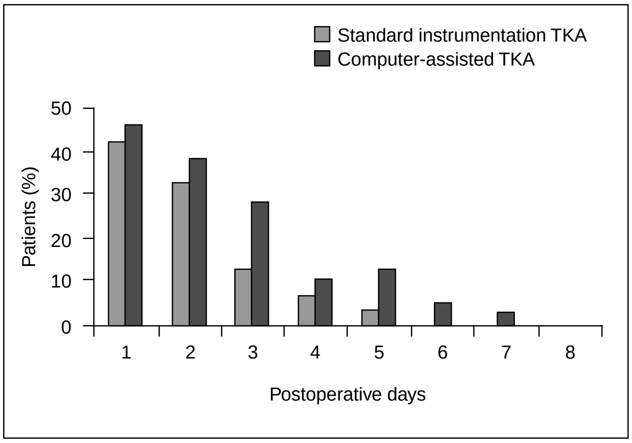
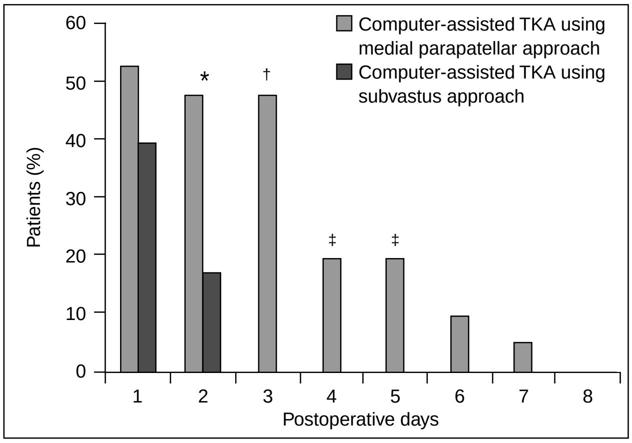


Figure 3 Postoperative quadriceps dysfunction (>25° lag) of patients with standard instrumentation TKA and those with computer-assisted TKA.



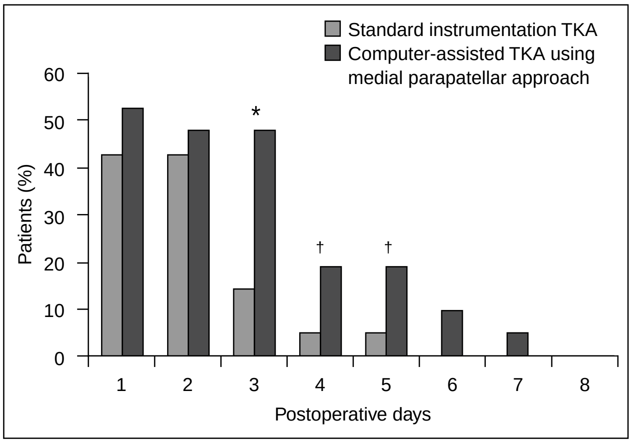
* p=0.043, one-sided Fisher's exact test
† p=0.001, one-sided Fisher's exact test
‡ p=0.073, one-sided Fisher's exact test

Figure 4 Postoperative quadriceps dysfunction (>25° lag) of patients with computer-assisted TKA through a medial parapatellar approach and those through a subvastus approach.

who underwent computer-assisted TKA with respect to postoperative quadriceps dysfunction (Fig. 3). Early postoperative quadriceps dysfunction was associated more strongly with computer-assisted TKA through a medial parapatellar approach than through a subvastus approach (Fig. 4). No significant difference was noted in the incidence of quadriceps dysfunction between medial parapatellar and subvastus approaches using standard instrumentation TKA after day 2. The medial parapatellar approach resulted in a significantly higher incidence of quadriceps dysfunction in TKA performed with computer navigation than standard instrumentation (Fig. 5). No patient who received surgery through the subvastus approach had a lag of >20° at 48 hours postoperatively, regardless of instrumentation used.

DISCUSSION

Computer-assisted TKA through the medial parapatellar approach is associated with a delayed recovery of the quadriceps during early postoperative rehabilitation, because of the additional quadriceps dissection required to place the femoral tracking array.



* p=0.018, one-sided Fisher's exact test
† p=0.014, one-sided Fisher's exact test

Figure 5 Postoperative quadriceps dysfunction (>25º lag) of patients with standard instrumentation TKA and those with computer-assisted TKA using medial parapatellar approach.

The results of this study can be extrapolated to any navigation system with similar requirements for positioning of the femoral tracking array. Quadriceps dysfunction following computer-assisted TKA via a medial parapatellar approach was most pronounced from days 2 to 5. This became insignificant after day 5.

No significant difference in hospital stay was demonstrated for either surgical approach or instrumentation used. Nonetheless, should accelerated discharge protocols be considered, persistent quadriceps dysfunction following computer-assisted TKA using a medial parapatellar approach could delay hospital discharge.

No difference in the incidence of quadriceps dysfunction after day 2 was observed between the medial parapatellar and subvastus approaches when standard instrumentation was used. When performing computer-assisted TKA, however, the subvastus approach was associated with a lower incidence and a shorter duration of quadriceps dysfunction.

Variations in surgical skill between the 2 surgeons independent of the approach used are unlikely to account for the difference in incidence of quadriceps dysfunction when performing computer-assisted TKA because the results of the 2 surgeons for TKA performed with standard instrumentation were comparable.

CONCLUSION

The subvastus approach is recommended for computer-assisted TKA as it reduces the incidence and duration of early postoperative quadriceps dysfunction.

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