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A Comparison Between Subvastus and Midvastus Approaches for Staged Bilateral Total Knee Arthroplasty: A Prospective, Randomised Study

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ABSTRACT

This prospective randomised study was undertaken to compare surgical parameters as well as clinical and radiological outcomes of subvastus (SV) to midvastus (MV) approaches in staged bilateral total knee arthroplasty (TKA). Twenty-three patients, aged 55–76 years, who underwent staged bilateral TKAs, were followed up for 6 months. The SV approach was used on one knee and MV approach on the other. We found similar lateral retinacular release rates and patellar resurfacing rates between the two approaches .The SV approached knees had a more significant blood loss and increased operative time compared to the MV approached knees but they achieved significantly earlier active straight-leg raises (SLR) postoperatively ($p<0.05$ for all). The average postoperative pain, flexion, and Knee Society scores were comparable for both approaches. TKA via SV vs. MV approaches provides comparable satisfactory short-term clinical and radiological outcomes, even though there was slightly more difficulty, more blood loss and longer operative times with the SV approach.

Key Words:
Total knee arthroplasty, Subvastus approach, Midvastus approach

INTRODUCTION

Total knee arthroplasty (TKA) is commonly performed using the medial parapatellar (PP) arthrotomy approach [1, 2] and has consistently shown reproducible excellent results in long-term studies [3, 4, 5]. Although this TKA approach offers excellent exposure for proper component placement and alignment, some studies have reported deficits in quadriceps muscle function due to violation of a major portion of the extensor mechanism [6,7], which potentially disturbs the medial-to-lateral balance of patella tracking.

The SV approach was developed to overcome these limitations through avoidance of a quadriceps tendon incision, preserve extensor mechanism function and thereby reduced related complications [8]. Fewer lateral retinacular releases are required to improve patella tracking with this approach [9]. Several studies report favourable short-term results including faster recovery for the subvastus (SV) approach when compared to medial PP arthrotomy [10-12]. Of note, exposure can be difficult, especially in obese patients, those with a large vastus medialis muscle mass or when there is severe deformity. The midvastus (MV) approach was therefore developed as alternative for TKAs that disrupts less of the extensor mechanism as compared to the medial PP approach. Some investigators report a better outcome in the early postoperative period compared to the medial PP approach [13, 14]. However, potential damage to neural and vascular structures due to the vastus medialis incision cannot be excluded [15].

To our knowledge, there are few studies comparing the SV and MV approaches [16, 17] and only one study compared surgical parameters and clinical outcomes associated with the two approaches [18]. The purpose of this study was to compare the surgical parameters, clinical and radiological outcomes of the SV and MV approaches for bilateral TKA with use of a prospective randomised design.

MATERIALS AND METHODS

Twenty-seven patients (fifty-four knees) scheduled to undergo staged bilateral TKA were enrolled in a prospective, randomised study from January 2009 to June 2010 at Hospital Sultanah Aminah, Johor Bahru, Johor, Malaysia and were followed up for six months postoperatively (only early differences between the groups were of interest). Inclusion criteria consisted of: scheduled to undergo primary TKA for a diagnosis of osteoarthritis; and anteroposterior and lateral radiographs confirming the presence of bony changes, revealing grade III or IV OA, as assessed by the Kellgren-Lawrence Scale [19]. The exclusion criteria were: body mass index of more than 30; very severe deformities (> 20° on the mechanical axis); previous major arthrotomy; previous high tibial osteotomy; any neuromuscular pathology; mental incompetence for evaluation. Of those, three patients were excluded due to obesity and another one because of severe valgus deformity. Demographic characteristics for the

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Table I: Demographic Characteristics

Mean age (range) (yr)	62.9 (range, 55- 76)
Sex (F:M)	18:5
Mean body mass index (range) (kg/m2)	27.9 (range, 23.4- 29.8)
Diagnosis	All osteoarthritis (23 subjects)
Knee deformity	All varus (23 subjects)

Table II: Comparison of preoperative clinical characteristics

	Subvastus Approach	Midvastus Approach	P value
Knee flexion (degrees)	98.6(85-110)	98.4(90-120)	0.874
Knee Society knee Score (points)	46.6(40-55)	45.9(38-55)	0.162
Knee Society function score (points)	49.3(35-60)	48.0(30-60)	0.056

Table III: Comparison of Surgical Parameters

Surgical parameter	Subvastus Approach	Midvastus Approach	P value
Surgical time (min)	74.0 (70.0-76.0)	67.0 (62.0-71.0)	0.001*
Blood loss (ml)	457.3 (350-720)	435.0 (340.0-710.0)	0.027*
Lateral retinacular release	1 subject (4.3%)	1 subject (4.3%)	
Patella resurfacing	2 subjects (8.6%)	2 subjects (8.6%)	

*significant

Table IV: Comparison of Postoperative Clinical Outcomes

	Subvastus Approach	Midvastus Approach	P value
Pain Day 1 (points)	4.0(2-6)	4.4(3-7)	0.083
Pain Day 5 (points)	2.2(1-4)	2.4(1-4)	0.056
SLR (days)	2.5(2-3)	3.2(2-4)	0.001*
Final follow-up:			
Knee flexion (degrees)	115.6(105-125)	116. 0(110-120)	0.426
Knee Society knee Score (points)	90.1(81-100)	89.6(81-100)	0.186
Knee Society function score (points)	89.5(80-100)	89.1(80-100)	0.328

*significant
SLR-Straight Leg Raise

twenty-three enrolled patients can be found in Table I. All operations were performed by the senior surgeon (Z.H.K.) using the SV approach in one knee and the MV approach in the contralateral knee. The senior surgeon had performed more than 100 total knee arthroplasties using each of the two approaches (MV and SV) prior to starting this study. The patients were informed that the surgery would employ the use of a different muscle incision in each knee, and they gave informed consent to participation in the study procedure. The study was approved by the Institutional Ethics Committee.

Simple randomisation was carried out in the operating suite using a sealed-envelope system containing a piece of paper written either SV or MV - the envelope was opened at the time of the first knee surgery. The more painful knee was always operated first and the other knee 8 to 12 weeks later using the other surgical approach. The same prosthesis model (cemented posterior stabilized knee prosthesis, Foundation Total Knee, Encore, Austin, Texas) was implanted in all cases. Patellar resurfacing was performed at the discretion of the surgeon on the basis of patella pain during preoperative evaluation as well as intraoperative findings. After a midline skin incision identical for all patients, the knee was exposed by the SV approach (SV TKA) as described by Hoffman *et al* [20] or using the MV approach (MV TKA) according to the technique of Engh *et al* [15]. A careful gentle blunt digital dissection was performed at vastus medialis muscle interval so as not to damage any neurovascular structures; electrocautery of any bleeding points was performed during the MV approach to prevent postoperative hematoma and/or bleeding in the interval of the vastus medialis split [21]. The same criteria for lateral release were employed for all patients; central symmetrical tracking of the patella in the trochlear groove was required prior to capsular closure. A drain tube was inserted before wound closure and was removed 24 hours postoperatively. The procedure was performed under tourniquet control for all patients and the tourniquet was deflated only after application of compression dressing.

All patients received epidural anaesthesia and followed an identical postoperative pain protocol. This included epidural analgesia administered through a continuous epidural catheter until second postoperative day and followed by oral analgesia after catheter removal. All patients (all knees) were prescribed same postoperative rehabilitation protocol, consisting of five days of postoperative inpatient rehabilitation, followed by at least two to four weeks of outpatient physical therapy. Rehabilitation started on the first postoperative day with continuous passive knee movement set at 60° and then increased daily by 10°. Mobilization began on the second postoperative day with assistance from a physical therapist and using a walking frame with full weight bearing on the operated leg. Patients were discharged on the fifth postoperative day after demonstrating stable full weight bearing walking using a walking frame.

Assessment

Data collection for all patients included operative time from incision to final closure, intraoperative blood loss, total blood in drain bottle for first 24 hours postoperatively, the need for lateral release and/or patellar resurfacing, and any complications as recorded in the study form; all results were used to compare the two surgical approaches. Total blood loss was recorded as the sum of recorded intraoperative loss and amount of blood collected in drain bottle during the first 24 hours.

Baseline clinical evaluation included determination of knee flexion and the Knee Society Knee Scoring System and Knee Society Knee Function Scores [22], from two weeks prior to surgery (Table II). Postoperatively, inpatient evaluation by the physiotherapist, who was blinded to the approach used during consisted of daily evaluation of knee flexion and the ability to perform a straight leg raise (SLR). Knee flexion was again assessed by the physiotherapist at approximately two weeks, six weeks, twelve weeks and six months following the index arthroplasties. At final follow-up, patients were evaluated using the Knee Society Knee Scoring System and Knee Society Knee Function Scores. The visual analogue scale (VAS) pain score was used to assess pain at Day 1 and Day 5 after surgery with this particular evaluation performed by the Acute Pain Service Team, who is experienced in these assessments and were blinded to the surgical approach. Anteroposterior and lateral radiographs of the operated knee taken on the postoperative day were evaluated by a single observer with regard to implant position, tibiofemoral angle on the anteroposterior radiograph and the tibial component slope on the lateral radiograph according to the Knee Society TKA roentgenographic evaluation form [23]. Component and overall alignment of neutral ± 2° was rated as correct.

Statistical Methods

Statistical analysis was performed using the paired t test in SPSS version 19 (SPSS Inc, Chicago IL.) for Windows for all parameters examined (blood loss, operative time, the need for lateral release and/or patellar resurfacing, VAS pain score, range of motion (ROM), SLR, Knee Society knee score and Knee Society functional score). Statistical significance was set at $p < 0.05$.

RESULTS

No patients were lost to follow-up and all 23 patients were available for review. There were 18 female and 5 male patients with an average age of 62.9 years (range, 55–76 y). We found similar lateral retinacular release rates for the two approaches (one case in each approach). Two patellae were resurfaced for each approach. The total operative time was significantly longer ($p<0.05$) in the SV TKA group (74.0 minutes; range, 70-76 m) when compared to the MV TKA group (67.0m; range, 62-71m). There was significantly more blood loss ($p<0.05$) in the SV TKA group (457.3 ml; range, 350-720 ml) than in the MV TKA (435.6 ml; range, 340-710 ml). A comparison of surgical parameters can be found in Table III.

The average postoperative pain on Day 1 and Day 5, as recorded on the VAS, was comparable for both approaches. Active SLR was achieved slightly earlier ($p < 0.02$) in the SV TKA (2.5 days; range, 2–4 d) than in the MV TKA group (3.2d; range, 3–4 d). Flexion at Day 1, 5, 14 and 90 did not differ substantially between the two approaches. At the 6 months postoperative visit, average flexion was 115° (range, 105-125°) and 116° (range, 110-120°), respectively, in the SV TKA and in the MV TKA groups.

The mean Knee Society knee and Knee Society function scores for the SV TKA improved from 46.6 and 49.3 points, respectively at the preoperative evaluation to 90 and 89 points at the time of the final follow-up. The mean Knee Society Knee Scoring System and Knee Society Knee Function Scores for the MV TKA improved from 45.9 and 48.0 points, respectively, at the preoperative evaluation to 89.6 and 89.1 points at the time of final follow-up. There was no significant difference between the approaches with respect to either Knee Society Knee Scoring System ($p = 0.186$) or function ($p = 0.328$) scores at the time of the final follow-up. A comparison of postoperative clinical outcomes can be found in Table IV.

Radiographic analyses revealed correct (neutral ± 2°) AP-plane component position in all patients in both approaches. All tibial components were within 2° of neutral and the tibial component slope was within 6° to 8° on postoperative lateral radiographs.

Complications

We encountered no major intraoperative complications using either approach. Postoperatively, there were no cases of haematoma, infection, or deep vein thrombosis.

DISCUSSION

Several authors report advantages of performing TKA using the SV approach such as an earlier return to SLR [10], fewer lateral releases [9], increased quadriceps strength at 6 weeks postoperatively [24] and a significant improvement in quadriceps peak torque at 6 months [12]; similarly, certain reports cite advantages of the MV approach including decreased pain, earlier return of SLR, fewer lateral releases, improved range of motion, and no limitations of exposure [13, 14, 25] when compared to the medial PP approach. However, few studies have compared the SV approach directly to the MV approach in TKA. Berth *et al.* [16] and Chang *et al.* [17] focus on comparison of the effect of the SV and MV approaches on quadriceps activity as indicator of recovery and did not compare the surgical parameters and clinical outcomes for the two surgical approaches. Therefore, in the present study, we compared surgical parameters, clinical and radiological outcomes of the SV to the MV approaches in staged bilateral total knee arthroplasty with use of a prospective randomised design. Our ability to compare results in same patients reduced or eliminated variability introduced by age, body mass index, comorbidity, activity level, and gender differences in other studies.

In a study by Callaghan *et al* [18] comparing the results of 8 SV TKAs with 10 MV TKAs in 18 patients, less blood loss and shorter tourniquet time were reported in the SV group. In our study of bilateral TKAs, the total operative time was significantly longer in the SV TKA group. There was also significantly more blood loss in the SV TKA group. Generally speaking, surgical time and blood loss are indirect markers of the difficulty encountered in exposure for TKAs. We encountered slight difficulty in exposure and visualization in very overweight patients, patients with large vastus medialis muscle mass, and patients with more severe deformities using the SV approach. However, using the MV approach we did not experience such difficulty and completed treatment of 23 knees without problems.

Some authors have reported that the SV approach and MV approach are associated with quicker functional recovery and rehabilitation than the PP approach in TKAs [8, 12, 14, 26]. However, few studies compared the functional recovery and rehabilitation using the SV approach to the MV approach. In a study by Berth *et al.* [16], the authors report no significant difference in quadriceps voluntary contraction and voluntary activation between the SV and MV approach in TKA. However, 6 months after surgery, patients who underwent SV TKAs experienced more pain than those who had MV TKAs. Callaghan et al compared [18] the effect of the SV TKAs and MV TKAs on quadriceps activity using electromyographic analysis. There was an earlier return of SLR with the SV technique, but there was no significant difference in electromyographic data and thus concluded that there was no evidence of denervation of the vastus medialis muscle with either approach. A recent study by Chang *et al.* [17] compared peak muscle torque using hamstring/quadriceps ratio data from 20 SV TKAs to 10 MV TKAs using dynamometer measurements and reported no statistically significant different between the two approaches. In the present study, active SLR was achieved earlier in the SV TKAs compared to the MV TKAs, but average postoperative pain on Day 1 and Day 5 was comparable for both approaches. Postoperative flexion did not differ substantially between the two approaches at inpatient and final follow up.

Our data show no significant difference between the groups with respect to either Knee Society knee or Knee Society function scores at the time of final follow-up. The MV approach requires some splitting of the vastus medialis obliquus muscle but the SV approach maintains integrity of the extensor mechanism, which offers some theoretical advantage. There were similar lateral retinacular release rates for the two groups but SLRs were achieved earlier in the SV approach.

Radiological outcomes of both approaches were comparable and within acceptable range in the present study. We conclude that, overall, proper component placement and alignment can be achieved using both approaches.

Importantly, there were no complications related to TKA in either approach. Postoperative haematoma and/or bleeding in the interval of the vastus medialis split has been previously reported [27], but can be avoided by careful blunt digital dissection in the vastus medialis interval taking care not to damage any neurovascular structures and then carefully inspecting for bleeding high in the interval of the vastus medialis split, using electrocautery of any bleeding points as suggested by Kelly *et al* [22].

The present study has several limitations. First, the relatively small size of the study group somewhat limits the ability to draw meaningful conclusions. Second, the follow-up period of six months was short. Therefore, we are unable to ascertain the longer-term effects of these two approaches. Formal quadriceps strength testing was not performed to compare knees managed with the two surgical approaches. A final limitation is that the assessment of certain measures such as radiographic outcome parameters, are prone to interobserver variation.

CONCLUSION

In summary, TKA via SV and MV approaches provides comparable satisfactory short term clinical and radiological outcomes, although there was slight difficulty, more blood loss and longer operative time with the SV approach. Both approaches are safe and do not present any additional risk of complications.

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