Early functional results of the subvastus and medial parapatellar approaches in total knee arthroplasty

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Introduction
A number of techniques for total knee replacement have been described to allow for easier surgical technique but with preservation of the integrity of extensor mechanism, and one of them is the subvastus (SV) approach. It causes less damage to the extensor mechanism and blood supply, which will cause less pain in the postoperative period and earlier return of quadriceps strength.
Patients and methods
Forty primary total knee replacement patients were divided into two groups, each with 20 patients. Group I had a medial parapatellar (MPP) approach and group II had the SV approach.
Results
The SV approach allowed earlier straight leg raising, shorter hospital stay, earlier quadriceps strength improvement, and better stair score and function score when compared with the traditional MPP group.
Conclusion
The SV approach for primary total knee arthroplasty is less invasive than the conventional MPP approach when considering vascular and muscular anatomy.

Keywords:
knee arthroplasty, knee society score, parapatellar, subvastus

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Introduction

The standard medial parapatellar (MPP) approach for total knee replacement violates a major portion of the extensor mechanism with a potential for vascular injury to the patella, with or without a lateral patella release with patellofemoral instability and maltracking at a rate of 5–30% [1–5]. The subvastus (SV) approach was recommended by Hofmann *et al.*, 19913 as an alternative arthrotomy in total knee arthroplasty (TKA) and is an example of these newer approaches. It preserves the integrity of the extensor mechanism and maintains the vascular supply to the patella by avoiding the articular branch of the descending geniculate artery. Theoretically, the SV approach should provide the best recovery with early rehabilitation because it causes the least damage to the quadriceps during surgery [6–9].

Preservation of the quadriceps during TKA is argued to result in less pain, earlier functional recovery, and shorter length of hospital stay. Other proposed advantages of the SV include a reduction in analgesic requirements, earlier improvement in muscle strength, earlier independent straight leg rising, and decreased hospital length of stay [10–12].

Patients and methods

From July 2012 to September 2013, a prospective study was undertaken to compare the early functional results of the MPP approach with the SV approach in 40 unilateral primary TKA cases. Patients was divided in two groups with 20 patients in each: group I via MPP approach and group II via SV approach. Inclusion criteria included primary OA knee patients with total knee replacement. Exclusion criteria included prior knee surgery, previous bony injuries around the knee, previous deep-knee scar, and damage of the extensor mechanism. Patients' demographic data are shown in Table 1.

Group I (MPP) and group II (SV) were homogenous with regard to age, sex, cause of surgery, preoperative clinical state, and type of implanted knee system. The demographics of the two subgroups were not statistically different.

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All procedures were performed by the same surgical team under spinal anesthesia via an anterior midline skin incision. All procedures were performed under tourniquet, which was released before closure. In all cases, a posterior stabilized cemented prosthesis with a fixed insert was used. Moreover, in all cases, the patella was not resurfaced. Drains were used in all knees for 24–48 h.

Technique

The SV approach was started by a skin incision performed at 30° of knee flexion and was started 5–6 cm above the upper pole of the patella and continued along the medial border of the patella to the medial limit of the tibial tuberosity.

Table 1 Demographic data

Patients	Data	MPP group (*N*=20)	SV group (*N*=20)	*P* value
Sex	Male/ female	3/17	4/16	
Age	Average	64±7	66±6	0.3
	Range	53–78	55–75	
Weight (kg)	Average	74±9	78±6	0.11
	Range	58–87	65–85	
Height (m)	Average	1.66±0.05	1.68±0.05	0.14
	Range	1.58–1.75	1.6–176	
BMI	Average	28±3	27±2	0.5
	Range	19.6–32.4	21–30.3	
Smoking (yes/no)	Yes/no	4/16	7/13	0.48
HTN	Yes/no	6/14	10/10	0.34
DM	Yes/no	3/17	5/15	0.69
CHD	Yes/no	3/17	1/19	0.61
COPD	Yes/no	2/18	1/19	0.99

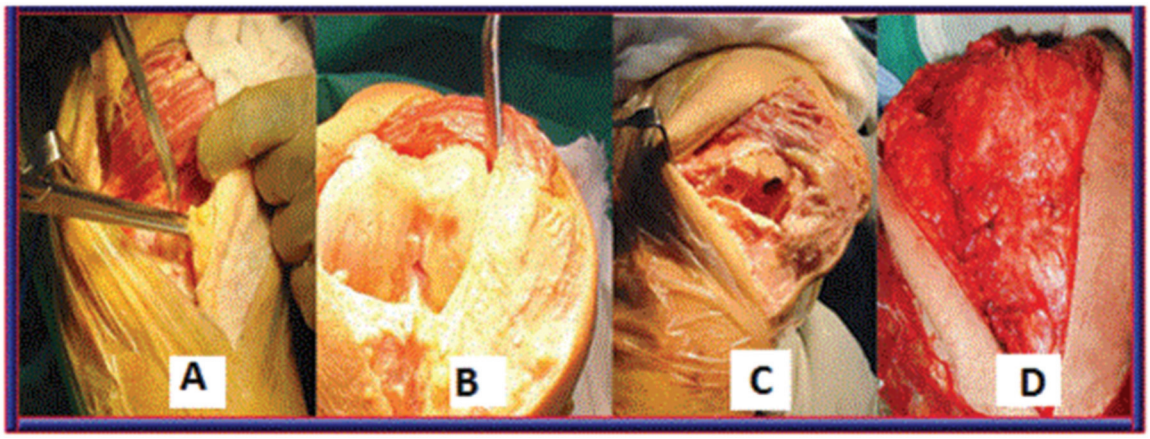
CHD, chronic heart disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HTN, hypertension; MPP, medial parapatellar; SV, subvastus.

The arthrotomy started at the upper medial pole of the patella and continued along the patella, leaving the appropriate margin of a synovial capsule, and continued farther down to the tibial tuberosity. The proximal part of the arthrotomy extended medially and proximally, along the inferior edge of the vastus medialis. The knee was flexed for the skin incision and incision of the inferior aspect of the capsule. The vastus medialis was then dissected with the knee flexed or extended. Using blunt dissection until the medial intermuscular septum, the vastus medialis was then retracted proximally and laterally while maintaining its attachment to the patella without everting it. The femur and tibia were prepared, and the prosthesis was inserted (Fig. 1).

There were three lateral releases in group I (MPP) and two lateral releases in the group II (SV). Patellar tracking was assessed using the rule of no thumb and a lateral release was performed if patellar tilt or subluxation was detected [13,14]. For both the MPP and SV approaches, wound drains exited laterally, avoiding the vastus lateralis where possible, and were removed after 48–72 h postoperatively. In both groups, thromboprophylaxis was carried out postoperatively until discharge using 40 mg enoxaparin sodium (low–molecular-weight heparin) subcutaneously, and, on discharge, it was changed to oral prophylaxis, warfarin for 6 weeks. Antibiotic prophylaxis was begun with 2 g of intravenous cefoperazone sodium 1 h before the operation and was continued for 3 days with a maintenance dose of 1 g every 12 h.

In both groups, physical therapy begun on postoperative day 1 with weight-bearing as tolerated; range of motion exercises and gait training continued twice a day during the hospital stay, which included

Figure 1



(a) The dissection along the inferior edge of VM. (b) The exposure of femur and tibia. (c) After preparation (d) VM after prosthesis insertion. VM, vastus medialis.

active exercises, and walking exercises twice daily under the supervision of an experienced physiotherapist. No continuous passive motion machines were used. After discharge from the hospital, patients continued rehabilitation at home according to the same rehabilitation protocol, which included walking with full weight-bearing, quadriceps muscle strengthening, and range of motion exercises.

The operating surgeon graded the adequacy of the surgical exposure as excellent, satisfactory, or inadequate on the basis of ease of everting or retracting the patella, amount of patellar ligament released, and view of the proximal tibia.

Follow-up and evaluation

Comprehensive assessment was carried out on the basis of clinical and functional knee society scores (KSS) at 2 weeks and at 3, 6, and 12 months postoperatively. For accurate assessment of return of extensor mechanism function, extension lag was defined as passively correctable active extension deficiency and flexion contracture was defined as lack of active extension.

The primary outcome measure was the KSS (200 points). For better discrimination, its component scores, the KSS objective (100 points) and KSS functional (100 points) were also considered. Secondary outcome measures included days to straight leg raising (SLR) and intraoperative secondary outcome, for example, operation duration (min), estimated blood loss (intraoperative plus postoperative drain), and length of postoperative stay in the orthopedic ward (in days). The primary outcomes, range of motion, and quadriceps strength, were measured at different follow-up periods preoperatively (baseline) and postoperatively, each at week 2, month 3, month 6, and month 12.

Quadriceps muscle strength (excellent, good, fair, and poor) was evaluated by manual assessment in comparison with the other side (Karpman and Smith, 2009).

Statistical analysis

PASW, version 18 (Chicago, Illinois, USA) and PASS 11 were used for sample size calculation and statistical analysis. The primary efficacy end point was prospectively defined as improvement of knee society knee score. Assuming an SD of 10%, the required sample size after setting the power to 80% power to detect a knee society knee score difference of 10%, as statistically significant at the 5%, was 32; hence, each group required at least 16 participants. Allowing a drop of 20%, each group included 20 participants at least. The primary analysis was intention-to-treat and involved all patients who were assigned.

Descriptive analysis was conducted to explore the characteristics of the participants at baseline. The median, the 25th, and the 75th interquartile percentiles of the different knee scores, the mean and the SD of age, height, weight, and BMI, and the percentages of the sex distribution by intervention type were calculated.

Analysis of secondary outcomes (days to SLR, operation time, adequacy of exposure, length of stay) was performed using the Student *t* test or the Fisher exact test, as appropriate, to determine differences between the two treatment groups.

To compare the different knee society subscores across the different time periods, Friedman's analyses were carried out. Post-hoc tests were used to compare the scores between one time period and the one that preceded it. As post-hoc tests were used several times, the significance level was divided by the number of planned comparisons, and each two-sample test was accordingly performed at the reduced level. A Kruskal–Wallis test was used to compare the total knee and functional score and subscores between the two intervention groups at the different time periods.

Results

Operative time was significantly longer in group II (SV) than in group I (MPP) (P=0.012), while the hospital stay was significantly shorter in group II (SV) (P=0.013). During follow-up, group II (SV) had an earlier return to full SLR by an average of 3.4±1.2 days, while in group I (MPP) it was 5.1±1.6 days (P=0.001). As regards quadriceps' strength, there was periodic improvement over time in both groups, except in the second week, wherein group II (SV) had stronger quadriceps (P=0.02).

After 12 months, range of motion was found to be significantly different (P=0.023) for group II (SV), with 122.5±4.5°, and, for group I (MPP), it was 117.75±7.5° (Table 2).

As regards the clinical KSS, there was improvement at different follow-up periods in both groups with no statistically significant difference between them (Table 3). The overall function score showed a significant deterioration during the second week for

Table 2 Comparison between range of motion (in deg.) for both groups at different follow-up periods

Time of follow-up	Preoperative	2nd week	3rd month	6th month	12th month
Group I	93±13.99	62.5 ±8	92.5 ±7.69	109.25 ±10.42	117.75 ±7.5
Group II	97.75±12.7	66 ±6.8	95.25 ±7.34	115 ±6.68	122.50 ±4.7
P value	0.268	0.145	0.255	0.055	0.023*

*Significantly different from the precedent time period.

Table 3 Clinical knee society score in points for both groups at different time intervals

Time of follow-up	MPP group (*N*=20)	SV group (*N*=20)
Preoperative	38 (31.5–44)	42 (39–46)
2nd week	59 (54.75–61.75)*	60 (53–62)*
3rd month	76.5 (69.25–78)*	73.5 (69.25–78.75)*
6th month	82.5 (80–84)*	83 (82–84.75)*
12th month	88 (87.5–89.75)*	90 (84.75–90)*
	<0.0125	<0.0125

Data are median 25th and 75th (interquartile). MPP, medial parapatellar; SV, subvastus. *Significantly different from the precedent time period.

both groups; otherwise, there was periodic improvement during follow-up.

Discussion

Good knee function after TKA is related to many technical factors including surgical approaches, biomechanical and anatomical relationships, and alignment. In a recent meta-analysis study of randomized controlled trials that compared between the three most commonly used surgical approaches of TKA (MPP, midvastus, and SV), Liu and colleagues revised 11 randomized controlled trials comparing SV and MPP approaches. A total of 932 patients (male individuals: 40.9%; female individuals: 59.1%) with 936 TKAs were randomly divided into SV and MPP groups. There was no significant difference between them with regard to KSS, range of motion, operative time, blood loss, hospital stay, and postoperative complication. The same meta-analysis showed that the SV group had significant advantages over the MPP group in earlier SLR and less lateral retinacular release (*P*=0.05) [12].

In our study, the SV group had functional advantage over the MPP group in the early postoperative period, as demonstrated by a shorter hospital stay (*P*=0.013) and an earlier 'SLR' (*P*=0.044), indicating an earlier return of quadriceps' function in the SV group.

The operative time for the SV group was significantly longer in comparison with the MPP group, as this procedure is more technically difficult and may be explained by the learning curve to gain experience with this technique.

Hence, the SV approach allows faster SLR, shorter length of stay, and earlier improvement of the quadriceps' strength, and this can be achieved without jeopardizing the alignment or inducing more complications than the MPP approach.

There was no significant difference between the two groups in the estimated blood loss within the first 24–48 h. Postoperative medial thigh hematoma developed in three knees of the SV group. These were transient and did not influence eventual range of motion, rehabilitation, transfusion rates, or pain levels.All functional outcome parameters progressively improved from the second week onward postoperatively in both the MPP and SV groups. The essential beneficial influence of the SV approach on pain was observed in the initial period of assessment. Pain improved significantly overtime in both groups. By the 12th month, there was a significant difference in range of motion with the SV group having a better range of motion (*P*=0.023). Weinrauch *et al.* [15] showed that patients after knee replacement via SV approach reached 90° of flexion earlier but were similar at the time of discharge. In the current study, the average total KSS at the 12th month showed no difference between groups. Stairs subscore improved in both groups without significant difference between them, except at the third month, which indicates an earlier improvement in group II (*P*=0.001). This result was correlated with the early SLR and the earlier improvement in the quadriceps' strength in the SV group. In our study, there was no clinical evidence of deep venous thrombosis in either group or other major complications.

The lack of statistical significance in the overall knee society knee score and functional score is not attributable to the absence of the suitable sample size and type-II error as an a priori sample size analysis was performed before the study had begun.

Lack of true randomization may affect the integrity of currently available data. Future studies must address this methodological inadequacy.

Lack of instrumental quadriceps' strength measurement on which previous study conclusions were based (i.e. Cybex isokinetic dynamometer system and LIDO isokinetic dynamometer) was not performed in this trial.

Conclusion

The SV approach allowed earlier SLR, shorter hospital stay, earlier quadriceps' strength improvement, and better stair score and function score when compared with the traditional MPP group. An intact quadriceps' mechanism and correct component positioning achieved with this exposure provided reliable patellofemoral stability. The SV approach for primary TKA is less invasive than the conventional MPP approach when considering vascular and muscular anatomy.

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Conflicts of interest

There are no conflicts of interest.

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