Subvastus Versus Medial Parapatellar Approach in Total Knee Arthroplasty: Meta-analysis

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abstract

Full article available online at Healio.com/Orthopedics. Search: 20121120-16

The subvastus and medial parapatellar approaches are 2 commonly performed techniques in total knee arthroplasty, but the optimal approach for total knee arthroplasty remains controversial. The purpose of this study was to compare the effectiveness and safety of the subvastus vs medial parapatellar approach.

The PubMed, Embase, Cochrane Library, Inter-Services Intelligence Web of Knowledge, and Chinese Biomedical Literature databases were searched for eligible quasi-randomized, controlled and randomized, controlled trials. Two authors independently extracted data and assessed the methodological quality of the included studies according to the Cochrane handbook version 5.1.0. Statistical analysis was performed using Review Manager version 5.1 software. Eight randomized, controlled trials and 1 quasi-randomized, controlled trial involving 940 primary total knee arthroplasties were included for meta-analysis. Meta-analysis revealed significant differences favoring the subvastus group in Knee Society Score in terms of function at 4 to 6 weeks (weighted mean difference [WMD] = 5.09; 95% confidence interval [CI], 3.08 to 7.09; \( P < .01 \)) and knee score at 12 months (WMD = 2.17; 95% CI, 0.01 to 4.34; \( P = .05 \)) and lateral retinacular release (odds ratio = 0.34; 95% CI, 0.14 to 0.79; \( P = .01 \)) when compared with the medial parapatellar approach. However, both groups showed similar results in range of motion (\( P > .05 \)), operative time (WMD = 2.15; 95% CI, -3.61 to 7.35; \( P = .42 \)), blood loss (WMD = -31.07; 95% CI, -91.89 to 29.75; \( P = .32 \)), hospital stay (WMD = -0.18; 95% CI, -0.67 to 0.31; \( P = .47 \)), and postoperative complications (\( P > .05 \)).

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Messrs Teng, Du, Jiang, and Ma, Ms Pan, and Drs Gao, Wang, An, and Xia have no relevant financial relationships to disclose.

The authors thank Matthew H. Liou for the English editing of this article.

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doi: 10.3928/01477447-20121120-16
Total knee arthroplasty (TKA) is a successful intervention for patients with advanced knee osteoarthritis or rheumatic arthritis because it provides significant pain relief, function improvement, relatively low perioperative morbidity, and long-term implant survival. According to reports, more than 500,000 TKAs are performed annually in the United States, 38,000 in Australia, and 540,000 in Europe.

The medial parapatellar and subvastus approaches are 2 commonly performed techniques for TKA. The medial parapatellar approach, which is the standard approach introduced by Langenbeck in 1879, provides excellent exposure but violates the quadriceps mechanism and vascular supply of the patella, which could lead to complications, including patellar fracture, subluxation and dislocation, avascular necrosis of the patella, button loosening, and anterior knee pain.

The subvastus approach was developed by Hofmann et al in 1991, with the aim of maintaining the integrity of the extensor mechanism and decreasing the vascular damage of the patella. Therefore, the subvastus approach has theoretical advantages for rehabilitation after TKA. Previous studies have confirmed that it offers the benefits of less lateral retinacular release, greater quadriceps strength, less blood loss, and improved patellar tracking when compared with the medial parapatellar approach. However, the disadvantages, such as more technical requirements and greater difficulty in knee exposure and patellar eversion, limit the increased use of this technique.

Several trials have compared the clinical results of the subvastus and medial parapatellar approaches in TKA, but the conclusions were conflicting. Van Hemert et al and Bourke et al advised not to use the subvastus approach because no significant benefits were found. However, Roysam and Oakley and Sastre et al recommended using the subvastus approach for TKA due to its superior clinical and functional results. To determine the optimal approach for TKA, the current authors performed a meta-analysis to compare the efficiency and safety of the subvastus and medial parapatellar approaches.

**MATERIALS AND METHODS**

**Criteria for Considering Studies for Review**

All published randomized, controlled trials or quasi-randomized, controlled trials comparing the clinical results of the subvastus and medial parapatellar approaches in TKA were considered for inclusion without language restriction. Nonrandomized, controlled trials were not considered for inclusion. Adult patients with osteoarthritis or rheumatic arthritis were included. Patients who had a high anesthetic risk (ie, cardiac problems, respiratory depression, low blood pressure, and uncontrollable bleeding in patients with heart or blood problems), knee surgeries within the previous 12 months, and cognitive or language disorders were excluded. Patients in the experimental group underwent the subvastus approach, and patients in the control group underwent the medial parapatellar approach.

Primary outcomes were the Knee Society scoring system and range of motion (ROM). Secondary outcomes were: (1) lateral retinacular release, (2) operative time, (3) blood loss, (4) hospital stay, and (5) postoperative complications (ie, wound or joint infection, pulmonary em-
<table>
<thead>
<tr>
<th>Study/Country</th>
<th>Interventions</th>
<th>No. of Participants (M/F)</th>
<th>Total TKAs (SV/MP)</th>
<th>Mean Age, y SV/MP</th>
<th>Prosthesis</th>
<th>Follow-up</th>
<th>Outcome Measures*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roysam &amp; Oakley10/ UK</td>
<td>SV/MP</td>
<td>89 (47/42)</td>
<td>89 (46/43)</td>
<td>70.2/69.8</td>
<td>Cement, unclear; patella resurfaced, unclear</td>
<td>3 mo</td>
<td>2-4, 6, 7</td>
</tr>
<tr>
<td>Weinhardt et al11/ Germany</td>
<td>SV/MP</td>
<td>52 (19/32)</td>
<td>52 (26/26)</td>
<td>69.7±9.1/73.7±6.8</td>
<td>Cement, yes; patella resurfaced, yes</td>
<td>13 d</td>
<td>2, 4-6</td>
</tr>
<tr>
<td>Bridgman et al12/ UK</td>
<td>SV/MP</td>
<td>231 (119/112)</td>
<td>231 (116/115)</td>
<td>70.1±8.0/70.9±8.1</td>
<td>Cement, unclear; patella resurfaced, 7/115 in MP group, 10/116 in SV group</td>
<td>12 mo</td>
<td>1-3, 6</td>
</tr>
<tr>
<td>Sastre et al13/ Spain</td>
<td>SV/MP</td>
<td>104 (N/A)</td>
<td>104 (56/48)</td>
<td>Unknown</td>
<td>Cement, unclear; patella resurfaced, yes</td>
<td>12 mo</td>
<td>1, 2, 6</td>
</tr>
<tr>
<td>Pan et al14/ China</td>
<td>Mini-SV/MP</td>
<td>68 (20/48)</td>
<td>68 (35/33)</td>
<td>62.5 (54-70)/63.2 (50-75)</td>
<td>Cement, yes; patella resurfaced, no</td>
<td>18 mo</td>
<td>1-6</td>
</tr>
<tr>
<td>Varela-Egocheaga et al15/Spain</td>
<td>Mini-SV/MP</td>
<td>100 (27/73)</td>
<td>100 (50/50)</td>
<td>68.02±8.14/70.64±7.88</td>
<td>Cement; yes; patella resurfaced: yes</td>
<td>36 mo</td>
<td>1, 2, 4, 6, 7</td>
</tr>
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<td>Van Hempt et al16/ Netherlands</td>
<td>SV/MP</td>
<td>40 (13/27)</td>
<td>40 (20/20)</td>
<td>70.3±11.8/70.9±7.1</td>
<td>Cement, no; patella resurfaced, no</td>
<td>3 mo</td>
<td>1, 2, 4-6</td>
</tr>
<tr>
<td>Dutka et al17/ Poland</td>
<td>SV/MP</td>
<td>169 (93/76)</td>
<td>180 (97/83)</td>
<td>70.3±6.1/71±5.1</td>
<td>Cement, no; patella resurfaced, no</td>
<td>24 mo</td>
<td>1, 6</td>
</tr>
<tr>
<td>Bourke et al18/ Australia</td>
<td>SV/MP</td>
<td>76 (31/45)</td>
<td>76 (36/40)</td>
<td>68.1±8.2/67.7±6.5</td>
<td>Cement, yes; patella resurfaced, unclear</td>
<td>18 mo</td>
<td>1, 2, 4-7</td>
</tr>
</tbody>
</table>

*Abbreviations: F, female; M, male; MP, medial parapatellar; N/A, not available; SV, subvastus approach; TKAs, total knee arthroplasties.

1. Knee Society scoring system; 2. range of motion; 3. lateral retinacular release; 4. blood loss (mL); 5. operative time (min); 6. postoperative complications; 7. hospital stay.

bolus, urinary tract infection, patellar dislocation, death, knee stiffness, and deep venous thrombosis.

**Search Methods for Identifying Studies**

A systematic literature search for eligible trials published between November 2011 and June 2012 was conducted in the PubMed, Embase, Cochrane Library, Inter-Services Intelligence Web of Knowledge, and Chinese Biomedical Literature databases. The following search terms and strategies were used in the search, and some search terms were combined: (1) arthroplasty, replacement, knee (Medical Subject Headings), (2) knee replac*, (3) knee arthroplasty, (4) arthroplasty, replacement, knee (Medical Subject Headings) or knee replac* or knee arthroplasty, (5) subvastus, (6) mini-subvastus, (7) southern, (8) subvastus or mini-subvastus or southern, (9) standard, (10) parapatellar, (11) standard or parapatellar, (12) subvastus or mini-subvastus, or southern or standard or parapatellar, (13) arthroplasty, replacement, knee (Medical Subject Headings) or knee replac* or knee arthroplasty and subvastus or mini-subvastus, or southern or standard or parapatellar. In addition, reference lists of the included studies and Google Scholar were searched for other relevant studies.

**Data Collection and Bias Risk Assessment**

Two reviewers (Y.T., W.D.) assessed the potential eligibility of studies identified in the search according to the selection criteria and then determined the possible trials to include. The methodological quality of the included randomized, controlled trials was independently evaluated based on the Cochrane Handbook version 5.1.0 by the reviewers.17 If any disagreements occurred, a third reviewer (J.J.) joined the discussion until a consensus was reached. The authors used the following specific domains that were recommended by the Cochrane Collaboration to judge the risk of bias of randomized, controlled trials: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, (6) selective reporting, and (7) other sources of bias. Each domain was evaluated by yes, no, or unclear guidelines: yes=low risk of bias; no=high risk of bias; unclear=unclear risk of bias.17

**Statistical Analysis**

The Cochrane software (Review Manager version 5.1.0) was used for meta-analyses. Regarding dichotomous variables, the odds ratio (OR) with 95%
confidence interval (CI) was calculated. Continuous variables were pooled as the weighted mean difference (WMD) with 95% CIs. Heterogeneity among the included randomized, controlled trials was expressed by the chi-square test and $I^2$. If heterogeneity was not significant ($P<.10; I^2<50\%$), the fixed-effects model was used for meta-analyses. For the statistical heterogeneity ($P>.10; I^2>50\%$), the random-effect model was used to incorporate heterogeneity among studies. Sensitivity analysis was performed to validate the results in the following ways: (1) excluding the studies using the mini-invasive surgery in TKA, (2) omitting the outcomes of quasi-randomized controlled trials in meta-analysis, and (3) exploring the possible causes for statistical heterogeneity. Subgroup analysis was used for the results with different time points of measurement and various complications.

**RESULTS**

**Description of Studies**

Nine studies that met the inclusion criteria were included in the meta-
Of the included trials, 8 were randomized controlled trials \(^\text{10,14-16,19-22}\) and 1 was a quasi-randomized, controlled trial (randomized by hospital number). \(^\text{23}\) In addition, 2 quasi-randomized, controlled trials (randomized by surgeon) were excluded \(^\text{11,24}\) because the data were unavailable for meta-analysis.

The characteristics of individual randomized, controlled trials are presented in Table 1. A total of 940 primary TKAs (subvastus group, \(n = 482\); medial parapatellar group, \(n = 458\)) were performed. Follow-up ranged from 13 days to 36 months. Both groups were well matched for the preoperative parameters of age, sex, body mass index, knee scores, flexion deformity, and ROM. In addition, 2 studies used minimally invasive surgery in the subvastus group. \(^\text{21,22}\)

### Subgroup Analysis

#### Risk of Bias in Included Studies

Table 2 presents the risk of bias of the included studies. Six studies reported the method of randomization, \(^\text{10,15,16,20-22}\) 2 of which were by envelope, \(^\text{10,16}\) three by computer, \(^\text{15,20,21}\) and 1 by random number table. \(^\text{22}\) Two studies did not report the method of randomization, \(^\text{14,19}\) and 1 was not sufficiently randomized. \(^\text{23}\) Five studies used sealed envelopes or telephones for allocation concealment. \(^\text{10,15,16,20,21}\) Seven trials performed double blinding to patients and assessors. \(^\text{10,14-16,20,21,23}\) Regarding the missing outcome data, 3 and 4 patients were lost to follow-up in the reports by Sastre et al \(^\text{16}\) and Bourke et al \(^\text{15}\), respectively.

### Effects of Interventions

#### Primary Outcome: Knee Scoring System

Seven studies evaluated knee function using 6 measure scores: Knee Society Score (KSS), \(^\text{14,15,20,23}\) the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), \(^\text{14,20}\) the Hospital for Special Surgery Knee Score (HSS), \(^\text{11}\) the medical outcomes study Short Form 36 (SF-36), \(^\text{20}\) the European Quality of Life questionnaires, \(^\text{20}\) and the Barthel scale. \(^\text{16}\) Due to the incompleteness of original data, the current authors only included 4 studies using the KSS for meta-analysis. \(^\text{15,20,22,23}\)
sis was performed for total function and knee scores at different time points. The fixed-effects model was used for meta-analysis of function score at 6 weeks and 6 months because heterogeneity was not found, and others used the random-effects model. Subgroup analysis revealed that significant differences favored the subvastus group in function score at 4 to 6 weeks (WMD = 5.09; 95% CI, 3.08 to 7.09; P = .01) and KSS at 12 months (WMD = 2.17; 95% CI, 0.01 to 4.34; P = .05), and other results were comparable between the 2 groups at 1 year (Table 3).

Primary Outcome: Range of Motion (Degree). Postoperative ROM was reported in all trials, but only 5 studies represented the detailed data as mean and standard deviation that could be involved for meta-analysis. Using a random-effects model for obvious heterogeneity, the meta-analysis of the subgroup demonstrated that no significant differences existed between the medial parapatellar and subvastus groups postoperatively at 4 to 6 weeks (WMD = 2.15; 95% CI, −1.43 to 5.72; P = .24), and at 3 months (WMD = 2.89; 95% CI, −1.48 to 7.26; P = .20), 6 months (WMD = −0.11; 95% CI, −2.18 to 1.97; P = .92), and 12 months (WMD = 3.48; 95% CI, −1.81 to 8.76; P = .20) (Figure 2).

Secondary Outcome: Lateral Retinacular Release. Four randomized, controlled trials were available for meta-analysis. No heterogeneity was found between trials (P = .57). With the fixed-effect model, the result showed that the subvastus group had statistically fewer lateral retinacular releases than the medial parapatellar group (OR = 0.34; 95% CI, 0.14 to 0.79; P = .01) (Figure 3).
Secondary Outcome: Blood Loss (mL), Hospital Stay (Days) and Operative Time (Minutes). The meta-analysis showed that no significant heterogeneity was found in these 3 outcomes. Using a fixed-effects model, no results reached a statistically significant difference with respect to operative time (WMD = 2.15; 95% CI, −3.61 to 7.35; \( P = .42 \)) (Figure 4), blood loss (WMD = −31.07; 95% CI, −91.89 to 29.75; \( P = .32 \)) (Figure 5), and hospital stay (WMD = −0.18; 95% CI, −0.67 to 0.31; \( P = .47 \)) (Figure 6).

Secondary Outcome: Postoperative Complications. Eight studies reported postoperative complications.\(^{10,15,16,19-23}\) A fixed-effects model was used for the meta-analysis because of nonsignificant heterogeneity among studies (\( I^2 = 0\% \)). The meta-analysis revealed that the total morbidity was comparable between groups (OR = 0.75; 95% CI, 0.46 to 1.21; \( P = .24 \)). Subgroup analyses also found no difference for superficial infection (OR = 0.99; 95% CI, 0.24 to 4.04; \( P = .99 \)), deep infection (OR = 0.95; 95% CI, 0.31 to 2.95; \( P = .93 \)), and knee stiffness (OR = 0.50; 95% CI, 0.12 to 2.03; \( P = .33 \)) (Figure 7).

Sensitivity Analysis

A sensitivity analysis eliminated the effect of the minimally invasive technique. When a study applying the mini-subvastus approach in TKA was excluded,\(^{22}\) the heterogeneity among studies disappeared in total KSS at 3 months (\( I^2 = 0\% \); \( P = .40 \)) and 12 months (\( I^2 = 24\% \); \( P = .27 \)), function score at 3 months (\( I^2 = 0\% \); \( P = .75 \)), and knee score at 3 months (\( I^2 = 13\% \); \( P = .27 \)).
Using a fixed-effects model for nonsignificant heterogeneity, most results were stable compared with the original results, except that a significant advantage was absent in knee score at 12 months (WMD = 0.93; 95% CI, −0.79 to 2.65; P = .29).

A sensitivity analysis also excluded the effect of a quasi-randomized, controlled trial. The analysis showed no major changes compared with the original results.

**DISCUSSION**

Although a previous systematic review comparing the clinical outcomes of the subvastus and medial parapatellar approaches has been published, the authors did not perform a meta-analysis for the insufficient reports. Between January 2009 and March 2012, seven new studies, including 6 randomized, controlled trials and 1 quasi-randomized, controlled trial, reported their findings regarding this topic. Therefore, the current authors performed this study to determine which approach is a better choice for TKA.

The current meta-analysis was based on 9 studies (940 primary TKAs). The main finding was that only mild advantages were associated with the subvastus group in better KSS function score at 1 month postoperatively and less lateral retinacular release. The authors found no difference in ROM, blood loss, hospital stay, operative time, or postoperative complications between the 2 groups.

Sensitivity analyses were performed to investigate the effects of the mini-invasive technique and low-quality study in the overall meta-analysis. The authors detected that a study using the mini-subvastus approach might be an important source of heterogeneity. After removing this study, the heterogeneity vanished in several items, and the significance in knee function at 12 months favoring the subvastus group was gone. The explanation might be that the mini-invasive technique in TKA provided better clinical results via reducing the skin incision, preserving the vastus medialis insertion, and avoiding patellar eversion.

This has been proven in individual randomized, controlled trials; Pan et al and Varela-Egocheaga et al found significantly higher KSSs in the mini-subvastus group within 9 months and 3 years postoperatively, respectively. Previous reports also suggested that the mini-subvastus approach provides better knee recovery, shorter hospital stay, less bleeding, and postoperative pain.

In the current study, statistical heterogeneity was evident from the clinical nonuniformity, such as the measure method, observation time, types of prosthesis, and surgical procedure. Despite the heterogeneity, the authors attempted to offer a reliable conclusion by following efforts. First, heterogeneity was incorporated using a random-effects model in meta-analysis. Second, the authors reanalyzed the outcomes using a fixed-effects model after removing the potential source of heterogeneity and then compared those with the raw data. The results showed similar estimates except for 1 (KSS knee function score at 12 months), which suggested that the results were stable.

Regarding the KSS, the subgroup analysis demonstrated that the subvastus group achieved a significantly higher KSS function score at 4 to 6 weeks and knee score at 12 months, but sensitivity analysis excluded the difference in knee function. This result corroborated earlier studies, in which the subvastus approach offered superior short-term functional outcomes. Nevertheless, some studies disagreed with this. Van Hemert et al and Bourke et al reported no differences in the early postoperative period; the latter found a greater KSS functional score related to the medial parapatellar approach at 12 (P = .032) and 18 (P = .028) months.

Range of motion was commonly used as an objective tool for knee recovery after TKA. The meta-analysis suggested that no difference was found in the ROM between groups within 1 year of follow-up. This result was in accordance with the individual randomized, controlled trials by Roysam and Oakley and Van Hemert et al. However, Pan et al and Varela-Egocheaga et al reported a significant long-term benefit for ROM in the mini-subvastus group up to 9 months and 3 years postoperatively, respectively. This might be caused by the mini-invasive technique used in these studies. Other factors, such as preoperative baseline values of patient characteristics (ie, age, body mass index, and pain score), prosthetic design, and postoperative pain management, can also affect the measurement of ROM.

Lateral retinacular release during TKA improved patellar stability and tracking but separated the patellar vascularity that could result in more potential complications. When performing a meta-analysis, the statistical difference was presented between 2 groups. Perhaps the explanation was the different indications used for lateral release. Currently, no thumb or towel clip tests are the principal methods for lateral retinacular release. Although no thumb test is most widely used, Cho et al and Archibeck et al suggested that it might overestimate the necessity for lateral retinacular release. They also recommended the towel clip test as the indication for lateral retinacular release.

When a new surgical approach is introduced, the rate of adverse events should be given serious consideration. Theoretically, the subvastus approach has advantages over the medial parapatellar approach in morbidity by avoiding potential injuries to the patellar vascularity and extensor mechanism. Nevertheless, the meta-analysis showed similar outcomes between both groups with respect to the total postoperative complications, as well as the subgroup analyses for knee stiffness and superficial and deep wound.
infections. It is possible that the subvastus approach increased the difficulty in exposure and reduced access and visibility, which would prolong the tourniquet time and thereby lead to more potential complications. In addition, the follow-up period was relatively short, which also resulted in a shortage of data concerning the long-term complications.

The current study had several limitations. First, the risk of selection bias should be concerning because the method of randomization was incorrect in 1 study and unreported in two studies. Allocation concealment was inadequate in 4 trials. Second, blinding to patients and assessors was unclear in 2 trials, which might cause a high risk of detection bias. Third, the concern of reporting bias also should be raised because only 1 protocol was prespecified before trial. Fourth, the outcomes of continuous data in some trials were not reported as mean and standard deviation. Although the authors attempted to get the detailed data from authors, only Van Hemert et al. replied but did not provide useful data. In addition, the follow-up periods were relatively short in some studies, which might ignore the long-term results (eg, the rates of revision and prosthesis loosening).

The implications for future research should include the following aspects. First, future trials should improve the quality of study according to the CONSORT Statement. Second, the evaluation scores for knee recovery vary, such as use of KSS, WOMAC, HSS, and SF-36; thus, a uniform measurement tool that could reflect a reliable, valid, and responsive result is needed for the standard report. Moreover, a hypothesis that the mini-subvastus approach may provide better results than the subvastus approach could be raised, but few published studies compared the mini-subvastus and subvastus approaches in TKA. Therefore, future research can focus on this hypothesis.

**CONCLUSION**

This meta-analysis showed that the subvastus approach in TKA appears to provide better results in KSS function score and less lateral retinacular release, but no differences were found in ROM, blood loss, hospital stay, operative time, or postoperative complications between the subvastus and medial parapatellar groups. Further well-designed randomized, controlled trials are needed to compare the clinical effect of these approaches in TKA.

**REFERENCES**


