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Mini-midvastus versus mini-medial parapatellar approach in simultaneous bilateral total knee arthroplasty with 24-month follow-up

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Objective: Comparisons of mini-midvastus (mMV) with mini-medial parapatellar (mMPP) approach in total knee arthroplasty (TKA) have been performed in the past but were often compromised by variables such as disease, pain tolerance, bone quality, and surgeon. The aim of this study was to minimize the influence of these factors in order to more accurately evaluate these 2 approaches.

Methods: Forty-five patients who had bilateral arthritis of the knee with similar deformity and preoperative range of motion (ROM) on both sides agreed to have 1 knee replaced via mMV approach (Group I) and the other via mMPP approach (Group II) were evaluated. Postoperative clinical outcomes, postoperative complications, perioperative parameters, and knee component positioning were analyzed.

Results: No significant differences were found between the mMV and mMPP groups with regards to functional assessment, patient satisfaction, postoperative complication, quadricep strength, pain at the point of incision, degree of soft tissue release, as well as ROM. Nor were significant differences found between the 2 groups in terms of perioperative parameters and radiographic component positioning.

Conclusion: The present study did not detect any substantive difference between the mMV and mMPP approaches for TKA. The decision between the 2 surgical approaches should be based on surgeon experience and preference.

Keywords: Minimally invasive; mini-medial parapatellar approach; mini-midvastus approach; total knee arthroplasty.

Level of Evidence: Level II Therapeutic Study

With smaller skin and capsule incisions, avoidance of patellar eversion and tibiofemoral dislocation, and minimisation of knee hyperflexion, minimally invasive surgery (MIS) has been established as a method in total knee arthroplasty (TKA).[1–3] The MIS approach can effectively relieve postoperative pain, promote recovery, improve functional outcomes, reduce length of hospital stay and costs, improve cosmetics, as well as increase patients' satisfaction.[1,3] Consequently, MIS TKA has become increasingly popular with both surgeons and subjects.

As a result of such advantages, MIS techniques were subsequently adopted in TKA by surgeons through a va-

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riety of minimally invasive approaches such as the mini-midvastus (mMV), mini-medial parapatellar (mMPP), quadriceps-sparing, and mini-subvastus approaches. Tenholder et al. performed TKA using a minimally invasive medial parapatellar approach and found less blood transfusion and better flexion in the perioperative period when compared with standard techniques.[4] Simultaneously, the mMV approach has been popularized and reported to lead to earlier improvement of postoperative flexion and higher Knee Society scores (KSS) than standard TKA.[5] Moreover, comparisons of mMV approach with mMPP approach in TKA have been performed.[6–9] However, studies were compromsed by variables such as disease, pain tolerance, bone quality, and surgeon.

To eliminate these variables, Heekin et al.[10] reported 40 consecutive patients who underwent staged bilateral TKA and were prospectively randomized for mMPP approach in 1 knee and mMV approach in the other. The results demonstrated that there were no major differences in outcomes between the 2 approaches. However, to our knowledge, there is a scarcity of data comparing the 2 techniques in terms of functional outcome as well as radiological results in simultaneous bilateral TKA.

The present study investigated the mMV approach and mMPP approach in subjects undergoing simultaneous bilateral MIS TKA performed by the same surgeon to determine which approach provided better early outcomes. It was hypothesized that there is no difference in early functional and radiologic outcomes for the mMV approach and mMPP approach in TKA.

Patients and methods

Between January 2007 and January 2013, a total of 45 patients aged 60–75 years suffering from bilateral knee arthritis with similar deformity and preoperative range of motion (ROM) on both sides were offered simultaneous total knee replacement; 1 knee would undergo the mMV approach while the other would undergo the mMPP approach. Patients were requested to agree to random selection by lottery as to which knee would receive mMV and which one mMPP. The inclusion criteria were defined as follows: (1) no significant neurologic impairments; (2) no uncontrolled hypertension; (3) no other unstable lower-extremity orthopedic conditions; (4) a minimum of 80° of active knee flexion; (5) no greater than 15° knee varus, 15° valgus; and (6) a body mass index (BMI) of 40 kg/m^2 or less. Exclusion criteria were active infection, previous open knee surgery on the affected side, physiological or neurological impairment likely to impede postoperative rehabilitation, immunosuppression, and pregnancy. The study protocol was approved by our Institutional Review Board, and written informed consent was obtained from all patients.

All surgeries were performed by the same surgeon using the same posterior stabilized implant (Genesis™ II, Smith & Nephew, Memphis, TN, USA). At a distance of a 5 mm from the patella, the patellar aponeurosis was released with electrocautery rather than resurfaced. In patients from Group I, a straight skin incision was made, beginning at the level of the tibial tubercle, crossing the medial one-third of the patella, and extending for 2 cm proximal to the superior pole of the patella (Figure 1a). Subsequently, an mMV capsular incision was made from a point 2 cm proximal to the patella, extending 2 cm into the vastus medialis obliquus muscle. In Group II, the surgical approach consisted of a straight anterior midline skin incision extending from the superior aspect of the tibial tubercle to the superior border of the patella (Figure 1b). A limited medial parapatellar arthrotomy was performed with 2- to 3-cm division of the quadriceps tendon above the superior pole of the patella. In both approaches, using differential force, the limited arthrotomy could be moved as a "mobile window" from medial to lateral and from superior to inferior as necessary. The patella was subluxed laterally but not everted, and soft tissue balancing was completed in a standard manner.

Starting on the second postoperative day, patients used a continuous passive motion (CPM) machine

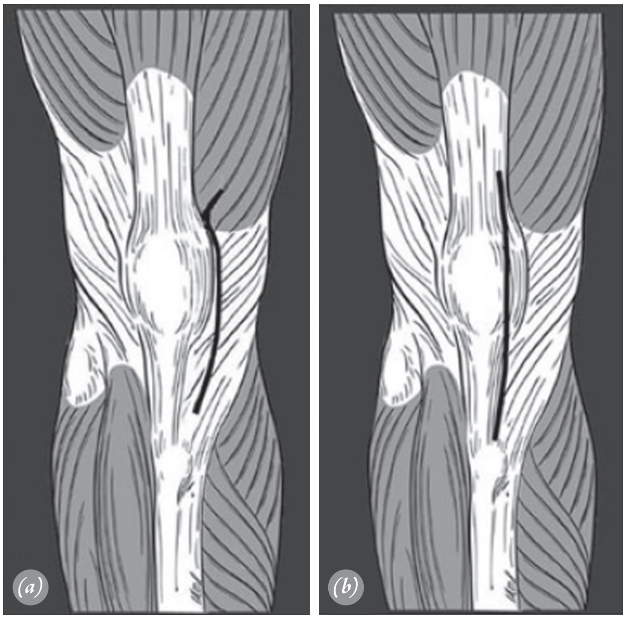

Fig. 1. **(a, b)** Diagrams of minimally invasive approaches used in this study.

for at least 6 h/day. At the same time, active and passive ROM exercises were initiated, as well as ambulation with crutches or a walker once a day with physical therapy supervision. Patients used crutches or a walker with full weight-bearing for 6 weeks and subsequently used a cane.

Clinical evaluations were prospectively assessed for all subjects preoperatively and continued postoperatively at 1, 3, 6, 12, 18, and 24 months. Each knee was rated according to the KSS, Hospital for Special Surgery (HSS) score, functional score, ROM, quadricep strength as determined by straight leg raising time, pain at the incision, as well as degree of soft tissue release.

Other parameters examined included skin incision length, tourniquet time, and total blood loss. Any complications were recorded.

All subjects had preoperative and 24-month postoperative weight-bearing anteroposterior (AP), hip-to-ankle, standard weight-bearing AP, lateral, as well as merchant X-rays. The preoperative mechanical axis and tibiofemoral angles were recorded from preoperative weight-bearing hip-to-ankle radiographs. The postoperative mechanical axis, tibiofemoral angle, AP femoral component angle, and AP tibial component angles were also measured from hip-to-ankle weight-bearing radiographs. The weight-bearing axis from the center of the femoral head to the center of the talus was reported as falling within the medial, central, or lateral third of the knee.

Normality of data distribution was analyzed with the Kolmogorov-Smirnov, Shapiro-Wilk, and paired t-tests. However, if variables violated the normality assumption, Wilcoxon signed-rank test was employed. The threshold for statistical significance was set at a value of $p<0.05$. Statistical analysis was performed using SPSS 13.0 (SPSS Inc., Chicago, IL, USA).

Postoperative primary outcomes were analyzed using 2-way repeated measures analysis of covariance (ANCOVA). This method takes into account outcome measurements taken over time, and successive outcomes were correlated. Although the significance level was established a priori at $p=0.05$ for all statistical tests, the level of significance was corrected with use of the Bonferroni method for multiple comparisons.

Results

Mean tourniquet time was 85.3±5.6 min in Group I and 82.1±3.3 min in Group II ($p=0.254$). Mean skin incision length was 11.2±1.0 cm in Group I and 10.6±2.5 cm in Group II ($p=0.302$). Estimated total blood loss was 224.6±5.6 ml in Group I and 220.1±3.4 ml in Group II ($p=0.125$). Mean straight leg raising time was 1.5 days (range: 1–3 days) in Group I and 1.8 days (range: 1–4 days) in Group II, which was not statistically significant ($p=0.133$). Incidence of lateral retinacular was 2/45 in Group I and 2/45 in Group II ($p>0.05$).

Preoperative KSS was 44.3±5.2 points for Group I and 44.8±7.3 points for Group II. At 24-month follow-up, KSS was 91.3±6.3 points for Group I and 92.17±4.3 points for Group II. There was significant improvement between preoperative and 24-month follow-up KSS for both Group I and Group II ($p<0.001$); however, there were no significant differences between Group I and Group II regarding KSS either preoperatively or postoperatively (Figure 2a).

Mean preoperative HSS in Group I was 59.5±4.0, and it improved to a mean score of 89.6±9.1 at 24-month follow-up ($p<0.001$). Mean preoperative HSS in Group II was 57.4±7.0, which improved to 87.9±6.4 at 24-month follow-up ($p<0.001$). No significant difference was detected between the 2 groups regarding HSS either preoperatively or postoperatively (Figure 2b).

Mean preoperative pain score in Group I was 18.2±1.6, which increased to 42.2±3.2 at 24-month follow-up ($p<0.001$). Mean preoperative pain score in Group II was 17.9±2.0. This score increased to a mean of 43.9±4.1 at 24-month follow-up ($p<0.001$). No significant difference was noted between Group I and Group II with regard to pain score either preoperatively or postoperatively (Figure 2c).

Mean preoperative functional score in Group I 48.3±5.7, which increased to 69.3±7.2 at 24-month follow-up ($p<0.001$). Mean preoperative functional score in Group II was 45.4±5.1. This score increased to a mean of 68.4±4.4 at 24-month follow-up ($p<0.001$). There were no significant differences between Group I and Group II regarding functional score either preoperatively or postoperatively (Figure 1d).

Preoperative knee ROM in Group I averaged 5.8±0.6° in extension and 109.3±9.2° in flexion. Preoperative knee ROM in Group II averaged 5.5±0.4° in extension and 114.1±10.1° in flexion. There were no significant differences between Group I and Group II regarding either preoperative extension or flexion. Postoperative knee ROM in Group I averaged 0.8±0.1° in extension and 115.3±11.0° in flexion. Postoperative knee ROM in Group II averaged 1.0±0.2° in extension and 117.4±9.9° in flexion. No significant difference was detected between the 2 groups regarding either postoperative extension or flexion (Figure 2e, f).

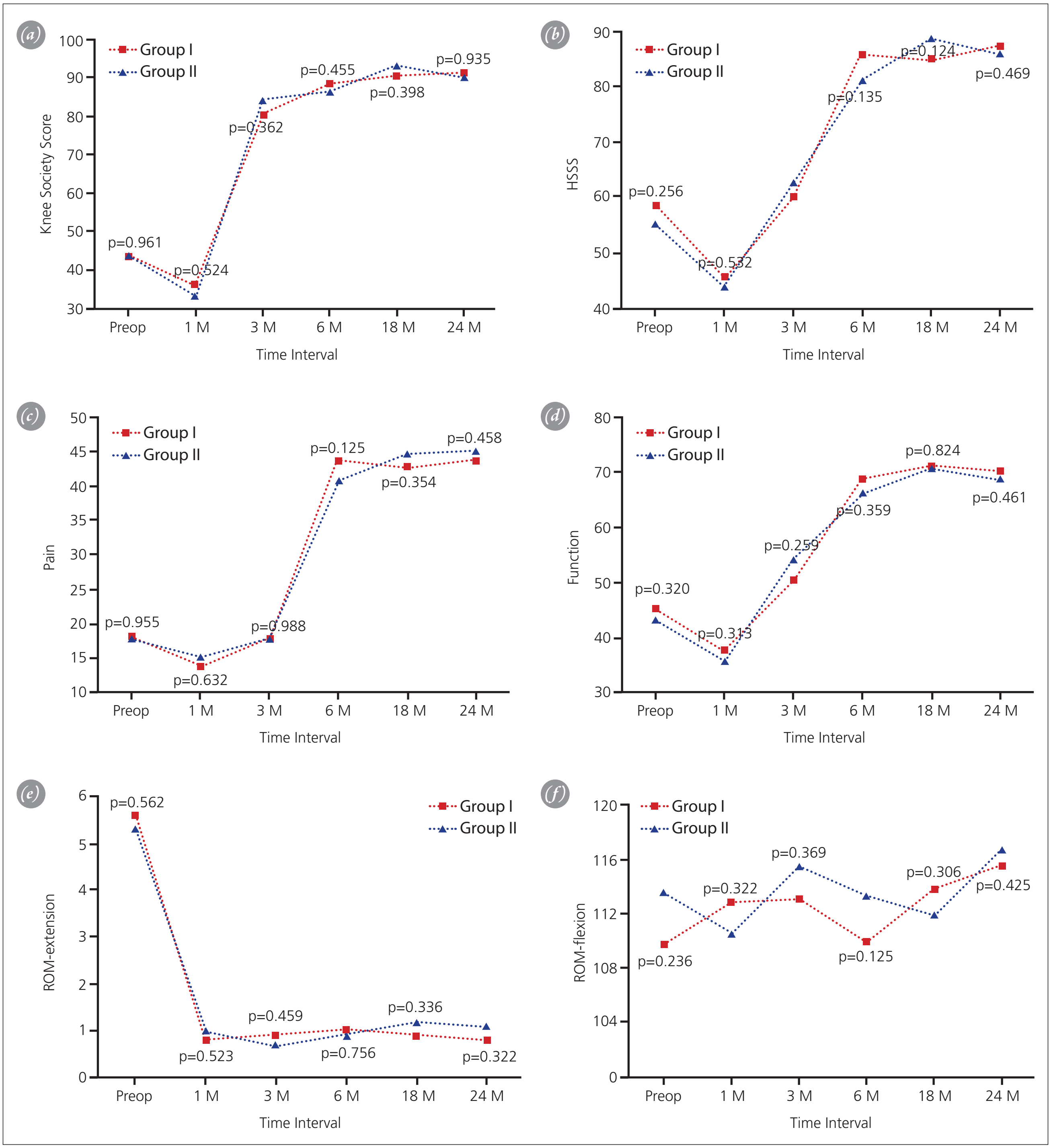

Fig. 2. **(a-f)** Results in mMV and mMPP groups. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Preoperative AP tibiofemoral angle and overall mechanical axis were measured to determine the severity of malalignment (Table 1). Postoperative alignments measured from hip-to-ankle radiographs (AP tibiofemoral angle, AP tibial component, AP femoral component angles, and overall mechanical axis) are presented in Table 2.

No complications such as infection, deep venous thrombosis, prosthesis malalignment, loosening, or obvious polyethylene wear were observed.

Table 1. Preoperative alignment data.

Variable	Group I	Group II	p
	Mean±SD	Mean±SD	
Anteroposterior tibiofemoral angle (°)	2.3±0.4	2.5±0.7	0.435
Overall mechanical axis (°)	-3.0±0.2	-3.3±0.5	0.763

SD: Standard deviation.

Table 2. Postoperative alignment data.

Variable	Group I	Group II	p
	Mean±SD	Mean±SD	
Anteroposterior tibiofemoral angle (°)	6.1±0.4	6.5±0.4	0.398
Anteroposterior tibial component angle (°)	0.7±0.1	0.8±0.2	0.276
Anteroposterior femoral component angle (°)	5.5±0.6	5.1±0.3	0.487
Overall mechanical axis (°)	-0.4±0.2	-0.5±0.3	0.061

SD: Standard deviation.

Discussion

Numerous comparative studies analyzing the results of mMV TKA with mMPP TKA are available in the literature.[6–9] The majority of these studies compared the results of these 2 approaches in different patient groups. However, the significance of such comparisons is greater if compromising factors are minimized. The major finding of the present study is that functional outcomes, especially ROM recovery, were similar for both mMV and mMPP procedures in simultaneous bilateral TKA during the first postoperative 24 months.

A variety of MIS TKA approaches–including mMV, mMPP, mini-subvastus, as well as the quadriceps-sparing approach–have been developed to overcome disadvantages associated with traditional MPP, such as severe early postoperative pain and long rehabilitation periods. Of these approaches, the mini-subvastus and quadriceps-sparing techniques have decreased in popularity due to greater difficulties associated with learning the techniques and in preserving the extensor mechanism as the result of a more distal insertion of the vastus medialis obliquus than originally believed.[11–13] Therefore, in the present study, we investigated whether the mMV and mMPP approaches can be performed as routine MIS TKA approaches.

The present study detected no differences between the mMV and mMPP approaches in terms of clinical outcomes throughout the first postoperative 24 months. A previous study on clinical outcomes in the early recovery phase indicated that mMV resulted in earlier improvement in ROM, better knee scores, as well as less postoperative pain in the initial postoperative period than the conventional medial parapatellar approach.[14] It was also reported that patients who underwent mMV regained motion sooner and had greater ROM at short-term follow-up compared to MPP patients.[15] Nevertheless, that study was retrospective, and the MPP subject data was based on historical records rather than concurrently accumulated data. Regarding the mMPP approach, in a simultaneous bilateral TKA work, Schroer et al.[16] found greater ROM improvement at 1-week postoperatively in mMPP when compared to a conventional medial parapatellar group.

It is crucial to select an appropriate statistical method for evaluating serial changes in clinical outcomes. The aforementioned previous work used only Student's t-test to compare the 2 approaches at each follow-up. Nevertheless, that statistical method does not provide a comprehensive statistical analysis of the effect of the 2 approaches over time. Statistical testing which does not consider multiple comparisons over follow-up points leads to increased Type I errors.[17] It is possible that the better clinical outcomes displayed in the aforementioned previous studies were the result of Type I errors. As a result, in the present study, repeated measures ANCOVA with Bonferroni correction were used to evaluate clinical outcomes in order to reduce the risk of Type I errors.

Because of the difficulties induced by limited working space, MIS approach can result in ligament imbalance, leading to knee instability. Misalignment can result in abnormal patellar tracking, increased polyethylene wear, early loosening, and poor functional outcomes.

[3,5,7,8] In the present study, all components obtained proper alignment, and no differences were noted in radiographic outcomes between the 2 approaches. Thus, long-term durability of the components and success of the 2 approaches may be inferred. These results are facilitated by use of the mobile window technique as well as instruments specifically designed for MIS-TKA. These improved procedures contribute to proper visualization of the different parts of the knee without compromising the soft tissue or positioning of the components.[18–20] Nevertheless, long-term follow-up is needed in order to verify our findings.

Although we aimed to conduct a well-designed study, some potential limitations must be acknowledged. First, the lack of blinded data collection might have led to biased results. Double-blinded studies comparing the mini-subvastus procedure with traditional TKA were met with resistance by a sampling of our patients and our hospital institutional review board. Second, specific outcomes were not analyzed in the present study. Finally, the follow-up period was only 24 months. Therefore, at the present time, the authors cannot speculate whether there will be differences between the 2 groups in regard to long-term outcomes. In the future, the authors should conduct a long-term follow-up study to compare the clinical results of the 2 groups.

No significant differences were detected in short-term outcomes between mMV and mMPP approaches. MIS-TKA can be successfully performed by a senior surgeon through both approaches; ultimately the choice of the surgical approach will depend on the surgeon's experience and preference.

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Conflics of Interest: No conflicts declared.

References

1. Zhang Z, Zhu W, Zhu L, Du Y. Superior alignment but no difference in clinical outcome after minimally invasive computer-assisted unicompartmental knee arthroplasty (MICA-UKA). Knee Surg Sports Traumatol Arthrosc 2014. [Epub ahead of print]
2. Yoo JH, Park BK, Han CD, Oh HC, Park SH. Minimum 5-year Follow-up Results of Minimally Invasive Total Knee Arthroplasty Using Mini-Keel Modular Tibial Implant. Knee Surg Relat Res 2014;26:149–54.
3. Khakha RS, Chowdhry M, Norris M, Kheiran A, Patel N, Chauhan SK. Five-year follow-up of minimally invasive computer assisted total knee arthroplasty (MICATKA) versus conventional computer assisted total knee arthroplasty (CATKA) - A population matched study. Knee 2014;21:944–8.
4. Tenholder M, Clarke HD, Scuderi GR. Minimal-incision total knee arthroplasty: the early clinical experience. Clin Orthop Relat Res 2005;440:67–76.
5. Juosponis R, Tarasevicius S, Smailys A, Kalesinskas RJ. Functional and radiological outcome after total knee replacement performed with mini-midvastus or conventional arthrotomy: controlled randomised trial. Int Orthop 2009;33:1233–7.
6. Zhang Z, Zhu W, Gu B, Zhu L, Chen C. Mini-midvastus versus mini-medial parapatellar approach in total knee arthroplasty: a prospective, randomized study. Arch Orthop Trauma Surg 2013;133:389–95.
7. Li XG, Tang TS, Qian ZL, Huang LX, Pan WM, Zhu RF. Comparison of the mini-midvastus with the mini-medial parapatellar approach in primary TKA. Orthopedics 2010;33:723.
8. Huang Z, Shen B, Ma J, Yang J, Zhou Z, Kang P, et al. Mini-midvastus versus medial parapatellar approach in TKA: muscle damage and inflammation markers. Orthopedics 2012;35:1038–45.
9. Lonner JH. Minimally invasive approaches to total knee arthroplasty: results. Am J Orthop (Belle Mead NJ) 2006;35(7 Suppl):27–9.
10. Heekin RD, Fokin AA. Mini-midvastus versus mini-medial parapatellar approach for minimally invasive total knee arthroplasty: outcomes pendulum is at equilibrium. J Arthroplasty 2014;29:339–42.
11. Liu Z, Yang H. Comparison of the minimally invasive and standard medial parapatellar approaches for total knee arthroplasty: systematic review and meta-analysis. J Int Med Res 2011;39:1607–17.
12. Aglietti P, Baldini A, Sensi L. Quadriceps-sparing versus mini-subvastus approach in total knee arthroplasty. Clin Orthop Relat Res 2006;452:106–11.
13. Kim YH, Sohn KS, Kim JS. Short-term results of primary total knee arthroplasties performed with a mini-incision or a standard incision. J Arthroplasty 2006;21:712–8.
14. Pietsch M, Djahani O, Hofmann S. Minimally invasive mini-midvastus approach as standard in total knee arthroplasty. [Article in German] Orthopade 2007;36:1120–8. [Abstract]
15. Halder A, Beier A, Neumann W. Mini-subvastus approach for total knee replacement. [Article in German] Oper Orthop Traumatol 2009;21:14–24.
16. Schroer WC, Diesfeld PJ, Reedy ME, LeMarr AR. Mini-subvastus approach for total knee arthroplasty. J Arthroplasty 2008;23:19–25.
17. Gauvreau K, Pagano M. Student's t test. Nutrition 1993;9:386.
18. Wohlrab D, Zeh A, Mendel T, Hein W. Quadsparing

approach in total knee arthroplasty. [Article in German] Oper Orthop Traumatol 2009;21:25–34. [Abstract]
19. Juosponis R, Tarasevicius S, Smailys A, Kalesinskas RJ. Functional and radiological outcome after total knee replacement performed with mini-midvastus or conventional arthrotomy: controlled randomised trial. Int Orthop 2009;33:1233–7.
20. Nestor BJ, Toulson CE, Backus SI, Lyman SL, Foote KL, Windsor RE. Mini-midvastus vs standard medial parapatellar approach: a prospective, randomized, double-blinded study in patients undergoing bilateral total knee arthroplasty. J Arthroplasty 2010;25(6 Suppl):5–11, 11.e1.