



Minimal invasive midvastus versus standard parapatellar approach in total knee arthroplasty

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Objective: The aim of this study was to compare the short-term results of total knee arthroplasty (TKA) surgeries performed with minimally invasive mini-midvastus (MMV) incision and the standard medial parapatellar technique (ST).

Methods: Twenty patients (18 males, 2 females; mean age: 67.25±6.70) operated with the ST and 19 patients (4 males, 15 females; mean age: 64.53±7.53) operated with the MMV approach were retrospectively evaluated. The surgery time, blood loss, time to straight leg raise (SLR) postoperatively, range of motion (ROM) and Knee Society (KSS) score and Hospital for Special Surgery (HSS) score were compared between the groups. Radiological evaluation was made with standing orthoroentgenographs both pre- and postoperatively. Mean follow-up time was 29.4±8.2 months in the ST and 17.7±11.1 months in the MMV group.

Results: In the early postoperative period (10th day), the MMV group was significantly better than the ST group in terms of ROM. Time to SLR and blood loss values were also significantly better in the MMV group. However, there was no significant difference between the groups after the sixth month, for ROM, KSS and HSS values (p>0.05). Surgery time was significantly longer (with a mean difference of 22 minutes) in the MMV group. Radiological examination revealed ideal alignment in both groups. No deep or superficial infection was detected. Two patients in the MMV group had skin problems which healed after clinical follow-up.

Conclusion: Our results suggested that functional results of TKAs performed via the MMV approach are better in the first six months when compared to those of the ST.

Key words: Total knee arthroplasty; minimal invasive; midvastus approach; medial parapatellar approach.

Total knee arthroplasty (TKA) has been successfully performed in the advanced stages of knee osteoarthritis for years.^[1-4] This is one of the most successful interventions among orthopaedic surgeries. Despite the reports of prosthesis survivals up to 15-20 years, many patients experience pain and difficulty while walking in the early postoperative period; and gaining full functionality may take a long time, reducing the overall satisfaction rate.^[5-7]

Classical approach used in the standard total knee arthroplasty is the 'medial parapatellar' approach.^[1,2,8-12] To avoid some disadvantages of this method, capsular exposure has alternatively been performed via subvastus and midvastus incisions. However, minimally invasive approach promote a faster healing time.^[13,14] In the medial parapatellar approach, the quadriceps tendon, vastus medialis obliquus (VMO) muscle and the rectus

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femoris (RF) tendon are cut longitudinally and proximally to expose the knee joint, using a long skin incision. This incision enables a perfect exposure of all compartments of the knee joint while causing a significant loss in strength of the extensor mechanism of the knee. This damage in the extensor mechanism may be the cause of the persistent pain after TKA.^[6,15] These concerns encouraged the use of minimally invasive approaches in TKA.

The aim of this study was to compare the short-term results of TKA performed with minimally invasive mini-midvastus (MMV) incision and the standard medial parapatellar technique (ST).

Patients and methods

Nineteen patients (4 males, 15 females) underwent TKA with MMV approach between 2009 and 2010. The control group consisted of 20 patients (2 males, 18 females) who underwent TKA with ST. All patients were diagnosed with primary osteoarthritis. Patients with a body mass index (BMI) above 35, patients with a previous open knee surgery, patients with a preoperative active knee flexion of less than 80 degrees, a flexion contracture above 15 degrees, a varus deformity above 15 degrees, and a valgus deformity were excluded from the study. Mean follow-up time was 17.6 (range: 6 to 37) months in the MMV and 29.4 (range: 11 to 43) months in the ST group. The demographic data of the patients are shown in Table 1.

Table 1. Demographic data of the patients.

	ST Group n=20		MMV Group n=19		P values
	Mean	SD	Mean	SD	
Age	67.25	6.70	64.53	7.53	0.25
BMI	32.56	3.02	32.02	2.38	0.59
KSS (Total)	42.70	10.61	43.00	5.78	0.86
HSS score	58.60	4.76	61.29	3.80	0.07*

BMI: body mass index, KSS: Knee Society score, HSS: Hospital for Special Surgery score, SD: standart deviation. *Statistically significant difference.

Genesis 2 (Smith & Nephew, Memphis, TN, USA) ligament-retaining prosthesis was used in all cases and a pneumatic tourniquet was used during surgery. All patients were given prophylaxis with 2 g of cefazolin. In the MMV group, a straight skin incision that started 2 cm proximally to the superior patellar pole, passed through the 1/3 medial of the knee and ended 2 cm distal to the knee joint line was made while the knee was in flexion (Fig. 1). Mean incision length was measured as 11 (range: 9 to 12) cm with the knee in extension. Patellar retinaculum was exposed with an incision 1 cm medial to the patella, and capsular incision was extended 2-3 cm into VMO fibers, 2 cm proximal to the superior patellar pole (Fig. 2). The patella was displaced toward the lateral but not everted.

In the ST group, again a straight incision through the patellar midline was performed as the knee was

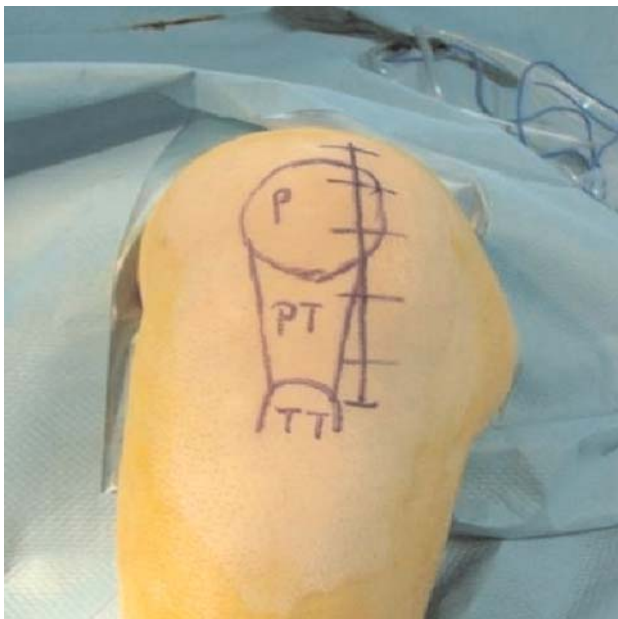


Fig. 1. Skin incision in the midvastus approach. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

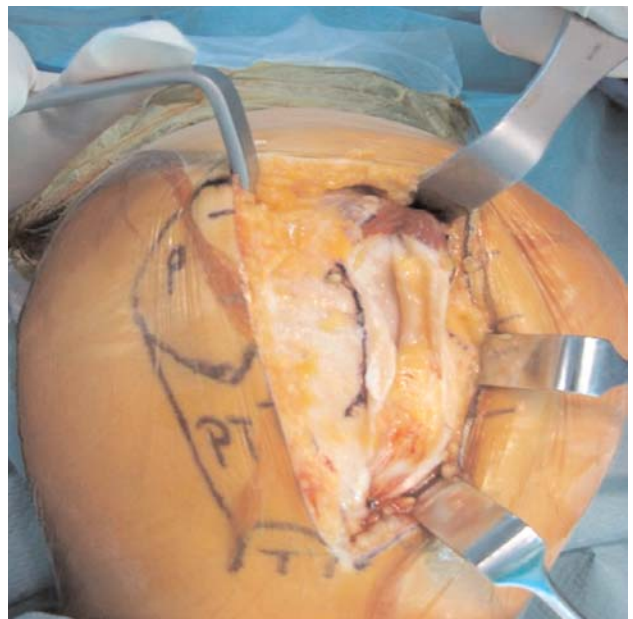


Fig. 2. Capsular incision in the midvastus approach. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

extended. The mean length of the incision was 20 (range: 16 to 24) cm. Patellar retinaculum was longitudinally opened through the medial of the patella and capsular incision was extended proximally from the attachment point of the RF and VMO muscles toward the proximal, and distally 2 cm below the level of the tuberosity of the tibia. The knee joint was flexed after the patella was everted. Using specially designed instruments, a distal femoral osteotomy was performed in the MMV group, followed by tibial and anteroposterior femoral osteotomies. The patella was replaced in cases with a significant cartilage defect. Intramedullary guide was used during femoral osteotomies and extramedullary guide during tibial osteotomy in all patients. Suction drain was kept for 24-48 hours postoperatively. Based on their weights, patients received low-molecular-weight heparin (enoxaparin) and deep vein thrombosis prophylaxis throughout the first ten days. On the first postoperative day, isometric quadriceps and active knee range of motion exercises were begun, along with passive range of motion exercises a continuous passive motion (CPM) device. Narcotic PCA analgesia was used in the early postoperative period and then intravenous and oral analgesics were introduced for pain control.

Patients were examined preoperatively, at the first and 10th postoperative days, and at the first, 2nd, 3rd, 6th and 12th months follow-ups and evaluated for knee extension, range of motion (ROM), active straight leg raise (SLR), postoperative blood loss, surgery time, component alignment, functional and total Knee Society score (KSS) and Hospital for Special Surgery (HSS) score, visual analog scale (VAS) and complications. Radiological assessment was made with anteroposterior and lateral standing orthoroentgenographs pre and postoperatively. Mechanical axis deviation (MAD), Femorotibial angle, medial proximal tibial angle (MPTA), lateral distal femoral angle (LDFA), posterior tibial slope angle, and femoral posterior condylar angle were measured. Postoperative ROM was measured with a goniometer. None of the radiological and clinical examinations were carried out by the surgeon.

In statistical analysis, chi-square test was used to compare the qualitative, independent samples t-test to compare the groups. The Mann-Whitney U test was used for comparison when the data did not comply with normal distribution. The significance level was set at $p < 0.05$.

Results

Patients who underwent TKA with MMV approach gained functionality faster in the short term and also had

a higher ROM in the knee joint. Mean knee ROM was 107.65 degrees in the MMV and 100.5 in the ST group on the 10th day ($p < 0.05$). Yet, we observed no significance difference between two groups in the final follow-up. Mean ROM was 107 degrees in the MMV and 109.5 in the ST group on the 12th month follow-up ($p > 0.05$). There was also no significant difference in terms of KSS and HSS scores on the 12th month follow-up; total KSS was 88.59 in the MMV and 89.65 in the ST group ($p > 0.05$) whereas mean HSS score was 90.41 in the MMV and 90.20 in the ST group ($p > 0.05$). However, MMV group had better results than the ST group in terms of postoperative blood loss and time to active SLR. In the MMV group SLR was achieved on an average of 1.82 days and in the ST group on 2.9 days ($p = 0.0001$). Based on the postoperative drainage, the amount of postoperative blood loss was noted as 635 ml for the MMV and 1125 ml for the ST group ($p = 0.0001$). Postoperative results are shown in Table 2.

Radiological examination revealed ideal alignment in both groups. There was a significant difference between the LDFA values of MMV and ST groups (87.88 ± 1.31 and 91.65 ± 1.34 , respectively) ($p < 0.05$).

None of the patients experienced a major complication. Two patients in the MMV group developed a superficial necrosis which later recovered merely by close clinical follow-up.

Discussion

Medial parapatellar approach is the main surgical approach in TKA. In this classical approach, a long parapatellar arthrotomy is performed following a skin incision of 20-25 cm. After wide soft tissue dissection, the patella is everted and the knee joint is subluxated during tibial osteotomy. Standard medial parapatellar approach not only provides a perfect exposure of the surgical field but also eases the use of large guides of knee arthroplasty, making it a popular technique. However, the damage to the quadriceps tendon, eversion of the patella, the damage to the posterior joint capsule due to the subluxation of the knee joint, and adhesions in the suprapatellar region are the major causes of persistent pain after surgery.^[6,15,16]

Although the length of skin incisions performed, with the knee extended, in minimally invasive knee arthroplasty surgeries may vary between 6 and 13 cm, surgeries with incisions smaller than 14 cm are usually accepted as "minimally invasive".^[4,9,10,17,18] However, this is not the length of the skin incision is not what makes the surgery less invasive.^[5,19] Deep dissection is also small as the skin incision. The surgery is performed

Table 2. Demographic data of the patients.

	ST Group n=20		MMV Group n=19		P value
	Mean	SD	Mean	SD	
Operation time (minutes)	83	12.39	105	8.47	0.0001*
Blood loss (ml)	1125	115.08	635.29	180.07	0.0001*
Knee flexion at 10th day (°)	102.5	9.10	107.65	9.03	0.094
ROM at 10th day (°)	100.5	10.5	107.6	9.34	0.035*
Knee flexion at final visit (°)	111.5	8.12	108.82	11.11	0.404
Knee ROM at final visit (°)	109.5	9.44	107.06	11.6	0.485
Active straight leg raise time (day)	2.9	0.44	1.82	0.72	0.0001*
Incision length (cm)	15	0.7	11	1	0.0001*

ROM: range of motion. *Statistically significant difference.

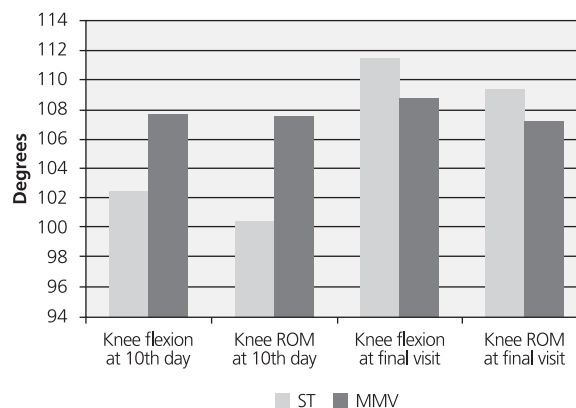
through this small incision by creating a moving window. Thus, excessive flexion-extension of the knee joint is avoided, integrity of the quadriceps tendon is preserved, the patella is not everted, and soft tissue damage is lesser.

In our study, mean incision length while the knee was extended was 11 cm in the MMV group. However, we think that fast recovery in the early postoperative period was due to the less soft tissue damage rather than the size of the incision which we deem as a secondary benefit. Pain in knee arthroplasty is a major complication that restricts the knee movements and complicates rehabilitation in the postoperative period. Minimally invasive approach helps pain relief by minimizing the soft tissue damage.^[3,5,11,19-22] Standard comparison of the patients in terms of pain was not possible in our study as we could not monitor the VAS values in the early term. As for the late term, there was no significant difference between the VAS values. As our pain assessment was completely subjective, we think MMV patients had less pain when compared to the ST group in the early term where no VAS assessment was performed. The most positive outcomes of TKA performed with minimally invasive approach are high degree of flexion and early regain of joint movements and functionality,^[3-5,8,10,11,16,18-21,23-28] helping the rehabilitation period and decreasing the length of hospital stay.^[3,18,20,21,29] Especially climbing up and down stairs is achieved earlier.^[18,19] However, these positive outcomes rarely prevail^[16,22,24,30] as they will show similarity to the outcomes of standard arthroplasty in the long term.^[5,8,10-12,19-21,25,28,29,31]

Patients in the MMV group had better results in terms of flexing their knees and their range of motion compared to the ST group on the 10th day. However, there was a significant difference only in the range of

motion. We can argue that extension restriction due to weakness of the quadriceps muscle in the MMV group especially in the early term was less, causing this difference. Therefore, we observed a significant increase not only in flexion but also in the range of motion. However, all these differences disappeared in the later term and patients in both groups showed no difference in terms of flexion and ROM during the final follow-up (Fig. 3).

Performance of SLR by the patients operated with minimally invasive approach points out to the return of quadriceps muscle strength.^[11,22,29] This increase in the quadriceps muscle strength have been reported in quantitative studies.^[8,13,27,31] In their elaborative studies, Schroer and Nestor measured the pre- and postoperative muscle strengths of their patients with a dynamometer and reported that patients had gained their preoperative quadriceps muscle strength in a short period and even exceeded those levels by 30% in 3 to 6 months.^[15,31] Similarly, we observed that SLR in the MMV group was achieved earlier. However, we detect-

**Fig. 3.** Range of motion of the knee in the MMV and ST groups.

ed no significant difference between the two groups in terms of functional and total KSS and HSS scores. This difference in the quadriceps muscle strength between the two groups is of great importance for the return of patients to daily activities like walking without support, climbing up and down the stairs and walking long distances is directly proportional to the quadriceps muscle strength. This difference is even more obvious especially in bilateral TKA.^[32] In our study, we observed that in accordance with short time to SLR, patients operated with minimally invasive approach were rehabilitated easier and mobilized faster.

Another advantage of the minimally invasive approach is the need of less transfusion as the blood loss is less.^[3,4,32] The increased number of transfusion is a risk factor for infection. However, several studies showed there was no difference in terms of blood loss, as a matter of fact, early mobilization and wide ROM in the early postoperative period might lead to an increase in blood loss.^[5,10,22,33] In our series we observed that the loss in the ST group was almost two-fold of that of the MMV group. As a matter of fact the mean number of transfusion was lesser in MMV group.

Main argument against minimally invasive knee arthroplasty is the extended surgery time which may lead to increased rate of complications.^[11,34,35] Fierce debates have taken place discussing the component malalignment and subsequent complications in long-term. Malalignment is a major cause of failure after TKA and may lead to aseptic loosening in short term. Studies showed that an error of a few degrees in alignment may increase the failure rate in early term by 17 times,^[34,36,37] making some authors advocate that the method is a unnecessary and risky show of mastery.^[33,34] During minimally invasive TKA, implantation of the tibial component with the lateral tibial plateau not fully in sight may result in malalignment of the tibial component. Medialization have been reported especially for the tibial component.^[22,23] Incomplete view of transepicondylar axis, which is taken as the reference point during femoral osteotomies, may lead to implantation of the femoral component in internal rotation or varus.^[21,32,37,38] Other major intraoperative complications include fractures of the lateral femoral condyle and patellar tendon ruptures, especially in muscled or obese patients.^[11,39] We think that malalignment and other complications will be reduced if minimally invasive TKA is performed on patients with appropriate indication by experienced surgeons. None of our patients had a malalignment problem. The approach

also seems to be radiologically safe as reported by several studies with large series of patients.^[3-5,8,12,18-24,28-32]

Patient selection is also of great importance in reducing complication rates. Although there is no absolute contraindication, minimally invasive TKA should be usually avoided in patients with an advanced stage genu varum deformity (femorotibial angle >195 degrees), knees with valgus deformity, morbid obesity (BMI>40), a flexion contracture above 25 degrees, an active flexion less than 80 degrees and in muscled male patients.^[11,19,37]

Mean surgery time in the MMV group was 22 minutes longer than the ST group. Although surgery and tourniquet application duration was at least 35 minutes longer than the ST for the first 10 cases, surgery time shortened after the tenth case and had no difference compared to the ST in the last 4 cases. However, in general, surgery and tourniquet application duration is longer than the ST in minimally invasive TKA surgeries.^[4,12,23,28,32]

Excessive retraction due to minimal exposure may impair wound healing. In muscled male patients the surgery is challenging due to the large bones and difficulty in dislocating the patella and wound healing problems are more common.^[4,23,25,28] Thus, when the dislocation of the patella is not easy, the surgeon should extend the incision and switch to the classical method. Two of our patients experienced wound problems due to excessive retraction during surgery. However, both healed without further intervention.

Finally, smaller incision makes the patient think that the surgery will also be small and simple, and will generate a positive psychology.^[33]

We did not observe any major complication in patients operated with the MMV technique. Radiologically ideal alignment was achieved in all patients. We can postulate that minimally invasive TKA enables fast mobilization in short term and expedites recovery time, do not give rise to complications, making it a safe technique although it is impossible to draw a definite conclusion due to our small series of patients.

Small population of patients, short follow-up time, lack of standard comparison in terms of pain due to inability to monitor VAS values in the postoperative early period, lack of functional comparison due to inability to check the knee scores (KSS and HSS), and the retrospective nature of our study are main drawbacks of our study.

Total knee arthroplasty performed with MMV approach enables faster regain of joint movements and functionality in the early postoperative period. However,

in long term there is no significant difference between the results of the patients operated with the standard technique and minimally invasive approach.

Conflicts of Interest: No conflicts declared.

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