Patellar Tracking and Anterior Knee Pain are Similar After Medial Parapatellar and Midvastus Approaches in Minimally Invasive TKA

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Abstract

Background Since the medial parapatellar (MPP) approach in conventional TKA can cause patellar maltracking and anterior knee pain, some orthopaedic surgeons use the midvastus (MV) approach instead of the MPP approach to reduce patellar maltracking. Minimally invasive surgical (MIS) TKA has been developed to limit the damage to the surrounding muscle and reduce the necessity of patellar eversion during surgery. Thus, MIS TKA might be associated with proper patellar tracking and a low

incidence of anterior knee pain. However, this presumption has not been confirmed.

Questions/purposes We asked whether the incidence of patellar maltracking and anterior knee pain differed with the MV and MPP in association with MIS TKA.

Methods We prospectively followed 59 patients (60 knees) treated with 60 primary cemented MIS TKAs from August 2009 to September 2010. We randomized the patients into two groups: 30 who had a limited MPP approach and 30 who had a mini-MV approach. We recorded the occurrence of anterior knee pain, patellar tilting, and subluxation. The minimum followup was 12 months (mean, 18.03 months; range, 12.00–25.08 months).

Results We found no differences in anterior knee pain (two of 30, 7% versus two of 30, 7%), mean patellar tilt ($3.4^\circ \pm 2.9^\circ$ versus $3.0 \pm 2.3^\circ$), and mean patellar subluxation (1.5 ± 1.1 mm versus 1.1 ± 0.7 mm) between the limited MPP and mini-MV groups, respectively.

Conclusions MIS TKA using either the MPP or MV approach has a low incidence of patellar maltracking and anterior knee pain.

Level of Evidence Level I, therapeutic study. See the Guidelines for Authors for a complete description of the levels of evidence.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Abnormal patellar tracking after TKA can lead to diminished ROM, anterior knee pain, crepitation, an overload to the polyethylene implants, and abnormal implant wear [10, 13, 24]. Patellar tilt and displacement can worsen during the long-term postoperative period when performed with a medial parapatellar (MPP) approach [15, 20, 22, 26]. The midvastus (MV) approach, which was popularized in the

last decade, has some potential advantages regarding patellar tracking and lateral retinacular release rate [8, 9, 17, 31]. Therefore, some orthopaedic surgeons use the MV approach rather than the MPP approach to reduce patellar maltracking.

Minimally invasive surgical (MIS) TKA uses a smaller incision, typically does not require eversion of the patella, and involves less quadriceps muscle splitting and thereby minimizes quadriceps muscle damage. It was believed to reduce hospitalization time [4, 28], increase ROM [14, 28], reduce pain [4, 14], and more rapidly restore function [4]. In addition, if the quadriceps in the MPP approach is cut no more than 2 cm above the superior pole of the patella, the quadriceps recovers more rapidly [6, 27]. Although these studies showed early recovery and less postoperative pain with MIS TKAs, they did not address the incidence of patellar maltracking or development of anterior knee pain.

We asked whether the incidence of patellar maltracking and anterior knee pain differed with the MV and MPP in association with MIS TKA.

Patients and Methods

From August 2009 to September 2010, we performed 60 primary cemented MIS TKAs. Thirty limited MPP approaches and 30 mini-MV approaches were selected at random using a list of random numbers generated by a computer program. We considered for inclusion all patients with primary osteoarthritis, age older than 50 years, ROM greater than 90°, varus deformities less than 30°, valgus deformities less than 30°, and flexion contractures less than 30°. We excluded 14 patients with secondary osteoarthritis (eg, rheumatoid arthritis, posttraumatic arthritis) and severe deformity. Assessments of patellar tilt angle, subluxation, and patellar maltracking were made according to the method described by Gomes et al. [11]. During the study

we performed 60 primary cemented TKAs in a total of 59 patients. No patients were lost to followup. The minimum followup was 12 months (mean, 18 months; range, 12–25 months). No patients were recalled specifically for this study; all data were obtained from medical records and radiographs.

We performed a sample-size estimation based on the incidence of patellar maltracking in TKA which showed that 30 patients in each group would be required to show a difference with a risk difference of 5% (28% versus 33%) at a significance level of 0.05 and power of 80%.

We recorded demographic data including age, sex, site, BMI, preoperative ROM, preoperative knee score, and preoperative deformity. There were no differences between groups (Table 1).

One of us (BP) performed all procedures with a posterior-stabilized prosthesis (NexGen[®] LPS Hi-Flex; Zimmer, Inc, Warsaw, IN, USA) and patellar resurfacing in all cases. All patients received a spinal block with morphine 0.1 mg to 0.2 mg. After the spinal block, 1 g cefazolin and 750 mg tranexamic acid were given intravenously. A thigh tourniquet was inflated to 300 mm Hg in all cases before skin incision. The anteromedial skin incision was performed from the upper pole of the patella to the tibial tubercle. In the mini-MV group, the vastus medialis oblique (VMO) muscle was split approximately 2 cm along its fiber from the superomedial pole of the patella. The MPP retinaculum then was cut distally along the medial aspect of the patella and patellar tendon to the upper border of the tibial tubercle. The knee was extended and the patella rotated 90°; the patella was resected using an onlay technique. After the patella was cut, the knee was flexed 70° to 90° and the patella was laterally subluxated, but not everted. The femur and tibia were cut with the assistance of the small, modified instrument that can cut from medial to lateral.

In the limited MPP group, the quadriceps was cut 2 cm above the upper pole of the patella along the medial border

Table 1. Demographic data

Variable	Limited MPP approach group (n = 30)	Mini-MV approach group (n = 30)	p value
Age (years)*	67 ± 6.0 (60–79)	67 ± 4.9 (54–73)	0.42
Sex (female/male)	23/7	25/5	0.08
BMI (kg/m ²)*	26 ± 2.3 (22–31)	27 ± 2.4 (22–31)	0.22
The Knee Society score (points)*	34 ± 2.5 (28–52)	33 ± 2.2 (28–52)	0.70
ROM (°)*	119 ± 12 (90°–140°)	113 ± 13 (90°–140°)	0.09
Varus deformity (°)*	6.6 ± 7.0 (2°–30°)	8.1 ± 5.8 (2°–29°)	0.39
Valgus deformity (°)*	15 ± 4.5 (2°–3°)	17 ± 1.4 (2°–30°)	0.64
Flexion contracture (°)*	10 ± 3.4 (5°–25°)	12 ± 2.9 (5°–30°)	0.42

* Values are expressed as mean ± SD, with range in parentheses; MPP = medial parapatellar; MV = midvastus.

of the VMO. The arthrotomy ran medial to the border of the patella and patellar tendon. We finished the patella first, without everting it. We used the same instrument to finish the femur, tibia, and patella in both approaches. Thirty milliliters of bupivacaine was injected into the capsule and quadriceps tendon and the VMO muscle before the incision was closed. One intraarticular drain (10-gauge) was inserted before the incision was closed. A compressive bandage was used after closing the skin incision. We recorded the incidence of lateral retinacular release during surgery, skin incision length, operative time, blood loss, and postoperative patellofemoral complication (eg, patellar clunk, patellar crepitation, and fracture).

The compressive bandage, Foley catheter, and intravenous fluid were removed on postoperative Day 1. The patients also started to do ankle pumps, active assistive ROM knee exercise, and ambulate with partial weight-bearing. The cool pack also was applied. The drain was removed on Day 2 and the patient was discharged from the hospital on Day 3. We assessed blood loss from a RedivacTM drain (Atrium Medical, Hudson, NH, USA). Postoperative pain was assessed using a VAS. All patients were asked to do a straight leg-raising test (SLRT) on Day 1. The patients were asked to perform quadriceps exercise, approximately 20 repetitions three times per day, as soon as possible to improve patellar tracking and reduce anterior knee pain.

We followed patients at 6 weeks, 3 months, 6 months, 1 year, and annually thereafter. Our research assistant questioned patients at each visit regarding anterior knee pain during low chair-rising activities and stair climbing. If the patient presented with anterior knee pain, the assistant scored the pain using a 10-point VAS, with 0 representing no pain and 10 representing the maximum pain experienced. We obtained a Knee Society Score[®] (KSS) [12] at each visit. At each visit, we also obtained AP, lateral, and skyline view radiographs. We recorded the occurrence of patellar tilt and subluxation from imaging. Patellofemoral complications such as patellar clunk, crepitation, fracture, and infection were recorded. We assessed patellofemoral complications by the history, physical examination, and

imaging. Two of us (BP and YT) independently evaluated the skyline view and measured patellar subluxation and patellar tilt using the methods of Gomes et al. [11]. We used the means of the two values for statistical analysis. For patellar tilt and subluxation, the interobserver reliabilities using Pearson's correlation coefficient were 0.944 and 0.974 respectively.

We computed the means and standard deviations of the KSS, ROM, knee alignment, femoral and tibial component alignment, tibial slope, and the bone-patellar angle using Student's t-test. We determined the difference in the mean patellar tilt, patellar subluxation, and VAS for anterior knee pain between both groups using Student's t-test and the differences in the percentage of patients who had anterior knee pain and patellar maltracking between both groups using the chi-square test. All 60 randomized knees were included in the data analysis. We used SPSS[®] version 13 (SPSS Inc, Chicago, IL, USA) for the analysis.

Results

The two approaches showed the same percentage of anterior knee pain (five of 30 [17%] versus five of 30 [17%]) and same mean VAS score for anterior knee pain (3.4 versus 3.4) at 6 weeks. At 3 months postoperatively, patients who had the limited MPP approach had a higher percentage of anterior knee pain and mean VAS score for anterior knee pain than patients who had the mini-MV approach (five of 30 [17%] versus three of 30 [10%] and 3.2 versus 3.0, respectively) and 6 months (four of 30 [13%] versus two of 30 [7%] and 2.5 versus 2.3, respectively). However, the two techniques had the same percentage of anterior knee pain (two of 30 [7%]) and mean VAS score (1.0) after quadriceps recovery (at 1 year) (Table 2).

We found no differences between the two groups in patellar tilt and patellar subluxation at 6 weeks, 3 months, 6 months, and 1 year (Table 3). Sixteen percent of patients with the limited MPP approach and 10% of patients with the mini-MV approach had a patellar tilt angle greater than

Table 2. VAS and percentage of patients presenting with anterior knee pain

Time	VAS score (points)*			Anterior knee pain (number of patients)		
	Limited MPP approach group	Mini-MV approach group	p value	Limited MPP approach group (n = 30)	Mini-MV approach group (n = 30)	p value
6 weeks	3.4 ± 1.3 (0–5)	3.4 ± 1.1 (0–5)	0.92	5 of 30 (17%)	5 of 30 (16.7%)	1.00
3 months	3.2 ± 1.3 (0–4)	3.0 ± 0.9 (0–4)	0.42	5 of 30 (17%)	3 of 30 (10%)	0.28
6 months	2.5 ± 1.2 (0–3)	2.3 ± 0.8 (0–3)	0.37	4 of 30 (13%)	2 of 30 (7%)	0.39
1 year	1.0 ± 0.3 (0–1)	1.0 ± 0.3 (0–1)	1.00	2 of 30 (7%)	2 of 30 (7%)	1.00

* Values are expressed as mean ± SD with range in parentheses; MPP = medial parapatellar; MV = midvastus.

5°, and only 3% of patients in both groups had patellar subluxation greater than 5 mm (Table 3).

Postoperative pain, blood loss, ROM, and KSS were similar between groups (Table 4). All patients who had the limited MPP approach performed the SLRT on Postoperative Day 1. However, one patient in the mini-MV approach group could not perform the test on Day 1. The mini-MV approach was associated with longer ($p = 0.001$)

mean operative time (114 versus 97 minutes) and longer ($p = 0.001$) mean skin incision length (9.0 versus 8.6 cm). The alignment of the prosthesis and bone patellar angle was the same in both groups (Table 4).

No patient in either group experienced any complications such as patellar crepitation, patellar clunk syndrome, fracture, and infection (Table 4). No patient in either group needed lateral retinacular release.

Table 3. Patellar tilt angle, subluxation, and maltracking

Time	Tilt (°)* and tilt > 5° (%)			Subluxation (mm)* and subluxation > 5 mm (%)		
	Limited MPP approach group	Mini-MV approach group	p value	Limited MPP approach group	Mini-MV approach group	p value
6 weeks	2.7 ± 2.4 (0–9)	2.6 ± 1.7 (0–8)	0.80	1.2 ± 1.0 (0.0–3.0)	1.0 ± 0.6 (0–2.7)	0.59
	3 of 30 (10%)	2 of 30 (7%)	0.64	0 of 30 (0%)	0 of 30 (0%)	1.00
3 months	2.9 ± 2.5 (0–10)	2.6 ± 1.8 (0–8)	0.60	1.2 ± 0.9 (0–3.0)	1.0 ± 0.6 (0–2.7)	0.52
	4 of 30 (13%)	2 of 30 (7%)	0.39	0 of 30 (0%)	0 of 30 (0%)	1.00
6 months	3.4 ± 2.7 (0–10)	3.0 ± 2.4 (0–8)	0.55	1.4 ± 1.05 (0.1–3.3)	1.0 ± 0.7 (0–2.7)	0.26
	5 of 30 (17%)	3 of 30 (10%)	0.28	0 of 30 (0%)	0 of 30 (0%)	1.00
1 year	3.4 ± 2.9 (0–10)	3.0 ± 2.3 (0–8)	0.49	1.5 ± 1.1 (0–3.5)	1.1 ± 0.7 (0–2.7)	0.31
	5 of 30 (17%)	3 of 30 (10%)	0.28	1 of 30 (3%)	1 of 30 (3%)	1.00

* Values are expressed as mean ± SD with range in parentheses; MPP = medial parapatellar; MV = midvastus.

Table 4. Secondary outcomes

Variable	Limited MPP approach group (n = 30)	Mini-MV approach group (n = 30)	p value
The Knee Society Score [®] at 1 year (points)*	96 ± 2.0 (95–100)	96 ± 2.3 (95–100)	0.55
ROM (°)*	125 ± 5 (120–140)	123 ± 5 (115–140)	0.13
Skin incision (cm)*	8.6 ± 0.6 (8–10)	9 ± 0.7 (8–10)	< 0.001
Operative time (minutes)*	97 ± 6 (90–115)	114 ± 5.5 (105–120)	< 0.001
Blood loss (mL)*	368 ± 58 (300–550)	386 ± 74 (310–650)	0.29
Return to SLRT at Day 1 (number of patients)	100% (30 patients)	97% (29 patients)	0.31
Knee alignment (°)*	5.3 ± 1.5 (4°–7°)	5.1 ± 0.9 (4°–7°)	0.22
Femoral component alignment (°)*	Valgus 4.1 ± 1.4 (3°–6°)	Valgus 4.2 ± 1.1 (3°–7°)	0.77
Tibial component alignment (°)*	Valgus 1.2 ± 1.1 (–1° to 3°)	Valgus 0.9 ± 1.3 (–2° to 3°)	0.45
Posterior slope (°)*	5.7 ± 1.9 (3°–10°)	5.4 ± 1.9 (3°–10°)	0.58
Bone-patella angle (°)*	1.4 ± 4.8 (–8° to 12°)	1.9 ± 4.0 (–2° to 12°)	0.70
Postoperative VAS score for pain (points)*			
Day 1	3.0 ± 0.9 (2–5)	3.2 ± 1.1 (2–5)	0.36
Day 2	2.5 ± 0.7 (2–4)	2.6 ± 0.8 (2–4)	0.48
Day 3	2.2 ± 0.4 (2–3)	2.3 ± 0.5 (2–3)	0.55

* Values are expressed as mean ± SD, with range in parentheses; MPP = medial parapatellar; MV = midvastus; SLRT = straight-leg raising test.

Table 5. Comparison of data in the literature

Study	Design	Tilt		Subluxation		Anterior knee pain (%)
		Tilt > 5° (%)	Mean (degrees)	Subluxation > 5 mm (%)	Mean (mm)	
Baldini et al. [2]	Prospective	13	NA	13	NA	18
Meftah et al. [18]	Retrospective cohort	NA	0.84 ± 0.3*	NA	1.5	11
Burnett et al. [5]	RCT	NA	NA	NA	NA	21
Barrack et al. [3]	RCT	NA	NA	NA	NA	19
Waters and Bentley [29]	RCT	21.8	NA	NA	NA	5.3
Wood et al. [31]	RCT	24	2	9	NA	10

* Value is expressed as mean ± SD; RCT = randomized controlled trial; NA = not available

Discussion

Abnormal patellar tracking and development of anterior knee pain after a TKA can result from many causes [10, 13, 24]. The changes in patellar tracking with time with the MPP approach are an important concern for many orthopaedic surgeons [15, 20, 22, 26]. As a result, they use the MV approach instead of the MPP approach in conventional TKAs [8, 9, 17, 31]. The extensor mechanism suffers less damage and the patella is not everted in a MIS TKA, which would result in good patellar tracking and lower incidence of anterior knee pain. However, the literature shows only early recovery and less postoperative pain in patients who have had MIS TKAs [4, 14, 28], but does clarify the incidence of patellar maltracking or the development of anterior knee pain. Additionally, it is unclear whether the incidence of patellar maltracking or anterior knee pain differ with the MPP or MV approach in MIS TKAs. We therefore asked whether the incidence of patellar maltracking and anterior knee pain differed with the MV and MPP in association with MIS TKA.

There are some limitations to our study. First, we used the same protocol of multimodal analgesia for pain control in all patients [16, 29]. However, we did not record morphine consumption or consider that in assessing pain. Therefore, we cannot ensure the pain would have been similar independent of morphine use. Second, we used only subjective questions to evaluate anterior knee pain. We did not use the patellofemoral scoring system for knee arthroplasty that included subjective and objective clinical aspects [2]. Therefore, we only showed intensity of pain, but not the limitation of function. However, all patients had only mild pain. We believe mild anterior knee pain should have no effect on the function in either group. Third, measurement of patellar alignment (tilt and subluxation) was performed using the standard skyline view radiographs, not the weightbearing axial view. Because both groups had MIS TKA, there should be a slight decrease or maintenance of the patellar tilt and subluxation in the

weightbearing axial view. In one study weightbearing radiographs showed a lower rate of patellar tilt and subluxation than standard radiographs in the same patient after conventional TKA [2]. Therefore, we assume that patellar tilt and subluxation should have a lower rate; using the weightbearing axial view might not likely differentially effect on the measures of patellar tilt and subluxation in the two approaches.

We found essentially normal patellar tilting and subluxation: means of 3.4° and 1.5 mm, respectively, in the limited MPP group and 3.0° and 1.1 mm, respectively, in the mini-MV group at 1 year. The MPP group with conventional TKAs reportedly has a tilt angle of 0.8° to 8.4° and subluxation of 1.5 mm [11, 19, 20, 22]. The MPP approach had a tilt angle of 3.19° to 5.38° [22]. The MV approach has a tilt angle of 2.57° to 2.95° [22]. We found that 16% of patients who had the limited MPP approach and 10% of patients who had the mini-MV approach had a patellar tilt angle greater than 5° after 1 year of followup. Previous studies suggest that 13% to 24% of patients after conventional TKA had a patellar tilt angle greater than 5° [2, 30, 32]. In our study only 3% of patients in both groups had patellar subluxation greater than 5 mm. Other studies showed 9% to 13% of patients after conventional TKA had patellar subluxation greater than 5 mm [2, 32]. In comparison to conventional TKA, we found both techniques with MIS TKA were associated with decreased patellar tilt and subluxation. In addition, the anterior knee pain patients experienced with both techniques was decreased. The reported incidence of lateral retinacular release in conventional TKAs was 3.8% to 14.3% but was 0% in our study [1, 13, 33]. None of our patients needed this procedure. We found no other patellofemoral complications such as patellar clunk, patellar crepitation, and fractures. The literature however reports patellar crepitation ranging from 0% to 13.5% [19, 23]. Although both techniques of MIS TKA did not result in a stiff knee or the need for manipulation later in our patients, the literature reports 2% to 13.5% rates of manipulation [7, 18, 21, 25, 34].

We found a 7% (four of 60 knees) incidence of anterior knee pain with a mean VAS score of 1 point (range, 0–1 points) for anterior knee pain at the 1-year followup in both groups. All patients experienced mild occasional pain. Previous studies showed the incidence of anterior knee pain after conventional TKAs with patellar resurfacing varying from 5.3% to 21.0% of patients (Table 5) [2, 3, 5, 19, 30, 32], and the VAS score for anterior knee pain range from mild to moderate pain [2, 19, 30].

Our observations suggest neither the MIS TKA with a limited MPP approach nor the mini-MV approach compromises patellar tracking although patients exhibited a lower incidence of anterior knee pain with the MPP approach. We suspect this is because the quadriceps is cut only 2 cm above the superior pole of the patella in the limited MPP approach. We therefore believe the limited MPP approach is appropriate for MIS TKA because it is easy to displace the patella laterally and as a result, is an easier operation. Conversely, we recommend the mini-MV approach for use in patients with stiff knees and severe deformities because of the procedural necessity to extend the quadriceps incision.

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