Minimally Invasive and Standard Total Knee Arthroplasty Result in Similar Clinical Outcomes at a Minimum of Five-Year Follow-Up

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Background: *Although a minimally invasive total knee arthroplasty (MIS-TKA) fails to show superior short-term clinical results over a standard technique, the longer-term outcomes remain unknown.*
Objective: *Evaluate the intermediate clinical outcomes of MIS-TKA, comparing to those of standard technique.*
Material and Method: *The authors retrospectively collected data from the patients who underwent uncomplicated total knee arthroplasty between March 2004 and December 2005. Patients with a body mass index (BMI) over 30 kg/m^2 or with severe deformity and those who required a complex surgical procedure were excluded. Patients were divided into 2 groups based on the surgical approach: 27 patients (31 knees) and 26 patients (33 knees) for the MIS-TKA and standard TKA, respectively. Pre- and perioperative data were collected. Clinical and functional outcomes were followed-up to a minimum of 5 years.*
Results: *The means follow-up in the MIS- and standard TKA groups were 73 and 74 months, respectively. Pre- and perioperative data did not show any differences between the two groups except for more females and lower BMI in the MIS-TKA group. At 2- and 5-year post-operative follow-up, the knee society pain and functional scores improved significantly in both groups ($p < 0.001$). There were no differences in the postoperative alignment, range of motion and the knee society scores between MIS- and standard TKA. In addition, post-operative complications were similar in both groups (2 manipulations under anesthesia and 1 traumatic rupture of patellar tendon in each group).*
Conclusion: *The present study showed that there were no differences in the intermediate-term post-operative function between MIS-TKA and standard TKA in a well-selected patient population. Thus, orthopedic surgeons should not compromise their surgical exposure by using small and unfamiliar surgical technique. Since MIS-technique may increase the post-operative complication rate, a long-term study to evaluate the results of MIS-TKA is still needed.*

Keywords: *Minimally invasive surgery (MIS), Total knee arthroplasty, Clinical outcome, Intermediate-term result*

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Total knee arthroplasty (TKA) is a well-established procedure with an excellent long-term track record[1-6]. However, many patients remain unsatisfied with clinical outcomes including postoperative pain and functional recovery[7-9]. Minimally invasive surgical (MIS) approach in TKA was proposed in order to minimize disruption of the quadriceps mechanism by some certain surgical steps such as using mobile skin window, lateral patella subluxation instead of eversion, the use of down-sized instruments and avoidance of complete tibiofemoral dislocation[10-13]. MIS-TKA is initially proposed for non-obese patients with mild to moderate deformity[14]. However, many surgeons attempted to utilize this MIS technique in a large group of patients including those with severe deformity. This may lead to an increased risk of postoperative complications[15].

Although some authors suggested that MIS-TKA has additional benefits on the post-operative functional outcomes when compared to standard approach[10,11,14,16-18], recent meta-analyses failed to show superior short-term clinical and radiological results of MIS technique over standard TKA[19,20]. Furthermore, there is a criticism that MIS-TKA increases the rate of postoperative complications such as malalignment, which may consequently lead to aseptic loosening[21]. The present study aimed to compare the intermediate outcomes between MIS- and standard TKA in an ideal

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group of patients undergoing TKA. The authors' hypothesis was that the clinical results and the rate of postoperative complications of MIS-TKA at a minimum of 5 years follow-up were similar to those of the standard technique.

Material and Method

Following institutional review board approval, the investigators retrospectively collected data from patients who underwent uncomplicated TKA between March 2004 and December 2005. Only patients who were good candidates for a MIS technique were included. Thus, patients with a body mass index (BMI) over 30 kg/m^2, those with severe deformity (flexion contracture more than 10 degrees, varus or valgus deformity more than 15 degrees) and those who required a complex surgical procedure such as bone grafting were excluded. Patients were divided into 2 groups based on the surgical technique: MIS- and standard TKA groups. There were 27 patients (31 knees) and 26 patients (33 knees) for the MIS- and standard TKA, respectively. Pre- and peri-operative data were obtained from the medical records including patient characteristics, range of motion (ROM) skin incisional length, tourniquet time, blood loss and amount of opioid consumption during the hospitalization. Pre- and post-operative mechanical tibiofemoral angles (TFA) were measured from the anteroposterior standing hip-to-ankle radiographs[22]. The pre- and post-operative TFA were expressed as a deviation from 180 degrees either in varus or valgus alignment. Clinical and functional performances were assessed using the modified knee society score[23] at preoperative period and repeated at 6 weeks, 2- and 5-year postoperative follow-up.

Operative details

All operations were performed by a single surgeon (CM). Both surgical techniques were performed through a midline skin incision and a medial parapatellar arthrotomy. The prostheses used in the present study were all Sigma PFC rotating platform posterior stabilized total knee system with mobile bearing tibial tray (DePuy Orthopedics, Inc., Warsaw, IN). Patellar resurfacing was performed in all cases. All components were cemented. A tourniquet was used for all patients and was deflated after the skin was closed and dressings applied.

For the MIS-TKA group, the limited medial parapatellar approach as described by Scuderi et al was utilized[12], which incised the quadriceps tendon approximately 2-3 centimeters above the superior pole of the patella to gain exposure of the knee joint. The patella was resurfaced first in order to facilitate patellar inversion and subluxation laterally. Bone cuts were performed using downsized instruments. The authors preferred to cut the tibial surface first and use the cut bony surface itself as a guide to complete the remaining cut, while ensuring that retractors were placed medially, posteriorly and laterally to protect all ligamentous and vital neurovascular structures. The cut portion was then removed in a piecemeal manner if necessary. Next the distal femoral cut was performed using the intramedullary femoral cutting guide allowing for distal femoral valgus cut of 5-7 degrees depending on the preoperative alignment. After the distal femoral cut was made, soft tissue balancing was performed in extension with a spacer block in place. Three references (tibial cut surface, transepicondylar axis and Whiteside line) were used to determine proper rotation of the femoral component and the remaining cuts were made to ensure equalization and parallelism of the flexion-extension gap. Both tibial and femoral surfaces were cut in situ with avoiding complete dislocation of the tibiofemoral joint. The trial components were inserted and tested for mechanical alignment, stability, range of motion, and patellar tracking. Components were cemented using 2 batches of the cement starting with the tibial tray and the patellar component. The second batch for the femoral component was prepared while the first cement was hardening.

As for standard TKA, the sequence of the surgery was similar to that described for the MIS group. However, the authors did not follow the critical surgical steps of MIS-TKA. In this standard group, the quadriceps tendon was incised more than 3 centimeters and extended further if necessary. Patellar eversion was performed and standard surgical instrument was utilized instead of downsized instrument.

During postoperative recovery, each patient was maintained on the elastic stockings, sequential compression device and low molecular weight heparin as a form of DVT prophylaxis. Antibiotics were given for 48 hours after the surgery. The blood conservation system was used for 24 hours and the drain was discontinued on the first postoperative day. The patient started their physical therapy and knee motion with the continuous passive motion (CPM) machine as tolerated. The CPM machine was set at 40 degrees of flexion and 0 degree of extension in the first post-operative day and then increased 10 to 15 degrees of flexion on the following day. All patients were mobilized

out of bed and started walking as tolerated on the first postoperative day. The postoperative pain was controlled with intravenous opioids via the patient-controlled analgesia (PCA) machine for two days, followed by oral pain medication and morphine intravenously as needed. The intravenous fluid and foley catheter were removed on the second post-operative day. Typically, the patients were discharged on the third or fourth postoperative day to either home or skilled nursing facility.

Statistical analysis

Data are shown as mean ± SD for continuous variables while categorical variables are presented as frequencies and percentages. Each variable was evaluated for normality. Following the descriptive analysis, differences between MIS- and standard TKA groups on the outcome scores were analyzed using independent samples t-tests. All analyses were conducted using SPSS® software (version 17.0; SPSS Inc, Chicago, IL, USA).

Results

The mean follow-up in the MIS- and standard TKA groups were 73 months (range, 60 to 84 months) and 74 months (range, 67 to 80 months), respectively. There were more females in the MIS-TKA group (67.7% versus 39.4% for MIS- and standard TKA, respectively). Although BMI in the MIS-TKA was significantly lower than in the standard group (26.1 versus 27.9 kg/m^2 for the MIS and standard TKA, respectively), the magnitude of difference was very small. There were no differences in other patients' characteristics, preoperative knee society pain and functional scores between the 2 groups ($p > 0.09$) (Table 1). The mean incisional length in the standard TKA group was longer than the MIS-TKA group (12.2 versus 9.7 cm, $p < 0.001$). There were no differences in the post-operative alignment, the tourniquet time, the operative blood loss and the amount of morphine used during hospitalization (Table 1).

At 2- and 5-year postoperative follow-up, the knee society pain and functional scores improved significantly in both groups ($p < 0.001$). However, there were no differences in these scores between the MIS and the standard groups (Fig. 1). There were 3 post-operative complications for each group. These included 2 cases of manipulation under anesthesia and 1 traumatic rupture of the patellar tendon in the MIS group. The same complications occurred in the standard TKA group.

Discussion

Although there is no clear definition of MIS-

Table 1. Pre- and Perioperative Data

Preoperative variables	MIS (n = 31)	Standard (n = 33)	p-value
Age (yrs)	69.1 ± 8.9	67.2 ± 9.5	0.402
Female sex (%)	21 (67.7%)	13 (39.4%)	0.043
Right side (%)	15 (48.4%)	16 (48.5%)	0.808
Body mass index (kg/m^2)	26.1 ± 3.2	27.9 ± 2.4	0.011
Range of motion (degrees)	127.4 ± 7.5	123.2 ± 12.1	0.096
Preoperative TFA (degrees)*	5.8 ± 3.4	5.5 ± 4.0	0.730
Preoperative Knee society pain score	44.7 ± 11.2	42.2 ± 14.9	0.460
Preoperative Knee society function score	49.5 ± 14.7	51.2 ± 13.8	0.635
Perioperative data	**MIS (n = 31)**	**Standard (n = 33)**	**p-value**
Incision (cm)	9.7 ± 1.2	12.2 ± 1.3	< 0.001
Tourniquet time (min)	92.9 ± 16.1	96.2 ± 12.3	0.370
Operative blood loss (ml)	701.1 ± 355.6	791.2 ± 463.0	0.388
Amount of morphine consumption	87.5 ± 68.7	91.2 ± 64.1	0.832
Postoperative TFA (degrees)*	0.5 ± 6.8	0.4 ± 6.9	0.598

Data was presented as mean ± SD for continuous variables and number (%) for categorical variables. MIS = Minimally invasive approach, TFA = Mechanical tibiofemoral angle. *The pre- and post-operative TFA were expressed as a deviation from 180 degrees in either varus or valgus alignment.

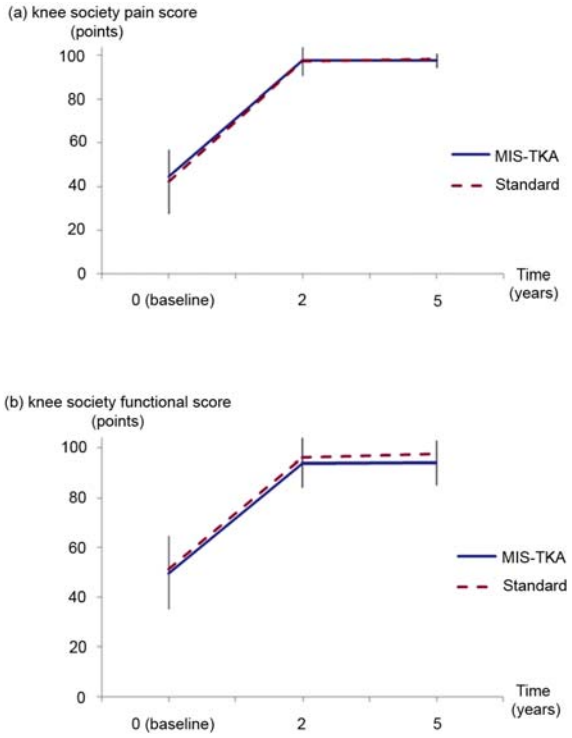

Fig. 1 The diagrams showing Knee society pain (a) and functional scores (b) of patients underwent MIS and standard TKA over a period of 5 years follow-up

TKA, many arthroplasty surgeons agreed that MIS-TKA should be applied to the technique that minimally disrupt the quadriceps mechanisms[24,25]. Several MIS-TKA approaches have been described: mini-medial parapatellar[12,26], mini-midvastus[18], mini-subvastus[27], quad-sparing[28] and mini-lateral approach[15]. The theoretical advantages of these MIS techniques are to reduce soft tissue damage, preserve quadriceps function and improve time to functional recovery[18,24,28]. However, based on a current level I evidence, MIS-TKA has failed to demonstrate the superior short-termed results over the standard technique[19,20]. The present study aimed to compare the functional outcomes between MIS- and standard TKA in an ideal group of patients undergoing TKA at a minimum of 5 years follow-up.

The present study showed that there were no differences in both short- and intermediate-term functional outcomes between MIS- and standard TKA. The authors' results were similar to those previously reported[19,20]. Other factors such as postoperative pain management and rehabilitation protocols therefore may have a larger effect on functional outcomes than the surgical approach alone[29]. In addition to the theoretical benefit in postoperative function, it is also claimed that MIS technique reduces postoperative blood loss and shorten the length of hospital stay[14]. Blood loss is one of the factors that must be considered during TKA. However, this benefit can be offset by the prolongation of operative time[30]. In the present study, the amount of post-operative blood loss and the operative time were similar in both techniques. These results were also consistent with those reported in other studies[31].

It is widely concern that MIS approach may increase the risk of postoperative complications, including alignment outliers and component malposition, due to its limitation in surgical exposure[21,32,33]. Jackson et al[34] reported the overall complication rate of 31.4% in patients who had TKA via quadriceps-sparing approach (patellar tendon avulsion 1%, collateral ligament rupture 1.4%, arthrofibrosis 10%, minor wound complications 11% and unintended cement retention 8%). Conversely, the present study showed an overall complication rate of 9.7 and 9.1% for MIS-and standard TKA, respectively (1 patellar tendon rupture and 2 arthrofibrosis requiring manipulation for each group). Unlike the current investigation, Jackson's study included a broad group of patients including those who were not ideal candidates for the MIS technique: patients with body mass index > 33 kg/m^2 and severe deformity > 10 degrees. Utilizing the MIS technique in an inappropriate patient population therefore may lead to a high rate of complication in their study. Sharkey et al[35] reported that 55.6% of revision TKAs, which were performed over a 3-year period was done within 2 years of the index procedure. Fifty-five percent of these revisions were associated with technical failure. Since an excellent long-term surgical result of TKA should not be compromised by inadequate and unfamiliar surgical exposure, the authors, therefore, recommend orthopaedic surgeons to utilize any surgical approaches that they are familiar with.

The present study has several limitations. First, the present study has small number of patients in each group. Second limitation is due to its retrospective design that is prone for a selection bias. With the MIS-TKA patients tending to be thinner and female, this selection bias should have favored the MIS group in terms of better outcomes. Still, MIS-TKA did not show superior outcomes when compared to standard approach in the present study, regardless of BMI or sex differences. Since the present study included only patients who were good candidates for a MIS technique

(thin and mild to moderate deformity), the mean length of skin incision in the standard group was therefore lower than that previously reported in other study[17]. It is also important to point out that the authors focused on the surgical technique used to minimize disruption of the quadriceps mechanism, not the length of skin incision to define MIS technique. Lastly, although the present study showed that there was no clinically relevant difference between MIS- and standard TKA at a minimum of 5 years follow-up, the authors acknowledge that this follow-up period is still too short to evaluate the long-term success of TKA. A longer-term clinical follow-up of these patients to investigate whether the good early functional results will remain is still needed.

In conclusion, the present study provides the intermediate outcomes of patients who were ideal candidates for MIS-TKA at a minimum of 5 years follow-up. Since there were no differences in the intermediate-term postoperative function between MIS-TKA and standard TKA, orthopaedic surgeons should use any surgical techniques that they are most familiar with. Because survivorship of the prostheses in these 2 surgical techniques can't yet be determined, a longer-term follow-up of these patients is still needed.

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Potential conflicts of interest

None.

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การผ่าตัดเปลี่ยนข้อเข่าเทียมแบบแผลเล็กให้ผลการรักษาทางคลินิกไม่แตกต่างจากการผ่าตัดแบบมาตรฐานที่ระยะเวลาการตรวจติดตามผลอย่างน้อย 5 ปี

อาศิส อุนนะนันทน์, จตุรงค์ พรรัตนมณีวงศ์, คริสโตเฟอร์ เอส เมาว์

ภูมิหลัง: *แม้ว่าการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบแผลเล็กจะให้ผลการรักษาในระยะสั้นไม่แตกต่างจากการผ่าตัดแบบมาตรฐานอย่างไรก็ตามผลการรักษาในระยะกลางและระยะยาวนั้นยังคงไม่ทราบ*

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบผลการรักษาทางคลินิกในระยะกลางระหว่างการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบแผลเล็กกับการผ่าตัดแบบมาตรฐาน*

วัสดุและวิธีการ: *เป็นการศึกษาย้อนหลัง จากผู้ป่วยที่เข้ารับการผ่าตัดเปลี่ยนข้อเข่าเทียมระหว่างเดือนมีนาคม พ.ศ.2547 ถึงธันวาคม พ.ศ.2548 โดยคัดเฉพาะผู้ป่วยที่มี Body mass index (BMI) น้อยกว่า30 กก./ม.^{2} หรือมีข้อเข่าผิดรูปที่ไม่รุนแรง ทั้งนี้ผู้เข้าร่วมวิจัยจะถูกแบ่งเป็น 2 กลุ่มตามชนิดของการผ่าตัดคือกลุ่มการผ่าตัดแบบแผลเล็ก 27 คน (31 เข่า) และกลุ่มการผ่าตัดแบบมาตรฐาน 26 คน (33 เข่า) ผู้นิพนธ์ได้ทำการเก็บข้อมูลก่อนระหว่างหลังผ่าตัดรวมทั้งผลการรักษาทางคลินิกที่ระยะเวลาการตรวจติดตามอย่างน้อย 5 ปี*

ผลการศึกษา: *ระยะเวลาการตรวจติดตามเฉลี่ยของกลุ่มการผ่าตัดแบบแผลเล็กเท่ากับ 73 เดือนและกลุ่มการผ่าตัดแบบมาตรฐานเท่ากับ 74 เดือน โดยทั้ง 2 กลุ่มไม่พบความแตกต่างของข้อมูลก่อน ระหว่าง และหลังผ่าตัด ยกเว้นกลุ่มการผ่าตัดแบบแผลเล็กจะมีจำนวนผู้ป่วยหญิงมากกว่าและมี BMI น้อยกว่า เมื่อประเมินผลการรักษาภายหลังผ่าตัดที่ 2 และ 5 ปี พบว่า ผลการรักษาทางคลินิกทั้ง knee society pain score และ knee society functional score ของทั้ง 2 กลุ่มเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ แต่เมื่อเปรียบเทียบระหว่างกลุ่ม การศึกษานี้ ไม่พบความแตกต่างของ แนวแกนขาหลังผ่าตัด, พิสัยการขยับข้อเข่า รวมถึง scores ดังกล่าวนอกจากนี้ทั้ง 2 กลุ่มยังพบภาวะแทรกซ้อนหลังผ่าตัดที่เหมือนกัน(ดมยาสลบเพื่อดัดเข่า 2 ราย ต่อกลุ่มและมีการฉีกขาดของเอ็นลูกสะบ้า 1 รายต่อกลุ่ม)*

สรุป: *การศึกษานี้พบว่าการผ่าตัดเปลี่ยนข้อเข่าเทียมแบบแผลเล็กให้ผลการรักษาทางคลินิกระยะกลางไม่แตกต่างจากการผ่าตัดแบบมาตรฐาน ดังนั้นศัลยแพทย์ออร์โธปิดิกส์จึงควรหลีกเลี่ยงการทำผ่าตัดแบบแผลเล็กหากไม่มีความคุ้นเคยกับเทคนิคการผ่าตัดแบบแผลเล็กเนื่องจากการผ่าตัดแบบแผลเล็กนั้นอาจก่อให้เกิดภาวะแทรกซ้อนเพิ่มขึ้นได้*