Comparative Study between 2 cm Limited Quadriceps Exposure Minimal Invasive Surgery and Conventional Total Knee Arthroplasty in Quadriceps Function: Prospective Randomized Controlled Trial

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Objective: *To compare the recovery time and straight leg raising test after total knee replacement between 2 cm limited quadriceps exposure minimally invasive surgery total knee replacement (2cm Quad MIS TKR) and conventional total knee replacement.*

Material and Method: *The authors conducted a randomized controlled trial in 40 osteoarthritis knee patients in two groups. Total replacement was performed by the same surgeon and the same prosthesis was used in each group.The function of Quadriceps muscle (straight leg raising test) range of motion was evaluated postoperatively.*

Results: *The 40 patients enrolled in the present study followed the complete study. After surgery with 2 cm Quad MIS TKA, quadriceps function recovery time was faster than with conventional total knee replacement. The quadriceps function was evaluated by the straight leg raising test (SLRT) in sitting and lay down position and the time of ambulation.*

Conclusion: *Operative treatment with 2 cm Quad MIS TKA improved recovery time in quadriceps function when compared with conventional total knee replacement.*

Keywords: *Total knee arthroplasty, 2 cm Quad MIS TKA, Quadriceps function*

J Med Assoc Thai 2008; 91 (2): 203-7
Full text. e-Journal: *http://www.medassocthai.org/journal*

Total Knee Arthroplasty (TKA) has been preformed for 30 years. Many patients have benefited from progressive advances in total knee replacement technique and design. These improvements are the result of a 20-years follow up. The follow-up results have been incorporated in the conventional total knee replacement procedures. In other advances, minimally invasive surgery (MIS) has gained more popularity by surgeons as it is a minimally invasive technique toward total knee replacement[1-6]. Surgeons experienced in minimally invasive techniques understand that MIS refers to more than just providing the patient with a small and less noticeable, more cosmetically appealing surgical incision. MIS encompasses a much broader scope, including minimal interruption and dissection of neurovascular tissues, muscles, tendons and ligaments. Therefore, the development of MIS TKA to functional MIS TKA concentrates to evaluate function of the knee especially recovery time of quadriceps function.

Principle of functional MIS TKA is less invasive to tissue so that functional outcomes are assumed better than conventional TKA but clinical outcomes may be varied[8-10]. The present research studies the functional outcomes of quadriceps function between 2 cm limited quadriceps exposure (2 cm Quad MIS TKA) and conventional total knee replacement.

Material and Method

Between November 2004 and February 2005, 40 patients in Phramonkutklao Hospital scheduled for

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elective total knee replacement were enrolled in the present study. The inclusion criteria were of osteoarthritis knee Albalh stage 5 and flexion contracture < 20 degree. Exclusion criteria were inflammatory joint disease, severe joint laxity > grade 2, bone loss, and life threatening medical condition.

The patients were randomized into two groups, 20 patients in the convention total knee replacement group and 20 patients in the 2 cm Quad MIS TKA group. Each group received surgery from the same surgeon who was skilled and experienced in the operative techniques for conventional TKA and MIS TKA. The ethics committee of Phramonkutklao Hospital approved the present study.

The surgical technique for conventional TKA is detailed. An incision was done in midline on knee flexion, a retinaculum incision was done by medial parapatellar approach, a proximal incision was along the medial border above 4 cm of patella and a distal incision of 3-4 cm was done along the patellar tendon. Open knee joint, extended knee and everted patella and incise lateral patellofemoral plicae to release tightness of the knee joint. Flexion knee and remove anterior & posterior cruciate ligament, anterior horn of medial & lateral meniscus and osteophyte.

The tibia was cut perpendicular to be mechanical axis then the distal femur was cut in valgus 5 degree perpendicular mechanical axis of the femur. Flexion & extension gap and varus & valgus alignment were checked. The prosthesis was replaced then the wound was closed without drainage.

The surgical technique for 2 cm Quad MIS TKA, the 9-10 cm midline incision was done on knee flexion. The retinaculum incision was done by medial pararetinacular approach, proximal incision were not longer than 2 cm above patella. Patella were not everted and other procedures were done the same as conventional TKR. Finally the prosthesis was replaced with cement and then wound was closed without drainage.

The authors evaluated the quadriceps and knee functions of patients, recorded the time of functional recovery at 8 and 12 hours then every 24 hours after the operation. The results were presented with mean, range and Standard deviation (SD)

Results

The forty patients were enrolled in the present study between November 2004 and February 2005, 20 patients in the conventional TKA group and 20 patients in the 2 cm Quad MIS TKA group. Each group has demographic data, Table 1.

Table 1. Demographic data

Information		Conventional TKA (n = 20)	2 cm Quad MIS TKA (n = 20)
Age	Mean (yr)	67.5	68.4
	Range (yr)	56-80	58-78
Sex	Male	4	3
	Female	16	17
Site	Left knee	12	11
	Right knee	8	9

The demographic data in Table 1 shows that both groups were not different. From Table 2 and 3, tourniquet time and operative time were also not different in statistically significant both groups ($p = 0.313$ and 0.140). The recovery time of quadriceps function (SLRT sitting, SLRT lying down and ambulation), the "2 cm Quad MIS TKA group" was faster than the conventional TKA group ($p < 0.05$). Recovery time of knee functions (extension to 0 degree and flexion to 90 degree) the 2 cm Quad MIS TKA group was faster than the conventional TKA group ($p < 0.05$). Hospital stay, the 2 cm Quad MIS TKA was shorter than the conventional TKA ($P < 0.05$).

Discussion

From the present study, 2 cm Quad MIS TKA is better than conventional TKA, especially the recovery time of quadriceps function. However, the present study should have added a sample size for statistical significance. Literature review revealed that MIS TKA is a difficult technique and demand much skill and experience of the surgeon. This lead to time-consuming operation and greater risk than conventional TKA. However, in the present study, there was no difference because the limited quadriceps exposure 2 cm above patellar is wider than quadriceps sparing. Therefore, the surgical technique was not so difficult and tourniquet time was not so long as in quadriceps sparing[7,11]. Even longer limited quadriceps exposure can preserve the functional outcome of the quadriceps muscle. Almost all 2 cm Quad MIS TKA patients could do straight leg raising 4-6 hours postoperative. Care is important in the preoperative training and pain control program[1,5,6,7,13].

The authors started to do minimal invasive surgery by decreasing the skin incision to nearly 5.5 cm in length. However, because of the smaller incision, the operation became harder to perform and the authors found that mistakes easily happened. Nonetheless, the

Table 2. Mean and standard deviation of Tourniquet time, Operative time, Range of motion, Quadricep function and Hospital stay

Information	Conventional TKA (n = 20)		2 cm Quad MIS TKA (n = 20)	
	Mean	SD	Mean	SD
Tourniquet time (Minute)	80.250	16.098	74.750	17.879
Operative time (Minute)	122.750	17.583	112.750	23.868
Range of motion of knee				
1. Extension 0^0 (hour)	31.800	12.480	12.000	4.496
2. Flexion 90^0 (hour)	31.800	18.220	19.800	6.678
Quadricep function				
1. SLRT sitting (hour)	57.600	22.568	24.000	9.537
2. SLRT lay down (hour)	72.300	28.375	27.600	12.971
3. Ambulation (hour)	58.800	14.515	31.800	14.185
Hospital stay (hour)	134.400	30.557	100.800	16.700

Table 3. Test mean between in 2 groups by t-test

Information	Conventional TKA (n = 20)		2 cm Quad MISTKA (n = 20)		p-value
	Mean	SD	Mean	SD	
Tourniquet time(minute)	80.250	16.098	74.750	17.879	0.313
Operative time (minute)	122.750	17.583	112.750	23.868	0.140
Range of motion of knee					
1. Extension 0^0 (hr)	31.800	12.480	12.000	4.496	0.000
2. Flexion 90^0 (hr)	31.800	18.220	19.800	6.678	0.009
Quadricep function					
1. SLRT sitting (hr)	57.600	22.568	24.000	9.537	0.000
2. SLRT lay down (hr)	72.300	28.375	27.600	12.971	0.000
3. Ambulation (hr)	58.800	14.515	31.800	14.185	0.000
Hospital stay (hr)	134.400	30.557	100.800	16.700	0.000

great importance is the recovery of quadriceps function and it was not reproducible as it relates to the smallest incision. Walking ability and postoperative pain did not relate directly to only surgery but was related to the pain control program.

In considering a surgical improvement, the authors should also concentrate on the recovery of quadriceps function, especially the straight leg raising test. Therefore, the authors started to increase quadriceps exposure, centimeter by centimeter from the upper pole of the patella to 4 cm above the upper pole of the patella. The best result came at 2cm above the patella. It gave the adequate exposure and early recovery of quadriceps function. Therefore, the authors conducted a study between 2cm Quad exposure and conventional TKA.

From the present results, most of the patients could do the straight leg raising test 4-6 hours after surgery and all patients did it within 24 hours after surgery. The patients of conventional TKR mostly could do SLRT 3 days after surgery. Operation time was not different but was a little longer in the conventional TKR due to longer soft tissue and skin to close.

MIS TKR is not an abrupt change of procedure. Workshop in cadavers and the number of cases and regular surgery are important. The authors saw many complications from newly qualified MIS surgeons with workshop certificates who did not have actual

surgery experience and tried their first case with the smallest incision possible. Nearly all of the authors' preliminary 100 cases during a 6-months period were to test the 2cm Quad exposure. Then the authors shared the study. When comparing the present result of 2 cm Quad and Midvastus exposure, both have adequate exposure and better early quadriceps recovery[6,12].

However, elderly patients do not gain much advantage to walk early or SLRT just 24 hours after surgery if their operative time is longer than the usual procedure. The present result did not show any difference in the 2-4 weeks postoperative treatment.

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การศึกษาเปรียบเทียบการทำงานของกล้ามเนื้อต้นขาภายหลังการผ่าตัดเปลี่ยนข้อเข่าเทียมด้วยเทคนิค 2 cm Quad minimal invasive surgery total knee arthroplasty กับวิธีมาตรฐาน

ธไนนิธย์ โชตนภูติ, พิพัฒน์ องค์น้ำทิพย์, กฤษณ์ กาญจนฤกษ์, พิชัย อุดมบัวทอง

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบการทำงานของกล้ามเนื้อต้นขา (quadriceps function) หลังการผ่าตัดข้อเข่าเทียมด้วยเทคนิค 2 cm Quad MIS TKA กับวิธีมาตรฐาน*

วัสดุและวิธีการ: *ทำการสุ่มเลือกผู้เข้ารับการวิจัยจำนวน 40 คน เพื่อเข้ารับการผ่าตัดเปลี่ยนข้อเข่าเทียมเทคนิค 2 cm Quad MIS TKA และวิธีมาตรฐานกลุ่มละ 20 คน ผ่าตัดโดยศัลยแพทย์ท่านเดียวหลังการผ่าตัดผู้ทำการวิจัยจะประเมินผลการกลับคืนของ quadriceps function*

ผลการศึกษา: *การผ่าตัดเปลี่ยนข้อเข่าเทียมด้วยเทคนิค functional MIS TKA มีผลต่อการกลับคืนของ quadriceps function ได้เร็วกว่าวิธีมาตรฐานอย่างมีนัยสำคัญทางสถิติ โดยวัดจากระยะเวลาที่ทำ straight leg raisting test (SLRT) และ ambulation ได้*

สรุป: *การกลับคืนของ quadriceps function ภายหลังการเปลี่ยนข้อเข่าเทียมด้วยเทคนิค 2 cm Quad MIS TKA เร็วกว่าวิธีมาตรฐานอย่างมีนัยสำคัญทางสถิติ*