Complete Release of Superficial Medial Collateral Ligament in TKA:

Surgical technique and mid-term results

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Purpose: *Intraoperative medial collateral ligament (MCL) injury or attenuation during total knee arthroplasty (TKA) has been reported with satisfactory clinical knee function and stability. However, there was no report on clinical outcomes and knee stability following intentionally complete release of intact superficial MCL (sMCL) during TKA. We demonstrated the surgical technique of sMCL release and reported mid-term clinical outcomes.*
Methods: *A consecutive series of 35 patients, who underwent TKA and had intraoperatively complete release of sMCL using the subperiosteal technique previously described by Insall, was evaluated for clinical outcomes and knee stability. The surgical technique for sMCL release, the prosthesis and the postoperative rehabilitation protocols were uniform without additional external knee support. A digital dynamometer was used for the quantitative measurement of knee stability in the mediolateral plane at a static 20-lb force. Laxity of the MCL was graded as 0, 1+ and 2+ if the gap was 0 mm, > 0 mm and ≤ 5 mm, and > 5 mm, respectively. Weight-bearing radiographs of patients at the latest follow up (FU) were evaluated.*
Results: *Preoperatively, the mean tibiofemoral varus angle of the studied group was 14.3° (±6.4°). The mean age and body mass index (BMI) were 70 years, 26.4 kg/m^2, respectively. The 10- to 12-mm polyethylene inserts were used in 5% of patients, whilst 14- to 17-mm inserts were used in 95% of patients. At the mean 6-year FU (range: 2-8 years), the mean Knee Society (KS) clinical and function scores were 94.3 and 84.2 points, respectively. The mean maximum range of motion (ROM) was 135.1°. Regarding the knee stability test, knees with grade 0, 1+ and 2+ were found in 84.4%, 15.6% and 0%, respectively. One patient in the studied group had revision due to infection. The 6-year survivorship for reoperation related to MCL instability was 100%.*
Conclusion: *During ligament balancing for varus knees in TKA, some surgeons tend to avoid performing complete release of the sMCL due to concerns on postoperative knee instability. The subperiosteal release of the sMCL made a full-thickness layer of medial soft tissue attaching with the sMCL, which provided adequate strength to withstand the valgus stress force from daily function. According to the present study, it confirmed a satisfactory mid-term result of TKA with subperiosteally complete release of sMCL in terms of clinical outcomes, knee stability, range of motion, and survivorship. However, it was found that a thicker polyethylene insert related to the release was more common. In conclusion, subperiosteally complete release of the sMCL during TKA provided reliable postoperative medial soft tissue tension and clinical results at mid-term.*

Keywords: *Medial collateral ligament, Release, Outcomes, Total knee arthroplasty*

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Introduction

During total knee arthroplasty (TKA) in fixed varus deformity, several bone and soft tissue procedures for proper gap balancing have been reported in the literature[1-6]. Regarding the bony procedure, removal of medial osteophytes provides a relaxation of the medial soft tissue structure[3]. However, bony procedure alone may provide a partial correction of varus deformity. Thus, further soft tissue procedures, such as a complete release of the medial collateral ligament (MCL), may be necessary for the correction of a deformity in order

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to achieve a balanced medial gap and lateral gap in the coronal plane[5]. Concerning soft tissue procedures of medial gap balancing, several investigators proposed different release techniques[1,4-6], as well as a release in sequential steps[2,5]. In fact, to routinely visualize the medial proximal tibia in the standard medial knee arthrotomy, the deep part of MCL is subperiosteally released without an effect on the laxity of the medial soft tissue sleeve, while the release of superficial MCL (sMCL) increases the medial soft tissue laxity[4]. Thus, the so-called MCL release usually refers to a release of the sMCL. Classical MCL release to correct medial soft tissue tension was described by Insall et al[1]. Later on, Clayton et al[2] proposed the sequential MCL release beginning from the tibial attachment to the femoral attachment. Recently, Bellemans et al[6] proposed a new technique of MCL release with multiple needle punctures.

Although some investigators reported clinical outcomes following iatrogenic injury or attenuated sMCL during TKA[7,8], there has been no study addressing the clinical outcomes of TKA following intentionally complete release of the sMCL at the time of surgery. The purpose of the present study was to evaluate the mid-term outcomes and knee stability in patients who underwent TKA with intentionally complete release of the sMCL at the time of surgery.

Materials and Methods

From March 2004 to March 2007, a series of 35 patients (35 knees), who had late-stage knee osteoarthritis with a varus deformity and underwent TKA with intentionally complete release of the intact sMCL at the time of surgery, were evaluated for clinical outcomes and knee stability. Selection criteria included patient age of 45 to 85 years, advanced primary knee osteoarthritis, no previous major knee surgery, body mass index (BMI) of less than 30 kg/m^2, a varus deformity which required complete release of sMCL for gap balancing at the time of surgery, and no contralateral TKA within 1 year at the latest follow-up (FU). All surgeries were performed by a single surgeon (AT) using a single surgical approach (mini-midvastus approach), a single total knee system (NexGen Legacy Posterior Stabilized (LPS)-Flex, Warsaw, IN, USA) with routine patellar resurfacing. A single 3-day rehabilitation protocol[9] was used in all patients in the studied group.

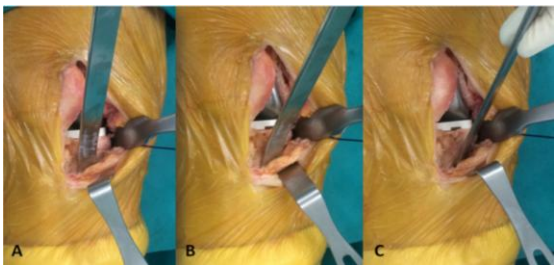
Surgical exposure, bone cuts, and gap evaluation

Following the less invasive-midvastus approach, the femoral exposure was made with a 2- to 3-cm split along the fiber of the vastus medialis obliquus in order to gain complete visualization of the whole anterodistal femur with 60° of knee flexion. Medial osteophytes were removed from both the femoral and tibial sides. Standard subperiosteal exposure of the medial tibia towards the posteromedial corner was made using a curve osteotome. The medial tibial exposure towards the distal direction was limited to 1 cm at the mid-medial plateau, and was limited to 0.5 cm at the posteromedial tibial corner.

The anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) were resected. Sequential bone cuts were made, including a distal femoral cut, proximal tibial cut and femoral anteroposterior cuts according to the proper femoral sizing with a 3-degree external rotation. The menisci were totally resected following distal femoral and proximal tibial bone cuts in a one-piece technique under direct visualization. The provisional gap evaluation in flexion and extension was made. The fine-tuning of the gap balancing was evaluated and made after femoral chamfer cuts, final tibial preparation with trial components in place. In all knees, the anterior referencing system for the femoral component was used. If an in-between size was measured, the smaller size was chosen. The patella was resurfaced in all patients and all components were cemented.

Determining of superficial MCL release and technique

With trial components in place and the knee in full extension, knees which had a tight medial gap and > 2-mm lateral gap of varus stress test were indicated for complete sMCL release. The technique was as described by Insall et al[1,10], including the subperiosteal release of sMCL using a slim osteotome (Fig. 1A). The release was made on the tibial attachment along the anteromedial part of the tibia until free of soft tissue resistance without pes anserinus insertion violation (Fig. 1B and 1C). In contrary, sMCL release was not indicated if there was no medial gap tightness with negative valgus stress test and ≤ 2-mm lateral gap of varus stress test.



(A) (B) (C)

Fig. 1 Demonstrating the technique of subperiosteal sMCL release. (A) With the knee in slight flexion, the release was made from the tibial attachment along the anteromedial part of the tibia cortex using a slim osteotome. (B) The osteotome was tilted to accommodate the curvature of the anteromedial tibia and was gently dived to 5-8 cm from the tibial joint line along the anteromedial part of the tibial shaft. (C) When the release was complete, it was free of distal soft tissue resistance.

Patient care and ambulation

Following the actual insertion of components, the tourniquet was not deflated for hemostasis. The vacuum drainage was removed at 18–24 hours after surgery. No additional external knee support was used during the postoperative period in any patient. Early postoperative ambulation[9] was started on the morning of the next day, including voluntary upright sitting, knee straightening, feet dangling, and full-weight walking with a walker under the supervision of orthopaedic fellows. The discharge criteria included ability to flex the operated knee to 90° and to walk independently with a walking aid.

Outcome evaluation

Follow-up was done at 2 weeks, 6 weeks, 12 weeks, and 6 months, and every year postoperatively. Patients were evaluated for clinical and functional outcomes using the Knee Society (KS) clinical and functional scores[(11)], range of motion (ROM), and quantitative measurements of knee stability in the mediolateral plane using a digital dynamometer (MicroFET2TM, Hoggan Health Industries, Salt Lake City, UT, USA) at a static 20-lb force for the valgus stress test where the knee is flexed to 30° as described by Koo and Choi[(7)]. Laxity of the MCL was graded as 0, 1+ and 2+ if the gap measured from the valgus stress radiography was 0 mm, > 0 mm but < 5 mm, and between 5-10 mm, respectively. Weight-bearing radiographic evaluations of individual patient at the latest FU were compared with that at the 3-month FU which was determined as the baseline.

Results

The mean FU time was 71 months (range: 48-98 months). Patient's demographic data and perioperative data are shown in Table 1. There was a high incidence in the thickness of polyethylene insert used in the studied group. Ninety-five percent of knees had 14-mm and 17-mm polyethylene inserts, of which, postoperative radiographs showed a relative elevated joint line ranging from 2 to 5 mm (Fig. 2). KS clinical and function scores, maximum passive knee ROM, and radiographic tibiofemoral angle at the latest FU are shown in Table 2. Regarding knee stability, more than 80% of knees in the studied group were defined as stable (grade 0 for valgus stress test) as shown in Table 2.

At the latest FU, all patients had later contralateral TKA at an average time of 4 months after the first TKA. The primary reason for contralateral TKA was sciatica related to leg-length inequality. One patient underwent reoperation due to deep infection and was successfully managed with a 2-stage revision surgery. The 6-year survivorship for reoperation for any reason and for reoperation related to MCL instability was 97.2% and 100%, respectively.

Fig. 2 Examples of pre- and 5-year postoperative radiographs of a patient whose TKA was performed with complete sMCL release. The single-limb standing anteroposterior radiograph showed that the limb was in accepted alignment without medial gap opening; however, the joint line was elevated due to the 17-mm polyethylene insert.

Table 1 Demographic data and intraoperative parameters

Parameters	Studied group (n=35) Complete sMCL release	
	Value	Range
Age* (year)	70	58-81
Gender (number)		
Male	2	
Female	33	
Side (number)		
Right	22	
Left	13	
BMI* (kg/m^2)	26.4±2.0	19.6-32.9
Preop anatomical varus deformity* (degree)	14.3-6.4	10.0-25.0
Polyethylene Thickness (number and %)		
10 mm	0	
12 mm	2 (5%)	
14 mm	24 (69 %)	
17 mm	9 (26 %)	

* presented in mean ±SD

Table 2 Clinical parameters

Parameters	Studied group (n=35) Complete sMCL release	
	Value	Range
KS clinical score*	94.3±3.40	89-98
KS function score*	84.2±7.6	80-94
Maximum passive ROM* (degree)	131.1±9.8	115-150
Valgus stress test (number and %)		
0	27 (84.4 %)	
1+	5 (15.6 %)	
2+	0	
Latest postoperative TFA* (degree)	5.6±2.2	1.0-9.0

* presented in mean±SD

Discussion

In performing primary TKA, a neutral mechanical axis, of which the tibiofemoral angle is approximately 4 to 6 degrees of anatomical valgus, is the target alignment. To do so, a proper soft tissue balance in both flexion and extension is mandatory[12]. As the postoperative MCL tension and integrity play very important roles to stabilize the knee following TKA against the valgus force in the frontal plane, improper soft tissue release in moderate to severe varus knee in this plane usually results in an unsatisfactory outcome related to knee instability[13,14]. In Asia, arthritic knees with moderate to severe fixed varus deformities are very common[15,16]. Thus, at TKA surgery, contracture of MCL in varus knee osteoarthritis is usually a problematic issue to address. Although there have been reports on satisfactory clinical outcomes following intraoperative tears of MCL[7,8], some surgeons tend to avoid performing complete release of the MCL for ligament balancing, due to concerns of postoperative knee instability and impaired mid- to long-term clinical outcomes.

The sMCL has its origin on the medial epicondyle and its tibial insertion on the medial aspect of the upper tibia[4]. It consists of anterior and posterior fibers along the anteromedial to posteromedial parts of the knee joint which provide an important role as the primary medial stabilizers of the knee joint in flexion and extension, respectively. According to the literature related to complete release of the MCL, most studies focused on surgical techniques rather than clinical outcomes[1-6]. The subperiosteal technique of sMCL release for varus knees during TKA was originally described by Insall et al[1]. Technically, this release peels the sMCL off together with the periosteum from its tibial insertion just medial to the pes anserine tendon insertion to the medial aspect of the upper tibia. When the release is complete, a 6- to 8-cm distance of dissection from the joint line along the medial aspect of the proximal tibia is usually obtained. Thus, this technique provides a full-thickness layer of medial soft tissue attaching to the sMCL. When the subperiosteal sleeve heals to bone, it provides an indirect solid attachment of the sMCL to the bone via the periosteum. However; Mihalko and associates[4] suggested that the posterior oblique ligament and the posterior capsule should not be released when the subperiosteal sMCL release technique is used because of the possibility of destabilizing the medial soft-tissue sleeve.

In the present study, we found that the quantitative measurement of the valgus stress test demonstrated no MCL laxity in more than 84% of patients, which agreed with the concept that subperiosteal release provides no further attenuation of the sMCL. Although MCL laxity of < 5 mm was found in 16% of patients, patients had satisfactory clinical results. At the mean 6-year FU, there were similar outcomes including KS clinical and function scores, knee stability, and radiographic evaluation. Thus, we assume that this procedure is safe to perform in indicated patients.

The major effect of TKA with complete sMCL release in the present series was the necessity to use a thicker polyethylene insert in order to balance the tight medial gap to the lax lateral gap. In the present study, 96% of knees had a 14-mm or 17-mm polyethylene insert, while the knees with no release usually required a 10-mm or 12-mm polyethylene insert. Therefore, an elevated joint line related to thicker polyethylene following complete MCL release occurred in most knees in the present study. Although an elevated joint line after TKA might somewhat relate to limited postoperative ROM[17], the study by Selvarajah and Hooper demonstrated no limitation of postoperative ROM after TKA which had elevated joint lines of 10 mm[18]. The postoperative knee ROM in the present study was in agreement with their study. It could be implied that a 2-mm to 5-mm elevated joint line following well-balanced gaps in TKA still facilitated satisfactory outcomes.

A weakness of the present study was the small number of participants in the studied group due to a limited number of patients who were

indicated for complete release of sMCL. Additionally, there was no quantitative measurement of the valgus-varus stress test at the intraoperative period. Thus, the intraoperative test could be biased by the surgeon's judgment for proper soft tissue tension. The strengths of the present study were that it was a mid-term FU of a series of patients with few variations of confounding factors, including surgeon, prosthesis, perioperative protocol, and postoperative soft tissue tension measurement.

Conclusion

At 6-year FU, complete subperiosteal release of sMCL during TKA in osteoarthritic knees with varus deformities provides satisfactory mid-term outcomes. It provided stable and reliable postoperative tension of the medial soft tissue sleeve of the knee; however, a thicker polyethylene insert was the common effect following the release.

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การทำ complete release ของ superficial medial collateral ligament ในขณะผ่าตัดเปลี่ยนข้อเข่าเทียม: เทคนิคการผ่าตัดและผลการรักษาในระยะ mid-term

พงศ์พร ประทีปทองคำ, พบ, อารี ตนาวลี, พบ, ณัฐเดช เมฆรุ่งจรัส, พบ, สีหธัช งามอุโฆษ, พบ

วัตถุประสงค์: มีงานวิจัยที่แสดงว่าการรักษาของการฉีกขาดหรือการยืดตัวของ medial collateral ligament (MCL) ในขณะผ่าตัดเปลี่ยนข้อเข่าเทียมได้ผลดีทั้งเรื่องอาการทางคลินิกและความมั่นคงของข้อเข่า อย่างไรก็ตาม มีรายงานจำนวนน้อยมากที่แสดงผลการรักษาของการตั้งใจทำ complete release ของ MCL ขณะผ่าตัดเปลี่ยนข้อเข่าเทียม คณะผู้วิจัยแสดงเทคนิคการผ่าตัดหัตถการนี้และผลการรักษาระยะ mid-term

วิธีการศึกษา: กลุ่มผู้ป่วยจำนวน 35 ราย ซึ่งได้รับการทำ complete release ของ superficial MCL (sMCL) ในขณะผ่าตัดเปลี่ยนข้อเข่าเทียมตามเทคนิคของนายแพทย์ Insall ซึ่งเป็นการ release ลึกต่อชั้นใต้เยื่อหุ้มกระดูก และไม่ใช้อุปกรณ์พยุงข้อเข่าหลังการผ่าตัด ทั้งนี้ กลุ่มผู้ได้รับการประเมินผลทางคลินิกและความมั่นคงของข้อเข่าหลังจากการผ่าตัด โดยการตรวจความมั่นคงของข้อเข่าทำโดยใช้มาตรกำลังกล้ามเนื้อดิจิทัล ด้วยแรงชนิด static ขนาด 20 ปอนด์ การตรวจความหย่อนตัวของ MCL แบ่งเป็น 3 ระดับ คือ 0, 1+ และ 2+ แปลผลเมื่อตรวจพบการหย่อนตัวเป็นระยะ 0 มม. การหย่อนตัวมากกว่า 0 มม. แต่ไม่เกิน 5 มม. และการหย่อนตัวมากกว่า 5 มม. ตามลำดับ

ผลการศึกษา: ก่อนการผ่าตัด กลุ่มผู้ป่วยมีค่าเฉลี่ยมุม tibiofemoral เป็นมุมเบ้เข้า 14.3° (±6.4°) มีค่าเฉลี่ยอายุ และดัชนีมวลกาย 70 ปี และ 26.4 กก./ม.^{2} ตามลำดับ ร้อยละ 5 และ 95 ของผู้ป่วย มีอัตราการใช้หมอนรองข้อเข่าเทียมขนาด 10 ถึง 12 มม. และ 14 ถึง 17 มม. ตามลำดับ ที่ค่าเฉลี่ยการติดตามผู้ป่วย 6 ปี (พิสัย, 2-8 ปี) ค่าเฉลี่ย Knee Society (KS) clinical, function scores และมุมงอข้อเข่ามากสุด เท่ากับ 94.3 คะแนน 84.2 คะแนน และ 135.1° ตามลำดับ ร้อยละ 84.4 ร้อยละ 15.6 และร้อยละ 0 มีความมั่นคงของข้อเข่าเกรด 0, 1+ และ 2+ ตามลำดับ พบการติดเชื้อในผู้ป่วย 1 ราย ซึ่งรักษาหายดีในเวลาต่อมา อัตราการรอดชีพ 6 ปี สำหรับการถูกผ่าตัดซ้ำจากความไม่มั่นคงของ MCL เท่ากับร้อยละ 100

สรุป: ศัลยแพทย์จำนวนมากหลีกเลี่ยงการทำ complete release ของ sMCL ในขณะผ่าตัดเปลี่ยนข้อเข่าเทียม เนื่องจากกังวลว่าอาจเกิดความไม่มั่นคงของข้อเข่าหลังการผ่าตัด การ release sMCL ด้วยวิธีเลาะให้ลึกต่อชั้นเยื่อหุ้มกระดูก ในกลุ่มผู้ป่วยของงานวิจัยนี้ ทำให้เกิด full-thickness layer ของ medial soft tissue sleeve จึงทำให้เกิดความแข็งแรงพอต่อการต้านแรง valgus stress ที่เกิดขึ้นจากการใช้งานข้อเข่าในชีวิตประจำวันได้ ทำให้ได้ผลการรักษาระยะ mid-term เป็นที่พอใจในเรื่องผลการรักษาทางคลินิก ความมั่นคงของข้อเข่า พิสัยการเคลื่อนไหวของข้อเข่า และอัตราการรอดชีพ อย่างไรก็ตาม ผู้ป่วยกลุ่มนี้มีการใช้หมอนรองข้อเข่าเทียมที่หนาขึ้นในอัตราสูง โดยสรุป การทำ complete release ของ sMCL ด้วยวิธีเลาะให้ลึกต่อชั้นเยื่อหุ้มกระดูก ยังคงทำให้ระดับความแข็งแรงของ medial soft tissue sleeve ที่ติดตามผลถึงระยะ mid-term เชื่อถือได้