Results of Posteromedial Capsule and Superficial Medial Collateral Ligament Release on Gap and Alignment in Total Knee Arthroplasty for Varus Knee Deformity by Computer-Assisted Surgery Measurement

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Abstract

Objective: Soft tissue release and gap balancing in varus knee deformity following total knee arthroplasty (TKA) are important issues that lack conclusive results. Various techniques including posteromedial capsule (PMC) and superficial medial collateral ligament (sMCL) release have been used for varus knee correction and flexion gap balance.

Methods: We retrospectively reviewed data from patients who had undergone TKA with computer-assisted surgery measurement and the use of PMC and sMCL release by the preservation of anterior attachment of pes anserine at our institute from November 2015 to February 2016. Gaps and alignment were measured and recorded by computer-assisted surgery measurement.

Results: Twenty-one patients were enrolled. The mean age was 68.0 (48.0-78.0) years with a mean preoperative hip-knee-ankle angle of 8.1 (3.5-16.0) degrees and a mean flexion contracture (FC) of 11.3 (3.5-16.0) degrees. The mean corrections for varus deformity after PMC and sMCL release were 4.9 ± 2.8 and 3.4 ± 1.7 degrees, respectively, with the mean FC after PMC and sMCL release correction of 5.6 ± 3.5 and 1.3 ± 2.9 degrees. The mean medial extension gap changes after PMC and sMCL release were 1.8 ± 1.4 and 1.7 ± 1.0 millimetres, respectively, with mean medial flexion gap after PMC and sMCL release changes of 0.7 ± 0.9 and 5.1 ± 2.1 millimetres, respectively. There was no significant change in lateral gaps after PMC and sMCL release. No instability of the knee was found.

Conclusion: The sMCL released with the preservation of the anterior attachment of pes anserinus in total knee arthroplasty has an additional effect on varus knee correction and flexion gap balance after PMC release without the creation of knee instability.

Keywords: total knee arthroplasty, varus knee, computer-assisted surgery, superficial medial collateral ligament release, posteromedial capsule release

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ผลของระยะห่างและแนวของข้อเข่าเทียม จากการตัดเยื่อหุ้มข้อเข่าส่วนหลังด้านใน และการตัดส่วนตื้นของเอ็นยึดข้างข้อเข่าด้านใน ในการผ่าตัดเปลี่ยนข้อเข่าเทียมชนิดข้อเข่าโก่งออกด้านนอก โดยใช้คอมพิวเตอร์ช่วยในการผ่าตัดและวัดผล

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บทคัดย่อ

วัตถุประสงค์: การจัดสมดุลเนื้อเยื่อรอบข้อเข่าในการผ่าตัดเปลี่ยนข้อเข่าเทียม เป็นขั้นตอนที่มีความสำคัญ และในปัจจุบันยังไม่มีแนวทางปฏิบัติอย่างชัดเจน เทคนิคการผ่าตัดโดยการเลาะเนื้อเยื่อส่วนเยื่อหุ้มข้อเข่าส่วนหลังด้านใน (posteromedial capsule : PMC) และการเลาะส่วนตื้นของเอ็นยึดข้างข้อเข่าด้านใน (superficial medial collateral ligament : sMCL) ในการผ่าตัดเปลี่ยนข้อเข่าเทียมในผู้ป่วยที่มีเข่าโก่งออกด้านนอก (varus knee)

วิธีดำเนินการวิจัย: จากการศึกษาแบบย้อนหลังในผู้ป่วยที่ได้รับการผ่าตัดเปลี่ยนข้อเข่าเทียมโดยใช้คอมพิวเตอร์ช่วยในการผ่าตัดและวัดผลที่วชิรพยาบาลตั้งแต่ พฤศจิกายน 2558 ถึง กุมภาพันธ์ 2559 โดยใช้เทคนิคการตัดส่วนโดยการเลาะเนื้อเยื่อส่วนเยื่อหุ้มข้อเข่าส่วนหลังด้านในและการเลาะส่วนตื้นของเอ็นยึดข้างข้อเข่าด้านในโดยไม่เลาะส่วนกล้ามเนื้อเพส แอนเซอรีน (pes anserine) ออก ตามลำดับ

ผลการวิจัย: จากผู้ป่วยที่ได้รับการผ่าตัด 21 ราย พบว่า อายุเฉลี่ยของผู้ป่วยคือ 68.0 (48.0-78.0) ปี และค่าเฉลี่ยของมุมระหว่างสะโพก-เข่า-ข้อเท้า (hip-knee-ankle : HKA) เท่ากับ 8.1 (3.5-16.0) องศา โดยมีข้อเข่าติดในท่างอ (flexion contracture : FC) อยู่ที่ 11.3 (3.5-16.0) องศา ผลการของการผ่าตัดภายหลังการเลาะ PMC ส่งผลให้มุม HKA และ FC ลดลงเท่ากับ 4.9 ± 2.8 และ 3.4 ± 1.7 องศาตามลำดับ ผลของการผ่าตัดภายหลังการเลาะ sMCL ส่งผลให้มุม HKA และ FC ลดลงเท่ากับ 5.6 ± 3.5 และ 1.3 ± 2.9 องศาตามลำดับ ค่าเฉลี่ยของการเพิ่มระยะระหว่างข้อเข่าด้านใน ในท่าเหยียดภายหลังการเลาะ PMC และ sMCL เท่ากับ 1.8 ± 1.4 และ 1.7 ± 1.0 มิลลิเมตร สำหรับค่าเฉลี่ยของการเพิ่มระยะระหว่างข้อเข่าด้านใน ในท่างอ เท่ากับ 0.7 ± 0.9 และ 5.1 ± 2.1 มิลลิเมตร ไม่พบการเปลี่ยนแปลงของระยะระหว่างข้อเข่าด้านนอก และไม่พบภาวะเข่าไม่มั่นคงหลังการผ่าตัด

สรุป: ผลของการผ่าตัดเปลี่ยนข้อเข่าเทียม ชนิดพยาธิสภาพเข่าโก่งออกนอก โดยการเลาะส่วนตื้นของเอ็นยึดข้างข้อเข่าด้านในโดยไม่เลาะส่วนกล้ามเนื้อเพส แอนเซอรีน (pes anserine) ออก ภายหลังการเลาะเนื้อเยื่อส่วนเยื่อหุ้มข้อเข่าส่วนหลังด้านใน สามารถแก้ไขภาวะเข่าโก่งและจัดสมดุลของระยะข้อเข่าด้านในได้ดี โดยไม่ทำให้เกิดภาวะเข่าไม่มั่นคงหลังผ่าตัด

คำสำคัญ: การผ่าตัดเปลี่ยนข้อเข่าเทียม เข่าโก่งออกด้านนอก การผ่าตัดโดยใช้คอมพิวเตอร์ช่วยผ่าตัด การเลาะส่วนตื้นของเอ็นยึดข้างข้อเข่าด้านใน การเลาะเนื้อเยื่อส่วนเยื่อหุ้มข้อเข่าส่วนหลังด้านใน

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Introduction

Osteoarthritis (OA) of the knee is the most common articular disease, especially among the elderly population. In severe cases, it frequently causes pain and knee deformity, which worsens quality of life[1-3]. Total knee arthroplasty (TKA) is the treatment of choice in severe cases, which bypasses conservative treatment. Nowadays, the number of knee arthroplasty procedures has been increasing due to good clinical outcomes and patient satisfaction[4-6]. The goals of treatment in OA of the knee include restoring the axis of the knee by bone resection and gap balancing[7-11]. Varus deformity of the knee is a common pattern in OA. Soft tissue balancing by medial soft tissue release plays an important role in the correction of this type of deformity. Correction of varus deformity by the release of the superficial medial collateral ligament (sMCL) was suggested by Insall et al., but current reports have been varied and inconclusive[12-16]. From previous studies, the release of the posteromedial capsule (PMC) and sMCL showed additive effects on flexion and extension gaps in TKA[17-18]. Mullaji et al.[18] studied the effect of sequential release on fresh cadaveric knees using a CT-free computer navigation system. Data from the study showed severe instability of the knee after the release of sMCL. Therefore, it was suggested not to perform sMCL release except in the case of recalcitrant varus deformity.

Mihalko et al.[19] described the technique of sMCL release with preservation of pes anserine insertion by subperiosteal release from tibial insertion just medial to the pes anserine tendon and insertion to the medial aspect of the upper tibia extending 6 to 8 cm past the joint line. This is less extensive than the technique previously described by Insall[20] because it preserves the anterior attachment of pes anserine insertion, which plays an important role in knee stability. This modified Insall technique has become the main technique for sMCL release in our practice for more than 10 years.

The aim of this study was to analyse the amount of medial and lateral gap changes after the sequential release of PMC and sMCL using computer-assisted surgery (CAS) in patients who had undergone TKA. The gaps were measured before and after PMC and sMCL release using the modified Insall technique by the preservation of the anterior attachment of pes anserine. The hypothesis of this study is releasing sMCL after PMC release by using this technique will provide an additive effect on varus correction without the creation of instability.

Methods

After receiving approval from the Vajira Institutional Ethics Committee (study reference number 051/61), all procedures were performed in accordance with relevant guidelines. We retrospectively reviewed data from patients with primary OA of the knee who had undergone CAS TKA with a navigation system (Brainlab software knee 2.6) at our institution from November 2015 to February 2016. Inclusion criteria included patients aged 45-80 years diagnosed with primary OA of the knee through varus alignment (determined as hip-knee-ankle angle > 0 degrees) who had undergone unilateral TKA. Exclusion criteria included posttraumatic arthritis of the knee, inflammatory joint disease, revision surgery, and cases in which PMC or sMCL release was not performed. All patients underwent the same standard surgical procedure, as described below.

The Midvastus approach was done in all patients. After arthrotomy, as much osteophyte as possible was removed. Initial soft tissue release, just enough to move the tibia anteriorly, was done; the normal depth of release was about 2 to 3 centimetres below the joint line at the anterior part of the tibia extending to the equator of the tibia on the medial side. Subsequently, the CAS pins were inserted, and a CT-free navigation system was assembled. The proximal tibia was resected first using mechanical alignment, and a 220 Newton spring-loaded device (DePuy, Johnson and Johnson)

was inserted between the cut surface and distal femur for measuring gaps before and after each step of soft tissue release. An extension gap was defined as a gap between a proximal tibia cut and a distal femur in full extension. A flexion gap was defined as a gap between the posterior condyle of the femur and proximal tibia cut at 90 degrees of knee flexion.

PMC release was done by the release of the posteromedial corner and semimembranosus expansion (figure 1a-b). PMC release was not performed in a hyperextended knee or flexion contracture deformity below 5 degrees. sMCL was subperiosteally released, without pes anserine insertion detachment, after PMC release was done if varus deformity was more than 3 degrees using a bone chisel (figure 2a-b). We recorded all data at full extension, 30, 60, 90 and 120 degrees of flexion, respectively, after each soft tissue release step via Brainlab navigation system software 2.6 (figure 3a-d). After PMC and sMCL release, standard CAS TKA was continued. During the CAS procedure, after the trial TKA prosthesis was inserted, the stability of the knee was assessed. Intra-operative knee instability was identified as a gap change of more than 1 mm. after varus and valgus stress.

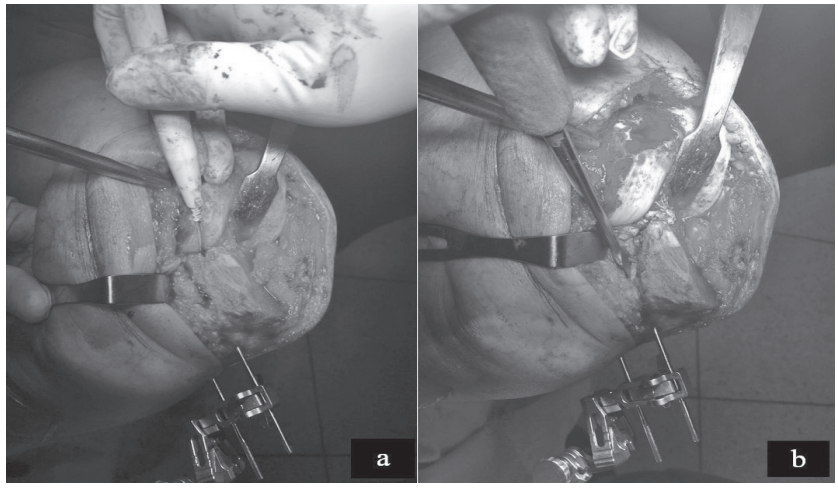

Figure 1a Initial posteromedial capsule release on the left knee using electrocauterisation
Figure 1b Posteromedial capsule release then release subperiosteally by a bone chisel

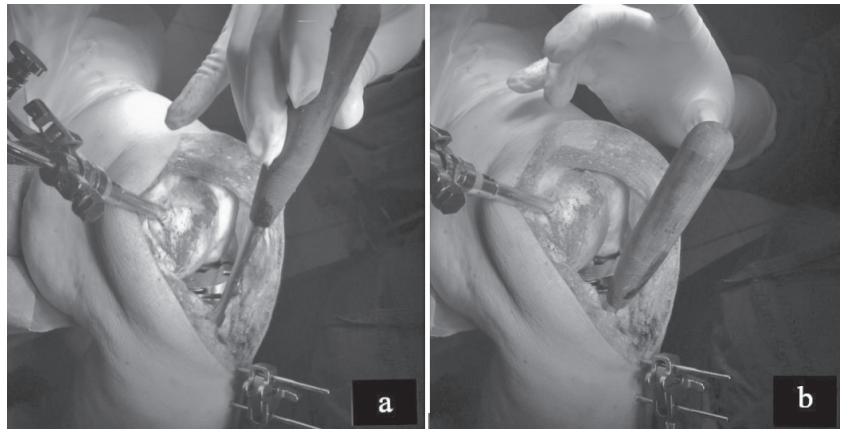

Figure 2a-b Superficial MCL of left knee was subperiosteally released downward to 8-10 cm. below joint line without pes anserine insertion detachment using bone chisel

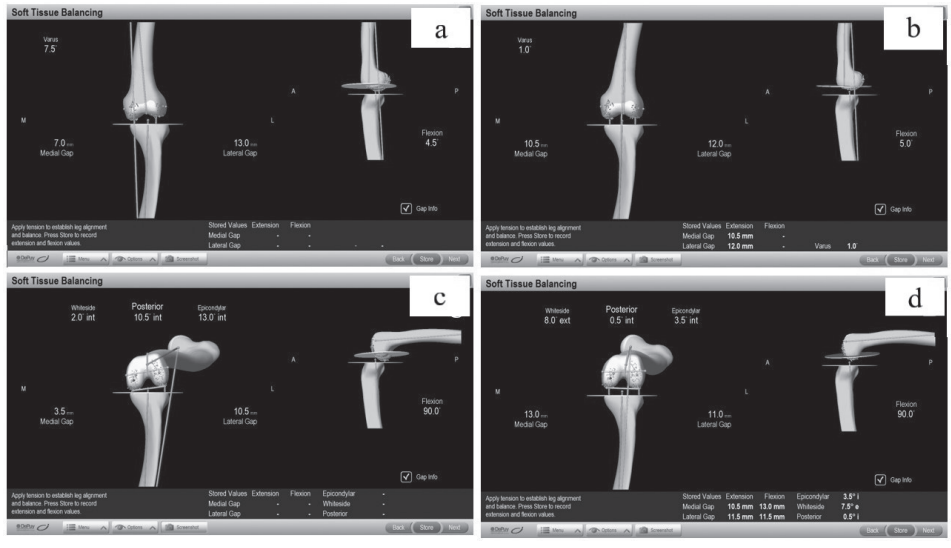

Figure 3a-d	CT-free navigation software showed how to measure alignment, extension and flexion gaps
Figure 3a	This figure shows medial and lateral extension gaps before PMC and sMCL release
Figure 3b	This figure shows medial and lateral extension gaps after PMC and sMCL release
Figure 3c	This figure shows medial and lateral flexion gaps before PMC and sMCL release
Figure 3d	This figure shows medial and lateral flexion gaps after PMC and sMCL release

Results

There were 21 patients (16 female and 5 male) with a mean age of 68.0 (48.0-78.0) years. The mean body mass index was 28.5 (20.7 – 39.9) kg/m^2. The mean preoperative hip-knee-ankle angle was 8.1 (3.5-16.0) degrees of varus with a mean flexion contracture of 11.3 (3.5-16.0) degrees. Sixteen knees were implanted with a fixed-bearing knee prosthesis, while the other five knees were implanted with a mobile-bearing knee prosthesis (table 1).

Table 1 Demographic data

			Range	SD
Gender	Female	16 (76.2%)		
	Male	5 (23.8%)		
Age (year)		68.0	48.0 – 78.0	9.0
BMI (kg/m^2)		28.5	20.7 – 40.0	5.0
Side	Right	13 (61.9%)		
	Left	8 (38.1%)		
Prosthesis	PFC Sigma	15 (71.4%)		
	Attune	1 (4.8%)		
	LCS	5 (23.8%)		
Comorbidity	Yes	11 (52.4%)		
	No	10 (47.6%)		
Preoperative HKA (degree)		8.1	3.5 - 16.0	3.4
Flexion Contracture (degree)		11.3	2.0 - 28.0	5.3

From the records, we performed PMC release in all patients and combined PMC and sMCL release in fourteen patients. The mean corrections of varus deformity after PM and sMCL release were 4.9 ± 2.8 and 3.4 ± 1.7 degrees, respectively, while the mean corrections of flexion contracture after PMC and sMCL release were 5.6 ± 3.5 and 1.3 ± 2.9 degrees, respectively, as shown in figure 4a-b.

The mean medial extension gap changes after PMC and sMCL release were 1.8 ± 1.4 and 1.7 ± 1.0 mm. respectively. The mean medial flexion gap changes after PMC and sMCL release were 0.7 ± 0.9 and 5.1 ± 2.1 mm., respectively (figure 5).

The mean lateral extension gaps after PMC and sMCL release were -1.3 ± 1.8 and -1.1 ± 1.6 mm., respectively. The mean lateral flexion gaps after PMC and sMCL release were -0.2 ± 1.0 and 0.1 ± 1.8 mm. (figure 5). No intra-operative instability was found. Postoperative varus and valgus stress tests were performed at full extension and 30-degree flexion. All patients' knees were stable and had no unstable feeling of the knee afterwards. The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

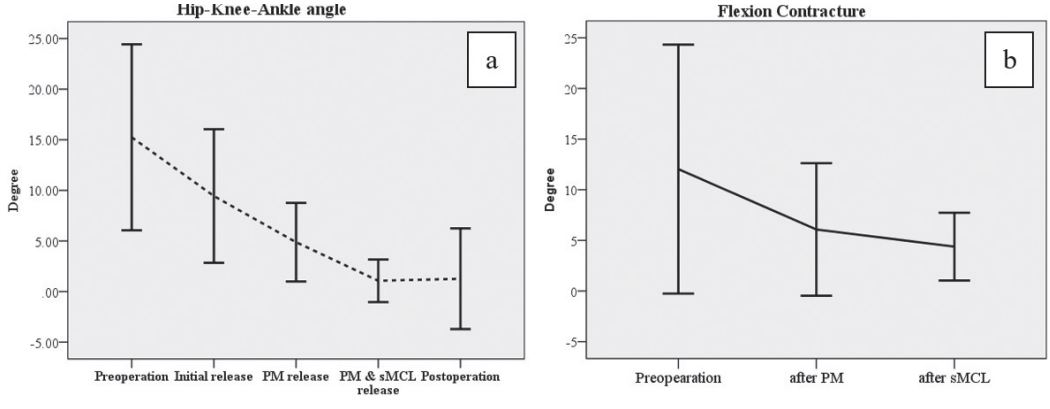

Figure 4a Hip-Knee-Ankle (HKA), Axis-X represents HKA and FC preoperative, after PMC and after sMCL release
Figure 4b Flexion contracture (FC) correction, Axis-Y shows HKA and FC (Degree), Positive HKA angle is defined as varus alignment

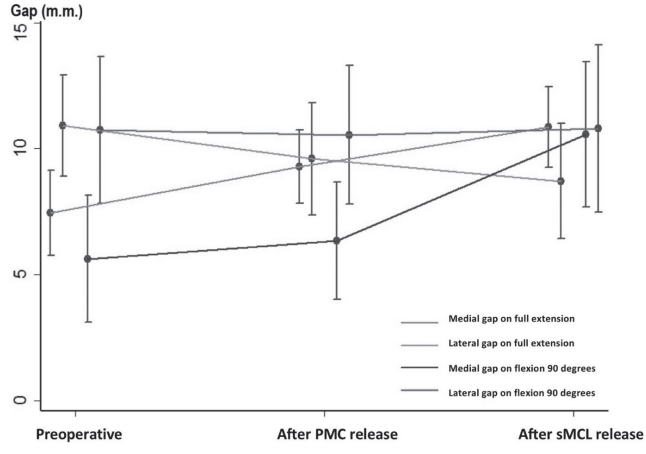

Figure 5 Medial and lateral gaps (mm.) changes at full extension and 90 degree flexion
Axis-X represents Medial and lateral gaps preoperative, after PMC and after sMCL release
Axis-Y shows Medial and lateral gaps (mm.)

Discussion

sMCL release had an effect on varus correction of both gaps with more effect on the flexion gap. The results also showed the negative effect of medial soft tissue release on the lateral gap. We believe that mechanical axis alignment restoration can explain this result.

Our results showed PMC release in total knee arthroplasty affected varus correction, including flexion contracture, similar to a previous study[17-19]. This technique had effects on both flexion and extension gaps with more effect on the extension gap.

Moreover, our results did not show instability after sMCL release, which was reported in the non-preserving insertion of the pes anserine sMCL release technique, pie-crusting or multiple needle puncturing techniques in previous studies[18, 21-23]. Differences in the results may have been caused by the surgical technique used in this study. Previously, the traditional technique had an over-correction effect on the flexion gap, while the modified technique in this study did not[24].

One of the main differences in the release technique was release without detachment of insertion of pes anserinus anteriorly; previous studies also showed the same results [25]. We believe that pes anserine provides dynamic stabilisation throughout the entire range of motion.

The strengths of this study included the use of CAS to record the changes in gaps among all patients, which provided minimal measurement error. Further, the results of PMC and sMCL release may be varied in long-term follow-up. Further study and long-term follow-up should be carried out.

This study had some limitations. First, a retrospective descriptive study was carried out with female predominance. Second, a small sample size was observed, but the changes in the gap were significant. Third, we used different types of prostheses.

Conclusion

The sMCL release with the preservation of anterior attachment of pes anserinus in TKA had an additional effect on varus knee correction after posteromedial capsule release without the creation of knee instability.

Conflict of interest

The authors declare no conflicts of interest in the completion of this study.

Acknowledgement

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