Is it sufficient to reconstruct the superficial medial collateral ligament only in medial knee instability? A comparative study

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Received: 13 May 2018
Revised: 1 June 2018
Accepted: 22 June 2018
Published: 6 January 2022

The Egyptian Orthopaedic Journal 2021, 56:285–290

Introduction
The medial collateral ligament (MCL) is the primary static stabilizing structure on the medial aspect of the knee, contributing up to 78% of the restraining force to valgus loads. Sims and Jacobsen reported that 99% of medial injuries requiring operation had an associated injury to the posterior oblique ligament (POL), which was overlooked in many reports.
Hypothesis
Reconstruction of both superficial MCL and POL might be clinically advantageous in regaining valgus stability compared to superficial MCL reconstruction alone. Both groups were compared regarding the following parameters: clinical evaluation according to the Lysholm and the International Knee Documentation Committee rating scoring systems and stress valgus x-ray.
Patients and methods
Between January 2015 and April 2017, we conducted a prospective randomized analytical study, including 30 patients suffering from grade III MCL injury. They were divided into two groups (A) and (B). For group A, 15 patients underwent superficial MCL reconstruction only, while for group B, concomitant reconstruction of the superficial MCL and POLs.
Results
The mean Lysholm score in group A preoperatively was 37.9±8.1 and became 91.0 ±6.3 postoperatively with *P* value less than 0.001, while in group B, it was 38.7±11.4 and became 92.9±8.3 with *P* value less than 0.001. There was no statistical significant difference between both groups postoperatively (*P*=0.478). Regarding ligament examination of International Knee Documentation Committee score postoperatively, the frequency of cases of A, B, C, and D grades of Lachman in group A was 53.3, 40, 6.7, and 0%, respectively, versus 80, 20, and 0% in group B, and this difference was not statistically significant (*P*=0.4). According to valgus stress test, the frequency of cases of A, B, C, and D grades in group A was 66.7, 33.3, and 0%, respectively, versus 73.3, 26.7, and 0% in group B, and this difference was not statistically significant (*P*=0.7). The stress valgus x-ray evaluation of the degree of gapping in extension in group A was 1.7 ±0.5 versus 1.3±0.7 in group B and this difference was not statistically significant (*P*=0.1), and the degree of gapping in flexion in group A was 1.8±0.4 versus 1.4±0.7 in group B and this difference was not statistically significant (*P*=0.1).
Conclusion
There was no difference in the clinical and the radiological outcome between the reconstruction of the superficial MCL alone versus the concomitant reconstruction of the POL in patients with medial knee instability.

Keywords:
medial collateral, posterior oblique ligament, reconstruction

Egypt Orthop J 56:285–290

1110-1148

Introduction

Injury to the medial collateral ligament (MCL) is the most common knee ligament injury [1]. The MCL is the primary static stabilizing structure on the medial aspect of the knee, contributing up to 78% of the restraining force to valgus loads [2]. Sims and Jacobsen reported that 99% of medial injuries requiring operation had an associated injury to the posterior oblique ligament (POL), which was overlooked in many reports [3]. It is generally accepted that incomplete tears and isolated complete tears of the MCL can be treated nonoperatively with early functional rehabilitation [4]. However, grade 3 injuries of the MCL, especially those associated with other ligamentous injuries, sometimes lead to chronic instability followed by disability [5]. Anatomical reconstruction of the MCL with the

semitendinosus and gracilis tendons was introduced by Yoshiya *et al*. [6]. Three techniques for reconstructing the MCL and the POL have been described. Two use semitendinosus autografts with the pes anserinus insertion of the tendon left intact [7]. There is deficient literature regarding the optimal treatment of grade 3 MCL injuries. Our hypothesis was that reconstruction of both superficial MCL and POL might be clinically advantageous in regaining valgus stability compared to superficial MCL reconstruction alone. Both groups were compared regarding the following parameters: clinical evaluation according to the Lysholm and the International Knee Documentation Committee score (IKDC) rating scoring systems and stress valgus x-ray.

Patients and methods

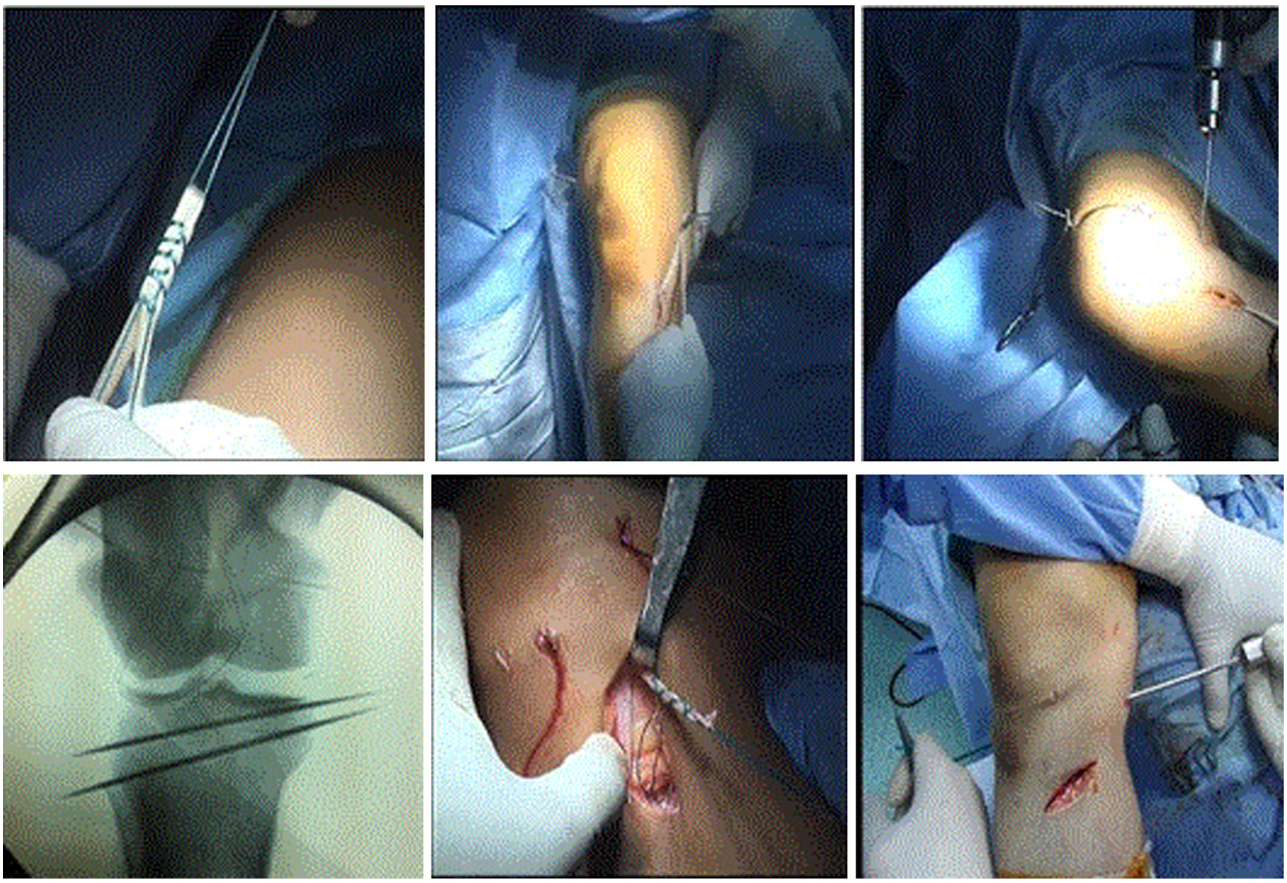
Between January 2015 and April 2017, we conducted a prospective randomized analytical study, including thirty patients suffering from grade III MCL injury. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Cairo University, Cairo, Egypt. The patients were allocated a sequential study number and there were no exclusions after randomization. An informed consent was obtained from all the patients before operation. The patients were divided into two groups. For group A, 15 patients underwent superficial MCL reconstruction only, while for group B, concomitant reconstruction of the superficial MCL and POLs was done for the other 15 patients. The inclusion criteria were skeletally mature patients suffering from MCL injury grade III alone or as a part of multiligamentous knee injury and with intact hamstring tendons of the injured limb. We excluded skeletally immature patients with malalignment and previous surgery involving the injured limb. All the patients were evaluated through proper history taking, clinical evaluation, and radiological evaluation using stress valgus/varus plain x-ray views and MRI. They were rated according to the Lysholm knee score and IKDC. The mean time from injury to reconstruction was 3.4 months (2–6 months).

Operative technique

The patients were laid supine under spinal anesthesia and a tourniquet was applied. Valgus stress test was done under anesthesia at full extension and 30° flexion and compared with the contralateral side as well as examination of the other knee ligaments. A diagnostic arthroscopy was done with special attention to the medial compartment to evaluate the degree of the opening of the medial compartment and the "meniscus rise" sign. For both groups, the semitendinosus tendon (ST) is harvested using the tendon stripper and left distally attached. The free end of the tendon is cleaned and sutured using no.2/0 vicryl. The graft then was doubled and a loop was done (Fig. 1). The length of the loop should be longer than the distance between the distal attachment of the tendons and the medial femoral epicondyle by 2 cm. A stab incision was done over the tip of the medial femoral epicondyle. A K-wire was drilled just posterior and proximal to the tip. An isometry test then was done by pulling the graft around the wire and the change in the length during flexion and extension should not exceed 2 mm. If it was isometric, the tunnel was then drilled with a drill of the same diameter of the looped end of the graft. A shuttle was done using a cerclage wire. For group B patients, blunt subcutaneous dissection was carried out to the posteromedial aspect of the tibia, then through a stab incision, a K-wire was drilled 1 cm below the joint line, and its position can be checked using the image intensifier. The tunnel was then drilled aiming to the anterolateral aspect of the tibia using a drill of 7-mm diameter. A shuttle was done using a cerclage wire. For both groups, the looped end of the graft was passed subcutaneously to be pulled inside the femoral tunnel using the shuttle. Thus, the superficial MCL had been reconstructed. Fixation of the superficial MCL was done in 30° flexion and neutral rotation of the foot with applying a varus force to the knee using the interference bioscrew that had the same diameter of the tunnel. For group A, the free end of the graft was sutured to the base of the graft using vicryl no 2. For group B, the free end of the graft was passed subcutaneously to be pulled into the tibial tunnel through the shuttle to reconstruct the POL. Fixation was done in full extension and neutral rotation of the foot with applying a varus force to the knee. The fixation was done using the interference bioscrew of 7-mm diameter. For associated injuries like anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL), we used the contralateral hamstring tendons or the ipsilateral quadriceps tendon for reconstruction of ACL or PCL. The tunnels of the MCL then were done and the shuttles without passing the graft. The ACL or PCL was then reconstructed after which the graft of the MCL was then passed and fixed.

Postoperatively, the patients were advised to use ice therapy as much as tolerable. A hinged knee brace was applied for 6 weeks. Discharging the patient was within

Figure 1



Surgical technique: the harvested graft is doubled and looped (a), testing the isometric point around the k-wire drilled for the superficial medial collateral ligament (b), drilling at the posteromedial aspect of tibia 1 cm above the joint level for posterior oblique ligament (c), verification of the position of the k-wire using image intensifier (d), the looped end of the graft is passed into the femoral tunnel using cercilage shuttle (e), and fixation of the reconstructed posterior oblique ligament at the tibial tunnel in full extension and neutral rotation (f).

24 h. All patients were evaluated after surgery every two weeks up to the second postoperative month, monthly up to 6 months. In this study, the mean follow-up period was 18 months (range: 12–24 months). After assessment of the patients clinically and radiographically with stress x-rays at full extension and 30° flexion, the postoperative rating scales (Lysholm, IKDC) were recorded and all data were documented 6 months postoperatively.

Statistical analysis

Data management and analysis were performed using SigmaStat program; version 3.5 (Systat Software Inc., 2107 North First Street, Suite 360 San Jose, CA, USA). The graphs were done using Microsoft Excel 2007 (Microsoft Cooparation, Washington, USA). The numerical data were statistically presented in terms of mean, SE, median, and interquartile range. Categorical data were summarized as percentages. Comparisons between numerical variables of two groups were done by unpaired Student's *t*-test for parametric data or Mann–Whitney rank-sum test for nonparametric data. Comparisons between numerical variables at pre-and postoperative time points were done by Student's paired *t*-test for parametric data or Wilcoxon signed-rank test for nonparametric data.

Results

Thirty patients suffering from medial knee instability were included in this study and divided into two groups, their demographic data are shown in Table 1. Both groups were comparable regarding age distribution at the time of the operation and sex ($P>0.05$).

The mean Lysholm score in group A preoperatively was 37.9±8.1 and became 91.0±6.3 postoperatively with P value less than 0.001, while in group B, it was 38.7±11.4 and became 92.9±8.3 with P value less than 0.001. There was no statistically significant difference between both groups postoperatively ($P=0.478$) (Table 2).

IKDC: The objective assessment and sports performance recovery were categorized according to the function test grading of the IKDC form. In group A, 14 patients had associated ACL injury, while in

Table 1 Patient data

Parameters	Group A (*n*=15) [*n* (%)]	Group B (*n*=15) [*n* (%)]	*P* value
Age (years)			
Mean±SD	27.7±5.8	27.7±10.0	1.000
Range	17–39	17–45)	
Median (IQR)	28.0 (23.5–30.75)	24.0 (22.0–36.5)	
Age groups (years)			
15–30	11 (73.3)	10 (66.7)	**1.000**
>30–45	4 (26.7)	5 (33.3)	
Sex			
Males	14 (93.3)	11 (73.3)	**0.330**
Females	1 (6.7)	4 (26.7)	
Associated injuries			
ACL	14	12	
Meniscus tears			
Medial meniscus	10	8	
Lateral meniscus	2	2	

ACL, anterior cruciate ligament; IQR, interquartile range.

Table 2 Lysholm score

	Group A (*n*=15)	Group B (*n*=15)	*P* value
Lysholm score			
Preoperative			
Mean±SD	37.9±8.1	38.7±11.4	0.478
Median (IQR)	36 (33–43)	36 (31–42)	
Postoperatively			
Mean±SD	91.0±6.3	92.9±8.3	
Median (IQR)	90 (86–95)	95 (86–100)	

IQR, interquartile range.

group B, 12 patients had associated ACL injury. Regarding ligament examination postoperatively, the frequency of cases of A, B, C, and D grades of Lachman in group A was 53.3, 40, 6.7, and 0%, respectively, versus 80, 20, and 0% in group B, and this difference was not statistically significant (*P*=0.4). According to valgus stress test, the frequency of cases of A, B, C, and D grades in group A was 66.7, 33.3, and 0%, respectively, versus 73.3, 26.7, and 0% in group B, and this difference was not statistically significant (*P*=0.7).

Stress valgus x-ray was performed to assess the difference between the degree of gapping of the medial compartment in millimeters (mm) in relation to the normal side pre- and postoperatively in both groups. Postoperatively, the degree of gapping in extension in group A was 1.7±0.5 versus 1.3±0.7 in group B and this difference was not statistically significant (*P*=0.1) (Table 3), and the degree of gapping in flexion in group A was 1.8±0.4 versus 1.4 ±0.7 in group B and this difference was not statistically significant (*P*=0.1); both groups were comparable regarding the degree of gapping in extension and in flexion (*P*=0.1) Table 4.

Discussion

The MCL is the most commonly damaged ligamentous structure of the knee joints [8]. Sims and Jacobsen reported that 99% of medial injuries requiring operation had an associated injury to the POL, which was overlooked in many reports [3]. The treatment of MCL injury has evolved from nonoperative management to aggressive surgical repair or reconstruction; most surgeons prefer nonoperative treatment because of the MCL's good self-healing ability [8,9]. However, grade 3 injuries of the MCL, especially those associated with other ligamentous injuries, sometimes lead to chronic instability followed by disability [5]. Currently, there is a broad academic controversy on the treatment of MCL injury, and the surgeons who support surgical treatment of third-degree MCL injury have various conflicting views on surgical approach and treatment procedures [10–12]. Several forms of surgical treatment have been described for chronic medial instability of the knee, including proximal advancement or reconstruction of the MCL [13]. Nonanatomical reconstruction of the MCL has been carried out using the medial head of gastrocnemius or pes anserinus. Bosworth described anterior translation of the semitendinosus tendon and its implantation on the medial femoral condyle, which resulted in slight laxity during flexion in half of the cases [14]. Anatomical reconstruction of the anterior component of the MCL with the semitendinosus and gracilis tendons was introduced by Yoshiya and colleagues. Although they reported normal or nearly normal results according to the IKDC score in all 24 cases, injury to the posteromedial corner was not considered in the study [6]. Kim and colleagues described a

Table 3 IKDC item

IKDC item	Group A			Group B			
	Preoperative	Postoperative	*P* value	Preoperative	Postoperative	*P* value	*P* value postoperative
A—effusion							
Normal (A)	4 (26.7)	12 (80)		4 (26.7)	12 (80)		
Near normal (B)	9 (60)	3 (20)	0.011*	11 (73.3)	3 (20)	<0.001*	0.143
Abnormal (C)	2 (13.3)	0		0	0		
Severely abnormal (D)	0	0		0	0		
B—Passive motion deficit							
1—Lack of extension							
Normal (A)	13 (86.7)	14 (93.3)	0.543	15 (100)	14 (93.3)	0.309	1.000
Near normal (B)	2 (13.3)	1 (6.7)	<0.001*	0	1 (6.7)	0.007*	0.195
Abnormal (C)	0	0		0	0		
Severely abnormal (D)	0	0		0	0		
2—Lack of flexion							
Normal (A)	3 (20)	13 (86.7)		2 (13.3)	10 (66.7)		
Near normal (B)	9 (60)	2 (13.3)		10 (66.7)	5 (33.3)		
Abnormal (C)	3 (20)	0		3 (20)	0		
Severely abnormal (D)	0	0		0	0		
C—Ligament ex							
1—Lachman test							
Normal (A)	1 (6.7)	8 (53.3)		3 (20)	12 (80)	<0.001*	0.348
Near normal (B)	0	6 (40)		0	3 (20)	<0.001*	0.690
Abnormal (C)	12 (80)	1 (6.7)		12 (80)	0		
Severely abnormal (D)	2 (13.3)	0		0	0		
2—Valgus test							
Normal (A)	0	10 (66.7)		0	11 (73.3)		
Near normal (B)	2 (13.3)	5 (33.3)		4 (26.7)	4 (26.7)		
Abnormal (C)	12 (80)	0	<0.001*	11 (73.3)	0		
Severely abnormal (D)	1 (6.7)	0	<0.001*	0	0		

*Statistically significant.

Table 4 Stress valgus x-ray difference

Stress valgus x-ray difference	Preoperative		Postoperative		*P* value
	Group A (*n*=15)	Group B (*n*=15)	Group A (*n*=15)	Group B (*n*=15)	
In extension					
Mean±SD	6.7±1.3	5.6±1.6	1.7±0.5	1.3±0.7	0.106
Range	4–8	3–8	1–2	0–2	
Median	7 (6–8)	5 (4–7)	2 (1–2)	1 (1–2)	
In flexion					
Mean±SD	7.7±1.3	5.9±1.6	1.8±0.4	1.4±0.7	0.103
Range	5–9	3–8	1–2	0–2	
Median	8 (7–9)	6 (4–7)	2 (2–2)	2 (1–2)	

concomitant reconstruction of the superficial MCL and POL ligaments using a distally based hamstring tendon. A tunnel was done at the medial femoral condyle. A 6.5-mm cancellous screw was inserted into the tunnel tightened, while the semitendinosus tendon looped around the shank that was tensioned manually to allow fixation of the tendon at the distal edge of a washer. The free end of the graft was sutured around the direct head of the semimembranosus tendon to reconstruct the POL. Although they reported normal or nearly normal results according to the IKDC score and stress valgus x-ray in 22 cases from 24 cases, methods of fixation either of the superficial MCL or the POL are weak and the washer may cause fraying of the graft [7]. Martin Lind and colleagues described anatomical reconstruction of both superficial MCL and POL using a distally based hamstring tendon that was looped. The number of patients was large (50) and the least follow-up period was 2 years, which is long in comparison with the other studies. However, it was a retrospective study that is a weakness point and the other thing is that they fixed the POL in 60° flexion although the POL anatomically is tight in extension [1]. Laprade and colleagues also described anatomical reconstruction of both superficial MCL and POL using two separate grafts that were

fixed in the native origins and insertions of the superficial MCL and POL after exposing them. Although it is an anatomical method but it requires massive dissection that increases the morbidity of the patients, the follow-up period was short and the presence of four tunnels with four tools of fixation is too much with the risk of overriding of the tunnels [15]. To our knowledge, this study is the first comparative study that compares the functional results of reconstruction of the superficial MCL only versus reconstruction of both superficial MCL and POL in a minimally invasive technique for both. We compared both groups prospectively regarding the Lysholm score, IKDC score, and the difference between degrees of gapping of the medial compartment in mm in relation to the normal side in stress valgus x-ray. The mean Lysholm score in group A preoperatively was 37.9±8.1 and became 91.0±6.3 postoperatively with *P* value less than 0.001, while in group B, it was 38.7±11.4 and became 92.9±8.3 with *P* value less than 0.001. There was no statistically significant difference between both groups postoperatively (*P*=0.478). Regarding the IKDC evaluation using valgus stress test, the frequency of cases of A, B, C, and D grades in group A was 66.7, 33.3, 0, and 0%, respectively, versus 73.3, 26.7, 0, and 0% in group B, and this difference was not statistically significant (*P*=0.7). Postoperatively, the degree of gapping in extension in group A was 1.7±0.5 versus 1.3±0.7 in group B and this difference was not statistically significant (*P*=0.1), and the degree of gapping in flexion in group A was 1.8±0.4 versus 1.4 ±0.7 in group B and this difference was not statistically significant (*P*=0.1); both groups were comparable regarding the degree of gapping in extension and in flexion (*P*=0.1). Regarding the surgical technique in this study, the use of a distally based hamstring tendon put away the need of fixation at the tibia. The use of image intensifier during making the tunnel of the POL provides more accurate tunnel positioning. The minimally invasive way of reconstruction decreases the morbidity of the patient, especially that it is usually associated with other ligament injuries. Our study is limited by a number of factors. First, the average follow-up is short and further long-term follow-up is necessary to ensure that instability does not recur over time. Second, the majority of the surgical procedures are not for isolated medial knee reconstructions. Finally, this procedure could only be performed on a knee with an intact tibial attachment of the semitendinosus. There was no difference in the clinical and the radiological outcome between the reconstruction of the superficial MCL alone versus the concomitant reconstruction of the POL in patients with medial knee instability.

Conclusion

There was no difference in the clinical and the radiological outcome between the reconstruction of the superficial MCL alone versus the concomitant reconstruction of the POL in patients with medial knee instability.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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