

Clinical and Functional Outcomes of Early Collateral Ligament and Late Cruciate Ligament Reconstructions in Multi-Ligament Knee Injuries; a Prospective, Cross-Sectional Study

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Abstract

Background: Multi-ligament knee injury is common after knee dislocation. There are different approaches for treating multi-ligament knee injuries; however, choosing the best approach is a challenging issue.

Objectives: This study aimed to investigate the efficacy of early reconstruction of collateral ligaments and delayed reconstruction of cruciate ligaments in multi-ligament knee injury.

Methods: In this prospective study, 24 patients who had a grade 3 tear in one collateral ligament in addition to tears in two other knee ligaments were enrolled. At the first stage, collateral ligaments were reconstructed; after the patient gained full range of motion, reconstruction was done for the cruciate ligaments. Patients were followed-up for one year and postoperative evaluations were conducted through clinical tests, International Knee Documentation Committee scores, and Lysholm scales.

Results: Twenty-four patients were entered into the final analysis. Synchronous injury of anterior cruciate ligament, posterior cruciate ligament, medial collateral ligament, posterior oblique ligament, posterolateral corner, and lateral collateral ligament had the highest frequency (37.5%). At the one-year follow-up, the average Lysholm and IKDC scores were 86.4 ± 3.5 and 83.8 ± 4 , respectively. Range of motion was normal in all patients at the end of the study. Furthermore, in varus and valgus stress tests, the outcomes of reconstruction were better on the lateral side of the knee than on the medial side.

Conclusion: The results revealed that a two-stage surgery consisting of early reconstruction of collateral ligaments and delayed reconstruction of cruciate ligaments have good clinical and functional outcomes in multi-ligament knee injuries.

Keywords: Multi-ligament knee injury, Reconstruction, Collateral ligaments, Knee Dislocation, Cruciate ligaments.

Introduction

Multi-ligament knee injury (MLKI) is one of the most common complications of knee dislocation (1-3). The prevalence of knee dislocation and MLKIs is 0.2 -2%; however, they are associated with high morbidity and short- and long-term outcomes such as loss of range of motion, pain, and failure of ligament reconstruction (4,5).

Surgery is necessary after MLKI to stable the knee joint, though treatment of MLKIs is often associated with vascular and neurological complications (6). There is no uniform protocol for the operative treatment of acute knee dislocations (7-9). In fact, the heterogeneity, low number of patients, and many different surgical techniques for these injuries have prevented a consensus on treatment (10-12).

Early surgical reconstruction which can have better clinical outcomes is advocated in some studies (13,14). Conversely,

some studies have reported that delayed reconstruction may be as effective as early reconstruction (15,16).

In some patients with knee dislocation, the knees largely remain unstable despite the use of an external fixator; thus, patients are likely to have subluxation (17). One acceptable treatment method is reconstruction or repair of the collateral ligaments within two weeks after injury to stabilize the knee followed by reconstruction of the cruciate ligaments after the patient achieves full range of motion.

Objectives

Considering the results of previous studies, this study aimed to evaluate the clinical and functional outcomes of early surgical reconstruction of the collateral ligaments and delayed reconstruction of the cruciate ligaments in multi-ligament knee injuries.

Materials and Methods

This prospective interventional study was conducted on patients with knee dislocation who referred to Taleghani Hospital during the first two weeks after trauma from 2015 until 2017. During this period, 38 patients with acute multi-ligament knee injury were referred to the hospital.

Patients aged over 18 and less than 50 years who had a grade 3 tear in one collateral ligament in addition to tears in two or more other ligaments were included in this study. Patients who suffered from neurological or vascular defects, avulsion fractures of the collateral or cruciate ligaments, severe soft tissue damage around the knee, proximal MCL tear, or grade 1 or 2 tears in the collateral ligaments were excluded from the study. Eventually, 24 patients met the inclusion criteria and were enrolled in the study.

Primary evaluation

Patients were moved to the operating room and the following tests were performed: varus and valgus stress tests for collateral tears, Lachman and anterior drawer test (ADT) for ACL tears, and posterior drawer test (PDT) and dial test for PCL tears. In addition, stress views and MRIs were taken to confirm injuries to the collateral and cruciate ligaments.

Surgical technique

All patients underwent reconstruction rather than repair of

the collateral ligaments in the first stage. Patients who had LCL and PLC tears underwent reconstruction surgery according to the LaPrade technique (Figure-1) (Figure-2) (17), and those with MCL tears underwent reconstruction of the superficial MCL using allograft by tibial and femoral tunnels. Allografts were fixed by absorbable screws in both tunnels.

Postoperatively, hinged knee braces were used for all patients and rehabilitation was immediately performed to recover range of motion inside the knee brace. The rehabilitation program was similar for all patients.

Subsequent to acquiring full range of motion, patients underwent arthroscopic surgery for reconstruction of the cruciate ligaments.

In ACL reconstruction, active flexion and extension exercises were permitted for patients immediately after surgery; however, in PCL reconstruction, active flexion and extension exercises were permitted 6 weeks after surgery. The PCL hinge knee brace was used for 6 months after surgery for all patients. In the follow-up assessment at the 2nd, 6th, and 12th months, patients' range of motion was examined using a goniometer. At the final follow-up, the Lysholm and IKDC forms were completed to determine knee instability and activity level. Knee stability was assessed by clinical tests including PDT, ADT, and varus and valgus stress tests.

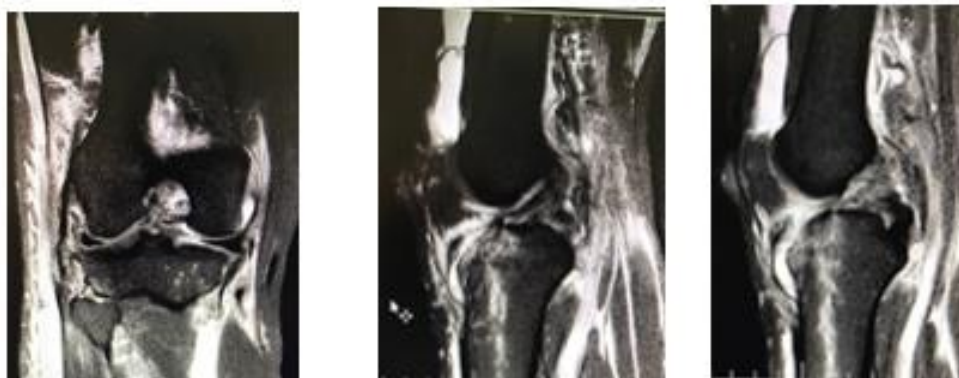


Figure-1. MRI in one of the patients. Tears of Lateral collateral ligament at fibular head, popliteus tendon at femoral side and posterior cruciate ligament at femoral side.

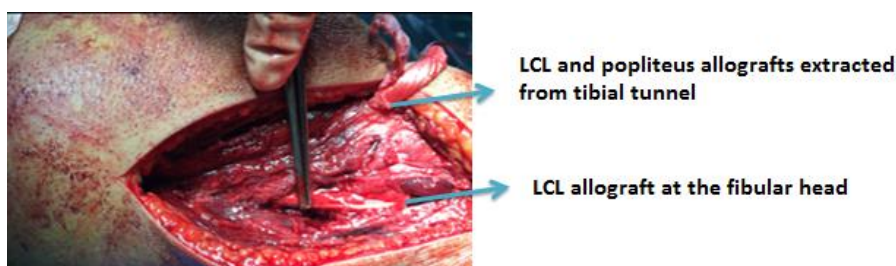


Figure-2. In acute stage lateral and posterolateral reconstruction was performed by LaPrade method.

Data collection

Demographic data including age, gender, and BMI, and injury-associated data including mechanism of injury, evidence of fracture, frequency of ligament injury, and location of the injury were recorded at the baseline of the study. IKDC and Lysholm scores in addition to range of motion were recorded in the postoperative period.

Statistical analysis

Statistical analysis was performed using SPSS software (Version 25.0. Armonk, NY: IBM Corp.). Continuous (such as age, BMI, gap between the first and second operations, Lysholm and IKDC scores) and categorical variables (such as gender and type of multi-ligament knee injuries) were reported as means±standard deviation (SD) and percentages, respectively. Differences between categorical variables, like comparisons of the lateral and medial reconstructions, were analyzed using the chi-square test, and improvement in range of motion over time was analyzed using the Friedman test.

Ethical Considerations

The current study was conducted according to the Declaration of Helsinki and was approved by the Ethical Committee of Shahid Beheshti University of Medical Sciences with the Registration code of IR.SBMU.RETECH.1396.32.

Results

Demographic characteristics

The current study investigated 24 patients, 18 (75%) males and 6 (25%) females. The mean age of patients was 29±9.25 years, the mean BMI was 46.2±24.47, and the gap between the first and second operations averaged 10±2.5 weeks. Twenty-one patients (87.5 %) incurred their injuries in an accident (vehicle or motorcycle), and 3 patients (12.5%) had sport injuries. Half of the patients had a right knee injury and the other half had a left knee injury. There was no evidence of fracture in 21 patients (87.5%), though three patients had capsular avulsions (12.5%).

Among the 24 patients who suffered from multi-ligament knee injuries, ACL and PCL, MCL, POL, PLC, and LCL synchronous injury had the highest frequency (37.5%) (Table-1).

Among the injured ligaments, ACL and PCL had the highest frequency (95.8%), and PLC had the lowest frequency

(54.2%) (Chart-1).

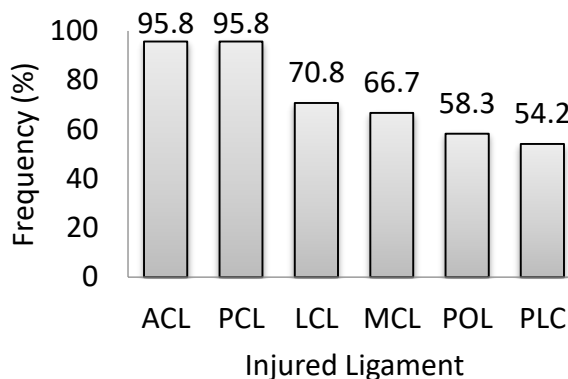


Chart-1. Location of injury

Table-1. Frequency of type of knee multi-ligament injuries

Percentage	Frequency	Ligament
ACL-PCL-MCL-POL-PLC-LCL	37.5	9
ACL-PCL-MCL-POL	20.8	5
ACL-PCL-LCL-PLC	16.7	4
ACL-PCL-LCL	8.3	2
ACL-PCL-MCL	8.3	2
ACL-MCL-LCL	4.2	1
PCL-MCL-LCL	4.2	1
total	100	24

ACL: Anterior Cruciate Ligament, PCL: Posterior Cruciate Ligament, MCL: Medial Collateral Ligament, PLC: Posterolateral Complex, LCL: Lateral Collateral Ligament, POL: Posterior Oblique Ligament

Follow-up result

Clinical results

Knee range of motion (ROM) after 2 months was lower than 45 degrees in two patients for whom knee manipulation was performed under anesthesia. After 6 months, knee ROM was higher than 60 degrees in all patients, and all patients had reached a complete range of motion at the end of the 12th month. The results of the Friedman test indicated that ROM improvement over time was statistically significant (*p*-value=0.0001) (Table-2).

One year after surgery, 18 (75%) patients were capable of doing extreme exercises such as jumping and running; 4 (16.7%) patients were capable of doing heavy work, but were afraid of running and jumping; and two (8.3%) patients were only capable of performing daily activities (Chart-2). Moreover, 20 (83.3%) patients felt no knee instability during very heavy activities, and four (16.7%) patients experienced knee instability only in heavy activities.

Table-2. Range of motion in postoperative follow-up

ROM	Two months after the surgery Number (%)	Six months after the surgery Number (%)	One year after the surgery Number (%)	P-Value
<45°	2 (8.3)	0 (--)	0 (--)	0.0001
45-60°	0 (--)	0 (--)	0 (--)	
60-90°	8 (33.3)	4 (16.7)	0 (--)	
90-120°	10 (41.7)	14 (58.3)	0 (--)	
>120°	4 (16.7)	6 (25)	24 (100)	
Total	24 (100)	24 (100)	24 (100)	

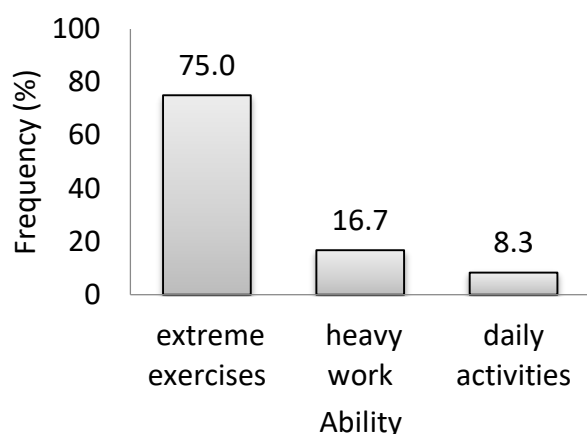


Chart-2. Physical ability of patients at one-year follow-up

One year after surgery, the ADT test for 23 patients with ACL tears showed that the anterior displacement in the operated side compared to the opposite side was less than 31 mm in two patients, between 3 to 5 mm in 16 patients, and between 5 to 10 mm in five patients. Furthermore, PDT test results among 23 patients with PCL tears showed that the posterior displacement compared to the opposite knee was between 3 and 5 mm in four patients, between 6 and 10 mm in 14 patients, and more than 10 mm in five patients; the posterior displacement was not less than 3 mm in any of the patients.

The valgus stress test results revealed that among 18 patients who received MCL reconstruction, the medial opening of the knee was less than 5 mm in three patients, 6-10 mm in eleven patients, and more than 10 mm in four patients compared to the opposite knee.

The varus stress test showed that among the 17 patients who underwent lateral reconstruction, the lateral opening of the knee was less than 5 mm in eight patients, 6-10 mm in eight patients, and more than 10 mm in one patient. Hence, lateral reconstruction demonstrated better clinical results than

medial reconstruction. Also according to the chi-square test results, lateral reconstruction was significantly better compared to medial reconstruction (p -value=0.037).

Failure of the treatment strategy was observed in one patient. Treatment of a 62-year-old patient who underwent reconstruction of the MCL, LCL, and PCL was considered a failure following the final clinical examination. The patient suffered from stiffness after reconstruction of the LCL and MCL in the initial stage; hence, knee manipulation was performed for this patient.

Functional results

The one-year follow-up average Lysholm and IKDC scores were 86.4 ± 3.5 and 83.8 ± 4 , respectively.

Discussion

The most important finding of this study was that early reconstruction of lateral and posterolateral ligament disruptions or early reconstruction of medial collateral disruptions from the tibial side or midsubstance and late reconstruction of the ACL or PCL had acceptable clinical and functional outcomes.

Over the past 50 years, the treatment of knee dislocation has changed considerably. Recent studies on knee dislocation have reported different findings, and there is no single treatment for this injury (18). Most studies on knee dislocation have either examined a limited number of cases or conducted retrospective investigations. More satisfactory results have been reported for surgical reconstruction of dislocated knee compared with non-surgical treatments (19). However, it is still unknown whether an early or a delayed surgical reconstruction provides a better outcome or whether a single- or two-stage surgery is better.

Clinical management of a dislocated knee is the major challenge of surgery, and it has to be done by surgeons who have extensive experience in the reconstruction of knee

ligaments. The time and type of surgery are two pivotal points in the treatment of patients with knee dislocation. In a systematic review by Sheth et al. (20), early surgery of multi-ligament knee injury resulted in a higher Lysholm score compared to delayed surgery, while there was no significant difference between the early and delayed surgery in terms of IKDC, Tegner activity scale, or total arc of motion. A highly experienced rehabilitation team is a crucial point in early reconstruction to make the patient ready for one-step reconstruction within two to three weeks after MLKI. Unlike many studies supporting early reconstruction, a recent systematic study by Hohmann et al. (16) concluded that other than ROM, there was no further significant difference between the results of early and delayed reconstructions. In some patients with knee dislocation, the knees largely remain unstable despite the use of an external fixator; thus, such patients are likely to have subluxation (21). Therefore, one of the acceptable treatments is the reconstruction or repair of the collateral ligaments within two weeks after injury to stabilize the knee followed by reconstruction of the cruciate ligaments after patient has achieved full range of motion (22, 23). However, the outcomes of the repair of grade 3 posterolateral knee injuries were worse than those of reconstruction (24). Repair, reconstruction, or repair with augmentation have also been reported for grade 3 medial knee injuries (25). In the present study, reconstruction surgery was performed for all acute grade 3 medial and lateral tears. In a study by Liow et al., seven patients with knee dislocation underwent ligament repair and reconstruction within two weeks after surgery and were compared with 14 patients who had delayed reconstruction (26). Although the outcomes in the early surgical group were better according to the Lysholm score, Tegner activity scale, and anterior translation, both groups were similar in terms of IKDC score and ROM. However, in this study, the cruciate ligaments were reconstructed by the open technique in the acute stage. In another study, Fanelli et al. recommended that lateral ligaments should be repaired within two to three weeks after injury (27). They believed that during this period, the capsule will be improved, and it will be possible to perform the arthroscopic technique; however, this technique entails a good rehabilitation team to reduce the risk of arthrofibrosis.

Some authors have suggested that early reconstruction is better for PCL and collateral ligaments, while the ACL can be reconstructed in the next step (28,29). According to Shapiro

and Freedman, there is a higher risk of arthrofibrosis with early reconstruction of cruciate ligaments (30).

In this study, 24 patients with acute knee dislocation underwent early reconstruction surgery of the collateral ligaments, and after they had achieved full range of motion in the knee, delayed reconstruction surgery of the cruciate ligaments was performed. Considering the conflicting results obtained for repair of collateral ligaments, especially on the lateral side, all patients underwent collateral reconstruction in the acute phase. Following the final clinical examination, 3 out of 18 patients with grade 3 MCL injury had a joint opening of more than 10 mm compared with the contralateral knee after the MCL repair, while only 1 out of 17 patients with lateral knee tear had a joint opening of greater than 10 mm after reconstruction of the lateral side injury. This indicated that reconstruction of the lateral side of the knee had better clinical results compared with the medial side. This difference may be due to the fact that in the lateral side, the anatomic reconstruction method was performed, while in the medial side, only reconstruction of the superficial MCL was conducted. In this study, the treatment of one male patient was considered a failure for the construction of all three ligaments, i.e. LCL, MCL, and PCL. This patient was a 61-year-old man who failed to have sufficient bone density to achieve stable fixation during surgery. Moreover, he had poor cooperation in the postoperative rehabilitation program.

This study has some limitations. A control group would have been necessary to compare the results with the study population; however, due to the small number of MLKI patients, it was difficult to compare these patients with those undergoing other therapeutic methods or to conduct a randomized trial. Furthermore, the present study relied mostly upon subjective examinations.

In this study, the IKDC and Lysholm scores were used to investigate functional outcomes. Both stated criteria are subjective, and clinical examination was the only objective measure. It would be better to conduct a more objective examination like radiologic stress views.

Conclusions

Early reconstruction of the collateral ligaments, especially in the lateral position, followed by reconstruction of the cruciate ligaments in the late stage will provide acceptable functional and clinical outcomes.

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Authors' Contribution

All authors pass the four criteria for authorship contribution based on the International Committee of Medical Journal Editors (ICMJE) recommendations.

Conflict of Interests

The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

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