Short to Mid-term outcome of single-stage reconstruction surgery of multiligament knee injury

Abstract

Objects: Multiligament knee injury (MLKI) is a complex orthopedic injury leading to the tear of at least two of major knee ligaments. Yet, there is no consensus regarding the optimal management of this debilitating condition. The aim of this study was to evaluate the outcome of MLKI in patients treated with single-stage multiligament reconstruction surgery.

Methods: In a retrospective study, consecutive eligible MLKI patients who underwent surgical reconstruction were included. Objective evaluation of the outcome included active extension and flexion. Subjective evaluation of the outcome included the Lysholm score and the International Knee Documentation Committee (IKDC) form in Persian. Post-operative complications were also recorded.

Results: A total of 41 patients with the mean age of 31.95±7.82 years and an average follow-up period of 36.9±17.8 months were evaluated. The average time from injury to surgery was 11.5±8.9 months. The mean Lysholm and IKDC score were 86.9±11.5 and 70±18.7, retrospectively. The mean Lysholm and IKDC score were not statistically different in patients who underwent surgery less than 6 months after the injury compared to those who were reconstructed after 6 months ($p=0.07$ and $p=0.3$, respectively). Postoperative restricted range of motion was observed in seven patients that were resolved with physiotherapy. The only surgical complication was a popliteal artery injury.

Conclusions

Single-stage reconstruction surgery of MLKI provides an acceptable outcome. However, several aspects of this reconstruction such as the timing of the surgery still remain to be resolved in future investigations.

Keywords

Multiligament knee injury, reconstruction surgery, outcome, complication.

Introduction

Multiligament knee injury (MLKI) is a complex orthopedic injury that usually occurs as a result of traumatic knee dislocations. However, not all MLKI are caused by knee dislocations. MLKI is referred as the tear of at least two of the four major knee ligaments including anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), posteromedial corner (PMC) including the medial collateral ligament (MCL), posterolateral corner (PLC) including the lateral collateral ligament (LCL). MLKI can be further complicated by the concurrence of fracture, vascular and nerve damage (1, 2). Knee dislocation is associated with vascular injury in 30% to 35% of cases in forms of arterial rupture or thrombosis, which may lead to the limb amputation in case of inadequate management (3). Thus, the vascular injury should be inspected in all cases of knee dislocations, even in ultra-low velocity dislocations. The neural damage, especially peroneal nerve injury, is also a potential consequence of knee dislocation. Neurovascular injuries are commonly seen when the PLC is injured (4) (Figure 1).

The morbidity of MLKI is considerable and affected patients may experience pain and instability even several years after initial injury (2, 3, 5). Due to the serious consequences of a neglected injury, a high index of suspicion should be devoted to MLKI diagnosis. However, as the knee dislocations account for < 0.02% of all orthopedic injuries (6, 7), the diagnosis could be dificult. Although a clinical examination is the cornerstone of determining the extent of the injury and to formulate the treatment plan, it is not always reliable. Stress radiographs could be used to aid in the diagnosis of ligament injuries as reported by James et al (8). Moreover, MLKI treatment options vary from conservative management to acute or chronic repair/reconstruction of the injured structures. Even though, there is a paucity of high-level evidence on the optimal surgical management of this uncommon but debilitating condition. Although there is no clear consensus regarding the superiority of either single-staged or staged surgery of MLKI, some surgeons choose to stage because of concomitant injuries such as fractures, vascular injuries, life-threatening head, thorax or abdominal injuries (2, 9). Moreover, the management of the MLKI is controversial in many other aspects such as the type of treatment (surgical versus non-surgical), type of surgery (repair versus reconstruction), and the timing of treatment (early versus late) (2). Thus, further evidence is needed to resolve the existing controversies.

Cohort studies on the outcome of MLKI treatment are a valuable approach to reach a consensus regarding the best treatment option. The aim of this study was to report the outcomes of MLKI in a cohort of patients treated with single-stage multiligament reconstruction surgery.

Patients and methods

In a retrospective study, consecutive MLKI patients who underwent surgical reconstruction at Shafa Orthopedic Hospital, Tehran, Iran, between 2011 and 2016 were evaluated for eligibility criteria. This study was approved by the institutional review board of our university and informed consent was obtained from patients in order to use their medical data for publication.

The diagnosis of MLKI was mainly performed by magnetic resonance imaging (MRI) for a complete evaluation of the damaged ligamentous knee restraints and stress radiography for establishing the functional consequence of the MRI findings.

Inclusion criteria were: patients who sustained an MLKI and underwent single-staged surgical reconstruction, the age of more than 18 years, a follow-up period of at least 10 months, and the complete medical records. Exclusion criteria were: the presence of any malalignment, concurrent fracture, past history of lower extremity ligament surgery, osteoarthritis associated knee pain, systemic disease, and hip/spine problems. After considering these criteria, 41 patients were identified as eligible for this study.

The patients' clinical and demographic data were extracted from their electronic medical files. Preoperative evaluation of patients was performed using plain radiography, stress radiography, MRI, duplex sonography or computed tomography angiography if needed.

The Schenck classification was used for categorizing knee dislocations based on the pattern of multiligamentous injury (10). Objective evaluation of the outcome included active extension and flexion that was assessed in comparison with the contralateral knee. Subjective evaluation of the outcome included Tegner Lysholm knee scoring scale (Lysholm score) (11) and the International Knee Documentation Committee (IKDC) form in Persian (12), in both of which a higher score represents a higher level of function and lower level of disability. Lysholm score was also categorized into four subsets including excellent (95-100), good (84-94), fair (65-83), and poor (<63). IKDC score was categorized into four subsets including IKDCA (normal), B (nearly normal), C (abnormal), and D (severely abnormal). All post-operative complications such as neurovascular events, compartment syndrome, and infection were also recorded.

Surgical technique

The surgery was performed after a preoperative period of one month to allow soft-tissue repair, reducing the possibility of fluid extravasation during arthroscopy and compartment syndrome, and reaching an acceptable range of motion to prevent postoperative stiffness. The patients were placed in the supine position on the operating table under general anesthesia. Subsequently, the ligamentous injuries were re-assessed. The uninvolved limb was wholly placed on the table in full extension. Tourniquet was used in all patients but two, in whom the popliteal artery was repaired earlier.

For the reconstruction of ACL and PCL, the anatomic arthroscopic transtibial technique was used. In this regard, the correct positioning of the femoral and tibial tunnel was performed using ACUFEX Director PCL Tibia Aimer (Smith & Nephew ACUFEX instruments, USA). Then, the position side was checked with radiography and cruciate grafts were fixed in the femoral side with screw or Endobutton (ConMed, Linvatec or Smith & Nephew, USA). Tibialis posterior allograft was used for the reconstruction of the majority of PCL injuries. Tibialis anterior allograft was used for the reconstruction of the majority of ACL and PLC injuries. Semitendinosus autograft was used for the reconstruction of MCL. After that, arthroscopic re-evaluation of the knee and arthroscopic gap test was performed at a tension position. A gap of less than 8 mm in the most medial part of the knee, less than 10 mm in the medial compartment, and less than 12 mm in the most lateral part of the knee was considered normal (13). If the gap was more than normal, medial and lateral reconstruction was accomplished. Larson method was used for the reconstruction of PLC. Peroneal nerve was explored and protected in this procedure. The order of ligament fixation was as follows: PCL, PLC, ACL, and MCL (14). While all PLC injuries were managed with reconstruction surgery, the majority of MCL injuries were managed non-surgically. Surgical treatment of MCL was performed in 7 cases, using open reconstruction technique. At the end of the surgery, the knee range of motions was assessed to prevent potential knee capture during the reconstruction process.

Postoperative rehabilitation

After the surgery, the limb was supported with a hinged knee brace in full extension. Isometric quadriceps exercises were started a few hours after the surgery and passive full extension of the knee and straight leg raise was advised. Strengthening of hamstring muscles was scheduled at week 12 after the surgery in patients with PCL reconstruction. The day after the surgery, the crutch walk toe touch was begun and progressive weight bearing was initiated in 4-6 weeks. At the end of week 4, 0-90° flexion was planned for the patients in the presence of the knee brace. Three months after the surgery, a soft hinged knee brace was substituted and full-weight bearing was started. After 6 months, the brace was removed completely. In two patients, long leg cast was used for four weeks after the surgery, due to their non-adherence to post-operative protocol.

Statistical analysis

SPSS for Windows version 16 was used for all statistical analyzes. The descriptive presentation of the data was provided by mean ± standard deviation (SD) or number and percentage. Parametric tests including independent t-test and one-way ANOVA or their non-parametric counterparts (Mann–Whitney U-test and Kruskal–Wallis test) were used to evaluate the mean difference between two or more samples. A p value of less than 0.05 was considered significant.

Results

Patient demographics

A total of 41 patients including 39 (95.1%) males and 2 (4.9%) females with the mean age of 31.9±7.8 years (range 18-50 years) were studied. The average time from injury to surgery was 11.5±8.9 months (range 1-36 months). Frank dislocation was present in three (7.3%) patients, which was reduced by primary care providers. The mechanism of injury was high energy (motor-vehicle accidents) trauma in 38 (92.7%) patients and low energy trauma (sports accidents) in three (7.3%) patients. The average follow-up period of patients was 36.9±17.8 months (range 10-

72 months). According to the Schenck classification, KD I, KD II, KD III, and KD IV class were identified in 15 (36.6%), 5 (12.2%), 16 (39%), and 5 (12.2%), respectively. The clinical and demographic characteristics of the patients are demonstrated in Table 1.

Pre-operative concomitant injuries were as follows: meniscus tear in eight (20.5%) patients, cartilage lesion in 5 (12.8%) patients, vascular lesion in two (5.1%) patients, peroneal nerve injury and partial sensory and motor loss in three (7.3%) patients, complete sensory and motor loss in one (2.5%) patient.

Cartilage lesion was grade I in one patient and grade II in the remaining four patients. None of the cartilage lesions underwent chondroplasty. Meniscus tear was managed with partial meniscectomy in five patients and meniscus repair in three.

Subjective outcomes

The mean Lysholm score was 86.9±11.5 (range 48-100). Accordingly, excellent, good, fair, and poor Lysholm score was observed in nine (22%) patients, 21 (51.2%) patients, eight (19.5%) patients, and three (7.3%) patients, respectively.

The mean Lysholm score was not considerably different in different types of dislocation (p=0.58). Moreover, this score was not considerably different in patients with the age of fewer than 30 years compared to those with the age of more 30 years (p=0.87). The mean Lysholm score was not statistically different in patients whose surgery was performed at the first 6 months after the initial injury (p=0.27). Moreover, the Lysholm score was not statistically different in high-energy traumas in comparison with low-energy traumas (p=0.07). In addition, no association was seen between the Lysholm score and other clinicodemographic characteristics including gender and the knee dominancy (Table 2).

The mean IKDC was 70±18.7 (range 25.3-98.2). Accordingly, grades A, B, C, and D of IKDC were seen in two (4.9%) patients, 13 (31.7%) patients, 14 (34.1%) patients, and 4 (9.8%) patients, respectively.

The mean IKDC was not statistically different in patients whose surgery was done at the first 6 months after the initial injury (p=0.07). Moreover, the mean IKDC score was not statistically different in high-energy traumas in comparison with low-energy traumas (p=0.3). No significant association was observed between IKDC and other clinicodemographic characteristics of the patients including gender, age, and the knee dominancy (Table 2).

Clinical outcome

Post-operative restricted range of motion was observed in seven patients. In this respect, lack of extension of up to 3-5° was observed in one patient (2.4%). Lack of flexion of up to 6-15° and 16-25° was also seen in four (9.8%) and two (4.2%) patients, respectively. At the last follow-up, all of the patients obtained a full or nearly full range of motion with regularly scheduled physiotherapy and none of them needed manipulation or arthroscopic lysis for arthrofibrosis.

Medial-sided reconstruction was performed in seven patients with MCL injuries, while the other 14 MCL injuries were managed non-surgically. The surgical or non-surgical management of MCL was determined by the surgeon considering several factors including the number of the involved ligament, type of dislocation, the location of the tear (distal or proximal), and the extent of medial opening at valgus stress test after the reconstruction of other ligaments.

Mild (side-to-side difference of >3.8mm at stress valgus test) and moderate (side-to-side difference of >9.8mm at stress valgus test) medial joint space opening was observed in two (28.5%) and one (14.3%) patients of reconstruction group, respectively. Mild medial joint space opening was observed in seven patients (50%) of non-surgically managed patients, as well. This difference was not statistically significant (p=0.33).

Operative and postoperative complications

The only surgical complication was a popliteal artery injury, which occurred during the reaming of the PCL transtibial tunnel. This patient underwent a popliteal artery bypass at another center. At a follow-up of 48 months, the patient returned to his work with no further complications.

Non-adherence to postoperative rehabilitation protocol led to a revision ligamentous reconstruction surgery in one patient, who was referred with the trauma of the same knee. This patient was first managed with anatomic ACL+PLC reconstruction, which failed three months later. After a year, the patient underwent ACL+PCL+PLC reconstruction with Larson method. Long leg cast was used to prevent further complications (Figure 2).

No case of deep vein thrombosis, compartment syndrome, wound problem, iatrogenic neurologic disorder, infection, and periarticular fracture after reconstruction was identified in our patients.

Discussion

In this study, we reported the outcome of MLKI in patients that were treated with single-staged surgical reconstruction. All reconstructions of this study were single-staged, and no multi-staged reconstruction was used in this cohort. Based on our results, single-staged reconstruction of MLKI could result in an acceptable outcome, at least in short-term.

We did not find a significant difference in the outcome of patients who were treated less than 6 months from the injury and those who were treated after 6 months. Moreover, we did not find a significant association between the outcome of the patients and other clinicodemographic characteristics such as age, gender, type of dislocations and etc.

Peskun et al. evaluated the outcomes of surgical and nonsurgical treatment of MLKI in an evidence-based review. In their study, they compared the outcome of 855 patients from 31 studies who were managed with surgery, with 61 patients from 4 studies who were managed non-surgically. Their results revealed the superiority of operative management over non-operative treatment across several clinical and functional domains (16). Similar results were reported in the study of Levy et al who systematically reviewed factors affecting the decision-making in the MLKI management (2). We observed an acceptable functional outcome following the surgical management of MLKI, which was in accordance with the results of earlier investigations.

In a prospective trial study, Stannard et al. compared the results of repair versus reconstruction of the PLC in 57 knees, 44 (77%) of which had MLKI. At a minimum follow-up of 24 months, the failure rate was 37% in direct repair and 9% in reconstruction approach, although the mean Lysholm and IKDC scores were not statistically different between the two groups (17). The study of Mariani et al. revealed a higher rate of flexion loss, a higher rate of posterior sag sign, and a lower rate of return to pre-injury activity level in direct repair group in comparison with reconstruction groups. Lysholm and IKDC scores were similar in different groups in their study (18). Based on these reports, we selected reconstruction over direct repair in the management of MLKI, which provided an acceptable outcome.

The timing of surgery is one of the most controversial topics in the MLKI management (19). Early surgery is generally performed during the first three weeks of the injury. A systematic review of the outcome of early surgery of MLKI in 80 patients and late surgery in 50 patients, revealed that the early surgery is accompanied with higher mean Lysholm scores (90 vs 82), as well as a higher percentage of excellent/good IKDC scores (47% vs 31%). However, favorable outcome of late surgery with significant improvement and a return to activity has also been reported in many patients (20-22). Karataglis et al. evaluated the outcome of 35 patients who received operative treatment at an average of 32 months after the initial injury, from which 60% reported excellent or good outcomes at a mean follow-up of 40 months (20). Fanelli and Edson studied the outcome of 41 PCL/PLC injuries that received treatment at a range of 4 to 240 months after the initial injury and obtained excellent functional results at a minimum follow-up of 24 months (21). In our study, the outcome of 9 patients who were treated less than 6 months from the injury was not significantly different from those who were treated after 6 months.

None of our patients underwent surgery at the acute phase of the injury (first three weeks). It has been suggested to avoid acute surgery of combined ligament injury, due to a high incidence of arthrofibrosis (19, 23, 24). A systematic review of Mook et al. also suggests that acute surgery is highly associated with deficits in the range of motion (25). However, Levy et al. (26) did not find the same results as Mook et al. Thus, the timing of the surgery needs to be more codified in future investigations.

Generally, low-energy injuries have relatively less soft-tissue damage and a better outcome is expected in these injuries (27). We did not find a statistical difference between the outcome of MLKI with high-energy and low-energy trauma. However, it should be noticed that only three low-energy traumas were included in our study, and thus, this result contains a low statistical power.

There is little consensus regarding the best strategy for the management of MCL injury. Some studies suggest early conservative management of the MCL with bracing, while other propose surgical approach (28). While non-surgical management of MCL injuries was performed in the majority cases of our study, no significant difference was observed between the outcomes of patients who were managed non-surgically in comparison to those who were managed surgically. Our study has some weaknesses which should be pointed out. The short to mid-term follow-up period of patients did not allow evaluating long-term complications of MLKI such as the incidence of degenerative joint disease. Moreover, the surgeries were done with four different surgeons, which could have influenced the outcomes. In addition, some of the statistical analyses were not powered enough due to the small number of the patients in some groups, as earlier mentioned.

Conclusions

In accordance with the results of the earlier investigation, our study revealed the acceptable outcomes of single-stage reconstruction surgery of MLKI in affected patients. However, inconsistent results of different investigations in several aspects of MLKI treatment, such as the appropriate timing of the surgery, needs to be further codified in future investigations with larger sample size.

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Figure legends

Figure 1: Anterior-posterior radiograph of a multiligament right knee injury under varus stress test, complicated with peroneal nerve injury in association with PLC damage.

Figure 2: (A) Anterior-posterior radiograph of the injured right knee under varus stress test; (B) Lateral radiograph of the same knee with manual posterior drawer test; (C) Anterior-posterior plain radiograph of the same knee after reconstruction failure; (D) Anterior-posterior plain radiograph of the same knee after second surgery (ACL+PCL+PLC reconstruction); (E) Lateral plain radiograph of the same knee after the second surgery.