Review Article

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# Functional outcomes following Multiligament Knee Reconstruction

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## Abstract

**Purpose:** The purpose of this descriptive review was to study the available literature on final functional outcomes of multiligament knee injury (MLKI) reconstructions. Specific study factors included 1) Surgical vs nonoperative treatment 2) Repair vs reconstruction vs combined procedure 3) early vs late surgery; Single stage vs two stage procedures .

**Methods:** A PubMed search was performed from 1966 until 2020 and search terminologies included multiligament Knee injury, multiple ligament knee injury , knee dislocation, multiligament knee reconstruction and functional outcomes. Study inclusion criteria were 1) Levels I to IV evidence. 2) Multiligament knee injury being defined as disruption of minimum 2 of the 4 major knee ligaments. 3) Assesment of final outcome both based on subjective clinical, functional scores like return to sports, preinjury activity level and stability scores. 4) Minimum of 12 month follow up .

**Results:** 4 high level studies compared surgical with non-operative treatment .There were higher Lysholm scores (85 vs 67) in surgically treated patients (pts) as well as higher IKDC scores (69% vs 64%) and return to sport (41% vs 18%).The four studies comparing repair with reconstruction of damaged ligaments showed similar mean Lysholm (84 vs 84) and excellent IKDC scores . Nevertheless repair of the posterolateral corner (PLC) had a higher failure rate (39% vs 8 %) and lower return to sport activities (25% vs 51%). Similarly repair of the cruciates achieved decreased stability and range of motion. 8 articles were studied comparing early (within 3 weeks ) with delayed surgery . Early treatment resulted in higher mean Lysholm scores (89 vs v82), higher percentage of excellent IKDC scores (57% vs 41%) as well as higher mean ROM ($129^0$ vs $124^0$)

**Conclusions:** This review suggests that the best treatment guidelines for MLKI is still awaited, but better functional and clinical outcomes have been achieved with reconstruction rather than repair. Surgery must be performed within first 3 weeks to 6 weeks for better results .When feasible ACL reconstruction can be delayed thereby reducing rate of arthrofibrosis.

**Keywords:** Descriptive review, Functional outcomes, Multiligament knee injury , Multiple ligament knee injury , Knee reconstruction

## Introduction

Multiple ligament knee injuries are complex limb threatening pathologies often resulting from traumatic knee dislocations. The reported incidence in literature is 0.02-0.2 % of all orthopaedic injuries [1]. As many knee dislocations reduce spontaneously prior to presentation the true incidence may be underestimated [2]. With higher number of high velocity road traffic accidents and increasing participation of youngsters in contact sports the incidence is further increasing. Due to the high energy of trauma there is often concomitant fracture, vascular or nerve damage about the joint [3]. Limited evidence for optimal treatment is available as these injuries have a low incidence and are often heterogenous [4]. Consequently the best treatment for MLKI is still a matter of debate : repair vs reconstruction, early vs delayed surgery, single vs staged reconstruction, surgical vs conservative, autograft vs allograft are the most common issues. The purpose of this systematic review is to understand the functional outcome after management of MLKI focusing on the three above mentioned aspects of treatment

## Materials and Methods

In this descriptive review, a search of all published studies and their reference lists, regarding treatment of multiligament injured knee was performed in the Medline database on Pubmed.

The terms used for the research were : "knee dislocation", "multiligament knee reconstruction" and "multiple ligament-injured knee" in the period between 1996 and 2020. Studies included in the analysis met the following guidelines : 1) they provided levels I to IV evidence 2) they defined "multiligament "as the disruption of at least two of the four major knee ligaments)(anterior cruciate ligament [ACL], posterior cruciate ligament [PCL], posteromedial corner [PMC], and posterolateral corner [PLC] 3) they had a minimum of 12 months follow up, with a mean of at least 24 months and 4) they included measures of functional and clinical outcome. Studies which included MLKI patients requiring treatment for compounding factors like fracture dislocation, neurovascular injuries open wounds etc. were excluded.

## Outcome measures

Commonly employed "knee specific"

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measures are designed to more clearly distinguish the impact of knee symptoms on overall function and include the Lysholm, International Knee Documentation Committee (IKDC) scores (knee specific) as well as the Tegner score (activity level) [5].

Traditionally the Lysholm score has been the most commonly employed measure in studies of MLKI.

The IKDC Score incorporates subjective ,objective and functional measurements, including patient symptoms, range of motion (ROM), ligament examination, functional tests, and X-ray findings [6]. For this reason Wascher et al. described the IKDC as probably the best rating system for critically assessing the results of knee dislocation treatment [7]. Peskan et al. and Whelan et al. showed that the overall proportion of multiligament knee injured patients achieving normal or near normal IKDC scores was 61.3% [5]. In comparison outcome analysis after reconstruction of isolated ACL injury patients suggests that between 78% (hamstring) and 80% (bone patellar tendon bone group) have class A or B final overall IKDC score [8].

The Tegner score is a sport specific activity level quantifying activity from 0 to 10, where an individual competing in sports at an elite level has an activity level of 10, a person at recreational sports level activity a score of 6 and an individual on disability pension due to knee problems has a level of 0 [9]. Some problems exist with this score because it relates activity to specific sports rather than specific function , and it has not been validated [10,11].

## Results

### Surgical vs Conservative treatment

Four main studies have compared operative to non operative treatment; all are level III or IV retrospective cohorts [12-15]. Richter et al. study being the largest of these, compared 63 patients treated with a combination of early and late surgery to 26 patients treated non-operatively. Statistically superior outcomes were demonstrated in the surgical group in terms of the Lysholm score (78.3 vs 64.8), the Tegner score (4.0 vs 2.7), IKDC activity level, Lachmann test, as well as working ability and sports ability [4,14]. (Table 1)

With regard to ROM and contractures however a study by Peskun et al. who performed an evidence based review of 31 articles published between 2000 and 2010 showed no statistically significant difference between operative and non-oprative groups. Statistically significant difference between the two cohorts was however seen in return to employment and sports. In contrast Dedmond et al [16] meta-analysis published in 2001 which was a meta-analysis (Level IV evidence) of 15 articles published between 1966 and 1999, failed to show that return to preinjury employment or athletic activity was improved by operative management. The possible explanation is that this 2001 study had insufficient numbers to detect a significant difference or that surgical techniques have improved over the last decade. Both Peskun et al. and Dedmond et al. showed aggregate average better Lysholm scores for the operative group.

Most Surgeons especially those with experience of high volume of MLKI pts agree that operative management is likely the gold standard (Fanelli et al. [17], Laprade et al. [18]). In conclusion multiple meta-analysis, systematic reviews and evidence based reviews have constantly shown better clinical and functional outcomes in operatively managed patients compared to those managed non operatively. Despite this there will always be a subset of patients who have to undergo non operative management in view of the comorbidities like head injury, polytrauma, advanced age, medical comorbidities, poor patient complicance and soft tissue compromise about the knee [5].

### Repair vs Reconstruction

The primary repair of tears of the cruciate ligaments is generally associated with increased failure rates and poor results. The corners however are thought to have higher healing capacity and thus more amenable to acute repair With exception of few studies, Hua et al. [23], Difelice et al. [24] who have shown satisfactory if not excellent outcomes with early acute repair of all ligaments. Other such early studies have shown high failure rates and residual laxity with early repair alone and therefore have led many authors to prefer augmenting the repair with a graft reconstruction.

Four studies fulfilled all inclusion and exclusion criteria of systematic review of repair vs reconstruction of injured ligaments (in MLKI), one of which was a metaanalysis Frosch et al. [25]. (Table 4)

Frosch et al. [25] performed a meta-analysis of nine articles in 2013, comparing an aggregate of 195 patients. No significant difference in outcome was found between the 40 pts who underwent ACL, PCL repair in comparison to the 73 pts who underwent cruciate reconstructions. Mariani et al. [28] compared three groups who underwent either direct ACL/PCL repair, ACL reconstruction/PCL repair or ACL/PCL reconstruction. All three groups had similar final mean Lysholm scores and excellent/good IKDC scores. However direct repair of the cruciate ligaments resulted in a higher rate of flexion loss greater than $6^0$,

**Table 1:**

| Treatment | Authors | No. knees | Year | Age | Lysholm | IKDC | ROM | Contarcture | RTE % | RTS % |
|---|---|---|---|---|---|---|---|---|---|---|
| Operative | Engebretsenetal [4] | 85 | 2009 | 33 | 81 | 64 | NR | NR | NR | NR |
| | Hirschmannetal [19] | 68 | 2010 | 30 | 83 | 58 | 125 | 2 | 82 | NR |
| | Richter etal[14] | 63 | 2002 | 34 | 78.3 | NR | NR | 11%>5 | 85 | 56 |
| | Tzurbakisetal [20] | 48 | 2006 | 29 | NR | 77 | 130 | 1.6 | NR | NR |
| | Fanelli and Edson [21] | 35 | 2002 | Nr | 91.2 | NR | NR | NR | NR | NR |
| | Karataglisetal[22] | 35 | 2006 | 35 | NR | NR | 118 | 3.1 | 91 | 46 |
| Nonoperative | Richter etal [14] | 26 | 2002 | 34 | 64.8 | NR | NR | 24%>5 | 53 | 17 |
| | Plancher and Siliski [15] | 19 | 2008 | 26 | 70.5 | NR | 108 | 3.8 | 69 | 31 |
| | Wong etal [12] | 11 | 2004 | 22 | NR | 63.7 | 137 | 1.8 | NR | NR |
| | Rios etal [13] | 5 | 2003 | 34 | NR | NR | NR | NR | NR | NR |

Abbreviations :NR,notreported;ROM, range of motion; RTE return to employment; RTS return to sport

**Table 2:**

Summary of Functional and Clinical Results in Studies Comparing Surgical Treatment With Nonoperative Treatment in Multiligament Knee Injuries.

| | Return to work | | Return to sport | | Mean ROM | | Mean flexion loss | |
|---|---|---|---|---|---|---|---|---|
| | Surg | Con | Surg | Con | Surg | Con | Surg | Con |
| Peskun et al. | 80,90% | 57,80% | 50% | 22,20% | 116,7° | 118,2° | 1,8° (15,9%) | 3,1° (24%) |
| Dedmond and Almekinders | 58% | 50% | 31% | 14% | 123° | 108° | 0,5° | 3,5° |
| Total | 69% | 54% | 41% | 18% | 119,85° | 113,1° | 1,15° | 3,3° |

Abbreviations: Surg, surgical treatment; Con, conservative treatment; NR, not reported.

**Table 3:**

| Year | Design | Level of evidence |
|---|---|---|
| Frosch etal. [25] 2013 | Metaanalysis | IV |
| Levy etal[26] 2010 | Retrospective | III |
| Stannard et al [27] 2005 | Prospective | II |
| Mariani et al [28]1999 | Retrospective | III |

**Table 4:**

Summary of Demographics and Functional Results in Studies Comparing Repair With Reconstruction of Damaged Structures in Multiligament Knee Injuries.

| | No. Of patients | | Mean age (yr) | | Mean FU (mo) | | Mean Lysholm Score | | IKDC (%Excellent/Good) | | Failures | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Repair | Recon | Repair | Recon | Repair | Recon | Repair | Recon | Repair | Recon | Repair | Recon |
| Frosch et al. | 40 | 73 | 31,4 | 31,4 | 47 | 47 | 77,5 | 73,3 | 77,5 | 73,3 | NR | NR |
| Levy et al. | 10 | 18 | NR | NR | 34 | 28 | 85 | 88 | 79 | 77 | 40% | 6% |
| Stannard et al. | 35 | 22 | 31 | 36 | 33 | 33 | 88 | 91 | 71 | 77 | 37% | 9% |
| Mariani et al.[a] | 17 | 6 | 25 | 35 | 83 | 83 | 85 | 85 | 24 | 25 | NR | NR |
| Total | 102 | 119 | 29,1 | 34,1 | 49,3 | 47,8 | 83,9 | 84,3 | 62,9 | 63,1 | 39% | 8% |

Abbreviations: F/U, follow-up; Recon, reconstruction; NR, not reported.
[a] Repair groups 1 and 2 were combined for greater clarity.

higher rate of posterior sag sign and lower rate of return to preinjury activity level.

The articles by Levy et al. [26], Stannard et al. [27] analyzed results of PLC repair/reconstruction which has been discussed along with other studies on isolated ligaments in discussion ahead.

## Early vs Delayed Surgery

The search found 8 articles evaluating early vs delayed surgery over a 15 year period between 1999 and 2014, reporting a total of 260 cases; Of these 260 patients, 149 were treated early, mean 10.6 (3-21 ) days, whereas 111 patients were treated with a mean of 294 (21-1890) days. The sample size varied between 13 and 60 patients , mean age range from 26-44 years with a mean follow up of more than 2 years . All 8 studies included clinical outcomes using the Lysholm score. The pooled estimates for the Lysholm score demonstrated a significantly higher score, suggesting better outcomes for the group undergoing early surgical intervention. The early surgery group had $3^0$ greater ROM as compared to the late surgery group. The IKDC scores also clearly favoured early intervention. Most importantly 31% of all patients undergoing early surgery intervention had a normal or near normal knee compared to only 15% of patients with delayed reconstruction. (Table 5)

Wascher et al. (1999);[7]; Liow et al. (2003);[29];Harner et al. (2004); [30]; Tzurbakis et al. [20]; Subbiah et al. [31]; Li et al. (2013);[32];Zhang et al. 2013 [33]; Wajsifz et al. [34].

## Discussion

The evidence based review of literature has several limitations like small sample size in most studies due to the relative rarity of MLKI. Also when assessing the outcomes of MLKI one must keep in mind that most studies include a variety of knee injury patterns. Thus it is difficult to accurately predict the outcome of a patient with a particular ligament injury [17]. Differing treatment regimens, different functional and clinical outcome measures also reduce the validity of these study conclusions. In the discussion ahead a comprehensive literature review with upto date outcome conclusion for individual ligament tear patterns is provided

## Posterolateral corner (PLC)

PLC lesions are rare in isolation representing only 1.6% of all acute ligamentous knee injuries. In the setting of MLKI the frequency increases from 43% to 80% [35]. With respect to management of PLC injuries the decision of whether to repair or reconstruct would depend on time of injury, tear pattern. Generally repair is possible only before 3 weeks, as after that scar formation occurs and tissue identification is not possible [29,30]. Intuitively tears occurring as avulsions from femur or tibia are more amenable to repair in comparison to musculotendinous junction tears and thin stretched out ligaments. Nevertheless some authors showed that the location of Fibular collateral ligament (FCL)/PLC tear did not show a significant effect on overall survival of repair, ROM or subjective outcome scores. This suggests that the repair technique itself is responsible for the higher failure rate observed in this group, as opposed to the degree or nature of the tear [26].

There are a few comparative studies between PLC repair and reconstruction. Stannard et al. [27] and Levy et al. [26] in their two high quality works , showed better outcomes with the PLC reconstructions as compared with their repairs. The average failure rate was found to be 7.5% after reconstruction and 38.5% after repair with similar mean Lysholm and IKDC scores at final follow-up [36]. In conclusion most authors preferred reconstruction over repair due to a lower failure rate. The possible exception is bony avulsion injuries of the ligaments (Arcuate, fibular head avulsions) [37]. With respect to reconstruction technique newer anatomic reconstructions fare better [18]. Wymenga et al. [38] group have clearly demonstrated that both Larsons fibular sling procedure and Laprade anatomic reconstruction fare equally well in terms of functional outcome. Although these techniques always restore good external rotation stability, varus laxity could not be restored in all patients and reconstructed knee did not become as stable as the other knee. These results assist both surgeon and patient to have realistic expectations of this operation .

## Medial Collateral ligament (MCL) and Posteromedial corner (PMC)

The majority of isolated medial injuries heal without surgical intervention [39]. A recent review article by Moatshe et al. [40] has summarized most of the controversies related to management of medial side injuries in the setting of MLKI. There is an increased risk of developing persistent anteromedial rotatory instability if high grade medial knee instability is treated non-operatively that can lead to increased forces on the reconstructed cruciate ligaments, therefore most authors advocate for concurrent surgical treatment of medial

**Table 5:**

Characteristics of the included studies.

| Study | Study design | Sample size | Time to surgery | Mean age (years) | Length of follow-up (months) | Intervention | Outcome |
|---|---|---|---|---|---|---|---|
| Wascher et al. (1999) | Level IV case series | Acute: 9<br>Chronic: 4 | 11 (7–18)<br>337 (45–517) | 26.2 (14–40)<br>30.5 (20–51) | 37.5 (24–50)<br>40.2 (28–54) | Allograft ACL/PCL | Lysholm 91.8 ROM 2–132<br>KT 1000 4 mm<br>Lysholm 79.2 ROM 3–126<br>KT 1000 5.6 |
| Liow et al. (2003) | Level IV case series | Acute: 8<br>Chronic: 14 | 10.4 (3–14)<br>860 (180–1890) | 25.4 (16–35)<br>35 (15–43) | 25.1 (8–36)<br>37.6 (6–84) | ACL/PCL auto/allograft<br>LCL repair<br>PLC repair | Lysholm 87 Tegner 5<br>ROM 10–136<br>Lysholm 75 Tegner 4.4<br>ROM 7–132 |
| Harner et al. (2004) | Level III retrospective cohort study | Acute: 19<br>Chronic: 12 | 12 (5–21)<br>195 (150–630) | 28.4 (16–51) | >24 | ACL/PCL Allograft<br>LCL allograft<br>MCL repair | Lysholm 91 + 7 (72–100),<br>ROM 1–128<br>Lysholm 80 + 17 (50–100)<br>ROM 1–129 |
| Tzurbakis et al. (2006) | Level IV retrospective case series | Acute: 38<br>Chronic: 10 | 7.5 ± 5.8<br>204.7 ± 138.1 | 28.6 + 11.9 | 51.3 ± 29.9 (24–96) | ACL/PCL autograft<br>PLC/PMC.MCL repair/recon<br>LCL repair/recon | Lysholm 87 ± 12.3<br>Tegner 4.4 ± 2.1<br>ROM 2–132<br>Lysholm 81.7 ± 13.3<br>Tegner 5.2 ± 2.2<br>ROM 1–134 |
| Subiya et al. (2011) | Level IV case series | Acute: 11<br>Chronic: 8 | 5.4 (1–14)<br>126 (30–540) | 36 (14–33) | 23.6 (530)<br>19.6 (14–33) | ACL/PCL autograft | Lysholm 93.3 (81–100)<br>Lysholm 90 (82–100) |
| Li et al. (2013) | Level IV retrospective case series | Acute: 6<br>Chronic: 9 | | 37.7 (26–48)<br>36.4 (28–47) | 90 (72–144) | ACL/PCL ITB autograft<br>PMC/MCL reapir | Lysholm 87.5 (81–95)<br>Tegner 3.9 + 0.6<br>ROM 3–132<br>Lysholm 82.1 (74–92)<br>Tegner 3.4_0.5 2–119 |
| Zhang (2013) | Level IV retrospective case | Acute: 48<br>Chronic: 11 | 7.3 (1–13)<br>114 (30–270) | 43.7 (21–63) | 30 | ACL/PCL Allograft<br>MCL/LCL repair/recon | Lysholm 87.6 + 10.2<br>Lysholm 80.5 + 13.3 |
| Wajsifz et al. (2014) | Level IV retrospective multicentre case series | Acute: 10<br>Chronic: 43 | <21 days<br>222 (21–56,100 | | 49 (12–146) | ACL/PCL Autograft<br>PLC repair/recon | Lysholm 81.4 (62.1–100)<br>Lysholm 76.5 (37–100) |

structures in a MLKI [41].

The medial collateral ligament (MCL) is often repaired with suture anchors if avulsed from femoral or tibial side in setting of MLKI with midsubstance tears repaired with side to side sutures [30]. Owens et al. performed primary repair of complete MCL avulsion in 11 patients with knee dislocation with excellent valgus stability reported in all patients [42]. No direct prospective comparison of repair vs reconstruction of the MCL exists.

However in 2012 Stannard et al. [43] in a series of 71 patients with knee dislocations compared outcomes of Surgical repair vs reconstruction of PMC. The failure rate was 20% (6 of 24) in the repair group and 4% (2 of 48 ) in the reconstruction group.

In conclusion reconstruction has a lower failure rate than repair for PMC injuries in MLKI knees similar to the findings of the PLC.

## ACL and PCL

Owens et al. [42] performed open primary repair of ligaments in 30 consecutive knee dislocations within the first 2 weeks including primary repair of ACL and PCL. Excellent functional outcomes with a mean postoperative Lysholm score of 89 was reported with minimal permanent loss of ROM and good stability. Gregory Di Felice et al. [24] retrospectively reviewed 48 MLKI patients treated with primary repair. 55% of ACL and 73% of PCL tears were amenable to repair when treated within 6 weeks of injury. Recently addition of internal brace was done on the primary repair. ACL repair failed in 9% and PCL repair in 17%. Hua et al. [23] performed open single stage repair of all ligaments in 17 MLKIs and reported no knee laxity during final follow up (mean 4.8 years). The lack of many studies comparing cruciate repairs with reconstruction is problematic and many surgeons would feel unfamiliar with open repair in the age of better and well established reconstruction techniques. Although the likelihood of encountering a cruciate ligament avulsion fracture amenable to direct repair is increased in the setting of knee dislocation, the incidence of stiffness has been suggested to be greater when directly fixing ACL avulsions [44].

In a study of 2002, Fanelli and Edson et al. [21] treated 35 ACL and PCL tears with arthroscopic reconstruction using various grafts. At a minimum of 24 month follow up good outcomes were reported with a mean Lysholm score of 91.

Few studies comparing cruciate repair and reconstruction have been performed. Richter et al. [14] performed a surgical repair or reconstruction in 63 patients and conservatively managed 26 patients. The outcome in the surgical treatment group was better than in the conservative group. Within the surgical treatment group, no outcome differences were observed between cruciate ligament reconstruction and transosseous fixation. Mariani et al. [28] looked at the outcome in groups of patients with ACL, PCL injuries treated with three surgical techniques: both cruciates repaired, both cruciates reconstructed or ACL reconstruction compared with PCL repair. All three groups had very similar IKDC and Lysholm scores. It was noted that direct repair of both cruciates had statistically significant increased rates of posterior sag and lower rates of return to preinjury level, whereas both cruciate reconstruction group had increased return to sport rates.

In conclusion operative repair when feasible but mostly reconstruction is better treatment option than conservative treatment. Despite similar scores achieved by the two possible surgical treatments ACL and PCL repair usually leads to possible instability.Primary repair when feasible (femoral peel off lesions) with internal brace should be in the surgical armamentarium of an arthrosopic surgeon treating these severe injuries where there is always limited graft options

## Conclusions

### Operative vs Non-Operative

Based on upto date available evidence it would be safe to suggest that when permitted operatively managed patients fared overall better than those managed conservatively

### Early vs Late Surgery

Early surgery is usually defined as surgical repair or reconstruction performed less than 3 weeks-6 weeks [18] after injury. Damaged tissues are usually anatomically well identifiable, with minimal retraction and repairable before 3 weeks. Allowing 10 days for capsular healing if combined single stage arthroscopic and open procedure is planned the optimal window for surgery is likely between 10-20 days after injury [26]. Current available evidence suggests that patients treated early (3-6 weeks) have improved outcomes [18].

### Repair vs Reconstruction

It is generally believed that direct primary repair of cruciates fares less well as compared to repair of the corners. Many recent prospective studies however have shown higher failure rates with isolated repair of damaged collateral ligaments especially in the PLC; and augmentation/delayed reconstruction generally fare better than early repair.

Keeping in mind few studies showing encouraging outcomes of primary repair when feasible (avulsion type), the optimal strategy is likely one where both repair and reconstructive techniques are combined to allow immediate stability and mobilization (aggressive rehab) [18].

### Outcome measures

Most of the studies mentioned above have used variety of both knee specific scores and generalized patient scores. The non uniform use of outcome measures makes comparison between studies very difficult. Further research hopefully will develop a multiligament injury specific quality of life measure which will be an important tool in understanding the outcomes after knee dislocation

## Clinical Relevance

This descriptive review clearly guides the treating surgeon that whenever feasible MLKI should be treated early surgically with single stage repair plus reconstruction and put the patient on aggressive rehab to achieve consistent good outcomes.

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