

# Operative management of the medial collateral ligament in the multi-ligament injured knee: an evidence-based systematic review

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**Abstract** While it is generally accepted that most partial and isolated medial collateral ligament (MCL) injuries can be treated non-operatively, ideal treatment of the MCL in multi-ligament knee injuries remains controversial. High failure rates with repair of the posterolateral corner in the multi-ligament injured knee have been recently reported, favoring reconstruction instead. The same maybe true for MCL injuries, however evidence-based treatment recommendations are lacking in the current orthopedic literature. The purpose of this study was to perform an evidence-based systematic review of the operative management (repair and/or reconstruction) of the MCL in the setting of multi-ligament knee injuries. A comprehensive search of MEDLINE and the Cochrane databases for all relevant articles published in English from 1978 to 2008 on the outcomes of surgical management (repair and/or reconstruction) of the MCL in the setting of combined ligament injuries was performed. Inclusion criteria included articles published in (1) English, (2) on human subjects, (3) between the years of 1978 and 2008, (4) had minimum 12-month follow-up, with a mean of at least 24 months, (5) on surgical management of MCL injuries, (6) associated with multi-ligament injuries (three or more ligaments) and/or knee dislocation, and (7) reported objective outcome data on the respective patient cohorts. Exclusion criteria consisted of technique papers, case reports, studies that included fractures associated with MCL injury and those that included pediatric patients. The review identified eight relevant studies. Five articles focused on MCL repair,

while three articles focused on MCL reconstruction. No prospective studies compared MCL repair or reconstruction with non-operative treatment or directly compared MCL reconstruction with MCL repair. Currently there is a paucity of objective data on the outcomes regarding surgical management of MCL tears in the combined ligament injured knee. This systematic review demonstrated satisfactory results in both repair and reconstruction groups. Future objective outcome-based studies as well as comparative studies are needed to further evaluate the optimal treatment modality before evidence-based recommendations can be made. Therefore, individual treatment decisions for each patient should be based on the characteristics and nature of the injury.

**Keywords** MCL · Knee dislocations · Surgical management · Multi-ligament

## Introduction

The medial collateral ligament (MCL) complex is one of the most commonly damaged ligamentous structures after a traumatic injury to the knee joint. 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 [15]. Injuries to the MCL may occur as an isolated entity or as a component of a combined traumatic ligamentous disruption to the knee.

It is generally accepted that incomplete tears and isolated complete tears of the MCL can be treated non-operatively with early functional rehabilitation [4, 7, 8, 17, 22, 24, 26, 30, 31, 33]. This is mainly due to the excellent healing capability of this ligament found in both animal and human clinical studies [2, 22, 40]. In the

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setting of multi-ligament knee injuries, the treatment of complete MCL tears continues to be a controversial topic [4, 13, 16, 18, 34]. High failure rates with repair of the posterolateral corner in the multi-ligament injured knee have been recently reported, favoring reconstruction instead [35]. The same is maybe true for MCL injuries in this setting, however evidence-based treatment recommendations are lacking in the current orthopedic literature.

The purpose of this study is to perform an evidence-based systematic review of the current literature for the outcomes of surgical management (repair and/or reconstruction) of the MCL in the setting of multi-ligament knee injuries in order to assist with the rationale for treatment decision-making.

## Methods

A comprehensive literature search was performed using the MEDLINE and Cochrane Central Register of Controlled Trials databases using various combinations of subject headings and keywords. Subject headings used in the literature search included MCL, knee, and treatment outcomes. Keywords used in the search strategy were the following: repair, reconstruction, anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), multi-ligament knee injury, and knee dislocation. A manual reference check of all acceptable papers was then performed in order to supplement the electronic searches and to identify other potentially relevant studies.

Study selection for inclusion in the systematic review was determined by examining the title, keywords and abstract of all articles obtained from the literature search. Inclusion criteria included articles published in (1) English, (2) on human subjects, (3) between the years of 1978 and 2008, and (4) had minimum 12-month follow-up, with a mean of at least 24 months. In addition, the authors had to have reported on (5) surgical management of MCL injuries, (6) associated multi-ligament injuries (three or more ligaments) and/or knee dislocation, and (7) objective outcome data on the respective patient cohorts. Exclusion criteria consisted of technique papers, case reports, studies that included fractures associated with MCL injury and those that included pediatric patients.

Two independent reviewers performed the search and the clinical studies were then evaluated with relevant data extracted from the articles. Study designs eligible for inclusion within the study included prospective randomized controlled trials, prospective and retrospective nonrandomized controlled trials, and uncontrolled case series. Studies not meeting the above guidelines were excluded.

## Results

The initial MEDLINE and Cochrane database search results yielded 312 citations using the above search strategies. Using the first three inclusion criteria (i.e., articles published in English, on human subjects, and between the years 1978 and 2008) the citation number was decreased to 188 articles. Articles were then retrieved for further review and were evaluated to see if they satisfied the remaining criteria for inclusion. The final database included eight studies spanning the years 1978–2008 and all were Level IV evidence. Of these, five (63%) reported on MCL repair and three (37%) reported on MCL reconstruction. There were no studies found that directly compared MCL reconstruction with MCL repair.

### MCL repair

The majority of information currently in the orthopedic literature regarding operative management of MCL injuries has been focused on ligament repair. Five studies evaluating the outcomes of repair of the MCL were included for outcomes review [5, 20, 29, 36, 43]. All five included studies were retrospective reviews (Level IV).

Of the five studies, four studies focused on MCL repair in the setting of knee dislocations and one in the setting of multi-ligament injuries. A combined cohort of 55 MCL repairs in the setting of knee dislocation was obtained from the four studies. The mean age was 33 years, ranging from 17 to 58 years overall, with all studies exhibiting wide age ranges. All four utilized the Lysholm score to record post-operative outcome. The combined average Lysholm score was 84 with range from 43 to 100. One study utilized the IKDC score to record post-operative outcome [5]. The demographics and functional results of these MCL repair studies are detailed in Table 1.

In 1999, Ibrahim [20] evaluated a cohort of 40 patients (41 knees) with traumatic knee dislocations who underwent surgical reconstruction of the ACL and PCL. Eighteen patients within this group sustained complete MCL ruptures that were repaired. With a mean clinical follow-up of 39 months, 89% of patients were found to have clinically stable knees to valgus testing. Mean post-operative Lysholm scoring was 79.2, however, mean Tegner score decreased to 4.7 (4–7) from a pre-injury score of 7.6 (5–9). The study showed that the above method for surgical treatment of traumatic knee dislocations in accordance with an aggressive rehabilitation program, yields functional stability and early return to work.

Owens et al. [29] retrospectively reviewed the outcomes of primary repair of knee dislocations in 25 patients (28 knees). A consecutive series of knee dislocations operated on by a single surgeon, diagnosed radiographically or with

**Table 1** Summary of demographics and functional results in studies describing outcomes of MCL repair in multi-ligament knee injuries

Study	Patients		Mean age (years)		Mean F/U (months)		Valgus testing (% stable)		Mean Lysholm score		IKDC (%excellent/good)		Tegner score	
	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con
Bin et al.	10	N/A	33	N/A	97	N/A	70	N/A	90	N/A	80	N/A	4	N/A
Owens et al.	11	N/A	36	N/A	48 <sup>a</sup>	N/A	100	N/A	85	N/A	ND	N/A	3.8	N/A
Tzurbakis et al.	5	N/A	29 <sup>a</sup>	N/A	51 <sup>a</sup>	N/A	ND	N/A	87	N/A	67 <sup>a</sup>	N/A	4.2 <sup>a</sup>	N/A
Ibrahim et al.	18	N/A	26 <sup>a</sup>	N/A	39 <sup>a</sup>	N/A	89	N/A	79 <sup>a</sup>	N/A	ND	N/A	4.7 <sup>a</sup>	N/A
Yeh et al.	16	N/A	38	N/A	28	N/A	ND	N/A	84	N/A	ND	N/A	ND	N/A

N/A not applicable to study, ND not documented in study

<sup>a</sup> Results for entire study patient cohort; unable to extrapolate just MCL patient data

multidirectional instability and MRI evidence of bicruciate injury, were included. A total of 11 complete MCL ruptures were observed in this study group, all which underwent primary repair and a standard post-operative rehabilitation protocol. At an average follow-up of 48 months a mean loss of 1.9° of extension, and 10.2° of flexion, a mean arc of 119.3° of motion, and a mean post-operative Lysholm of 85 were observed. Clinical valgus stability testing showed mean values of 0.0 and 0.5 mm at full extension and 30°, respectively. The most problematic complication that occurred in the study was post-operative stiffness, seen in 27% of patients with MCL repair and 18% of patients overall. All of these patients required manipulation and arthroscopic lysis of adhesions. The authors concluded that acute repair of the ligaments coupled with an early rehabilitation program produces outcomes comparable with reconstruction as reported in the established literature.

Yeh et al. [43] in 1999 retrospectively reviewed 31 traumatic knee dislocations treated with arthroscopic reconstruction of the PCL with non-operative management of the ACL. Sixteen of these patients had associated complete tears of the MCL and this cohort underwent collateral ligament repair. With a mean follow-up of 28 months (range 12–48), the MCL repair subset within this cohort had a mean Lysholm score of 84. Post-operative range of motion was noted to be excellent with an average of  $1 \pm 2^\circ$  extension to  $130 \pm 4^\circ$  flexion. The authors noted the importance of subacute PCL reconstruction using arthroscopic techniques. They also emphasized the importance of repair of associated collateral ligament injuries.

A case series of patients undergoing a two-stage protocol for knee dislocations was reported by Bin and Nam [5] in 2007. They reviewed 15 knees in 14 patients, 10 of whom sustained MCL injuries with valgus laxity on clinical exam and were treated with repair. The collateral ligaments were repaired within 2 weeks of injury after swelling had subsided with ACL/PCL reconstruction as needed for continued instability. At a mean follow-up of 97

months, seven of the ten patients had grade 0 instability on stress radiography at latest follow-up. The mean Lysholm score for the cohort was 89.6, mean Tegner score was 4, and IKDC scores were normal in three, near-normal in eight, and abnormal in four. No limitations of final knee range of motion or complications were encountered. The authors concluded that two-stage management of multiple knee ligament injuries allowed for shorter operative times and lowered the incidence of arthrofibrosis.

In the fifth and final retrospective study, intermediate-term results of the surgical treatment of various multiple ligament knee injuries was evaluated by Tzurbakis et al. [36]. Forty-eight cases were classified into three groupings, according to the structures damaged at the time of injury. Group C consisted of knee dislocation patients. This group was then divided into three subsets with the first subset (C1—six patients) group consisting of knee dislocation patients with cruciate ligament injuries associated with medial structure injury. Five of these patients underwent repair of the MCL. Within the knee dislocation patient subset, the average follow-up was 51 months. Functional scores decreased from pre-injury level in all three groups after surgical management, with an overall mean Lysholm score in Group C of 87.4 and Tegner activity score of 4.2. Clinical valgus stability was not commented on in the study, however, IKDC evaluation showed 67% normal or near-normal knee function in the knee dislocation group. The authors noted that in their patient cohort, irrespective of the anatomical structures damaged, multiple ligament knee injuries should be considered serious injuries and have similar clinical progression needing surgical treatment in order to restore function and avoid knee instability.

#### MCL repair versus non-operative treatment

A search for articles comparing MCL repair with non-operative treatment was performed. There were no reports found in the English-language literature directly comparing the results of these two treatment modalities.

**Table 2** Summary of demographics and functional results in studies describing outcomes of MCL reconstruction in multi-ligament knee injuries

Study	Patients		Mean age (years)		Mean F/U (months)		Valgus testing (% stable)		Mean Lysholm score		IKDC (%excellent/good)		Tegner score	
	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con	Surg	Con
Ibrahim et al.	15	N/A	27 <sup>a</sup>	N/A	43 <sup>a</sup>	N/A	93	N/A	91 <sup>a</sup>	N/A	45 <sup>a</sup>	N/A	5.7 <sup>a</sup>	N/A
Yoshiya et al.	3	N/A	26	N/A	27	N/A	67	N/A	N/A	N/A	100	N/A	NP	N/A
Fanelli et al.	8	7	ND		24–120		100	87.5%	91 <sup>a</sup>		ND		5.3 <sup>a</sup>	

N/A not applicable to study, ND not documented in study

<sup>a</sup> Results for entire study patient cohort; unable to extrapolate just MCL patient data

### MCL reconstruction

Two retrospective studies evaluating the outcomes of reconstruction of the MCL were included for outcomes review [21, 44]. Literature directly comparing the results of MCL reconstruction and non-operative management revealed one such article [9]. The characteristics of these three MCL reconstruction studies are further detailed in Table 2.

Yoshiya et al. [44] published a retrospective case series evaluating 22 patients with combined ligament knee injuries who underwent operative management of the associated cruciate ligament injuries and MCL reconstruction using autograft semitendinosus/gracilis tendons. All patients underwent operative intervention for acute gross medial instability (six patients) or chronic Grade III tears with excessive medial joint opening on clinical valgus stress testing (18 patients). Of the 22 patients with combined ligament injuries, three patients had multi-ligament knee injuries (ACL and PCL). However, due to the complex nature of reconstructing three ligaments and concern over the increased morbidity involving such an extensive procedure, only the MCL and the cruciate ligament (ACL or PCL) with a major component of sagittal instability were reconstructed. The remaining patients had injury only to the ACL or PCL alone and these were reconstructed in 12 and 7, respectively. IKDC scores for the three patient subset of the overall cohort found 3/3 (100%) near-normal function with one patient complaining of mild persistent pain/instability. MCL integrity was tested with stress radiographs and noted to be stable in 20/24 patients. Average side-to-side valgus testing showed a statistically significant decrease in medial joint space opening from  $4.9 \pm 0.9$  mm preoperatively to  $0.2 \pm 0.5$  mm post-operatively ( $P < 0.05$ ).

More recently, Ibrahim et al. [21] reported their series of multi-ligament reconstructions of the knee following traumatic dislocation. Fifteen of the included 20 patients had MCL involvement and reconstruction was performed using an artificial ligament. Post-operative MCL function was evaluated using manual valgus stress testing at 30° flexion.

14/15 (93%) of knees had stable knees to manual testing when compared to the contralateral side with one patient showing 1+ laxity. They advocated the reconstruction/repair of all cruciate and collateral ligament injuries. Unfortunately, as with the other above studies, the authors failed to discuss if operative management of the concomitant MCL injuries improved objective knee function.

### MCL reconstruction versus non-operative treatment

Fanelli and Edson [9] in 2002 published a series of 35 patients with acute and chronic multi-ligament injured knees that underwent operative intervention. While the majority of the study focused on outcomes of ACL/PCL reconstruction, in this cohort of patients 15 had associated injuries involving the MCL. Seven of these patients were treated non-operatively with bracing and eight treated with reconstruction consisting of a semitendinosus autograft or allograft with reinforcement using posteromedial capsular advancement. Post-operative MCL function was evaluated using manual valgus stress testing in 30° flexion. 7/7 (100%) of the operatively treated MCL injuries and 7/8 of the braced MCL's were deemed stable. They noted that treatment decisions for operative or non-operative treatment depended on the degree of medial side damage, although no clarification was given on the characterization of lower versus higher grade lesions.

### MCL repair versus MCL reconstruction

A similar search for articles comparing the operative management of MCL injuries with either MCL repair or MCL reconstruction was performed. There were no reports found in the English-language literature directly comparing the results of these two treatment modalities.

## Discussion

The most important finding of our systematic review was that repair or reconstruction of the MCL in the setting of

the multi-ligament injured knee yields satisfactory results based on the best available evidence in the literature. Having said that, it is difficult to draw any strong clinical conclusions due to the lack of Level I studies of adequate size. In fact, there were not even any Level II or III studies that met our inclusion criteria.

The anatomic importance of the MCL stems from its function as the primary static restraint to valgus-directed loads with secondary resistance to abnormal external tibial rotation [15, 28, 38]. The MCL complex is composed of one large ligament, the superficial MCL, and a series of capsular thickenings and tendinous attachments. These latter structures include the deep MCL and capsular attachments from the main common tendon of the semi-membranosus tendon, known as the posterior oblique ligament. It is situated within the second tissue layer, according to the three-layer anatomical concept originally described by Warren and Marshall [39].

A recent anatomic study by LaPrade et al. [27] showed that the superficial MCL has one proximal femoral attachment site situated in a depression proximal and posterior to the center of the medial epicondyle. They also found two distinct tibial insertion sites, a soft-tissue attachment directly over the anterior arm of the semi-membranosus and one directly onto bone just anterior to the posteromedial crest of the tibia. This specific anatomical information is critical in planning reconstructive options and techniques.

#### Classification system

Classification of injuries to the MCL was first described by Hughston in 1976 [19] and further clarified in 1994 [18]. Hughston used two related systems that took into account severity and laxity of ligament injury. In contrast, Fetto and Marshall [12] in 1978 defined MCL injuries in their own classification system by the presence of valgus laxity at different degrees of flexion. The degree of injury to the MCL routinely determines the method of treatment. It is generally accepted that Hughston Grade I and II injuries (partial tears) and isolated Hughston Grade III injuries (complete tears) of the MCL can be treated non-operatively with early functional rehabilitation [4, 7, 8, 17, 22, 24, 26, 30, 31, 33]. This is also true for Fetto and Marshall Grade I and II injuries. This is mainly due to the excellent healing capability of this ligament found in both animal and clinical studies [2, 22, 40].

The treatment of Hughston Grade III MCL tears associated with other ligamentous injuries within the knee and Fetto and Marshall Grade III tears continues to be a controversial topic [4, 13, 16, 18, 34]. These injuries have been treated both non-operatively as well as operatively, with primary repair or reconstruction using various surgical

techniques. In cases of multi-ligament knee injuries, the cumulative effect of these damaged structures on knee stability may be more pronounced due to the functional deficiency of one ligament directly affecting the healing of others [25, 41].

#### Outcome standardization

Interpretation of this available information has been complicated for two reasons. First, it is difficult in many studies to assess the homogeneity of injury severity within the patient cohorts as most authors used different classification schemes. Not to mention the fact that the above noted classification systems conflict and overlap with one another to a certain degree. Also, multiple studies on management of MCL injuries have failed to clearly define the specific objective outcome measures to assess stability of the MCL. The ability to measure outcome data is paramount when attempting to compare different treatment interventions in an evidence-based model.

The latter issue can be highlighted especially in current literature pertaining to MCL reconstructions. Many recent articles pertaining to MCL reconstruction have been in the form of technique papers [1, 6, 14, 37]. These studies have all highlighted the operative technique, proximal and distal fixation methods, as well as rationales behind the development of their respective procedures. Most have failed at providing any notable objective clinical outcome data on the results of their techniques.

Multiple review articles have been published in recent years highlighting the clinicopathological features, diagnosis, and treatment of MCL injuries in the setting of combined ligament disruption [3, 10, 11, 23, 32]. In general, these studies have also failed to highlight or discuss operative outcomes. To our knowledge, this is the first review specifically evaluating the outcomes of operative management (repair or reconstruction) of these injuries.

The strengths of this review include the clear definition of the research question to eliminate bias in the selection of the included studies and adherence to a research protocol that was developed prior to the analysis. After developing the research question and protocol, a comprehensive literature search was undertaken including the use of electronic databases and manual bibliography cross-referencing as recommended by Wright et al. [42].

The primary limitation of this review is that a direct analysis of MCL repair and MCL reconstruction was not possible due to the fact that there are no trials in the current literature looking at the comparative outcomes of these two treatment modalities. Of the included studies, the heterogeneity of patient populations, lack of clear injury severity, and variable outcome evaluation tools within the studies makes formal comparison or meta-analysis between MCL

repair and reconstruction difficult. Study populations were found to have significant variables potentially influencing treatment decisions and ultimate outcome including patient characteristics, associated injuries and treatment of those additional injuries. An example of this is the wide age range (17–58) in the retrospective MCL repair studies, as there are obvious differences in the functional demands and activity levels at the extremes of this range. In addition, all of the included studies were retrospective in design (Level IV) with inherent selection and recall biases. The relative dearth of Level I evidence in the orthopedic literature comparing treatments of MCL in multi-ligament injured knee reflects the complexity and variability of these injuries in general and helps explain the numerous treatment rationales and techniques used for clinical decision-making.

## Conclusion

Currently there is a paucity of objective data on the outcomes regarding surgical management of MCL tears in the combined ligament injured knee. This systematic review demonstrated satisfactory results in both repair and reconstruction groups. Future objective outcome-based studies as well as comparative studies are needed to further evaluate the optimal treatment modality before evidence-based recommendations can be made. Therefore, individual treatment decisions for each patient should be based on the characteristics and nature of the injury.

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