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ORIGINAL ARTICLE

# Tunnel-Less Medial Collateral Ligament Reconstruction in MLKI: A Novel Technique to Prevent Tunnel Convergence

**Prahalad Kumar Singhi[1] · Pratik M. Rathod[2] · Ajay Gowtham Amutham Elangovan[3] · Gopi Kumarasamy[1] · Sivakumar Raju[1] · M. Chidambaram[1]**

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**Abstract**

**Introduction** Medial collateral ligament is an important structure to stabilize the knee against valgus/rotatory forces and requires prompt treatment especially in MLKI scenario. The primary aim is to assess the outcome of our modified tunnel-less technique of MCL repair with hamstring augmentation/reconstruction using suture anchors and staples in MLKI.

**Materials and Methods** This retrospective study included 26 patients of MLKI with concomitant valgus instability. All patients underwent MCL reconstruction or repair with augmentation.

Patient demographic data, mode of injury, ligament injury pattern, surgical intervention, functional outcome and complications were compiled and evaluated. Outcomes including Lysholm score and ML-QOL score were computed at frequent intervals of 6, 12, and 18 months and final follow-up.

**Results** Of the 26 patients (21 males and 5 females), 9 patients underwent MCL repair with augmentation and 17 had MCL reconstruction. We had three cases of foot drop and one patient with vascular injury. The mean follow-up period of all the cases was $46.05 \pm 10.04$ months. Functional outcomes using Lysholm score improved significantly from $55.20 \pm 6.42$ at baseline to $90.79 \pm 4.23$ at final follow-up. Similar results were observed with the ML-QOL score which improved from $159.54 \pm 14.65$ to $61.04 \pm 8.80$ at final follow-up.

**Conclusion** This novel tunnel-less technique of MCL augmentation/reconstruction proved to be effective in stabilizing the knee, with significant improvements in functional outcomes. Thus, it provides a feasible alternative for the management of MCL injury in MLKI, avoiding tunnel convergence and subsequent failures.

**Keywords** Medial collateral ligament (MCL) · Multi-ligamentous knee injury (MLKI) · Knee reconstruction · PROMs · ML-QOL · Tunnel-less technique

## Introduction

The medial collateral ligament (MCL) is the primary restraint to valgus force, especially at 0 and 30 degrees of knee flexion [1, 2]. It is a primary stabiliser of the knee, supporting against the rotatory and valgus forces acting on the knee [3]. MCL injuries can occur at the proximal (femoral insertion), mid-substance or distal tibial site which may form a Stener-like lesion [1, 2]. The widely accepted scale for assessing the grade of severity is the medial opening of

✉ Pratik M. Rathod
pratik3800@gmail.com

Prahalad Kumar Singhi
singhiprahalad@gmail.com

Ajay Gowtham Amutham Elangovan
ajaygowthamae3@gmail.com

Gopi Kumarasamy
gopikumar26@gmail.com

Sivakumar Raju
profsivakumarspine@gmail.com

M. Chidambaram
chidambaram.ortho@gmail.com

1 Department of Orthopedics, Preethi Institute of Medical Sciences, Madurai, Tamil Nadu, India

2 Division of Arthroplasty and Trauma, Department of Orthopaedics, Preethi Institute of Medical Sciences, Madurai, Tamil Nadu, India

3 Department of Orthopedics, Gowtham Multispeciality Hospital Pvt Ltd, Coimbatore, Tamil Nadu, India

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the joint described by Degrace et al. [2]. Though indirect injuries related to sports are more frequent, direct injuries secondary to valgus force at the knee are common in motor vehicle accidents [4, 5]. MCL is extracapsular and hence most of the injuries heal non-operatively, with few needing surgical management [5, 6].

Multi-ligament knee injuries (MLKIs) are defined as a tear of two or more of the four major knee ligaments. MCL injury associated with MLKI is an indication for surgery, to provide a stable, painless and functional knee. While surgery is mainly preferred, the timing of the surgery, staging, and repair/reconstruction technique remains debatable. With evidence aside, the decision on early vs delayed, single/staged intervention is usually based on the surgeon's expertise, patient factors and available graft options. A recent review suggests that there is insufficient evidence to conclude whether a single or staged procedure has better outcomes. There are several techniques for repair with augmentation, and reconstruction of MCL in MLKI with no clear winner [7]. Tunnel convergence remains another major concern during these procedures. The primary aim is to assess the outcome of tunnel-less technique of MCL augmentation/reconstruction with hamstring tendon using suture anchors and staples in MLKI.

## Materials and Methods

### Study Design

A retrospective analysis of patients having medial-sided injury along with MLKI was done at our institute from 2018 to 2022 after appropriate institutional review board approval [SRC/PHLP/ACAD-2023-2/009] and patient consent. All pertaining data were extracted from the medical records department of our tertiary care centre. Patients who satisfied the inclusion and exclusion criteria were recruited for this study. We selected patients who had undergone MCL reconstruction or repair with augmentation procedures and data about demographic variables, mode of injury, ligament injury pattern, surgical intervention, functional outcome and complications were compiled and evaluated. The term augmentation was used when a direct repair of the MCL was done in addition to the described technique of medial side reconstruction.

### Inclusion and Exclusion Criteria

All patients having MCL injury related to MLKI, (1) within the age limit of 15–65 years, (2) with associated meniscal injuries, and (3) associated with fractures around knee, were included in this study. Exclusion criteria included (1) open injuries, (2) patient not willing to participate in study and lost to follow-up, (3) polytrauma cases involving other systems, and (4) chronic cases with bony malalignment.

### Preoperative Protocol

26 patients who satisfied the inclusion and exclusion criteria were included in the study. A complete clinical and radiological assessment including standard knee radiographs, stress radiographs in chronic cases, CT scan (in case of bony avulsions) and MRI of the knee were done to classify the types of knee dislocation/MLKI and confirm the clinical diagnosis. All patients undergoing surgery were subjected to routine blood work as per our institute protocol. The treatment algorithm employed by our institute is summarised in Fig. 1. A diagrammatic representation of the MCL tear near the femoral aspect is shown in Fig. 2.

### Operative Technique

All surgeries were performed by a senior surgeon (PKS) under spinal/epidural anaesthesia. Position used was supine similar to standard Total Knee Replacement position (side support and bolster with knee in $90^0$ flexion). Under tourniquet control, with gravity-assisted saline inflow, diagnostic arthroscopy was performed with a 4-mm 30-degree arthroscope. After confirming the findings, we proceeded with either a single-stage cruciate and collateral repair with augmentation or a two-stage collateral repair with later cruciate reconstruction.

Following are brief steps in the novel technique to repair with augmentation/reconstruction of the MCL we employed in patients.

Repair of MCL and augmentation with gracilis or semitendinosis (semi-T) tendon were performed using the following steps:

Step 1: Direct MCL and meniscocapsular ligaments repair with suture anchor/fibre wires.

Step 2: Harvest and preparation of gracilis or semi-T tendon with intact tibial attachment.

Step 3: Graft interlacing through MCL.

Step 4: Graft fixation in the femur.

Step 5: Graft looped back again to the tibial attachment site and fixation using bone staples, can be routed posteriorly at POL insertion and fixed using another suture anchor in case of posteromedial instability.

### MCL and Meniscocapsular Ligaments Repair with Suture Anchor (Fig. 3)

We make a medial incision starting from the medial femoral epicondyle to 7 cm below the joint line, exposing the entire tibial insertion. We then dissect the pes sartorial fascia, identify the hamstring tendons and tag any one

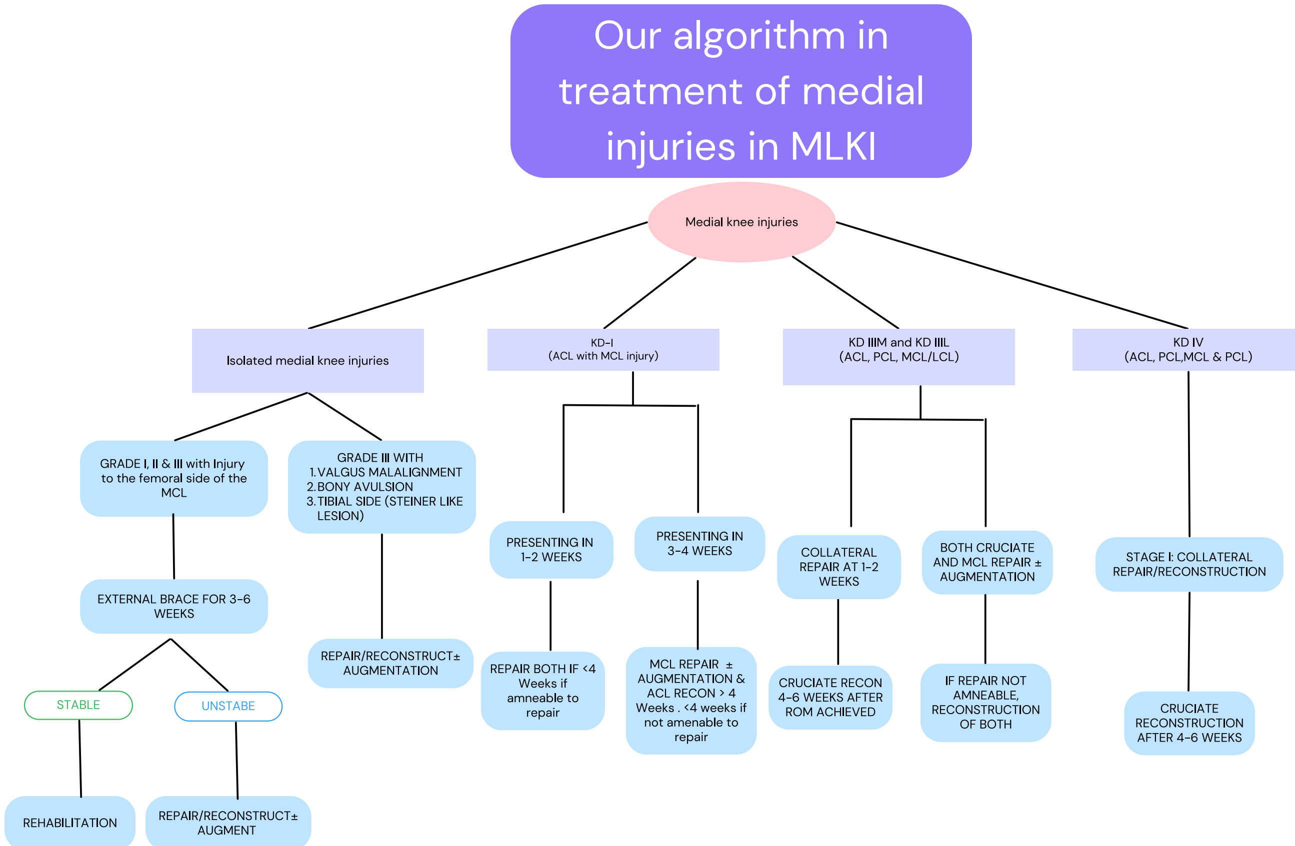


**Fig. 1** An algorithm for treating posteromedial knee instability

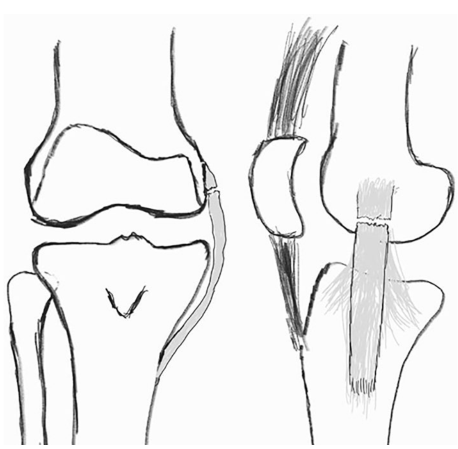

**Fig. 2** Representative AP and mediolateral image of the torn MCL

using an ethibond lasso for later harvest. An injury to the deep MCL/meniscocapsular ligaments is usually evident from an exposed joint surface. In such case, an anatomical repair of the deep and superficial MCL is done using single- or double-loaded anchors of choice depending on the tear pattern (Fig. 4). This repair restores the position of the medial meniscus.

## Tendon Harvest and Preparation

The isolated hamstring tendon, either the gracilis or Semi-T is harvested using an open tendon stripper, leaving the tibial attachment intact. The vincula if present are released. The harvested tendon is made free of muscle fibres, and the free end of the graft is prepared with a whip stitch using No. 5 ethibond.

## Graft Interlacing Through MCL

Subperiosteal elevation of the sMCL insertion is done at the level of hamstring insertion using medium-sized curved haemostat forceps. The gracilis is delivered underneath the sMCL insertion using shuttle sutures. Interlacing of the gracilis tendon to the MCL is done by sutures (2 Vicryl) or a suture anchor in case of sMCL insertional injury. This shifts the graft's tibial attachment to a more anatomical position of the native MCL (Figs. 4 and 5).

## Graft Fixation in the Femur

The medial epicondyle is exposed and a point 3.2 mm proximal and 4.8 mm posterior to the medial epicondyle is

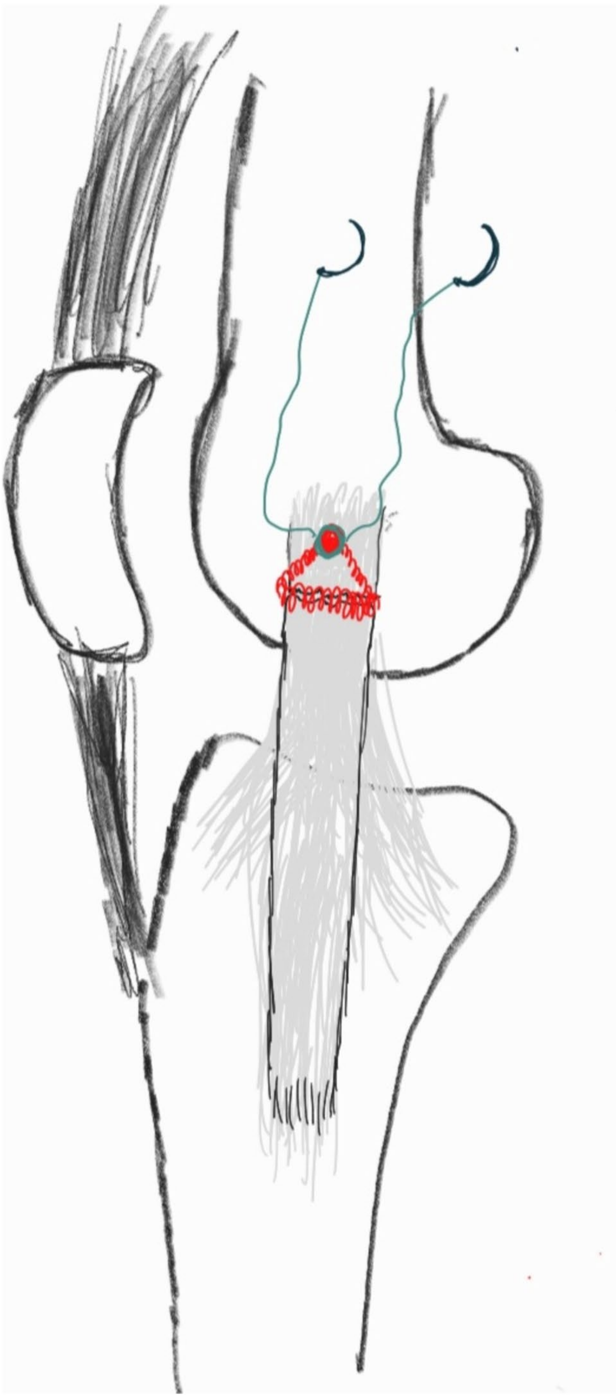

**Fig. 3** Representative image of the primary MCL repair

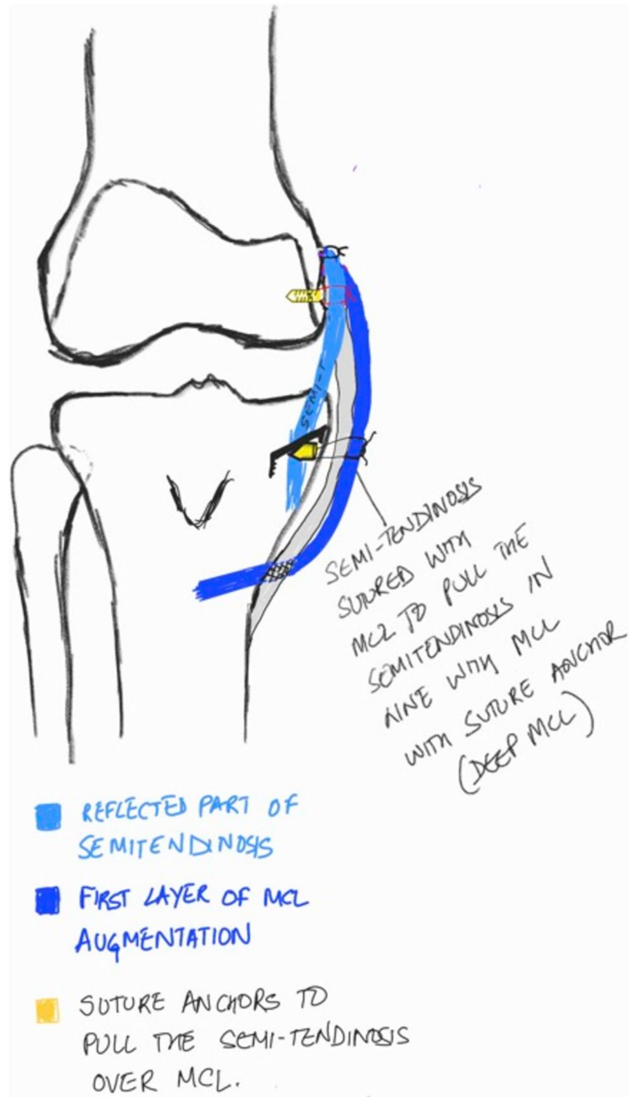


**Fig. 4** Representative image of the MCL augmentation from a anterior view along with meniscocapsular repair of the MCL

marked. A suture anchor is placed at the isometric point after elevation of the soft tissue with sharp dissection and periosteal elevation for better healing. The isometry is confirmed by passively performing the knee ROM and checking the marked point's displacement. The same is confirmed under the image intensifier. Once the isometric point is established, the weaved gracilis is passed underneath the soft tissue tunnel using a shuttle suture. The graft is then fixed to the suture anchor at the isometric point without any slackness using a sliding knot, with knee in 30-degree flexion and a varus closing force.

## Graft Looped Back to the Tibial Attachment

The sMCL usually has two tibial attachments, one 12 mm distal to the joint line (proximal tibial attachment) and another 60 mm distal to the joint line (distal tibial attachment). If only the sMCL needs to be addressed, the graft is looped back to the sMCL distal tibial attachment site with knee in 30-degree flexion/varus closing force and fixed with a bone staple. Alternatively, this fixation can be done through a minimally invasive approach through two separate

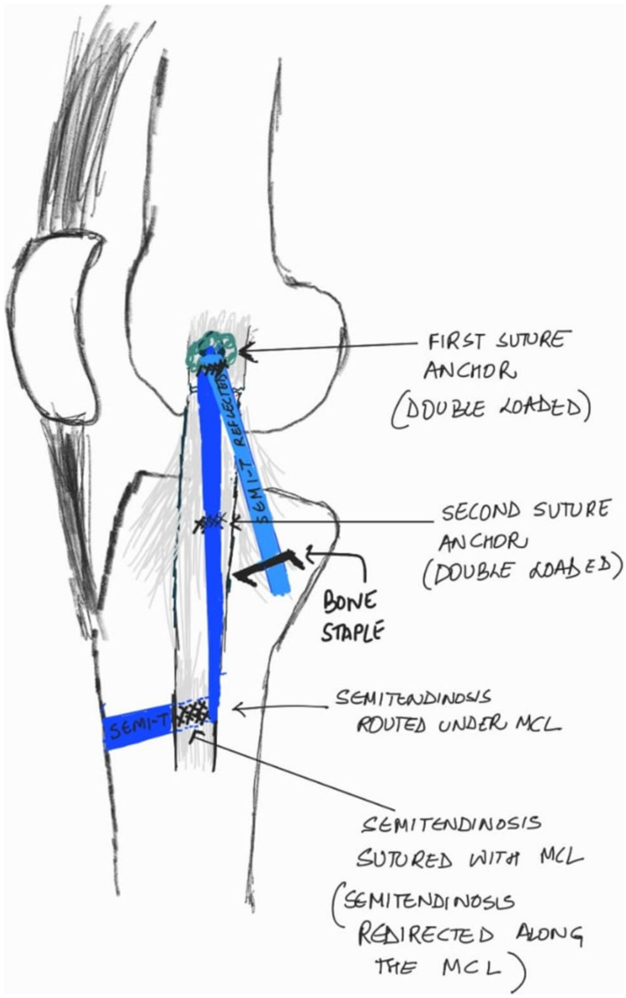


**Fig. 5** Representative image of the MCL augmentation from a medial view along with meniscocapsular repair of the MCL and rerouting of the Semi-T

incisions. If POL needs to be addressed, the looped graft from the femur is fixed with an anchor, inserted at a point 12 mm from the joint line just anterior to the posterior crest of the proximal tibia with the knee in full extension and varus closing force. Valgus stability is checked before skin closure. Sequential steps of the our technique of MCL repair and augmentations are depicted in Fig. 6. Similarly stepwise radiology before and after repair/reconstruction are depicted in Fig. 7.

### Post-Operative Protocol

All the patients were put on long knee braces post-operatively. On post-op day 1, the patient was started on a controlled continuous passive motion of the knee from 0 to 90 degrees, static quadriceps exercises and toe touch/partial weight bearing with crutches as tolerated. The associated ligament and meniscal injuries determined the further progress of rehabilitation.

### Follow-Up Protocol

The patients were followed up at 2 weeks for suture removal, and then visits were scheduled at 6, 12, and 18 months and final follow-up. The functional outcome scores were documented at each visit and compared.

### Statistical Analysis

The study data were categorised using descriptive statistics, and the results were analysed in Microsoft Excel using Office 365 and Statistical Package for the Social Sciences 2019 (SPSS v 26). The software calculates the mean age values and follow-up functional scores. We performed a repeated measures ANOVA to determine if the Lysholm scores/ML-QOL (multi-ligamentous injury quality of life) improved over time (6 months, 12 months, and 18 months) and whether the same was statistically significant [8, 9]. This test accounts for the correlation between repeated measures on the same patients (Fig. 8). Some of the values that were used are explained briefly as follows:

- F value: the F-statistic is a ratio of the variance between the group means to the variance within the groups. It is used to determine if there are any statistically significant differences between the group means.
- Num DF (numerator degrees of freedom): number of groups minus one (3 time points—1 = 2).
- Den DF (denominator degrees of freedom): total number of observations minus the number of groups (in this case, 26 patients * 3 time points—3 = 75—3 = 72).
- Pr > F (*p* value): This is the probability of observing an F-statistic as extreme as, or more extreme than, the one calculated, assuming the null hypothesis is true. A p-value less than 0.05 indicates statistical significance.

## Results

Out of the 26 cases included in our study, 21 were males and 5 were females with a mean age of 35 (range 18–65) (Table 1). Concerning the mechanism of injury, 16 patients had motor vehicle collisions, 8 had sports-related injuries and 2 patients had fall from height. Concerning the ligament injury pattern 17 were KDI, 5 were KDIII and 4 were KDIV. Of these, 9 patients underwent MCL repair with augmentation with semi-T, and 17 underwent only MCL reconstruction. Four of them had ipsilateral long bone fractures and were managed appropriately. Twenty-one patients underwent simultaneous MCL repair with augmentation and cruciate

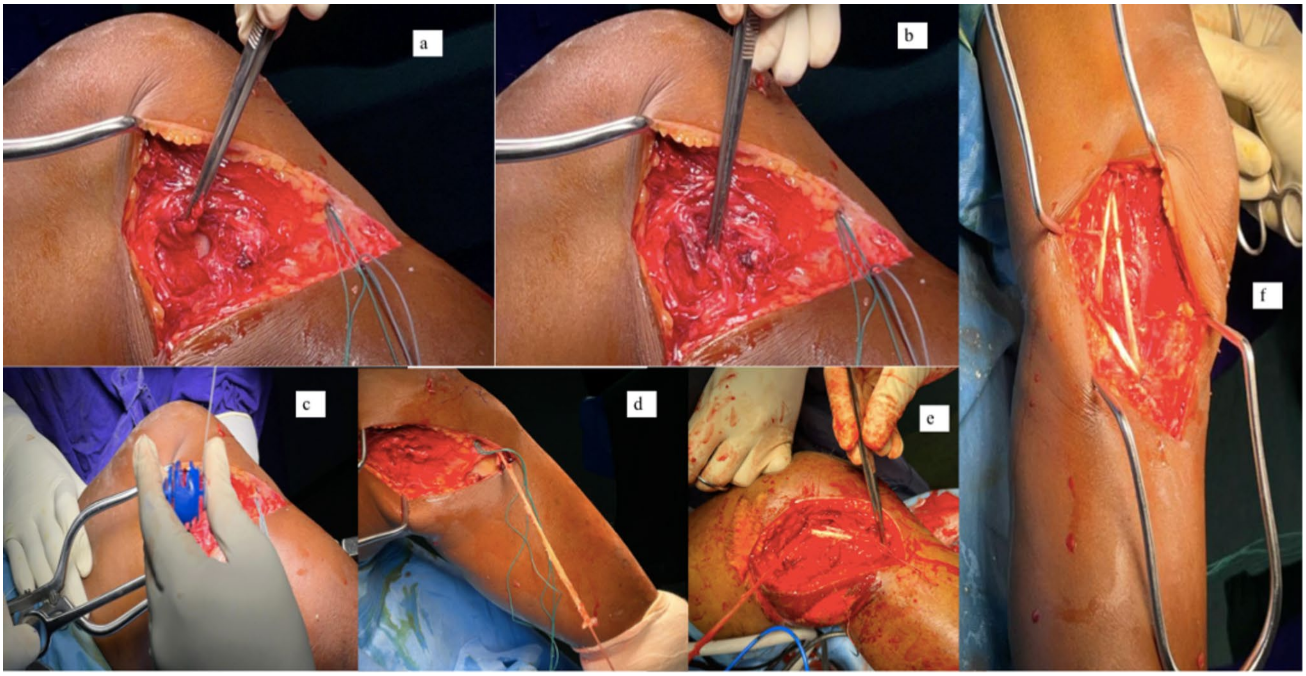


**Fig. 6** Sequential steps in tunnel-less technique of MCL reconstruction using bone staple and suture anchor. **a** The torn MCL and **b** the repaired MCL using suture anchor and fibre wires. **c** Placement of suture anchor in femoral epicondyle to fix the graft in the next step. **d** Rerouting of the graft below the MCL to mimic its course. The graft is fixed at the femoral anchor using a fibre wire. **e** The remnant graft is routed back to the tibia and fixed with a bone staple recreating the functional MCL

reconstruction, whereas 5 patients had staged MCL repair with augmentation and cruciate reconstruction. Three of the patients had foot drop preoperatively, while one patient had associated vascular injury for which bypass vascular repair was done (Table 1).

The mean follow-up period of all the cases was $46.05 \pm 10.04$ months. Functional outcomes using Lysholm score improved significantly from $55.20 \pm 6.42$ at baseline to $90.79 \pm 4.23$ at final follow-up, indicating better knee function. Similar results were observed with the ML-QOL score which improved from $159.54 \pm 14.65$ to $61.04 \pm 8.80$ at final follow-up, indicating better quality of life (Table 2). The results of the repeated measures ANOVA confirm that these changes are statistically significant (Table 3) ($p < 0.0001$).

## Discussion

The most important finding of this study was that our tunnel-less technique of MCL reconstruction consistently restored valgus stability when performed for both acute and chronic cases in the MLKI scenario. It prevents the possibility of tunnel coalition in KDIIIM and above injuries. We were able to achieve good results with improved short-term functional outcome in terms of Lysholm scores and PROM using ML-QOL scores.

The incidence of posteromedial knee instability has been rising, largely due to the prevalence of motor vehicle accidents and sports-related injuries. From the available evidence and literature, numerous treatment options are available for repairing, reconstructing and augmenting MCL for valgus instability. Table 4 summarises the multiple surgical techniques for the repair/reconstruction of the MCL.

The incidence of valgus/posteromedial instability has been rising, largely due to the prevalence of motor vehicle accidents and sports-related injuries. Hughston et al. were among the first ones to promote the repair of the posteromedial corner, they proposed the usage of non-absorbable sutures in a mattress manner to achieve an approximation of the ends of the torn ligament. While this may seem primitive, the usage of these techniques, along with augmentation and internal bracing, has given comparable results with reconstruction techniques [4]. While Ishibashi et al. in their study found that acute primary repair of extraarticular ligaments gives good knee stability without varus/valgus instability, they also concluded that acuter repair may decrease the need for subsequent cruciate ligament reconstruction [10]. Similarly, Gan et al. in their study of 47 patients concluded that there was a satisfactory outcome in terms of IKDC and Lysholm scores when patients with KDIII and KDIV underwent acute repair of extraarticular ligaments and anatomic reconstruction of

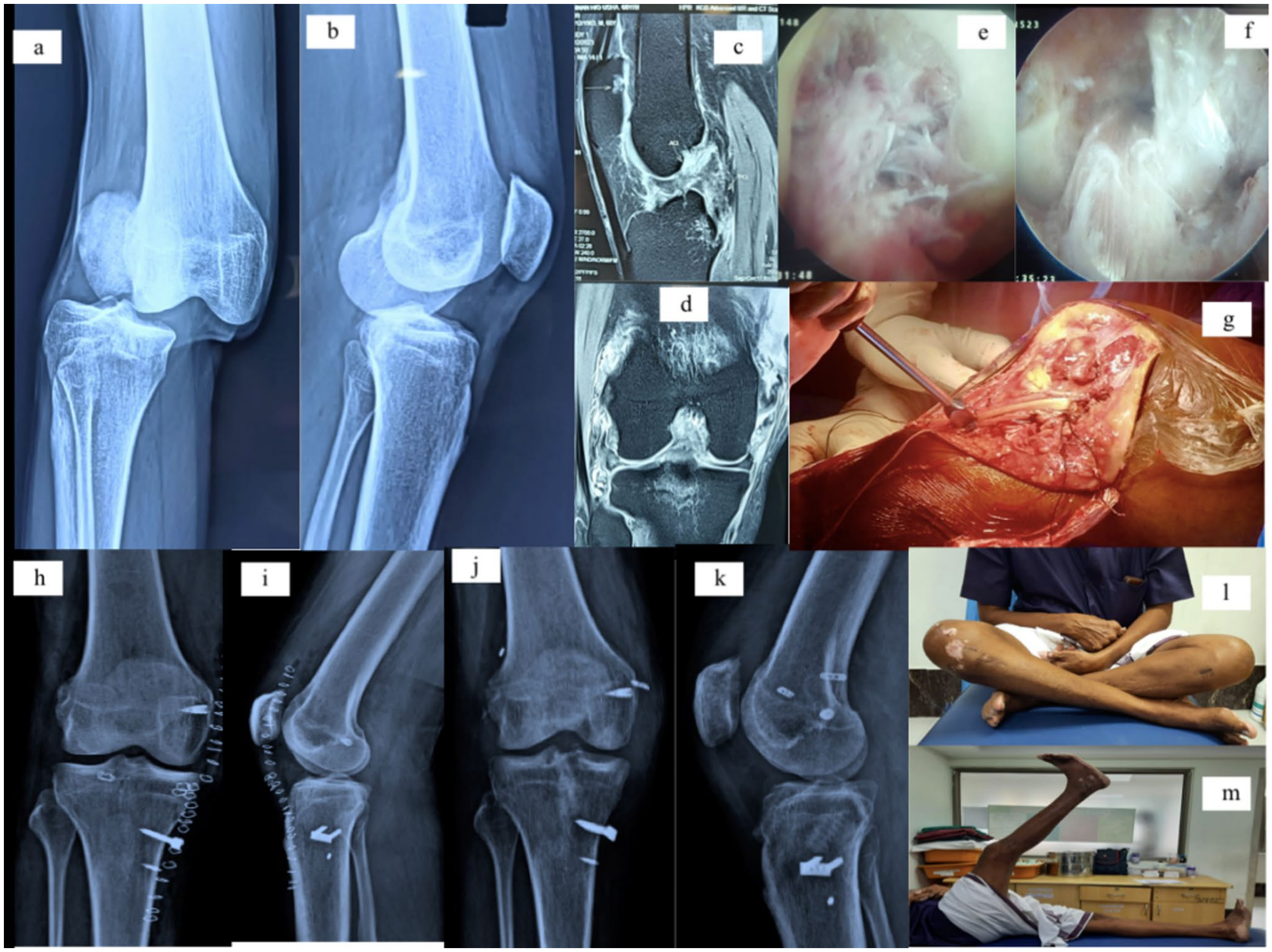


**Fig. 7** Sequential images showing diagnosis, intra-op reconstruction in a staged manner, and post-op X-rays including clinical functional return of the patient. **a**, **b** Orthogonal views of a dislocated knee joint. **c**, **d** Relevant cuts of bi-cruciate injury and both collateral injury. **e**, **f** Tear of both ACL and PCL and image after reconstruction of both ACL and PCL (second stage). **h**, **i** Reduction of the joint with reconstruction of the MCL with anchors and staples and primary repair of the LCL. **j**, **k** The post-op X-ray after the second stage of cruciate reconstruction. **l**, **m** A complete return to function with excellent Lysholm and ML-QOL scores

**Fig. 8** Graphical representation of improving scores of both the Lysholm and ML-QOL scores

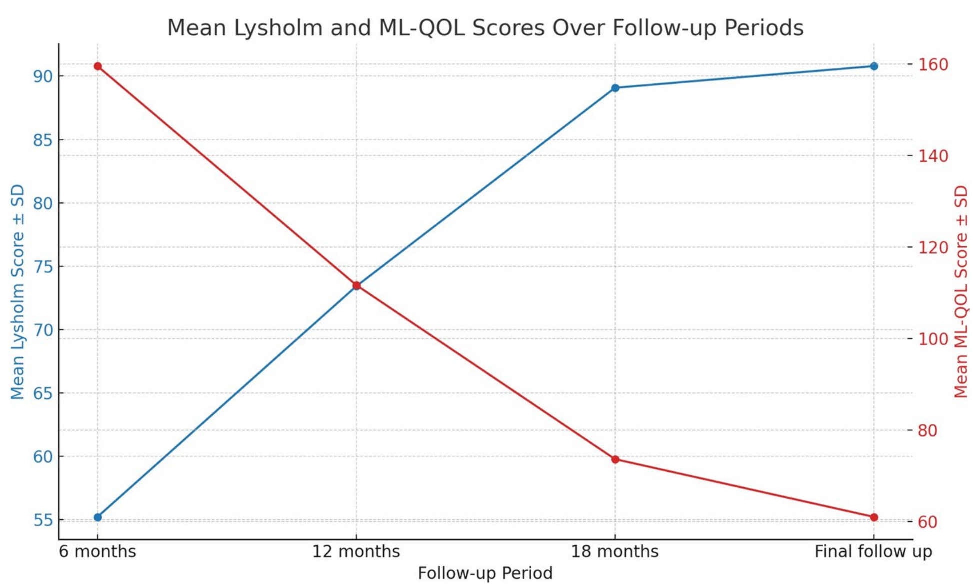

**Table 1** Demography of the study

| Sl. No | Category | Variable | Numbers |
|---|---|---|---|
| 1 | Sex | Male | 21 |
| | | Female | 5 |
| 2 | Mode of injury | RTA | 16 |
| | | Sports injury | 8 |
| | | Fall from height | 2 |
| 3 | Knee dislocation (KD) class | KDI | 17 |
| | | KDIII | 5 |
| | | KDIV | 4 |
| 4 | Types of MCL repair | MCL repair with augmentation | 9 |
| | | MCL reconstruction alone | 17 |
| 5 | Associated injuries treated | Simultaneous MCL repair/augmentation and cruciate reconstruction | 21 |
| | | Staged cruciate reconstruction after MCL repair/augmentation | 5 |
| | | Associated fractures | 4 |
| 6 | Complications | Foot drop | 3 |
| | | Vascular injury | 1 |

**Table 2** Lysholm scores and ML-QOL scores

| Sl. No | Follow-up period | Mean Lysholm score ± SD | Mean ML-QOL score ± SD |
|---|---|---|---|
| 1 | 6 months | 55.20 ± 6.42 | 159.54 ± 14.65 |
| 2 | 12 months | 73.41 ± 6.68 | 111.70 ± 12.87 |
| 3 | 18 months | 89.08 ± 5.01 | 73.66 ± 12.95 |
| 4 | Final follow-up | 90.79 ± 4.23 | 61.04 ± 8.80 |

**Table 3** ANOVA tests on Lysholm and ML-QOL scores

| Measure | *F* value | Num DF | Den DF | Pr > F |
|---|---|---|---|---|
| Lysholm scores | 220.123 | 2 | 50 | < 0.0001 |
| ML-QOL scores | 300.456 | 2 | 50 | < 0.0001 |

the cruciate [11]. We found that in acute conditions, it is always best to repair the native MCL whenever possible.

In contrast, La Prade et al. and others [12–17] (Table 5) suggested performing an anatomic reconstruction instead of repair, which they consider to give the best results. They also concluded that the repair and augmenting of the MCL with semitendinosus is an inferior construct both structurally and functionally to the anatomic ligamentous reconstruction [13]. Dong et al. found that triangular MCL reconstruction and the MCL repair without any internal brace had similar outcomes in terms of ROM, medial stability, and subjective outcomes. However, the repair group had poorer anteromedial stability when compared to the reconstruction group suggesting better stability in the reconstruction group [14].

There is sufficient evidence supporting better stability with reconstruction than repair alone, especially in mid-substance tears. We aim in combining repair with additional augmentation to restore native knee stability and minimise the possibility of residual valgus instability.

Similarly, Weimann et al. [15], in their biomechanical study concluded that reconstruction of POL (posterior oblique ligament) was instrumental in providing stability to the knee when reconstruction of both the PCL and MCL [15]. Priess et al. used two limbs to replicate the anatomy of the MCL using three bone tunnels and interference screws [16]. Lind et al. 2009 suggested that non-anatomic reconstruction using semitendinosis graft gave a stable knee in grade 3 and grade 4 medial instability, giving excellent results. However, in cases of MLKIs, there are high chances of tunnel convergences and subsequent failure [17]. All these authors have used the tunnels (anatomic/non-anatomic) for the reconstruction of MCL, and suggest that the reconstruction gives adequate stability of the knee when compared to the repair alone [14–17]. Broadly, the techniques for surgical intervention are summarised in Table 5.

Through our technique, we address both the superficial and deep MCL and the POL in case of posteromedial instability. Here, we do not create a separate femoral arm of POL which has its attachment 1.4 mm distal and 2.9 mm anterior to the gastrocnemius tubercle, but the same graft from the isometric point is reflected back to the tibia, although not anatomical, gives stability in par with the latter.

Fibre tape and internal bracing have taken an uptrend in managing ligamentous and tendinous injuries in recent years. They have a high tensile load for failure and give adequate time for the native tissue to heal [18, 19]. In their

**Table 4** Summary of types of MCL repair, reconstruction and augmentation

| Technique | Description |
| --- | --- |
| Primary repair | In cases of partial tears or low-grade MCL injuries, primary repair involves suturing the torn ends of the ligament back together. This technique aims to restore the original anatomy and function of the MCL |
| Augmentation | This involves using additional structures, such as tendon grafts (e.g. hamstring tendon), allografts, or synthetic materials, to reinforce the repair. The augmentation material is typically attached to the repaired MCL to enhance its strength and stability |
| Internal brace | An internal brace involves the use of a synthetic ligament-like structure that is anchored to the bone on either side of the MCL tear. This technique provides immediate stability to the injured ligament while allowing for natural healing to occur. The internal brace is designed to gradually degrade over time as the MCL heals and strengthens |
| Reconstruction | This involves replacing the damaged MCL with a graft (autograft). Common graft choices include the semitendinosus tendon and peroneus longus tendon |
| Double bundle repair | This technique involves reconstructing the MCL using two separate grafts or bundles to replicate the anatomy and function of the native MCL more closely. One bundle is typically placed in the superficial MCL (sMCL), and the other in the deep MCL (dMCL) to provide multidirectional stability. This approach is aimed at restoring both valgus and rotational stability of the knee joint |
| Anatomic reconstruction | Anatomic reconstruction aims to recreate the native anatomy of the MCL as closely as possible. This involves precise placement of the graft(s) in the original insertion sites of the MCL on the femur and tibia. By restoring the natural biomechanics of the MCL, anatomic reconstruction aims to optimise knee stability and function while reducing the risk of complications such as overconstraint or abnormal kinematics |

**Table 5** The available repair/reconstruction techniques described in the literature

| Sl. No | Authors | Type of fixation | Graft choice | Fixation technique |
| --- | --- | --- | --- | --- |
| 1 | La Prade (2012) | Anatomic reconstruction | Semitendinosus | Bony tunnels and anchors |
| 2 | Dong (2014) | Non-anatomic | Tibialis anterior and hamstrings | Bony tunnels and interference screws |
| 3 | Weimann (2012) | Non-anatomic | Semitendinosus | Cortical buttons and interference screws |
| 4 | Preiss (2012) | Non-anatomic | Semitendinosus | Bony tunnels and interference screws |
| 5 | Lind (2009) | Non-anatomic | Semitendinosus | Bony tunnels and interference screws |
| 6 | Hughston (1973) | Repair | Non-absorbable sutures | End to end repair of posterior oblique ligament along with capsular reefing |
| 7 | Tompkins (2023) | Internal brace | Use of fibre tape | Offloading the torn MCL to allow healing |
| 8 | Jelle P van der List (2017) | Internal brace | Use of fibre tape and anchors | Repair the torn MCL with sutures and offload with fibre tape and anchors |

cadaveric study, Tompkins et al. showed that mere placement of the fibre tape (internal bracing) in a torn MCL knee behaved similarly to the native knee under cycles of different valgus loads [18]. The same results were also promoted by Jelle P. van der List et al. [19], who repaired the torn ends of the MCL and then offloaded with internal bracing using limited incisions. It remains to be seen if the addition of such augments restores the biomechanics of the knee. We use more of a biological internal brace which helps in the healing and integration of MCL. In our series, although 65% of the cases were KDI, where the tunnel coalition is not an issue, our technique has several advantages which include, restoration of near normal anatomy, easy reproducibility, a single graft is sufficient which is an important factor in managing MLKIs in contrast to anatomical reconstruction.

Few studies show the inclusion of newer technology for increasing the stability of the reconstructed ligaments [20, 21]. LeVasseur et al. have augmented their repair/reconstruction with Biobrace (bio-inductive scaffold consisting of type I collagen and bioresorbable L lactide microfilaments), which is believed to improve the healing capability [20], while Hirahara et al. described percutaneous ultrasound-guided MCL augmentation with a suture tape [21]. Such newer techniques need rigorous study both biomechanically and clinically to anticipate any clear advantage over existing methods.

While the repair/reconstruction in the setting of MLKI poses a challenge for the surgeon to manage the multiple bony tunnels from converging, it is easier to manage with the tunnel-less reconstruction of the medial structures. Hence, we suggest a tunnel-less technique of reconstructing the MCL, which does the combined function of repair with augmentation or reconstruction with possible reproduction of native MCL function and knee kinematics. Though Yuen et al. have used a similar method of tunnel-less technique in the femoral footprint of MCL for reconstruction, they have used two anchors instead of one in the femur. Moreover, they have detached the distal insertion of the Semi-T for reconstruction unlike our technique [22]. Their findings are similar to ours regarding the "avoidance of tunnel collision" in MLKI setting.

Our technique is quintessential in the setting of multi-ligament injuries and osteoporosis, where bony tunnels may cause iatrogenic fractures. In our technique, we reroute the hamstring to mimic the MCL and posteromedial corner and achieve adequate stability. Such tunnel-less techniques will allow even the less experienced surgeon to get adequate knee stability without fearing tunnel convergence/fracture in MLKI patients. Our technique offers several advantages. First, the use of gracilis/semitendinosus grafts provides robust mechanical strength, essential for knee stability. Second, the integration of suture anchors and staples enhances the fixation of the graft, potentially reducing the risk of failure.

Strengths of this study include the ability to place the grafts without tunnel hindrance, especially in osteoporotic patients. The study has some limitations. Although quantification of medial opening through stress radiographs is an ideal method for computing outcomes, we did not include that in our study due to its retrospective nature and lack of data on all cases. The main limitation of our technique may consist of single surgeon experience with questionable bony integration of the graft when compared to the tunnel technique, but a follow-up of 5 years (two patients) shows adequate stability without compromising knee function. Another limitation is that we have not compared it with established techniques of MCL reconstruction and we had small subset of cases with relatively short-term follow-up. A multicentric study comparing tunnel-less and classical tunnel reconstruction needs to be done to evaluate if there are any significant clinical differences.

## Conclusion

Tunnel-less technique of MCL augmentation/reconstruction is a simple reproducible, cost-effective technique, with no risk of tunnel convergence and proved to be effective in stabilising the knee, with significant improvements in functional outcomes.

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**Author Contributions** PKS: the primary operating surgeons in this study and responsible for overseeing the study design and editing. PMR: drafting of the core manuscript and statistical analysis. GK: editing the manuscript. AGAE is the first assisting orthopaedic surgeon and participated in its design and editing the manuscript. SR and MC: study design and editing the manuscript. All the authors read and approved the final manuscript.

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**Data Availability** Data will not be shared.

## Declarations

**Conflict of Interests** The authors declare that they have no competing interests.

**Ethical Approval** Ethics approval was obtained from the institutional review board (IRB) of Preethi Institute of medical sciences, Madurai, Tamil Nadu, India.

**Consent for Publication** Informed written consent was obtained from the patient regarding publication of clinical material.

## References

1. Chen, L., Kim, P. D., Ahmad, C. S., & Levine, W. N. (2008). Medial collateral ligament injuries of the knee: current treatment concepts. *Current Reviews in Musculoskeletal Medicine, 1*, 108–113.
2. Andrews, K., Lu, A., Mckean, L., & Ebraheim, N. (2017). Review: medial collateral ligament injuries. *Journal of Orthopaedics, 14*(4), 550–554.
3. Vosoughi, F., RezaeiDogahe, R., Nuri, A., AyatiFiroozabadi, M., & Mortazavi, J. (2021). Medial collateral ligament injury of the knee: a review on current concept and management. *Archives of Bone Joint Surgery, 9*(3), 255–262.
4. Hughston, J. C. (1994). The importance of the posterior oblique ligament in repairs of acute tears of the medial ligaments in knees with and without an associated rupture of the anterior cruciate ligament. Results of long-term follow-up. *Journal of Bone Joint Surgery America, 76*(09), 1328–1344.
5. Phisitkul, P., James, S. L., Wolf, B. R., & Amendola, A. (2006). MCL injuries of the knee: current concepts review. *Iowa Orthopaedic Journal, 26*, 77–90.
6. Naik, A. M., Rao, S. K., & Rao, P. S. (2007). Medial collateral ligament avulsion from both tibial and femoral attachments: A case report. *Journal of Orthopaedic Surgery (Hong Kong), 15*(01), 78–80.
7. Makaram, N. S., Murray, I. R., Geeslin, A. G., Chahla, J., Moatshe, G., & LaPrade, R. F. (2023). Diagnosis and treatment strategies of the multiligament injured knee: a scoping review. *British Journal of Sports Medicine, 57*(9), 543–550. https://doi.org/10.1136/bjsports-2022-106425. Epub 2023 Feb 23 PMID: 36822842.
8. Chahal, J., Whelan, D. B., Jaglal, S. B., Smith, P., MacDonald, P. B., Levy, B. A., & Davis, A. M. (2014). The multiligament quality of life questionnaire: development and evaluation of test-retest reliability and validity in patients with multiligament knee injuries. *American Journal of Sports Medicine, 42*(12), 2906–2916. https://doi.org/10.1177/0363546514552629. Epub 2014 Oct 6 PMID: 25288625.
9. Briggs, K. K., Lysholm, J., Tegner, Y., Rodkey, W. G., Kocher, M. S., & Steadman, J. R. (2009). The reliability, validity, and responsiveness of the Lysholm score and Tegner activity scale for anterior cruciate ligament injuries of the knee: 25 years later. *American Journal of Sports Medicine, 37*(5), 890–897. https://doi.org/10.1177/0363546508330143. Epub 2009 Mar 4 PMID: 19261899.

10. Ishibashi, Y., Kimura, Y., Sasaki, E., et al. (2020). Acute primary repair of extraarticular ligaments and staged surgery in multiple ligament knee injuries. *Journal of Orthopaedics and Traumatology, 21*, 18.
11. Gan, Y., Zhuang, J., Jiang, W., et al. (2022). Complex repair and cruciate ligament reconstruction in kds III and IV multiligamentous knee injuries-results of mid-term follow-up. *Journal of Knee Surgery*. https://doi.org/10.1055/s-0042-1748172
12. Laprade, R. F., & Wijdicks, C. A. (2012). Surgical technique: Development of an anatomic medial knee reconstruction. *Clinical Orthopaedics and Related Research, 470*(3), 806–814. https://doi.org/10.1007/s11999-011-2061-1
13. LaPrade, R. F., DePhillipo, N. N., Dornan, G. J., et al. (2022). Comparative outcomes occur after superficial medial collateral ligament augmented repair vs reconstruction: a prospective multicenter randomized controlled equivalence trial. *American Journal of Sports Medicine, 50*(4), 968–976. https://doi.org/10.1177/03635465211069373
14. Dong, J., Wang, X. F., & Men, X. (2015). Surgical treatment of acute grade III medial collateral ligament injury combined with anterior cruciate ligament injury: anatomic ligament repair versus triangular ligament reconstruction. *Arthroscopy, 31*, 1108–1116.
15. Weimann, A., Schatka, I., Herbort, M., Achtnich, A., Zantop, T., Raschke, M., & Petersen, W. (2012). Reconstruction of the posterior oblique ligament and the posterior cruciate ligament in knees with posteromedial instability. *Arthroscopy, 28*(9), 1283–1289. https://doi.org/10.1016/j.arthro.2012.02.003. Epub 2012 Apr 27 PMID: 22541643.
16. Preiss, A., Giannakos, A., & Frosch, K. H. (2012). Minimal-invasive augmentation des medialen kollateralbandes mit autologen hamstringsehnen bei chronischen instabilitäten am kniegelenk [Minimally invasive augmentation of the medial collateral ligament with autologous hamstring tendons in chronic knee instability]. *Operation of Orthopaedic Traumatology, 24*(45), 335–347.
17. Lind, M., Jakobsen, B. W., Lund, B., Hansen, M. S., Abdallah, O., & Christiansen, S. E. (2009). Anatomical reconstruction of the medial collateral ligament and posteromedial corner of the knee in patients with chronic medial collateral ligament instability. *American Journal of Sports Medicine, 37*(6), 1116–1122. https://doi.org/10.1177/0363546509332498. Epub 2009 Mar 31 PMID: 19336612.
18. Tompkins, M. A., Williams, H., & Bechtold, J. E. (2023). An MCL internal brace can withstand cyclic fatigue loading and produce a valgus load to failure similar to that of intact knees. *Knee Surgery, Sports Traumatology, Arthroscopy, 31*, 3611–3617. https://doi.org/10.1007/s00167-023-07439-3
19. van der List, J. P., & DiFelice, G. S. (2017). Primary repair of the medial collateral ligament with internal bracing. *Arthroscopy Techniques, 6*(4), e933–e937. https://doi.org/10.1016/j.eats.2017.03.003
20. LeVasseur, M. R., Uyeki, C. L., Garvin, P., McMillan, S., & Arciero, R. A. (2022). Knee medial collateral ligament augmentation with bioinductive scaffold: surgical technique and indications. *Arthroscopy Techniques, 11*(4), e583–e589. https://doi.org/10.1016/j.eats.2021.12.011
21. Hirahara, A. M., Mackay, G., & Andersen, W. J. (2018). Ultrasound-guided suture tape augmentation and stabilization of the medial collateral ligament. *Arthroscopy Techniques, 7*(3), e205–e210. https://doi.org/10.1016/j.eats.2017.08.069. PMID: 29881691.
22. Yuen, W. L. P., & Loh, S. Y. J. (2023). Reduction of collision risk in multi-ligament knee injury KD-III-M and KD-IV surgery-superficial medial collateral ligament reconstruction with suture anchors. *Arthroscopy Techniques, 12*(3), e413–e420. https://doi.org/10.1016/j.eats.2022.11.025