

Percutaneous Superficial Medial Collateral Ligament Release Outcomes During Medial Meniscal Arthroscopy: A Systematic Review



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Purpose: To systematically review the literature to better understand the technique, outcomes, and complications after percutaneous superficial medial collateral ligament (sMCL) lengthening during knee arthroscopy to address isolated medial meniscal pathology. **Methods:** A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines using a PRISMA checklist. The inclusion criteria consisted of English-language articles or articles with English-language translations documenting the use of percutaneous sMCL lengthening during arthroscopic knee surgery to treat isolated meniscal pathology (repair vs meniscectomy) with reported postoperative outcomes and complications. **Results:** Four studies met the inclusion criteria, consisting of a total of 192 patients undergoing percutaneous sMCL lengthening. No perioperative complications related to iatrogenic chondral damage, fracture, or additional meniscal injury were reported. Mild postoperative pain at the medial needle tract site lasting up to 15 days after surgery was reported in 52% of patients (46 of 88). At final follow-up, laxity on valgus stress testing showed a range from 0 to 1.1 mm with a range from -0.3° to 0.9° of radiographic medial joint space widening compared with preoperative radiographs. The length of follow-up ranged from 1.5 to 24 months. **Conclusions:** The percutaneous “pie-crusting” technique remains the most commonly reported technique to lengthen the sMCL during arthroscopic meniscal surgery. Percutaneous lengthening represents a safe and effective method of increasing medial joint space visualization, with no reported perioperative or postoperative complications and with minimal, likely clinically insignificant residual joint laxity after surgery on valgus stress testing at final follow-up compared with preoperative values. **Level of Evidence:** Level IV, systematic review of Level IV studies.

In the knee, the meniscus functions as a shock absorber, effectively distributing the load transmitted within the knee while ensuring joint stability by providing joint congruity between the femur and tibia throughout flexion and extension. Meniscal tearing

represents one of the most commonly encountered pathologies in the knee, with a reported incidence as high as 6 per 1,000 persons in the United States alone.¹ Owing to the loss of effective load transmission, untreated meniscal tears may lead to articular cartilage damage and eventual loss, resulting in the development of early osteoarthritic changes within the joint.² As such, meniscal lesions are generally treated arthroscopically by primary repair or meniscectomy. In knees with tight medial compartments, particularly varus knees, the potential for missing meniscal pathology or misunderstanding the tear configuration because of poor visualization and iatrogenic chondral and meniscal injury is increased.³⁻⁸ Although manipulation using a valgus force on the knee may help visualization, the surgeon must recognize the potential for medial collateral ligament (MCL) rupture or fracturing of the femur.^{5,9,10}

The MCL is a viscoelastic structure that becomes stiff in the arthritic knee.^{11,12} To facilitate arthroscopic visualization of the medial compartment and meniscus,

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various MCL lengthening techniques have been described. Percutaneous, inside-out lengthening, or “pie crusting,” first described by Agneskirchner and Lobenhoffer,¹³ represents a minimally invasive technique involving repeated puncturing of the medial capsuloligamentous structures with an intramuscular needle to lengthen the superficial medial collateral ligament (sMCL).¹⁴ Variants of the traditionally described pie-crusting method include an inside-out technique in which the needle is inserted through the anteromedial arthroscopy portal to lengthen the deep MCL¹⁵ and release of the sMCL using an open approach with subperiosteal stripping.¹⁶ With results from the percutaneous technique being the most commonly reported, concerns for iatrogenic MCL rupture, residual laxity, saphenous nerve injury, postoperative instability, and other potential complications after lengthening exist and warrant evaluation.

The purpose of this study was to systematically review the literature to better understand the technique, outcomes, and complications after percutaneous sMCL lengthening during knee arthroscopy to address isolated medial meniscal pathology. We hypothesized that patients would possess excellent outcomes with a low rate of postoperative valgus laxity and complications.

Methods

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines using a PRISMA checklist.¹¹ All literature related to sMCL lengthening during arthroscopic knee surgery to treat medial meniscal pathology, published from January 1990 to May 2019, was identified. Two reviewers (M.G., D.K.) independently conducted the search in June 2019 using the following databases: PubMed, Biosis Previews, SPORTSDiscus, PEDro, and Embase. Each search included the following terms: meniscus AND medial AND arthroscopy AND meniscectomy AND repair AND medial collateral ligament AND release AND lengthening AND percutaneous AND open AND superficial.

The inclusion criteria consisted of English-language articles or articles with English-language translations documenting the use of percutaneous sMCL lengthening to increase medial joint space visualization during arthroscopic knee surgery to treat isolated medial meniscal pathology (repair vs meniscectomy) with reported postoperative outcomes and complications. The exclusion criteria were as follows: non-English-language studies; studies reporting lengthening techniques in total knee arthroplasty, deep MCL lengthening using an arthroscopic “inside-out” approach, and open sMCL lengthening by periosteal stripping; studies performed in cadaveric specimens; biomechanical studies; patients

undergoing medial meniscal surgery with concurrent treatment of concomitant injuries within the knee; studies not documenting the sMCL lengthening technique; or no recording of postoperative outcomes or complications after lengthening.

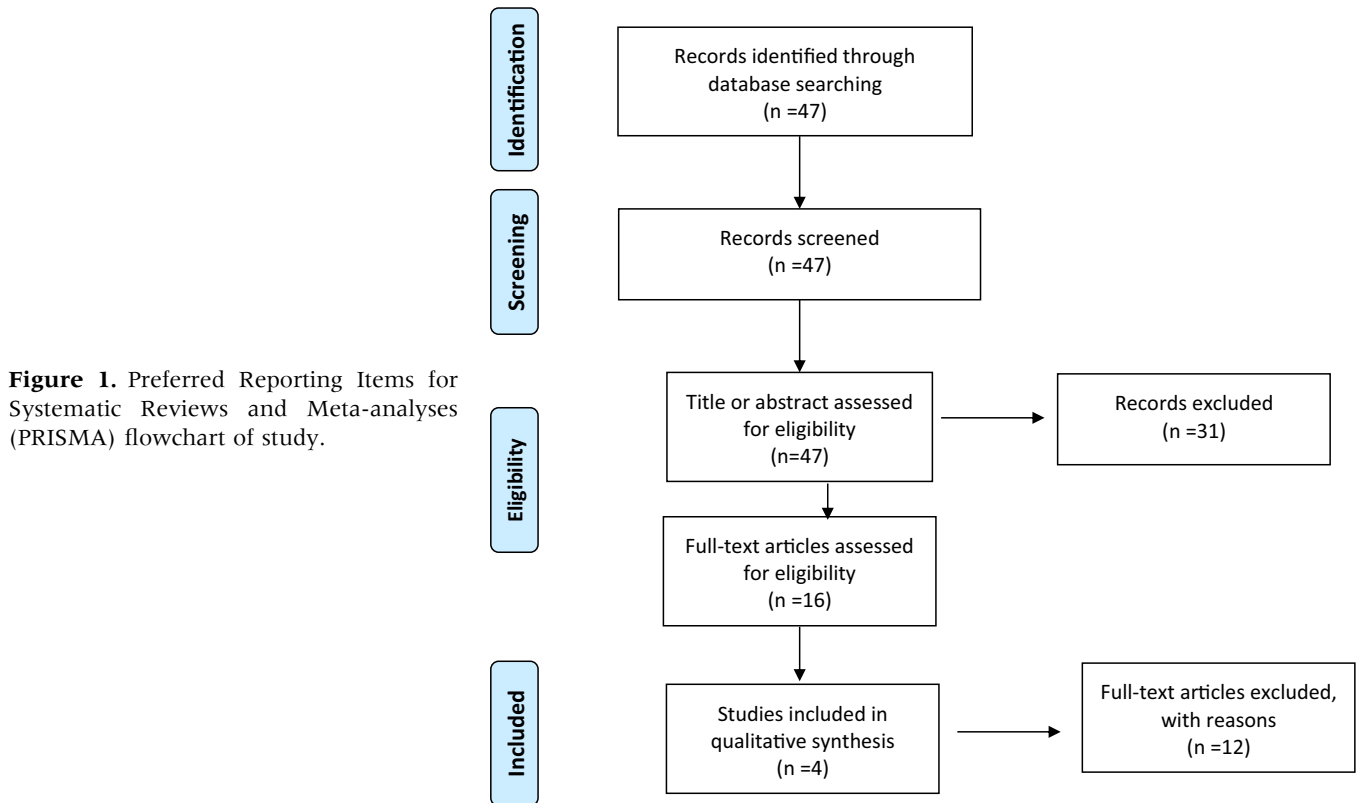
After the 2 independent authors’ searches of the databases, a total of 47 citations were identified. The search process is shown in the flow diagram in [Figure 1](#). After title and abstract assessment, a total of 16 full-text articles were selected for further evaluation. To ensure that all available studies were identified, references within each of the included articles were cross-referenced for inclusion if they were overlooked during the initial search. Statistical analysis was used to analyze reported postoperative clinical outcomes. All statistical analyses were performed using SPSS software (version 25.0; IBM, Armonk, NY).

Results

Of the 16 studies available for full-text review, 12 were excluded after initial literature review because of lack of reported postoperative outcomes ($n = 6$), use of cadaveric specimens ($n = 2$), techniques using deep MCL lengthening ($n = 2$) or open sMCL lengthening via periosteal stripping ($n = 1$), and lack of an English-language translation of the article ($n = 1$). A total of 4 studies were identified for analysis after application of the inclusion and exclusion criteria.

The 4 studies meeting the inclusion criteria consisted of a total of 192 patients undergoing percutaneous sMCL lengthening^{7,17-19} ([Table 1](#)). Men comprised 92% of patients (118 of 128); patient sex was not recorded in a single study.⁷ Overall patient age at the time of surgery ranged from 19 to 62 years. Arthroscopic meniscectomy was performed in 76% of patients (146 of 192), whereas meniscal repair was performed in 24% (46 of 192). No perioperative complications related to iatrogenic chondral damage, fracture, or additional meniscal injury were reported. Postoperative bracing was used in 2 studies,^{7,19} for a mean of 4 weeks after lengthening, whereas 2 studies reported no postoperative bracing.^{17,18} Two studies reported the presence of mild postoperative pain at the medial needle tract site lasting up to 15 days after surgery in 40% of patients (28 of 70).^{7,17} No incidences of saphenous nerve or saphenous vein injury were recorded.

The length of final follow-up ranged from 1.5 to 24 months after surgery. At final follow-up, laxity on valgus stress testing showed a range from 0 to 1.1 mm^{7,18,19} with a range from -0.3° to 0.9° ^{18,19} of radiographic medial joint space widening compared with preoperative radiographs. No cases of subjective instability were reported. The Lysholm score at final follow-up ranged from 85 to 94, and no postoperative complications were reported in patients.



Discussion

The principal findings of this investigation were that in the current literature, the percutaneous pie-crusting technique was the most commonly performed technique, men were treated more often than women, patients' ages ranged from 19 to 62 years, and arthroscopic medial meniscectomy was more common than repair, with no iatrogenic damage to the chondral surface or meniscus reported. Bracing was used for a mean of 4 weeks after percutaneous lengthening in 2 studies,^{7,19} and pain at the medial tract site resolved in all patients by 15 days. At final follow-up, minimal residual joint laxity on valgus stress testing was reported compared with preoperative assessment, with no reports of subjective instability or postoperative complications.

The ages of patients undergoing knee arthroscopy with sMCL release ranged from 19 to 62 years, which encompasses a wide range and includes patients in whom mild to moderate osteoarthritic changes with joint space narrowing are expected. The development of degenerative changes within the knee coincides with stiffening of the knee, with prior studies showing a 184% increase in stiffness in the medial compartment of arthritic knees compared with nonarthritic knees.^{11,12} Degenerative changes along with anatomic variation can lead to a stiffer knee and smaller compartment. As a result, a tight medial joint space

may lead to diagnostic errors with insufficient treatment or meniscal injury resulting in continued symptoms requiring revision surgery.²⁰⁻²⁴ Moreover, irreversible articular chondral injury, the most common complication after knee arthroscopy, is at higher risk of occurring in the setting of a tight medial compartment, accelerating degenerative changes in the knee.^{25,26} Controlled lengthening of the sMCL allows for improve visualization and instrument access, with the percutaneous pie-crusting method being the most commonly used technique.^{7,15,17,27,28} Initially introduced by Agneskirchner and Lobenhoffer¹³ for soft-tissue balancing during total knee arthroscopy, the percutaneous technique relies on visualization using the anterior-lateral portal.¹⁹ Advantages of the percutaneous release technique include release without compromising the synovial membrane, decreasing the risk of intra-articular septic complications,¹⁷ while avoiding intra-articular structures that may impede instrument insertion required during the inside-out approach used to lengthen the deep MCL.¹⁴

Percutaneous, outside-in lengthening is preferable when addressing the sMCL as a result of the MCL possessing an extra-articular course around the knee.¹⁷ This technique involves perforating the sMCL near the posteromedial compartment with a hypodermic needle during arthroscopy.¹⁴ The biomechanical studies by Gardiner et al.^{10,29} showed that the posterior MCL,

Table 1. Overview of Studies Included in Review

| Study | Journal (Year) | LOE | No. of Patients | Age, Mean \pm SD (Range), yr | Sex, n | Procedure, n | Lengthening Location | Needle Gauge | Postoperative Brace Use (Duration, wk) | Final Follow-Up, Mean (Range), mo | Valgus Laxity, Mean* | Outcomes, Mean \pm SD | Complications |
|------------------------------|--|-----|-----------------|--------------------------------|----------------|--------------------------------|--|--------------|--|-----------------------------------|--|--|---------------|
| Lons et al. ¹⁸ | Orthop Traumatol Surg Res (2018) | IV | 40 | 39 \pm 9 (20-54) | M, 33 F, 7 | Repair, 7 Meniscectomy, 33 | Submeniscal, posterior two-thirds | NR | No | 1.5 | +1.1 \pm 1.1 mm joint height +0.9° \pm 1° opening | NR | None |
| Claret et al. ¹⁷ | Knee (2016) | IV | 70 | 44 (19-62) | M, 44 F, 26 | Meniscectomy, 70 | Synovial-meniscal junction of posterior horn | 20 | No | 6 | None | Lysholm score, 92 \pm 4 Tegner score, 4 VAS score with activity, 1 VAS score at rest, 1 | None |
| Fakioglu et al. ⁷ | Knee Surg Sports Traumatol Arthrosc (2013) | IV | 18 | 43 (22-59) | NR | Meniscectomy, 18 | Posterior third, proximal to medial meniscus | 16 | Yes (4) | 8.3 (6-12) | +0.1 mm joint height | Lysholm score, 94 | None |
| Jeon et al. ¹⁹ | Knee Surg Sports Traumatol Arthrosc (2018) | IV | 64 | 40.9 \pm 12.5 | M, 41 F, 23 | Repair, 39 Meniscectomy, 25 | Posterior third, proximal to medial meniscus | 19 | Yes (4) | 24 | 0 mm joint height -0.3° opening | Lysholm score, 85.1 \pm 17.2 IKDC score, 82.4 \pm 19.3 VAS score, 1.1 | None |

F, female; IKDC, International Knee Documentation Committee; LOE, level of evidence; M, male; NR, not recorded; SD, standard deviation; VAS, visual analog scale score.

*Measured on valgus stress testing at final follow-up and compared with preoperative stress radiograph values.

proximal to the knee joint line, receives the highest strains with the knee in extension during an applied valgus load. In contrast, the cadaveric biomechanical study by Mihalko et al.,³⁰ comparing lengthening of the anterior half of the medial soft-tissue sleeve versus lengthening of the posterior half, reported improvement in medial joint space opening in knee flexion with anterior release. However, only 5 cadaveric specimens were used in each treatment group. All studies in our review reported lengthening along the posterior third of the MCL, warranting further study clinically evaluating the ideal location of sMCL lengthening to allow for adequate joint space opening while minimizing complications.

Release of the deep MCL has been less frequently reported. Park et al.²⁷ reported using an inside-out technique to release the posterior aspect of the deep MCL to achieve adequate visualization of the posterior-horn footprint, allowing the proper working space required for posterior meniscal root repairs. This involves multiple needle punctures through the anteromedial portal under direct visualization of the posterior aspect of the ligament.¹⁵ Park et al. advocated deep MCL release because they concluded that preservation of the sMCL is essential to avoid medial instability postoperatively; however, no further justification for sMCL preservation was provided. Meanwhile, Li et al.⁶ reported that release of the deep MCL added minimal to no discomfort postoperatively without increased MCL excursion or valgus knee laxity postoperatively. In addition, Todor et al.¹⁴ indicated that the deep MCL stores most of the tension in the MCL and, as such, represents the proper structure to release tension. However, several biomechanical studies have identified the sMCL as the primary stabilizer against valgus forces,^{11,12,31} reported to supply 50% to 80% of the resistance to valgus stress on the knee.¹¹ As such, although lengthening of the sMCL is more commonly reported, further studies comparing release of the sMCL and deep MCL regarding postoperative outcomes and complications are necessary to determine the optimal lengthening technique.

Lengthening of the sMCL has also been reported via subperiosteal stripping to release the distal attachment of the sMCL. Chung et al.¹⁶ evaluated 118 patients undergoing medial meniscal repair treated with postoperative bracing with a mean follow-up period of 42.4 ± 19.3 months. They reported no intraoperative complications, whereas pain at the sMCL area was reported in 18% of patients (21 of 118) at 3 months and 7% of patients (8 of 118) at 6 months, with no patients reporting pain by 12 months or at final follow-up. Meanwhile, despite postoperative bracing for 6 weeks after surgery, 12% of patients possessed grade I laxity ($\leq 5^\circ$ of valgus) at 30° of flexion by 3 months postoperatively; 8%, by 6 months; and 7%, by 12 months. Although periosteal stripping represents a more

invasive procedure, reflective of the increased duration of postoperative pain and laxity, further studies comparing the results of these techniques at mid- and long-term follow-up are needed.

No consensus currently exists on the necessity of postoperative bracing after arthroscopic meniscal repair or meniscectomy with concomitant sMCL release. Authors have reported that bracing in the setting of grade I or II MCL laxity is not necessary to prevent destabilization of the knee in the postoperative period.^{17,18} Meanwhile, Fakioglu et al.⁷ reported bracing postoperatively for ethical purposes given the lack of evidence regarding postoperative bracing, speculating that the use of the brace prevented objective instability in patients with grade I laxity. Meanwhile, Jeon et al.¹⁹ reported bracing as a prophylactic measure to prevent further injury to the MCL from valgus forces after lengthening. Although the MCL possesses an abundant vascular supply, allowing for good healing potential after injury,^{32,33} the impact of postoperative bracing on potential injury risk after sMCL lengthening remains unknown.

Despite no reported perioperative and postoperative complications, potential disadvantages of the percutaneous technique include injury to the saphenous nerve and vein.^{7,17,28} However, such injuries are rarely reported when proper lengthening is performed, given that the cadaveric study by Roussignol et al.²⁸ using 10 anatomic specimens found the saphenous nerve and vein to be remote from the percutaneous needle site in the medial knee. In addition, the reported degree of postoperative laxity was minimal, with no patient complaining of laxity requiring prolonged immobilization using a brace or evaluation for possible ligamentous rupture. Fakioglu et al.⁷ reported that compared with preoperative medial joint space width on valgus stress radiographs, mean laxity was significantly greater at 1 week (+2 mm) and 3 months (+0.9 mm) after surgery but decreased to 0.1 mm by 6 months. Although no statistical comparison regarding postoperative joint laxity based on the use of postoperative bracing could be performed, further study is required, especially concerning the sustained laxity reported after periosteal stripping.¹⁶

Limitations

This study is not without limitations. Because of the strict inclusion and exclusion criteria, only 4 articles were identified and included. The small sample size and inherent heterogeneity of reported data limited our ability to conduct any meaningful statistical analyses assessing differences in outcomes between studies using percutaneous sMCL lengthening. Moreover, the limited number of investigations examining alternative sMCL techniques limited any analyses on outcomes between techniques. Outcomes and complications related to sMCL lengthening after arthroscopic knee surgery

performed for the treatment of chondral, bony, or ligamentous injuries were not examined in this study, limiting the generalizability of our results only to patients undergoing arthroscopic treatment for medial meniscal pathology.

Conclusions

The percutaneous pie-crusting technique remains the most commonly reported technique to lengthen the SMCL during arthroscopic meniscal surgery. Percutaneous lengthening represents a safe and effective method of increasing medial joint space visualization, with no reported perioperative or postoperative complications and with minimal, likely clinically insignificant residual joint laxity after surgery on valgus stress testing at final follow-up compared with preoperative values.

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