



# Medial collateral ligament release during knee arthroscopy: key concepts

Vicente Carlos da Silva Campos<sup>1</sup>

Francisco Guerra Pinto<sup>2</sup>

Diogo Constantino<sup>1</sup>

Renato Andrade<sup>3-5</sup>

João Espregueira-Mendes<sup>3,4,6-8</sup>

- Complete access to the posterior medial compartment of the knee may represent a technical challenge during arthroscopy in patients with a tight tibiofemoral joint space.
- Medial collateral release reduces direct iatrogenic cartilage damage in the medial compartment of the knee through manipulation with instruments.
- We recommend performing medial collateral release in surgeries that access the posteromedial compartment (e.g. partial meniscectomy for ruptures of the posterior horn of medial meniscus or posterior root repairs) when the patient has a tight tibiofemoral joint space.
- There are two main techniques to perform medial collateral release: inside-out and outside-in. Regardless of the technique used, releasing medial ligament structures is a safe and effective method to be used in the diagnosis and treatment of injuries to the medial compartment.

**Keywords:** Medial Collateral Ligament; knee arthroscopy; pie-crusting

Cite this article: *EFORT Open Rev* 2021;6:669-675.

DOI: 10.1302/2058-5241.6.200128

## Introduction

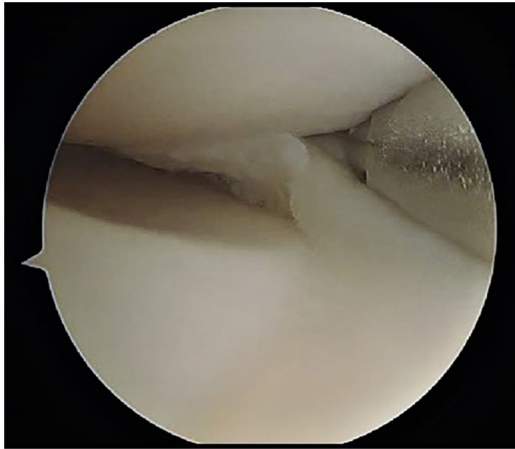
Arthroscopy of the knee is among the most common surgical procedures performed by orthopaedic surgeons.<sup>1</sup> Basic knee arthroscopy includes proper visualization of the eight regions the knee.<sup>2</sup> However, accessing the posteromedial compartment may represent a technical challenge during arthroscopy in patients with a tight tibiofemoral joint space (Fig. 1). In fact, the posterior horn of the medial meniscus is one of the most difficult areas for knee arthroscopy to access. The posteromedial compartment is reported to be the one of the greatest sources of diagnostic errors in knee arthroscopy.<sup>3-7</sup>



**Fig. 1** Tight medial tibiofemoral joint space.

In cases of inadequate opening in the medial joint space, manipulation with instruments might cause iatrogenic chondral damage (Fig. 2). Iatrogenic chondral injuries may occur directly when using surgical instruments, or indirectly due to inadequate treatment of meniscal injuries. The iatrogenic chondral damage – also known as ‘arthroscape’ – is the most common complication. An analysis of 3714 arthroscopic procedures showed a 2% prevalence rate of iatrogenic chondral lesions.<sup>8</sup> These ‘minor’ cartilage injuries might result in chondrocyte death and contribute to early degenerative changes due to the limited healing capacity of cartilage tissue.<sup>9</sup> As orthopaedic surgeons and medical doctors, we have to always bear in mind our oath to *primum non nocere*. A recent editorial has made a call to action for arthroscopic and related surgeons to develop techniques and instruments to prevent *iatrogenesis imperfecta*.<sup>10</sup>

The application of an external rotation and valgus force to the knee helps to expose the medial compartment during knee arthroscopy, but it is important to consider the



**Fig. 2** Difficult manipulation of instruments may lead to chondral damage.

potential risk of medial collateral ligament (MCL) rupture or avulsion fracture in the femur.<sup>11</sup> The use of a joint distractor, intraarticular release of the medial capsule and medial collateral ligament<sup>4,12</sup> or use of inframeniscal<sup>13,14</sup> portals have been suggested in an attempt to improve visualization of the medial compartment. However, technical difficulties, associated morbidity and lack of reproducibility hinder their use in everyday practice.

In the early 2000s, Agneskirchner and Lobenhoffer described a minimally invasive inside-out technique to open the medial compartment through repeated percutaneous puncture of the capsuloligament structures of the posteromedial region using an intramuscular needle.<sup>15,16</sup> In the following years, other authors have described similar methods with minor modifications.

Variants of the method traditionally described include inside-out techniques through the anteromedial portal and elongation of the superficial MCL (sMCL) deep beam, liberation of the sMCL superficial beam using an open approach with subperiosteal removal and outside-in pie-crusting percutaneous techniques.<sup>17–22</sup> The most frequent concerns in medial collateral release are the iatrogenic rupture of the MCL, saphenous nerve or vascular injury, residual instability and postoperative pain.<sup>21</sup>

The prevalence of this surgical gesture has not yet been defined in the literature. In our centre we use the pie-crusting technique in almost half of all arthroscopies for partial meniscectomy of the medial meniscus. When dealing with medial meniscus posterior horn suture or root refixation we routinely perform the pie-crusting technique. When these techniques are associated with anterior cruciate ligament reconstruction, we hardly ever need to release the MCL.

The purpose of this review is to recall some useful basic science and clinical data that might encourage other

surgeons to embrace this technical gesture as a routine in their surgical practice.

## Anatomy

There are three static ligament stabilizing structures of the medial region of the knee that are relevant for the MCL release technique: the sMCL, the deep MCL (dMCL) and the posterior oblique ligament (POL).<sup>23,24</sup>

### *The superficial medial collateral ligament (sMCL)*

The sMCL is the largest structure over the medial region of the knee, with a length of 10 to 12 cm. The femoral insertion is rounded-shaped and is located at approximately 3.2 mm proximal and 4.8 mm posteriorly to the medial epicondyle. There are two tibial insertions, one proximal and one distal. The proximal portion is fixed on the anterior region of the semimembranosus muscle without a proper bone insertion close to the tibial plateau. The distal bundle has a wide base and its insertion is located immediately anterior to the posteromedial crest of the tibia, posterior and deeper to the pes anserinus involved in its bursa.<sup>23</sup> The sMCL is the primary stabilizer for valgus stress, especially the proximal portion, in knee flexion. The distal division of the sMCL contributes most importantly as a secondary stabilizer of the external tibial rotation.<sup>24,25</sup>

### *The deep medial collateral ligament (dMCL)*

The dMCL represents an important thickening of the joint capsule with bundles parallel to the anterior portion of the sMCL. The dMCL is divided into the menisiofemoral and menisiotibial ligaments. The menisiofemoral ligament has a deeper and more distal insertion in relation to the sMCL femoral insertion, with its distal extension to the medial meniscus. The menisiotibial ligament is shorter and thicker, and inserts immediately distal to the edge of the articular cartilage in the tibial plateau.<sup>23</sup> The dMCL contributes not only as a secondary stabilizer of stress in valgus, but also as a stabilizer in the internal rotation between knee extension and 90 degrees of knee flexion.<sup>24,25</sup>

### *The posterior oblique ligament (POL)*

The POL consists of three main elements: superficial, central (tibial) and capsular. The femoral insertion of the ligament is joined by the different bundles, 7.7 mm distally and 6.4 mm posteriorly to the adductor tubercle. The superficial portion is a thin fascial expansion that wraps proximally around the anterior portion of the semimembranosus and continues with the central portion of the ligament. The central component, the most significant structure of the ligament, has a posterior obliquity direction relative to the fibres of the sMCL. It is closely related to the posteromedial portion of the medial meniscus and

the meniscotibial portion of the posteromedial capsule. The capsular division represents a fascial expansion of the distal semimembranosus in its anterior portion and in close relation to the meniscofemoral ligament of the posteromedial capsule, oblique popliteal ligament and to the proximal edge of the medial gastrocnemius.<sup>23</sup> The POL stabilizes the internal rotation of the tibia in extension and secondarily contributes to static resistance to stress in valgus.<sup>24,25</sup>

## Surgical techniques

Several techniques have been described with the aim to increase the intraarticular space of the medial compartment during knee arthroscopy, allowing a better visualization and manipulation of the surgical instruments. Pie-crusting of the MCL is especially relevant when treating tears of the posterior horn of the medial meniscus. A contraindication for this procedure is an acute injury of the MCL.<sup>26</sup>

The valgus stress and external tibial rotation manoeuvre is well established as a non-invasive measure to increase the space in the compartment.<sup>27</sup> This manoeuvre must be performed primarily in the evaluation of the compartment and, subsequently, concomitantly with the MCL release technique to increase intraarticular space. Regardless of the technique chosen, it is paramount to continuously apply this manoeuvre to stretch the medial ligament structures.

The surgical techniques described all have the same goal but vary in the execution method (either inside-out or outside-in), in the released structure (sMCL, dMCL or POL) and in the surgical instrument employed to perform the release (18-G needle, banana blade, electrocautery hook device or microfracture awl).

### Inside-out

Several authors advocate the use of an inside-out technique to release the dMCL.<sup>17,26,28</sup> Atoun et al<sup>17</sup> described an arthroscopic transportal dMCL pie-crusting release, in the transition region between the body and the posterior horn of the internal meniscus. Inspection is performed with the arthroscope through the anterolateral portal and the dMCL is sequentially punctured with an 18 mm needle through the anteromedial portal. The release begins from posterior to anterior, under direct visualization, immediately proximal to the meniscus junction.

Javidan et al<sup>26</sup> suggest that the dMCL release is performed under direct visualization, but with the arthroscope introduced into the anteromedial portal at the time of the surgical gesture. A blade (banana blade) with a protection guide is introduced through the anterolateral portal for a submeniscal release of the dMCL and

meniscocapsular ligaments. The release is usually done in the posterior third of the medial meniscus. The technique includes a movement of repeated perforations (with the blade in a horizontal position) of the dMCL and meniscocapsular ligaments, in which a sound is often audible accompanying the structure release and the consequent increase in the joint working space.

Bert<sup>28</sup> describes a technique that is similar to the one previously described. He uses an electrocautery hook device to perform the dMCL and meniscocapsular ligaments release. The releasing procedure starts 7 to 8 mm superior to the meniscal wall of anterior to posterior movement. The microfracture puncture in the lower region of the meniscus at the meniscocapsular junction is suggested as well.

### Outside-in

The outside-in technique remains the method most widely used to release ligament structures with the purpose of increasing the medial tibiofemoral space during knee arthroscopy.<sup>12,16,18–22,29–33</sup>

The use of 16 or 18 G needles is agreed on as the instrument to perform the release, but the released structures and location of the pie-crusting differ according to author (Fig. 3).

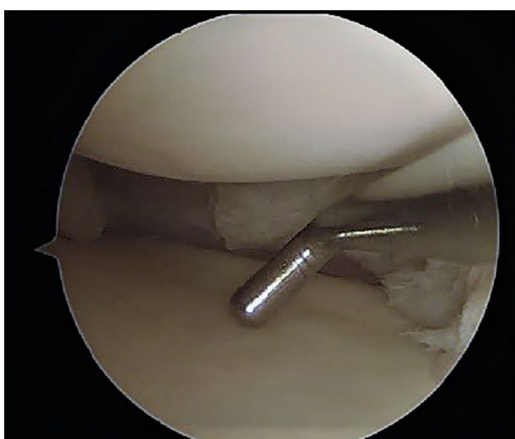
Most authors argue that after establishing the portals and inspecting the different compartments, the palpation hook should be placed vertically in the compartment to check whether there is free access to the posteromedial region of the knee. The perpendicular portion of the hook is often 5 mm. Some authors consider that if the opening is less than that measurement, the MCL release technique



**Fig. 3** Outside view of the landmarks to identify the location for the release of the medial collateral ligament.



**Fig. 4** Measurement of medial compartment opening with the hook before the release.



**Fig. 5** Measurement of medial compartment opening with the hook after the release.

should be performed if gestures in the medial compartment are expected (Fig. 4, Fig. 5).<sup>31</sup> The use of transillumination with the arthroscope in the medial region is useful to identify the saphenous vein and saphenous nerve at the time of skin puncture.<sup>22</sup>

Regarding the structures and location of the release, most authors advocate the release of the POL and/or the posterior third of the sMCL at the level of the joint line.<sup>16,20–22,29,32,34</sup> Other authors suggest the release of the dMCL using an outside-in technique.<sup>18,19,31,32</sup> The needle is inserted into the posteromedial region through single or multiple skin punctures. Moran et al<sup>29</sup> suggest the percutaneous release is 1.5 cm posterior and slightly distal to the medial epicondyle. The MCL release is accomplished with in-out punctures every 2 mm (covering the width of the MCL) and should be perpendicular to MCL fibres. Occasionally, the intraarticular visualization of the needle tip entry is noticed through the anterolateral portal.

A ‘popping’ sound is often audible when the ligament structures subside.

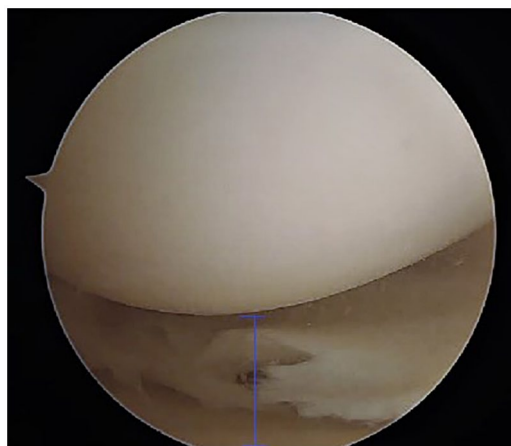
Chung et al<sup>30</sup> describe an alternative technique for MCL release that uses periosteal elevation of the distal insertion of the sMCL. Through a 3 cm incision in the anteromedial region of the proximal tibia, they perform a subperiosteal release that is distal to the insertion of the pes anserinus. A posterior and inferior dissection movement is employed to preserve the proximal insertion of the sMCL, dMCL and POL.

## Outcomes

The outcomes of the medial release techniques are related with their intended outcome (medial joint space opening), the potential complications (saphenous vein injury) and residual morbidity (pain and joint instability) that may emerge due to the MCL release. There are no studies directly comparing the outcomes of inside-out and outside-in techniques.

### Medial joint space opening

The quantification of the opening in the medial compartment of the knee after releasing the knee ligament structures is a crucial parameter because it is the main goal of this surgical gesture (Fig. 6). Cadaveric studies have reported the amount of opening after releasing the MCL. Roussignol et al<sup>35</sup> used arthroscopy to measure the increase in the articular space of the medial compartment after sequential release of the MCL from anterior to posterior. The compartment opened by 1 mm after the release of the anterior third, 2.3 mm after releasing of the anterior two-thirds, and 3.9 mm after subtotal release. Claret-García et al<sup>36</sup> using ultrasound assessment, also reported an increase of 2.9 mm medial tibiofemoral space after dMCL pie-crusting.



**Fig. 6** Medial joint space opening after medial collateral release.

There are some clinical studies that measured the medial space joint opening while performing medial release. In a retrospective study of 60 patients, the release of the posterior third of the sMCL and POL resulted in an average increase from 2.5 mm to 5.7 mm in the height of the internal compartment space, as measured arthroscopically. The radiographic tibiofemoral medial space opening under knee valgus stress was, on average, 5.9 mm in the preoperative stage, 9.2 mm at the first postoperative week, and 6.1 mm at three months postoperatively.<sup>34</sup> Polat et al<sup>33</sup> prospectively measured the medial tibiofemoral space in a series of 18 patients. They reported an average height of the medial tibiofemoral space of 5 mm, 7.5 mm and 12.1 mm with the knee in a neutral position, with appliance of valgus stress at 30° and after pie-crusting of the MCL respectively. Zhu et al found the median medial joint space widths of the

affected side and the unaffected side for valgus stress radiographs were 6.8 mm and 4.3 mm on the first day, 5.5 mm and 4.2 mm in the fourth week, and 4.8 mm and 4.3 mm at the 12th week, respectively. Fakiaglou et al<sup>20</sup> stated the median medial joint space width on valgus stress radiographs was 7.1 mm preoperatively and 9.1 mm, 8.0 mm and 7.2 mm in the first week, and third and sixth months, respectively.

#### *Residual knee instability and pain*

There is a general concern about medial iatrogenic instability of the knee caused by the medial release. Most clinical studies report no significant residual laxity or subjective instability after knee arthroscopy with medial release (Table 1). Indeed, Li et al<sup>19</sup> report their experience of over two decades of percutaneous release of sMCL with no cases of clinically medial instability.

**Table 1.** Residual knee joint laxity and/or instability after medial release during knee arthroscopy for meniscal surgery

Reference	N	Released structure	Technique	Follow-up	Residual laxity / instability	Residual pain
Claret et al <sup>21</sup>	70	Posterior region of the MCL	Outside-in	6 months	None presented clinical subjective instability by valgus tests at 0° and 30°.	28 patients reported mild pain at the medial needle tract lasting for 15 days.
Fakiaglou et al <sup>20</sup>	18	Posterior third of the sMCL	Outside-in	6 months	No significant difference in radiographic joint space width (under valgus stress) between the preoperative and follow-up (7.1 mm vs 7.2 mm). Clinical valgus stress with the knee in 30 degrees of flexion showed a < 5 mm opening (compared with the contralateral) with a firm end point on the medial side (Grade I injury) in all patients, which recovered in an average of 3.5 weeks.	All patients reported mild pain at the medial needle tract lasting for 15 days.
Jeon et al <sup>22</sup>	64	Posterior third of the MCL	Outside-in	24 months	No radiographic medial opening laxity as compared to preoperative state, either in absolute values (8.2° vs. 7.9°) or in side-by-side comparison (-0.1 mm vs. -0.1 mm).	No significant differences between MCL release and non-released groups in pain intensity.
Chung et al <sup>30</sup>	118	Distal release of the sMCL	Outside-in	12 months	8 patients (7%) showed grade I laxity valgus stress with the knee in 30° flexion, but none had subjective instability or laxity in valgus stress with the knee in full extension.	Pain in 18 (15%) and tenderness in 21 (18%) patients at 3 months; pain in 5 (4%) and tenderness in 8 (7%) patients at 6 months; no pain or tenderness after 12 months.
Javidan et al <sup>26</sup>	35	dMCL and meniscocapsular attachments	Inside-out	Non-reported	No case of chronic knee valgus laxity.	Non-reported
Lons et al <sup>32</sup>	40	sMCL	Outside-in	6 weeks	Average increase of 1 degrees and 1 mm of medial opening under valgus stress, but without feeling of instability.	Non-reported
Polat et al <sup>33</sup>	18	Posterior third of the MCL	Outside-in	8.9 months (range, 6–12)	2 patients (11%) showed grade I laxity valgus stress with the knee in 30° flexion, but none had subjective instability.	No pain or tenderness over the MCL.
Han et al <sup>34</sup>	60	Posterior third of the MCL	Outside-in	22 months	No cases of residual knee laxity	Pain improved from 5.57 to 1.80 points in VAS score, from baseline to last follow-up. No specific pain intensity report related to the pie-crusting technique.

Note. MCL, medial collateral ligament; sMCL, superficial medial collateral ligament; dMCL, deep medial collateral ligament; VAS, visual analogue scale.

Postoperative pain over the MCL is also an often-cited concern when performing medial pie-crusting. Indeed, there seems to exist some mild pain or tenderness over the MCL in the short-term follow up (two weeks to three months), but that completely resolves at the long-term follow-up (Table 1). Atoun et al<sup>17</sup> suggested that their dMCL release using the inside-out technique may cause less pain than outside-in pie crusting.

#### *Saphenous neurovascular injury*

Injury to the saphenous nerve and vein is one of the potential risks when performing medial pie-crusting. The most frequent location of the saphenous vein is about 1.7 cm behind the posterior limit of the sMCL.<sup>35</sup> The authors of the inside-out techniques argue that, by using this technique, this neurovascular injury is virtually impossible. The outside-in technique has a theoretically increased risk of saphenous nerve injury because this nervous structure can be severed as the needle courses on its way to the dMCL.

Despite the theoretical risk of injury to the neurovascular structures, there is no documentation of this complication by the various authors who use a pie-crusting technique.<sup>19,21,22,29,32–34</sup> The use of transillumination with the arthroscope at the time of cutaneous puncture is crucial to prevent damaging these neurovascular structures and it should be performed 1 cm above the posterior half at the level of the joint line.<sup>34</sup>

#### *Postoperative bracing*

There is no consensus as to whether patients should use postoperative immobilization or duration of the bracing in cases of release of the medial structures of the knee arthroscopy. Different authors used postoperative immobilization for two to six weeks as a prophylactic measure, reporting concern about the potential further damage of the MCL injury.<sup>20,22,30,33,34</sup>

The scientific literature is still scarce on this topic, and there are few studies that compare MCL healing after pie-crusting during arthroscopy between those patients who used or did not use postoperative mobilization. However, it has been demonstrated that immobilization is not necessary for the healing of the MCL ligament in the postoperative period after performing outside-in pie-crusting, with no further complications in the patients who did not use postoperative bracing.<sup>19,21,22,32</sup>

Lyu<sup>37</sup> reported that even with extensive arthroscopic medial release for medial compartment osteoarthritis of the knee there were no complications of instability without postoperative immobilization. Even in the event of iatrogenic MCL lesions associated with a valgus force applied during arthroscopy, Jung et al<sup>38</sup> showed that there is no need for specific postoperative immobilization

with excellent healing rates at six weeks postoperatively without long-term repercussions.

## Conclusion

Regardless of the technique used, releasing medial ligament structures during knee arthroscopy has well-documented advantages with minimal associated risks in the diagnosis and treatment of injuries to the medial compartment. Its use should be part of surgeons' daily practice when performing knee arthroscopy of the posteromedial compartment in the presence of a tight medial compartment. The use of postoperative immobilization after medial pie-crusting is still not well established, but the evidence suggests that not using bracing does not impair MCL healing or increase the risk of postoperative complications.

#### AUTHOR INFORMATION

<sup>1</sup>Hospital Curry Cabral, Lisboa, Portugal.

<sup>2</sup>Hospital Ortopédico de Sant'Ana, Hospital Cruz Vermelha Portuguesa, Universidad de Barcelona, Nova Medical School, Lisboa, Portugal.

<sup>3</sup>Clínica Do Dragão, Espregueira-Mendes Sports Centre – FIFA Medical Centre of Excellence, Porto, Portugal.

<sup>4</sup>Dom Henrique Research Centre, Porto, Portugal.

<sup>5</sup>Porto Biomechanics Laboratory (LABIOMEPE), Faculty of Sports, University of Porto, Porto, Portugal.

<sup>6</sup>ICVS/3Bs, PT Government Associate Laboratory, Braga/Guimarães, Portugal.

<sup>7</sup>3B's Research Group – Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, Barco, Guimarães, Portugal.

<sup>8</sup>School of Medicine, Minho University, Braga, Portugal.

Correspondence should be sent to: Vicente Carlos da Silva Campos, Serviço de Ortopedia – Hospital Curry Cabral – Centro Hospitalar Lisboa Central, Rua da Beneficência N° 8, 1050-099 Lisboa, Portugal.  
Email: vicentescampos@gmail.com

#### ICMJE CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest relevant to this work.

#### FUNDING STATEMENT

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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