Results of a New Treatment Concept for Concomitant Lesion of Medial Collateral Ligament in Patients with Rupture of Anterior Cruciate Ligament

Fabian Blanke, MD[1] Jochen Paul, MD[2] Maximilian Haenle, MD[1] Jannes Sailer, MD[3] Geert Pagenstert, MD[3] Lutz von Wehren, MD[4] Stephan Vogt, MD[1] Martin Majewski, MD, MBA[4]

[1] Department of Orthopaedic Sports Medicine and Arthroscopic Surgery, Hessing Stiftung Augsburg, Augsburg, Germany
[2] Department of Orthopaedic Sports Medicine and Arthroscopic Surgery, Rennbahnklinik Muttenz, Basel, Germany
[3] Department of Orthopaedic Surgery, University Hospital Basel, Basel, Switzerland
[4] Department of Orthopaedic Surgery, Hospital Oberengadin, Samedan, Switzerland

Address for correspondence Fabian Blanke, MD, Department of Orthopaedic Sports Medicine and Arthroscopic Surgery, Hessing Stiftung Augsburg, Hessingstraße 17, Augsburg 86199, Germany (e-mail: Fabian.Blanke@hessing-stiftung.de).

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Abstract

Anteromedial knee injury with rupture of anterior cruciate ligament (ACL) and concomitant lesion of medial collateral ligament (MCL) is common in athletes. No standardized treatment concept can be found within the literature. This study presents results of a new treatment concept for concomitant MCL lesions in patients with ACL rupture. In this study, 67 recreational athletes with ACL injury and concomitant MCL lesion were treated according to a distinct treatment concept. Patients were classified in six different types of concomitant MCL lesion depending on grade of MCL lesion and presence of anteromedial rotatory instability (AMRI). Final classification and surgical indication were determined 6 weeks posttraumatic. All patients received ACL reconstruction. MCL was treated by surgical or conservative regime due to type of concomitant MCL lesion. International Knee Documentation Committee (IKDC), AMRI, and Lysholm scores were evaluated both preoperatively and after 6 weeks, 16 weeks, 12 months, and 18 months postoperatively. All patients could be uniquely classified and treated according to the introduced treatment concept. AMRI was verifiable in patients with grade II and III MCL lesions. All patients showed good to excellent clinical results at the follow-up examinations. In all 67 patients (100%), the findings were graded as normal or nearly normal according to the IKDC knee examination form. Lysholm score averaged 93.9 at final follow-up. The introduced treatment concept showed good results on short-term outcome and provides a sufficient treatment strategy for concomitant MCL lesions in athletes with ACL rupture.

Keywords
- anterior cruciate ligament
- medial collateral ligament
- AMRI
- treatment concept

The medial collateral ligament (MCL) and the anterior cruciate ligament (ACL) are the most commonly injured ligaments of the knee.[1] Anteromedial knee injury with a rupture of the ACL and concomitant lesion of the MCL is common, especially in athletes. While surgical treatment of an ACL injury is well established to allow individuals to return to demanding activities, the treatment of concomitant MCL lesions is discussed controversially in the literature.[2–4] Conservative

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treatment of concomitant grade I MCL injuries is generally advised.[2,5] However, the treatment regime of concomitant grade II and III MCL lesions is inconsistent with different treatment strategies.[1–3,6] Currently, standardized diagnostics and treatment guidance for concomitant MCL lesions do not exist in the literature.[2,6] Inadequate treatment of concomitant MCL injury can, however, lead to a persistent instability.[4,5,7,8] Therefore, treatment guidance with other clinical parameters which could help in treatment decision is required. Furthermore, anteromedial rotatory instability (AMRI) is a frequent complication in combined ACL/MCL injuries with an increasing incidence according to the degree of MCL lesion and reflects the severity of instability.[2,5] The value of AMRI in the treatment decision of concomitant MCL lesions nevertheless is still uncertain. However, the presence of AMRI might be an important factor in decision making for or against surgical treatment. In this article, it was hypothesized that AMRI is the crucial clinical factor to differentiate between surgical and nonsurgical treatment of concomitant MCL lesions. Therefore, a new treatment concept for concomitant MCL lesions with a special focus of AMRI was evaluated retrospectively to develop an injury classification and treatment algorithm.

Materials and Methods

A total of 67 recreational athletes who sustained an acute ACL rupture and a concomitant MCL lesion were investigated retrospectively. Patients with nonoperatively treated ACL injury, osteoarthritis (Kellgren-Lawrence grade >2), concomitant meniscal or chondral lesion, history of other knee injuries or of surgical treatment of lower extremity, and patients with general diseases (e.g., rheumatoid arthritis) were excluded from the study. These 67 patients included 32 men and 35 women with a median age of 39 years (range: 19–66 years) at the time of surgery. All causes of injury were sports-related injuries. Types of sports included alpine skiing, ice hockey, cross country skiing, and soccer. All patients underwent a specific diagnostic workup with a diagnosis of the degree of MCL lesion and presence or absence of AMRI. In addition to a single-bundle ACL reconstruction, conservative or surgical treatment of the MCL (described later) was performed according to a distinct treatment concept. Indications were determined 6 weeks after the initial injury and a period of rehabilitation. All surgeries were performed by senior surgeons and the same protocol was used for the postoperative rehabilitation. All patients were followed up with detailed data collection after 6 weeks, 3 months, 1 year, and 1.5 years postoperative. Descriptive statistics were used to display the postoperative outcome results. This retrospective study has been approved by the Institutional Review Board (University Hospital Basel, Switzerland, ID 191/11) before commencement.

Clinical Evaluation

Preoperative and in the follow-up visits, all patients underwent an examination with the valgus stress test, Lachman test, Slocum drawer test, valgus stress test in full extension, pivot shift test, and range-of-motion (ROM) assessment; in addition, the International Knee Documentation Committee (IKDC) scores and AMRI were evaluated. Valgus stress testing and the classification of the degree of MCL lesion were done according to Fetto and Marshall.[5] Fetto and Marshall defined their grade I injuries as those without valgus laxity in both 0 and 30 degrees of flexion, grade II injuries as those with a valgus laxity in 30 degrees of flexion but stable in 0 degrees of flexion, and grade III as those with a valgus laxity in both 0 and 30 degrees of flexion. A positive Slocum drawer test was detected by performing the anterior-drawer test while holding the tibia in external rotation. A positive Slocum drawer test, any evidence of anterior subluxation of the medial tibial plateau during the valgus stress test with the knee in 30 degrees of flexion, or an increasing medial instability under valgus stress in full extension indicated the presence of AMRI. The valgus stress test with the knee in 30 degrees of flexion was performed with the examiner's hand on the anterior border of the tibia plateau. Anterior movement of the tibia plateau while applying valgus stress to the knee indicated AMRI. Valgus stress test in full extension was used because the ACL acts as an important valgus stabilizer in full extension. An increasing medial instability in full extension clearly stands for complete rupture of the medial sided structures with combined rupture of the ACL and consequently the presence of AMRI. Concerning the overall evaluation of the knee, the IKDC evaluation form and the Lysholm-Knee scoring scale were used to evaluate the postoperative knee function such as symptoms, stability, and functional changes in sports and daily activities.

Treatment Concept

The patients were classified in six different types of concomitant MCL lesion depending on the degree of MCL lesion and the presence or absence of AMRI. According to the degree of MCL lesion, patients were primarily divided into injury types I to III. Depending on the presence of AMRI, these types were subclassified in A-type lesion (AMRI absent) or b-type lesion (AMRI present). After 6 weeks, a final examination with the conclusive definition of injury type was performed and the surgical indications for the MCL were determined. All patients received an ACL reconstruction afterward. In patients with a MCL injury types Ia, IIa, and IIIa, the MCL lesion was treated conservatively. In patients with a presence of AMRI (injury types Ib, IIb, and IIIb), the concomitant MCL lesion was treated operatively.

Surgical Procedure

All patients in this study received an ACL reconstruction (semitendinosus tendon autograft). In patients with a MCL injury types Ib, IIb, and IIIb, a surgical treatment of the MCL was additionally performed in a standardized technique. After the knee was examined under general anesthesia, a routine diagnostic arthroscopic procedure was performed through an anterolateral portal with the tourniquet inflated to 300 mm Hg. Longitudinal incision was made over the pes anserinus with cranial extension to prepare the distal and medial part of the MCL as well as the semitendinosus tendon.

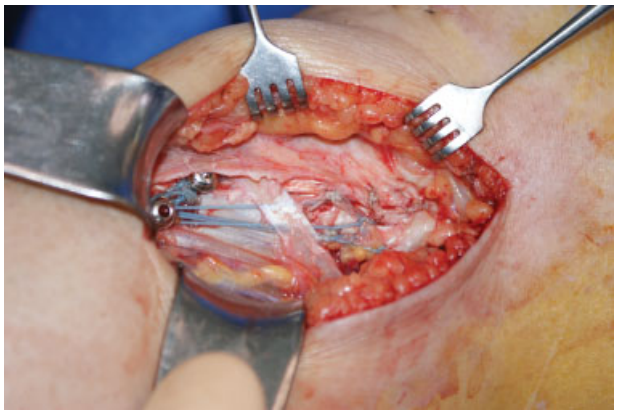

Fig. 1 Medial collateral ligament repair with fiber wire sutures and blocking screws.

The MCL was then detached distally and the tibial plateau was debrided with cortical microfracturing. Single-bundle ACL reconstruction was performed by anteromedial drilling for the femoral socket followed by tibial drilling. The tibial socket preparation was done by retrograde drilling (FlipCutter, Arthrex, Naples, FL). Femoral and tibial fixation was secured in Tight-Rope technique (ACL Tight Rope, Arthrex). After the ACL reconstruction, a subtle preparation of the MCL was performed and the distal part of the MCL was doubled and loaded with two fiber wire sutures in circumferential cross-stitch technique. Then the MCL was tensioned and pulled distally while continuous varus stress was applied to the ipsilateral knee joint. The MCL was reattached with one or two blocking screws within the foot print area and excessive ligamentous material was removed (►**Fig. 1**). Proximal avulsion fractures were treated by an additional screw fixation. Finally, the above layers were reconstructed to allow regular healing and prevent a consecutive tissue adhesion. The treatment of an injured posteromedial corner (PMC) was performed by posteromedial plication with a tensioning of the capsule in the anterior and proximal direction according to the technique described by Hughston.[3]

Nonsurgical Procedure

In Patients with a MCL injury types Ia, IIa, and IIIa, the concomitant MCL lesions were treated by a knee brace with weight bearing as tolerated and crutches for initial pain relief. The patient was allowed to start isometric and ROM exercises within flexion from 90 to 10 degrees (E/F: 0–10–90 degrees) immediately. After 2 weeks, the extension was unlimited and after 4 weeks unlimited flexion was approved. Crutches were discontinued when the patient was able to demonstrate a limp-free walk. Anti-inflammatory medication was prescribed for 14 days.

Table 1 Distribution of types of concomitant MCL lesion initially and after 6 weeks

Concomitant MCL lesion (type)	Posttraumatic ($n = 67$)	6 wk posttraumatic ($n = 67$)
Ia	24	31
Ib	0	0
IIa	11	9
IIb	15	12
IIIa	0	0
IIIb	17	15

Postoperative Care and Rehabilitation

For all patients, a compressive ice wrap was applied within the first 24 to 48 hours after surgery, to minimize swelling. All patients were allowed to have an active-assisted or passive mobilization allowing F/E 0–10–70 degrees of ROM 24 hours after surgery. During the first 4 weeks, weight bearing with 20 kg was permitted and the knee was protected with a knee brace allowing the aforementioned ROM. From 4 to 6 weeks, the patients were allowed to perform active ROM exercises and weight bearing was permitted within the patients' tolerance. After 6 weeks, mobilization with full ROM was allowed. After 3 months, the patients started progressive activities and were weaned off brace use gradually.

Results

All patients could be uniquely classified and treated according to the introduced treatment concept. Several patients showed a downgrading of the MCL lesion after 6 weeks compared with the posttraumatic situation (►**Table 1**). At the final classification after 6 weeks, none of the patients showed an injury type IIIa. Therefore, none of the patients with a MCL lesion type I showed AMRI, whereas all patients with type III MCL lesions had evidence of AMRI. These results led to the proposal of a definitive treatment algorithm for patients with an ACL/MCL injury (►**Fig. 2**).

Functional Results

The medial stability had distinctly improved at the 18-month follow-up with valgus instability grade A in 64 out of 67 patients (96%) and grade B in the remaining 3 patients (4%) according to IKDC. Seventeen patients (25%) showed grade C and 16 patients (24%) showed grade D valgus instability preoperatively. The incidence of AMRI could be reduced from 40% (27/67 patients) before therapy to 0% (0/67 patients) at the final follow-up examination (►**Tables 2** and **3**). At the final follow-up, all patients had no problems in activities of daily life with normal or nearly normal ROM (►**Table 2**). Sixty-two patients (93%) reached full ROM in flexion and extension equivalent to grade A according to the IKDC score. Four patients (6%) had persistent lack of up to 15-degree flexion compared with the opposite side and two patients (3%) showed a lack of 5-degree extension in the recent follow-up, whereas one patient had both flexion and extension deficiency after the treatment. All the 67 patients had returned to performing at a normal (grade A, 87%) or nearly normal (grade B, 13%) level of sports, whereas 66% of patients (44/67) showed grade C and 34% (23/67) grade D according to IKDC score preoperative (►**Table 2**). The median

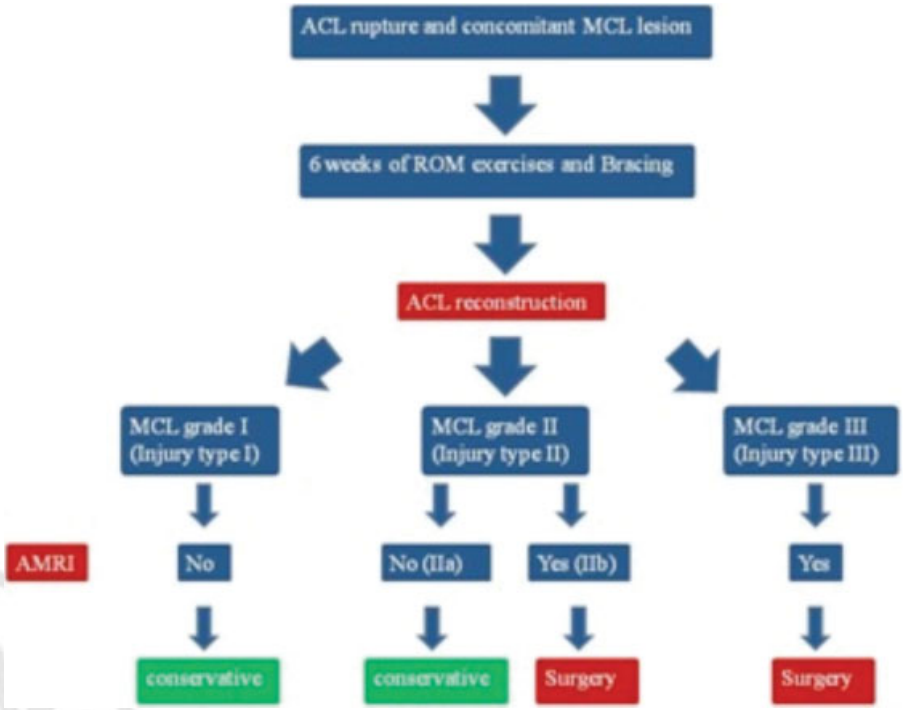

Fig. 2 Proposal of treatment algorithm for patients with anterior cruciate ligament (ACL)/medial collateral ligament (MCL) injury.

Lysholm score was 94 (85–100 points) after treatment. At the final follow-up, 61 of 67 patients (91%) had a negative or a Lachman grade A result and all patients (100%) had a negative pivot shift test and were graded as A according to the IKDC scores. Only six patients (9%) had Lachman grade B with firm endpoint in the recent follow-up examination. Occurrence of slight anteroposterior instability (Lachman grade B) was similar in patients with operative and nonoperatively treated MCL lesions (►**Table 4**). Preoperatively, 48 of 67 patients showed Lachman test grade C and 19 out of 67 patients showed grade D according to IKDC and all patients had positive pivot shift test. Seven patients showed wound complications in the clinical course. Four patients developed hypertrophic scar tissue and three patients prolonged wound secretion with abacterial inflammation. No infections or other complications were found at our recent follow-up. No revision surgery was needed up to date.

Discussion

The most important finding of this study was that AMRI seems to be a crucial factor for the decision between surgical and nonsurgical treatment of concomitant MCL lesions. Therefore, it should be considered in the treatment decision of ACL/MCL injuries. Especially in grade II MCL lesions, evaluation of AMRI could add important information. The presented treatment concept for concomitant MCL lesions could be proposed as an injury classification and a treatment algorithm, because it contains simple usage in clinical workup and is based on important clinical parameters as the grade of the MCL lesion and the presence of AMRI.

It was shown that AMRI happens when the medial sided structures are injured and the ACL is ruptured.[9,10] Currently, it is simply demonstrated that AMRI is a mandatory complication in an ACL rupture and complete MCL lesion with an insufficiency of the PMC.[11,12] However, there is no clinical data at which certain grade of a concomitant MCL lesion AMRI occurs and the role of AMRI in the treatment decision remains uncertain.[2,9,10] In our opinion, AMRI might be a clinical sign for a noncompensable medial injury. In patients with the presence of AMRI, a singular ACL reconstruction could be lacking in restoring stable knee joint kinematics. Therefore, AMRI might be a key factor to decide between a surgical and nonsurgical treatment of the concomitant MCL lesion. It is a

Table 2 Patients characteristics at final follow-up (median; range)

Concomitant MCL lesion	Valgus instability (IKDC grade A)	Anterior instability (IKDC grade A)	AMRI	Subjective score (IKDC grade A)	Lysholm score
Type I	100%	90%	0%	94%	95; (90–100)
Type II	95%	91%	0%	81%	94; (85–100)
Type III	87%	93%	0%	80%	90; (85–100)

Abbreviations: AMRI, anteromedial rotatory instability; IKDC, International Knee Documentation Committee; MCL, medial collateral ligament.

Table 3 Incidence of AMRI before treatment and at final follow-up

Concomitant MCL lesion		AMRI
Type I	Before treatment	0 (0%)
	After treatment	0 (0%)
Type II	Before treatment	12 (57%)
	After treatment	0 (0%)
Type III	Before treatment	15 (100%)
	After treatment	0 (0%)

Abbreviations: AMRI, anteromedial rotatory instability; MCL, medial collateral ligament.

well-known fact that the superficial layer of the MCL is the primary restraint to valgus forces and also plays a significant role in restraining external rotation.[9,13,14] Moreover, it was shown that AMRI is verifiable in patients when there is more than 15-mm opening of the medial joint space in 30-degree flexion independent of the stability in 0-degree flexion.[10] Therefore, AMRI might already be a possible complication in partial MCL lesions without complete rupture of the deep MCL (grade II according to Fetto and Marshall) but an involvement of the PMC. This is consistent with the results of this study. AMRI was verifiable in all patients with grade III MCL lesions and even in several patients with grade II lesions. Thus, the borderline between a surgical or nonsurgical treatment of MCL lesions in patients with an ACL rupture should be already set in grade II MCL lesions. The heterogeneity of the treatment results of concomitant MCL in the current literature might be due to the fact that the presence of AMRI was generally not considered. In our opinion, assessment of AMRI is crucial in combined ACL/MCL injuries and surgical treatment of concomitant MCL lesions should be performed when AMRI is present.

Treatment Strategies of Concomitant MCL Lesions in the Literature

The treatment of concomitant MCL lesions is evaluated in several studies in the literature.[7,15–27] There is a general agreement on the fact that an isolated lesion of the MCL heals satisfactorily without an operative intervention.[6] However, for concomitant MCL lesions, there is little consensus regarding a surgical or nonsurgical treatment regime.[2,5,6] The conservative treatment of a concomitant grade I MCL lesion seems appropriate, because of a limited injury to the medial structures and a preserved stability of the ligament. This was confirmed by several studies.[20,25,27] In contrast, the treatment strategies for concomitant grade II and III MCL lesions are nonuniform. In concomitant grade II MCL lesions, different results after a surgical and nonsurgical treatment were reported.[19,23,28] The treatment results of grade III MCL lesions are equally inconsistent and the treatment strategies differ. In a prospective trial, an increased valgus opening was found at the final follow-up after reconstruction of the ACL alone.[15] In contrast, other prospective trials reported excellent treatment results after an ACL reconstruction alone.[18,21] Excellent results at final follow-up were also shown after surgical treatment of both ACL and MCL in patients with ACL ruptures and grade III MCL lesions in another study.[22] The heterogeneity of all these results represents the existing problems in the management of concomitant MCL lesions in patients with an ACL rupture. The treatment decision for a concomitant MCL lesion is difficult and decision guidance does not exist. Therefore, AMRI could be a helpful parameter in these cases.

Grading of Isolated and Combined MCL Lesions

Furthermore, a crucial problem of most studies addressing MCL injuries is the inconsistent grading of the MCL lesions.[4,7,21,27,29–31] Existing classifications of MCL lesions are nonuniform and lead to a confusing injury specification with intermingling of the injury severity and the ligament laxity.[32,33] In several studies, the MCL lesion was graded by valgus stress test in 30-degree flexion alone and the extend of the instability was measured in millimeters.[18,22,34] If the MCL, however, was tested only in 20- to 30-degree flexion, a grade II lesion could be overestimated and hence classified in a grade III lesion. Therefore, the treatment results of several studies seem disputable and it remains unclear whether a nonsurgical treatment of grade III MCL lesions is sufficient. At present, the classifications of isolated MCL lesions are also used for concomitant MCL lesions in patients with ACL rupture. The authors of this study therefore prefer the classification of Fetto and Marshall because it documents the instability from loss of all medial-sided structures, with evaluation of MCL in 0- and 30-degree flexion, which may affect the treatment options.[5] To our believe in combined ACL/MCL injuries, this classification should be expanded with an assessment of AMRI as proposed in this study to detect the extent of the injury and find the appropriate treatment strategy.

Timing of Surgical Intervention in Combined ACL/MCL Injuries

The timing of ACL surgery in patients with a combined ACL–MCL injury remains controversial. Because of the fear of

Table 4 Outcome results at final follow-up of patients with operatively and nonoperatively treated MCL lesions (median; range)

Concomitant MCL lesion	Valgus instability (IKDC grade A)	Anterior instability (IKDC grade A)	AMRI	Subjective score (IKDC grade A)	Lysholm score
Nonoperative	100%	90%	0%	94%	94.5; (90–100)
Operative	89%	92%	0%	80%	92; (85–100)

Abbreviations: AMRI, anteromedial rotatory instability; IKDC, International Knee Documentation Committee; MCL, medial collateral ligament.

arthrofibrosis, there is an inherent recommendation of late ACL reconstruction in patients with an ACL/MCL injury.[2,3,23] Moreover, it was assumed that an instable MCL may affect the sufficient healing of the ACL reconstruction.[31,34,35] Thus, it was recommended to reconstruct the ACL after the complete healing of the MCL. However, there is also evidence that the ACL is acting as a secondary stabilizer of the valgus stability.[3,13,36] It is believed that an instability secondary to disruption of the ACL may reduce the quality of healing of the MCL, thus further increasing a valgus instability.[17,18,21,37] Therefore, an early reconstruction might be favorable to provide a nurturing environment for a faster MCL healing.[37,38] However, in this point, there is a vast disagreement in the literature because the risk of a postoperative stiffness after early ACL reconstruction is also well documented especially in combined ligament injuries.[2,23,24,29,39,40] Moreover, there is huge evidence that the MCL can heal spontaneously without an early reconstruction of the ACL.[2,15,21,24,26] As a consequence of these disagreements, an accepted treatment algorithm in the recent literature does not exist. The authors of this study suggest that the possibility of a conservative healing should be awaited. In the opinion of the authors, 6 weeks is an appropriate period to assess the healing process of the MCL. Moreover, it was shown in this study that spontaneous healing and downgrading of the MCL lesion is possible, as the number of the patients with a MCL lesion type IIB was reduced at the final classification after 6 weeks compared with the acute posttraumatic situation.

Surgical Treatment of Concomitant MCL Lesion

In this study, the surgical treatment of a concomitant MCL lesion was performed by strengthening and reattaching of the ligament. Because of the thickness and collagenous microstructure of the MCL, endogenous scar tissue enables a sufficient re-tensioning 6 weeks posttraumatic and a tendon augmentation is not necessary. Moreover, the location of the MCL lesion is not important with this surgical technique. A repair of the PMC was additionally performed in a technique according to Hughston[3] to restore the rotational stability. Treatment consisting of this surgical technique and according to the introduced treatment algorithm led to a normal or nearly normal (grade A or B) ligament stability and subjective scores according to IKDC in all patients. It should be mentioned that these results are in contrast to other studies which reported poorer results after a MCL/PMC repair.[11,12,41–43] However, most patients in these studies had suffered from a multiligament or chronic ligament injury which indicates a more severe and complex knee injury.[11,12] In these patients, a MCL/PMC reconstruction with auto-/allograft might be more sufficient.

This study contains several limitations. The patient population is small and the analysis is retrospective and uncontrolled. Comparative trials are requested in the future to look at operative versus nonoperative treatment specifically of the type IIb lesions. Moreover, the diagnosis of AMRI was quite subjective and based on clinical tests exclusively. However, AMRI is a dynamic finding and the diagnosis is not possible by imaging tools. Furthermore, it should be mentioned that the patient population of this study was selective with high sportive demands, which limits a global validity. A therapy regime of another patient population might be more conservative with similar results. Therefore, complementary studies are needed in the future to estimate the value of the presented results.

Conclusion

AMRI seems to be a crucial factor for the decision between surgical and nonsurgical treatment of concomitant MCL lesions and should be considered in the treatment decision. Especially in grade II MCL lesions, evaluation of AMRI could add important information. The presented treatment concept for concomitant MCL lesions could be proposed as an injury classification and a treatment algorithm in this kind of injury.

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