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Percutaneous medial collateral ligament release in arthroscopic medial meniscectomy in tight knees

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Abstract
Purpose Visualization and surgery of tears in the posterior medial meniscus are difficult in tight knees. Iatrogenic chondral lesions might cause serious morbidity, and residual tears may result in inadequate symptom relief. We evaluated the clinical and radiological results of superficial medial collateral ligament (MCL) release during arthroscopic medial meniscectomy in tight knees.
Methods Eighteen patients [median age: 43 years (22–59); median follow-up: 8.3 months (6–12)] who underwent arthroscopic meniscectomy were included in the study. Patients with ligamentous injuries, severe chondral damage or meniscal repairs were excluded. Preoperatively, anteroposterior knee radiographs were obtained with 11-kg valgus stress using a specialized instrument. During the operation, if opening of the medial knee in 30° flexion under 11-kg valgus stress was inadequate, controlled release of the posterior portion of the MCL was performed using a 16-gauge needle. Intraoperative valgus stress was monitored using a specially designed lateral support with mounted load cell. MCL injury was evaluated both with magnetic resonance imaging (MRI) and valgus stress radiographs, which were obtained in the 1st week and 3rd and 6th months postoperatively to monitor healing of the elongated MCL.
Results In all patients, meniscectomy could be performed with adequate visualization of the posterior medial meniscus and without iatrogenic chondral injury. The median medial joint space width on valgus stress radiographs was 7.1 mm preoperatively and 9.1, 8.0 and 7.2 mm in the 1st week, and 3rd and 6th months, respectively ($p < 0.0001$). On MRI, the injured structure was the posterior two-thirds of the MCL. Median Lysholm score, which was 42 points before the operation, had increased to 94 points at the final follow-up ($p = 0.0002$).
Conclusion Controlled release of the MCL in tight knees allowed easier handling in posterior medial meniscus tears and a better understanding of tear configurations, avoiding iatrogenic chondral lesions. The MCL injury healed uneventfully.
Level of evidence IV.

Keywords Meniscus · Arthroscopy · Medial collateral ligament · Tight knee

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Introduction

Arthroscopic resection of symptomatic and irreparable meniscal tears is commonly performed with successful clinical outcomes and low rates of complications [4, 11]. The posterior third of the medial meniscus is a common localization of the meniscal tears, and an unrestricted view of this portion of the meniscus is a prerequisite for adequate resection [6, 23]. Since the medial femoral condyle obstructs the visualization of the posterior horn of the medial meniscus in stable knees, it is generally difficult to visualize and to use instruments to attend to meniscal pathologies in this area, especially in patients with tight knees [3, 6, 26].

This area is reported to be the one of the greatest sources of diagnostic errors in knee arthroscopy [25, 26]. In cases with inadequate opening in the medial joint space, manipulation with instruments might cause iatrogenic chondral damage in these patients. Since the spontaneous healing capacity of the cartilage lesions is limited, those iatrogenic lesions might contribute to degeneration of the articular cartilage and osteoarthritis [2, 8].

On the other hand, meniscal fragments unwittingly left behind because of inadequate visualization might result in continued symptoms and reoperation [9, 23, 25]. The use of an aggressive force to open the medial joint space might result in rupture of the medial collateral ligament (MCL) or even fracture of the femur [4, 10, 15]. Alternatively, the use of a joint distractor, intra-articular release of the medial capsule and MCL with electrocautery [19, 25] or the use of posteromedial [3, 6, 20] or inframeniscal [16, 18] portals have been described for opening the medial compartment. However, technical difficulties and additional morbidities related to the techniques preclude their use in everyday practice.

In 2004, Agneskirchner and Lobenhoffer [2] and later the same authors [1] and also Bosch [7] described a minimally invasive technique to open the medial compartment by puncturing the posteromedial capsuloligamentous structures percutaneously with the use of a needle. More recently, a similar technique has been described by several other authors [16, 18, 24]. Although they reported that the injured structures healed uneventfully, there were no data on the injury localization, healing patterns or complications.

In this study, we used the same technique as described by Agneskirchner and Lobenhoffer [1] to enlarge the medial joint space in tight knees, that is, percutaneous puncturing of the posteromedial capsuloligamentous structures with the use of a needle. The purpose of our study was to identify: (a) the structures injured during release, (b) the extent of the medial joint space opening, (c) the healing pattern of the injured structures and (d) any complications related to the technique.

Materials and methods

This study was approved by the local ethical committee. Eighteen patients with a median age of 43 years (22–59) who were operated between December 2007 and June 2009 were included. The median follow-up was 8.3 months (6–12). A total of 66 isolated medial meniscectomies were performed within this period. All adult patients with irreparable meniscal tears and elderly patients with degenerative tears were included in this study. Patients with ligamentous injuries, severe chondral damage or meniscal repairs were excluded.

Equipment

Two identical load cells (single point load cell; capacity 50 kg; accuracy 0.01 kg; model L6D, ZEMIC Ltd., Hanzhong, Shaanxi, China) were used in two different instruments. One of the load cells was mounted on the arthroscopic lateral post to monitor the amount of valgus stress that was applied to the patient's extremity during the operation. The other load cell was used in the stress radiography device. Stress was applied from the lateral joint line by the pressure device on which the load cell was mounted. Identical load cells were used to decrease the bias in data collection. Data were converted to kilogram with a portable data converter.

Preliminary study

Prior to starting the evaluation, the amount of valgus force applied to the patient's extremity was measured in 10 patients with a median age of 40 years (32–56). To visualize the posterior third of the medial meniscus, one consultant orthopaedic surgeon (MHO) and one resident (OF) each worked separately during the arthroscopy in the same patient to force the extremity into valgus using their body and perceptively determined the level of force they considered to be the maximum that could be applied without giving rise to complications. The maximum amount of load received by the load cell mounted on the lateral post was read from the data converter and recorded. These data were then calculated to obtain an average valgus force that was used by the two operating surgeons. This number (11 kg) was then used in the study group as the maximum amount of force to be applied to the knee during arthroscopy and also during the radiographic examinations. Although the load cells had an accuracy to 0.01 kg, the nearest whole number was recorded as the measurement, since it is likely not feasible to perceive less than 1 kg when the surgeon uses his/her body to force the extremity into valgus.

Surgical technique

All operations were performed by the senior author (MHO) or under his supervision. Standard anterolateral and anteromedial portals were used with a 30° viewing scope. A tourniquet inflated to 300 mmHg was used. Prior to the operation, the possible location of the MCL was drawn by a

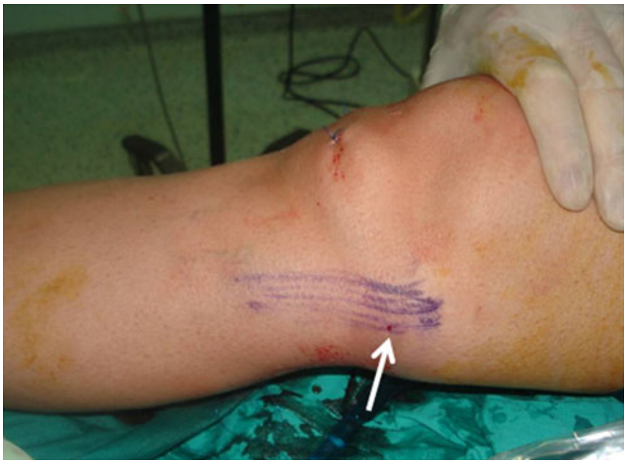

Fig. 1 The site of percutaneous medial release (*white arrow*). The possible localization of the MCL was drawn with a permanent marking pen

sterile marking pen starting from the palpated medial epicondyle (Fig. 1). With the knee in extension to 30° flexion, valgus and external rotation stress was applied to the leg by the surgeon using his body. The amount of valgus stress was monitored from the screen of the data converter, which was connected to the lateral post. When visualization or instrumentation of the posteromedial meniscus under 11-kg valgus stress was inadequate, controlled release of the posteromedial capsuloligamentous structures with the metal inner shaft of the 16G indwelling venous cannula (hereafter referred to as the "needle") was performed. The targeted point for release was the posterior third of the superficial MCL proximal to the medial meniscus (Fig. 1). Puncture at the site produces a cracking sensation with a concomitant opening in the medial joint space seen on the arthroscopy monitor. If the opening was determined to be adequate, puncturing was stopped. Otherwise, without removing the needle from the skin, the posteromedial capsuloligamentous structures were punctured again in the horizontal plane while endeavouring to limit the punctures to the posterior half of the MCL, and the process was continued until the desired medial joint space opening was attained. No more than four punctures were required for this purpose. Postoperatively, a short-hinged knee brace was worn for 4 weeks without restriction in joint motion and with full weight-bearing.

Radiographic examinations

With the patient in supine position and the knee in 20°–30° flexion, an anteroposterior knee radiograph with 11-kg valgus stress was taken with the X-ray beam centred in the joint line with the tube distance of 1 metre from the cassette. Radiographs were taken preoperatively and in the postoperative 1st week and 3rd and 6th months to monitor

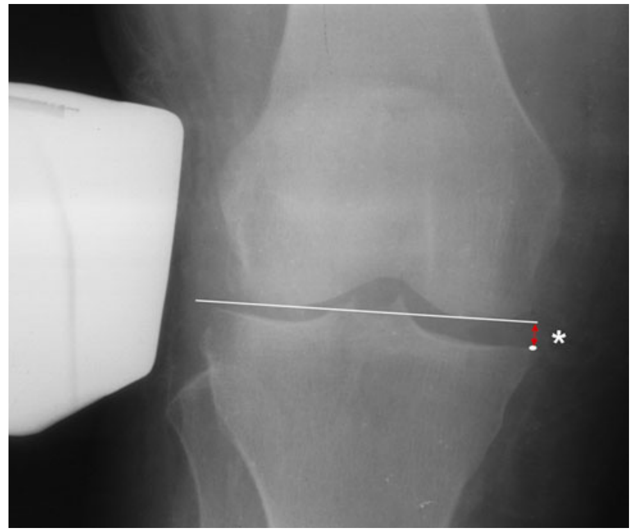

Fig. 2 Anteroposterior stress radiograph of the right knee. Radiographic measurement of the joint space width (*asterix*) is documented

healing in the injured medial structures. Stress radiographic examination was somewhat painful for some of the patients in the early postoperative period. To decrease the pain at the medial side of the knee during radiographic examination, the lateral force to the knee was increased gradually.

Radiographic measurements

Measurements were evaluated blindly (without knowledge of the time after operation) by two examiners (OF and HY) to decrease the observer bias. The joint space width was measured as follows: A horizontal line (distal femoral line) was drawn tangent to the most distal portions of the femoral condyles. From this line, a perpendicular line was drawn to the most medial point of the medial plateau. The length of this vertical line was measured with a digital calliper with accuracy to 0.1 mm and recorded as the joint space width (Fig. 2). Measurements were corrected for magnification. Radiographic magnification was determined by placing a metal object with a known size on the X-ray cassette.

Magnetic resonance imaging (MRI) analysis

MRI of the knee was performed in all patients 1 week after the operation. A special superficial sagittal section was taken in addition to the regular sections to evaluate the localization of the injury in the posteromedial capsuloligamentous structures. On the sagittal MRI sections, the width (anteroposterior distance) of the MCL was divided into three equal parts and the injured site was recorded accordingly. In coronal sections, the localization of the injury was recorded with reference to the medial meniscus.

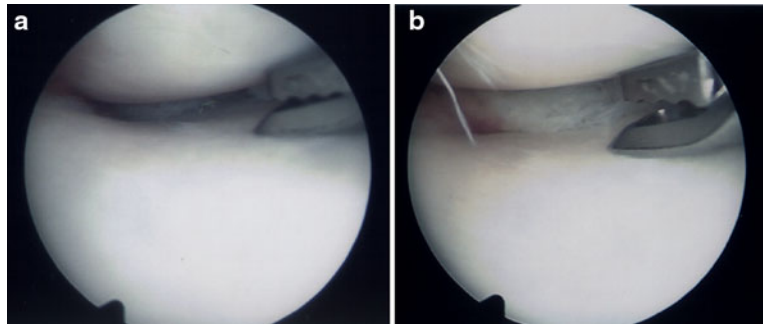

Fig. 3 Arthroscopic view of the medial compartment under valgus stress, before (**a**) and after (**b**) percutaneous release. The mouth of the instrument (Duckbill® up-biter) easily enters the joint after percutaneous release

Patient evaluation

Subjective discomfort of the patients was evaluated by Lysholm score. The severity of collateral ligament injury on physical examination was evaluated by the extent of joint line opening with valgus stress with the knee in 30° flexion, that is, ≤5 mm, Grade I (minor sprain); 6–10 mm, Grade II (partial tear); and >1 cm and no solid end point, Grade III (complete tear). As on the radiographic examinations, valgus stress test in the early postoperative period was also painful in some of the patients. Gentle manipulations and patient reassurance allowed us to perform the examinations.

Statistical analysis

Differences between the related measurements were evaluated by Friedman two-way analysis of variance by ranks. When the p value from the Friedman test was statistically significant, Bonferroni-corrected Wilcoxon signed rank test was applied to determine stepwise differences. Intra-class correlation coefficients for intra- and inter-observer reliabilities were assessed by using two-way random effects models. The Statistical Package for the Social Sciences (version 11.5.0, SPSS Inc, Chicago, IL) was used for statistical analyses, and a p value of 0.05 was considered significant.

Results

All meniscal tears except one were located in the posterior third of the medial meniscus. In the case of exception, there was a chronic bucket handle tear starting from the anterior horn extending to the posterior horn of the medial meniscus, which was determined as irreparable. Distribution of the tears was as follows: horizontal cleavage tear ($n = 4$), radial tear ($n = 4$), parrot beak tear ($n = 1$), complex tear ($n = 8$) and bucket handle tear ($n = 1$). In all patients, a partial meniscectomy could be performed with adequate visualization of the posterior medial meniscus and successfully avoiding iatrogenic chondral injury (Fig. 3a, b).

The median Lysholm knee score, which was 42 points (24–64 points) before the operation, had increased to 94 points (88–100 points) at the final follow-up ($p = 0.0002$). On sagittal MRI sections in 14 patients, the needle punctures were located within the posterior and middle thirds of the MCL (Fig. 4a), but in the remaining 4 patients, the injury was restricted to the middle third. In all patients, the localization of the injury was proximal to the medial meniscus in coronal sections (Fig. 4b).

The joint space width, as calculated from the valgus stress radiographs, was a median 7.1 mm (3.7–9.6) preoperatively and 9.1 mm (6.2–11.3), 8.0 mm (5.3–10.1) and 7.2 mm (3.9–9.8) in the postoperative 1st week and 3rd and 6th months, respectively, and the difference was statistically significant ($p < 0.0001$). However, there was no significant difference between the preoperative and 6th month postoperative joint space width measurements, indicating the healing of the injured structures. Intra- and inter-observer reliability scores were all >0.99 with 95 % confidence intervals of agreement ranging from 0.97 to 1.00.

No intraoperative complications were encountered. In the postoperative period, all patients reported a mild pain at the medial needle tract lasting for 15 days. In the final follow-up, there was no pain on palpation within this area. Moreover, there was no sign of saphenous nerve or vein injury. There was a superficial ecchymosis that resolved spontaneously in all patients.

On physical examination, during valgus stress with the knee in 30° flexion, there was a < 5-mm opening with a firm end point on the medial side (Grade I injury) in all patients compared to the uninjured sides, which recovered in an average of 3.5 weeks.

Discussion

The most important finding of the present study is that controlled release of the MCL in tight knees is safe and effective for facilitating adequate visualization of the tear configuration, and in more importantly, for easy and atraumatic use of instruments.

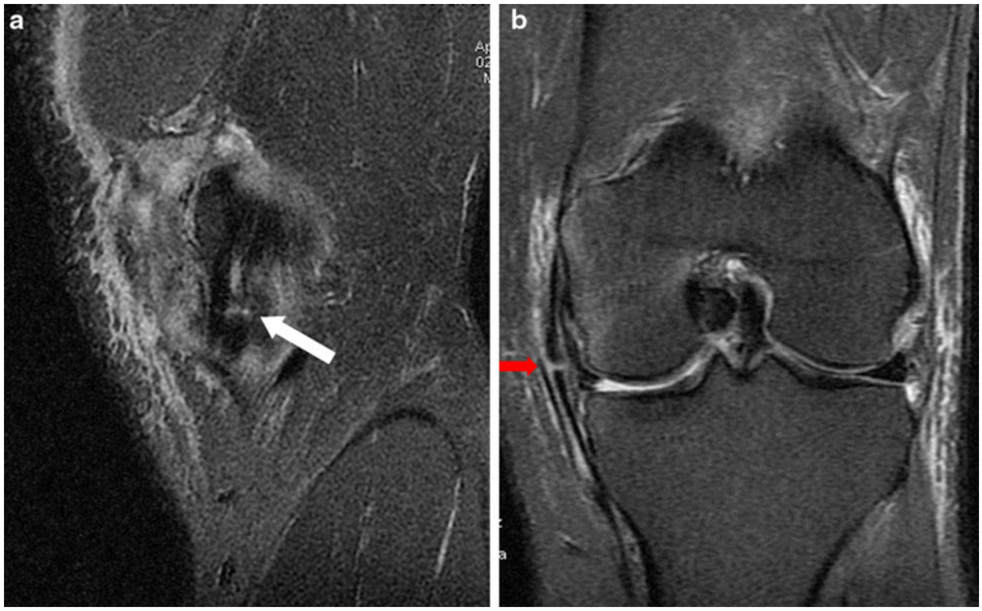

Fig. 4 **a** Sagittal T2-weighted image. The injured part of the MCL was located in the posterior two-thirds (*white arrow*). The anterior one-third was intact. **b** Coronal T2-weighted image. The site of the percutaneous release was proximal to the medial meniscus (*red arrow*)

Tears in the posterior part of the medial meniscus are seen frequently. This area, referred to as the weak point (Achilles tendon) of knee arthroscopy, is difficult to visualize and to reach with instruments, especially in patients with tight knees in which the joint opening under valgus force is insufficient [6, 26].

The superficial MCL acts as the prime stabilizer of the medial side of the knee [5, 12–14]. Biomechanical studies have shown that the highest strains in the MCL have been recorded in the posterior region of the ligament proximal to the joint line with the knee in extension during valgus loading [12, 13]. Therefore, this area is thought to be the primary restraint to medial knee opening during valgus force in arthroscopy. Although Park et al. [24] used a similar posteromedial release technique and reported that the released structure was the deep MCL, there was no radiographic examination in their study to support their claim. Our MRI findings showed that the site of percutaneous release was on the posterior two-thirds (area with the highest strain) of the superficial MCL, leaving the anterior third intact.

The lesions seen on MRI sections should not be interpreted as a total rupture or cut of the MCL. In the literature, it has been shown that the patients with total MCL rupture had an average 4–8.5-mm enlargement of the medial side of the knee joint by applying a valgus force, compared with the contralateral healthy knee [17]. Our findings on the stress radiographic examination demonstrated a 2 mm enlargement of the joint space width on average, and we concluded that the injury to the MCL was partial. Although less objective than the radiographic examinations, medial instability found on physical examination with <5 mm opening compared to the uninjured extremity with a firm end point supported this conclusion, in which tears could be classified as Grade I.

Our results on stress radiographic examinations indicated that the iatrogenic laxity recovered within 3 months, which might indirectly indicate a successful healing of the injured structures. The transient laxity on clinical examination, which recovered after an average of 3.5 weeks, also supported our radiographic findings.

Although Grade I medial laxity was present on the physical examination in all patients after the operation, patients did not suffer from objective instability. We speculate that this was a result of the use of the hinged brace. However, since we did not have a control group without brace, we cannot make a firm conclusion in this regard. On the other hand, no brace was used in clinical series with even a more extensive medial release, the “arthroscopic decompressive medial or posteromedial release”, to decompress the medial compartment in the treatment of medial compartment osteoarthritis [19, 21, 22]. Since no high level studies were published on the fate of percutaneous medial release during arthroscopy, we decided to use a brace for ethical purposes.

The major limitation of this study was the selection of 11 kg as the maximum amount of load to be applied to visualize the posterior third of the medial meniscus during arthroscopy, and this amount of force was also used in stress radiographic examinations. The calculation of this number was based on the subjective perception of two operating surgeons that this force was the maximum level possible without leading to complications. We did not observe any intraoperative complications such as MCL rupture or femoral fracture. Therefore, one might use more force to open the medial side, especially in younger and taller patients with longer extremities and stronger musculature. However, since we needed a certain number for radiographic measurements and since this amount of force was sufficient in most of our patients, this value was selected for standardization in our study. The precision and margin for error on calculation of the joint space width is another limitation of our study.

In daily practice, when performing arthroscopic meniscectomy in a patient with a tight knee, posteromedial release with needling allows easier use of the instruments without damaging the articular cartilage.

Conclusion

Controlled release of the MCL in tight knees allowed easier handling in posterior medial meniscus tears and a better understanding of tear configurations, thereby avoiding iatrogenic chondral lesions. The MCL injury healed uneventfully.

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References

1. Agneskirchner JD, Bernard M, Lobenhoffer P (2005) Verbesserte Ubersicht bei arthroskopischen eingriffen am innenmeniskus-hinterhorn durch perkutanes needling des innenbandes. Artroskopie 20(7):75–77
2. Agneskirchner JD, Lobenhoffer P (2004) Arthroscopic meniscus surgery: technical operative methods. Unfallchirurg 107(9): 795–801
3. Ahn JH, Oh I (2004) Arthroscopic partial meniscectomy of a medial meniscus bucket-handle tear using the posteromedial portal. Arthroscopy 20(7):e75–e77
4. Allum R (2002) Complications of arthroscopy of the knee. J Bone Joint Surg Br 84-B(7):937–945
5. Ballmer PM, Jakob RP (1988) The non operative treatment of isolated complete tears of the medial collateral ligament of the knee. A prospective study. Arch Orthop Trauma Surg 107(5): 273–276
6. Bin SI, Kim JM, Shin SJ (2004) Radial tears of the posterior horn of the medial meniscus. Arthroscopy 20(4):373–378
7. Bosch U (2006) Percutaneous perforation of the posteromedial capsuloligamentous structures to avoid cartilaginous damage due to arthroscopic intervention at the medial meniscal posterior horn in narrow joints. Oper Orthop Traumatol 18(5–6):481–484
8. Buckwalter JA (2002) Articular cartilage injuries. Clin Orthop Relat Res 402:21–37
9. Ciliz D, Ciliz A, Elverici E, Sakman B (2008) Evaluation of postoperative menisci with MR arthrography and routine conventional MRI. Clin Imaging 32(3):212–219
10. DeLee JC (1985) Complications of arthroscopy and arthroscopic surgery: results of national survey. Committee on Complications of AANA. Arthroscopy 1(4):214–220
11. Fabricant PD, Jokl P (2007) Surgical outcomes after arthroscopic partial meniscectomy. J Am Acad Orthop Surg 15(11):647–653
12. Gardiner JC, Weiss JA, Rosenberg TD (2001) Strain in the human medial collateral ligament during valgus loading of the knee. Clin Orthop Relat Res 391:266–274
13. Gardiner JC, Weiss JA (2003) Subject-specific finite element analysis of the human medial collateral ligament during valgus knee loading. J Orthop Res 21(6):1098–1106
14. Giannotti BF, Rudy T, Graziano J (2006) The non-surgical management of isolated medial collateral ligament injuries of the knee. Sports Med Arthrosc 14(2):74–77
15. Huber W, Trieb K (2002) Serious consequences of the wrong diagnosis of meniscal lesion in a case of stress fracture of the distal femur. Arthroscopy 18(8):935–938
16. Jo CH et al (2009) Under-meniscal portal: an alternative portal for an easy access to the medial and lateral menisci. Knee Surg Sports Traumatol Arthrosc 17(11):1344–1346
17. Kennedy JC, Fowler PJ (1995) Medial and anterior instability of the knee. An anatomical and clinical study using stress machines. Clin Orthop Relat Res 321:3–9
18. Kim JM, Bin SI, Kim E (2009) Inframeniscal portal for horizontal tears of the meniscus. Arthroscopy 25(3):269–273
19. Leon HO, Blanco CE, Guthrie TB (2001) Arthroscopic decompressive medial release of the varus arthritic knee: expanding the functional envelope. Arthroscopy 17(5):523–526
20. Lubowitz JH, Rossi MJ, Baker BS, Guttmann D (2004) Arthroscopic visualization of the posterior compartments of the knee. Arthroscopy 20(7):675–680
21. Lyu SR (2008) Arthroscopic medial release for medial compartment osteoarthritis of the knee: the result of a single surgeon series with a minimum follow-up of four years. J Bone Joint Surg Br 90-B(9):1186–1192
22. Moriya H, Sasho T, Sano S (2004) Arthroscopic posteromedial release for osteoarthritic knees with flexion contracture. Arthroscopy 20(10):1030–1039
23. Nielsen DM, Twyman R (2005) Arthroscopic visualization of the posterior horn of the medial meniscus. Arthroscopy 21(10):1272
24. Park YS et al (2011) Arthroscopic pullout repair of posterior root tear of the medial meniscus: the anterior approach using medial collateral ligament pie-crusting release. Knee Surg Sports Traumatol Arthrosc 19(8):1334–1336
25. Spahn G (2003) Arthroscopic revisions in failed meniscal surgery. Int Orthop 27(6):378–381
26. Tolin BS, Sapega AA (1993) Arthroscopic visual field mapping at the periphery of the medial meniscus: a comparison of different portal approaches. Arthroscopy 9(3):265–271