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Arthroscopic posteromedial capsular release for knee flexion contractures

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Abstract Extension deficits of the knee can cause functional limitations in patients after knee surgery or injury. Most frequently, they are treated with manipulations, arthroscopic anterior compartment debridements, or open posterior capsular releases once nonoperative treatment fails. However, an arthroscopic posteromedial capsular release to manage flexion deficits has yet to be studied comprehensively. Arthroscopic posteromedial capsular releases of the knee can result in improved knee motion postoperatively. An arthroscopic posteromedial capsular release involves sectioning the posteromedial capsule at its meniscofemoral portion, midway between its femoral attachment and its posterior horn medial meniscus junction. A review of 15 patients who underwent this operation was performed. Passive knee extension and flexion was measured in patients in the supine position using a goniometer at preoperative evaluations, under anesthesia prior to and immediately after the posteromedial capsular release, and at postoperative follow-up evaluations. The average time from the arthroscopic posteromedial capsular release to the final postoperative follow-up was 24.1 months. Preoperative knee extension averaged 14.7° in 15 patients. The average immediate postoperative knee extension averaged −0.9°. At the final postoperative follow-up, knee extension averaged 0.7°. Overall knee motion improved from an average arc of motion of 101.6°–129.4°. Arthroscopic posteromedial capsular releases and the concurrent postoperative rehabilitation program were effective in the treatment of knee extension deficits. The encouraging results of this study compare well to data presented in open posterior capsular release studies. We believe that arthroscopic posteromedial capsular releases are an effective means to address symptomatic knee extension deficits.

Keywords Arthroscopic posteromedial capsular release · Flexion contracture · Arthrofibrosis

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Introduction

Postoperative, or postinjury, arthrofibrosis, with a resultant lack of full extension of the knee, can significantly limit a patient's overall function. The etiology of knee flexion contractures may include adhesive bands due to excess scar tissue formation, extension blocks that resist motion, entrapment of the patella, ACL graft malposition or excess tension, cyclops lesions, soft tissue calcification, and a fibrotic posterior joint capsule [5, 7, 15].

Flexion contractures adversely affect postoperative outcomes and are one of the main causes for deterioration of knee function after surgery [19]. Loss of knee extension is particularly disabling. Extension loss results in greater morbidity and disability than does flexion loss, leading to increased stress on the quadriceps mechanism and patellofemoral joint [7, 15].

The majority of postinjury or postsurgical flexion contractures can be at least partially corrected with physical therapy, serial extension bracing or casting, and joint manipulation [7]. Some patients, however, will not respond to noninvasive techniques and will require intraarticular surgical intervention. It has been reported that treatment for arthrofibrosis should ideally be started as soon as any

arthrofibrosis or a plateau in a gain in knee motion is recognized after the initial injury or surgery, because surgical treatment done after more than one year has elapsed has been reported to be less successful in regaining lost motion [1, 10].

In many flexion contractures, the posterior capsular tissues are shortened and prevent full knee extension. Open posterior capsular releases have been described in a number of studies to address knee flexion contractures [11, 12]. The goal of a posterior capsulotomy is to regain the normal posterior joint space and capsular tension. A posteromedial open approach has been primarily described, with the possibility of a posterolateral approach only added if necessary, to divide the capsule with a transverse incision [6, 10, 11].

Regarding arthroscopic techniques, an arthroscopic limited posterior capsule release in cadavers, described by Ahn et al. [3], was shown to increase distance between the posterior cruciate ligament and the popliteal neurovascular bundle. A similar arthroscopic sectioning of the posteromedial knee capsule demonstrated clinical improvement in symptoms related to osteoarthritis as well as an average improvement in knee extension from 13° to 6° and in knee flexion from 129° to 130° [9, 13]. However, an arthroscopic posteromedial capsular release to specifically address extension deficits has not been thoroughly studied. Descriptions of arthroscopic arthrolysis, using an anterior approach, to treat knee flexion contractures exist in the literature [2, 10, 16, 17]. However, none of these have directly addressed the posterior capsule. Thus, the purpose of this study was to describe the surgical technique and to evaluate patients who had an arthroscopic posteromedial capsular release for the treatment of knee flexion contractures. We hypothesized that an arthroscopic posteromedial capsular release of the knee would result in improved knee motion postoperatively.

Materials and methods

Study design

Inclusion criteria for patients to undergo an arthroscopic posteromedial capsular release included a symptomatic knee extension deficit of 10° or more compared to the normal contralateral knee. Moreover, their extension deficits were not adequately managed through previous conservative or operative measures such as physical therapy, manipulations or anterior compartment arthroscopic debridements. Additionally, their knees could not be manipulated into full extension under anesthesia (both on initial induction of anesthesia and after an anterior compartment debridement if needed).

All patients who underwent an arthroscopic posteromedial capsular release between September 1998 and October 2004 were evaluated for improvements in knee motion. Passive knee motion was measured in patients in the supine position with a goniometer at preoperative evaluations, intraoperative presurgical and postmanipulation instances, and at postoperative follow-up evaluations. Total knee arc of motion was evaluated as degrees of flexion less degrees of extension from a neutral position. Measurements of recurvatum were denoted by negative values.

Two-sample *t*-tests were used to evaluate the differences in the preoperative versus postoperative knee motion (extension, flexion, and arc of motion) measured in the operating room under anesthesia. Mann–Whitney *U*-tests were used to evaluate the changes in extension, flexion, and arc of motion measured at preoperative and postoperative follow-up evaluations. Pearson's correlation was used to examine the relationship between knee extension measured in the clinic versus knee extension measured in the operating room under anesthesia.

Surgical technique of arthroscopic posteromedial capsular release

The surgical goal of the arthroscopic posteromedial capsular release was to section the meniscofemoral portion of the posteromedial capsule, midway between its femoral attachment and its posterior horn medial meniscus junction, and debride any adhesions between the posterior condyles and the posterior joint capsule.

Anesthesia included an indwelling epidural catheter for every patient. This was part of the protocol to provide adequate pain control in the immediate post-operative period and allow appropriate physiotherapy to commence. In addition, for some patients, especially for procedures in which a more extensive anterior compartment debridement was anticipated, general endotracheal anesthesia was also concurrently performed. In such instances, the patient was intubated after the epidural catheter was in place and found to be functioning adequately.

After induction, an exam under anesthesia was performed with a goniometer to document both the injured and normal contralateral knee flexion and extension. A gentle manipulation was performed at this time to attempt to regain full extension, and flexion as necessary. If full extension could not be achieved at this point, the patients underwent an arthroscopic evaluation. The foot of the bed was dropped and the upper thigh was placed in a leg holder. It was important to try and abduct the thigh and slightly externally rotate the leg in the leg holder to allow

for easier access to a posteromedial knee arthroscopic portal for the arthroscopic posteromedial capsular release.

Standard anterior working arthroscopic portals were made to allow for identification and treatment of any suprapatellar pouch and medial or lateral gutter or compartment pathology at this time. Once all anterior knee pathology had either been assessed or treated, a further attempt was made to manipulate the knee into full extension. If this was not successful, the approach for the arthroscopic posteromedial capsular release was performed.

The posteromedial aspect of the joint was next visualized by placing a 30° arthroscope medial to the posterior cruciate ligament, between the medial femoral condyle and the posterior cruciate ligament. It was sometimes necessary to place a blunt arthroscopic obturator in this interval to break through adhesions or scar tissue prior to inserting the arthroscope medial to the posterior cruciate ligament. At this point, the arthroscope was used to view a spinal needle placed under direct vision to localize a posteromedial arthroscopic portal (Fig. 1a). The portal was then prepared by making a small incision (Fig. 1b) and advancing a cannula through the incision into the posteromedial joint under direct visualization.

The posteromedial capsule was then carefully and completely separated away from the posteromedial structures and the medial gastrocnemius tendon and muscle

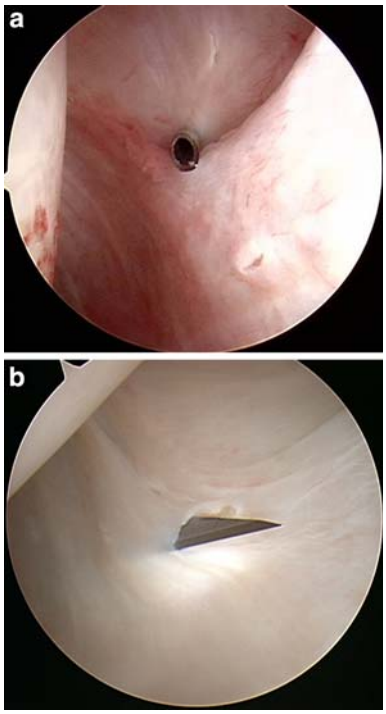

Fig. 1 **a** Spinal needle used to localize the location of the posteromedial arthroscopic portal (*left knee*). **b** Direct visualization of the incision used to create the posteromedial arthroscopic portal (*left knee*)

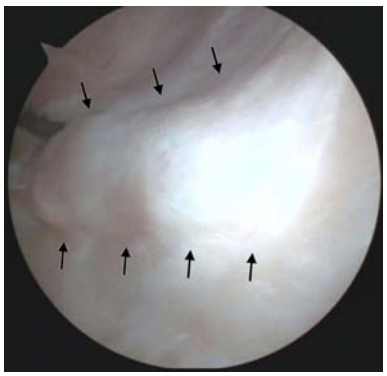

Fig. 2 Arthroscopic blunt obturator (*between arrows*) used to separate the posteromedial capsule from the medial gastrocnemius complex and other tissues (*left knee*)

using a blunt obturator from the arthroscopic camera or a small periosteal elevator (Fig. 2). The arthroscopic basket punch and arthroscopic shaver instruments, which were always utilized with the shaver blade facing anteriorly, were then used to release the posteromedial capsule under direct visualization, starting medially and proceeding laterally to the midline in line with the posterior cruciate ligament (Fig. 3a–c). The medial gastrocnemius muscle and tendon became visible as the posteromedial capsule was released (Fig. 4a, b).

Once the arthroscopic posteromedial capsular release was completed the knee was then manipulated to regain full extension, and flexion as necessary. To achieve a range of motion in extension similar to the normal contralateral knee, manipulation was performed with the goal of the heel being lifted off the foot of the operating table while the distal thigh at the knee was held against the operating table. This indicated that at least some degree of hyperextension had been achieved. A sterile goniometer was used to verify that full extension was regained.

Postoperative management

Postoperatively, patients were admitted to the orthopaedic floor for analgesic management and physical therapy. It has been demonstrated that an early, rigorous postoperative rehabilitation regimen is crucial for patients undergoing reconstructive knee operations to retain range of motion [14]. For patients with an isolated extension deficit, dynamic extension splinting was used in 4-h alternating cycles. Patients were instructed to wear the splint at night. Patients treated for a concurrent flexion deficit were put into a continuous passive motion (CPM) machine with a full range of motion at a slow speed, alternating with dynamic extension splinting in four hour blocks. Patients were encouraged to weightbear as tolerated with the use of

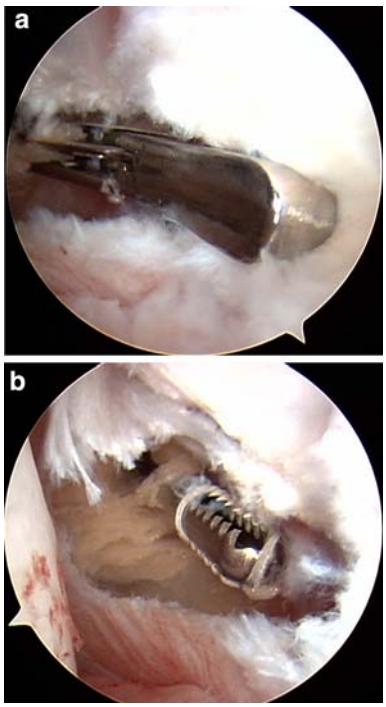

Fig. 3 **a** Arthroscopic basket punch used to incise the posteromedial capsule (*left knee*). **b** Arthroscopic basket punch used to further incise the posteromedial capsule (*left knee*). **c** Completing the arthroscopic posteromedial capsular release with an arthroscopic shaver (*left knee*)

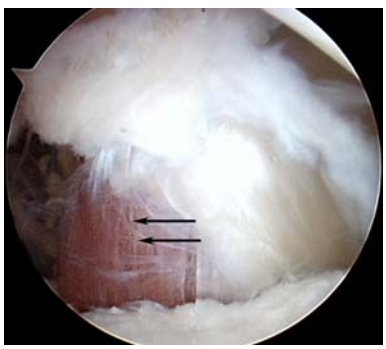

Fig. 4 **a** Arthroscopic view of the posteromedial knee after arthroscopic release of the posteromedial capsule (*left knee*). **b** Arthroscopic view of the posteromedial knee after arthroscopic release of the posteromedial capsule (*right knee*). The longitudinal muscle fibers of the medial head of the gastrocnemius are visible

crutches, and they could wean off of crutches when they were able to walk without a limp.

Proper postoperative analgesic control was imperative for maintaining the extension gained after the arthroscopic posteromedial capsular release and manipulation. The indwelling epidural catheter remained in place for 1–2 days, at which time the patient was weaned off the epidural as pain permitted and switched to oral analgesics once it was demonstrated they could maintain full knee extension in the splint. A cold compression device was also used for edema and pain control as needed. Patients were placed on deep venous thrombosis prophylaxis, which was at a minimum an enteric-coated 325 mg aspirin daily for 2 weeks. Other anticoagulation medications were held until the epidural catheter was discontinued.

At the time of discharge, patients were prescribed daily physical therapy, stressing full range of motion, for 1–2 weeks postoperatively. The dynamic extension splint was used for a minimum of 2 h twice a day and for nighttime use for 6 weeks and reevaluated at that time to determine the need for further use. It was recommended that patients work on low impact exercises only until 6 weeks postoperatively and avoid activities which could cause pain or swelling, which would potentially contribute to hamstring spasm and/or a loss of extension during this time frame. They were then allowed a progressive increase in their activities as tolerated, and were only limited in their activities if their knee extension decreased from that measured at the time of surgery.

Results

Individual patient demographics and averages are listed in Table 1. The study consisted of seven men and eight women, with a mean age of 32 years. All 15 patients had previously undergone a knee operation to address various acute or chronic pathologies and subsequently developed or retained a flexion contracture postoperatively.

The original pathology that led to the knee flexion contractures in the 15 patients included seven isolated ACL tears, two multi-ligament knee injuries, one lateral meniscus tear, one combined ACL tear and medial meniscus tear, one infected knee joint, one quadriceps tendon injury, one partially dislodged osteochondritis dissecans lesion of the medial femoral condyle, and one case of post-traumatic arthrofibrosis. The average time from the last ipsilateral knee operation to the arthroscopic posteromedial capsular release was 18.5 months. In addition to the posteromedial capsular release, intraarticular debridement of arthrofibrosis was performed in 12 patients, arthroscopic partial lateral meniscectomy in one patient, revision notchplasty in three patients, chondroplasties in two patients, intraarticular hardware removal in two patients, and an open reduction and internal fixation with bone grafting of an osteochondritis dissecans lesion in one patient.

Preoperative knee extension in the clinic averaged 14.7° (range, 7.0°–28.0°). Knee extension measured under anesthesia prior to surgical intervention yielded an average value of 15.5° (range, 10.0°–21.0°), which correlated with the former ($P < 0.05$). Average extension upon immediate completion of the arthroscopic posteromedial capsular release and knee manipulation under anesthesia improved

Table 1 Operative data and clinic knee motion measurements for all patients

Patient	Age[a]	Last operation	Months from last operation to APCR	Extension (°)			Flexion (°)			Arc of motion (°)			Total months F/U
				Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	
1	22	ACLR	13.5	11.0	−5.0	16.0	135.0	135.0	0.0	124.0	140.0	16.0	21.8
2	36	ACLR, partial medial meniscectomy, articular chondroplasty	15.3	12.0	0.0	12.0	125.0	135.0	10.0	113.0	135.0	22.0	31.0
3	32	ACLR, lateral meniscus repair	7.8	15.0	0.0	15.0	88.0	131.0	43.0	73.0	131.0	58.0	20.3
4	42	Partial lateral meniscectomy	11.6	25.0	0.0	25.0	135.0	135.0	0.0	110.0	135.0	25.0	34.6
5	21	ACLR	40.3	18.0	−5.0	23.0	125.0	135.0	10.0	107.0	140.0	33.0	25.1
6	42	Arthroscopic debridement	47.1	28.0	15.0	13.0	88.0	125.0	37.0	60.0	110.0	50.0	18.6
7	53	Arthroscopic debridement	4.5	18.0	0.0	18.0	76.0	120.0	44.0	58.0	120.0	62.0	31.1
8	21	ACLR	40.4	7.0	0.0	7.0	135.0	137.0	2.0	128.0	137.0	9.0	12.5
9	52	ACLR	52.0	10.0	−1.0	11.0	135.0	130.0	−5.0	125.0	131.0	6.0	15.8
10	15	ACLR	3.5	10.0	0.0	10.0	115.0	120.0	5.0	105.0	120.0	15.0	18.3
11	16	Anterograde drilling for MFC OCD lesion	5.7	10.0	5.0	5.0	125.0	135.0	10.0	115.0	130.0	15.0	12.7
12	41	Arthroscopic debridement, medial meniscus repair	9.4	14.0	3.0	11.0	130.0	130.0	0.0	116.0	127.0	11.0	13.7
13	40	ACL, PCL, MCL, and posterolateral corner reconstruction	3.0	15.0	5.0	10.0	90.0	120.0	30.0	75.0	115.0	40.0	60.5
14	17	ACLR	12.7	15.0	−4.0	19.0	112.0	128.0	16.0	97.0	132.0	35.0	29.3
15	26	ACLR	10.7	12.0	−3.0	15.0	130.0	135.0	5.0	118.0	138.0	20.0	16.6
Mean	32		18.5	14.7	0.7	14.0**	116.3	130.1	13.8**	101.6	129.4	27.8**	24.1

Pre preoperative evaluation; *Post* last postoperative evaluation; *Δ* changes (post–pre); *ACLR* anterior cruciate ligament reconstruction; *PCL* posterior cruciate ligament; *MCL* medial collateral ligament; *APCR* arthroscopic posteromedial capsular release; *OCD* osteochondritis dissecans; *MFC* medial femoral condyle; *F/U* follow-up

** $P < 0.05$

[a] Years at time of posteromedial capsular release operation

to −0.9° (range, −5.0° to 5.0°, $P < 0.05$). Manipulation of the knee under anesthesia to a neutral or hyperextended position was achieved in 11 of the 15 patients (73.3%), and no patient continued to have an extension deficit greater than 5.0° after the posteromedial capsular release procedure was completed.

The average time from the arthroscopic posteromedial capsular release surgery to the last follow-up was 24.1 months (Table 1). Average postoperative knee extension improved to 0.7° (range, −5.0° to 15.0°, $P < 0.05$, Fig. 5). Eleven patients (73.3%) were able to either hyperextend their knee to some extent or achieve a neutral position, and all but one patient (93.3%) achieved knee extension of 5.0° or less at last follow-up. The average elapsed postoperative time to achievement of recurvatum or neutral knee extension in the 11 patients was 5.7 months.

Total knee arc of motion increased from an average of 101.6° (range, 58.0°–128.0°) measured preoperatively to 129.4° (range, 110.0°–140.0°) postoperatively ($P < 0.05$,

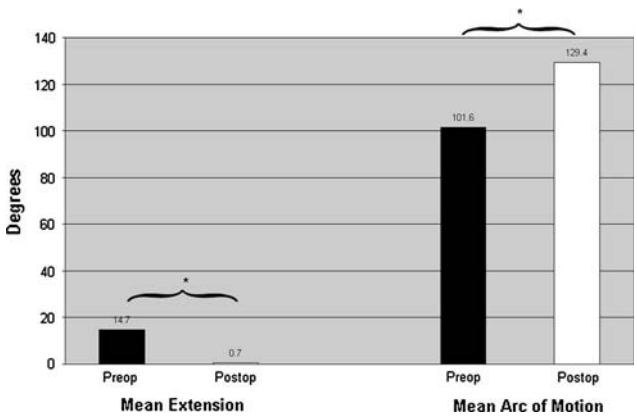

Fig. 5 Average knee motions measured in clinic preoperatively and most recent evaluation postoperatively, *$P < 0.05$

Fig. 5). The total knee arc of motion measured under anesthesia also improved from an average of 110.3° (range, 76.0°–135.0°) prior to surgical intervention to an average

of 137.1° (range, 126.0°–151.0°) upon completion of the arthroscopic posteromedial capsular release and knee manipulation ($P < 0.05$).

There were no preoperative complications associated with an arthroscopic posteromedial capsular release. In particular, this included no intraoperative fractures, postoperative infections, or any deep venous thromboses.

Discussion

The technique of an arthroscopic posteromedial capsular release for flexion contractures of the knee has been found to be a very effective means to treat this difficult condition. Mean knee extension improved from 14.7° to 0.7°. Additionally the optimistic results of this study were obtained despite a mean time to treatment from index operation or failed operative management of 18.5 months. It has been shown that success in treating knee flexion contractures deteriorates significantly after 1 year from index injury or operation [1, 10]. Although conservative management should continue to remain the initial approach to extension deficits, arthroscopic posteromedial capsular release with immediate and continued physical therapy is a valuable option in patients refractory to these measures.

Extension deficits of the knee can greatly limit normal knee range of motion, often leading to altered biomechanics, pain, arthritic changes, and decreased strength. In patients with extension deficits, knees can be limited in both active and passive extension, and there may be a spring-like end point at forced extension. Release of the contracted tissue was successful as was evidenced by intraoperative range of motion analysis performed before and after capsulotomy. In this context knee extension improved from an average of 15.5° to −0.9°. It has been demonstrated that a 5° loss of extension can cause a noticeable limp and patellofemoral pain with minimal walking, and a loss of 10° of extension is very poorly tolerated [18]. Cosgarea et al.'s [5], indications for surgery included a functional deficit, restricted motion greater than a 10° extension loss, and failure to improve with nonoperative therapy for 2 months.

The results from this study resemble data from studies of the traditional open posterior capsular release method [11, 12]. Extension improved to a mean value of 2° in a study by Lobenhoffer et al. [11] of 24 patients with an average follow-up of 18 months (range, 6–38 months). In a retrospective review of eight patients by Millett et al. [12], loss of extension improved from a preoperative mean of 18.8°–1.25° postoperatively and overall arc of motion improved from a mean of 62.5°–124°.

The arthroscopic technique described here utilizes standard arthroscopic instruments and a carefully integrated rehabilitation program to effectively address knee flexion contractures. Direct arthroscopic visualization of intra-articular structures such as the medial meniscus and posterior cruciate ligament may aid in avoiding damage to these tissues compared to the open posteromedial capsular release that may not offer sufficient visualization. An arthroscopic approach also avoids medial structures such as the superficial medial collateral ligament, and the posterior oblique ligament. Moreover, the advantages of arthroscopic versus open knee surgery in terms of decreased operative time, faster recovery, improved pain control, and increased postoperative function have been previously documented in various studies [4, 8, 20]. Further research would be needed to better elucidate these potential benefits as they pertain specifically to an arthroscopic posteromedial capsular release.

In summary, the technique of an arthroscopic posteromedial capsular release with the use of a posteromedial arthroscopic portal, and under direct visualization, provides an effective means to treat patients with symptomatic loss of knee extension for whom full extension cannot be achieved via a manipulation under anesthesia. Careful attention to the arthroscopic and rehabilitation principles reviewed can lead to improved knee motion in the majority of patients with this complex problem.

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