

# Lysis of Pretibial Patellar Tendon Adhesions (Anterior Interval Release) to Treat Anterior Knee Pain after ACL Reconstruction

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## Abstract

We report the clinical results of an anterior interval release for recalcitrant anterior knee pain associated with decreased patellar mobility after anterior cruciate ligament (ACL) reconstruction.

Thirty consecutive patients with recalcitrant anterior knee pain and decreased patellar mobility after ACL reconstruction underwent an arthroscopic lysis of adhesions and scar of the distal patella tendon from the proximal anterior tibia (anterior interval release). Anterior knee pain was initially treated nonoperatively. Failure of nonoperative treatment was defined by recalcitrant anterior knee pain and no improvement in functional outcome, assessed by Lysholm scores and patient questionnaires. Minimum clinical follow-up was 2 years. All anterior interval release procedures were also performed by the senior author using a high inferolateral viewing portal in order to arthroscopically evaluate the anterior interval between the patella tendon and tibia. Prior to anterior interval release, Lysholm score averaged 68 (range 18–90). Postoperative Lysholm score averaged 85 (range 68–100) ( $P < 0.0001$ ). Postoperative range-of-motion did not change significantly. Postoperative instability examinations were all graded zero using the International Knee Documentation Committee (IKDC) system. Average patient satisfaction at follow-up was 8.0 (1 = very dissatisfied; 10 = very satisfied).

Early operative intervention with an anterior interval release has been shown in this series to result in significantly improved functional out-

comes in the treatment of recalcitrant anterior knee pain after ACL reconstruction.

## Introduction

Arthroscopic anterior cruciate ligament (ACL) reconstruction has become one of the most commonly performed procedures in orthopedic surgery and knee reconstruction.<sup>13,14,21</sup> Over the last decade, the results of arthroscopic ACL reconstruction have remained outstanding in most peer-reviewed series, regardless of surgical technique.<sup>13,21</sup> However, the published literature regarding postoperative complications after ACL reconstruction remains quite sparse.<sup>5,6,10,38</sup>

Anterior knee pain is a well-documented complication after arthroscopic ACL reconstruction and has been reported as the most common complaint after ACL surgery.<sup>1,6,10,19,30,31,34,38</sup> While the initial studies reported anterior knee pain after patellar tendon autograft reconstruction, recent work confirms a real incidence of anterior knee pain even after hamstring or allograft ACL reconstruction.<sup>1,32</sup> Consequently, the etiology of this anterior knee pain remains elusive and controversial.<sup>6,12,24,27,32</sup>

Paulos et al.<sup>26,27</sup> were the first to describe the “infrapatellar contracture syndrome (IPCS),” an “exaggerated pathologic fibrous hyperplasia” of soft tissue in the anterior knee after intra-articular surgery and specifically after ACL reconstruction. IPCS can create significant arthrofibrosis, loss of knee motion, decreased patellar mobility (“patellar entrapment”), and even patella infera. The diagnosis of IPCS according to these authors

was based on a “decrease in patellar mobility as compared with the opposite knee,” zero or negative passive patellar tilt, and less than 2 cm of superior/inferior patellar glide. Without appropriate identification and aggressive treatment, IPCS after ACL reconstruction results in significant functional morbidity.

Several others have also documented the incidence of adhesions of the patellar tendon to the anterior tibia after arthroscopic procedures.<sup>2,4,8,15,16,20,22,26-29,33,36,37</sup> Ahmad et al.<sup>2</sup> demonstrated the biomechanical effect of such patellar tendon adhesions to the anterior tibia. These authors documented an effective patella infera when the patellar tendon was adhered to the anterior tibial cortex in this pretibial recess. The adhesions were shown to significantly alter both patellar and tibial kinematics and contact – potentially increasing patellofemoral and tibiofemoral contact forces that may eventually result in arthrosis.<sup>2,8,15,35,41</sup>

We have encountered a population of patients with recalcitrant anterior knee pain after ACL reconstruction that have failed conservative treatment and have subtle alterations in patellar mobility despite a full range of flexion and extension. To our knowledge, this clinical entity and its appropriate treatment have not yet been described. We report here the clinical results of an arthroscopic release of pathologic adhesions in the pretibial recess (anterior interval release) in these patients to treat the anterior knee pain.

## Materials and Methods

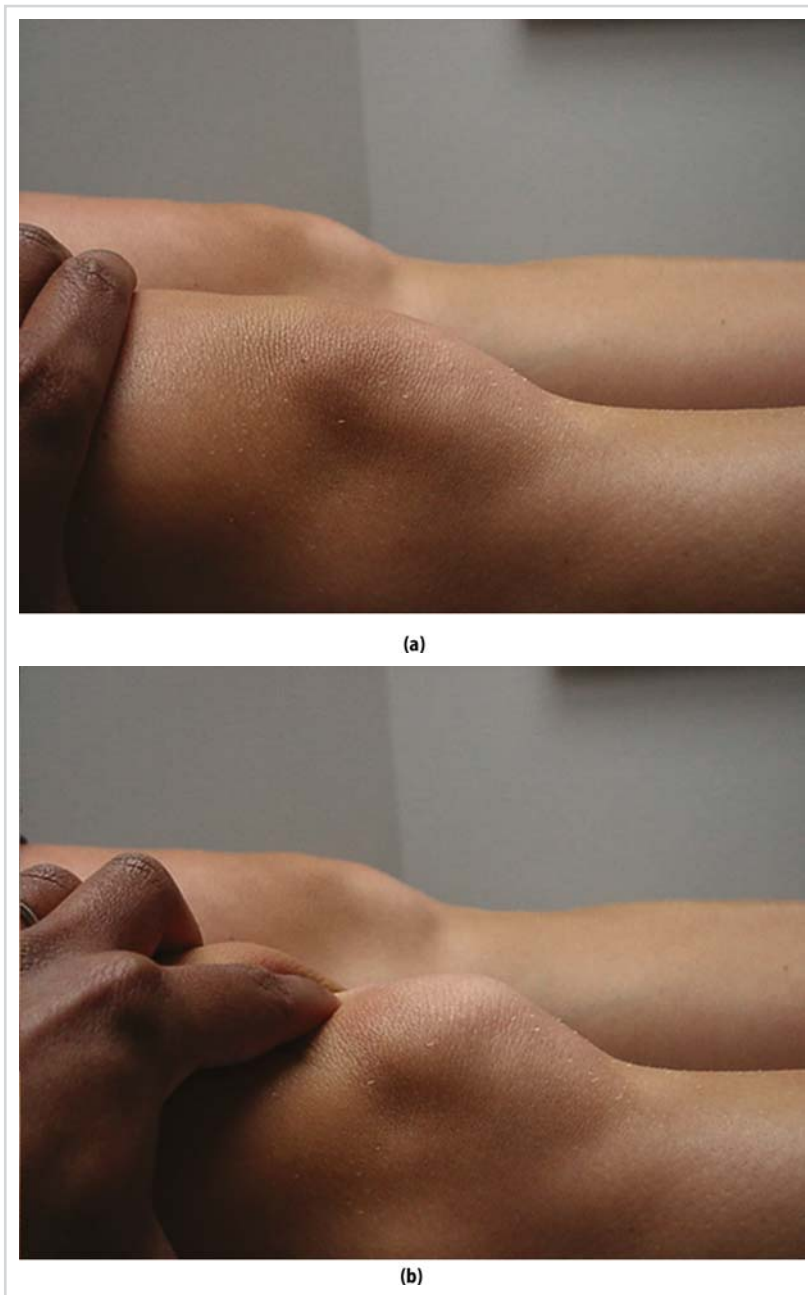
Between 1992 and 1998, 30 consecutive patients with recalcitrant anterior knee pain after isolated ACL reconstruction underwent an arthroscopic anterior interval release by the senior author. All 30 patients had previously undergone arthroscopic ACL reconstruction by the senior author, using a 2-incision technique and an ipsilateral bone-patellar tendon-bone autograft with interference screw fixation. Mean age at the time of ACL reconstruction was 32 years (range 16–43 years). There were 14 men and 16 women patients. For all 30 patients, the ACL reconstruction was the first surgery performed on that knee. Mean duration between injury and ACL reconstruction was 6 weeks (range 2–16 weeks). No patient demonstrated abnormal posterior, posterolateral, varus, or valgus examinations. Criteria required before proceeding with ACL reconstruction included ability to perform a supine straight-leg raise, flexion greater than

90°, and no warmth of the knee relative to the contralateral side.<sup>7,33</sup> Intraoperatively, no patient demonstrated other ligament pathology in addition to the ACL injury. Seventeen patients underwent concurrent meniscus trephination, and no patients underwent a meniscus repair. Postoperative rehabilitation followed the same protocol: full passive and active range-of-motion exercises (with emphasis on terminal extension), crutches in the immediate postoperative period with progressive full weightbearing, and a hinged knee brace for the first 6 postoperative weeks. Strengthening exercises did not begin until full range-of-motion was achieved.

All 30 patients complained of disabling anterior knee pain within 6 weeks of the ACL reconstruction. All Lachman examinations were graded zero using the International Knee Documentation Committee system (IKDC). Physical examination demonstrated significantly restricted passive patellar and patellar tendon mobility relative to the contralateral side, both in medial/lateral and in superior/inferior excursion. All patients demonstrated less than 2 cm of superior/inferior passive patellar excursion, decreased medial/lateral passive patellar excursion relative to the contralateral side, and an inability to passively “tilt” the inferior pole of the patella away from the anterior tibial cortex (Figure 18.1).<sup>20,28</sup> Range-of-motion in all 30 patients averaged 0° of extension (range 5° of hyperextension to a 3° lack of full extension) and 140° of flexion (range 130°–155°). No patients demonstrated either a 10° or greater loss of knee extension or a 25° or greater loss of knee flexion.<sup>20,28</sup>

Initial treatment consisted of nonsteroidal anti-inflammatory (NSAID) medication, patellar mobilization exercises, and closed-chain quadriceps-strengthening exercises for a minimum of 12 weeks in all 30 patients. Failure of conservative treatment was identified by recalcitrant anterior knee pain and no further improvement in functional outcome as assessed by a standardized patient questionnaire and the scoring system of Lysholm and Gillquist.<sup>39</sup>

The anterior interval release was performed at a mean duration of 9 months after the ACL reconstruction (range 6–12 months). Postoperative rehabilitation consisted of immediate passive patellar mobilization exercises, immediate progressive weightbearing with crutches, and no brace.



**Figure 18.1.** Normal passive "tilt" of the inferior pole of the patella away from the anterior tibial cortex.

Minimum clinical follow-up after the anterior interval release was 2 years. All patients were objectively examined by the senior author, functionally evaluated using the scoring system of Lysholm and Gillquist,<sup>39</sup> and subjectively evaluated using a standardized patient ques-

tionnaire. The questionnaire documents pain, stiffness, function during daily and sporting activities, and satisfaction based on a 10-point scale (1 point = very dissatisfied; 10 points = very satisfied). Statistical significance for data analysis was set at  $P < 0.05$ .

## Surgical Technique for Arthroscopic Anterior Interval Release

Arthroscopy was performed with the arthroscope in an inferolateral portal relative to the patella and the working instruments in an inferomedial portal. In all cases, the inferolateral viewing portal was placed at the level of the patella with the knee in full extension (Figure 18.2). This high portal (originally described by Patel<sup>23</sup>) is approximately 1 cm proximal to the standard inferolateral arthroscopy portal and provides clear visualization of the anterior soft tissues in the retropatellar and pretibial regions.<sup>23</sup>

After standard arthroscopic evaluation of the knee and confirmation of an intact ACL graft, the infrapatellar and suprapatellar regions were evaluated. In all cases, the infrapatellar fat pad and patellar tendon were adhered to the anterior tibial cortex below the inferior pole of the patella. These anterior interval adhesions prevented normal motion of the intermeniscal ligament over the tibial plateau during dynamic flexion and extension. An anterior interval release was performed by releasing this scar tissue (Figure 18.3) from medial to lateral just anterior to the peripheral rim of the anterior horn of each meniscus (Figure 18.4A). The release was performed either with electrocautery or with a thermal ablation device (Arthrocare, Arthrocare Corporation, Sunnyvale, California, USA). The release also proceeded from proximal

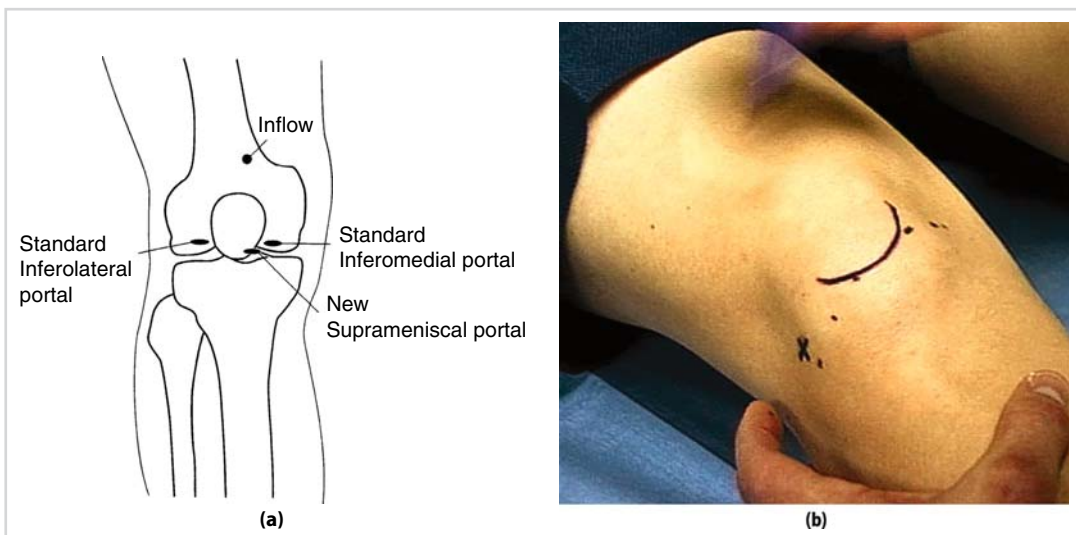
(at the level of the meniscus) to approximately 1 cm distal along the anterior tibial cortex (Figure 18.4B). Great care was taken to avoid cauterizing or burning the bone of the anterior tibia or the patellar tendon. Meticulous hemostasis was obtained prior to completion of the procedure by cauterizing any bleeding vessels in the infrapatellar fat pad.

## Results

Examination under anesthesia revealed all patients had less than 2 cm of superior/inferior passive patellar excursion, decreased medial/lateral passive patellar excursion relative to the contralateral side, and an inability to passively tilt the inferior pole of the patella away from the anterior tibial cortex. Intraoperative examination immediately after anterior interval release demonstrated that all patients had at least 2 cm of superior/inferior passive patellar excursion, equal medial/lateral patellar excursion relative to the contralateral side, and the ability to passively tilt the inferior pole of the patella away from the anterior tibial cortex.

Postoperative range-of-motion did not change significantly from the preoperative evaluation and averaged 0° of extension (range 5° of hyperextension to 2° lack to full extension) and 145° of flexion (range 140°–155°).

Postoperative stability examinations revealed IKDC grade zero Lachman, posterior drawer,



**Figure 18.2.** High inferolateral viewing portal for the arthroscope.

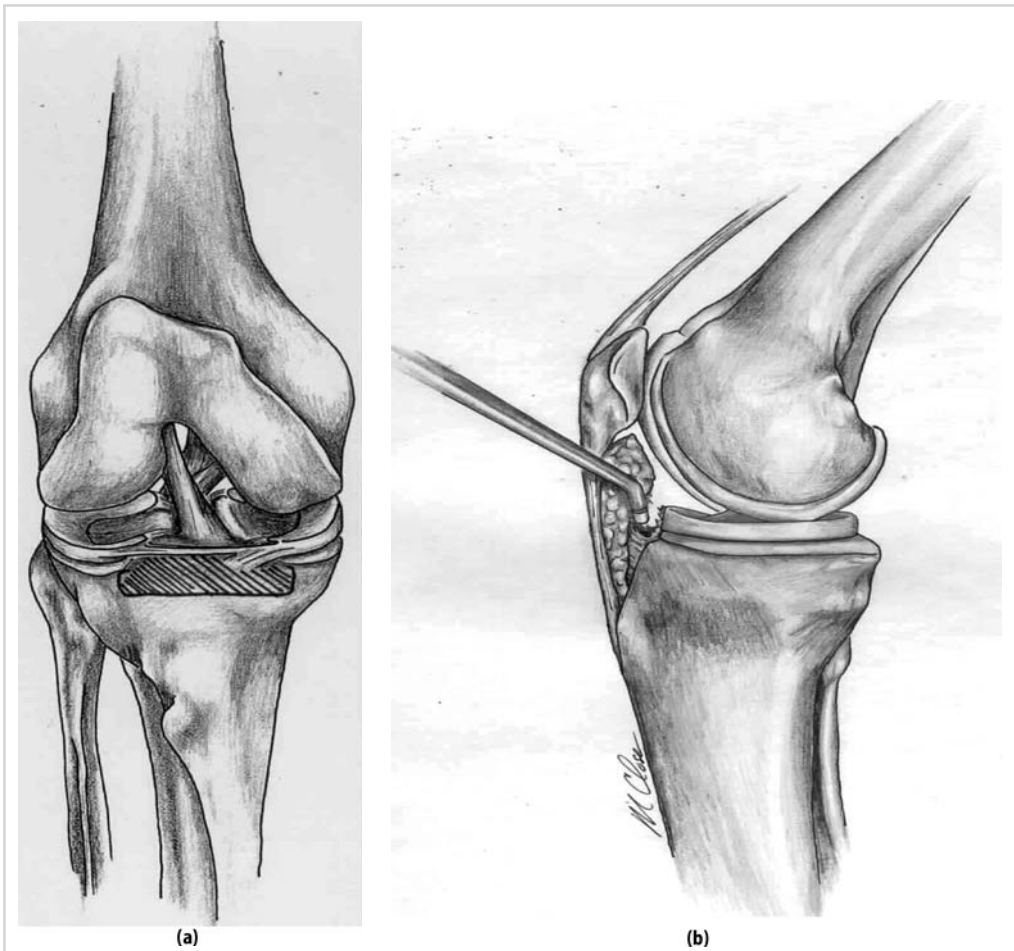


**Figure 18.3.** “Anterior interval release” from medial to lateral just anterior to the peripheral horn of each meniscus.

varus stress, and valgus stress tests. Postoperative posterolateral corner examination was normal in all patients.

After failure of nonoperative treatment, preoperative Lysholm score averaged 68 (range 18–90). After arthroscopic anterior interval release, postoperative Lysholm score significantly increased to an average of 85 (range 68–100) ( $P < 0.0001$ ).

Based on the preoperative patient questionnaires, 74% of patients reported moderate to severe pain, 63% reported moderate to severe stiffness, and 58% reported that their knee functioned abnormally. Postoperatively, 21% reported moderate to severe pain, 5% reported moderate to severe stiffness, and 16% reported that their knee functioned abnormally.



**Figure 18.4.** Drawing of anterior interval release, demonstrating area of medial-lateral release (a) and superior-inferior release from the level of the meniscus to approximately 1 cm distal along the anterior tibial cortex (b).

Preoperatively, average patient satisfaction was 2.0 (range 1–5) while postoperatively, average patient satisfaction increased to 8.0 (range 5–10) (1.0 = very unsatisfied; 10 = highly satisfied).

## Complications

Six of the 30 patients (20%) underwent reoperation within 1 year after the initial anterior interval release for recalcitrant anterior knee pain. Preoperative evaluation, as well as examination under anesthesia, revealed that patellar entrapment had recurred with less than 2 cm of passive superior/inferior excursion and an inability to passively tilt the inferior pole of the patella away from the anterior tibial cortex.<sup>20,28</sup> In all 6 cases, scar tissue had reformed in the anterior interval and was again released arthroscopically. Qualitatively, the scar tissue appeared to be less robust than the tissue identified in the initial anterior interval release procedure. Postoperative rehabilitation in these patients stressed patellar mobilization exercises. No other complications or reoperations occurred in this population of patients during the study period. No patients suffered from patellar tendonitis during the study period.

## Discussion

Postoperative adhesions of the patellar tendon to the anterior tibia (anterior interval scarring) have been described by several authors.<sup>2,4,8,15,16,20,22,26-29,33,36,37</sup> The etiology of these adhesions remains unknown. Hughston<sup>10</sup> has proposed that iatrogenic injury to the infrapatellar fat pad and subsequent scarring is the responsible cause, and Rosenberg et al.<sup>30</sup> have documented this scarring via computed tomographic scan after patellar tendon graft harvest for ACL reconstruction. Still, the correlation between such anterior interval scarring and anterior knee pain after ACL reconstruction has remained controversial.

We hypothesized that the cause of recalcitrant knee pain after ACL reconstruction in this patient population was anterior interval scarring. Release of this scarring significantly improved functional outcome scores in the majority of patients. We postulate that the cause of this scarring after ACL reconstruction is the hematoma that necessarily forms in the soft tissues of the anterior knee after drilling of the tibial tunnel. Based on this same proposed mechanism, current investigation is underway evaluating the incidence of anterior interval scarring and recalcitrant anterior knee

pain after either hamstring or allograft ACL reconstruction.

Noyes et al.<sup>20</sup> have proposed that patellar adhesions and associated subtle patella infera may lead to patellar pain due to increased stress on the patellofemoral cartilage. In a retrospective review, Rosenberg et al.<sup>30</sup> identified narrowing of the patellofemoral joint space in over 50% of their patients with ACL-reconstructed knees, relative to the contralateral uninjured side. Furthermore, Paulos et al.<sup>26-28</sup> have documented the clear association between patella infera and radiographic changes of patellofemoral arthrosis in patients with patellar entrapment and IPCS. These findings were confirmed by Millett et al.<sup>16</sup> who identified patella infera and patellofemoral arthrosis in cases of global arthrofibrosis. These reports suggest that abnormal stress on the patellofemoral articulation can be a leading cause of anterior knee pain after ACL reconstruction.

Ahmad et al.<sup>2</sup> have biomechanically demonstrated the alteration in contact position in the patellofemoral articulation due to anterior interval adhesions. Such altered contact appears to lead to altered stress in the cartilage and may lead to recalcitrant anterior knee pain.<sup>8,15,35,41</sup> Several authors have described the surgical management of these adhesions when associated with IPCS or arthrofibrosis of the knee.<sup>3,4,7,11,16,17,22,29,36,37,40</sup> Paulos et al.<sup>26,28</sup> recommend resecting all fibrous scar tissue between the inferior pole of the patella and the anterior tibial plateau and releasing the patellar tendon from the anterior tibial cortex (anterior interval release). Richmond et al.<sup>29</sup> describe arthroscopically resecting fibrotic areas of the infrapatellar fat pad and also releasing the adhesion of the fat pad to the anterior tibia (anterior interval release). In both of these published studies, anterior interval adhesions were associated with significant arthrofibrosis of the knee and significant preoperative limitations of motion in terminal extension and/or terminal flexion.

The group of patients in the present study represents a special population whose appropriate management, to our knowledge, has not yet been documented in the peer-reviewed literature. These patients all experienced recalcitrant anterior knee pain that was clearly refractory to conservative treatment, all demonstrated pathological restriction of patellar and patellar tendon mobility, but all patients maintained a preoperative range-of-motion that did not qualify for a diagnosis of IPCS based on the criteria

published by Paulos et al.<sup>28</sup> In our opinion, this group of patients represents an earlier (perhaps less aggressive) stage of anterior interval scarring, which may eventually lead to full-blown IPCS. However, all patients experience significant functional morbidity due to this anterior interval scarring, despite a preserved arc-of-motion. It is the diagnosis and prompt treatment of these patients that is the focus of this study.

All 30 patients presented here suffered from recalcitrant anterior knee pain after ACL reconstruction. All failed at least 3 months of conservative treatment. One weakness of this retrospective study is the lack of a designated concurrent control group. However, those patients in our clinical experience with anterior knee pain after ACL reconstruction whose pain resolved and who regained patellar mobility after 3 months or less of conservative treatment became the inherent control group to aid in the decision to proceed to surgical management. Based on this clinical experience, we have arbitrarily identified a timeline of at least 3 months of failed conservative treatment and at least 6 months after the ACL reconstruction as the point at which surgical management should be considered.

All of the patients presented here demonstrated subtle finding of patellar entrapment: decreased superior/inferior passive patellar excursion (less than 2 cm), decreased medial/lateral passive patellar excursion, and inability to passively tilt the inferior pole of the patella and the patellar tendon away from the anterior tibial cortex.<sup>20,28</sup> Paulos et al.<sup>26,28</sup> describe limitation of flexion and/or extension along with the abnormality in patellar mobility. In our opinion, the study group presented here is too early in the natural course of anterior interval scarring to demonstrate restricted motion. The hallmark clinical signs described previously for abnormal patellar mobility remain important in our evaluation of all patients after ACL reconstruction, especially those with anterior knee pain. If the subtle signs of decreased passive patellar excursion and tilt are identified early, we remain confident that the majority of these patients can be managed with nonoperative methods for their anterior knee pain.

The findings of this study have led us to alter both our surgical technique during ACL reconstruction and our initial postoperative management of all patients undergoing ACL reconstruction. Intraoperatively during the recon-

struction, we pay particular attention to avoiding injury to the infrapatellar fat pad and to obtaining meticulous hemostasis. Postoperatively, we now emphasize passive patellar mobility in the immediate and ensuing postoperative periods and also focus on obtaining terminal knee extension. Shelbourne et al.<sup>32</sup> have indicated that perhaps the incidence of anterior knee pain after ACL reconstruction may be reduced by obtaining full extension postoperatively. However, as demonstrated in the biomechanical model of Ahmad et al.,<sup>2</sup> anterior interval scarring and patellar tendon adhesions cause anterior tibial translation. In this clinical situation, emphasizing extension can be *detrimental* since full extension may excessively stress the ACL graft when anterior interval scarring is present, due to anterior tibial translation. These findings have led us to pay close attention to patella and patellar tendon mobility and excursion during the physical examination of any patient with an ACL reconstruction, to prevent these potential complications.

Six patients (20%) in this study developed recurrent intractable anterior knee pain after the initial anterior interval release procedure, requiring a second arthroscopic procedure. This is a significant portion of the patient population in this study group. Potential reasons for failure of the first anterior interval release procedure are either an error in appropriately diagnosing the etiology of the anterior knee pain or a technical failure to adequately perform the anterior interval scar tissue release. Both of these points highlight weaknesses in the present study design and patient population. However, all procedures were performed by the same experienced knee surgeon. Furthermore, we continue to encounter a subgroup of this patient population that requires a second anterior interval release procedure because the scarring and adhesions have reformed. In all of these cases, the scar tissue is clearly less abundant but still restricts patella mobility. Again, we cannot definitively conclude whether this scar tissue either was inadequately released in the first procedure or recurred secondary to the particular biology of each patient. Still, the fact that these 6 patients experienced initial pain relief after the first (and again after the second) anterior interval release is encouraging for the correctness of both diagnosis and surgical management.

During the surgical management of anterior interval scarring, we have identified certain key aspects of the anterior interval release. The most

important technical point is the use of the inferolateral arthroscopic viewing portal of Patel.<sup>23</sup> This portal (placed lateral to the patellar tendon at the level of the inferior pole of the patella with the knee in full extension) allows for a “bird’s-eye” view of the anterior soft tissues of the knee. In our experience, if this high viewing portal is not used, the standard inferolateral portal (just above the level of the meniscus) prevents adequate evaluation of the anterior interval – possibly contributing to missed anterior interval pathological scarring.

Lastly, during the anterior interval release, it is important to clearly visualize the anterior horns of each meniscus during the division of scar tissue to prevent iatrogenic damage. In addition, the intermeniscal ligament should be clearly identified, both to demarcate the anterior interval and to prevent iatrogenic destabilization of the meniscal horns. The release should progress distally from the level of the meniscal horns by approximately 1 cm along the anterior tibial cortex. Care should be taken not to cauterize or burn the bone of the anterior tibia or the patellar tendon. In our experience, the release is complete when the intermeniscal ligament and the anterior horn of the medial meniscus moves more than 1 cm over the tibial plateau during full flexion and extension. Also, the infrapatellar fat pad can be seen to lift away from the anterior tibial cortex after adequate release.

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