Arthroscopic Lysis of Adhesions for Treatment of Post-traumatic Arthrofibrosis of the Knee Joint

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Abstract: Normal knee range of motion varies slightly between individuals and measures approximately 0° to −5° of extension to 140° of flexion. A full arc of motion is required for normal gait and knee function. Loss of normal joint range of motion may occur after a traumatic knee injury and may contribute to increased pain, lower functional outcome scores, and decreased patient satisfaction. Although multiple factors may contribute to the development of motion loss, the occurrence of intra-articular scar tissue adhesions, or post-traumatic arthrofibrosis, may limit the patient's knee motion in the early postoperative period. Once motion loss has been identified, it can be a challenging complication to manage. Arthroscopic lysis of adhesions with manipulation under anesthesia is a reliable surgical technique that can improve range of motion in patients with knee stiffness due to post-traumatic arthrofibrosis.

Normal knee range of motion varies slightly between individuals and measures approximately 0° to −5° of extension to 140° of flexion. A full arc of motion is required for normal gait and knee function. Loss of normal range of motion may occur after a traumatic knee injury and may contribute to increased pain, lower functional outcome scores, and decreased patient satisfaction. Minor loss of motion in terminal extension can significantly alter knee function. The patellofemoral joint reactive force decreases as the knee is extended, and the inability to obtain terminal extension may result in muscle fatigue and increase a patient's risk of patellofemoral arthritis.[1,2] Loss of extension may be due to intra-articular or extra-articular factors. Jackson and Schaefer[3] coined the term "cyclops lesion" to describe a fibro-proliferative scar formation occurring in the intercondylar notch. The resulting mass effect in the intercondylar notch may contribute to extension loss and/or restrict flexion by limiting patellar motion. Patellar excursion may be limited by adhesions between the ligamentum mucosum and prepatellar fat pad or by adhesions located in the medial and lateral gutters.[4] As motion loss becomes more chronic, extra-articular musculotendinous contracture may develop and contribute to motion loss.

In a meta-analysis by McNamara et al.,[5] the mean knee range of motion after open reduction−internal fixation for tibial plateau fractures was 109°. Several risk factors for motion loss after traumatic knee injury have been identified, including fracture severity, external fixation, malreduction, soft-tissue injury, surgical timing, and postoperative immobilization. Well-performed surgical techniques such as anatomic fracture reduction, stable internal fixation, and early range of motion may decrease the risk of post-traumatic arthrofibrosis; however, residual motion loss is a common complication after traumatic knee injury.

Arthroscopic lysis of adhesions with manipulation under anesthesia (MUA) is not a newly described technique for the treatment of knee stiffness. In 1982 Sprague et al.[6] described their technique for percutaneous release of adhesions under arthroscopic control, reporting a mean passive flexion increase from 70° to 115°. In 1987 Paulos et al.[4] described both open and arthroscopic techniques for flexion loss due to arthrofibrosis and contracture affecting the patella. More recently, a 9-step arthroscopic sequence to address intra-articular adhesions was described by Kim et al.[7] to systematically identify and address intra-articular adhesions. We routinely perform our surgical interventions using this systematic arthroscopic surgical approach (Video 1).

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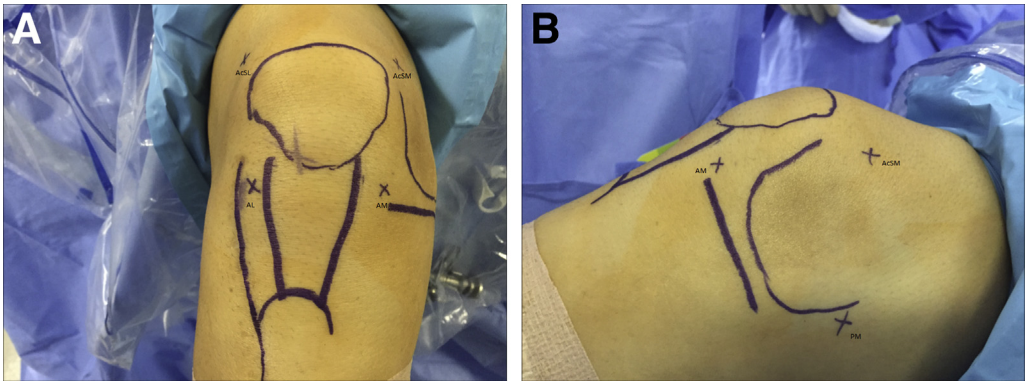

Fig 1. The patient is positioned supine, with the right knee held in an arthroscopic leg positioner. A sterile skin marker is used to show the anatomic landmarks and portal placement used to perform arthroscopic lysis of adhesions, followed by manipulation under anesthesia. Anterior (A) and medial (B) views of the knee show portal placement. One should note that the prior surgical incision has been marked, which was a lateral approach used to perform open reduction−internal fixation for a fracture of the tibial plateau. For this procedure, standard anteromedial (AM) and anterolateral (AL) portals are used, in addition to accessory posteromedial (PM), accessory medial suprapatellar (AcSM), and accessory lateral suprapatellar (AcSL) portals, as shown in these preoperative photographs.

Surgical Technique

The procedure is performed with a standard 30° arthroscope (Stryker 4-mm 30° Ideal Eyes arthroscope), an arthroscopic shaver (Stryker 4.0-mm Formula Series Tomcat arthroscopic shaver), and an arthroscopic ablator (Stryker 3.5-mm 90-S SERFAS Energy Suction Probe). The patient is prepared and draped in routine fashion. An arthroscopic leg holder is used, which facilitates access for instrumentation in the posterior joint space. The arthroscopic portals used for the procedure include standard anteromedial and anterolateral portals, medial and lateral suprapatellar portals, and posteromedial and posterolateral accessory portals. After insufflation of the joint, the arthroscope is inserted into the anterolateral portal, and a diagnostic arthroscopy of the anterior compartments is performed. A standard anteromedial portal is established, and the debridement begins in the medial aspect of the suprapatellar region. Tissue adhesions are identified and debrided with an arthroscopic shaver (Fig 1). Most of the arthroscopic debridement is performed with the arthroscopic shaver, which minimizes the risk of thermal injury to the articular cartilage. After lysis of the intra-articular adhesions, a medial release is performed. We routinely perform medial and lateral releases in patients with limited patellar mobility. The debridement is continued proximally to the level of the vastus medialis musculature and quadriceps tendon, which serve as the anatomic landmarks for the proximal extent of the capsular release (Fig 1B). Next, the arthroscope is moved into the anteromedial portal, and the arthroscopic shaver is placed into the anterolateral portal. Again, adhesions in the suprapatellar region are debrided. A lateral retinacular release is then performed

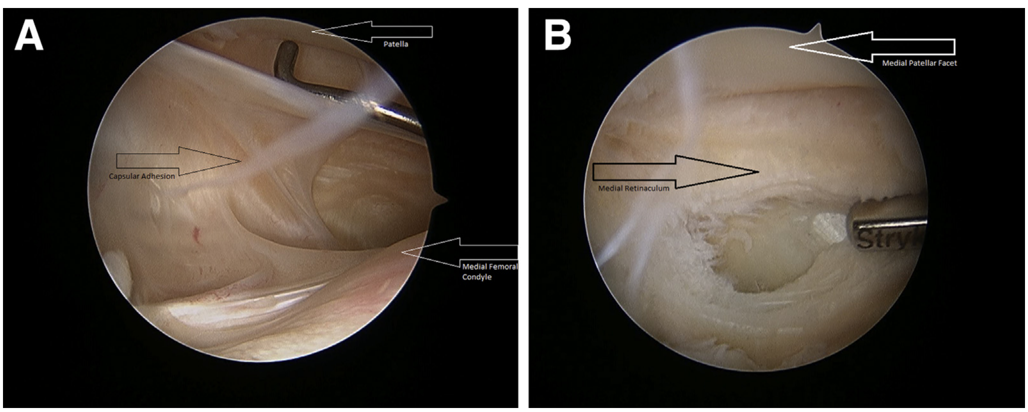

Fig 2. In the right knee, the arthroscope is placed in the anterolateral portal, viewing the suprapatellar region and the medial retinaculum. (A) Capsular adhesions are identified in the medial recess, which restrict patellar mobility. (B) The same arthroscopic field of view is shown, after lysis of adhesions has been performed, showing the medial capsular release. This release is being performed with a 4.0-mm arthroscopic shaver.

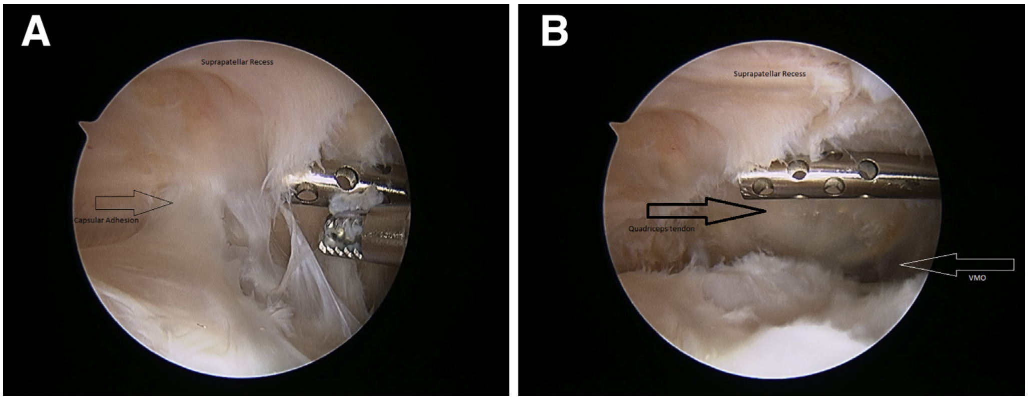

Fig 3. With the arthroscope placed in the anterolateral portal of the right knee and visualizing the suprapatellar region, the capsular release is continued superiorly. (A) The suprapatellar region is visualized before debridement and clearly shows significant adhesions between the quadriceps tendon and suprapatellar fat pad. (B) The same arthroscopic field of view is shown after debridement and capsular release. One should note the quadriceps tendon and fibers of the vastus medialis oblique (VMO), which serve as the anatomic landmarks for the superior extent of capsular release. Debridement should continue superiorly until the undersurface of the quadriceps tendon and the VMO are clearly visualized.

in a line from the quadriceps musculature superiorly and carried distally to the level of the anterolateral arthroscopic portal.

With the arthroscope placed back in the anterolateral portal and shaver in the anteromedial portal, the intercondylar region is debrided. Adhesions between the infrapatellar fat pad and ligamentum mucosum are debrided to allow visualization of the femoral insertion of the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL). It is not uncommon to encounter highly vascularized scar tissue in this region, and we recommend the use of an arthroscopic ablator in this region to minimize bleeding and postoperative hemarthrosis. Next, the interval between the ACL and lateral femoral condyle is developed with the arthroscopic shaver in preparation for instrumentation and viewing in the posterolateral joint space. Similarly, with the arthroscope placed in the anteromedial portal and the shaver placed in the anterolateral portal, the interval between the PCL and medial femoral condyle is developed. In cases in which there is dense scar tissue beneath the femoral attachments of the ACL or PCL, a limited notchplasty of the medial or lateral femoral condyle may facilitate arthroscopic access to the posterior joint spaces.

With the arthroscope placed in the anteromedial portal, access to the posteromedial joint space is obtained by passing the arthroscope beneath the femoral attachment of the PCL as the leg is held in approximately 30° of flexion. By use of a spinal needle, the location of a posteromedial portal is identified. A superficial skin incision is made, and a blunt trocar

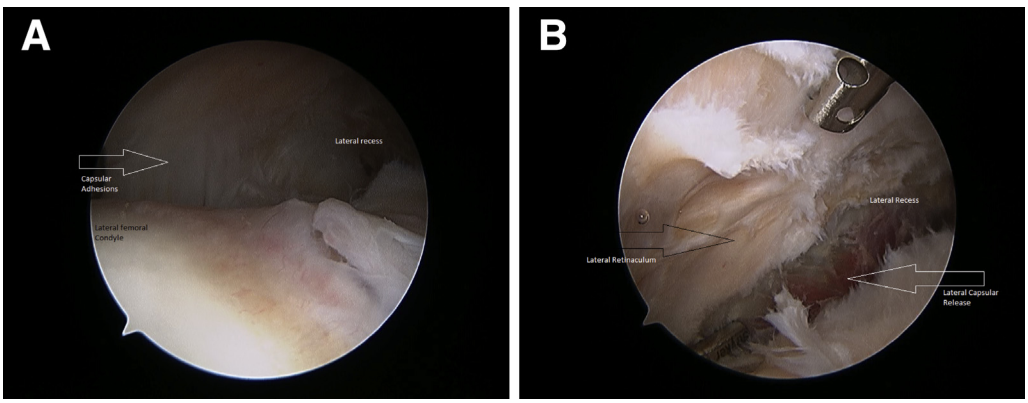

Fig 4. In the right knee, the arthroscope is placed in the anteromedial portal and the arthroscopic shaver is placed in the anterolateral portal to visualize the lateral recess. (A) Arthroscopic field of view before debridement and capsular release. (B) Continuation of the superior capsular release into the lateral capsular recess. Adhesions of the lateral retinaculum are debrided, and a lateral release is performed. The lateral release completes what is a nearly circumferential capsular release in the suprapatellar region, resulting in improved patellar excursion and greater knee flexion.

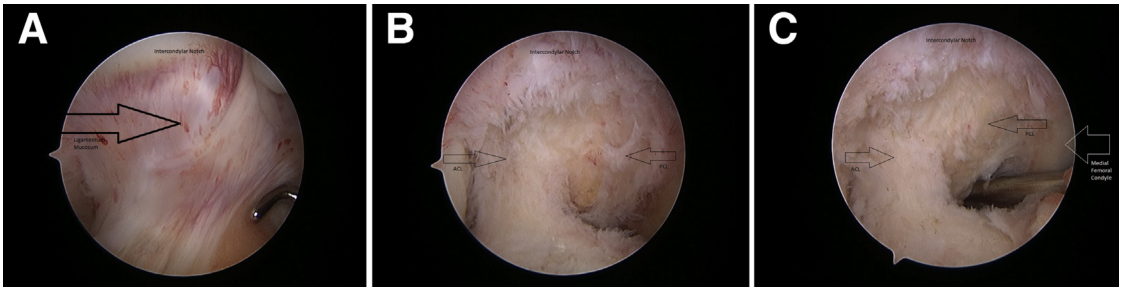

Fig 5. The arthroscope is placed in the anterolateral portal of the right knee, visualizing the intercondylar notch. (A) Arthroscopic field of view before debridement. One should note the hypertrophic ligamentum mucosum. Significant debridement may be required in this region, and an arthroscopic ablator can be used to coagulate the highly vascular scar tissue found in this region. (B) The intercondylar notch is visualized after extensive arthroscopic debridement. The tibial attachment of the anterior cruciate ligament (ACL) and femoral attachment of the posterior cruciate ligament (PCL) can now be clearly visualized. (C) Insertion of the arthroscopic shaver beneath the femoral attachment of the PCL to perform a "limited" notchplasty. Debridement beneath the femoral insertions of the ACL and PCL will facilitate access into the posteromedial and posterolateral joint spaces.

and cannula are placed percutaneously to establish the portal. By use of a sweeping motion in line with the femoral axis, a viewing space is created. The arthroscopic shaver is introduced, and debridement of the posterior capsular adhesion is performed. Care is taken not to carry the debridement laterally to the view of the arthroscope because the popliteal neurovascular bundle is directly adjacent to the capsule at this level. After debridement of scar tissue adhesions, a formal release of the posterior capsule can be performed. This release should be performed at the level of the medial gastrocnemius insertion on the distal femur. The fibers of the medial gastrocnemius tendon serve as a useful anatomic landmark to confirm complete capsular release (Figs 2-7). Next, the arthroscope is brought back into the anterior compartment, and under direct visualization, a switching stick is placed under the ACL into the posterolateral compartment. A 6.5-mm arthroscopic cannula is placed over the switching stick and then replaced with the arthroscope, allowing visualization of the posterolateral joint space. Under direct visualization, a spinal needle is used to establish a posterolateral portal. A switching stick is placed, and blunt dissection is used to sweep back and forth along the posterior cortex of the femur. The arthroscopic shaver is placed, and capsular release is performed. Care is taken to control the shaver suction and avoid debridement medial to the arthroscopic view. Of note, the popliteal neurovascular bundle passes slightly lateral to the midline, and care should be taken not to carry the capsular release too far medially.

After arthroscopic debridement and posterior capsular release, the shaver is placed back into the suprapatellar region and a final irrigation of the joint is performed to

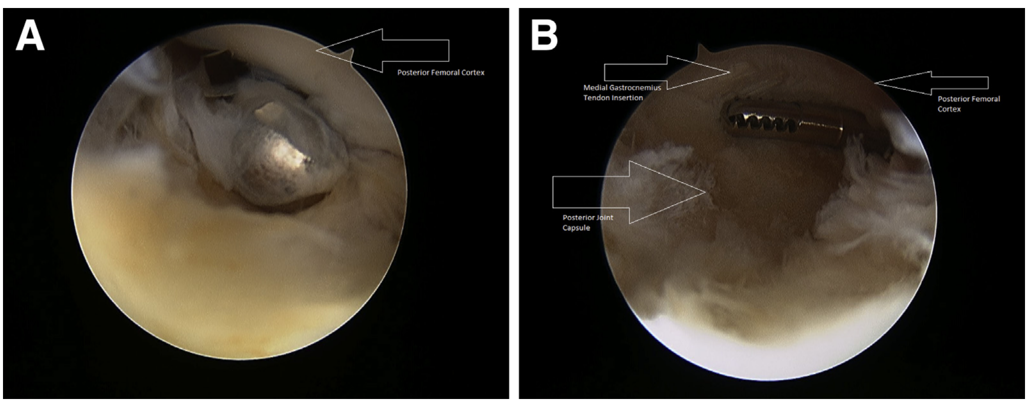

Fig 6. In the right knee, the arthroscope is placed in the anterolateral portal and passed beneath the posterior cruciate ligament insertion on the medial femoral condyle, allowing visualization of the posteromedial joint space. (A) An outside-in technique has been used to establish a posteromedial working portal, and the arthroscopic shaver has been inserted into the posteromedial joint space. One should note the position of the shaver with the blade held facing the posterior femoral cortex while debridement of adhesions is performed. (B) The same arthroscopic field is shown after initial debridement of adhesions. One should note the significant increase in capsular space. After lysis of adhesions is performed, the medial gastrocnemius is palpated deep to the capsule adjacent to its insertion onto the posterior femoral cortex. The posterior capsule is released at the level of attachment on the posterior femur, which allows visualization of the medial gastric tendon insertion.

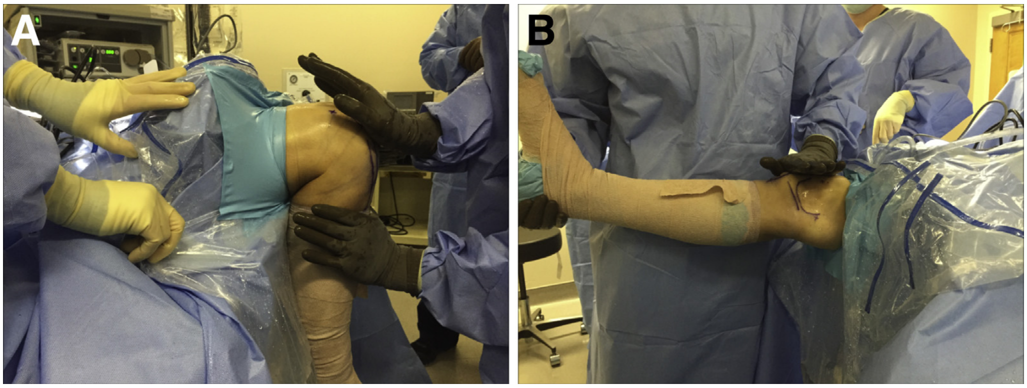

Fig 7. (A, B) An arthroscopic debridement has been completed in this right knee. A manipulation under anesthesia was performed, and improved range of motion was documented with the arthroscope.

remove loose debris. A suction drain is inserted into the medial suprapatellar portal and placed in the medial gutter. The arthroscopic instrumentation is removed, and a formal MUA is performed. Improved range of knee motion is documented using an arthroscopic camera.

After the surgical procedure, a multimodal pain regimen is initiated to reduce pain and inflammation, which includes an indwelling femoral nerve catheter, nonsteroidal anti-inflammatory medications, and narcotic pain medications. The suction drain is removed on postoperative day 2 in the clinic. The indwelling femoral nerve block is used for 72 hours and removed by the patient at home. Physical therapy is initiated the day of the procedure and is performed daily for the first postoperative week and then 2 to 3 times per week for 6 weeks.

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
The arthroscopic technique is minimally invasive.	There is an inability to address extra-articular causes of motion loss and contracture.
Arthroscopic posterior capsular release may result in decreased surgical morbidity compared with open surgical techniques.	There is a risk of injury to the posterior neurovascular structures.
Early recognition of post-traumatic motion loss and early arthroscopic lysis of adhesions may increase functional range of motion in patients with traumatic knee injury and motion loss.	Arthroscopic techniques may not be as beneficial in patients presenting with more chronic motion loss.
Postoperative therapy protocols including aggressive range-of-motion exercises supervised by a physical therapist, as well as a multimodal pain regimen, may increase the likelihood of maintaining range-of-motion gains documented during the surgical procedure.	Even with routine therapy, early motion gains observed in the immediate postoperative period may not be maintained. An inability to comply with an aggressive postoperative physical therapy protocol is a contraindication to surgical intervention.

Discussion

Although multiple factors may contribute to the development of motion loss, the occurrence of intra-articular scar tissue adhesions, or post-traumatic arthrofibrosis, may limit the patient's ability to regain a functional arc of motion in the early postoperative period. Once motion loss has been identified, it can be a challenging complication to manage. With the goal of maintaining a maximal range of knee motion, several treatment options have been recommended to prevent post-traumatic arthrofibrosis. Initial management should focus on control of pain and inflammation, and

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Patient selection is vital to surgical success. The surgeon should consider early operative intervention in compliant patients in whom motion loss is due to postoperative scar tissue, not malreduction or noncompliance.	In a patient who is unwilling to participate in a rigorous postoperative physical therapy program, the range-of-motion improvements gained during the surgical intervention may not be maintained. Noncompliance is a contraindication to surgical intervention.
It is important to use a systematic approach to the surgical debridement to ensure that the arthroscopic procedure will identify and address intra-articular causes of flexion and extension contracture.	Inadequate debridement in the intercondylar region may cause a difficulty or inability to access the posterior compartment of the knee joint arthroscopically.
The surgeon should use electrocautery in areas of highly vascular scar tissue and place a surgical drain to decrease the risk of postoperative hemarthrosis.	Postoperative hemarthrosis may cause significant pain, limiting participation in physical therapy, and increase the risk of recurrent scar tissue formation.
A multimodal pain control regimen should be used, including narcotics, nonsteroidal anti-inflammatory drugs, and an indwelling peripheral nerve block.	Lack of adequate pain control may compromise the postoperative physical therapy program.

a supervised physical therapy program should be initiated in the early postoperative period. Additional modalities include dynamic splinting, continuous passive motion, and MUA. Continuous passive motion and prolonged passive stretching programs have been identified as useful when initiated in the immediate postoperative period. Later in recovery, MUA may be performed if motion loss is recalcitrant to stretching and physical therapy. In a recent study reviewing 40 patients undergoing MUA for motion loss due to post-traumatic knee arthrofibrosis, Sassoon et al.[8] reported a mean range-of-motion arc improvement from 59° to 110°. Moreover, Haller et al.[9] reported successful results when MUA was performed within 3 months of definitive fracture management. Given these findings, dynamic splinting, passive motion, or early manipulation protocols may be most effective when motion loss is treated early in the postoperative period. If motion loss is more severe or identified outside of the early postoperative period (>3 months), an arthroscopic surgical intervention should be considered.

Historically, open surgical techniques have been considered most beneficial in a setting in which scar tissue and contracture limit knee flexion and patellar motion. Open techniques including lysis of infrapatellar and prepatellar adhesions and quadricepsplasty have been reported to be successful in regaining flexion; however, open surgical procedures involve additional surgical morbidity and may be less favorable for management of flexion contracture. Furthermore, open surgical procedures have a significant risk of morbidity or surgical complications related to open surgical dissection in the posterior aspect of the knee joint.[10] There are advantages and disadvantages to an all-arthroscopic technique (Table 1). Although we prefer arthroscopically assisted release, one limitation to an arthroscopic approach would be the inability to address extracapsular causes of motion loss such as muscle and tendon contracture. The addition of open surgical procedures, such as quadricepsplasty and hamstring tendon release, could be considered in patients presenting with more chronic motion loss.

When one is planning an arthroscopic surgical intervention for treatment of post-traumatic arthrofibrosis, it is important to identify and address the structural causes of both flexion and extension loss. Intra-articular causes of flexion loss include capsular adhesions in the suprapatellar region, medial recess, lateral recess, and intercondylar region.[4,6] Loss of extension may be due to the mass effect of intercondylar adhesions or posterior capsular adhesions. The ability to access both anterior and posterior compartments in a minimally invasive manner makes arthroscopic lysis of adhesions an attractive treatment option. There are several pearls and pitfalls relating to an all-arthroscopic surgical technique (Table 2). When one is planning the surgical procedure, it is important to recognize motion loss early in the postoperative period. Early surgical intervention may prevent the development of extra-articular musculotendinous contracture necessitating an open surgical intervention. We routinely consider arthroscopic lysis of adhesions between 3 and 6 months after definitive fracture management in patients presenting with a total arch of motion of less than 100° or flexion contracture of greater than 15°. The ideal surgical candidate also has shown compliance with a supervised physical therapy program. In conclusion, we have found that arthroscopic lysis of adhesions with MUA is a reliable surgical technique that can improve range of motion in patients with knee stiffness due to post-traumatic arthrofibrosis.

References

1. Magit D, Wolff A, Sutton K, Medvecky MJ. Arthrofibrosis of the knee. *J Am Acad Orthop Surg* 2007;15:682-694.
2. Matthews LS, Sonstegard DA, Henke JA. Load bearing characteristics of the patello-femoral joint. *Acta Orthop Scand* 1977;48:511-516.
3. Jackson DW, Schaefer RK. Cyclops syndrome: Loss of extension following intra-articular anterior cruciate ligament reconstruction. *Arthroscopy* 1990;6:171-178.
4. Paulos LE, Rosenberg TD, Drawbert J, Manning J, Abbott P. Infrapatellar contracture syndrome. An unrecognized cause of knee stiffness with patella entrapment and patella infera. *Am J Sports Med* 1987;15:331-341.
5. McNamara IR, Smith TO, Shepherd KL, et al. Surgical fixation methods for tibial plateau fractures. *Cochrane Database Syst Rev* 2015:CD009679. doi: 10.1002/14651858.CD009679.pub2.
6. Sprague NF, O'Connor RL, Fox JM. Arthroscopic treatment of postoperative knee fibroarthrosis. *Clin Orthop Relat Res* 1982:165-172.
7. Kim DH, Gill TJ, Millett PJ. Arthroscopic treatment of the arthrofibrotic knee. *Arthroscopy* 2004;20:187-194. doi: 10.1016/j.arthro.2004.04.036 (suppl 2).
8. Sassoon AA, Adigweme OO, Langford J, Koval KJ, Haidukewych GJ. Manipulation under anesthesia: A safe and effective treatment for posttraumatic arthrofibrosis of the knee. *J Orthop Trauma* 2015;29:e464-e468. doi: 10.1097/BOT.0000000000000395.
9. Haller JM, Holt DC, McFadden ML, Higgins TF, Kubiak EN. Arthrofibrosis of the knee following a fracture of the tibial plateau. *Bone Joint J Br* 2015;97:109-114. doi: 10.1302/0301-620X.97B1.34195.
10. Oliveira VG, D'Elia LF, Tirico LEP, et al. Judet quadricepsplasty in the treatment of posttraumatic knee rigidity: Long-term outcomes of 45 cases. *J Trauma Acute Care Surg* 2012;72:E77-E80.