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IN BRIEF

Complications in Brief

Meniscus Repair

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Background

The evolution of meniscus repair has led to expanded indications and a proliferation of techniques. We review the complications of meniscal repair associated with preoperative, intraoperative, and postoperative errors.

Avoidance of Major Complications

Establishing an accurate diagnosis and understanding indications for meniscal repair are essential to avoiding complications (Table 1). Patient selection is key and repairs should be reserved for tears that have a good chance of healing. Tears in the avascular inner-third and complex or degenerative tears (Fig. 1) in older patients with limited healing potential should be resected. Concomitant knee ligamentous instability should be addressed to avoid failure of repair.

The repair technique should be tailored for the tear location and size, and the potential complications related to each technique must be considered (Table 2). Vertical mattress constructs with braided nonabsorbable suture yield the most durable repair (Fig. 2). Rasping or augmentation with fibrin clot may promote healing (Fig. 3). Care should be taken to avoid iatrogenic meniscal or chondral injury during instrumentation.

A thorough understanding of the anatomy about the knee (Table 3) is critical to avoid iatrogenic neurovascular injury. The saphenous nerve and vein are at risk with medial repairs and the peroneal nerve is at risk with lateral repairs (Fig. 4). The popliteal vessels and tibial nerve are in close proximity to the posterior horn of the lateral meniscus.

The postoperative protocol should protect the repair to allow healing while at the same time promote motion to prevent potential arthrofibrosis (Table 4).

Detection and Treatment of Major Complications

Many complications associated with meniscal repair are detected at the initial arthroscopy. Iatrogenic chondral or meniscal injuries should be addressed with debridement or repair. Improperly placed or tensioned sutures or devices should be revised to ensure a stable and durable repair

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Table 1. Complications related to errors in diagnosis/indications.

Complication	Clinical effect	Prevention	Detection	Remedy
Incorrect or incomplete diagnosis [38, 48]	Patient undergoes surgery when the meniscus is not the source of pain	Physical examination should show joint line pain and positive findings on meniscal provocative maneuvers that correlate to the patient's symptoms Correlate imaging studies to examination findings Examination under anesthesia/diagnostic arthroscopy to identify extent of injury or associated injuries	No change in quality of pain after surgery	Evaluate for other potential sources of knee pain
Poor patient selection [8, 13]	Performing surgery for patients who will not benefit or will likely sustain failure of a repair	Patient screening Review expectations and risk factors for unsuccessful repair with the patient Ensure patients will be able to comply with a strict postoperative protocol Repairs are a relative contraindication in patients older than 40 years	Persistent pain or recurrence of symptoms after surgery indicates failure of repair Postoperative MRI to evaluate integrity of repair	Perform meniscectomy in patients who do not meet criteria for repair Return to operating room for resection of failed repair
Repairing chronic or degenerative tears [10, 25, 37]	Degenerative tears are unlikely to heal	Older patients and patients with arthritic changes more likely to have degenerative type tears Chronicity of symptoms could indicate a tear that is more degenerative Comprehensive evaluation of tear type and pattern at arthroscopy	Persistent pain or recurrence of symptoms after surgery indicates failure of repair Postoperative MRI to evaluate integrity of repair	Chronic or degenerative tears should be resected Return to operating room for resection of failed repair
Repairing tears in the avascular zone [8, 19, 39, 49]	Tears in the avascular zone are unlikely to heal resulting in failure of repair	Tears within 3 mm of the meniscosynovial junction usually have adequate blood supply Preoperative MRI to determine size, configuration, and capacity for healing (residual rim width) Diagnostic arthroscopy to assess zone in which meniscus is torn (red-red; red-white; white-white) Evaluation of the substance of the tear and adjacent tissue helps determine capacity to heal Calibrated probes can be used to assess residual rim width	Persistent pain or recurrence of symptoms after surgery indicates failure of repair Postoperative MRI to evaluate integrity of repair	Return to operating room to resect failed repair
Repairing tears with complex geometry [10, 12, 37]	Complex tear patterns are less likely to heal and will require further surgery	Avoid repairing radial, horizontal cleavage, and oblique tears Preoperative MRI helps to define the nature and extent of tear Comprehensive evaluation of tear type and pattern at arthroscopy	Persistent pain or recurrence of symptoms after surgery indicates failure of repair Postoperative MRI to evaluate integrity of repair	Debridement or resection of these tear patterns results in a better functional outcome Return to operating room for resection of failed repair

Table 1. continued

Complication	Clinical effect	Prevention	Detection	Remedy
Repairing a tear in an unstable knee [5, 10, 28, 39]	Persistent instability may compromise the repair integrity	Evaluate the patient for ACL or other ligamentous deficiency Careful physical examination and MRI evaluation helps to decrease this complication	Examination under anesthesia/diagnostic arthroscopy	Reconstruct cruciates concomitantly with meniscal repair. The only indication for meniscal repair in an ACL-deficient knee is a staged procedure (ie, open physes)
Over-repairing or over-treating meniscal tears [19, 41, 45, 46]	Unnecessary repair exposes patients to potential iatrogenic meniscal injury, complications related to suture, and/or postoperative complications (stiffness)	Tears that are < 1 cm and partial thickness tears generally heal without intervention. Stable, peripheral tears that do not displace may be treated with abrasion and trephination (especially lateral tears posterior to the popliteal hiatus)	Comprehensive evaluation of tear type and pattern at arthroscopy	Avoid repairing tears unnecessarily

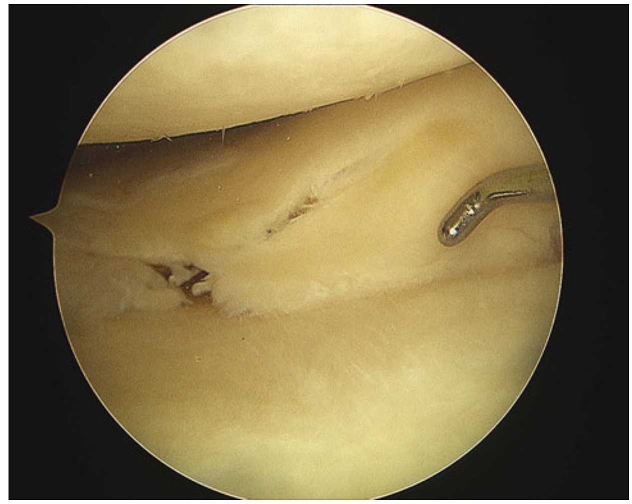

Fig. 1 Degenerative tears and tears with complex geometry are not suited for repair and are best addressed with partial meniscectomy.

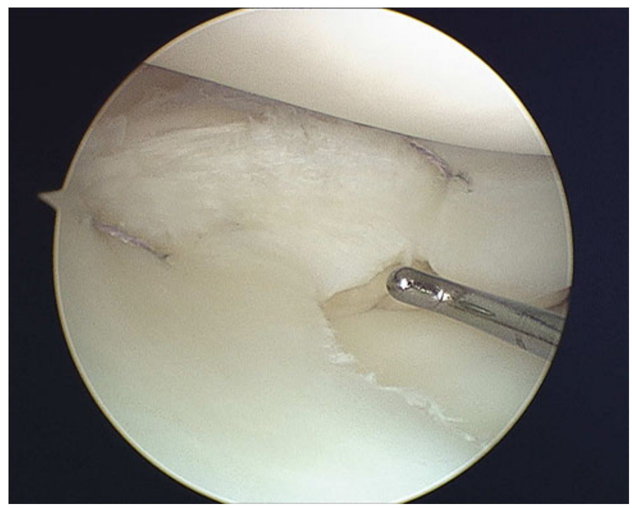

Fig. 2 A repair construct using nonabsorbable, braided suture in a vertical mattress configuration spaced every 3 to 5 mm yields the best results.

construct. Nerve injuries manifest as diminished motor and/or sensation distally and can be documented and monitored with electromyography or nerve conduction studies. Reexploration and nerve repair or grafting may be necessary in some cases. Arterial injuries with compromise of distal perfusion mandate urgent vascular surgery consultation.

Patients for whom meniscal repair fails generally have persistence or recurrence of symptoms after surgery. MR arthrography can detect failure to heal, retears, or chondral injury. Repeat arthroscopy may be needed for revision repair or meniscectomy. Postoperative arthrofibrosis may require a return to surgery for lysis of adhesions or manipulation under anesthesia.

Table 2. Complications related to technical errors.

Complication	Clinical effect	Prevention	Detection	Remedy
Improper technique chosen [8, 23, 43]	May result in technically challenging repair with limited exposure (can injure patient/ surgeon)	Use proper technique dependent on location of tear: outside-in for anterior horn; inside-out or all-inside for body and posterior horn region (inside-out gold standard) Assess the location and size of the tear arthroscopically before deciding on optimal technique	Intraoperative difficulty in performing repair with chosen technique	If tear cannot be addressed by one repair technique, try alternative technique that best secures the tear Some tears are best addressed with hybrid repairs
Improper suture choice [9, 39]	May result in iatrogenic meniscal injury, mechanical failure, and/or improper healing	Permanent suture recommended as it allows for longer and more stable fixation permitting more complete maturation and remodeling Greater risk of cut-through with monofilament suture Braided, nonabsorbable suture is ideal for meniscal repair	When using meniscal repair kits or devices, check that proper suture is loaded	Remove and replace inappropriate suture
Improper suture pattern used [32, 42]	May result in a repair that is biomechanically inferior with a poor clinical result and persistent pain	Vertical mattress suture pattern biomechanically superior to horizontal with lower rates of pullout Sutures should be placed every 3–5 mm Zone-specific cannulas can help in placing proper sutures in specified zones of the meniscus	After repair, assess the integrity and strength of repair with arthroscopic probe	Attempt to use vertical mattress sutures when possible and avoid horizontal configuration Alternate knots on superior/ inferior surface when possible Remove or augment biomechanically inferior suture constructs
Improper tensioning of the suture during repair [1, 8, 37, 49]	May result in iatrogenic meniscal injury or failure of the repair construct and poor healing	Avoid excessive tension which may cause meniscal injury, cut-through Avoid too little tension which may impair healing and allow persistent instability Improper tension/tethering to capsule may lead to loss of range of motion Medial repairs should be tied with the knee in 0^{o}-20^{o} flexion Lateral repairs should be tied with the knee in 90^{o} flexion Pass sutures before ACL reconstruction and tie after graft fixation Familiarize yourself with the proper tension of 2–0 suture to reduce intraoperative error	Assess meniscus after each suture is tied Take the knee through range of motion while observing the meniscocapsular junction	Remove and replace sutures that are poorly tensioned Damaged meniscal tissue may necessitate resection

Table 2. continued

Complication	Clinical effect	Prevention	Detection	Remedy
Iatrogenic meniscal or chondral injury [8, 29, 38, 47]	Improper technique can result in damage to the meniscus worse than the original tear making repair and salvage more difficult	Portal placement is key to prevent damage to anterior horn (introduce blade upward to avoid meniscus) Make second portal under direct arthroscopic observation Avoid excessive debridement around meniscal roots to prevent destabilization Avoid excessive trephination which can cut through the meniscus 70°-arthroscope can improve observation	Thorough arthroscopic evaluation at the end of the case helps to detect any other injuries to the meniscus or cartilage surface that may have occurred	Excessive meniscal damage may require resection of injured tissue Cartilage injury may require osteochondral repair, microfracture, or chondroplasty
Not adequately preparing tear for healing [3, 27]	Failure of repair may result	Rasping of meniscus tissue or augmentation with fibrin clot may improve healing potential	Clinical examination and MR arthrography	Repeat arthroscopy with revision repair versus meniscectomy

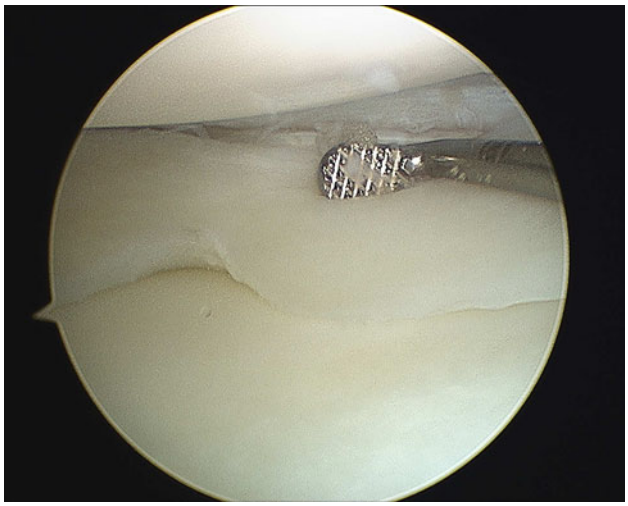

Fig. 3 Rasping of the meniscal tear facilitates healing.

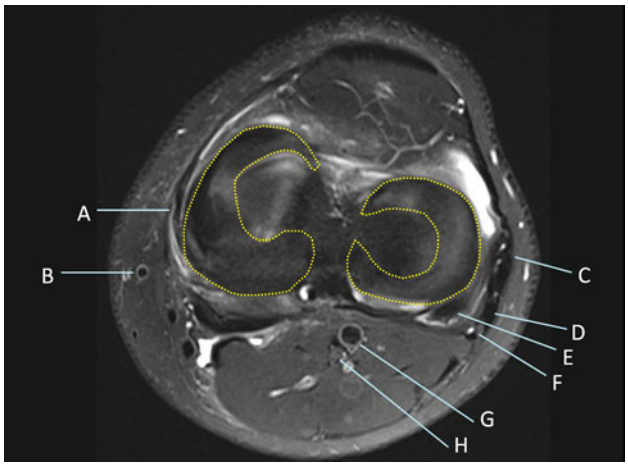

Fig. 4 Thorough knowledge of the structures around the knee is necessary to prevent injury or tethering during meniscal repair. In this axial MRI cut at the level of the knee, the lateral and medial menisci are outlined. On the medial side of the knee, the medial collateral ligament (**A**) and saphenous vein and nerve (**B**) are at risk. On the lateral side of the knee, the iliotibial band (**C**), lateral collateral ligament (**D**), popliteus tendon (**E**), and peroneal nerve (**F**) are at risk. Posteriorly, the popliteal artery (**G**) and tibial nerve (**H**) are in proximity to the posterior horn of the lateral meniscus.

Summary

Meniscal repair affords preservation of meniscal tissue which may improve function and durability of the knee. Understanding the indications, knowledge of the applied anatomy, technical proficiency, and appropriate postoperative management are imperative to ensure optimal outcome and avoid complications.

Table 3. Neurovascular complications.

Complication	Clinical effect	Prevention	Detection	Remedy
Saphenous nerve and vein injury [4, 22, 24, 30]	Sensation deficits on the medial leg/foot and/or painful neuroma	Associated with medial repairs Knowledge or anatomy: nerve travels on undersurface of sartorius anterior to gracilis and superficial to semimembranosus Transillumination of the saphenous vein via the inferolateral portal helps to identify the location Flexion/extension of the knee based on location of repair to move nerve into a safer position	Persistent neuropathic pain after surgery Positive Tinel's over injured nerve	Neuroma may require surgical exploration and excision
Peroneal nerve injury [1, 2, 21, 31, 38]	Deficits in ankle/toe dorsiflexion and lateral leg/dorsal foot sensation	Associated with lateral repairs Knowledge of anatomy: common peroneal is on the medial side of the biceps muscle and on lateral side of the lateral head of the gastrocnemius; lies posterior and deep to the biceps at the level of the joint line Safe area of suture passage is area between posterior edge of iliotibial band and biceps Nerve is at greatest risk with more posterior repairs and divergent sutures Use of lateral retractors by a qualified assistant who can directly observe the needles as they exit the posterolateral capsule Flex knee to 90° to relax the nerve and take it away from the posterior horn of the lateral meniscus	EMG may help to characterize and monitor peroneal nerve injury	Nonoperative treatment for purely sensory deficits Reexploration may be indicated for peroneal neurapraxia that does not resolve Primary repair or grafting for significant nerve laceration
Injury to popliteal vessels [1, 18, 31, 40]	Injury to popliteal artery may cause loss of distal perfusion and need for amputation in some cases	Knowledge of anatomy: popliteal neurovascular bundle is in close proximity to the posterior horn of the lateral meniscus Tip of any surgical instrument must be clearly visible in posterior knee 70°-arthroscope may aid in observation of the posterior knee	Excessive intraoperative bleeding or loss of pedal pulses Pseudoaneurysm may manifest as bruit/thrill behind knee or asymmetric distal pulses and warrants further vascular studies	Injury to the popliteal artery necessitates urgent vascular consultation Fasciotomies may be required in cases of arterial injury with prolonged ischemia
Injury to lateral geniculate artey [14, 31]	Hemarthrosis/ hematoma postoperatively May prevent meniscal healing by diminishing blood supply	Knowledge of anatomy: artery on posterolateral aspect of the capsule at the joint line Adequate exposure to preserve these vessels along the lateral joint line	Postoperative effusion	Aspiration of hematoma and compressive dressing

EMG = electromyography.

Table 4. Postoperative complications.

Complication	Clinical effect	Prevention	Detection	Remedy
Device fracture/ migration [7, 11, 17, 26, 34, 35, 44]	Associated with all-inside devices, in particular earlier generation rigid devices Mechanical symptoms, chondral injury, or failure of repair construct	Use newer, flexible, suture-based devices rather than earlier rigid devices (such as the meniscal dart or arrow) that are more prone to fracture, migrate, and/or cause chondral injury Ensure proper deployment and avoid over-penetration by using calibrated instruments	Probe meniscus and tear after each device is inserted to ensure proper deployment Postoperative pain, effusion, and mechanical symptoms may present with implant failure or migration Postoperative MR arthrography may show failure of repair or chondral injury	Remove improperly deployed implants Repeat arthroscopy for implant removal, repeat repair versus meniscectomy, and/or chondroplasty
Perimeniscal cyst formation [15, 36]	Pain and focal swelling after meniscal repair by formation of synovial fluid cyst adjacent tear May indicate failure of repair to heal	Limit meniscal trephination and number of needle passes with suture passing techniques May be caused by inflammatory response to nonabsorbable suture	Clinical evaluation for palpable, painful focal swelling at joint line Ultrasound or MRI to help characterize	Aspiration, decompression, or repeat arthroscopy May need revision meniscal repair
Arthrofibrosis, stiffness [4, 6, 33]	Pain with decreased range of motion after repair	Consider staged repairs if concomitant acute ACL reconstruction is planned Avoid excessive immobilization Avoid tethering of capsule with sutures with repair Postoperative rehabilitation protocol that emphasizes range of motion (preoperative therapy also helpful)	Loss of extension or flexion with failure to hit benchmarks during therapy	Manipulation under anesthesia or repeat arthroscopy with lysis of adhesions may be necessary in refractory cases Static progressive splints may provide some benefit
Hemarthrosis or effusion [33]	Continued pain, swelling, and loss of range of motion may be present	Avoid by maintenance of intraoperative hemostasis Use of drains is not routinely recommended	Postoperative knee effusion Analysis of aspirated fluid for infection or inflammatory etiology	Aspiration, occasionally repeat arthroscopy may be necessary
Recurrent tear of the meniscus [12, 16, 20, 49]	A brief period of improvement followed by recurrence of symptoms	May be impossible to prevent; avoid repairing menisci in unstable knees Partial weightbearing and avoidance of deep squats	MR arthography superior to conventional MRI for evaluation of retear Second look arthroscopy gold standard	Arthroscopy with meniscectomy versus repeat repair

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