Abstract

» Knee pathology represents one of the most common presentations in orthopaedic and sports medicine settings. Meniscal tears represent a large percentage of this pathology and are a common instigator of knee pain. Current literature that was analyzed for this article focuses on utilization of high-resolution ultrasound for the diagnosis of meniscal tears rather than magnetic resonance imaging. This review presents the benefits of ultrasonography and delves into the feasibility of introducing this as a diagnostic modality. For meniscal tear treatment, data demonstrating the degenerative osteochondral damage identified after meniscectomy as well as modalities for successful repair of avascular tears were also reviewed in the literature.

As a crucial physiological structure in the anatomy of the knee, the meniscus is critical, both in the numerous roles that it plays for the human body and because of its impact on the number of visits to orthopaedic and primary care offices for knee symptomatology. It is a crescent-shaped, fibrocartilaginous disc that provides shock absorption, lubrication to the joint space, and joint stability, as well as various other tasks. In contrast to other internal soft-tissue and ligamentous structures of the knee, the meniscus is typically injured in both traumatic acute settings and degenerative chronic settings.

Because of the high incidence of meniscal tears, competency in accurately diagnosing soft-tissue and ligamentous knee pathology is of critical importance for medical professionals in various fields. Current recommendations and practice guidelines recognize magnetic resonance imaging (MRI) as the gold standard for diagnosis of meniscal tears because of its high sensitivity and specificity measures. However, in an effort to prevent unnecessary expenditure on MRI testing, efforts have been made to investigate clinical testing, including McMurray, Thessaly, deep squat, and joint line tenderness tests, and patient and injury-specific factors that make a diagnosis of meniscal tears more likely. Additionally, the use of high-resolution ultrasonography in the diagnosis of meniscal pathology has recently been spotlighted in many research studies because of its lower cost, its ability to image the contralateral knee, and its portability.

Fortunately, what previously had to be surgically repaired by means of open total meniscectomy can now be managed with arthroscopic surgical intervention, including partial meniscectomy and internal repair. Of particular interest in the surgical management of meniscal tears is the propensity for earlier progression to osteoarthritis and the surgical failure rates among different surgical modalities. This is of high importance because of the sheer multitude of surgical meniscal repairs that are being performed. Additionally, with the development of various modalities for meniscal repair surfacing in recent years, data regarding long-term outcomes are now available for the last several years. These long-term outcomes are crucial for determining the

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best quality of care for patients with meniscal injury.

**Current Literature Review**

**History and Physical Examination Findings**

One of the most imperative aspects of assessing potential meniscal tears is special testing in a physical examination setting. However, as recent studies have attempted to prove, the diagnostic accuracy of tests, including the McMurray, Thessaly, deep squat, and joint line tenderness tests, is questionable. Despite this finding, it is evident that use of MRI as the primary, initial screening for meniscal pathology is unaffordable for a subset of patients.

Assessing the ability of special tests to aid in correctly identifying meniscal tears is multifactorial. This includes assessment of accuracy, which is measured by sensitivities, specificities, and positive and negative likelihood ratios, and also includes intraobserver and interobserver reliability. Ensuring that there is agreement in intraobserver and interobserver reliability is imperative to accurately assess the quality of these tests. A description of the mechanism and positive findings of these physical examination tests is summarized in Table I. First, in analysis of diagnostic accuracy, the Thessaly test, a newer clinical weight-bearing test, has been found to have highly variable accuracy from study to study\(^5\). In an effort to determine the accuracy of this test as compared with a non-weight-bearing test, the McMurray test, Goossens et al. found a lower sensitivity but higher specificity for the Thessaly test\(^5\). This difference was negligible, however, and was not statistically significant\(^5\). One common assumption is that a single special test alone may not be highly accurate in diagnosing meniscal tears, and that combining special tests improves diagnostic accuracy. Interestingly, however, Goossens et al. found that the addition of a positive McMurray test to a positive finding on the Thessaly test actually decreased accuracy from 62% to 54% when compared with arthroscopy\(^5\). In another means of assessing accuracy, at least 2 research studies focused on the positive and negative likelihood ratios of physical examination testing. With the ratios being nearly 1, it has been proposed in one study that a positive or negative result on the McMurray and Thessaly tests has little effect on the post-test probability of a meniscal tear\(^8\). To the contrary, studies have demonstrated positive likelihood ratios well above the value of 1 and even higher than that with MRI assessment, proving that the discrepancy regarding the true validity of special testing is not well defined\(^7\). Studies have reported that the diagnostic accuracy of physical examination testing is too low to use in isolation to diagnose meniscal pathology. Despite this, there is still certainty that special testing needs to be implemented during the physical examination. The testing may prove to have higher efficacy with degenerative changes compared with traumatic tears of the meniscus. However, given the current inaccuracy of the tests, implementation of guidelines for consistent and accurate techniques for assessment of the meniscus are needed.

**Diagnostic Imaging**

Diagnostic imaging is a critical component in evaluating the knee for possible internal derangements. Imaging confirms or refutes findings found on clinical examination, provides information regarding coexisting soft-tissue or cartilaginous injuries, and can potentially assist in determining whether or not surgical management is warranted based on the extent and location of such injuries. In current primary care and orthopaedic offices, MRI continues to remain the gold standard in diagnostic imaging of meniscal pathology. The overall accuracy of MRI in diagnosing meniscal tears has proven to be high, with sensitivities, specificities, positive predictive values, and negative predictive values ranging from 87% to 98%\(^2\).

**TABLE I Summary of Physical Examination Tests Used in Diagnosing Meniscal Tears**

<table>
<thead>
<tr>
<th>Physical Examination Test</th>
<th>Mechanism</th>
<th>Positive Test Finding</th>
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<tbody>
<tr>
<td>Thessaly (Snoeker et al.(^6))</td>
<td>Patient stands flat-footed on the affected limb in 20° of flexion. Examiner holds the patient’s hands and has him or her rotate 3 times in each direction.</td>
<td>Pain and/or sensation of locking or popping</td>
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<tr>
<td>Deep squat (Snoeker et al.(^6))</td>
<td>Patient stands flat-footed. Examiner holds the patient’s hands for stability while the patient squats as deeply as possible.</td>
<td>Internal knee pain and/or sensation of locking</td>
</tr>
<tr>
<td>Joint line tenderness (Snoeker et al.(^6))</td>
<td>Examiner passively puts the patient’s knee in 90° of flexion and palpates the tibiofemoral joint line.</td>
<td>Local area of tenderness when compared with the contralateral knee</td>
</tr>
<tr>
<td>McMurray (Ercin et al.(^25))</td>
<td>Patient lies supine with the affected knee and hip flexed. Examiner holds the knee joint with his or her index finger and thumb on the joint line. The other hand grasps the heel, moving the leg in internal and external rotation and moving the knee through flexion and extension.</td>
<td>Pain and/or a clicking or grinding sound is heard</td>
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\(^2\) http://dx.doi.org/10.2106/JBJS.JOPA.16.00022

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\(^5\) Goossens et al., 2017; 5(1): e4

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\(^6\) Snoeker et al., 2016

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\(^7\) McMurray test, Goossens et al., 2005

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\(^8\) Thessaly test, Goossens et al., 2005
Undoubtedly, there is a need for accurate imaging to diagnose tears and prepare for arthroscopic examination and repair or removal of the meniscus. This need is evidenced further by the moderate ability of various special tests to accurately diagnose meniscal injury. There has been documentation over the last 30 years that conventional and compound ultrasonography may have surpassed their roles in assessing the urinary tract, biliary system, and female gynecologic organs with the addition of menisci in musculoskeletal assessment.

Inclusion of ultrasonography in the diagnosis of meniscal tears has various potential benefits. These benefits include, but are not limited to, reduction in cost, ability to visualize the meniscus in ways that cannot be utilized with MRI, and reduction in the delay to undergo imaging. First, and possibly most important, is the ability of ultrasonography to accurately diagnose meniscal injury. With arthroscopic evaluation used as the standard for comparison, modern ultrasonography has shown an overall sensitivity, specificity, positive predictive value, and negative predictive value of 85.4%, 85.7%, 67.3%, and 94.4%, respectively. However, despite these relatively reasonable statistical measures of accuracy, interobserver variability and discrepancies among clinical settings have been demonstrated. Table II displays the ranges in these statistical measures of accuracy, as demonstrated by Wareluk and Szopinski. As established in that study, the positive predictive value is low for such imaging, which results from a higher number of false-positive findings. Despite this, with a high negative predictive value and specificity, medical providers and radiologists can essentially ensure that an ultrasound examination that is negative for a meniscal lesion rules out a tear with high certainty. This high negative predictive value is of questionable clinical relevance, however, given the inability of ultrasonography to visualize deeper structures of the knee, including the anterior cruciate ligament (ACL) and chondral structures.

In addition to a high level of accuracy in diagnosing meniscal tears, one of the primary benefits that musculoskeletal ultrasonography provides is reduction in cost of care and patient costs. In terms of Medicare reimbursement, data gathered in 2009 showed that the technical cost is $101 and $371 for nonvascular ultrasonography and noncontrast MRI, respectively. This fee represents the amount charged for nonphysician employees and equipment. In a similar trend, the difference in professional cost, or the fee for physician interpretation of the imaging, is $31 and $73 for ultrasonography and noncontrast MRI, respectively. With a relative value unit that is almost 3 times lower than that of MRI without contrast enhancement, musculoskeletal ultrasonography substantially decreases the time for assessment and interpretation, expense, and malpractice expense. Although ultrasonography decreases physician reimbursement rates, the potential benefit to patients as a result of quicker assessment, quicker interpretation, and reduced cost of care should not be overlooked.

In terms of the practical assessment of musculoskeletal ultrasonography, there are limitations with its diagnostic ability when compared with MRI, the gold-standard imaging tool. As may be suspected, there is a limitation to the depth of view that can be assessed by ultrasound examination of the internal structures of the knee. Despite this limitation, it has been shown that ultrasound examination does provide greater spatial comparison and finer detail in some areas when compared with MRI. In studies assessing the ability of ultrasonography to correctly diagnose the presence of needles at differing depths of penetration and anatomical locations within the meniscus, it has been shown that the anterior horn of the meniscus is harder to assess; however, all other locations were accurately reported. Although assessment of the anterior horn represents another limitation of ultrasound examination, it does provide a platform for one substantial benefit related to the nature of ultrasound examination of the extremities. During assessment with ultrasonography, one is able to manipulate the joint of interest in many different ways. One particular advantage of this is demonstrated in the improved visualization of the posterior horn of the meniscus with compression of the

<table>
<thead>
<tr>
<th>Statistical Measure</th>
<th>Range of Measurements</th>
<th>Overall Value</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>62.0% for lateral meniscal tears to 95.7% for nontraumatic injuries</td>
<td>85.4%</td>
</tr>
<tr>
<td>Specificity</td>
<td>70.4% for blunt injuries to 95.6% for lateral meniscal tears</td>
<td>85.7%</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>46.7% for blunt tears to 90.9% for recent (&lt;1 month ago) injuries</td>
<td>67.3%</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>87% for lateral meniscal tears in men to 98.4% for nontraumatic injuries</td>
<td>94.4%</td>
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gastrocnemius during the examination. Similarly, ultrasonography provides the additional benefit of bilateral assessment in cases in which meniscal tear of the affected knee is unclear, and with examination of patients with hardware in place. Although ultrasound imaging of the meniscus does fail to provide high enough visualization of the structure to provide insight as to surgical reparability, MRI has been shown to have similar limitations, and the decision regarding repairing or performing a meniscectomy has been shown to be best evaluated by arthroscopy.

Lastly, the evaluation of meniscal pathology is likely to improve with the expansions that have been made to further improve the diagnostic ability of conventional ultrasonography. These include the development of high-resolution ultrasound probes specified for particular anatomical locations, as well as the development of real-time compound sonography (RTCS). This technique exposes structures to ultrasound waves from various angles, which are compiled together to provide an image of the isolated anatomy. This increases the visualization of the structures with depiction of finer margins, decreases in clutter and unnecessary artifacts that can reduce image quality, therefore enhancing the contrast of structures. In comparison to conventional ultrasonography, RTCS has been shown to provide a substantial improvement in sensitivity, specificity, and accuracy of the location of meniscal tears, as well as improved interobserver reliability, as differences among observers were only isolated to the conventional ultrasound cohort.

As evidenced by the preceding data, ultrasonographic examination of the meniscus and other musculoskeletal tissues is diagnostically accurate and provides additional benefits, including reduction in cost, increased speed and timing of assessment, and examination when MRI is contraindicated. Potential comorbid demographic data, which have been previously thought to affect the ability of ultrasonography to accurately diagnose meniscal tears, have been shown to have no substantial impact on diagnostic accuracy. These factors include body mass index, sex, and physical activity level. According to these data, musculoskeletal ultrasoundography proves to be a relatively highly accurate, cost-effective, and timely source for assessment of potential meniscal tears. However, the studies evaluated in this review do specify the limitations of ultrasonography that should not be overlooked clinically. As concluded by Wareluk and Szopinski and in agreement with the American Institute of Ultrasound in Medicine, ultrasonography should not be used as the sole method of imaging in diagnosing meniscal tears, given the widely variable measurements of diagnostic accuracy among many studies. Additionally, as previously mentioned, ultrasonography has demonstrated difficulty in determining specific tear types and morphology, a limitation that is not seen with MRI of the meniscus. Therefore, further determination as to the usefulness of ultrasonography in diagnosing meniscal tears will rely on continued investigation into advances in modern ultrasonography, including specific probes that target visualization of the meniscus.

Surgical Management of Traumatic and Degenerative Tears

The surgical management of traumatic and degenerative meniscal lesions has undergone profound changes, and new advances have been made over the past several years. These changes include a progression from open surgery to arthroscopy and from complete meniscectomy to partial meniscectomy, as well as repair of meniscal tears by suture and biophysical devices. Of critical concern with these improvements is establishing a reduction in the early progression to osteoarthritis that invariably has been observed after total and partial meniscectomies. Additionally, assessment of surgical failure, as evidenced by meniscectomy after repair or incomplete healing on second-look arthroscopy, is of high importance.

As a relatively recent development in the realm of orthopaedic surgical practices, meniscal repair can occur with an arthroscopic inside-out, outside-in, or all-inside approach. The majority of orthopaedic surgeons now favor the inside-out or the all-inside technique, with the latter including the use of sutures or devices, including arrows or bioabsorbable screws. Investigation into the novel all-inside repair materials has shown that the strength provided by vertical mattress suturing exceeds that of horizontal suturing. Additionally, with the use of arrows, there is evidence of greater chondral damage and a threefold increase in reoperation rate when compared with the use of bioabsorbable screws or sutures. Even more recently, meniscal repair has included the concept of biological augmentation of the healing process that follows surgical management of such lesions. Various animal studies have demonstrated that application of human insulin-like growth factor-1 (IGF-1) and adult bone marrow mesenchymal stem cells to avascular lesions provides normal healing, as would be seen in a completely vascular tear. However, research has not yet been developed to demonstrate a suitable and effective vector for such treatment in the human population.

Many studies have been completed with the target of determining whether there is an earlier progression to osteoarthritis after meniscectomy than after meniscal repair. Stein et al. reported that there was a highly statistically significant increase in the prevalence of chondral deterioration in patients who received partial meniscectomy when compared with the repair group, using the Fairbank score for osteoarthritis. Interestingly, however, this protective effect was only demonstrated in the cohort of patients <25 years of age. This possibly demonstrates the inherent
Diagnosis, Imaging, and Surgical Repair of Meniscal Tears: An Update

Failure rates of different prevalent, the majority of meniscal repairs are becoming more prevalent in the past several years. However, while total meniscectomy has surged in the prevalence of early osteoarthritic failure was not significant, and there is no significant difference in failure rates of tears with intact ACLs compared with failure rates with concomitant ACL and meniscal tears.

Imperative to the clinical decision-making involved in assessing reparability of meniscal tears is the location of the tear. The meniscus is divided into multiple regions based on the vascular supply present in these respective areas. With the periphery of the meniscus having the most dense blood supply and vascularule, which progressively decreases moving medially through the meniscus, it is inherently observed that meniscal tears in the peripheral zone heal more adequately than those outside of the peripheral zone. This healing capability is crucial in the utilization of and clinical response to meniscal repair techniques. Despite various recommendations that white-white tears in the most medial aspect of the meniscus are nonreparable, the chondral deficits that ensue after partial and total meniscectomy should not be overlooked. Multiple prospective studies have demonstrated that there is an adequate success rate for healing after repair in patients who have progression of a meniscal tear into the middle third of the structure. These rates are determined by the low prevalence of tibiofemoral symptoms postoperatively and assessment of healing based on physical examination or arthroscopy. In a prospective study, Gallacher et al., using the definition of clinical failure as reoperation, established that 68% of avascular meniscal tears were repaired successfully. However, when the criterion for failure was revision requiring partial or total removal of the meniscus, 76% were successful. Additionally, the use of various injectable biomedical substances has been researched to aid in the healing process of avascular tears. Platelet-rich plasma (PRP) has been examined because of its potential to induce proliferation of extracellular matrices to enhance the healing process. Studies evaluating such use of PRP in controlled settings, however, are extremely limited. One investigation into this matter found that direct injection of PRP into meniscal lesions during open repair of horizontal meniscal tears demonstrated a slight improvement in clinical symptoms.

Another crucial factor in clinically determining the reparability of meniscal tears is the type and pattern of tear. When describing the variety of tears that exist, it is imperative to first determine if the tear is vertical or horizontal. Vertical tears occur perpendicular to the tibial plateau, and may be subclassified as radial, longitudinal, or bucket-handle. Radial tears originate in the red zone and extend to the periphery of the meniscus, while longitudinal vertical tears move circumferentially within the vertical axis of the meniscus. Also of concern, bucket-handle tears involve displacement into the tibiofemoral joint space, and urgent surgery is likely needed. Within the category of vertical tears, longitudinal and bucket-handle tears are typically amenable to repair; longitudinal tears have the most likely success rate with repair. In contrast, horizontal tears occur parallel to the tibial plateau, and oblique tears do not follow either of the 2 planes previously mentioned. Lastly, and least responsive to meniscal repair, are complex lesions, which are defined as a combination of 2 or more of the tear patterns previously described.

Various patient-reported scoring questionnaires and clinical symptom assessments are now used to provide data regarding the subjective success of surgical management of meniscal tears, and also to provide another subset of long-term outcomes. One example of a questionnaire that is commonly used is the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form. Expanding on previous findings that meniscal repair may demonstrate progression to osteoarthritis that was common in the older cohort population. In terms of functionality, it has been similarly demonstrated that the majority of patients undergoing meniscal repair returned to their baseline activity status prior to the injury, as determined by the Tegner Activity Scale. In contrast, only about half of those undergoing meniscectomy experienced that same result. Research verifying the increased prevalence of early osteoarthritic changes observed radiographically after meniscectomy has surged in the past several years. However, while meniscal repairs are becoming more prevalent, the majority of meniscal surgeries to date are meniscectomies. Failure rates of different surgical techniques have been evaluated in an effort to provide guidelines for the surgical management of meniscal lesions. Surgical failure has primarily been defined as meniscectomy following repair, or when a nonhealing tear has been seen on second-look arthroscopy. Failure rates of all-inside, inside-out, and outside-in repairs have been documented to range anywhere from 0% to 40%. Various studies have reported data indicating a failure rate of 8.9% to 9.8% for meniscal repair, while also demonstrating that there is a decrease in failure rate with the presentation of a concomitant ACL tear. The prevalence of increased healing in patients with concomitant meniscal and ACL tears is proposed to be secondary to the restorative nature of blood and bone marrow-derived progenitor cells present with the hemarthrosis that is induced by ACL reconstruction. Focusing the scope of comparison further, studies show that there is no significant difference in failure rates among the 3 previously mentioned modalities and open repair at long-term follow-up of >5 years. Additionally, there appears to be only a small increase in the failure rate of repaired medial tears compared with lateral tears. However, this increase was not significant, and there is no significant difference in failure rates of tears with intact ACLs compared with failure rates with concomitant ACL and meniscal tears.
more favorable outcomes, including reduced osteoarthritic changes, Melton et al. demonstrated that patients undergoing meniscal repair during ACL reconstruction showed lower IKDC scores compared with individuals undergoing meniscectomy during ACL reconstruction, which means that meniscal repair with concomitant ACL reconstruction provides better patient satisfaction and return to baseline functioning\(^2\). Also imperative to the quality of care that patients with meniscal injuries receive are nonoperative management options, rehabilitation practices after surgery, and consistent interrater categorization of meniscal tears. Regarding degenerative tears of the meniscus, current randomized controlled trials are investigating outcomes of degenerative tears that were treated surgically compared with treatment with physical therapy and monitored exercise. In a review of various randomized controlled trials, Buchbinder et al. demonstrated results showing no difference in pain or functionality 2 years after treatment, whether the treatment was made by surgical repair, debridement, or physical therapy. This end result occurred despite an initial increase in improvement at the 1-month follow-up for the debridement cohort\(^3\). Similarly, some studies have investigated whether outcomes are improved with more conventional, strict rehabilitation in comparison with free rehabilitation, which entails weight-bearing status after surgery and less restriction in range of motion with the wearing of a brace. Such studies have demonstrated that there was no increase in therapy failure or healing with free rehabilitation, as evidenced by functional outcome questionnaires such as the Tegner Activity Scale. It has been proposed that an additional benefit of free rehabilitation is retention of muscle strength, which is demonstrated by electromyographic data obtained from each rehabilitation cohort\(^4\). Importantly, the ability to maintain and provide exceptional quality of care depends partially on the consistent assessment of pathology among various medical providers, which is statistically measured by interobserver reliability. The International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine has provided a classification system for the evaluation and description of meniscal tears. The system evaluates tears based on criteria such as tear depth, location (including anterior to posterior), centrality to the popliteus, pattern of tear, tissue quality, tear length, and percentage of the meniscus that is excised if a meniscectomy is performed. Medical evaluation by different orthopaedists has shown acceptable reliability among providers for measurement of tear depth, location, pattern, length, tissue quality, and percentage of meniscus excised\(^2\). Consistent use of a scoring system that is similarly and consistently used among providers is necessary for validating clinical trials that assess the outcomes in patients with differing tear characteristics.

**Discussion**

As demonstrated in this literature review, improvement in the clinical assessment, radiographic evaluation, and management of meniscal pathology is imperative to bettering patient care, especially since it is one of the most common musculoskeletal conditions presenting in many fields of medicine. Although various trials and studies have demonstrated subpar accuracy in the ability of physical examination testing to diagnose tears, it remains an important initial assessment of the knee. With the patient’s best interest and care as the priority, introduction of the use of musculoskeletal ultrasonography, all-inside repair techniques, and more freedom for the patient in rehabilitation after surgical repair will provide new and improved management of a common musculoskeletal injury.

In order to improve medical care, whether it be in the realm of primary care, orthopaedics, or sports medicine, it is crucial to establish the correct mechanism for performing the specialized tests described in this review. Additionally, assessments regarding the required training and interrater reliability of those newly trained in musculoskeletal ultrasonography will be imperative to further promote the utilization of ultrasonography as a diagnostic modality for soft-tissue and ligamentous injuries of the knee. With additional training for orthopaedic and sports medicine providers, ultrasonographic examination of the meniscus may be advantageous for providers and patients in many ways. As indicated through this review article, ultrasonography provides nearly the accuracy of MRI, with one-third the expenditure in cost and the ability to manipulate the joint of interest to obtain better examination. Additionally, with adequate training of providers, the use of musculoskeletal ultrasound in the athletic setting will become advantageous because it will contribute to prompt diagnosis and management of acute meniscal injuries. However, patients with physical examination findings and history that indicate possible concomitant ligamentous tears will likely also need MRI prior to surgical repair. Despite the clinical benefits addressed, the legitimate practicality of ultrasonography in diagnosing meniscal tears continues to be questionable. This is evidenced by the inability of ultrasonography to determine tear morphology and visualize deeper anatomical structures of the knee. Therefore, additional assessment of diagnostic accuracy and development of high-definition probes that specifically target the meniscus will be necessary to fully establish the clinical relevance of this imaging modality.

Although some studies utilized in this review inherently possessed low heterogeneity of study populations because of an effort to control for various comorbidities, the primary result that meniscal repair is preferred over meniscectomy for a number of
reasons was still noteworthy. As the trend toward meniscal repair increases, additional investigation of repair techniques will be required as more long-term follow-up end points become available. With the biophysical agents that currently are available to use with meniscal repair, surgical repair should be attempted with an all-inside approach when possible, preferably with sutures or bioabsorbable screws. However, as this is one of the more novel techniques, an orthopaedic surgeon’s comfort with this approach should be factored into the decision. The inside-out surgical approach still should be highly considered because it has been used for many years and allows for good reproducibility and suture placement. With regard to the repair of avascular meniscal tears, studies have demonstrated predominantly clinical success with tears that extend from the periphery into the middle third of the meniscus. These results, in combination with data that demonstrate that meniscotomies continue to show unfavorable outcomes (e.g., early progression to osteoarthritis), demonstrate that use of meniscectomy should be limited, and training in surgical management of meniscal tears should reflect this. Although total avoidance of meniscectomy will not be possible, nor realistic in medical practice, repair of the meniscus has been demonstrated to be the superior approach, with the noted benefits of patient satisfaction and reduction of failure rates.

In conclusion, continued investigation and implementation of the data provided in this literature review, including the contradictory results (e.g., variable accuracy of physical examination testing), will prove to be critical in determining the best care for one of the most commonly evaluated musculoskeletal injuries. Further advances in diagnostic imaging modalities and materials for surgical repair, as well as utilization of the developments that have already been made in these areas, will increase patient satisfaction and quality of medical care.

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References