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Diagnostic Accuracy of McMurry's Test in the Diagnosis of Meniscal Tears

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Introduction

Meniscal tears are among the most common knee pathology seen in orthopedics.¹ There are two types of meniscus tears, acute tears and degenerative tears.² Acute tears are most common among athletes and typically occur through twisting or pivoting of the knee with a planted foot bearing their full weight.² Acute tears result in pain and swelling of the knee joint that is exacerbated by twisting and pivoting movements.² Over time the pain and swelling subside.² Patients who present later have symptoms of intermittent pain localized to the affected knee, locking or catching, instability, difficulty with deep knee bending, and loss of smooth motion.² Degenerative tears have an insidious onset and occur more often in older individuals secondary to degenerative joint disease.² Degenerative tears result in frayed, ratty, meniscal tissue causing swelling, joint line tenderness, and mechanical symptoms.² There are several types of meniscal tears including flap or oblique, radial or transverse, vertical or longitudinal which can develop into bucket handle, and complex degenerative tears.² If left untreated, meniscal tears can impair smooth motion of the knee, cause joint effusions, and can lead to osteoarthritis.² Therefore, it is important to accurately diagnosis meniscal tears.

The best recognized procedure to diagnosis meniscal tears before arthroscopy is magnetic resonance imaging (MRI).^{1,2} Meniscal tears or damage is a common incidental finding on MRI in the general population.² These findings are often associated with age and are not associated with pain.² Therefore, it is important that a detailed physical examination and history, including age, mechanism of injury, and onset of symptoms is completed prior to ordering an MRI.³ Additionally, arthroscopy can be utilized for diagnosing meniscal tears.² This is a minimally invasive procedure which requires a surgeon to make an incision in the knee and insert a camera to look for abnormalities such as a torn meniscus. The diagnosis of meniscal tears through history and physical exam alone is challenging.² A variety of physical maneuvers called special tests have been developed to aid in the diagnosis of meniscal tears.^{2,3,4} Special tests or provocative tests are used to elicit discomfort or a catching sensation during a specific maneuver that recreates the mechanism of injury. Common tests used to assess meniscal pathology are joint line tenderness, McMurry's, Thessaly, bounce home, and Apley's. The diagnostic accuracy of these special tests has been thoroughly reviewed; yet their reliability still remains uncertain.^{2,3}

McMurry's test is one of the most common special tests used to diagnosis meniscal tears. However, it has extensive variability in both sensitivity (16%-58%) and specificity (77%-98%).^{2,3} This variability is due to the examiner's experience and skill at performing McMurry's test. The test is performed by bending the knee beyond 90° of flexion, internally rotating the tibia testing the lateral meniscus, then externally rotating the tibia testing the medial meniscus.^{2,3} The same maneuvers are then performed with gradually increasing degree of knee flexion to progressively load more posterior portions of the menisci.^{1,3} During the McMurry's test the medial and lateral joint line is palpated, and McMurray's is considered positive when a click can be heard or felt.^{2,3} This study aims to investigate the diagnostic accuracy of McMurry's test in the setting of meniscal tears.

Table 1. PICO Framework

P	Population	Patients presenting with meniscal tears as defined by their history and physical examination.
I	Intervention	McMurray's Test
C	Comparison	Magnetic Resonance Imaging/knee arthroscopic results
O	Outcome	Increased effectiveness of identification of meniscal tears

Clinical Question

Does the use of the McMurray's test increase the effectiveness of identifying a meniscal tear as compared to MRI/knee arthroscopy results in patients presenting with meniscal tears as defined by their history and physical exam?

Methods

Search engines utilized for this study were Pubmed and Google Scholar. The following key terms were used: MRI/magnetic resonance imaging, McMurray's, meniscus, tear, clinical, diagnosis, accuracy/accurate. This search yielded 3,189 articles of which 32 articles were assessed for eligibility. Eligibility was determined via the inclusion/exclusion criteria as demonstrated in table 2. Three articles were determined to fit our eligibility criteria. "McMurray's Test and Joint Line Tenderness for Medial Meniscus Tear: Are They Accurate?" was chosen because it provided a comparison of McMurray's test, joint line tenderness, and knee arthroscopy for their diagnostic accuracy of meniscus tears. "Do Physical Diagnostic Tests Accurately Detect Meniscus Tears?" was chosen because it included the Thessaly test's diagnostic accuracy as compared to McMurray's and MRI/knee arthroscopy for both lateral and medial meniscus tears. Finally, "The Clinical Diagnosis of Meniscal Tear is Not Easy, Reliability of Two Clinical Meniscal Tests and Magnetic Resonance Imaging" was chosen because it included Apley's test, McMurray's test, and MRI.

Table 2. Criteria for Eligibility of Studies Assessed

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> ● Studies published from 2009-2019 ● Studies that directly compared McMurray's test to Magnetic Resonance Imaging or knee arthroscopy for the diagnosis of meniscal tears ● Studies that included other special tests to diagnose meniscal tears, and still included McMurray's and Magnetic Resonance Imaging or knee arthroscopy 	<ul style="list-style-type: none"> ● Meta-analyses, systematic reviews, or other research modalities that were not randomized control trials ● Studies that did not include McMurray's test ● Studies that did not include either Magnetic Resonance Imaging or knee arthroscopy ● Studies that did not occur in a clinical setting



PRISMA Flow Diagram

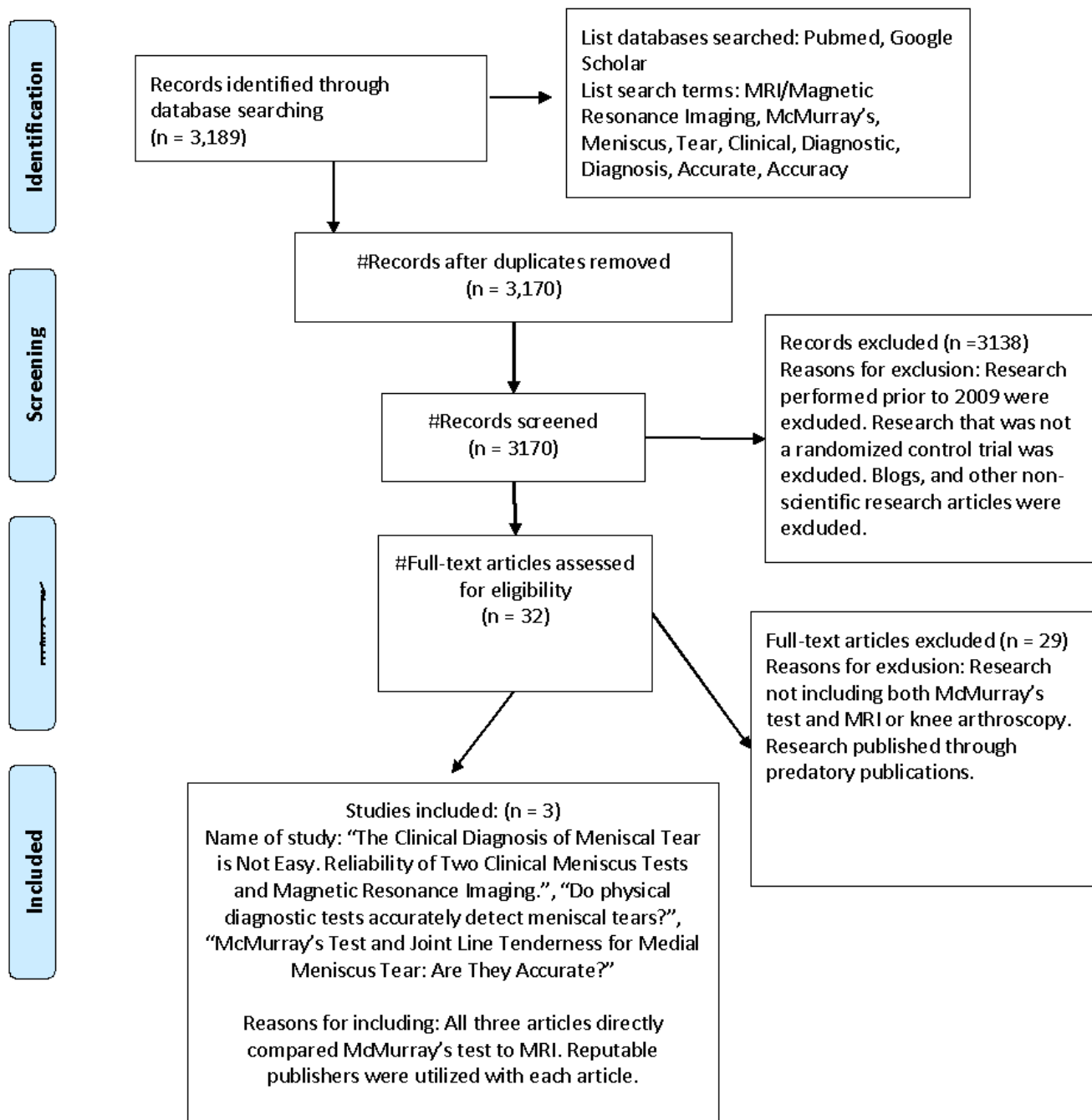


Figure 1. PRISMA Flow Diagram

Examined Studies

Study #1

“McMurray’s Test and Joint Line Tenderness for Medial Meniscus Tear: Are They Accurate?”

Objective: This study aimed to determine the diagnostic value of McMurray’s test and joint line tenderness for meniscus tears in order to prevent further diagnostic testing such as magnetic resonance imaging before the patient underwent a diagnostic arthroscopy.⁵

Study Design

Prospective data on 66 patients undergoing knee arthroscopy for knee symptoms was recorded at the Tribhuvan University Teaching Hospital’s orthopedic and trauma department between February 2011 and January 2012.⁵ Cases that reported multiligament injury excluded.⁵ All patients underwent a short interview about the mode of injury, duration of symptoms, and other demographic questioning. McMurray’s test and joint line tenderness were then performed and the results recorded.⁵ They defined a positive McMurray’s test as the presence of pain and/or a click/snap/clunk/thud in the patients’ knee while performing the test.⁵ Joint line tenderness was assessed with the knee in 90 degrees of flexion.⁵ The tests were performed by experienced orthopedic surgeons who were blinded to the imaging report.⁵ Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were then calculated (Table 3). They utilized the SPSS 16 package for analysis of the data, and the statistical significance was determined using the Chi square test.⁵

Study Results

Of the 66 patients included in the study 62.9% of them were male and ages ranged from 11-70 years.⁵ The 20-30 year old age group consisted of 54.8% of the patients included, and 4.8% of the patients were above 50 years old.⁵ Sports related injuries accounted for 21/66 (33.9%) of patients, 11/66 (17.7%) were from road traffic accidents, 12/66 (19.4%) were due to a fall from height, 3/66 (4.8%) were caused by squatting or standing from a squatted position, 14/66 (22.6%) were from spontaneous onset, and 1/66 (1.6%) was due to a pattern formed injury.⁵ The duration of symptoms varied from 1 week to 96 months. Pain was the most common cause of presentation seen in 45.2% of patients.⁵ Other symptoms included swelling (36.6%), locking (14.3%), and snapping (5.4%).⁵

Upon comparison of McMurray’s test and joint line tenderness with arthroscopic results, McMurray’s test proved to have higher sensitivity, specificity, positive predictive value, negative predictive value, and accuracy than joint line tenderness (Table 3).⁵ The results for McMurray’s test were found to have a p value of 0.007 and determined to be significant.⁵ The results for joint line tenderness were found to have a p value of 0.352 and determined to not be significant.⁵

Table 3. Biostatistical calculations for McMurray’s test and joint line tenderness for diagnosing meniscus tears compared to knee arthroscopic results.⁵

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy
McMurray’s Test	54%	79%	68%	67.50%	67.74%
Joint Line Tenderness	50%	61.70%	51.80%	60%	56.45%

Study Critique

This study compared its results to similar studies and found that McMurray’s test yielded variable sensitivities and specificities for diagnosing meniscus tears. One reasoning they gave for this is that their subset of patients consisted of variable mechanisms of injury whereas other studies focused on specific injury modalities. A downfall of this study that could account for a variation in all biostatistical calculations is the wide age range of patients in this study. They utilized patients from 11 years old to 70 years old. An 11 year old or a 70 year old will likely have a very different ability to localize/perception of pain than a 20-30 year old patient. Additionally, the flexibility of an 11 year old and a 70 year old will likely be vastly different making the functionality of the range of motion utilized during the McMurray’s test variable. The study points out that interobserver variability between the two orthopedic surgeons performing the tests could play a large role in the test results. Due to the McMurray’s test being highly dependent on the skill of the examiner, having people of different skillsets performing the tests can throw off the results. Finally, the low sample size of 66 patients allows for greater variability in biostatistical analyses which is a significant downfall of a study that encompasses a wide range of ages as well as mechanisms of injury.

Study #2

“Do Physical Diagnostic Tests Accurately Detect Meniscal Tears?”

Objective: The goal of this study was to validate the diagnostic ability of the Thessaly test to the McMurray’s test and joint line tenderness to the gold standard of MRI and knee arthroscopy for meniscus tears.⁴

Study Method

Patients were initially seen by the senior author and were included in the study given the presence of: a history of knee injury, symptoms of knee pain/discomfort, clicking sensation when moving the knee, locking of the knee, and knee swelling.⁴ These patients were scheduled for knee arthroscopy and on the day of surgery they were re-examined utilizing McMurray’s test, the Thessaly test, and joint line tenderness by an independent

observer blinded to the history, site, nature of the meniscal tear, details of the upcoming procedure to be performed, concomitant injuries, and MRI findings.⁴ Patients were excluded from the study for not signing the consent form or not being confident in the performance of the special tests due to anxiety or pain.⁴ 109 patients participated in this study with ages ranging from 16 years old to 56 years old.⁴ Additionally, 80 of the participants were male and 29 were female.⁴ All patients underwent MRI prior to undergoing knee arthroscopy by a single specialist arthroscopic knee surgeon.⁴ Final diagnosis was determined post knee arthroscopy and compared to findings of the special tests to determine specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and likelihood ratios(LR) (Table 4).⁴

Study Result

The study showed that physical diagnostic tests are not reliable for detecting all meniscus tears.⁴ In particular, McMurray’s test showed the lowest diagnostic accuracy for both lateral and medial meniscus tears, followed by the Thessaly test, and then joint line tenderness having the highest diagnostic accuracy (Table 4).⁴ MRI was concluded to be the investigation of choice due to high reliability, non-invasiveness, and lower cost than knee arthroscopy.⁴ However, the study points out that the diagnostic accuracy of knee arthroscopy remains the highest at 90-95% for both medial and lateral meniscus tears.⁴

Table 4. Biostatistical calculations for diagnostic accuracy of McMurray’s test, Thessaly test, and joint line tenderness for meniscus tears as compared to MRI and knee arthroscopic results.⁴

	Medial meniscus Sensitivity/Lateral meniscus sensitivity	Medial meniscus Specificity/Lateral meniscus Specificity	Medial meniscus PPV/Lateral meniscus PPV	Medial meniscus NPV/Lateral meniscus NPV	Medial meniscus Diagnostic accuracy/Lateral meniscus diagnostic accuracy	Medial meniscus LR of positive test/Lateral meniscus LR of positive test	Medial meniscus LR of negative test/Lateral meniscus LR of negative test
McMurray’s Test	50% / 21%	77% / 94%	86% / 50%	35% / 80%	57% / 77%	2 / 3	0.06 / 0.08
Thessaly Test	59% / 31%	67% / 95%	83% / 66%	37% / 81%	61% / 81%	2 / 6	0.6 / 0.7
Joint Line Tenderness	83% / 68%	76% / 97%	91% / 87%	59% / 91%	81% / 90%	3 / 22	0.2 / 0.3

Study Critique

This study was beneficial in that it separated the diagnoses of medial and lateral meniscus tears. Study #1 focused on diagnosing medial meniscus tears, but often did not distinguish as to which type of meniscus tear was being diagnosed which left for ambiguity of the results. However, study #2 did not discuss the experience of the independent observer performing the special tests throughout their study. Since special tests such as McMurray's and the Thessaly test are reliant upon the skill of the examiner, these results are difficult to qualitatively interpret. Where study #1 discussed how each special test was performed, study #2 did not include this in their methods. A description of how the special tests were performed would have helped to qualitatively interpret the results of the independent examiner. False-positives during joint line testing was discussed, as these could have been due to osteoporosis, osteochondral defects, collateral ligament injury, or fractures which were blinded to the independent observer. This could have also played a role in the efficacy of the other special tests being performed as well providing false-negatives for McMurray's or the Thessaly test. Selection bias was discussed by the authors which could have significantly impacted the results. The participants were chosen due to their high probability of having a meniscal tear, and therefore the probability of positive results was anticipated to be high by the examiners of the study. Finally, the sample size of study #2 was 109 (which is considerably more than the 66 seen in study #1, but still a small number of participants). These biases observed throughout the paper could have significantly affected the results.

Study #3

"The Clinical Diagnosis of Meniscal Tear is Not Easy, Reliability of Two Clinical Meniscal Tests and Magnetic Resonance Imaging"

Objective: The goal of this study was to clarify the reliability between McMurray's test, Apley's test, and MRI imaging in order to reduce the amount of unjustified knee arthroscopies.¹

Study Method

This study included 102 patients, ages 20-50 years old, that suffered from knee pain consequent to an acute injury to the knee.¹ All of the participants were previously clinically examined by one orthopedic surgeon and underwent MRI imaging post-examination.¹ The patients' history of pain, previous diagnosis such as osteoarthritis or diagnoses that can lead to osteoarthritis (psoriasis, articular fractures), other diagnoses such as rheumatoid arthritis/systemic lupus erythematosus/gout, and any previous knee surgery were obtained prior to examination.¹ Exclusion criteria included: diagnosed osteoarthritis, rheumatic disease, psoriasis, previous articular fractures, previous knee surgery, torn ACL, and mechanical locking of the knee.¹ All the 102 patients that met inclusion criteria/were not excluded were re-examined by two different orthopedic surgeons; both of which had performed more than 2000 knee arthroscopic procedures.¹ The two orthopedic surgeons were blinded to the patient's history, MRI results, and the results of the first clinical examination.¹ The McMurray's test was

performed by having the patient lay supine and the examiner manipulated the knee into flexion and extension while rotating the tibia in the femur.¹ Apley's test was performed by having the patient lay prone and the examiner rotated the tibia over a fixed femur while compressing the knee.¹ Sensitivity, specificity, PPV, NPV, positive LR, and negative LR were calculated given the results of the special tests performed by the two orthopedic surgeons compared to the results of knee arthroscopy (Table 5).¹

Study Results

Of the 102 participants, there were 74 cases of meniscal tear with 55 being medial, 12 being lateral, and 7 being both menisci.¹ McMurray's test showed higher specificity than Apley's test for diagnosing meniscal tears but a lower sensitivity.¹ Additionally, McMurray's test elicited 9 false positives and 11 false negatives whereas Apley's demonstrated 9 false positives and 10 false negatives. MRI revealed 4 false positives and 8 false negatives.¹ This study concluded that the clinical special tests being McMurray's and Apley's are only partially reliable and should be used as a quick way to judge necessity of MRI imaging.¹

Table 5. Biostatistical calculations for diagnostic accuracy of McMurray's test and Apley's test for meniscus tears as compared to MRI and knee arthroscopic results.¹

	Sensitivity	Specificity	PPV	NPV	Positive LR	Negative LR
McMurray's Test	79.7%	78.5%	90.7%	59.4%	3.7	0.2
Apley's Test	83.7%	71.4%	87.3%	62.5%	2.9	0.2

Study Critique

Study #3 is the strongest of the studies evaluated within this review. The authors of this study were the only ones with exclusion criteria that excluded patients with diagnoses of osteoarthritis, rheumatic disease, psoriasis, previous articular fractures, previous knee surgery, torn ACL, and mechanical locking of the knee. Mechanical locking of the knee was an exclusion criterion in an attempt to further remove patient's with osteoarthritis. However, mechanical locking of the knee is a common presentation of meniscal tears. The exclusion of these diagnoses is significant because they can interfere with the results of McMurray's or Apley's test eliciting false positives due to pain upon movement. Additionally, study #3 included information about the experience of the two orthopedic surgeons to support their usage as examiners for the special tests which provides reasonably validation of their findings. Both studies #1 and #2 did not acknowledge the experience of the examiners performing the special tests. Selection bias is still present in this study due to the inclusion of patients that were already scheduled for knee arthroscopy for a suspected meniscal tear diagnosis. A sample size of 102 runs into the same problem that studies #1 and #2 faced being that small exceptions to the participants could negatively affect the results of the study. However, this study only included patients ages 20-50 years old which

should allow for less fluctuation in the patient's interpretation of their knee pain as well as their ability to undergo the special tests.

Discussion

McMurry's test is a special test used to diagnosis meniscal tears. The test is performed by bending the knee beyond 90° of flexion, internally rotating the tibia testing the lateral meniscus, then externally rotating the tibia testing the medial meniscus.^{2,3} The same maneuvers are then performed with gradually increasing degree of knee flexion to progressively load portions of the menisci.^{2,3} During the McMurry's test the medial and lateral joint line is palpated, and McMurray's is considered positive when a click can be heard or felt.^{2,3} The diagnosis of meniscal tears through history and physical exam alone is challenging. Therefore, special tests such as McMurry's have been developed to aid in the diagnosis of meniscal tears. The diagnostic accuracy of McMurry's test has been thoroughly reviewed; yet it's reliability still remains uncertain.^{2,3} The aim of this review was to investigate the diagnostic accuracy of McMurry's test in the setting of meniscal tears. Each study compared the value and ability of McMurry's in diagnosing meniscus tears to the gold standard of MRI and knee arthroscopy. The sensitivity, specificity, PPV, NPV of McMurry's test for each study included in this review are summarized in Table 6.

All studies demonstrated McMurray's has low diagnostic value when applied individually and is not useful for the identification of meniscal tears. McMurray's is a complicated test that relies on the experience and technique of the observer; therefore, the accuracy of McMurray's relies on the experience of the clinician performing the test.^{1,4,5} Although McMurray's test alone is not reliable for detecting meniscus tears, it increases the diagnostic certainty when combined with other special test and clinical history.^{1,4,5} The decision to perform an arthroscopy of the knee should not be made on the results of clinical tests alone. All studies concluded that MRI is still the investigation of choice to diagnosis meniscal tears before arthroscopy due to its reliability, non-invasiveness, and low cost. However, knee arthroscopy remains the best procedure to diagnose meniscal tears with 90-95 percent accuracy.^{1,4,5} The physical exam, special tests, clinical history, and MRI results together increase the accuracy of diagnosing meniscal tears before arthroscopy, preventing the number of false negative arthroscopies.^{1,4,5}

The findings of these studies are limited by selection bias. The participants chosen had a higher probability of having a meniscal tear based off the inclusion criteria of each study. In study 1 all patients undergoing knee arthroscopy for knee symptoms of suspected meniscal tear were included.⁵ In study 2 the patients were chosen if they presented with knee pain/discomfort, clicking sensation when moving the knee, locking of the knee, and knee swelling.⁴ In study 3 participants included were already scheduled for knee arthroscopy due to a suspected meniscal tear.¹ Therefore, the probability of a positive result is anticipated to be high in each of these studies based on the study population they included.

Other limitations to the studies were the small sample size and differences in study populations within each study. The small sample size in these studies decreases the validity of the findings and increases the risk of

false-negative findings. Low power reduces the chance of detecting the true effect of the McMurray’s test in diagnosing meniscal tears. Selection bias which is present in all three studies is also more likely to affect underpowered studies skewing their results. The wide variation in ages included in each study make interpretation of the results difficult. Study 1 included patients 11 to 70 years old, study 2 included patients 16 to 56 years old, and study 3 included patients from 20 to 50 years old. The flexibility and anatomy of a 11-year-old is very different from a 70-year-old making the results from the McMurray test variable. Future studies should focus on including larger sample size and a more specific study population.

Table 6: Summary of all study’s biostatistical calculations for diagnostic accuracy of McMurray’s test for meniscus tears.^{1,4,5}

	Sensitivity	Specificity	PPV	NPV
Study 1	51%	79%	68%	67.50%
Study 2 Medial meniscus	50%	77%	86%	35%
Study 2 Lateral meniscus	21%	94%	50%	80%
Study 3	79.9%	78.5%	90.7%	59.4%

Citations

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