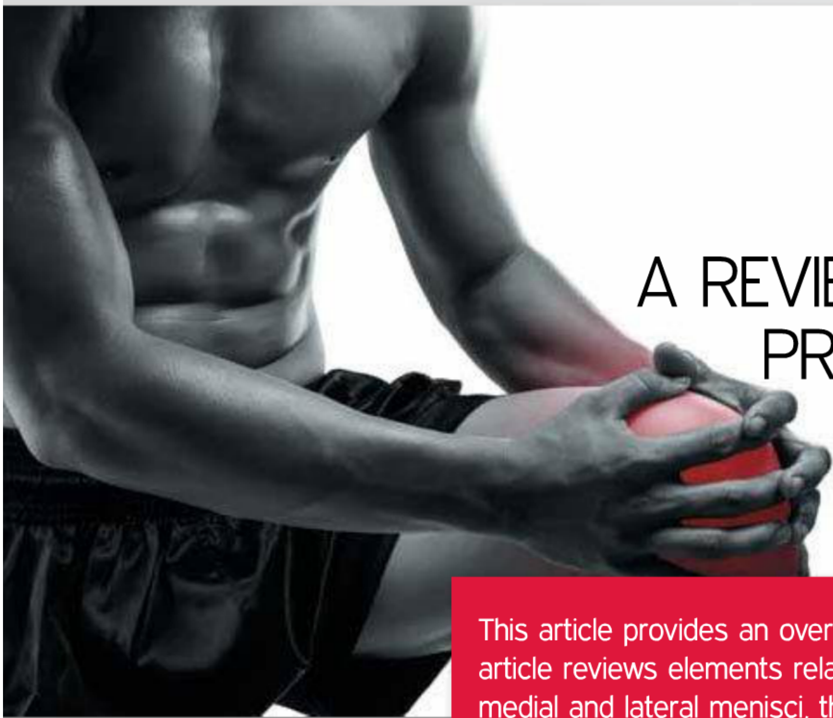


KNEE MENISCI

A REVIEW OF FUNCTION, PRESENTATION AND ASSESSMENT TOOLS

This article provides an overview of knee meniscal injuries. The article reviews elements relating the structure and function of the medial and lateral menisci, the common mechanisms of injury, and the presentation of signs and symptoms following injury. The article also provides descriptions of the current assessment tests and procedures commonly used by practitioners in confirming diagnosis of this injury. Finally the article reviews the research literature that evaluates the accuracy, specificity, sensitivity and predictive values of each test.

BY BRENDON SKINNER BSC, GSR, PAUL ASHWORTH BSC AND STEVE BATEMAN BSC

BASIC ANATOMICAL STRUCTURE

The word meniscus derives from the Greek word mēniskos meaning 'crescent', diminutive of mēnē, meaning 'moon' (1). The menisci are two fibro-cartilaginous wedge shapes which are found between the femoral and tibial condyles of the knee (2). They are meniscal, or half-moon in appearance and they are attached to the tibial plateau on the medial and lateral aspect of tibia (Fig. 1; Animation 1), with the medial meniscus covering approximately 60% and the lateral meniscus covering approximately 80% of the tibial plateau (1–3).

Role/purpose of the meniscus

The function of the menisci have been identified as: increasing joint congruity between the femur and tibia; increasing the proprioceptive reflexive feedback (4); absorption and transfer of load place upon the joint (2); and assisting the locking mechanism of the knee (3).

Medial meniscus

Although the medial meniscus occupies a smaller surface area on the tibial plateau (60%) it is the largest measuring meniscus anterior to posterior, with the posterior part being broader, this is due to its semicircular presentation (3).

The anterior horn of the medial meniscus is attached to the anterior aspect of the intercondylar fossa, anterior to the anterior cruciate ligament. The posterior horn is attached to the posterior intercondylar fossa, attaching between the posterior cruciate ligament and the posterior horn of the lateral meniscus (1,3). The entire periphery of the medial meniscus is attached to the joint capsule which limits the available range of movement achieved (3). Some of the posterior fibres of the medial meniscus also have an insertion with the transverse ligament of the knee (3).

Lateral meniscus

The lateral meniscus occupies a greater surface area (80%) than the medial meniscus (60%), however, it measures shorter anteriorly to posteriorly, this is due to its 4/5 of a circle presentation (3). Makris et al. (5) documented the vascularity differences

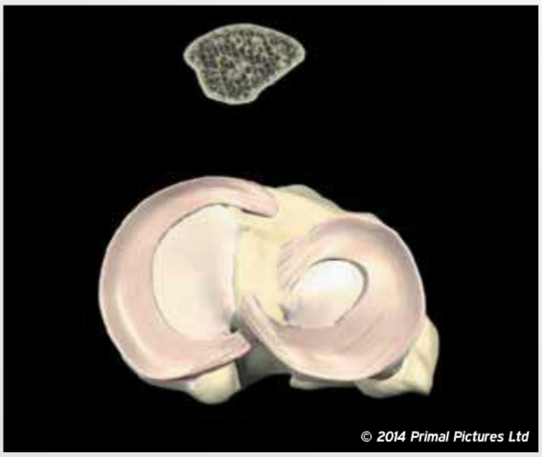
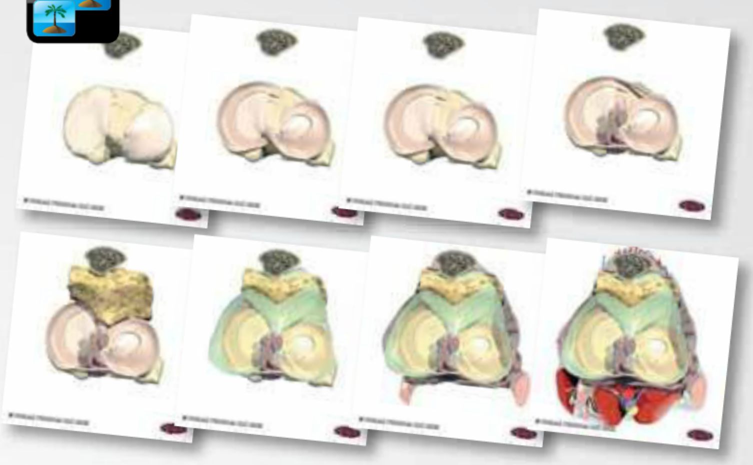


Figure 1: Outline of meniscal appearance

Slideshow 1: Menisci of the knee (sportEX, 2014)



within the menisci at particular ages. The authors identified the vascularity of the menisci from prenatal to shortly after birth and confirmed the menisci are fully vascularised, with the blood being supplied by the middle, medial and lateral inferior genicular arteries (3). At approximately 10 years of age, the vascularity is showing signs of abatement with only 10–30% of the menisci being vascularised (1). Once maturity has been achieved the menisci shows signs of vascularity in around 10–25% of the periphery (5). Due to the vascularity identification of the menisci there are two regions relating to the degree of blood they receive, the thick concave peripheral region is referred to as the red zone and the inner region which tapers to a free edge is referred to as the white zone, which is avascular (1,5). Subsequently, the location of the meniscal injury plays a huge part in whether the lesion will heal or not.

INJURY OF THE MENISCUS

Mechanics of meniscal Injury

The common mechanism for a meniscal injury is a planted foot with rotation of the femur on the tibia with a flexed knee (3,6). Acute tears during sport generally involve non-contact events with an associated cutting movement with the knee in some degree of flexion, or even hyperflexion (7), or a tear during landing activities that compromises the knee joint exposing it to the susceptible position of knee flexion and internal femoral rotation (7).

The pathomechanics of injury expose the medial meniscus to be the most common meniscus to be torn (6,7). This is due to the movement of the meniscus during 0–120° knee flexion whereby the menisci move posteriorly. Goldblatt et al. (7) documented that the lateral meniscus moves 11.2mm, but that the medial meniscus only moves 5.1mm, with the deep fibres of the medial collateral ligament (MCL) and semimembranosus guiding the movement. The entire periphery of the medial meniscus is attached to the joint capsule (3), and also forms an attachment to the deep fibres of the MCL which also limits the overall movement possible (7). It is this decreased movement of the medial meniscus that exposes it to be torn more frequently than the lateral meniscus, with the middle and posterior portions being the most commonly torn area (3,6,7).

Prevalence

It has been reported that incidence rate for meniscal tears was 60–70 per 100,000 people per year, with the ratio of male to female tears being between 2.5–4:1 (7,8). The peak injury incidence age for males has been identified as 21–30 years of age, whereas for

> "THE COMMON MECHANISM FOR A MENISCAL INJURY IS A PLANTED FOOT WITH ROTATION OF THE FEMUR ON THE TIBIA WITH A FLEXED KNEE"

females it is 11–20 years (6,8). Meniscal tears have been reported to account for 10–20% of all orthopaedic injuries (9) and 50% of knee surgeries (10).

Presentation

Meniscal injuries can be difficult to identify due to a proposed the lack of nociceptors located in the menisci (6); however, earlier studies by Day et al. (11) and Gray (12) confirmed there is nociceptive innervation to the menisci with the anterior and posterior horns being richly innervated and the outer third of the body of the menisci having a greater neural innervation than the middle third. The authors hypothesised this is due to the required biomechanical correction within the knee joint when it is loading the menisci too much laterally. To be accurate in assessing an athlete, a thorough history should be taken, including mechanism of injury as well as a using the appropriate special tests (8). Athletes presenting with a meniscus tear most commonly present with joint-line tenderness with a specific area of pain (6); audible confirmation at the time of injury is possible, with athletes reporting popping or clicking noise at the moment of femoral rotation on a fixed tibia (6). If ambulation is possible for the athlete with a meniscal tear, they may complain of a giving way sensation, or even a locked knee (6). Effusion is commonly delayed in appearance (24–48h post-injury).

MENISCAL INJURY ASSESSMENT TESTS

There are five common assessment tools used alongside a thorough subjective assessment that are frequently used by therapist when forming a diagnosis. The methods of application of these tests are described below.

McMurray test

Lateral meniscus: With the patient in a supine position support the knee with one hand (fingers along the joint line) and hold the sole of the foot with the other. Passively move the patient into full knee flexion. Medially rotate the tibia and extend the knee while applying a valgus force at the knee (the aim here is to 'trap' the meniscus between the tibial plateau and femur) (Video 1).

Medial meniscus: Repeat with external rotation of tibia and applied varus force.

Positive result: Snap or click at the joint line that is often accompanied by pain.

Apley test

The Apley test (Video 2) consists of two elements, the Apley's Compression and Apley's Distraction. During both phases the patient lies prone with the knee flexed to 90°.

Compression: Now apply a compression force along the tibial axis from the heel while again rotating the tibia medially and laterally (this has been likened to grinding a pepper pot). This can be repeated at varying angles of knee flexion. As with the McMurray test, the aim is to trap the meniscus between the tibia and femur.

Distraction: Using the therapist's knee, anchor the patient's femur to the couch. Grasp the tibia firmly and apply a distraction force along the lower leg. Rotate the tibia medially and laterally while applying the distraction force.

Positive result: Rotation plus compression is more painful than rotation plus distraction. Bilateral comparisons must also be considered.

Thessaly test

The patient stands in upright position with feet flat on the floor. The therapist supports the patient by holding their outstretched hands. The patient then stands on the effected leg and bends their knee to 5°. While supported, the patient then rotates their femur and body internally or externally three times (Video 3).

Repeat this procedure with the knee flexed at 20°.

Positive result: Medial or lateral joint-line discomfort possibly with a sense of locking or catching.

N.B. Always perform this test on the non-symptomatic knee first to familiarise the patient with good form and technique and to facilitate a baseline non-symptomatic result.

Ege's test

This is a weight-bearing test where the patient stands with feet 30–40cm apart and performs a variation of a squatting action (Video 4).

Medial meniscus: Instruct the patient to turn the feet into maximum external rotation and then perform a squat

online

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Video 1: The McMurray test (Skinner, Ashworth & Bateman, 2014)

Video 2: The Apley test (Skinner, Ashworth & Bateman, 2014)

Video 3: The Thessaly test (Skinner, Ashworth & Bateman, 2014)

keeping feet flat on the floor. The distance between the knees will increase as the squat is performed. Instruct the patient to squat as deep as possible before slowly return to start position.

Lateral meniscus: Repeat the above procedure with feet in maximal internal rotation. This time the distance between the knees will decrease.

Positive result: Pain and/or a clicking felt by the patient at the related site of the joint line.

N.B. Prevent further squatting as soon as pain or clicking is felt.

Joint-line tenderness (JLT)

Instruct the patient to sit on the edge of the couch with knees hanging at 90°. The therapist then palpates along the lateral and medial tibiofemoral joint line (Video 5).

Positive result: Focal pain is reported on palpation.

ANALYSIS OF RESEARCH FINDINGS

A wide range of clinical tests are used to diagnose meniscal pathology, with the five tests described above regularly forming part of a physical therapists practice. As practitioners' knowledge and skills grow we continue to seek to establish which of our clinical tools are the most effective. Each of the tests described have been evaluated for their diagnostic accuracy, validity, sensitivity and specificity. Definitions of the clinical measures used in research to establish the effectiveness of each test can be seen in Table 1 in accordance with Powel and Huijbregts (13). By attempting to document each test along with its strengths and weaknesses we aim to provide practitioners with a broader understanding of the range of tools they use to assess meniscal tears.

Akeski et al. (14) made comparisons between the McMurray test, Joint-line tenderness (JLT) and a proposed new weight-bearing test, Ege's Test, for their diagnostic value in an attempt to establish a more functional (mechanics replicating) test. Their findings report that 127 meniscal tears from the 150 tears diagnosed on arthroscopy were determined. In this investigation there were no statistically

Video 4: Ege's test (Skinner, Ashworth & Bateman, 2014)

Video 5: Joint-line tenderness test (Skinner, Ashworth & Bateman, 2014)

> "THE LOCATION OF THE MENISCAL INJURY PLAYS A HUGE PART IN WHETHER THE LESION WILL HEAL OR NOT"

TABLE 1: OPERATIONAL DEFINITIONS OF DIAGNOSTIC ACCURACY TERMS USED IN ESTABLISHING THE VALIDITY OF CLINICAL TESTS FOR MENISCAL PATHOLOGY (Skinner, Ashworth & Bateman, 2014)

Statistical measure	Definition	Calculation
Sensitivity	The proportion of people who have the dysfunction/condition who test positive	TP / (TP+FN)
Specificity	The proportion of people who do not have the dysfunction/condition who test negative	TN / (FP+TN)
Positive predictive value	The proportion of people who test positive and who have the dysfunction/condition	TP / (TP+FP)
Negative predictive value	The proportion of people who test negative and who do not have the dysfunction/condition	TN / (TN+FN)
Accuracy	The proportion of true results (both true positive and true negatives) in the population. An accuracy of 100% indicates the test identifies all injured and non-injured people correctly.	= (No. of TP + No. of TN) / (no. of TP + FP + FN)

TP, True positive; **FP**, False positive; **FN**, False negative; **TN**, True negative

TABLE 2: SUMMARY OF THE DIAGNOSTIC VALUES REPORTED BY AKESKI ET AL. (14) (Skinner, Ashworth & Bateman, 2014)

Diagnostic measure	Joint-line tenderness Medial / Lateral	McMurray Medial / Lateral	Ege's Medial / Lateral
Accuracy (%)	71 / 77	66 / 82	71 / 84
Sensitivity (%)	88 / 67	67 / 53	67 / 64
Specificity (%)	44 / 80	69 / 88	81 / 90
Positive predictive value (%)	74 / 47	80 / 59	86 / 58
Negative predictive value (%)	67 / 90	53 / 88	57 / 90

"THE THESSALY TEST AT 20° HAD A 94% DIAGNOSTIC ACCURACY RATE IN DETECTING MEDIAL MENISCUS TEARS AND 96% FOR LATERAL MENISCUS TEARS, AS WELL AS A PRODUCING LOW FALSE POSITIVE RATES AND LOW FALSE NEGATIVE RATES"

significant differences between the three tests in detecting tears; however, better accuracy, specificity and sensitivity were found using the Ege's test (findings summarised in Table 2). Findings indicated that the JLT gave higher accuracy rates but the specificity of the Ege's tests was noticeably higher (81% compared to 44%). Lateral meniscal tears were more accurately reported than medial tears with the Ege's test again providing better results when compared to the others.

Developing further from Akeski et al.'s (14) notion of the need for more functional weight bearing tests, Karachalios et al. (15) developed and investigated the Thessaly test. Utilising 213 symptomatic and 197 asymptomatic patients, who were all assessed by magnetic resonance scanning (and arthroscopic surgery in the symptomatic group), were clinically examined using the JLT, McMurray, Apley's Compression and Distraction tests and the new proposed Thessaly tests at 5° and 20° knee flexion, again using the same measures of validity as outlined in Table 1. The Ege's test was not used for comparison within the study. Findings from this investigation highlighted the Thessaly test at 20° had a 94% diagnostic accuracy rate in detecting medial meniscus tears and 96% for lateral meniscus tears, as well as a producing low false positive rates and low false negative rates, leading the authors to state that this test has changed their clinical practice, using MRI scanning as a second-line screening test for patients whereby the mechanics, history, and examination indicate the presence of a disorder other than a meniscal injury. The authors state that this change in practice has allowed a reduction in the

TABLE 3: VALUES FOR DIAGNOSTIC PARAMETERS OF THE CLINICAL EXAMINATION TESTS REPORTED BY KARACHALIOS ET AL. (15) (Skinner, Ashworth & Bateman, 2014)

Diagnostic measure	Joint-line tenderness Medial / Lateral	McMurray Medial / Lateral	Apley Medial / Lateral	Thessaly: 5° Medial / Lateral	Thessaly: 20° Medial / Lateral
Accuracy (%)	81 / 89	78 / 84	75 / 82	86 / 90	94 / 96
Sensitivity (%)	71 / 78	48 / 65	41 / 41	66 / 81	89 / 92
Specificity (%)	87 / 90	94 / 86	93 / 86	96 / 91	97 / 96
False positive (%)	8.8 / 9.3	4.2 / 12.4	4.6 / 13	2.9 / 8	2.2 / 3.7
False negative (%)	10 / 2	17.6 / 3.2	20 / 5.4	11.4 / 1.7	3.6 / 0.73

cost of diagnostic imaging and reduced the level of unnecessary MRI scanning. Table 3 summarises the key findings from the study.

Having identified previous inconsistencies in the diagnostic values reported in literature Chivers and Howitt (16) provided a narrative review of orthopaedic literature into physical examination tests used for knee meniscal injuries. Having provided a comprehensive review of the existing findings their review concludes by stating further investigation is needed to establish more advanced diagnostic methods. Practitioners are encouraged to use a battery of test to support their diagnosis is needed, and greater evidence is needed in relation to which combination of tests provides the greatest level of accuracy, along with the need to combine physical assessments with history taking. The accuracy of any one single diagnostic test is stated to be dependent upon the skill of the examiner, and the range of meniscal tests available highlights the reliability of each individual test is questionable. Table 4 summarises the ranges of sensitivity and specificity reported across the studies included within this review.

TABLE 4: SUMMARY OF RANGES FOR SENSITIVITY AND SPECIFICITY OF THE DIFFERENT TESTS [Skinner, Ashworth & Bateman, 2014: derived from Chivers & Howitt (16)]

Test	Sensitivity range (%)	Specificity range (%)
McMurray	16–70	59–98
Joint-line tenderness	55–95	15–97
Apley	13–41	80–93
Thessaly	65–92	80–97
Ege's	64–67	81–90

CONCLUSION

Meniscal injuries have long been, and continue to be a frequently occurring injury to both professional and recreational athletes. Many attempts have been made to establish accurate and reliable diagnostic tools to support physical therapists diagnosis skills and assist early detection. There are clear movements towards trying to develop more functionally relevant assessment procedures with the introduction of the Ege's and Thessaly tests; however, a lack of agreement and clarity remains over which diagnostic tool is the most reliable. With therapists' skills levels also reported to influence the accuracy of findings, therapists are encouraged to use a battery of tests and not rely on any given single procedure to ensure effective diagnoses are made.

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FURTHER RESOURCES

1. *Meniscal Injuries: Management and Surgical Techniques* by JD Kelly. ISBN 978-1461484868. (Harcover £99.51 £94.53 Kindle) Buy from Amazon http://spxj.nl/1rm3w8l

2. *Sports-Related Injuries of the Meniscus (Clinics in Sports Medicine)* by PR Kurveil. **Saunders 2012**. ISBN 9781455739356. (Hardcover £73.92 Kindle edition £52.47) Buy from Amazon http://spxj.nl/1vgUl1B

- If a battery of tests all provide positive results should patients still be required to undergo an MRI scan?
- Should therapists choose practical ability over the reliability of tests when choosing which assessment tool/test to choose?
- Should more research be conducted to develop further or alternative meniscal tests?

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KEY POINTS

- The menisci are half-moon shaped in appearance and attached to the tibial plateau on the medial and lateral aspect of tibia.
- The common mechanism for a meniscal injury is a planted foot with rotation of the femur on the tibia with a flexed knee.
- Common symptoms of meniscal injury include swelling, instability, clicking, locking and joint-line tenderness.
- The five common tests used for assessment of meniscal injuries include the McMurray, Apley, Thessaly, Ege's and the joint-line tenderness tests.
- Meniscal tears are reported to account for 10–20% of all orthopaedic injuries.
- The accuracy of any one single diagnostic test is stated to be dependent upon the skill of the examiner.
- Analysis of each assessment test indicates practitioners should use a battery of tests when assessing meniscal injuries.

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