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# The meniscal injuries in the soccer player: clinical field tests in closed kinetic chain. Validity and applicability

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## ABSTRACT

***Background.****The important biomechanical role played by the meniscus in the functionality and stability of the knee during sports performance is known in the literature. The combinations of torsional and axial load appear to be the cause of most meniscal injuries. Diagnosis of acute knee injuries has long been a topic of discussion throughout orthopedic literature. Many clinical tests and diagnostic studies have been developed to increase the clinician's ability to accurately diagnose these types of knee disorders.*

***Objective.*** *The objective of our study is to verify through a review of the literature if Clinical tests in a closed kinetic chain to diagnose the meniscal knee lesions have a validity, if they are correlated with the classical tests in the open kinetic chain and then propose them as a screening tool in the their practical applicability on the pitch during a competition or training.*

***Materials and methods.*** *In this systematic review of the literature we used the Search Equation of the Boolean Operators AND and OR within Search Equation. We have thus inserted specific Key words to the research topic: physical examination, meniscal tears, Physical Examination for Meniscus Tears, Clinical diagnosis of meniscal tears, tests for meniscal Injury specific to the research topic.*

*At the word "meniscus tear" we found, in December 2018, on PubMed 3814 abstracts and full-text articles. While on PubMed Central 4737 from which we have considered, it is our search only 841 for free Full-text articles.*

*To the keywords "Meniscal test" highlighted 1068 abstracts and Full-text articles on PubMed and 4986 abstracts and Full-text articles PubMed Central. We have tried to further refine our research by addressing it in the last 5 years with 417 articles published on PubMed. Of these we have selected, for our research, 166 free full text articles.*

***Results.*** *For the preparation of this review have selected 57 scientific articles. Recently, from the international scientific movement, tests have been reported, in a closed kinetic chain, that reproduce technical-athletic gestures, for the diagnosis of meniscal lesion. Among these the Thessaly Test and the Ege's Test, have shown a high diagnostic accuracy, approaching, in fact, reference models such as joint line tenderness, McMurray's test and Apley's compression test. Among other things, these tests, in CKC, stimulating technical / athletic gestural moments, these tests can find, "going towards the lesion" an indication and prescription both in rehabilitation training and in physical ones aimed at prevention, given the extremely articular environment proprioceptive, knee ligament capsule injuries and, in particular, meniscal lesions. We did not find any work related to the practical applicability of these clinical tests used during competitions and training.*

***Conclusions.*** *Meniscal tears are frequently found in sports. The diagnosis can be accurately performed in 75% of the knees on the basis of the clinical history alone, while the specific clinical tests that have been used for the detection of these lesions do not have high values of sensitivity and specificity if taken individually. In our study we have identified test clinic in closed kinetic chain that allow to operate a more incisive evaluation, correlating clinical expressivity with the specific gestures of the athlete.*



***Study Design.*** *Systematic Review.* ***Authorship Credit.*** *"Credit: "Equal Contribution" (EC).* ***Citation.*** *Rosario D'Onofrio, Mehul Padasala, Bojan Bjelica, Shamila Hussain, Jaymin H Bhatt; The meniscal injuries in the soccer player: clinical field tests in closed kinetic chain. Validity and applicability ; Ita. J. Sports Reh.2021; Po. 16;(8) 1651 – 1671 ; DOI : 10.17385/ItaJSRP.21.16.080101; ISSN 2385-1988 [online] ; IBSN 007-111-19 - 55; CGI J OAJI 0,101)] Published online.*

**Key words:** *physical examination, meniscal tears, meniscus, clinical diagnosis, meniscal test.*

## INTRODUCTION



Meniscal injuries are always frequently reflected in sport. They represent one of the most interesting pathologies for knee arthroscopy surgery. These may occur separately or in association with capsulo - ligamentous lesions and chondral pathologies. The posterior horn of the medial meniscus is the most commonly seen site, while longitudinal tears represent the most frequent lesions[1,2.] The isolated meniscal tears are common in young athletes and cause a significant suspension from sports activities with meniscal repair, as opposed, which cause a period of inactivity from very long sporting practice. In young patients, injuries related to sports such as football, basketball, football, baseball and skiing in particular are the most common cause of meniscal injuries, which account for more than 1/3 of all injuries in these sports[3].

The menisci are two semilunar, fibrocartilaginous discs located between the medial and lateral articular surfaces of the femur and tibia in each knee. The menisci play an important role in the knee providing multiple complex functions, including load bearing, stress distribution and shock absorption. Loads transmitted through the joint to the cartilage are partially borne by the menisci; hence they play an important role in both the protection of the cartilage and the subsequent development of degenerative osteoarthritis of the knee should the menisci become damaged. Damage to the menisci commonly occurs in two different scenarios: in young active individuals during sporting activity and in older individuals as a result of long-term degeneration of the menisci.

Reliable non-invasive diagnosis of meniscal tears is difficult. Magnetic resonance imaging (MRI) is often referred to as the gold standard for non-invasive diagnosis of meniscal tears. However, incidental meniscal findings on MRI of the knee are common in the general population. These incidental findings increase with age and are often not associated with pain. The only completely accurately way to diagnose meniscal tears is to perform an arthroscopy of the knee in order to image the menisci directly. However, this is an invasive procedure and therefore carries risks for the patient.

As an alternative to imaging or surgery there are a number of physical examination tests described for the diagnosis of meniscal tears. The most commonly used physical tests include the joint line tenderness Test, McMurray’s Test and Apley’s Test. These tests have been in use for many years, but are widely acknowledged to have limited specificity and sensitivity, particularly in the presence of other knee pathologies such as anterior cruciate ligament rupture. More recently Karachalios[29] have described a new physical test to detect meniscal tears – the Thessaly Test.[29] The Thessaly Test is reported to have a high sensitivity and specificity.

One study[4] found that in sports such as the highest percentages of meniscal tears were detected in football (19%), wrestling (13%) and rugby (9%). In wrestling and volleyball there is a high incidence of meniscal injuries associated with Anterior Cruciate Ligament (ACL) injury. While wrestling and rugby pose the greatest risk of meniscal injuries[4]. However, there are few studies on the epidemiology of meniscal injuries in a stable knee and in particular on lesions in young populations. Yeh PC[5] found 129 isolated meniscal injuries in

NBA athletes during 21 sports seasons. From the total, 77 (59.7%) affected the lateral meniscus and 52 (40.3%) the medial meniscus.

Injuries occurred more frequently during the races if they were related to the training sessions. The lateral meniscus had a statistically significant higher injury rate. The number of days absent from sport for lateral meniscal injuries and medial meniscus injuries were 43.8 ± 35.7 days and 40.9 ± 29.7 days, respectively.[5] There was a significant inverse relationship between age and frequency of lateral meniscal tears, with lateral meniscal injuries most likely to occur until the age of 30; beyond those medial meniscal tears were more common. Players with a body mass index (BMI) of > 25 had a higher risk factor for lateral meniscal injuries compared to players with a BMI below < 25. This is also confirmed by a 2015 work by Masini [5] which found 79 cases of meniscal injuries in a cohort of 9086 subjects from 2005-2012. Of these, 68 (86%) were male and 11 (14%) women. Meniscal injuries were also distributed both right (40) and left (39). The lateral meniscus (70%) was injured with a greater percentage than the medial meniscus (30%). The body mass index (BMI) in the population of patients with meniscal injury was 25.7 vs 24.6 for the cohort with healthy knees ($P < 0.05$).[6]



BMI was also greater in those with lesions of the lateral meniscus[1,7] than the medial (23.9) ($P < 0.05$). The average time lost from sports activity was 102 ± 112.7 days. In arthroscopic surgery, meniscal sutures resulted in an absence of 150.8 days compared to 101.0 for debridement ($P < 0.05$). There was no significant difference in the time of absence from sports activity between medial meniscus (90.9 days) vs lateral (106.9 days).

Accuracy in the diagnosis of these lesions can be made in 75% of patients, collecting only the history and clinical examination[8,9.] For clinicians, MRI is currently the most widely used imaging method for detecting meniscal tears, with a reported diagnostic accuracy of 98% .[35]

Sports gestures expressed in a closed kinetic chain produce axial forces on the knee joint. These compressive femorotibial forces determine "circumferential" stress on the meniscal body. Studies carried out by Seedhom[10] reported how the load that is transmitted is distributed for 70% in the lateral compartment and 50% of the load in the medial compartment.[47]

The meniscus transmits 50% of the compression load, in a closed kinetic chain, through the rear horns in extension, with an 85% flexion transmission of 90.° [47] Radin[11] has shown that these loads are well distributed when the menisci are healthy. However, removal of the medial meniscus creates a 50% to 70% reduction in the femoral condyle contact area and a 100% increase in contact stress.[11] The total lateral meniscectomy causes a decrease from 40% to 50% in the contact area and increases the stress related to the compressive femoro - tibial force[47] in the lateral component from 200% to 300% of normal. We must not forget how the menisci have important functions: stability[12,13,] nutrition[14,] joint lubrication[,15] proprioception.[16,17,18]

In a study of ligamentous function, Brantigan and Voshell[19] reported medial meniscus mobility on average 2 mm, whereas the lateral meniscus was markedly more mobile with about 10 mm of anterior-posterior displacement during flexion. Others[10,11] have reported that the medial meniscus undergoes 3 mm of anterior-posterior displacement while the lateral meniscus moves 9 mm during flexion. Thompson[20] in a study of 5 cadaveric knees reported that the mean medial meniscus excursion was 5.1 mm while the medial excursion averaged 11.2 mm along the articular surface of the tibia.[20] The results of these studies confirm a significant difference in segmental movement between the medial and lateral meniscus.

We must not forget for greater descriptive completeness as the knee joint is innervated by the posterior articular branch of the posterior tibial nerve and by the terminal branches of the obturator and the femoral nerves. The lateral portion of the capsule is innervated by the recurrent peroneus branch of the common peroneal nerve.

The mechanoreceptors present within the meniscus function as transducers, converting the physical stimulus of tension and compression into a specific electrical nerve impulse. The studies[10,11,16,18,19,21,22,23] on the meniscus identified 3 morphologically distinct mechanoreceptors[21];

a) Ruffini terminations,

b) corpuscles of Pacini,

c) golgi tendinous muscles organs.

Type I (Ruffini) mechanoreceptors are low threshold and adapt slowly to changes in strain and joint pressure. Type II mechanoreceptors (Pacini) are low threshold and adapt quickly to voltage variations. Types III (Golgi) are high-threshold mechanoreceptors, which signal when the knee joint approaches the range of terminal movement and are associated with neuromuscular inhibition. These neural elements were found in greater concentration in the meniscal horns, in particular the posterior horn. Ruffini receptors are thin, encapsulated globular globules found in groups of three to six in the collateral ligaments, cruciate ligaments, menisci and capsule of the knee joint. Each member of this cluster is innervated by the same myelinated parent axon. Ruffini terminations (type T) are low threshold mechanoreceptors responsible for the detection of static and dynamic factors such as joint angles, velocity and intra - articular pressure.[21,22,23]

The corpuscles of Pacini (type II) are mechanical regulators that adapt quickly to low threshold. They are elongated and conical and are enclosed in a capsule of connective tissue. They are responsible for signaling dynamic changes in tissue deformation and initiation, acceleration and cessation of joint movement. They can be found in the knee joint capsule, both in the cruciate ligaments and in the menisci.[11,13,47] The distribution of the aforementioned neuroreceptors in their designated structure follows a single model. For example, the distribution of the mechanoreceptors in the ligaments is exclusively in the distal and proximal areas. Furthermore, Kennedy[8] found that the neuroreceptors are located at the outer perimeter of the meniscus.[23,42,45]

Asymmetric knee components act in concert as a type of biological transmission that accepts, transfers and dissipates loads along the femur, the tibia, the patella and the femur.[47]The ligaments act as an adaptive link, with the menisci representing the mobile bearings.[11] Several studies have reported that various intra-articular components of the knee are sensitive, capable of generating sensorine signals that reach spinal, cerebellar and upper levels of the central nervous system.[41] These neurosensory signals are thought to determine conscious perception and are important for the normal function of the knee joint and the maintenance of tissue homeostasis.[24,25]

The perception of movement and joint position is mediated by mechanoreceptors that transduce mechanical deformation into electrical neural signals. Mechanoreceptors were identified in the anterior and posterior horns of the meniscuses. The fast-adapting mechanoreceptors, such as the Pacini corpuscles, are designed to mediate the sensation of joint movement and slow-fit receptors, such as the Ruffini terminations and the Golgi tendon. The organs are thought to mediate the sensation of joint position. [26] The identification of these neural elements (located mainly in the middle and outer third of the meniscus) indicates that the menisci are able to detect proprioceptive information in the knee joint, thus playing an important role in the sensory feedback mechanism of the knee. [22]These receptors are found in ligaments, capsule, tendons and knee menisci [26,40,45.] Based on scientific evidence[42,43,44,45] the "informatics" articular environment of the knee, as a whole, plays an essential role in the management of neuromuscular control in its static and dynamic gestural expressions.

The existence of mechanoreceptors of the Ruffini, Pacini, and tendinous Corpus of the Golgi is well known within the knee joint. These are present, in particular, in the joint capsule and ligaments[,46] as well as in the peripheral area of the meniscal body.[23,26,42,46]

Katonis[45] found in the anterior cruciate ligament, mechanoreceptors populations located mostly at the femoral and tibial ends of the ligament[47.] Just as Malanga[39] identified 5 different types of mechanoreceptors within the knee joint with greater concentration, in the meniscus and more precisely in the anterior and posterior horns and in the peripheral zone with greater vascularization, called red-red zone.[32] In the functional dynamics and in relation to the compressive femoro - tibial forces, the meniscus transmit, "cushioning and distributing" about 50% of the compressive forces of the knee in a joint range ranging from 0° to 90°. [49]

Biomechanical studies referring to the knee[15,46,48,49] have found that the compressive femoro tibial forces, for example in the relapse after a jump, are more "supported", thanks to the role of "sensor", from the peripheral component of the circumference meniscal (load values of 45% -70% of body weight). After meniscectomy, the same area of tibio-femoral contact can decrease up to 50-70% [49] with a decrease in neuromuscular control and a gradual evolution towards degenerative processes of the articular environment. These degenerative changes of the post-meniscectomy articular environment involve a deafferenzation of the articular receptor activity with an "intoxicated reading" by the Central Nervous System (CNS) of the receptor afferents [23,26,42,44,45,49] lesion or a meniscectomy will create an afferent blackout, related to the modulation of the femoro-tibial compression forces and to the control of the anterior femorotibial translational forces[49]

On the other hand, the loss of the functionality of the endo and exo-receptors will provoke adaptations and compensations that will affect as a whole, not only the entries of the postural system but also the muscle chains and the biomechanical pivots of the vertebral column and pelvis. Thus, we can state how the receptors located in the joint capsule and in the meniscus, signal and modulate the compressive femoro-tibial forces during the technical athletic gesture. Endoreceptors, as previously highlighted, function as listening and transmission stations for information related to the mechanical stresses produced on the joint. These regulate the physiological and biomechanical behavior, during the various degrees of the flexion / extension movement of the knee, modulating the control of gestural-simple and complex movements in varus-valgus internal and external rotation of the tibial femoral axis.

It becomes clear and evident how receptors of the articular environment must be "trained" to detect anomalous non-physiological situations that can stimulate an automatic response and / or a reflex defense.

The repetitiveness of technical / athletic gestures, with the monotony of sports-related training proposals and strategies, can contribute to establishing cyclic and repetitive adaptive neurophysiological patterns and patterns. This standardization of receptorial information will create a consequential quiescence of the latter with a consequential lack of an "experiential" memory in a neuro-afferential circuit. In this dysfunctional process the receptors will partially or completely alter their informational activity. The reduction of their perceptive level will in fact decrease the anticipatory mechanisms (feed-forward) that activate programmed "experiential" posturological responses, which must be pre-activated before the voluntary movement. Therefore at the time of "joint deformation" (compression, stretching, etc.) these potentially altered receptors transmit null or aberrant information.



In "preventive training that goes towards harmful etiopathogenetic moments" the various control receptor systems achieve a neurophysiological adaptability such as to create "experiential" control memories in relation to gestures or movements that we can define as "extreme". This will result in posturological correlations and adjustments. expressible with an improvement of the body's orientation in space in its fight against gravity and in the search for the best postural balance during simple and complex athletic technical gestures.

It is evident that we could use these clinical tests, which "go towards the injury", as preventive strategies. The proprioceptive stimulation at the level of the lesion mechanism will substantially allow us to propose strategies to prevent knee injuries in relation to the "lesion position" as could be a cutting maneuver with a knee valance at 20° of flexion and tibial rotation.[30,31]

Hence the need, deductive, of a personalization of preventive training in relation to the clinic and to the model of the harmful etiopathogenetic mechanisms. The high incidence of injuries occurring later during a sports or recreational session suggests that fatigue status may contribute to alter neuromuscular control of the lower limb. After this initial introduction we want with this document to examine the clinical tests, in close kinematic chain, to diagnose an acute meniscal lesion and their applicability and validity of tests correlating them with the classic tests in Open Kinetic Chain.

## MATERIALS AND METHODS

We have included in our research sources of scientific information such as studies, reviews, systematic reviews, scoping reviews, meta-analysis, cases series. In this context we decided to include only studies published in English with the exception of a reference study by the author. In contrast we have excluded: abstracts of conferences, opinion articles, magazine articles and newspapers. So in December 2018, we developed a research strategy on the electronic databases PubMed, and PubMed Central. We examined the reference lists of included studies, systematic reviews and narrative reviews and conducted the monitoring and analysis of citations to build a "core publications",

The next step was to identify and keywords and the terms of the index. We analysed the title and the index used to describe the studies identified in phase 1 and to identify the appropriate Key words to be included in the final research strategy. In this systematic review of the literature, the Search Equation of the Boolean Operators AND OR within the Search Equation was used, including, inserting the Key words specific to the research topic: physical examination, meniscal tears, Physical Examination for Meniscus Tears, Clinical diagnosis of meniscal tears, test for meniscal Injury at the word "meniscus tear" we found, on PubMed 3814 abstracts and articles Full text while on PubMed Central 4737. Later we selected and considered for our research only 841 articles between abstracts and free Full text.
The Key words "Meniscal test" highlighted 1068 abstracts and Full test articles on PubMed 4986 abstracts and Full test PubMed Central articles. We have tried to limit and further select our research addressing it in the last 5 years with 417 articles published on PubMed of these we have only selected, for our research, free full text articles 166. Consequently, all the articles were downloaded. Subsequently, cross references were made and any duplicates deleted before the selection criteria were applied. Thus, the full text was screened to be included in the review of the scope by the reviewers themselves independently. Any discrepancies were resolved during a consensus meeting. To validate the practical applicability of clinical tests, for the diagnosis of meniscal lesions, in the closed kinetic chain we decided to select 57 scientific articles that allowed us to develop, in a comprehensive way, this revision.

## TESTS IN CLOSED KINETIC CHAIN

### The Thessaly test: description

The Thessaly Test is a clinical test in a closed kinetic chain. It was originally described by Karachalios.[31] In its practical applicability it tries to reproduce the dynamic transmission of the load on the knee joint during rotational gestural gestures. The examiner supports the patient by holding his hands outstretched. The patient performs an internal and external rotation on the knee.[31] The test is positive when the patient perceives pain and / or a click or is audible both by the patient and by the examiner. (refer to the slightly flexed knee during the rotational movement). The Thessaly test (*Figure 1A and 1B*) is a dynamic reproduction of the load transmission, which is a physiological representation of the transmission of compressive femoro-tibial forces on the knee joint. The patient performs at angles of flexion of 5° and 20° a internal and external rotation movement three times, keeping the knee flexed first at 5° and then following the same procedure with the knee flexed at 20°. [31]



***Figure 1A.*** *The Thessaly test at 20° flexion. - Neutral rotation. Right knee side position.* ***Figure 1B****. The Thessaly test at 20° of Flexion - Neutral rotation right knee front Position.(D'Onofrio R.2013)*

**EGE'S TEST: description**

The Ege's Test described by Akseki,[32] is performed with the patient standing, in bipodal support, with the knees in extension and the feet spaced by 40 cm. To detect a medial meniscus lesion, the patient performs a squat with both legs in maximum external rotation and then returns to the starting position. For the lateral meniscal lesions both lower limbs are positioned in maximum internal rotation while the patient squats and returns slowly to the starting position. Starting from fully extended knees, with parallel feet held at a distance of 30-40 cm from each other.

The evaluation is aimed at identifying a possible:

a) Medial meniscal lesion; the patient performs a squat with both legs in maximum external rotation, and then slowly returns to the starting position (*Figures 3A and 3 B*),
b) lateral meniscal lesion; the patient performs a squat with the lower limbs in maximum internal rotation, and then slowly returns to the starting position (*Figures 4A and 4B*).

It is useful to clarify how a full squat is almost impossible to do it in internal rotation. Thus, the test is performed at substantially smaller bending angles. Therefore this test is positive when the pain or a click is felt by the patient or by the clinician.[17] The clicking or the perceived pain determine the end of the test. Also this evidence is ascertained in relation to the presence of a click or pain that are often felt around 90° of knee flexion where the compressive femoro-tibial forces are important. [39]


*Figure 3A, 3B*. *Ege's test. Evaluation for a medial meniscal injury, the patient perform a squat with both legs in maximum external rotation, before returning,slowly, in the starting position. (R. D 'Onofrio 2013).*


*Figure 4A, 4B*. *Ege's Test, lateral meniscal lesion, the patient performs a squat with limb lower in maximum internal rotation and then slowly return to the starting position. (R. D'Onofrio 2013)*

**Duck Walk Test, (Childress sign); description**

For the execution of the Duck Walk test (Childress sign) the patient is asked to squat and "walk like a duck" "walking crouched" and "swaying". It is positive in case of generalized pain in the joint line or painful "click". Pain in combination with a clunk suggests an injury of the posterior meniscus of the horn. The squatting position places great stress on the back horn of both meniscus.Childress sign originally described the Waddle Duck Waddle test in

medial meniscus injuries and described it as positive if incomplete flexion was limited by pain at the posteromedial line or by clicking.[56]
Most of his patients with a posterior medial meniscus injury reported a sharp click in the knee associated with acute pain at the posteromedial portion of the joint when they performed a squatting down resulting from a meniscal impingement at full flexion. A positive sign is evidenced by incomplete flexion limited by pain at the posteromedial articulation line or by articular "clicking".

## RESULTS



The main objective of this systematic review was to synthesise the most up-to-date literature for diagnostic accuracy studies for meniscal tears of the knee for soccer player. The overall three tests that were included within the meta-analysis ( Thessaly test,Ege test, Duck Walk test) indicate that they have poor accuracy.
Combined lateral and medial sensitivity of the Thessaly 5° test varied from 35%[53] to 65% [11.] Reasons for this are unclear as patient selection and exclusion criteria were similar in both studies. One explanation could be the different reference standards used. Karachalios[29] study was the only study that used MRI. Karachalios[29] also developed the Thessaly test, and therefore may have interpreted results differently or may have biased results inadvertently towards their own test. This authors[29] gives the Thessaly test substantially higher sensitivity and specificity scores than all the other studies that investigated it.[29]
Currently for the diagnosis of meniscal lesion are used as a clinical examination has the Joint Line Tenderness, McMurray's test and Apley's Compression Test or clinical evaluation in open kinetic chain. Recently, from the international scientific movement, clinical and functional tests have been reported for the evaluation of meniscal lesions that their easy applicability could be used on the "field". These tests in the closed kinetic chain are the Thessaly Test, the Ege's Test, the Duck walk test. [50,51]
Our review highlighted how the Thessaly Test and the Ege's Test have a high diagnostic accuracy, approaching, in fact, reference models "Gold Standard", reproducing substantially and faithfully, harmful lesions and etiopathogenetic gestures. The Thessaly test performed at 20° of knee flexion for medial lesions showed a sensitivity of 89%, a specificity of 97% with a diagnostic evidence close to 94% for lesions of the lateral meniscus, the test has a sensitivity of 92%, 96% specificity with 96% diagnostic evidence. The Thessaly test performed at 20° of knee flexion (*Figures 1A and 1B*) has a very high percentage of diagnostic accuracy, namely a) equal to 94% in diagnosing the medial meniscus lesions; b) 96% in diagnosing lateral meniscus injuries. These data are comparable with the accuracy rates reported for images expressed by magnetic resonance imaging. [37,38.]
Athletes, who have a meniscal lesion associated with an anterior cruciate ligament injury, the diagnostic accuracy of Thessaly reaches a level equal to a value of 90%. In theory, we can state that, with this test, the knee joint is subjected to compressive femoro-tibial forces, flexion and rotation, typical gestural movements, which faithfully reproduce the etiopathogenetic moments of the lesion.
The Ege test, in our review, showed a sensitivity of 67%, a specificity of 81% and a diagnostic accuracy of 71% for the tears of the medial meniscus. [32] For the lateral meniscus, the Ege test had a sensitivity of 64%, a specificity of 90% and an accuracy diagnosis of 84%. The Ege

test had the highest overall positive predictive value for mean meniscal injuries 86%. Overall, the accuracy of the Ege test was the same as that of JLT (Joint Line Tenderness) and was superior to the McMurray test.[32] We must not forget how these tests in the closed kinetic chain, given the extremely proprioceptive joint environment of the knee, stimulating technical / athletic gestural movements can find, "going towards the lesion" an indication and prescription both in rehabilitation training and in physical actions to prevention. On the other hand, we did not find any studies, however, concerning the practical applicability of these tests during the competitions and training sessions. [32]Although the Duck Walk test[37] may be clinically useful for differentiating meniscal knee injuries, there is a lack of evidence on the diagnostic accuracy of this test.[54,55,56] Van der Post of 2017[37] in a 2017 study the highlighted sensitivity of the Duck Walk test was 71% (95% CI, 59% -81%) and 39% low specificity (95% CI, 27% - 52%).[37] There was no difference in sensitivity between medial meniscal lesions (67%, 95% CI, 51% -80%) and lateral (76%, 95% CI, 50% -92%, P = 0.492).



## DISCUSSION

In international orthopedic literature there are numerous studies that describe various tests and diagnostic procedures in an attempt to ensure an accurate diagnosis of the meniscus lesion.[1,2,9,29,31,32,33,38,48.] Based on the current review, it is evident that there is a lack of correlation between the tests and that the most recent ones have not yet been subjected to rigorous scientific investigations[40,41.] If in the past diagnostic arthroscopies [1,27] have been proposed to confirm more or less the meniscal lesion, today the magnetic resonance has officially become the instrument and the non-invasive method widely used to investigate and detect such lesions. The diagnostic accuracy of magnetic resonance imaging is reported to be very high and equal to a percentage close to 98%.[28,29.]

Basically, all the clinical tests used to diagnose meniscal tears, tend, also in a diversified manner, to evoke "a pain", a "click" meniscal in association with a possible and possible limitation of the knee joint range. Despite the wide use of these clinical screening, certainly diversified among them (Joint-Line Tenderness, Bragard test, Steinmann test, Compression test, Apley test) their sensitivity, specificity, and diagnostic accuracy is not widely accepted in the current scientific literature.[4,30,31.] Anderson[57] states, for example, that the McMurray Test can diagnose more than 58% of meniscal injuries. Others[31,32,33] state that joint-line tenderness (JLT) tenderness is present between 77% and 85% of meniscal lesions.[34.]

Surachai Sae-Jung[33] to evoke pain or "click" in the context of meniscal injuries has introduced a clinical test that combines palpation / rotation / compression called "Khon Kaen University knee compression-rotation test better known as the KKU knee Compression-Rotation test.

In the KKU knee compression-rotation the knee compression is created by increasing the tibio - femoral compression forces with a subsequent rotation of the same which is rotated both internally and externally, while the “hand is listening” and / or perceives a "clicking sound". This maneuver is repeated at various knee flexion angles (0°, 30°, 60°, 90°,120°).

This study[33] published in 2007 involved sixty-eight patients aged between 18 and 39 years. These were examined before surgery with the KKU knee Compression-Rotation test and the results compared to the McMurray Test. For these tests, the sensitivity, the specificity, the

false positive, the false negative and the percentage of diagnostic accuracy were calculated, and compared, Crossing the results with the arthroscopic evidence.
The results obtained showed that the KKU knee Compression-Rotation test expressed: sensitivity, specificity and diagnostic accuracy equal to the levels of 86.27, 88.23, and 86.76%, higher than the percentages of the McMurray test that stood at values equal to 70.59, 82.35, and 73.53%. In other words, the KKU knee Compression-Rotation test had percentages of false positives and false negatives of 11.76 and 13.73% compared to the values of the McMurray test anchored at 17.65 and 29.41%. The combination of these two tests reported a diagnostic sensitivity equal to 90.20%. Both patients showed a meniscal lesion with a diagnostic probability of 97.14%. It becomes evident that this evaluation, together with the Griding test performed in an open kinetic chain, increases in fact the compressive femoro-tibial forces, favoring a diagnostic accuracy of the "Gold Standard" meniscal lesions. Hence the need to move towards evaluations that increase the compressive femoro - tibial forces.



Currently for their easy applicability are present in the Test Literature[29,31,32,34,37] in closed kinetic chain (Thessaly Test, Ege's Test, Duck walk test) for the evaluation of meniscal injuries.
It is on these principles that a recent study[31] has been inserted that showed how the Thessaly Test, carried out in a closed kinetic chain, expresses a high percentage of diagnostic accuracy (94-96%) compared to traditional clinical tests in the chain open kinetics.[36.] The Thessaly Test was introduced to improve the diagnostic accuracy of the clinical examination in detecting meniscal lesions. This test appears to be a valid alternative to other normally performed meniscal test, but additional diagnostic accuracy data is needed. A frequently used closed kinetic chain test is the Thessaly test and high sensitivity and specificity have been reported.[31,50,52,53.]
Karachalios[29] examined the sensitivity, specificity and diagnostic accuracy of this new dynamic test. In this investigation, the subjects were clinically examined with JLT, McMurray, Apley's and the Thessaly test just described at 5° and 20° of knee flexion. Two hundred thirteen (213) patients with a suspected meniscal injury diagnosed based on clinical history and the lesion mechanism (group A) was studied and compared with a group of 197 volunteers without lesions to the meniscus (group B). All patients underwent magnetic resonance of the knee and those in group A had further therapeutic arthroscopy.[29.] The results indicate that for medial meniscus injuries the test of Thessaly performed with a knee flexion of 5° is sensitive to 66%, 96% specific and accurate to 86%. For the lateral meniscus, sensitivity is 81%, 91% specificity and 90% accuracy. While the Thessaly test performed at 20° of knee flexion for medial lesions showed a sensitivity equal to 89%, a specificity of 97% with a diagnostic evidence close to 94%. For lesions of the lateral meniscus, the test has a 92% sensitivity and a 96% specificity with 96% diagnostic evidence.[29] For lesions associated with anterior cruciate ligament (ACL) lesions, the 5° Knee Flexion test was 65% sensitive, 80% specific and had a diagnostic accuracy of 80%.[29.] The test performed at 20° of knee flexion performed with sensitivity of 80%, 91% specificity and a diagnostic accuracy of 90% for these combined ACL and meniscus lesions. Experienced physiotherapists performed the 20° flexion Thessaly test and the McMurray test for both knees. The physiotherapist in this study[34] was blinded to clinical information about the

patient as well as the orthopedic surgeon who performed the arthroscopic examination was blinded to the results of the physiotherapist's clinical test.

A total of 593 patients were included in this study[34,] of whom 493 (83%) had a meniscal lesion, as determined by arthroscopic examination. The Thessaly test had a sensitivity of 64% (95% confidence interval [CI]: 60%, 68%), specificity of 53% (95% CI: 43%, 63%), positive predictive value of 87 % (95% CI: 83%, 90%), negative predictive value of 23% (95% CI: 18%, 29%) and positive and negative probability ratios of 1.37 (95% CI: 1.10, 1.70) and 0.68 (95% CI): 0.59, 0.78), respectively. The association of Thessaly and McMurray showed a sensitivity of 53% and a specificity of 62%. However, it is also important to point out how often the results of the Thessaly test alone or combined with the McMurray test do not seem useful to determine the presence or absence of meniscal lesions.[36.]



The Thessaly test had a sensitivity of 0.66, a specificity of 0.39 and a diagnostic accuracy of 54% when used by primary care physicians. This is comparable with a sensitivity of 0.62, a specificity of 0.55 and a diagnostic accuracy of 59% when used by musculoskeletal physicians. The diagnostic accuracy of the other tests, when used by primary care physicians, was 54% for the McMurray test, 53% for the Apley test, 54% for the joint line loss test and 55% for the clinical history. For primary care physicians, the age and past history of osteoarthritis were both significant predictors of the diagnosis of meniscal tears. For musculoskeletal physicians, age and a positive diagnosis of meniscal injuries during the clinical history were significant predictors of magnetic resonance imaging. No physical tests were significant predictors of magnetic resonance imaging in our multivariate models. The specificity of MRI diagnosis was tested in a subset of patients who had a knee arthroscopy and was low [0.53 (95% confidence interval 0.28 to 0.77)], although sensitivity it was 1.0. It is clear and obvious how the sensitivity, specificity and diagnostic accuracy of all tests were too low to be of routine clinical value as a reliable alternative to magnetic resonance imaging.

Akseki[32] compared the value of the Thessaly diagnostic test for loading with the other two most commonly used tests: the JLT and McMurray test. Of 150 knees in 150 patients, 89 reported a specific history of trauma. All patients had radiographic examination and underwent arthroscopic surgery. There were no statistically significant differences between the three tests in detecting a meniscus lesion. The Ege test had a sensitivity of 67%, a specificity of 81% and a diagnostic accuracy of 71% for medial meniscus injuries. For the lateral meniscus the Ege test had a sensitivity of 64%, a specificity of 90% and an accuracy diagnosis of 84%. The Ege test, among other things, had the highest overall positive predictive value for middle meniscus injuries 86%[32.] In general evaluation, the accuracy of the Ege test was the same as that of JLT (Joint-line tenderness) and was superior to the McMurray test.

This test appeared to be the most specific for both medial and lateral meniscus injuries. We can state that the Ege's test is able to diagnose meniscal lesions with the same accuracy of Joint-line Tenderness (JLT) but with greater specificity and, therefore, the Ege's Test should be incorporated into the routine knee examination[37.] Smith[52] found that the sensitivity for the 20 ° test of knee flexion was 75% (95% CI, 53% -89%), was similar to the calculated sensitivity of the Duck Walk test's 71% (95 % CI, 59% -81%). [53.]

The specificity of the Duck Walk Test's 39% (95% CI, 27% -52%) seems lower than that of the 20% Thessaly test (87%, 95% CI, 65% -96%), McMurray (84%; 95% CI, 69% -92%) and tenderness of the joint lines (83%, 95% CI, 61% -94%). However, specificity is less relevant, as both tests are used in practice as a screening test, not a confirmation test[53.] However, joint line pain in general is a clinically used endpoint for a positive test result[8,16,17.] Although the Duck Walk Test for meniscal injuries (Childress' sign or squat test) has been described in several studies[8,16,18,20] there is no evidence to suggest how clinically useful it can be to diagnose effectively a meniscal lesion.[54,55.] In fact we were able to find only a diagnostic study that evaluated this test in knees in ACL Injury.[56.] In this study, Pookarnjanamorakot[56] compared the Apley test, the sign of Childress' sign (squat test), the McMurray test, Steinmann sign (Joint-line tenderness). The Duck Walk Test in this study had the highest sensitivity of 68% for the detection of meniscal lesions in patients with ACL injury.



## CONCLUSIONS

Meniscal injuries are very common among professional and amateur athletes. They are one of the most common indications for knee surgery. The Meniscus play an essential role in modulating compressive femoro-tibial and torsional forces. The important afferential activity of receptors located in the peripheral area of the body and in the horns and on the central ligament pivot, contributes to the control of the stability of the knee during technical-athletic gestures related sports. To this purpose the afferential receptor stimulation must be the most specific possible in relation to the etiopathogenetic models of injury. The set of clinical tests to diagnose meniscal lesions in open kinetic chain (Joint-line tenderness, McMurray, Apley's) have a good validity and reliability, to diagnose these lesions. The results of our review highlight how clinical trials are used in the closed kinetic chain (Thessaly Test, Ege's Test, Duck Walk Test) to diagnose meniscal lesions. The advantage of using these tests is to reproduce specific sporting gestures and can, in the acute phase, be a practical means of clinical investigation to identify possible meniscal injuries. To remember, however, as the whole of the clinical history, clinical tests and diagnostic imaging, remains the "gold standard" clinical procedure to diagnose a meniscal lesion.

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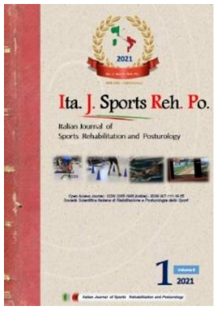


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