Accuracy of clinical examination and magnetic resonance imaging in arthroscopic knee surgery

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Background: *Diagnosis in knee injuries consist of clinical examinations and magnetic resonance imaging (MRI). The accuracy of these methods are varied. We performed a retrospective study to seek the accuracy of clinical examination and magnetic resonance imaging in arthroscopic knee surgery.*
Methods: *A total of 44 patients were selected for review. Data including sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were calculated.*
Results: *Arthroscopic examination should be kept as standard. The Lachman test is the most sensitive test to determine ACL tears, showing a sensitivity of 83% (95% confidence interval 0.64-0.99). The pivot shift test is the most specific test, showing a specificity of 85% (95% confidence interval 0.68-0.96). The McMurray test is the most sensitive test to determine meniscus tears, showing a sensitivity of 87% (95% confidence interval 0.76-0.96). The Apley test is a more specific test, showing a specificity of 86% (95% confidence interval 0.72-0.96). MRI of ACL showed a sensitivity of 96% (95% confidence interval 0.86-0.99). MRI of medial meniscus is a more sensitive test to determine meniscus tears, showing a sensitivity of 97% (95% confidence interval 0.88-0.99), MRI of lateral meniscus showed a sensitivity of 93% (95% confidence interval 0.84-0.99).*
Conclusion: *The clinical examination is an important and accurate diagnostic modality for the evaluation of knee injury. MRI is a more accurate diagnostic modality than clinical examination. It should be used when there is an uncertain indication for surgery.*

Keywords: *Clinical examination, magnetic resonance imaging, arthroscopic knee surgery*

The Thai Journal of Orthopaedic Surgery: 40 No.3-4: 19-23
Full text. e journal: *http://www.rcost.or.th, http://thailand.digitaljournals.org/index.php/JRCOST*

Introduction

The knee joint is the largest synovial joint in the body and is the most frequent source of musculoskeletal pain. Damage to the components within the knee joint usually occur as a result of injuries during sport activities or from car and motorcycle accidents. It is the numerous structures within it and their various pathologies, which result in pain and many other symptoms such as instability and restriction in range of motion[1]. Obtaining an accurate patient's history and physical examination can reveal the location of acute knee injury[2].

The anterior cruciate ligament (ACL) is an important stabilizing structure of the knee and its disruption is associated with pain and activity limitation[3]. The clinical diagnosis of an ACL injury is based upon history and physical examination findings with suspected cases confirmed by magnetic resonance imaging (MRI) or arthroscopy. Numerous clinical tests and findings have been proposed to aid in the diagnosis of ACL injuries. A popping sound, swelling and instability following high impact sport trauma along with a positive Lachman, anterior draw, or pivot shift test is the most common method of clinical diagnosis[4]. At present the diagnostic accuracy of these tests are varied. Magnetic resonance imaging (MRI) has become the gold standard for imaging soft tissue injuries of the knee[5]. However, the sensitivity of MRI for the detection of injury is not yet 100%. Sportsmen have occasionally undergone surgery with undiagnosed meniscal lesions on the basis of a normal MRI examination[6]. The sensitivity of MRI for the diagnosis of a lateral meniscus has been found to be significantly lower than that for the detection of a medial meniscus tears[7-9]. The lowest MRI sensitivity has been attributed to tears of the posterior horn of the lateral meniscus[10-12]. The presence of ACL tears are often associated with longitudinal tears of the lateral meniscus[13].

The purpose of this study is to determine the accuracy of clinical examinations and magnetic resonance imaging in arthroscopic knee surgery.

Materials and methods

A retrospectively review was conducted between 2014 and 2016 of 44 patients with arthroscopic knee surgery treated at Sawangdandin Crown Prince hospital. The inclusion criteria for this study were patients with a history of injury who underwent both MRI and arthroscopy knee surgery, patients who failed to show clinical improvement after 3 months, and those who had no

additional injury to the knee between the time of MRI/clinical diagnosis and surgery. Patients with degenerative changes, evidence of loose bodies in plain radiographs, any prior surgery for the index diagnosis, and articular surface fractures were excluded from the study.

The patients' examination included anterior drawer, pivot shift, and Lachman tests. Meniscus examination consisted of the McMurray and Apley tests. We recorded the physical examination findings for all patients.

The MRI findings were recorded by radiologist. Meniscal and ligamentous injuries were evaluated. The absence of an intrameniscal high signal was considered as a normal meniscus, while intrameniscal high signal intensity reaching the articular surface was regarded as a tear. The ACL was considered normal when it appeared as a band of fibres of low or intermediate signal intensity on both sagittal and coronal images. It was considered partially torn when it appeared fuzzy with an ill-defined outline and had abnormal signal intensity within, and as completely torn if there was disruption of all fibres, discontinuity, or avulsion from its attachment.

Arthroscopic surgery were done with complete preoperative care. A meniscus tear was diagnosed when there was discontinuity of its cartilage and we proceeded to identify according to size and shape of the tear. A complete tear of the ACL was diagnosed if the ligament was absent in the notch region, or if there was loss of ligament continuity with only ligament remnants at each end. We proceeded directly to reconstructive surgery and meniscus repair or meniscectomy in the same setting.

The data obtained from the study was analyzed using descriptive statistical methods (frequency, 95% confidence interval – percent) and the sensitivity, specificity, accuracy, positive predictive value and negative predictive value were calculated.

Results

There were 44 patients in the present study, with an average age of 25.8 years (range 14 - 40 years). The demographics data are shown in Table 1.

Table 1 Demographic data

Data	**Distribution**
Age (years): mean (SD)	25.8(5.2)
Gender (M/F)	32/12
Arthroscopic debridement	3
Meniscus repair or meniscectomy	14
ACL reconstruction	8
ACL reconstruction and meniscus repair/ meniscectomy	16
PCL reconstruction	3

The Lachman test is the most sensitive test to determine ACL tears, showing a sensitivity of 83% (95% confidence interval 0.64-0.99). The pivot shift test is the most specific test, showing a specificity of 85% (95% confidence interval 0.68-0.96). The McMurray test is the most sensitive test to determine meniscus tears, showing a sensitivity of 87% (95% confidence interval 0.76-0.96). The Apley test is a more specific test, showing a specificity of 86% (95% confidence interval 0.72-0.96), as shown in Table 2.

Table 2 Clinical examination results taking into consideration arthroscopic results as the definitive diagnosis

	Sensitivity (95% CI)	**Specificity (95% CI)**	**Positive predictive value (95% CI)**	**Negative predictive value (95% CI)**	**Accuracy (95% CI)**
Anterior drawer test	79 (58-94)	80 (61-95)	83 (65-95)	76 (54-93)	80 (60-95)
Pivot shift	75 (52-92)	85 (68-96)	86 (71-96)	74 (51-90)	80 (61-95)
Lachman	83 (64-95)	75 (53-92)	80 (62-95)	78 (56-93)	80 (59-94)
McMurray	87 (76-96)	79 (56-93)	90 (78-97)	73 (49-91)	84 (66-96)
Apley	83 (65-95)	86 (72-96)	93 (81-98)	71 (42-90)	84 (64-95)

MRI of ACL showed a sensitivity of 96% (95% confidence interval 0.86-0.99). MRI of medial meniscus is a more sensitive test for determining meniscus tears, showing a sensitivity of 97% (95% confidence interval 0.88-0.99), and MRI of lateral meniscus showing a sensitivity of 93% (95% confidence interval 0.84-0.99), as shown in Table 3.

Table 3 MRI results taking into consideration arthroscopic results as the definitive diagnosis

	Sensitivity (95% CI)	**Specificity (95% CI)**	**Positive predictive value (95% CI)**	**Negative predictive value (95% CI)**	**Accuracy (95% CI)**
Anterior cruciate ligament	96 (86-99)	95 (86-99)	96 (87-99)	95 (87-99)	95 (86-99)
Medial meniscus	97 (88-99)	93 (82-99)	97 (89-99)	93 (83-99)	95 (85-99)
Lateral meniscus	93 (84-99)	93 (81-99)	97 (86-99)	86 (78-96)	93 (82-98)

Discussion

We found that both physical examination and MRI were very sensitive and accurate in the diagnosis of ligamentous and meniscal injuries. These findings are resonant with those of Rayan et al, who conducted a correlational study on 131 patients with suspected traumatic meniscal or ACL injuries[14]. They concluded that carefully performed clinical examinations can give equal diagnosis of meniscal and ACL injuries in comparison to MRI scans and recommended that MRI be used to rule out such injuries rather than to diagnose them.

The anterior drawer test may be the least efficient tool in diagnosing ACL deficiency of the 3 methods which are most often used by practitioners as it is of unproven diagnostic value in this setting. In this study, we provided evidence that the anterior drawer test has a moderate specificity of 80% and sensitivity of 79%. Tores et al[15] put forward 3 potential cause for false-negative anterior drawer tests in acute conditions, especially in isolated ACL tears. First, hemarthrosis and reactive synovitis may preclude knee flexion to 90°, hindering performance of the test. Second, protective muscle action of the hamstrings (secondary to joint pain) provides a vector force opposite to the anterior translation of the tibia. Third, the posterior horn of the medial meniscus becomes buttressed against the posterior most margin of the medial femoral condyle and may preclude anterior translation of the tibia. Our results indicate that the Lachman test is the most sensitive method in diagnosing ACL rupture. The position of the knee during the test (20-30° of flexion) is less painful than the position of the knee during the anterior drawer test; hence, it reduces possible muscle action to protect the knee during testing[16]. The pivot shift test evaluates the combined tibiofemoral internal rotation and anterior tibia translation that occurs when the ACL is injured or deficient[17]. The pivot shift test is a complex multiplanar maneuver that incorporates 2 main components: translation (anterior subluxation of the tibial plateau followed by its reduction) and rotation (the rotation of the tibia relative to the femur)[18]. The reason for the low sensitivity may be explained by the fact that a patient with a chronic ACL deficient knee is familiar with this unpleasant phenomenon and will show protective muscle action[19].

Arthroscopic findings were used as the reference standard[20]. The sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI were calculated in the evaluation of meniscal tears. They found the sensitivity for medial meniscus and lateral meniscus tears to be 97% and 93%, respectively. The overall accuracy for medial meniscus and lateral meniscus tears were 92% and 88%, respectively. The majority of missed meniscus tears on MRI affect the peripheral posterior horns, similar to our study. They concluded that the sensitivity for diagnosing a meniscal tear was significantly higher when the tear involved more than one-third of the meniscus of the anterior horn. The sensitivity was significantly lower for tears located in the posterior horn and for vertically oriented tears. They concluded that lateral meniscus tears are more likely to be missed if the tear involves only one third of the meniscus or is in the posterior horn. The posterior root of the lateral meniscus can be difficult to assess on MRI for multiple reasons including pulsation artefacts from the popliteal artery, volume averaging, and the magic angle effect, because of the slope of the meniscus on the tibial eminence, and the complex anatomy related to the origin of the meniscofemoral ligament[8]. The accuracy of diagnosis on injured menisci, or cruciate ligaments will depend on the quality of imaging equipment and on the skills and expertise of the radiologist and arthroscopist[21]. The decision for therapeutic arthroscopy would then depend on both clinical examination and MRI findings. The false positive rate for meniscal injuries in our study was 6.6%. In comparison, Chambers et al. reported a false positive rate of 10.5% while Sharifah et al. reported 6.2%[20,22]. Many patients presenting with an ACL tear may not have symptoms of instability and may be keen for conservative management, opting out of reconstructive surgery. In such patients, a false positive MRI finding of a torn meniscus may increase the risk of unnecessary surgery.

The strengths of our study include the standardized imaging protocol for all our knees. As all patients were from a single surgeon, the

confounding effects from varying expertise of arthroscopy are also reduced. But this study had a few limitations. It was a retrospective study and contained incomplete data on some patients. The size of the study was relatively small, and thus some findings lack statistical power.

The clinical examination is one of the most important and accurate diagnostic modalities for evaluation of knee surgery. All patients with knee injury should be subjected routinely to a thorough clinical examination to make a provisional diagnosis. It is noninvasive, easy, and available. The MRI is an accurate diagnostic modality. It can be used whenever there is an uncertain indication for arthroscopy.

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ความถูกต้องของการตรวจร่างกายและการตรวจภาพถ่ายคลื่นแม่เหล็กไฟฟ้าในการผ่าตัดส่องกล้องข้อเข่า

สมบูรณ์ วุฒิพิริยะอังกูร, พบ

วัตถุประสงค์: *การวินิจฉัยอาการบาดเจ็บของข้อเข่าประกอบด้วยการตรวจร่างกายและการตรวจภาพถ่ายด้วยคลื่นแม่เหล็กไฟฟ้า ซึ่งความถูกต้องของการตรวจยังแตกต่างกัน วัตถุประสงค์ของการศึกษานี้เพื่อตรวจหาความถูกต้องของการตรวจร่างกาย และการตรวจภาพถ่ายด้วยคลื่นแม่เหล็กไฟฟ้าในการผ่าตัดส่องกล้องข้อเข่า*

วิธีการ: *การศึกษาวิจัยแบบย้อนหลัง โดยวัดความไว, ความจำเพาะ, ค่าทำนายผลบวก, ค่าทำนายผลลบและความถูกต้อง*

ผลการศึกษา: *จากผู้ป่วยจำนวน 44 ราย พบว่าการตรวจ Lachman มีความไวสูงสุดในการตรวจการบาดเจ็บของเอ็นไขว้หน้า โดยมีความไวร้อยละ 83 (95% ความเชื่อมั่น 0.64-0.99) การตรวจ pivot shift มีความจำเพาะสูงสุด โดยมีความจำเพาะร้อยละ 85 (95% ความเชื่อมั่น 0.68-0.96) การตรวจ McMurray มีความไวสูงกว่าในการตรวจการบาดเจ็บของหมอนรองข้อเข่า โดยมีความไวร้อยละ 87 (95% ความเชื่อมั่น 0.76-0.96) การตรวจ Apley มีความจำเพาะสูงกว่า โดยมีความจำเพาะร้อยละ 86 (95% ความเชื่อมั่น 0.72-0.96) การตรวจภาพถ่ายด้วยคลื่นแม่เหล็กไฟฟ้า เอ็นไขว้หน้ามีความไวร้อยละ 96 (95% ความเชื่อมั่น 0.86-0.99) หมอนรองกระดูกด้านในมีความไวสูงกว่าด้านนอก โดยความไวของ การตรวจหมอนรองข้อเข่าด้านในร้อยละ 97 (95% ความเชื่อมั่น 0.88-0.99) ส่วนความไวของ การตรวจหมอนรองข้อเข่าด้านนอกร้อยละ 93 (95% ความเชื่อมั่น 0.84-0.99)*

สรุปผลการศึกษา: *การตรวจร่างกายมีความสำคัญและถูกต้องในการวินิจฉัยการบาดเจ็บของข้อเข่า ถึงแม้ว่าการตรวจภาพถ่ายด้วยคลื่นแม่เหล็กไฟฟ้ามีความถูกต้องมากกว่า แต่ควรส่งตรวจก็ต่อเมื่อไม่แน่ใจว่าจะผ่าตัดผู้ป่วยหรือไม่*