

Clinical

A case of anterior cruciate ligament insufficiency

Clinical Professor of Surgery **Dr Sean McMillan**, student doctor **Elizabeth Ford**, and orthopaedic resident **Jim Stenson**, present a case report on the role of in-office diagnostic needle arthroscopy for intra-articular knee symptoms with a normal magnetic resonance imaging

Anterior cruciate ligament (ACL) injuries are one of the most commonly occurring orthopaedic sports medicine injuries. In the general population, ACL injuries account for approximately 64 per cent of all athletic knee injuries in jumping and pivoting sports.

That translates into more than 120,000 to 200,000 ACL reconstructions per year in the United States alone.^{1,3} Within the clinic setting, ACL injuries are most commonly diagnosed utilising the combination of a thorough history, physical examination, and advanced imaging modalities.

Currently, the imaging gold standard for the diagnosis intra-articular knee pathology is the use of magnetic resonance imaging (MRI).⁴ Together this combination has been successful and non-invasive in evaluating an ACL injury.

Limits of diagnosis

However, the reliability of MRI for diagnostic purposes is not always perfect. This can be due to a large number of variables including: poor quality MRI magnets, patient movement during the procedure, metallic artefacts, post-surgical changes in the tissues, and static rather than dynamic evaluation of the structures.

In ACL tears alone, various studies have questioned the accuracy of MRI in recognising the injury. MRIs have been reported to have varied sensitivity (90.9%), specificity (84.6%), accuracy (88.6%) and negative predictive value (NPV) (84.6%) of full thickness ACL injuries.⁵ These percentages are even lower when evaluating partial or chronic tears. Furthermore, the sensitivity, specificity, accuracy, and NPV of MRI to detect medial meniscus pathology has been shown to be 100 per cent, 52.6 per cent, 64 per cent and 100 per cent, respectively.

These limitations of diagnosis do not take into account those patients who cannot obtain an MRI for any reason. Examples of such reasons include: claustrophobia, metal in the body, body habitus, cost, and or MRI unavailability. Obtaining an accurate and confident diagnosis, in this setting, can be challenging for both the physician and the patient. Based upon this, many physicians have sought alternative imaging modalities to better obtain the answers to their patient's pathology.

Alternative imaging modalities

In-office diagnostic needle arthroscopy offers a minimally invasive option for healthcare providers to visualise large joints in a painless, safe, and time-effective manner. It

has been shown to be a cost-effective rapidly emerging tool that can provide similar or greater diagnostic accuracy compared to MRI.^{6,7} The ability to provide real-time dynamic visualisation of the patient's anatomy allows for more accurate decision-making by the physician and can potentially reduce the time from injury to diagnosis to recovery.

Furthermore, a recent study reveals that the risk of major and minor complications to be equivocal or better to that of any standard in office injection. Indications for use are based off intra-articular pathology. For the knee, the most commonly identified pathologies include, but are not limited to: meniscal tears, ACL tears, loose bodies, rotator cuff tears, labral tears, aid in decision-making for patient undergoing potential unicompartamental verses total knee replacements, and second look evaluations of cartilage procedures.

The Mi-Eye2™ is an in-office diagnostic needle arthroscopy that allows for real-time diagnostic capabilities for both the patient and surgeon (Figure 1). The handpiece comes as a sterile packaged disposable unit that connects to a Microsoft Surface tablet unit (Figure 2). It provides a 120° field of visualisation and produces an image that is 0° when viewing, as opposed to the standard arthroscopic 30° view. The tip of the hand-piece contains a 14-gauge outer sheath that is retractable upon entry to the joint to allow for the optics and light source to be deployed. The interface between the handpiece and the tablet can allow for still pictures and or video recordings. These images are transferable to a memory stick if so desired for the surgeon or the patient.

Case history

A 25-year-old competitive female horseback rider presented to clinic with a chief complaint of left knee instability and recurrent swelling, which has progressively worsened over the past year. History reveals that she underwent a left knee multi-ligamentous reconstruction with medial meniscectomy and medial femoral condyle micro-fracture six years ago after an equestrian accident. A review of her medical records reveals that she had a quadruple-stranded hamstring allograft ACL reconstruction performed along with an Achilles allograft posterior cruciate ligament (PCL) reconstruction.

She notes that she was able to return to a high level of functional activity post reconstruction, including a return to horseback riding and marathon running. Within the past 14 months, however, she has had several instability

episodes without an inciting re-injury event. Pivoting, jumping and plyometric activities are reported to elicit the most symptomatic instability. She denies catching or locking. Currently, she reports significant instability during rotational movements and plyometric exercises at the gym.

Physical exam

On physical exam, there was no gross deformity, erythema, or effusion noted. Range of motion was symmetric to the contralateral leg with -3° extension, and 145° of flexion. There was 1+ Lachman, positive apprehension with pivot shift testing, and 1+ posterior drawer testing. There was a negative McMurray's sign and negative varus/valgus gapping on collateral ligament testing. Motor testing demonstrates 5/5 quad strength and 5/5 hamstring strength. Sensation, perfusion, and reflexes were symmetric and equal bilaterally.

The patient had normal radiographs and was sent for an MRI of the left knee (Figure 3). The radiologist and treating orthopaedic surgeon had agreed that the ACL and PCL were intact based upon image review. The remainder of the joint was unremarkable. The patient was placed into three months of dedicated physical therapy and returned reporting worsening symptoms of instability. With her examination unchanged, the patient was offered an in-office diagnostic needle arthroscopy, which she agreed to.

Procedure technique

Informed consent was obtained by the treating physician from the patient after a discussion regarding the pros and cons of an in-office diagnostic needle arthroscopy under local anaesthesia versus an operating room arthroscopic evaluation under anaesthesia.

Following this, the patient was positioned sitting up with her knees bent to 90° off the end of the bed. A standard sterile betadine and alcohol prep were performed and the patient had a medial portal location anaesthetised through the injection of 10cc of 1 per cent lidocaine plain. Care was taken to make sure both the skin and capsular were numbed in a wheel fashion.

Once the skin was numbed, the procedure was undertaken. Inspection of the joint included both the medial and lateral compartments of the knee as well as the intercondylar notch. Access to the medial compartment was facilitated by placing a valgus force on the knee with the physician's assistant applying a stabilising force on the patient's thigh. This dynamic movement of the leg is the same as is performed in traditional operating



Figure 1: The fully integrated Mi-Eye2 tablet and handpiece that allows for a "single-stick" needle-based arthroscopy

room-based arthroscopy.

Similarly the lateral compartment was accessed by gently placing the patient's leg into a Figure 4 position.

Once the medial and lateral compartments were inspected, attention was turned to the ACL. Figure 4 demonstrates the ACL with the knee flexed at 90°. The image demonstrates a lack of re-vascularisation of the graft. Next, dynamic evaluation of the graft was undertaken by placing the knee into the "figure 4" position once again. Figure 5 demonstrates incompetency of the graft with a clear peeling away of the graft from the femoral wall. The PCL demonstrated evidence of vascularity without incompetence.

Discussion

Our case demonstrates needle arthroscopy to be a viable diagnostic tool for symptomatic patients with occult imaging findings. MRI is a valuable and minimally invasive diagnostic tool but is limited by artefact, anatomic variations, and misinterpretation of pathology.

Furthermore, the benefit seen through dynamic evaluation of the knee cannot be matched through a static MRI. Highly ordered collagen fibres oriented at 55° to the MRI beam cause the "Magic Angle Phenomenon" and falsely mimic meniscal tears.⁸ Additionally, MRI misses one in 14 patients with ACL pathology.⁹

The overall gold standard for intra-articular knee pathology continues to be surgical arthroscopy of the knee.¹⁰

Through the benefit of in-office needle based arthroscopy, the same benefits can be realised over a traditional MRI through a painless, minimally invasive technique. Furthermore, recent reports have shown the complication risk associated with the procedure, are at or below those seen with standard in office injections.

Operating room traditional surgical diagnostic arthroscopy can cause a patient to miss work and predisposes them to the medical side effects of anaesthesia. Furthermore, these same surgical risks can become compounded if the patient must be brought back at a later date for definitive surgical intervention for unanticipated findings, such as an incompetent ACL in the face of a "normal MRI". In-office needle arthroscopy can bridge the gap between the diagnostic limitations of MRI with the surgical risks of surgical diagnostic

arthroscopy within the operating room.

Findings and conclusion

Our findings further validate recent publications that found in-office needle arthroscopy to be superior to MRI in diagnosing intra-articular knee pathology. Deirmengian *et al* compared 106 patients with intra-articular knee pathology and found needle arthroscopy to be more sensitive and specific than MRI in identifying meniscal tears.¹¹ In a blinded, prospective, multicentre study of 110 patients, Xerogeanes *et al* found needle arthroscopy equivalent to surgical arthroscopy and superior to MRI for diagnosing intra-articular knee pathology.

Furthermore, the authors found office-based arthroscopy could result in up to US\$177 million (€153m) in savings for the healthcare system per year.¹² Additionally, separate studies by both McMillan *et al* and Voigt *et al* found significant economic benefit of utilising office-based arthroscopy due to improved accuracy of diagnoses compared to MRI.^{13,14}

In conclusion, we clearly demonstrate a role for diagnostic needle arthroscopy in the management of symptomatic patients with normal imaging studies.

In-office diagnostic needle arthroscopy offers a safe, accurate, and cost-effective means to diagnose missed or occult intra-articular knee pathology.

Further research is needed to identify the prevalence of missed injuries and the ability of needle arthroscopy to shed light on this problem.

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Figure 2: A closer view of the 14-gauge, 95mm length needle arthroscopy with a retractable outer sheath. This disposable needle arthroscopy provides a 0° image with a 120° field of view



Figure 3: A T2 sagittal image again showing an intact properly orientated ACL reconstruction (arrow)



Figure 4: Viewed from the medial portal with the knee flexed to 90°, the ACL (arrow) is visualised in what appears to be appropriate positioning. Of note is the shiny appearance of the graft and lack of vascularity of the graft



Figure 5: Viewed from the medial portal while the knee is dynamically placed into the figure-4 position, the ACL graft demonstrates incompetency as it peels off the femoral wall (arrow).

Authors' Disclosure Statement

Dr McMillan reports that he receives equity, patents, and is an advisory board member for Trice Medical. Student doctor Ford reports that she has equity in Trice Medical. Dr Stenson has no conflicts to report.

References available upon request.

• Sean McMillan will speak at the World Congress of Sport and Exercise Medicine, November 3 and 4, 2018 at The Alex, Dublin.

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