RADIOLOGY—TECHNICAL ARTICLE

Ultrasound-guided percutaneous tenotomy for the treatment of iliopsoas impingement: A description of technique and case study

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Summary

Iliopsoas impingement is a commonly recognised source of groin pain following total hip replacement. When conservative measures fail, open or arthroscopic iliopsoas tendon release can reliably alleviate pain and improve function. This article describes an alternative ultrasound-guided percutaneous technique, achieving iliopsoas tenotomy utilising a modified 18G coaxial needle and thus minimising the morbidity and cost associated with an open or arthroscopic procedure. This method proved successful with resultant complete resolution of patient symptoms. To the knowledge of the authors, this is the first case of ultrasound-guided percutaneous iliopsoas tenotomy for iliopsoas impingement post total hip replacement.

Key words: musculoskeletal imaging; nonvascular interventional radiology; ultrasound.

Introduction

The creation of a novel needle tenotomy device via a simple modification to an 18G coaxial, bevelled needle has recently been described by Hopkins and Sampson.[1] The needle modification involves the formation of an effective V-shaped cutting tip.

The iliopsoas muscle consists of the iliacus and the psoas muscles originating form the iliac bone, and lower thoracic and lumbar spine respectively. Distal insertion is via a common tendon onto the lesser trochanter of the femur. The iliopsoas tendon is positioned at the deep aspect of the relative large iliopsoas muscle belly such that it passes immediately anterior to the hip, separated from the capsule only by the iliopsoas bursa. This position renders it vulnerable to impingement post total hip replacement (THR).

Iliopsoas impingement is a commonly recognised source of groin pain often seen after THR with the reported incidence as high as 4.3%.[2] The acetabular cup acts as the most common site of impingement causing friction on the deep aspect of the iliopsoas.[3] Impingement can be caused by extrusion of cement and/or by a prominent acetabular component or reinforcement ring that is either too large for the native acetabulum or is in a retroverted or lateral position.[4] An increase in hip offset or hip length ≥1 cm is also a potential cause for tendon irritation.[5]

Iliopsoas impingement typically causes ill-defined groin pain, worse on active hip flexion.[5] Pain-specific activities, such as walking up flights of stairs or lifting the leg in and out of a motor vehicle, can be useful in differentiating iliopsoas impingement from other post THR causes of groin pain such as septic and aseptic loosening.[5] Other possible causes of pain should of course be excluded with blood analysis, imaging and possibly joint aspiration.

Ultrasound is able to detect complications of impingement including iliopsoas bursal thickening and effusions and iliopsoas tears and haematomas.[6] Dynamic ultrasound imaging on rest and contraction of the iliopsoas can elicit impingement at the anterior margin of the acetabular cup.[6]

Magnetic resonance imaging (MRI) can demonstrate the presence and magnitude of anterior extension of the acetabular cup beyond the bone and the resultant iliopsoas tendon impingement.[7] MRI is best performed with metal artefact reduction techniques such as fast spin-echo sequences with elongated echo train length and increased readout bandwidths.[8]

Ultrasound-guided anaesthetic-corticosteroid injections into the iliopsoas tendon and adjacent bursa can strongly support the diagnosis.[9] Injections are also considered part of the treatment algorithm prior to surgical intervention. Literature suggests a limited role for injections and other conservative therapies such as activity modification and non-steroidal anti-inflammatory medications.[9] Injections offer partial and temporary relief of symptoms.

After conservative management options fail, surgical alternatives, such as open or arthroscopic psoas tenotomy and revision hip arthroplasty, can reliably improve pain and function.[10] Open procedures generally carry higher risk of infection, morbidity and incur longer recovery times than do percutaneous procedures. Arthroscopic iliopsoas tendon release carries risk of injury to the femoral neurovascular bundle.[10]

Although not the norm, there are documented cases of image-guided musculoskeletal procedures providing effective treatment in musculoskeletal conditions that could otherwise be treated with open procedures. An example is ultrasound barbotage/aspiration in the treatment of calcific tendonitis.[11]

Case report

Below we describe a method of percutaneous, ultrasound-guided iliopsoas tenotomy, performed for a male patient age 72 who was experiencing symptoms of iliopsoas impingement post right THR (Corail Pinnacle, Leeds, England, UK; polyethylene/metal) for osteoarthritis. Seven months post THR, the patient reported worsening right groin pain that was incapacitating, ranging from 8/10 to 10/10 in severity. Pain was exacerbated by characteristic activities such as climbing in and out of his motor vehicle. Physical examination demonstrated groin tenderness and reproduction of symptoms upon stressing the iliopsoas tendon consistent with impingement.

Ultrasound demonstrated a thickened iliopsoas tendon and bursa with focal tenderness on transducer pressure. An ultrasound-guided iliopsoas bursal injection of 2 mL Celestone (Merck Sharp & Dohme Australia Pty Ltd, Sydney, New South Wales, Australia) and 3 mL 0.75% ropivacaine resulted in partial relief of symptoms for approximately 3 weeks. Upon relapse of symptoms, the decision was made to proceed to iliopsoas tenotomy. Following contemplation of arthroscopic or open tenotomy approaches, the treating orthopaedic surgeon referred the patient for percutaneous tenotomy in the hope of reducing morbidity and recovery time. The aim of the procedure being to divide the iliopsoas tendon at the level of the acetabular cup, leaving the surrounding muscle intact in order to maintain a level of function.

Fig. 1. Modified 18G needle showing newly created notch.

Methods

The nature of the intended procedure, its novelty and attendant risks and benefits were discussed with the patient. Informed, written consent was obtained.

The procedure was performed in an operating theatre under general anaesthesia with the patient's orthopaedic surgeon in attendance. The procedure was performed by a fellowship-trained musculoskeletal radiologist (MJS) experienced in ultrasound-guided intervention.

Sterile technique was used including sterile ultrasound probe cover. A *Toshiba Aplio 500* (Toshiba Australia, Adelaide, South Australia, Australia) Ultrasound machine was operated with a linear 14 MHz (14L5) transducer. An experienced musculoskeletal sonographer was in attendance for consultation and provision of technical expertise with respect to image optimisation.

A split operating table was utilised. This allowed the hip to extend to 15–20 degrees with resultant increased tension on the iliopsoas tendon aiding dissection of tendon fibres.

As described by Hopkins and Sampson,[1] a modified 10-cm 18G coaxial, bevelled needle (Chiba biopsy needle, Cook Medical, Bloomington, IN, USA) served as a percutaneous cutting device. Using a scalpel, a small notch was cut into the hub of the needle such that the stylet could be inserted and fixed at 180° to its normal orientation (Figs 1,2), creating a V-shaped cutting tip (Fig. 3).

A small skin incision was made through which the tenotomy needle was advanced. With real-time

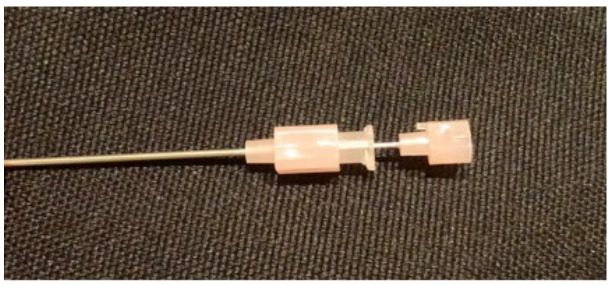

Fig. 2. Hub reinserted at 180 degrees to create the V-shaped effective cutting tip (V-tip).

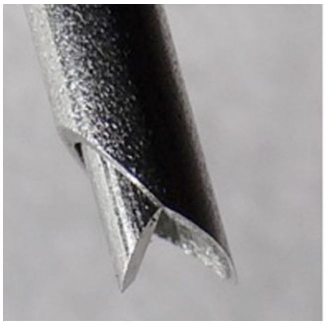

Fig. 3. Close up of V-tip created by rotating the stylet 180 degrees.

ultrasound guidance in the axial plane, the needle was manoeuvred to the superficial aspect of the iliopsoas tendon at the acetabular cup level. The radiologist operated the ultrasound probe with the non-preferred left hand and needle with the preferred right hand. The needle was kept in its original configuration (stylet bevel flush with the coaxial bevel) for this stage in order to minimise trauma to other tissues during positioning. This also allowed the bevel to be used to manipulate needle direction during manoeuvering (turning the needle hub and thus the bevel, permitted changes in needle trajectory for subtle positioning adjustments).

The stylet was then rotated 180° and locked into the cutting position using the newly created notch in the needle hub to form the V-shaped cutting tip. The target site for iliopsoas tenotomy at the acetabular cup level was confirmed by turning the probe into the sagittal plane (Fig. 4). Once correct position was confirmed, the probe was returned to the transverse plane for guidance. The needle was positioned such that the inverted stylet bevel lay adjacent to the superficial aspect of the tendon. Under direct ultrasound vision, the V-shaped cutting tip was repeatedly advanced and retracted in a sawing action through the iliopsoas tendon fibres to achieve tendon division (Figs 5,6). The operator's thumb remained on top of the needle hub, keeping the stylet engaged (Fig. 5). The femoral artery, nerve and vein were kept within the field of view throughout the procedure to ensure no contact with the neurovascular bundle was made (Fig. 6). Within approximately 5 minutes, there was a loss of resistance indicating tendon division.

At this point, 20 mL 0.75% ropivacaine was infiltrated into the cleft generated within the iliopsoas tendon (Fig. 7). This expanded the cleft and served the dual purpose of confirming fibre division and providing additional post-procedure comfort. The patient stayed in hospital the night of the procedure and was reviewed by his orthopaedic surgeon prior to discharge the following day.

Fig. 5. Sterile self-guided ultrasound approach using the modified 18G needle. Note operators thumb on needle hub keeping it locked in place so that V-tip remains in correct configuration.

Fig. 4. Sagittal sonogram demonstrating target site for tenotomy with 'tented'/impinged iliopsoas tendon overlying the acetabular cup of the THR.

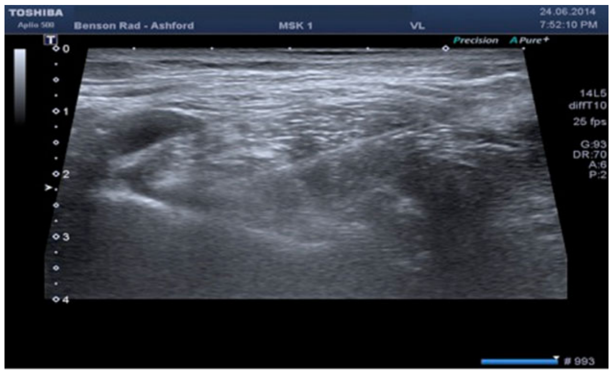

Fig. 6. Axial sonogram demonstrating division of iliopsoas tendon fibres using the modified 18G coaxial technique. Visualisation of the femoral neurovascular bundle at the left of image superficial to the tendon was maintained throughout the procedure.

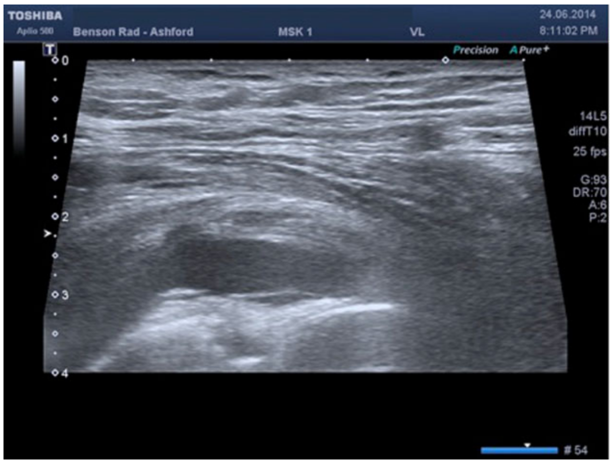

Fig. 7. Sagittal sonogram post iliopsoas tenotomy. A bolus of 20 mL of ropivacaine has been injected that reveals the defect at the site of successful tendon division.

Results

Based on immediate post-procedural ultrasound imaging demonstrating discontinuous tendon fibres and expandable cleft with local anaesthetic infiltration, there was evidence of successful complete dissection of the iliopsoas tendon at the acetabular cup level.

The patient was reviewed by his orthopaedic surgeon day one post-op, 2 weeks and 9 weeks post procedure. Frequency of follow-up was limited by the fact the patient lived in a regional centre. At day one the patient reported pain of a similar level to his preoperative state (8/10) and no significant new functional impediment. At 2 weeks, the patient reported significant improvement with pain reducing to 2/10. At 9 weeks, there was complete resolution of pain. There was no significant subjective or objective hip flexion weakness at this time. The patient described mild stiffness in the hip only at this point. Most importantly for the patient, daily activities involving hip flexion were now pain free. The patient was extremely pleased with this outcome.

Discussion

In the first in vivo trial of the needle tenotomy device described by Hopkins and Sampson,[1] efficacy was demonstrated, and a desirable clinical outcome was achieved. The technique proved fairly simple in the hands of a musculoskeletal radiologist familiar with ultrasound-guided intervention and took little time.

Important points permitting the procedure to be performed successfully included split table technique with hip extension that adds tension and fixes the tendon in place somewhat. Without this, the psoas tendon may roll away from the needle. Tension also aids tendon fibre division. It was imperative for the operator to hold the needle such that the thumb remained placed on the needle hub. This ensured the stylet remained engaged keeping the V-shaped cutting tip configuration in place. Failure to do so would allow the stylet to recede into the coaxial needle reducing the cutting ability of the needle. The assistance of an experienced musculoskeletal sonographer for image optimisation was also invaluable.

In the case described, the orthopaedic surgeon was keen to trial percutaneous tenotomy due to concern of neurovascular injury associated with hip arthroscopy (femoral nerve and vessels are not clearly in view during arthroscopic psoas debridement). The risk of injury to one or more branches of the lateral femoral cutaneous nerve, using the traditional anterior portal as described previously to be 0.5%.[12] Late bleeding at several weeks postoperatively has been described, attributed to laceration of a branch of the superior gluteal artery.[13]

Given that our technique combines a minimally invasive approach with the safety of continuous visualisation of the femoral neurovascular bundle, there is potential that this may become a favourable option.

It should be noted that the patient in this case study was a male of average build. This procedure may be difficult or potentially impossible to perform in a patient with large body habitus due to the depth of tissue and attenuation of the ultrasound beam degrading image quality. The coaxial 18G needle is currently available in a range of lengths from 5 cm to 20 cm catering for most individuals should visualisation be adequate.

We acknowledge the role of this technique remains unclear in young patients with malpositioned or lateralised cup, where revision traditionally represents the preferred option.[5]

Conclusion

Ultrasound-guided percutaneous iliopsoas tenotomy is a promising additional management option for iliopsoas impingement after THR and following failure of conservative therapy. The technique offers both minimised invasiveness and the safety benefit of direct and continuous visualisation of the femoral neurovascular bundle throughout the procedure. Obviously, the positive results are limited to a single individual at this stage. Following the excellent outcome of this pilot case, a more extensive clinical study comparing arthroscopic and open surgical outcomes against those achieved by iliopsoas tenotomy using ultrasound guidance is warranted.

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