NEW FRONTIERS IN REAL TIME ULTRASOUND

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Real time ultrasound imaging (RTUI) has been used extensively in medicine for the past 50 years. As an imaging modality it allows a rapid evaluation of the morphology and pathomorphology of organs and tissue. In physiotherapy, RTUI has become a valuable tool in the assessment and rehabilitation of musculoskeletal injuries, particularly given this dynamic imaging modality allows a real time perspective of anatomical structures.

Until recently, diagnostic musculoskeletal imaging has been solely the realm of sonographers and radiologists. Now with the advent of dedicated portable musculoskeletal ultrasound systems aimed at the physiotherapy and sports medicine markets, and specialised training, more clinicians outside of radiology are utilising this imaging technology. Physiotherapy has embraced RTUI as a feedback tool for muscle re-education in the rehabilitation of low back pain. Recent technological developments in the ultrasound systems, have opened up a variety of other uses within physiotherapy.

Dynamic Assessment of Postural Muscles

Rehabilitation of postural muscle imbalances involves diminishing excessive muscle activity and facilitating and coordinating insufficient muscle activity. RTUI allows muscle activity to be assessed by imaging muscle thickening during contraction as well as the pattern of this activity. It is therefore well suited to evaluating postural systems such as:

- lumbo-pelvic (transversus abdominis, pelvic floor)
- hip joint (iliacus, gluteus medius)
- scapulo-humeral (lower trapezius, upper trapezius)
- patella-femoral (vastus medialis)

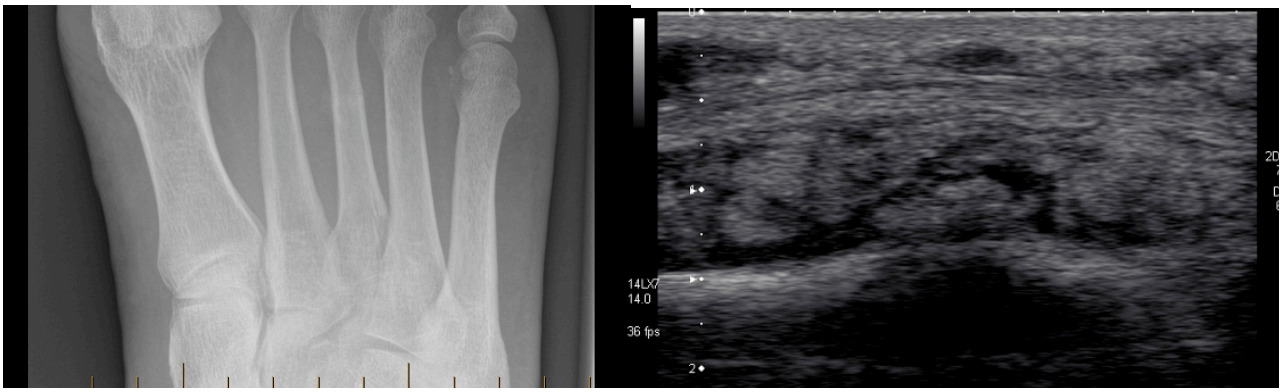
Ultrasound can be used as a visual form of biofeedback. As the patient views on a monitor the changes in their muscle activity ,they are able to modify dysfunctional patterns of activity. Feedback can be provided in a variety of positions (eg supine, standing, sitting) and enable facilitation of activity of the local synergy muscles or provide feedback of relaxation to overactive global muscles.

Grading Tendinopathies

The resolution of ultrasound imaging has improved to the point where we can now detect subtle changes in tendon morphology. This allows us to not only detect tendinopathies , but also grade where on the spectrum of severity the pathologies lie. Cook and Purdam (2009) suggest that tendon pathology is a dynamic continuum with the potential for tendon repair at the earlier stages. A thorough subjective and objective evaluation can point to which stage a tendon is at on this continuum. However, sonographic indicators revealed with RTUI can provide a better grading of tendinopathies. The ability to assess at which stage the tendinopathy is at ,then allows specifically designed rehabilitation protocols to be implemented. Resolution of the tendinopathy can also be followed with subsequent scanning, as a normalisation of the tendon characteristics is observed.

Detecting Fractures

Plain X-rays are the prime imaging choice when a fracture is suspected. Ultrasound however can assist in the diagnosis of various fractures. In particular stress fractures are commonly missed on plain X-rays and as they may take up to 10 weeks from the initial injury to when the fracture is visualised on X-ray. The ultrasound probe can be placed over the area of patient's pain to investigate any pathology. Fractures can be revealed by looking for periosteal reactions and cortical bone irregularities (see Figure 1)



(Figure 1 - shows a foot X-ray of a stress fracture on the lateral aspect of the 3rd metatarsal bone, the periosteal reaction was more obvious on RTUI (right image))

Assess Muscle Bulk

Measurements of muscle bulk can be a valuable marker of the effectiveness of a rehabilitation program. Imaging can be obtained at the start of program and at various subsequent intervals , looking for muscle thickening . A increased value gives the physiotherapist and patient positive reinforcement that rehabilitation protocols are being successful. This is useful particularly for patients in the post-surgical environment or athletes recovering from a chronic injury.

U/S Guided Needle Therapy

Ultrasound allows the visualisation of the needle tip in-situ, therefore enabling better specificity in guiding where the needle tip is placed when dry needling or injecting therapeutic agents such as cortisone or autologous blood (see Figure 2). For instance an area of the common extensor tendon origin identified as suffering from tendinosis, and can be targeted for dry needling, thereby improving the effectiveness of the treatment. Similarly, incorrect needle placement can be minimised by ultrasound guided needling , reducing the incidence of needling tissues adjacent to the targeted area (eg arteries, nerves, bone).

Figure 2 Ultrasound guided needle

Assessing Muscle Injuries

Muscle tears can be assessed and graded using RTUI (see Figure 3). This allows a more definitive diagnosis to be obtained and provide prognostic value. This aids in determining when exercises should be started and at what level of intensity. Also follow-up scanning can allow an assessment of the efficacy of therapeutic regimes. This can help to better gauge when to advance the level of exercises and when to return patient to work or sporting environments. For example, a contusion of the quadriceps can be monitored for the resolution of the hematoma. As the tissue heals, the blood products of the traumatised tissue will be resolved and replaced by scar tissue and normal muscle tissue.

Early identification of patients with large hematomas can also allow them to be referred off for therapeutic drainage to promote improved healing times. The detection of chronic complications such as myositis ossificans , scar tissue and muscle hernias can also provide valuable information to assist in treating recalcitrant conditions.

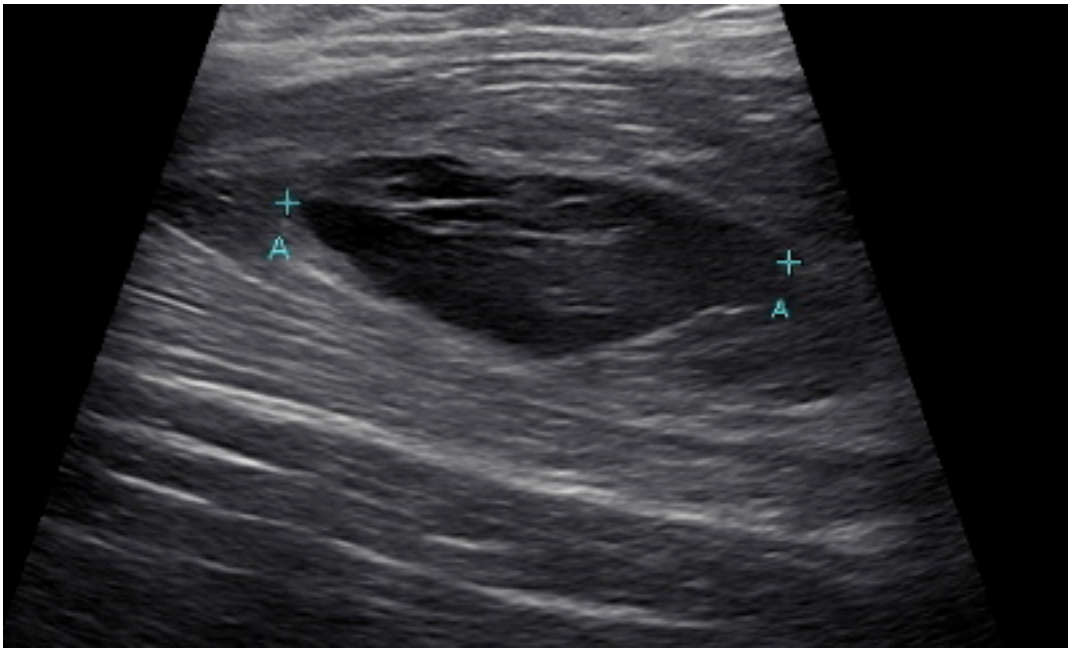


Figure 3 A grade II tear of adductor longus muscle

Future Directions in Real Time Ultrasound

Treatment of myofascial pain relies largely on the identification of myofascial trigger points which are causing the patients pain, muscle dysfunction, muscle weakness and limitation of motion. These discrete hyperirritable nodules can be deactivated by manual therapy and dry needling. Sonoelastrography is a new technology involving 2-D real time ultrasound imaging and assessing the elastic properties of soft tissue.This is currently being used to detect and localise breast tumours. The abnormal breast tissue is identified as it is less elastic than the surrounding soft tissue. Sonoelastrography may be a valuable tool in imaging myofascial trigger points as they have significantly greater stiffness compared to normal tissue. This technology shows real promise in providing an objective diagnostic technique to supplement the physical examination when detecting trigger points.

Advancements in hardware and software of RTUI units will mean better investigation into vasculature and blood flow characteristics within tissue. This will allow the early detection of inflammatory and blood flow changes associated with muscle and tendon injuries. It may also further help to characterise myofascial trigger points as these discrete regions are thought to exhibit altered flow characteristics compared to the surrounding tissue.

Ultrasound is sensitive enough to demonstrate subclinical soft tissue degenerative changes as well as identify dysfunctional pattern of the musculoskeletal system before the patient is symptomatic. RTUI may then become a useful screening tool and help to diagnose and correct underlying biomechanical faults.

Summary

Real time ultrasound imaging provides quick, non-invasive investigation of musculoskeletal tissue without ionising radiation. As we seek to diagnose and treat musculoskeletal injuries, RTUI is becoming a valuable adjunct to conventional methods. Physiotherapists are well placed to utilise this tool given their knowledge of anatomy, physiology and pathology. Indeed, with our knowledge of dysfunctional biomechanics which leads to musculoskeletal injuries, RTUI allows us to identify precise patterns of disease and therefore provide information about the underlying injury mechanism. Adequate training in the correct scanning technique and image interpretation is required if diagnostic errors are to be avoided. Basic training in the use of RTUI is now being covered at under-graduate and post-graduate physiotherapy courses. A variety of musculoskeletal imaging and core stability workshops are also now offered to physiotherapists. My personal feeling is that befor long this imaging modality will become widely accepted within mainstream practice. It's possible when a tendon, muscle or ligament injury is being considered, the clinical examination process will be "ask, look, feel, move, ultrasound".