Rehabilitative ultrasound imaging

Description

Neuromuscular deficits have been linked with chronic musculoskeletal conditions. The use of ultrasound imaging (USI) to aid rehabilitation of neuromusculoskeletal disorders has been called rehabilitative ultrasound imaging (RUSI) and defined as 'a procedure used by physical therapists to evaluate muscle and related soft tissue morphology and function during exercise and physical tasks. RUSI is used to assist in the application of therapeutic interventions, providing feedback to the patient and physical therapist (Teyhen 2006). Brightness mode (b-mode) USI is the most common form used by physical therapists and will be the focus of this summary.

Clinical utility: USI can distinguish between healthy adults and those with low back pain (LBP). Those with LBP have decreased muscle thickness, side-to-side asymmetry, and decreased ability to thicken the muscles during a contraction (Teyhen et al 2009). Moreover, when measured by USI, lumbar multifidus muscle asymmetry appears to be predictive of future episode of LBP up to three years later (Hides et al 2001). Finally, USI can distinguish between changes in muscle thickness during common LBP exercises when performed by healthy adults (Teyhen et al 2008) and is preliminarily supported as a biofeedback tool to enhance exercise effectiveness (Henry and Teyhan 2007).

Criterion-related validity: In a recent systematic review Koppenhaver et al (2009a) concluded that b-mode USI when applied in a rehabilitative setting is a valid tool to measure trunk muscle size and muscle activation during most sub-maximal contracted states. When comparing muscle thickness obtained by magnetic resonance imaging and USI, researchers have demonstrated substantial agreement (ICC 0.84 to –0.95) with only minimal differences between the modalities (0.03 to 0.21 cm^2) (Hides et al 1995, 2006). Although comparisons between electromyography and change in muscle thickness obtained by USI have most often demonstrated a curvilinear relationship (Hodges et al 2003), the ability of USI to measure muscle activation is likely context-dependent and is based on the muscle being measured, the task performed, and the intensity of the contraction (Koppenhaver et al 2009a).

Responsiveness to change: Motor control training has been demonstrated to increase multifidus cross sectional area ($p = 0.004$), decrease side-to-side asymmetry, and was associated with a 50% reduction in pain (Hides et al 2008b). Additionally, recent evidence suggests increased contracted thickness of the lumbar multifidus one week after a spinal manipulation was predictive of larger improvements in low back pain-related disability (Koppenhaver et al 2011). The minimal amount of change associated with clinical improvement has yet to be determined.

Reliability: In a recent systematic review Hebert et al (2009) concluded that the majority of high quality studies indicated that RUSI has good intrarater and inter-rater reliability (ICC > 0.90). The standard error of measurement was decreased by nearly 25% when using a mean of two measures and by 50% when using a mean of three measures (Koppenhaver et al 2009b). Novice raters, when properly trained, can assess the trunk muscles reliably (ICC 0.86 to 0.94) (Teyhen et al 2011).

Influence of sex and body mass index: Muscle thickness and cross sectional area is greater in males than females and is associated with increased body mass index (Teyhen et al 2007).

Commentary

The evidence for neuromuscular control deficits in those with neuromusculoskeletal conditions continues to grow. However, there are very few clinical tools that allow clinicians to measure these deficits reliably in an efficient and non-invasive manner. Evidence for the use of USI as a strategy to assist with these patient populations is growing. Guidelines and overviews of the use of USI to assess the abdominal, paraspinal, and pelvic floor muscles have been published to help guide clinicians who want to implement USI into their clinical setting (Teyhen et al 2007).

Although evidence for the role of USI to aid in rehabilitation continues to grow there are still a lot of unanswered questions. Future research needs to better define the limitations of USI to measure muscle function and the associated factors that influence change in muscle thickness as seen on USI. Additionally, future research needs to determine optimal training strategies to ensure that clinicians using USI are properly trained to utilise and interpret USI as an effective adjunct to traditional physical therapy interventions.

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