NJD Sports Injury Clinic
36 Moorland Crescent
Clitheroe, Lancs. BB7 4PY
United Kingdom
Tel: 44 (1200) 427457
e-mail: nick@njdsportsinjuries.co.uk
www.njdsportsinjuries.co.uk

Critical Appraisal of Therapeutic Ultrasound in the Treatment of Soft Tissue Injuries

Purpose

The purpose of this short précis is to review the literature and critically appraise the application of therapeutic ultrasound in the treatment of soft tissue injuries while identifying *key* aspects for safe and effective use.

Rationale

Ultrasound (US) has been used by a wide range of therapists, in many countries, for over 60 years, and is recognised as one of the most popular and established electrotherapy modalities *(1, 2)*. Despite extensive research of both *in vitro* and *in vivo* studies, findings remain equivocal *(3, 4)*.

Principles of ultrasound

Ultrasound machines convert electrical energy into mechanical energy which generates sound waves. These waves consist of mechanical compressions and rarefactions, which can be continuous or pulsed (Figure 1).

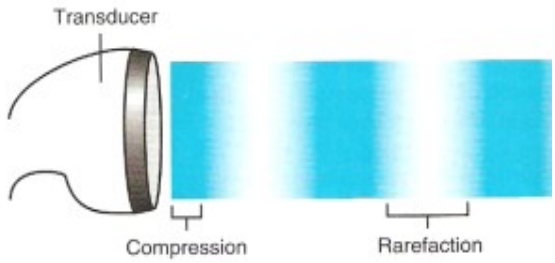

Figure 1 - Adapted from: Cameron, *(7)*

Therapeutic US machines commonly delivery frequencies of 1 and/or 3 MHz (Figure 2). As the waves travel through the tissues, decreasing exponentially, the ultrasound energy is absorbed bringing about biophysical effects. It is widely accepted and clinically significant that ultrasound energy is preferentially absorbed by high-protein, dense collagenous tissues *(5, 6)*.

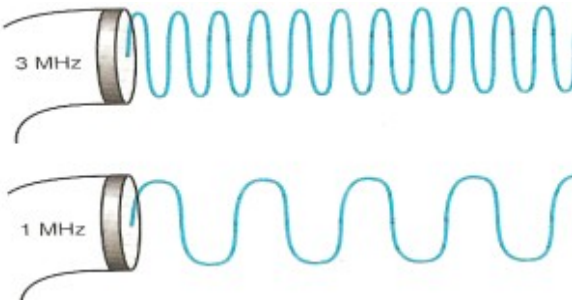

Figure 2 - Adapted from: Cameron, *(7)*

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Current practice

Historically, *thermal* mode was the primary use, whereas it is argued that currently, it is the *non-thermal* mode most commonly employed. In *thermal* mode, ultrasound is considered to be most effective when 'heating' tissues while using relatively high intensities, preferably in continuous mode. In *non-thermal* mode, the effects of ultrasound are attributed primarily to cavitation and acoustic streaming, achieved by low average intensities, in pulsed-mode, which up-regulates the activity level of the whole cell without heating *(8)*.

Physiological & biomechanical effects

Ultrasound is considered to be pro-inflammatory and pro-proliferative and can be applied at any stage of healing to accelerate the physiological aspects of tissue repair *(1, 8)*. Compared with sham, ultrasound appears to improve biomechanical properties by modestly increasing scar cross-sectional area and type I collagen *(9)*, while enhancing the appropriate orientation of newly formed fibres (*8*). However, to achieve these effects the application is both *'dose'* dependent *(8)* and '*tissue-critical'*, as demonstrated by recent (animal) studies *(2, 9)*. The clinical relevance may facilitate earlier return to activities and decrease risk of re-injury.

Psychological effects

While ultrasound is recognised for its biophysical effects, it can also have a significant psychological placebo effect *(5, 10)*, which, when combined can be considered as an additional bonus *(11)*.

Effective application

Current literature suggests that effective evidence-based application of ultrasound hinges on many considerations. These include critical awareness of ultrasound literature *(1,8)* and ongoing acquisition of operator knowledge and training *(11)*, tissue absorption rate *(5)*, correct operating parameters *(6,8)*, appropriate medium coupling *(12)*, correct interface angle of US head *(7)* and knowledge of the stages of tissue healing *(13)*.

The efficacy

Many reviews fail to support the efficacy of ultrasound *(14-17)*. However, a common finding amongst many reviews is the lack of methodologically acceptable studies *(18)*. Problems cited often include; lack

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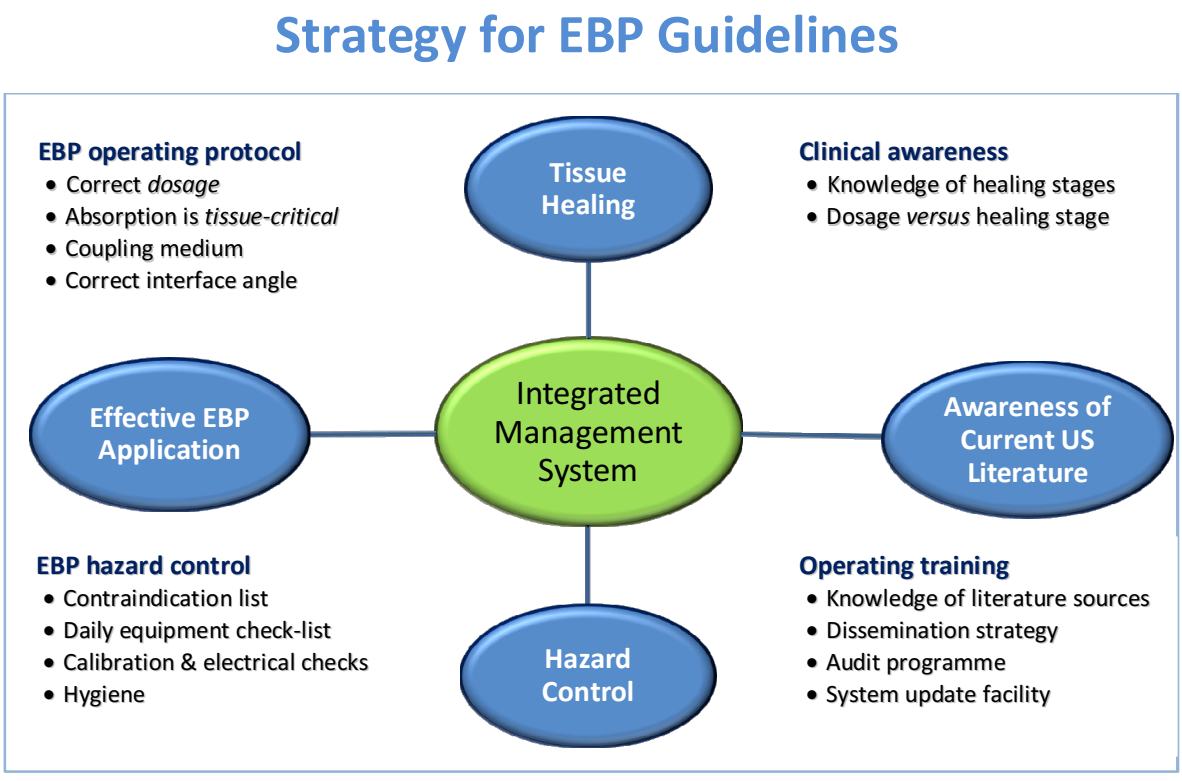
of calibration, inappropriate dosage, and lack of reliable outcome data. Furthermore, many reviews have considerable overlap in authors.

Hazards

Ultrasound is not without its hazards to both patient and therapist. Recent equipment surveys have highlighted an infection risk *(19)*, major calibration problems *(20)*, and electrical safety issues *(21)*. These findings substantiate the need for regular training and machine testing.

Conclusion

Although research findings are equivocal, the use of ultrasound remains extensive. Evidently, further high quality research is warranted to fill the gaps, especially in the clinical arena as opposed to the laboratory. Meanwhile, the literature clearly demonstrates the need for therapists to critically engage in current ultrasound literature and undertake regular training to keep abreast of evidence-based practice (EBP). Below is a proposed strategy for EBP guidelines based on a simple integrated management system - designed to assist in the safe and effective delivery of US.



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