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Ultrasound in contemporary physiotherapy practice

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Abstract

The use of therapeutic ultrasound as an element of physiotherapy practice is well established, but the nature of that practice has changed significantly over the last 20 years. This paper aims to review the rationale and range of applications for which this modality is employed in current practice. Whereas in the past, its primary use was as a thermal modality, it is argued that currently, it is the 'non-thermal' aspects of the intervention that are most commonly employed. The predominant use of therapeutic ultrasound is in relation to tissue repair and soft tissue lesion management, where the evidence would support its application in the inflammatory, proliferative and remodelling phases. The clinical outcomes appear to be dose dependent, and whilst this paper does not detail dose related clinical decision making, the broad issues are considered. The future possibilities for the use of the modality are reviewed, and although outside the immediate remit of this paper, the use of therapeutic ultrasound in fracture management is briefly considered.

Keywords: Ultrasound therapy; Soft tissue injury; Tissue repair

Contents

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1. Scope

Although therapeutic ultrasound has been used for over 50 years in physiotherapy, its use in the clinical environment has changed significantly over this period, and whereas in the past, its use was primarily for its thermal effect, it is now more widely employed for its 'non-thermal' effects, especially in relation to tissue repair and wound healing.

There is a substantial volume of published evidence relating to the effects and use of ultrasound as a therapeutic modality, and the overall aim of this paper is to review the current use of ultrasound in the realm of physiotherapy and associated practice, providing an overview of key issues. Whilst considering the evidence and providing key reference material, it does not purport to be a systematic review of the literature.

2. Historical use and recent developments

Ultrasound is almost certainly the most widely used of the electrophysical agents in current clinical practice. In addition to its widespread use by physiotherapists [1–3], it is also commonly used by numerous therapists from other professional groups (e.g. osteopaths, chiropractors, sports therapists). The results of a recent national survey of physiotherapists carried out in Australia [4] indicates that therapeutic ultrasound remains the most popular modality in use.

The results of a survey carried out in Britain in 1985 [2] showed that 20% of all physiotherapy treatments in NHS departments and 54% of all private treatments involved therapeutic ultrasound and the widely cited survey by Pope et al. [1] identified ultrasound as the most frequently employed modality (94%) and 64% of respondents reported that they used the modality more than once a day.

In the 1985 survey, it was shown that there were large variations in the use of ultrasound including a range of intensities from 0.1 to 3.0 W/cm^2 giving a variation factor of 30 from the lowest to the highest applied intensity. The current application of ultrasound for fracture healing at even lower doses (typically 0.03 W/cm^2) would take that to a factor of 100. This is a very substantial variation on just one factor that affects the output of the machine, and it is not surprising therefore that some research evidence is supportive of the modality whilst other publications are clearly not. Given that the effects of 'electrotherapy' interventions have a dose dependency [5], this wide variation in applied power would be expected to generate a range of effects including more and less effective therapeutic outcomes. Further identification of the critical machine and dose parameters is clearly needed and is being undertaken within this research group.

3. Physics related issues

The physics of therapeutic ultrasound are outwith the remit of this paper, but there are two essential issues that have a direct influence of practice and will therefore be identified in that context.

3.1. Coupling media

Ultrasound will be reflected at the metal/air interface found at the treatment head, it is necessary to provide a medium through which the ultrasound can freely pass in order to reach the patients tissues. This medium is most commonly referred to as a coupling medium, and several different types are used in practice. Given that the job of the coupling medium is to allow transmission of the ultrasound, a coupling medium that absorbs, changes or disturbs the ultrasound energy is not performing in an ideal way.

The coupling media used in this context include water, various oils, creams and gels. Ideally, the coupling medium should be sufficiently fluid to fill all available spaces, relatively viscous so that it stays in place, have an impedance appropriate to the media it connects, and should allow transmission of ultrasound energy with minimal absorption, attenuation or disturbance. For extensive discussions regarding coupling media, see [6–10]. Water and gel based media are clearly preferable to oil and cream based media. A recent detailed study considering the effect of different coupling gels on ultrasound transmission did demonstrate that there were differences in transmission characteristics and absorption levels of commonly employed ultrasound gels [9] but that there was no clinically significant difference between them. Most of the commonly employed gels only varied in their absorption characteristics by approximately 3% compared with water, and given the inaccuracy of clinical machine calibration [11], this is an insignificant variability. The addition of drug based material to the gel (for the purpose of phonophoresis) is not strongly supported by the literature, and the preliminary results from ongoing work in this unit (Todd and Watson) would suggest that the inclusion of pharmaceutical agents in the ultrasound gel appears to significantly reduce ultrasound transmission to the tissues, and therefore reduces the efficacy of the ultrasound component of the treatment. Whether this is outweighed by the clinical benefits of enhanced drug delivery remains to be established.

In an extension to this work, the capacity for various wound dressing materials to transmit ultrasound has been investigated. If it can be argued that of ultrasound energy can be effectively passed through a wound dressing without significant absorption, there is a potential value for not having to disturb the dressing in order to apply this modality which has an established role in chronic wound management [12–15]. Furthermore, US scanning of the wound bed and environment without having to remove the dressing may be clinically advantageous, especially given that the removal of wound dressings is considered to result in inhibited repair for several hours on each occasion [16].

A total of 48 different wound dressings were evaluated, and there was a very wide variation in their transmission