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ORIGINAL ARTICLE

Effects of position and operator on high-frequency ultrasound scan quality☆

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Skin integrity;
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Summary
Objectives: High-frequency ultrasound may evaluate those at risk for pressure ulcers. Images may be obtained by clinicians with limited training. The prone position is recommended for obtaining sacral scans but may not be feasible in the critically ill. This study investigated image quality using multiple operators and a variety of patient positions.
Research methodology: Sacral scans were performed in three randomised positions in 50 volunteers by three different investigators using a 20 MHz ultrasound system. General linear models and ANOVA random effects models were used to examine the effects of operator and position on image quality rating, and measures of dermal thickness and dermal density.
Results: The best scan for each position and operator was used for analysis ($n = 447$ images). Image rating varied by operator ($p = 0.0004$), although mean ratings were 3.5 or above for all operators. Dermal thickness was less for the prone position than in 90° or 60° side-lying positions ($p = 0.0137$, $p = 0.0003$). Dermal density was lower for the prone position than for the 90° or 60° positions ($p < 0.0001$ for both).

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Conclusions: These data show that overall scan quality was acceptable in all positions with all operators. However, differences were found between side-lying positions and the prone for dermal thickness and dermal density measures.

Implications for Clinical Practice

- The development of pressure ulcers is a costly complication of illness and patient care and the best preventive care strategies have been unable to completely eradicate them.
- Early identification of tissue changes that may eventually lead to tissue injury is critical to further reduce the incidence of pressure ulcers.
- HFUS technology may identify tissue oedema, a potential first sign of changes in tissue integrity, however quality scans and accurate measurements are required.
- HFUS images may be obtained on admission to acute or long-term care facilities by multiple clinicians with varying skill to identify those at risk and/or to document the presence of skin integrity issues.
- Using a variety of clinicians and patient positions may negatively affect image quality and the results presented here should be considered before data obtained from the HFUS images are used for patient care decisions.

Introduction

Pressure ulcers are a major health problem associated with pain, risk for infection, increased resource use and mortality (Russo et al., 2008). Hospitalised patients are at especially high risk for pressure ulcer development. The prevalence in adult critical care settings is between 8.8% and 12.1% (VanGilder et al., 2009), and 3.3% of ICU patients developed severe ulcers (Stage III, Stage IV, eschar/unable to stage or deep tissue injury [DTI]) (VanGilder et al., 2009). Currently, the Centers for Medicare and Medicaid Services (CMS) do not reimburse health care facilities for pressure ulcers acquired after admission (Medicare Program, 2009). Therefore pressure ulcer prevention or early identification has become a priority in health care settings to both reduce adverse outcomes and promote cost effectiveness.

The ability to detect subtle subepidermal oedema associated with early onset of tissue injury, prior to visible skin surface changes, has been reported using analysis of high frequency ultrasound (HFUS) images in the range of 20 MHz (Moghimi et al., 2010, 2011; Quintavalle et al., 2006). HFUS is a cost-effective and non-invasive method allowing immediate or convenience evaluation of subepidermal tissue with image documentation (Quintavalle et al., 2006). Thus, the use of HFUS to identify changes in skin integrity with the goal of early identification and intervention has the potential to identify the presence of underlying pressure ulcers before they appear on the surface. This may be a way to reduce pressure ulcer incidence and reduce hospital costs.

HFUS image analysis requires high-quality images, specific training and experience. However, the collection of data (images) may be achieved by operators following basic HFUS training. Primary HFUS training typically consists of eight hours of manufacturer-directed training for advanced practice nurses and wound care specialists who anticipate analysing HFUS images as well as teaching and/or demonstrating basic HFUS training to others. Therefore once trained, HFUS images may be obtained by a variety of health care providers. Little is known about the consistency in obtaining high-quality images with different operators. Ninety-five percent of all pressure ulcers develop on the lower portion of the body with the sacrum/coccyx most frequently affected (Vanderwee et al., 2007; Whittington et al., 2000). HFUS has been recently used to detect pressure-related skin injury based on patterns of fluid or oedema within dermal and subdermal tissues (Andersen and Karlsmark, 2008; Helvig and Nichols, 2012; Lucas et al., 2014; Porter-Armstrong et al., 2013; Quintavalle et al., 2006).

Ideal HFUS images of the sacrum are obtained when the patient is prone and the ultrasound probe is placed perpendicular to the patient's skin (Longport, 2007). In critically ill patients, use of a prone position may not be possible and as a result alternative and suboptimal positions may be used. These alternative positions may preclude obtaining optimal images due to differences in body position and difficulty in holding the probe in an optimal (perpendicular) position. Although use of a prone position is recommended to obtain a sacral scan, it is not known how a change in position may affect the quality of the image. Therefore, the purpose of this study was to evaluate the quality of HFUS images obtained by multiple operators in different subject positions (prone, left side-lying with 60° rotation, left side-lying with 90° rotation).

Methods

Setting and subjects

The study was conducted in a clinical learning centre in a school of nursing. A sample of 50 adult volunteers was drawn from the university and surrounding community using personal contact, electronic mailings, social media and fliers. For this initial study, volunteers were used since repeated repositioning in the critically ill patient may significantly