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The hand held Doppler device for the detection of perforators in reconstructive surgery: What you hear is not always what you get

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ARTICLE INFO

Article history:
Accepted 24 April 2014

Keywords:
Burn scar contracture
Planning perforator flaps
Hand held Doppler device
Detection perforator
Reliability
Validity

ABSTRACT

Background: Perforator-based flaps have become indispensable in the treatment of burn scars. Pre-operative perforator mapping is often performed by use of the hand held Doppler device, partly due to its convenience and the low costs. We expected to find sufficient evidence in literature to support the use of the device, however available literature showed a distinct lack of clinimetric studies that adequately tested the reliability.

Methods: To assess reliability, perforator locations were mapped independently by two clinicians using an 8 MHz Doppler device. In healthy volunteers the elbow region or the peri-umbilical region were randomly chosen to be the measurement areas of predefined squares (7 cm × 7 cm). Subsequently, the perforators within the area were mapped with Duplex to establish the validity by means of the positive predictive value.

Results: 20 volunteers were included. The hand held Doppler technique showed moderate reliability with a mean Dice coefficient of 0.56. Also, poor validity was found expressed by a mean positive predictive value of 55%.

Conclusions: Surprisingly, this study has shown that performance of the hand held Doppler device was moderate. The Doppler should not be used alone for the detection of perforators.

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http://dx.doi.org/10.1016/j.burns.2014.04.018
0305-4179/

1. Introduction

Scar contractures are frequently observed following extensive burn wounds. The use of perforator-based flaps in reconstructive (burn) surgery has increased significantly and has been established as a safe procedure [1–6]. Because perforators are distributed throughout the body, viable flaps can be raised from a great variety of anatomical locations [7]. The exact locations of perforators however, vary significantly between individuals. Pre-operative perforator mapping facilitates flap harvesting and saves operating time.

In the past many years, several advanced diagnostic tools have become available, such as Magnetic Resonance Imaging, Computed Tomography Angiography, Digital Subtraction Angiography and Color Doppler Sonography (Duplex) [8]. These techniques have proven to accurately detect perforator locations. They are however time consuming, cannot be performed during operation and most of these techniques are invasive and expensive. Furthermore, they have difficulty marking the exact location of identified perforators on the skin. A less modern device, the hand held Doppler, is on the other hand portable, inexpensive, easy to perform and interpret, and can be used during surgery by the surgeon. Furthermore, it has gained an important place as diagnostic tool in the upcoming field of perforator flaps because of its flexibility and readily available character [1,2,4–6,9].

The hand held Doppler device should be reliable and valid for application in clinical practice. When two clinicians use the same Doppler device they should be able to trace the same perforators. We expected to find sufficient evidence to support the use of the hand held Doppler device, however, available literature showed a distinct lack of clinimetric studies that adequately tested the reliability.

So far the Doppler device has only been studied for its validity, which means that a positive signal indicates the presence of a perforator [10–17]. The presented validity properties of the Doppler device differ considerably across studies [10–17].

Therefore, the aim of this study was to (1) test the reliability of the Doppler device for locating perforators and (2) assess the validity of Doppler as a diagnostic tool for detecting perforators?

2. Materials and methods

2.1. Subjects

Healthy volunteers participated in the study. The general principles outlined in the Declaration of Helsinki were followed. Participants were randomly assigned to two different groups based on the location in which perforators were mapped: elbow crease or the periumbilical region. Allocation concealment was carried out using sequentially numbered, opaque sealed envelopes. The sequence was determined by shuffling the envelopes by a researcher. The elbow crease was chosen because it is one of the areas prone to burn scar contractures, which are commonly released by means of perforator-based flaps [4]. The periumbilical region was chosen because this is a well-established location for perforator-based flaps, such as the DIEP flap. Each participant was positioned supine, with both arms resting alongside the body and the palms facing down. An area of 7 cm × 7 cm was marked using a plastic mold and a black permanent marker. To standardize the locations on the elbow or the abdomen, anatomical landmarks (the belly button and midline of the elbow crease respectively) were used.

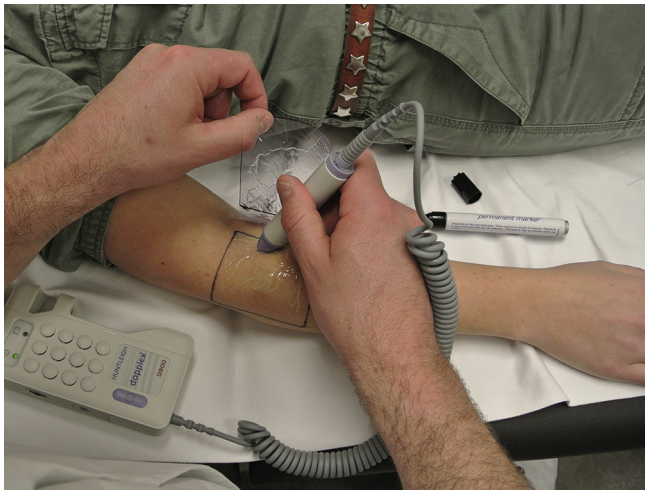

Fig. 1 – Example of the performance of Doppler mapping. The transparent sheet is lifted when mapping is performed and replaced on the skin to mark the locations with a permanent marker.

2.2. Hand held Doppler device

A Huntleigh Dopplex D900 (Cardiff, UK) with an EZ8 8 MHz probe and Parker Aquasonic 100 ultrasound transmission gel was used. The hand held Doppler device will be referred to as Doppler in this study. When a positive signal was located, the probe was moved in all directions to ensure that the signal did not continue in any direction; indicating an axial vessel instead of a perforator. Each perforator location was marked with a permanent marker, on a transparent sheet that was laid on top of the previously marked area on the skin (Fig. 1). This procedure ensured blinding of the observers.

2.3. Color Doppler sonography (duplex)

To assess the validity, Color Doppler sonography (iU22 Duplex with a L17-5 transducer, Philips, Eindhoven, The Netherlands) was used as standard for comparison, which has been succesfully used to preoperatively assess the vascularization of flaps for reconstructions in the head and neck, trunk and extremitites [8]. The same vascular laboratory technician mapped the perforators within the same squares described. These perforator locations were traced onto another transparent sheet using the permanent marker.

2.4. Measurement procedure

Two clinicians mapped the perforator locations within the squares on the participants. Both clinicians were plastic