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Use of a non-contact 3D digitiser to measure the volume of keloid scars: a useful tool for scar assessment☆

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Summary Keloid scars often fail to respond to treatment, so research into new therapeutic regimes is important. However, research is limited by a scarcity of reliable, objective scar assessment tools. The volume of a keloid scar should decrease with successful treatment. This study demonstrates the use of a non-contact 3D digitiser to measure digitally the volume of a keloid scar.

The scanner was used to scan 62 keloid scars and one fine-line normal scar. The scan took approximately 9 s to complete. The volume was measured using 3D reverse modelling software. A previously validated scar assessment scale was used to score the scars according to their physical parameters.

A significant correlation was found between volume and the scar score (Pearson's $r = 0.627$, $p < 0.001$). Linear regression was also statistically significant ($p < 0.001$, $R^2 = 0.44$). Therefore it was possible to predict the scar score from the measured volume.

This technique could allow monitoring of a patient on treatment, or comparison of treatments in a research setting. It overcomes previous problems with the measurement of scar volume as it is quantitatively objective and well-tolerated.

Keloid scars are raised scars which spread beyond the margins of the original wound and grow inexorably with time.[1] They can cause tremendous distress[2] and they recur after simple excision in 50–80% of case series.[3] The evidence behind many of the treatments in current use is limited,[4,5] and many keloid scars do not respond satisfactorily

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to any current treatment.[6] There has been a recent proliferation of research into new treatments. To increase our knowledge of the relative efficacy of current treatments, and to fully evaluate new techniques, an objective means of quantifying the severity of a keloid scar is required.[6] So far much of the work has been aimed specifically at assessing burn hypertrophic scars, and relatively few investigators have studied techniques specific to the assessment of keloid scars.[7]

Many of the scar assessment tools in current use are semi-quantitative observer based scales such as the Vancouver scar scale,[8] and more recently, a patient and observer scar scale.[9] However, these scales were designed to measure hypertrophic burn scars specifically, and some aspects may not be relevant or applicable to keloid scars.[7] There have been problems with assessing the pigmentation subscale of the Vancouver scar scale. Beausang et al.[1] developed a scale aimed at assessing a wider variety of scars. This scale is simpler than the Vancouver scale, and has been validated against histological findings and a panel rating of the scars on photographs. However, all of these methods lack objectivity, and most have not been validated with a single observer.

Several investigators have examined physical measurement of various attributes of scars.[7] A variety of attributes have been subject to assessment, including scar colour, tissue mechanics and surface area. However, no technique to date has been shown to be accurate in the assessment of keloid scars.

The volume of a keloid scar should decrease with successful treatment. This has previously been used by Ahn et al.[10] to show the value of silicone gel sheeting in prevention of hypertrophic scars, and by Nedelec et al.[11] to develop the Vancouver scar scale.

The present study investigates the hypothesis that it is possible to measure the volume of a keloid scar using a digital non-contact technique, and that the measured volume correlates with the physical severity, as defined by a range of parameters according to scar assessment scales currently in use. To the best of our knowledge, this is the first time that this technique has been described in the literature.

Methods

Patient selection

Patients were recruited directly from the plastic surgery outpatient clinic, from a record of scar clinic attendees, and from occupational therapy and pressure therapy clinics. Patients were given further information and asked to participate if they had a clinically raised skin scar.

Patients were excluded from the study if they were younger than 18 or older than 80, had impaired understanding of English learning disabilities or mental illnesses to the extent that they were unable to give informed consent, if their injury was caused by a particularly emotive event, such as a burn or surgery for breast cancer or if they had a severe co-existent skin condition, which may have either distorted the readings or the clinical assessment.

Patient recruitment

Patients thought suitable for inclusion were sent a letter and an information leaflet. They were given one week to absorb information about the study, following which, one of the investigators (BT) contacted them to further explain the study, answer any questions and confirm their participation in the study.

A total of 112 patients attending the skin scar clinic at Wythenshawe Hospital were contacted, from which a total of seven patients agreed to participate and were able to make an appointment in the limited time available to us. One patient was older than the upper age limit specified by the local ethics committee. Details of these patients are presented (Table 1).

This study was approved by South Manchester Local Research Ethics committee and the research directorate at South Manchester University Hospitals NHS Trust.

Materials

Konica-Minolta Vivid 900 non-contact 3D digitiser

The Vivid 900 (Konica-Minolta, Milton Keynes, UK) is a tool used in a variety of industries to scan a 3D image of an object. It has a digital camera and a scanning class I diode LASER with a wavelength of 690 nm. The LASER is aimed by a rotating mirror that draws the beam across the target. The camera picks up normal light (thus obtaining a colour picture of the target) as well as the LASER light. An integrated computer then constructs a 3D image of the target, based on the LASER reflections, which can be exported to a separate computer for further analysis.