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Variability in split-thickness skin graft depth when using an air-powered dermatome: A paediatric cohort study

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ARTICLE INFO

Article history:
Received 2 January 2017
Received in revised form
15 February 2017
Accepted 20 February 2017

Keywords:
Skin transplantation
Split-thickness skin graft
Pediatric burn
Donor site wound
Air-powered dermatome

ABSTRACT

Aim: Split-thickness skin grafts (STSG) taken using calibrated powered dermatomes are assumed to yield a graft of uniform thickness, though this assumption has never been analysed statistically. This study aims to test that assumption in a paediatric population.

Method: STSGs from a consecutive cohort of paediatric patients were analysed for mean thickness, measured from a central biopsy. All STSGs were taken from the thigh at a dialled thickness of 0.007 in. Data were analysed using non-parametric methods.

Results: There were 140 STSGs taken from 91 children. The median thickness was 6.94 thousandths of an inch, with a spread of thicknesses about this median (IQR 5.05–9.28). There were no significant differences when results were analysed by surgeon, patient age or gender, swipe number within the case, or the number of previous passes with the same blade.

Conclusion: STSG thickness is inconsistent, with a broad spread about a median value. This study provides no data to suggest there are pre-operative predictors of STSG thickness being significantly more or less than that dialled on a powered dermatome.

1. Introduction

Split-thickness skin graft (STSG) donor sites are considered uniform wounds, leading to their common use as a test bed in trials comparing different wound dressings [1–3]. Differences in time to re-epithelialisation are seen as being due to the products being tested, rather than any differences in the depth of the wound. It is well recognised that deeper wounds take longer to heal. If there were to be wide variation in the depth of STSG taken, then donor sites are not as uniform a wound as previously thought. This would introduce a potential confounder in studies of wound healing using STSG donor sites, a confounder not routinely accounted for in study design.

The ability to harvest a uniform split thickness skin graft (STSG) is seen as one of the hallmarks of a competent burns

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http://dx.doi.org/10.1016/j.burns.2017.02.010

surgeon. The majority of surgeons prefer a powered dermatome; citing harvest quality, better donor site results, and ease of use as their main reasons [4]. Our centre uses air-powered dermatomes for all STSGs, in keeping with this swing away from hand knives in favour of powered instruments. Earl Calvin Padgett and George J. Hood introduced the calibrated dermatome in 1938 [5]. A year later Padgett presented his experience in a publication emphasising "*. . . particularly the advantages of a type of skin graft which it has not been possible, for the writer at least, to cut previously, namely a skin graft* ***cut at a predetermined level*** *in the last quarter of the thickness of the skin . . .*" (emphasis added) [6]. This statement introduced the concept calibrated dermatomes provide uniformity in the depth of STSG, a concept largely unchallenged since.

The calibrated drum dermatome of Padgett and Hood underwent various modifications, chief among them the addition of electric power by Brown [7]. Padgett also subsequently developed a powered calibrated dermatome. Variations of calibrated powered dermatomes are the ones most surgeons will recognise in contemporary practice. The central feature of them, distinct from hand-knives, is a calibration system. The addition of power (air or electricity) allows for easier harvesting of large STSGs, without the size limitations or necessity for skin adhesives with Padgett and Hood's drum dermatome.

The aim of this study was to examine the accuracy in depth of STSGs harvested using a calibrated air-powered dermatome, by measuring the mean thickness of a central biopsy of the STSG and comparing that to the dialled thickness. A second aim was to examine the consistency of STSGs taken, when comparing the thickness of multiple grafts across different surgeons and patients.

Our hypothesis was that there would be a range of thicknesses about a median value. We hoped this median would be close to the set thickness on the dermatome. We expected a range of thicknesses, so a second hypothesis was that there would be pre-operative predictors of thicker or thinner STSGs. Potential predictors were patient specific (age and gender); or surgeon/equipment specific such as the particular surgeon operating, the age of the blade in use, or how many STSGs had been taken already in the operation. Such pre-operative predictors may allow compensation prior to harvesting a STSG, to bring the actual thickness taken closer to the desired thickness.

2. Methods

This study was undertaken as a part of a 3-arm parallel prospective randomised controlled trial of donor site dressings following STSG [8]. The trial was registered with the Australia and New Zealand Clinical Trials Register (ACTRN12614000380695) at the time of recruitment commencing [9]. The trial has approval from the Royal Children's Hospital Human Research Ethics Committee (HREC/14/QRCH/36), and from the University of Queensland Medical Research Ethics Committee (#2014000447). The methodology has been specified in advance and documented in a published protocol [8].

Consecutive patients (0–15 years) undergoing STSG were eligible. Exclusion criteria were non-English speaking families, children with known cognitive impairment, and children under the care or investigation of the Department of Communities, Child Safety and Disability Services. Recruitment was performed in the burns clinic or on the inpatient ward by a researcher not primarily involved in the clinical care of the patient. Written, informed consent was obtained from all participants. No inducements or payments were offered.

STSGs were harvested from the thigh in all cases using a pneumatic dermatome (Zimmer Inc., Warsaw, Indiana, United States), driven by compressed air at 1000–1400 kPa. The protocol permitted a depth setting between 0.005 and 0.008 in. (0.13–0.20 mm). All grafts analysed were harvested at 0.007 in., our local default setting. Surgeons have traditionally used thousandths of an inch when determining STSG thickness, and most powered dermatomes retain these settings. In deference to tradition, thicknesses have been cited this way.

Local anaesthetic or other tumescent infiltration prior to STSG harvest was not permitted, in an attempt to standardise the tissue pre-harvest. Liquid paraffin was used as a lubricant, and the donor site was stretched taut prior to harvest. Local anaesthetic (0.25% bupivacaine with epinephrine 1:200,000 AstraZeneca Pty Ltd, North Ryde, NSW 2113, Australia) was applied topically to the STSG donor site immediately after harvest. This method of local anaesthetic has been previously described to provide effective analgesia [10]. It was being used within the unit prior to the study, and is the subject of a further study investigating donor site pain after harvest. The surgeon performing the operation was recorded, as well as the blade and swipe number of the dermatome in use at the time (e.g. blade 1, first swipe). A scalpel was used to cut a small lentiform biopsy from the centre of each graft. These biopsies were placed into Eppendorf tubes containing 0.9% NaCl in theatre and then immediately transported and processed in the laboratory for cryo-embedding. Operations were performed as elective or semi-elective cases during daylight hours, so there was minimal delay in transport and processing.

A frozen section technique was used as it delivered a rapid demonstration of morphology for diagnosis measuring the thickness of a skin sample which may be lost or destroyed during fixation and processing procedures. Unfixed tissue samples were embedded flat in plastic moulds filled with Pelco® Cryo-Embedding Compound (Ted Pella Inc., Redding, California, USA). They were then rapidly frozen in isopentane precooled in dry ice to avoid ice crystal formation, which could damage tissue morphology. Sections of 7 or 10 μm thickness were cut perpendicular to the flat section, and stained with haematoxylin and eosin. Under a Nikon EP600 microscope, fitted with a Spot RT slider cooled CCD camera, these sections were examined and digital images taken. Thickness was then digitally measured using Image Pro Plus v5.1 software (Media Cybernetics, Rockville Maryland, USA). This software is commonly used for quantitative micrographic analysis, and in particular has been used previously for assessing epithelial thickness [11].

Slides undergoing analysis, and results, were anonymised (without reference to surgeon, age, gender, blade or swipe number) and analysed using SPSS for Mac, version 23 (IBM Corporation, Armonk, New York, USA). Data were graphed using the same program, and subsequently re-rendered for