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BurnCase 3D software validation study: Burn size measurement accuracy and inter-rater reliability

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ABSTRACT

Objective: The aim of this study was to compare the accuracy of burn size estimation using the computer-assisted software BurnCase 3D (RISC Software GmbH, Hagenberg, Austria) with that using a 2D scan, considered to be the actual burn size.
Methods: Thirty artificial burn areas were pre planned and prepared on three mannequins (one child, one female, and one male). Five trained physicians (raters) were asked to assess the size of all wound areas using BurnCase 3D software. The results were then compared with the real wound areas, as determined by 2D planimetry imaging. To examine inter-rater reliability, we performed an intraclass correlation analysis with a 95% confidence interval.
Results: The mean wound area estimations of the five raters using BurnCase 3D were in total 20.7 ± 0.9% for the child, 27.2 ± 1.5% for the female and 16.5 ± 0.1% for the male mannequin. Our analysis showed relative overestimations of 0.4%, 2.8% and 1.5% for the child, female and male mannequins respectively, compared to the 2D scan. The intraclass correlation between the single raters for mean percentage of the artificial burn areas was 98.6%. There was also a high intraclass correlation between the single raters and the 2D Scan visible.
Conclusion: BurnCase 3D is a valid and reliable tool for the determination of total body surface area burned in standard models. Further clinical studies including different pediatric and overweight adult mannequins are warranted.

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Abbreviations: BSA, body surface area; CI, confidence interval; ICC, inter-class correlation; Min, minimum; Max, maximum; SD, standard deviation; TBSA, total body surface area.

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1. Introduction

Accurate fluid resuscitation based on estimation of burned surface area has an essential impact on mortality and morbidity of thermally injured patients [1,2]. In thermally injured patients, especially in pediatric burn victims, a total body surface area (TBSA) of more than 60% burned is the main threshold for morbidity and mortality [3,4]. Reducing mortality and morbidity could be provided through an adequate estimation of the burn size[1,2]. However, Parvizi et al. [2] and Martin et al. [5] have described quite well, that there is still a lack in the accurate estimation of burned areas even for experienced staff. Incorrect estimation of the burn size leads to inadequate burn center admissions and more importantly faciliates over or under resuscitation and its associated morbidity and mortality [6]. Adequate fluid resuscitation within the first 24 h is crucial to prevent generalized edema, pneumonia, multiple organ failure and death [7]. Currently, commonly used methods for estimation of burn size are the ''Rule of Palm'' [8], ''Rule of Nines'' [9] and the ''Lund-Browder Chart'' [10]. Giretzlehner and colleagues [11] demonstrated, that the preferred methods of burn specialists are still the ''Rule of Palm'' followed by the ''Rule of Nines''. Many studies have focused on the lack of precision in these preferred methods, especially in children and obese victims [1,5,11–13]. Parallel to this, researchers are implementing 3D computer-based surface area estimation systems in clinical scenarios [12,14–17]. These systems may provide an accurate, reproducible, and precise estimation of burn size. In addition, these programs should allow an immediate collection of patient specific data.

The 3D computer-based estimation system, BurnCase 3D, offers a wide library of 3D-models. These models can be precisely adapted for age, gender, height, and weight allowing for accurate burned surface area estimation regardless of body compositions. The 3D-model can be translated, rotated, and scaled along three axes. In addition, a zoom to body regions can be performed. Physicians can represent burns by drawing on superimposed pictures of the burned areas in this 3D-model, allowing the burned surface areas to be automatically calculated by the system. At the time this research was conducted the literature reports no study validating the use of BurnCase 3D for burn area estimation.

The aim of this study was to compare the estimation of burned TBSA between BurnCase 3D and the gold standard (2D Scan) and to determine the accuracy of burn size measurements of burn specialists using the BurnCase 3D software. Further we sought to investigate inter-rater reliability of measurements of the same burned area when assessed by different physicians.

2. Methods

2.1. Sample size

A sample size of 30 burned areas for this pilot validation study were used. This study should provide estimations for coefficients of inter-class correlations and give an overview about the accuracy of BurnCase 3D using standard models.

2.2. Design

Thirty burned areas were pre planned and prepared using a special liquid on three mannequins, sizes ranging between 1% and 15% TBSA, 10 wounds representing burns on each mannequin. One male, one female, and one child were used. Five trained physicians assessed the size of all wound areas using the BurnCase 3D software. Burned areas (marked with consecutive ID numbers) were assessed under similar conditions by each of the physicians. Each assessor had chosen the most appropriate 3D-model inside the software based on gender and body composition to represent the ''patient'' (the mannequin). This chosen 3D-model (Fig. 1) was adapted to age, weight and height by the software. For each burned area of a ''patient'', each assessor photographed the wound areas and superimposed them on the 3D-model in order to trace the borders of the wounds correctly (Fig. 2). Burn sizewas calculated using the software system. This process was performed for each wound on all three mannequins (child, female and male). Every patient 3D-model as well as pictures and wound area estimations were stored in a local database.

After completion of the assessments by the specialists, the wounds were pulled off and cut in order to spread them to a 2-dimensional area. Measurement using a Brother MFC-9420CN flat-bed scanner (Brother International Corp., Bridgewater, NJ, USA) and the software ImageJ (http://rsbweb.nih.gov/ij/ provided by the National Institute of Health, Bethesda, MD, USA) for planimetric computer based measurements, were performed. Wounds of complex body areas made it necessary to cut the areas into subareas, to allow for a 2D scan. An example of the cut area of the circumferential wound on the female foot is depicted in Fig. 3.

This 2D area measurement is considered the gold standard and provided the exact size of the wounds. Physician's assessments were compared to each other and to the 2D calculated measures. To calculate the body surface area (BSA) of the mannequins, whole body scans using a Kinect for Windows (Microsoft, Richmond, VA, USA) device and the software ReconstructMe 2.0 (PROFACTOR GmbH, Steyr-Gleink, Austria) were performed. Post-processing for merging and closing the scanned meshes was performed with the software tool meshLabs (Pegasystems Inc., Cambridge, MA, USA) and a Poisson Reconstruction Filter. The mount of the mannequins was removed using the software tool Blender (Stichting Blender Foundation, Amsterdam, Netherlands).

2.3. Statistics

All burned area measurements were summarized in appropriate tables providing sample size, arithmetic mean, standard deviation, median, minimum, and maximum values by assessor.

The primary objective of this study was to analyze the level of agreement between the burn size measured by the BurnCase 3D software and the gold standard 2D measurements across the different raters.