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Comparison of Laser Doppler Imaging (LDI) and clinical assessment in differentiating between superficial and deep partial thickness burn wounds☆

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ABSTRACT

Purpose of presentation/study: To compare the accuracy of Laser Doppler Imaging (LDI) and clinical assessment in differentiating between superficial and deep partial thickness burns to decide whether early tangential excision and grafting or conservative management should be employed to optimize burn and patient management.
Study period: March 2015 to November 2016.
Methods/procedure details: Ninety two wounds in 34 patients reporting within 5 days of less than 40% burn surface area were included. Unstable patients, pregnant females and those who expired were excluded. The wounds were clinically assessed and LDI done concomitantly Plastic Surgeons blinded to each other's findings. Wound appearance, color, blanching, pain, hair follicle dislodgement were the clinical parameters that distinguished between superficial and deep partial thickness burns. On day 21, the wounds were again assessed for the presence of healing by the same plastic surgeons. The findings were correlated with the initial findings on LDI and clinical assessment and the results statistically analyzed.
Results/outcome: The data of 92 burn wounds was analyzed using SPSS (ver. 17). Clinical assessment correctly identified the depth of 75 and LDI 83 wounds, giving diagnostic accuracies of 81.52% and 90.21% respectively. The sensitivity of clinical assessment was 81% and of LDI 92.75%, whereas the specificity was 82% for both. The positive predictive value was 93% for clinical assessment and 94% for LDI while the negative predictive value was 59% and 79% respectively.
Conclusions: Predictive accuracy of LDI was found to be better than clinical assessment in the prediction of wound healing, the gold standard for wound healing being 21 days. As such it can prove to be a reliable and viable cost effective alternative per se to clinical assessment.

☆ This research was held at and the work is attributed to the department of Plastic Surgery & Burn Unit, King Edward Medical University/ Mayo Hospital, Lahore, Pakistan.

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Accurately assessing the depth of burn injuries is a major challenge to the burn surgeon and has a major impact on the management and prognosis of the burn. Though first degree (superficial), third and fourth degree burns are easily diagnosed and managed accordingly, it is the second degree burn that poses a major diagnostic conundrum. Differentiating between superficial and deep partial thickness burns is difficult [1] but important as the management plan and prognosis for the two are completely different. Superficial partial thickness burns re-epithelize by 21 days without any stigmata. On the contrary, deep partial thickness burns may re-epithelize per se, but are associated with burn scar pigmentation disorders, hypertrophic scarring and even contracture formation. Therefore, these burns like full thickness burns are best treated by early tangential excision and grafting. Inability to do so would inevitably result in bacterial colonization of the open wound and compromise patient parameters by prolonging the catabolic state presented by the open wound. Early excision and grafting limits the release of inflammatory mediators and preempts SIRS (systemic inflammatory response syndrome), metabolic derangements and sepsis that would eventually lead to multi organ failure [2] and death.

The most commonly used tool for diagnosis is serial visual and tactile assessments of the burn wound by an experienced plastic surgeon [3,4]. The gold standard to gauge the burn depth is however biopsy [5]. Though accuracy is stated to be 100%, the 2 mm punch biopsies taken from random areas of the burn wound are not representative of the whole burn as all burns are invariably mixed thickness. Biopsies are also invasive, painful, expensive, cause scarring and samples need to be assessed by an experienced pathologist [6]. They are therefore mainly used for research purposes [2,7,8].

Laser Doppler Imaging was first used by Niazi et al. [9] to assess the burn depth. It is a noninvasive, noncontact method that provides a two-dimensional image of the burn area giving an in depth analysis of the dermal circulation which would only be intact in the presence of undamaged dermis. Before having procured the LDI apparatus, clinical assessment was the sole and standard method for assessing burn wound depth at our facility. Our study aimed to compare the efficacy of our newly acquired Laser Doppler machine with serial clinical assessments in assessing burn wound depth in second degree burns to see which method was more reliable in assessing burn depth and hence in optimizing management and prognosis.

Materials and methods

92 wounds in 34 patients presenting in the burn unit at Mayo Hospital Lahore between March 2015 and November 2016 were included in the study. Partial thickness flame burns admitted within 5 days of the initial injury involving less than 40% surface area were included. Unstable patients, patients who expired, patients with co-morbid factors such as diabetes, liver disease or vascular problems and pregnant females were excluded from the study.

LDI was done between days 3-5 of the burn injury. Clinical assessment was concomitantly done by a senior plastic surgeon blinded to the LDI results. Superficial partial thickness burns were recognized by being painful, pink in appearance, by the presence of intact hair follicles in wound, blistering and the ability of the wounds to blanch on pressure. The clinical parameters for deep partial thickness burns were a tan to pink mottled appearance, loose or easily detachable hair follicles present in the wound and no blanching on pressure. Clinical assessments were done at the time of presentation to commence appropriate therapy, on the 3rd to 5th day for initial assessment of depth and then weekly by the same surgeon to assess for any signs of healing. Final assessment was done at 21 days when healing was assessed. Infection control was ensured and other parameters such as nutrition and hemoglobin levels were optimized to obviate factors that could compromise wound healing or progression of the wound to a deeper level.

The wounds were well washed and all dressings were removed before performing the LDI scan. Protective eyewear was provided to all personnel present in the room during scanning. Scans were done using the Moor LDI-B1 machine, using 256×64 resolution. The software used was Moor LDI-B1 burns software package Version 3X. Average scan duration was 2 min; the wound was scanned at an average distance of 65 cm (range 30–110 cm). The scanner is linked to a computer via a flexible arm. The head of the scanner was placed perpendicular to the wound to be scanned. Immobility of the patient was ensured as far as possible. Photographs of the area are also taken by the machine to depict the appearance of the burn wound in actual. The results were interpreted using a six-color palette ranging from dark blue to red corresponding to the amount of perfusion present, numerically represented as perfusion units or flux value by the computer (Fig. 1). Mean perfusion units of the whole wound calculated by the machine were used to determine the depth of the wound.

Blue on the colour palette of our machine represents deep burns or normal skin (<200 PU), yellow and green areas represented deep partial thickness (200–440 PU). Red signifies superficial partial thickness burns (>440 PU). Wounds were examined on the 21st day finally to assess for the presence or absence of healing and the results tallied with those of the initial clinical assessments and LDI.

The diagnostic accuracy, sensitivity and specificity, positive predictable value of the two techniques for predicting the actual burn depth were calculated and compared. The p-value was calculated using the Pearson chi-square test (SPSS version 17). The results were tabulated and analysed.

Results

The mean age of the patients was 28.43 (SD=11.03). The mean percentage of surface area burnt was 17.6%. The distribution of burn on the body is represented in Table 1. The findings on LDI and clinical exam corroborated with each other in 74 (80.43%) cases. Figs. 1–3 are representative of the disparity in the findings on clinical examination and LDI. 3 cases were wrongly diagnosed by both LDI and clinical assessment (Fig. 4).

The mean perfusion units for superficial partial thickness burns was 866.47 (±442.89) and for deep partial thickness burns was 342.04 (±118.51) as shown in Table 2.

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