

Use of laser-speckle contrast analysis in the study of “non healing” leg ulcers-a preliminary study

Keywords: leg ulcer, wound, metalloproteinases, laser-speckle contrast analysis, prostacyclin

Abbreviations: LASCA, laser speckle contrast analysis; ROI, region of interest; PU, perfusion unit; SSD, silver sulphadiazine dressing

Introduction

In the recent years leg ulcers pathophysiological interest have been focused on the role of chronic inflammation that triggers changes in the skin leading to ulcer onset.¹ Data emerging from biochemical findings on ulcer exudate, especially those concerning metalloproteinase levels, suggest a new hypothesis on new activation pathways of chronic inflammation playing an important role on the cell population in the wound tissue.²

Noninvasive imaging approach could provide greater information about a wound than the classical visual inspection during healing phases and help to understand what happen in those “non healing” wounds. In this study Laser-Speckle Contrast Analysis (LASCA) was tested on “non healing” ulcers of different etiology.

When a coherent light (as laser light) hits an object the scattered light will form a random interference pattern consisting in dark and brightness areas or speckle pattern. If the object is stationary the pattern will be clear, but with movement (as blood flow) speckle pattern will changes over time. By CCD camera is possible to capture these changes and depending on the degree of movement the level of blurring.^{2,3} The level of blurring is quantified by the speckle contrast and could be correlate with blood flow and blood perfusion measurement. Usually a helium-neon laser (633 nm) and CCD camera are employed for source and detector, respectively (Perimed AB). Aim of this research is the evaluation of skin circulation *in vivo* in patients affected of leg ulcers. Oxymethric studies on skin microcirculation based on survey of pO₂ and pCO₂ data have also shown that their values can be very low in areas of ulcer bottom and in the periwound.⁴⁻⁷ The application of the Laser-speckle Contrast Analysis (LASCA) allows to study *in vivo* perfusion of the skin, and particularly the area of ulcers and skin “healthy” environment.

Methods

15 patients (11 males and 4 females-average age 64,4±1,7 yy) affected of leg ulcers were enrolled at Operative Unit of Angiology in Ferrarotto Hospital (A.O.U. Vittorio Emanuele) Catania, Italy from march to june 2016 (Table 1).

All patients underwent to clinical, instrumental and serological examination and during admittance period routinary antiplatelet therapy was administrated. In venous patients affected of post-thrombotic syndrome antithrombotic therapy was administrated (acenocumarol or NAO) plus compressive therapy (high stiffness bandages) and local application of silver sulphadiazine surfactant polymeric dressing (Plurogel®, Plurogen Medline) directly on the wound. Vasculitic patients were assessed by arterial and venous echocolordoppler and serological immunoassays. In post-traumatic

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ulcer no arterial alterations were present. Therapy was carried out with steroids, analgesics and local advanced dressings in vasculitic ulcers (Figure 1).

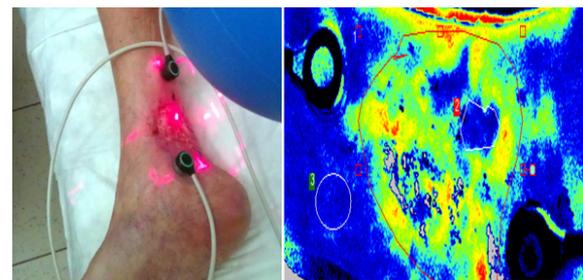


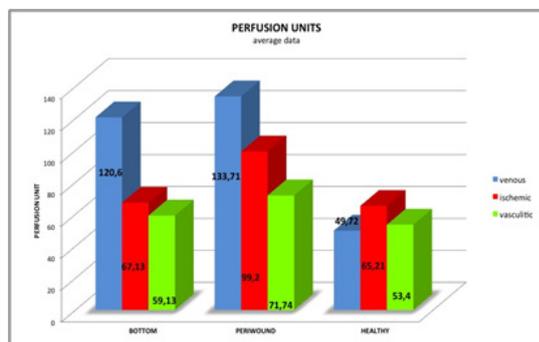
Figure 1 Microcirculatory evaluation in vasculitic ulcer. Oxymetry and LASCA after iloprost infusion. Reduction of PU in perilesional area and increase in the bottom of ulcer.

Table 1 Etiology.

ETIOLOGY	
ARTERIAL	4
VENOUS	5
VASCULITIC	4
POST-TRAUMATIC	1
CONTROL (HEALED VENOUS ULCER)	1

In each patient Laser Speckle Contrast Analysis (LASCA) (PeriCam PSI System, Perimed Italy) on three regions of interest (ROI) corresponding to the bottom of the wound, periwound area and peripheral area of skin as healthy skin were studied (Table 2).

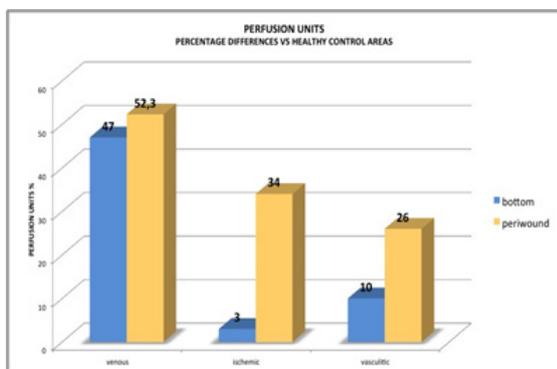
Table 2 Perfusion units (PU) average data measurement in ROI show a greater number in periwound areas both in venous than arterial and vasculitic ulcers.



Results

Data show increase of perfusion units (PU) in periwound areas in all ulcers. In venous and vasculitic PU were greater respectively 52,3 and 26% than healthy control. Also ischemic ulcers, even poorly, showed the same trend (Table 3).

Table 3 Percentage difference of PU versus healthy control in ROI of bottom and periwound in arterial, venous and vasculitic ulcer, respectively.



In this last group iloprost infusion have reduced PU in perilesional areas and increased PU in the bottom of ulcer. No significant changes were present in vasculitic ulcers after iloprost administration (Figure 2). Local administration of SSD (Silver Sulphadiazine Dressing) was followed by reduction of PU both in the bottom and periwound areas (Table 4). Data analysis at basal time highlight a greater amount of PU in periwound areas (ROI) than in the bottom and check areas.

After iloprost administration or SSD it can be observed a decreased number of PU in periwound and an increase in bottom areas (Figure 3).

Despite the limited number of cases examined, the preliminary data review implies a number of considerations:

- Imaging by means of laser-speckle allows the observation of the ulcer bed in real time and the changes that occur after administration of vasoactive substances
- There is a correlation between PU and oxymetry data

- Especially in vasculitis patients, where there is chronic inflammation of the skin oxymetry values tend to be hypoxic
- After the administration of drugs, a chronic inflammation in periwound area persists.

This could be interpreted as the primary cause of the chronicity of the lesion and the presence of elevated levels of MMPs in the exudate and ulcer tissue confirm the state of chronic inflammation.^{8,9}

Table 4 PU in bottom and in periwound areas before and after administration of SSD Dressing (Plurogel® medline).

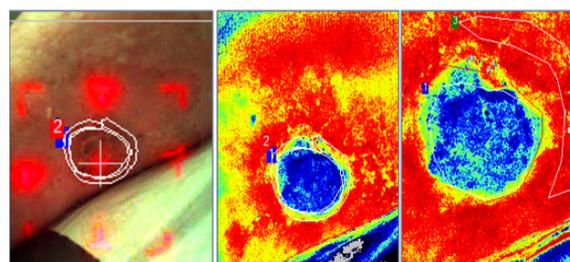
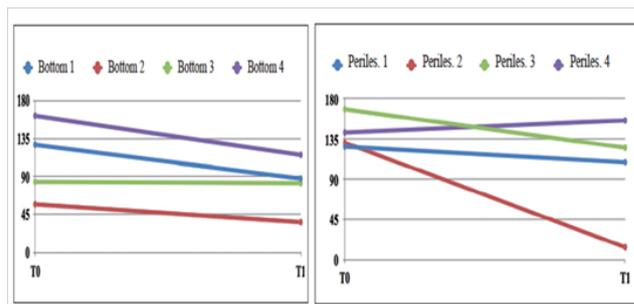


Figure 2 LASCA measurement in a ulcer shows. In periwound area is present inflammation.

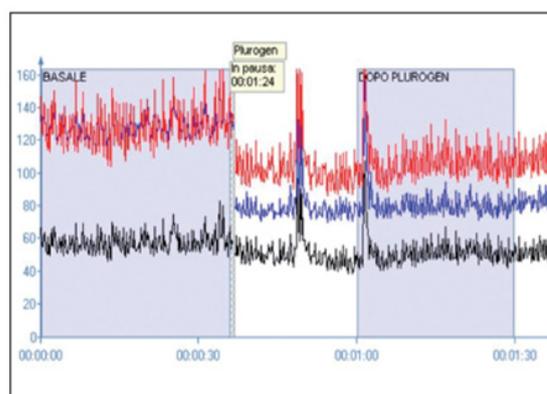
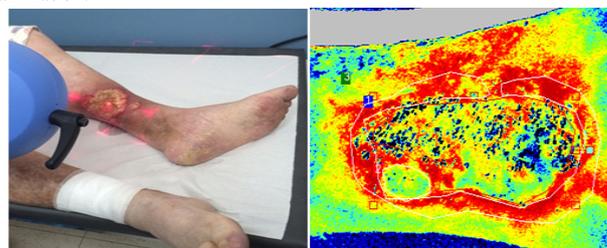


Figure 3 LASCA and oxymetric measurement in arterial ulcer before and after iloprost administration (30min) (above). After Plurogel®Medline administration with PU and oxymetric values decreased in 30min.

Even the administration of the SSD dressing (a transparent gel and which does not alter the refraction of the laser light) capacity is able to determine, especially in the bottom of the ulcer, the PU alterations observed after infusion of iloprost. It is not yet clear whether this information is related to anti-inflammatory and antibacterial properties of the dressing.

Conclusion

Data analysis highlights in all the ulcers the alteration of skin microcirculation especially in periwound areas where a greater number of PU is reduced. After the administration of iloprost or after local application of topical SSD dressing, at the same time as PU numbers in the bottom are increased. Because of Iloprost and SSD antiinflammatory properties it could be argued that in periwound areas a chronic inflammation is present and should be the real cause of delay in tissue repair. The data so far examined are not, of course, significant from a statistical point of view, but open up new diagnostic horizons in the field of wound care. Compared to other methods such as O₂ tensiometry, LASCA allows to evaluate in vivo and in real time microcirculation directly in the bottom of ulcer so as to verify the effectiveness of both systemic and local therapy.

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Conflict of interest

The author declares no conflict of interest.

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