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Temporal changes in the radiometric information of patients with diabetic foot disease

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Abstract

This work presents a temporal analysis of the metabolic evolution of patients with a diagnosis of diabetic foot disease and a group of control individuals, this as a response of an external stimulus. For this purpose, the *asymmetry and thermal response index* between the infrared images in the basal state and images acquired at different evolution times post stimulus was calculated. As a result, a difference in the temporal metabolic behavior of patients and disease-free subjects was observed.

1. Introduction

As previously noted by several authors [1, 2, 3], radiometric information shows abnormal asymmetries in presence of metabolic disruption, as Type 2 diabetes mellitus (DM2). At the same time, DM2 also implies changes in the temporal radiometric response of lower limbs after a stimulus is applied [4, 2, 3], mainly due to the presence of diabetic neuropathy. These changes in the way tissue responds to a stimulus, as well as the abnormal asymmetries caused by metabolic imbalance, are therefore signals of the disease's development.

Infrared (IR) images are graphical representations of the radiometric information from a target [5], that allow recording changes on this information, in a basal state as well as through time. Therefore, picturing the radiometric information of lower limbs by infrared imaging provides useful tools for the expert clinicians about the risk of diabetic foot disease (DFD).

According to Ortiz-Sosa *et al.* [3], both, asymmetric and temporal changes due to DFD can be characterized using the named *asymmetry and thermal response index* (ATR). This work aims to evaluate the temporal evolution of this index, studying a cohort of patients with DFD compared with a control group of disease-free individuals.

2. Methods

As part of the supervised clinical protocol DI/10/301/4/115 of the General Hospital of Mexico, a set of IR-images was acquired from a cohort of 36 patients clinically diagnosed with DFD and 18 control volunteers without the disease. Laboratory check-ups (blood tests and urinalysis) were made for both groups.

IR-images were obtained from the anterior and posterior view of the legs in passive mode (stand-still position) and active mode (with induced thermal stimulus). After the images were processed, the *asymmetry and thermal response index* (ATR) was obtained, as described in [3], in each image corresponding to the different times after the application of the stimulus.

For each view, the mean temporal behavior of the ATR was plotted, and then compared one with each other, as it is shown in the next section.

3. Results and discussion

Results obtained from the temporal analysis of the ATR are shown in Figs. (1) and (2). The graphs in Fig. (1) represent the temporal evolution of the ATR for the anterior and posterior views, respectively. Instead, Fig. (2) shows the comparative behavior from both views.

According to the results shown in Fig. (1), it can be observed that the control group presents a higher value in the ATR index, which means a greater response to the induced stimulus. This is expected since the index measures the difference between the basal state and each temporary state after the stimulus, and a healthy limb should have a greater response to an external stimulus.

In the case of the frontal view, after a recovery time, both groups reach a state in which the ATR does not present drastic modifications. However, in the analysis of the posterior view the value of the ATR for the controls does not decrease drastically in time. This could be explained considering that the back of the leg has a greater amount of muscle tissue, and thus in a healthy limb the recovery time should be faster in the posterior view respect the anterior view.

A common behavior in both views is that controls present higher values of the ATR, which is expected as they are less asymmetric in metabolic terms and have a greater response after the application of the thermal stimulus.

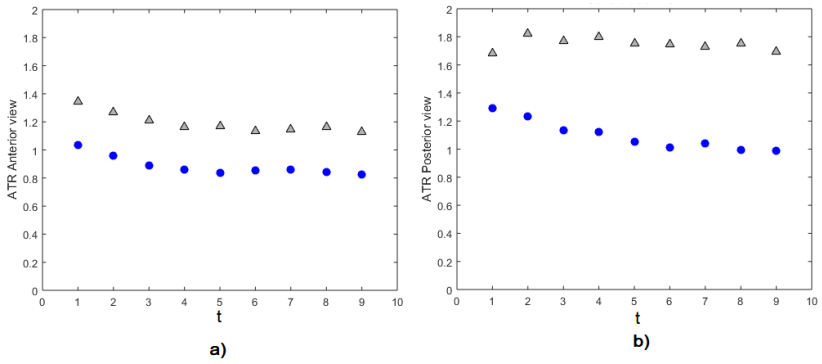

Fig. 1. *ATR index for the anterior (a) and posterior (b) views vs time. The blue circles represent patients and the gray triangles account for controls.*

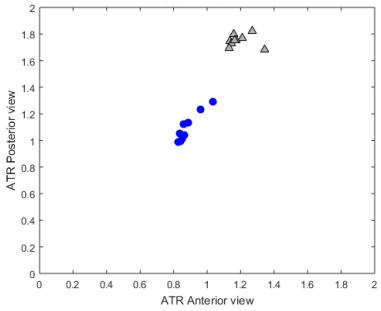

Fig. 2. *Comparison of the value of ATR index for patients and controls in the anterior (x-axis) and posterior (y-axis) views. As previously mentioned, the blue circles represent patients and the gray triangles account for controls.*

On the other hand, Fig. (2) reveals that the ATR values of both groups have a specific tendency, that allows that each group can be totally differentiated one of each other.

4. Conclusions

From the obtained results, a notorious difference in the mean temporal behavior of ATR from patients with DFD and free-disease volunteers, mainly for the posterior view. At glance, these results could allow identifying the metabolic degradation shown by patients diagnosed with DFD, but an extended analysis that confirms this observation is currently in process.

References

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