DIABETIC SHOE UPPER PRESSURES: PRELIMINARY APPROACH TO IDENTIFY RELATIVE LEVELS OF COMFORT AND INJURY

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Introduction

Diabetic foot is one of the most serious complications affecting the feet of diabetic patients. It is characterized by a progressive loss of protective skin sensitivity and requires an early diagnosis due to the imminent possibility of infection, ulceration, and amputation [1]. Frequently, the anatomical deformation of the foot and the use of misfit shoes compromise the biomechanics of the foot, causing abnormal overload and minor trauma that can precipitate ulceration. The most critical pressure points, located in the plantar and dorsal region of the foot, are already well identified. In this sense, in addition to increased clinical attention, the use of appropriate footwear is also an essential factor in preventing injuries. The shoe must have an internal length between 1 and 2 cm greater than the foot, it must be adapted to the widest part of the foot and the height of the toecap must guarantee sufficient space for the toes. The choice of shoes should be evaluated with the patient standing and preferably at the end of the day when the feet are more likely to be swollen. In more complex cases, the use of custom-made shoes should be advised [2]. This results in evident losses in the patient's ability to move.
The pressures that the shoes impose on the feet are extremely important and, although the plantar pressures are already well studied [3], the pressures involved between the upper of the shoe and the dorsal region of the foot is still a little addressed topic.
In this paper, we propose a preliminary approach to measure dorsal pressures and quantify relative levels of potential injury, to maintain a compromise between the comfort and safety of the diabetic patient's foot.

Methods

Looking for objective evidence that a concrete dorsal pressure threshold will jeopardize the integrity of the foot, our methodology consisted of: recognizing the critical locations of the dorsal region already described in the literature; create a method to locate sensors and measure pressure while walking; define a test procedure; and define groups of trial participants.

Results

In the acquisition of the measured pressure values it is proposed to use circular FSR sensors with an area of approximately 1 to 2 cm^2. In data processing and recording, a microcontroller based on the ATmega328, equipped with a memory card and powered by a battery, will be essential. After identifying the most critical dorsal pressure sites, the location of the FSR sensors and the method of data acquisition and recording were defined (Figure 1). These sensors can be attached to the inner lining of the shoe or sewed on a sock created for this purpose.

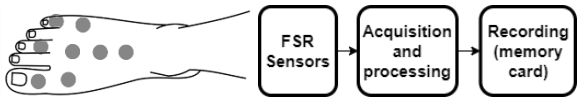

Figure 1: FSR locations and acquisition method.

As shown in Figure 2, for the implementation of a test protocol to identify standards and relative levels of comfort and injury, a group of participants (healthy, without diabetic foot and ages between 20 and 45 years) will be selected who will do a walk with different shoes (more or less tight). At the end they will answer a questionnaire to perception of comfort, whose answers will be analyzed and crossed with the pressure values acquired. It is expected to obtain standards that indicate relative levels of comfort and injury that can later be applied to patients with diabetic foot.

Figure 2: Test protocol and identification of comfort standards and relative injury levels.

Discussion

This method is shown as a practical approach to identify characteristic thresholds of dorsal pressures in the foot associated with different levels of comfort. But it is important to identify whether the pressure that will be considered as the injury threshold is the same for all users. The threshold that puts a given patient at risk may be different from another. However, this approach is essential to obtain more objective and concrete values of dorsal pressures.

References

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