Using PressureStat to identify feet at risk of plantar ulceration

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Introduction

In the development of plantar ulcers on the diabetic neuropathic foot, high plantar foot pressure is widely recognised as an important risk factor (Reiber et al, 1999). This article considers the use of the PressureStat device (Bailey Instruments, Manchester) in identifying people with peak plantar pressure and therefore a much greater risk of foot ulceration. Its simplicity of use and instant imaging make the instrument worth considering both for routine ulcer risk screening and as an educational aid for people with diabetes.

High plantar foot pressure is widely recognised as an important risk factor in the development of plantar ulcers on the diabetic neuropathic foot (Reiber et al, 1999). Anatomical factors associated with an increased loading in the plantar metatarsal area include lesser toe deformities, such as claw toes and hammer toes, and high-arched feet. The resulting intermittent pressure and shear stresses linked with these deformities may cause initial minor tissue damage, which may lead to tissue breakdown and, ultimately, the development of non-healing plantar foot wounds.

International guidelines on the prevention of foot problems recommend that people with diabetes should have their feet assessed at least annually for a range of ulcer risk factors including the presence of toe deformities, bony prominences and callus which can result in abnormal and potentially damaging foot loading (Apelqvist et al, 2000; American Diabetes Association, 2003). Although a threshold plantar pressure for foot ulceration is yet to be established (Cavanagh et al, 2000), peak pressure values greater than 600 kPa have been found to be associated with a significantly increased risk of foot ulceration (Armstrong et al, 1998; Frykberg et al, 1998). Early identification of foot risk should be followed by appropriate healthcare interventions (such as closer monitoring and provision of appropriate footwear and cushioning inserts) and structured patient education to encourage behavioural changes that might help avoid damage to the feet.

Identifying people with high plantar foot pressures could not only increase the chances of preventing the incidence of ulcers but also reduce the personal and economic burden associated with this distressing complication of diabetes (Boulton, 2004).

How the PressureStat works

The PressureStat mat (Bailey Instruments, Manchester) provides a semi-quantitative method of recording plantar foot pressures. The system consists of a transparent top layer with an adhesive coating on the underside, a middle layer, and a white rectangular bottom sheet measuring 360 mm by 165 mm, divided into 5 mm squares. The middle layer is similar to carbon paper in appearance, and it contains pressure-sensitive chemicals that transfer a weight-bearing impression of the foot to the adhesive coating embedded in the top layer.

Before use, the system is attached to a surface that is ideally hard and non-carpeted. A protective sheet is then removed from the top layer, exposing the adhesive, which is then allowed to make contact with the pressure-sensitive middle sheet. As the person walks across the mat, the footprint image becomes fixed onto the transparant top layer. Because the intensity of the black and white image is related to the intensity of the load applied, peak plantar pressure

ARTICLE POINTS

1 Identifying people with high plantar foot pressures could not only increase the chances of preventing the incidence of ulcers but also reduce the associated personal and economic burden.

2 The PressureStat mat (Bailey Instruments, Manchester) provides a semi-quantitative method of recording static or dynamic images of the foot.

3 In addition to pressure assessment, individual footprints can be classified as 'high', 'neutral' or 'low' arch.

4 To date, two studies have examined the usefulness of this kind of pressure-mapping system.

5 The PressureStat offers a quick, inexpensive and reliable method of plantar foot pressure screening.

KEY WORDS

- **Plantar foot ulcers**
- **Pressure screening**
- **PressureStat**

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PAGE POINTS

1 Garrow et al (2004) judged inter-observer agreement of foot type to be excellent.

2 The PressureStat offers an instant 'dark is dangerous' foot health education message for people with diabetes.

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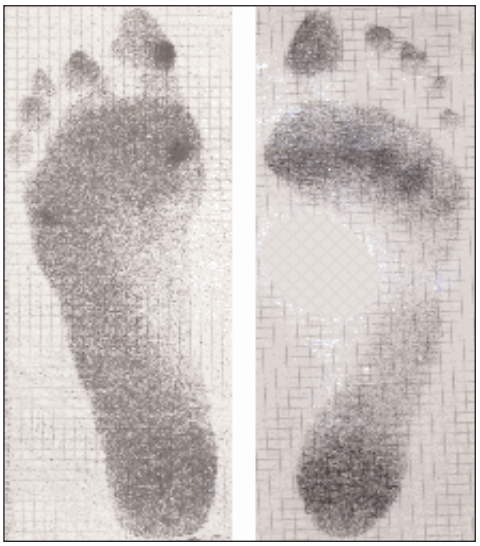

Figure 1. PressureStat images of a flat (left) and high-arched foot (right) with darkened areas indicating high plantar foot pressure.

appears as a darkened area on the footprint. These areas can be counted and can also be graded using the grey-scale calibration card provided with the system.

In addition to pressure assessment, individual footprints can be classified as 'high', 'neutral' or 'low' arch, depending on the area of the medial longitudinal arch that makes contact with the ground (*Figure 1*).

Advantages

The advantages of the PressureStat include the following.

- The time required to record a footprint of both feet is approximately 2 minutes.
- Images can be analysed immediately, results discussed with the patient and footprints filed in the medical records for reference and future comparisons.
- At around £1.30 (plus VAT) per use, the system is cost-effective and is thus suitable for routine patient screening.

Disadvantages

Disadvantages of the PressureStat are as follows.

- Because the mapping system needs to be long enough to accommodate the largest of feet, each footprint usually has to be folded to fit inside a standard record file.
- Pressure units on the calibration card are shown as kg/cm^2 rather than kPa, the SI unit for pressure. Conversion is relatively straightforward, though (1 kg/cm^2 is equivalent to 98.07 kPa).

Evidence

To date, two studies have examined the usefulness of this kind of pressure-mapping system. The first (van Schie et al, 1999) used an earlier but similar device, the Podotrack (Langer, Stoke-on-Trent). In this study, the pressure mat was placed on top of an optical pedobarograph and its ability to identify high-pressure areas was assessed against measurements taken using a computer-based system. Sensitivity and specificity values for the footprint images were high, indicating a good level of agreement between the Podotrack and the pedobarograph. This study also showed good levels of agreement between six trained clinicians in identifying high-pressure areas.

The second study (Garrow et al, 2004) involved three podiatrists, two diabetes specialist nurses and three physicians, who were asked to classify 30 PressureStat images as 'high', 'neutral' or 'flat' feet using three reference illustrations as a guide. With a combined kappa value of 0.86, the inter-observer agreement of the footprint system was judged to be excellent (a kappa value of 1 indicates complete agreement).

Conclusions

Although there is now a wide range of computer-based foot pressure systems, the time required for preparation, operation and analysing the data from in-shoe devices and pressure platforms, and especially the high cost, means that these systems are not ideally suited for use in everyday clinical practice. The PressureStat offers a quick and inexpensive method of monitoring plantar pressure and recording foot type. Larger studies are required to confirm the reproducibility of results from these devices and establish their suitability in both research and clinical practice. With the instant 'dark is dangerous' foot health education message, the system may not only be able to increase our patients' awareness of the potentially damaging stresses that act on the feet but also motivate them to avoid situations that put their feet at greatest risk of developing foot ulcers. ■