

IN-SHOE PRESSURE MEASUREMENT

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Abstract

Patients with foot problems are frequent visitors of outpatient clinics specializing in physical medicine and rehabilitation. Specialists in PMR may rely on their clinical examination or use additional assessment methods, such as in-shoe plantar measurements. For the purpose of the

present study the F-Scan was used on 430 patients. In most patients, plantar pressure were satisfactorily reduced with new orthopaedic shoes. The authors believe that in-shoe plantar pressure measurement is much more important at the time of the fitting of new shoes when it objectively demonstrates the results. When pressures are not distributed well, additional adaptations can be made to decrease them.

INTRODUCTION

Patients with foot problems are frequent visitors of outpatient clinics specializing in physical medicine and rehabilitation. Specialists may rely on their clinical examination or use additional assessment methods. The clinical exam is very effective in accurate evaluation of anatomical abnormalities, however, it is not as effective in evaluation of functional abnormalities (1). Functional abnormalities are especially difficult to evaluate under loading conditions, particularly in shoes. In the western world people seldom walk barefoot, so it is important for clinicians to assess the processes inside the shoes. Various platforms may be used for barefoot-walking assessment, while insoles with measurement sensors are needed for in-shoe measurement.

In-shoe plantar pressure can be measured with a variety of instruments, including force-sensing resistors or FSRs, piezoelectric sensors (in hydrocells) and capacitive transducers, as well as by critical light deflection (2). These instruments can be used as discrete sensors or they create a matrix of multiple sensors.

In discrete measurements, the sensors are positioned at specific anatomical locations only, whereas at matrix measurements, the sensors are organized in rows and columns and are located under the whole sole. Each method has its advantages and disadvantages and it is important for clinicians to be aware of the system's measurement properties.

The aim of the study was to find out whether in-shoe plantar pressure measurement was necessary before prescription or whether it was more important at the fitting of new shoes.

METHODS AND SUBJECTS

Methods

In-shoe plantar pressures were measured by the F-Scan system (Tekscan, Boston, MA). The system consists of

0.18mm-thick sensor insoles, which have pressure-sensitive, resistive, and conductive silver-based inks arranged in 60 columns and 21 rows embedded in Mylar coating. The columns and rows intersect, creating a "cell". There are 960 cells in each insole. The resistance at each cell is proportional to the pressure applied on its surface. These insoles are connected to cuff units (preamplifiers), which are attached to the lower leg with a Velcro strap. A 9.25m cable attaches the sensor and cuff unit to computer. The data were collected at 50 Hz. The F-scan has excellent resolution and provides reliable measures of relative pressure values (3, 4).

In all the patients, the measurements were performed twice, at their first visit before prescription and after the fitting of the new shoes.

Subjects

The study included all the patients who were examined at the Institute for Rehabilitation, Republic of Slovenia, at the outpatient clinic for foot problems, from January 1st 2003 to March 31st 2005, and for whom their physician believed that they needed in-shoe pressure measurement at examination or at fitting.

RESULTS

430 patients, 51.4% percent of them were women, were included into the study. They were 58 years old on average (sd 18 years, from 18 -90 years). They had from one to four different diagnoses. 70.9% had orthopaedic problems, 13.5% diabetes, 6.0% rheumatoid arthritis, 10.1% paresis and different neurological diseases. 52.8% were measured at the examination only, 15.1% at the fitting only and 32.1% at the examination and at the fitting (Figure 1).

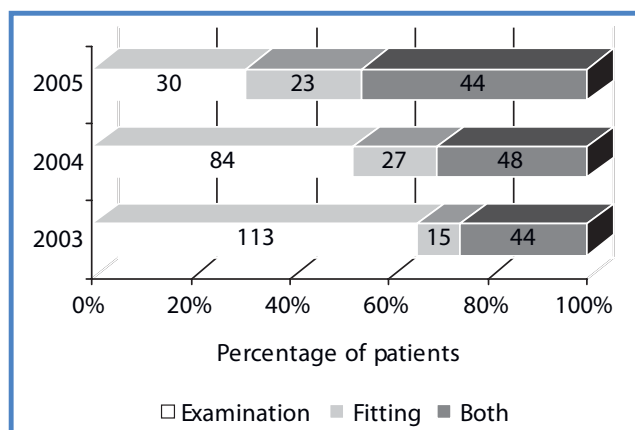


Figure 1: Percentage of patients, examined in different years, measured at examination only, at fitting only or at examination and fitting

Table 1 presents the characteristics of prescribed orthopaedic shoes for patients with different diagnoses.

Table 1: Characteristics of prescribed shoes for patients with different diagnoses

	Orthopaedic impairments	Diabetes	Rheumatoid arthritis	Neurological problems
High shoes	38.6	53.4	42.3	75.0
Custom-made insole	23.6	56.8	19.6	75.0
Lateral wedge	10.8	17.2	12.5	37.5
Medial wedge	7.5	6.8	3.8	37.5
Arch supports	70.8	41.3	61.5	25.0
Elevation	11.8	6.8	0	25.0
Soft material	56.0	68.0	61.0	50.0

Shoe adaptations successfully decreased excessive plantar pressures in 72.8 % of patients (Figure 2).

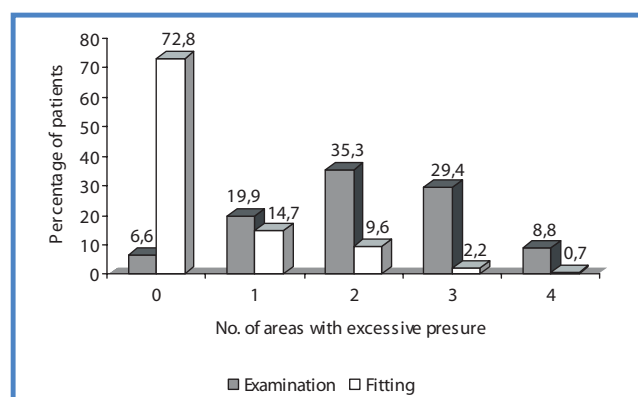


Figure 2: Percentage of patients with excessive plantar pressures at examination and at fitting

DISCUSSION

The study found a high level of agreement between medical diagnosis and prescribed characteristics of orthopaedic shoes.

The results do not clearly demonstrate how often diagnosis and prescription were actually based on in-shoe plantar measurements and how often on clinical examination only.

However, Figure 1 shows that in the first year in over 60% of the subjects plantar pressures were measured at the examination only, whereas in the last year only in one third of the patients pressures were still measured at the examination only while in over half of them they were measured at both, the examination and the fitting. It seems that we had realised that the measurements were not needed so much for diagnosis and prescription, but more for the evaluation of new shoes. That is in agreement with Ahroni (4) who states that high in-shoe pressure in diabetic subjects can be predicted in part from readily available clinical characteristics.

Additionally, the study found that with new shoes elevated plantar pressures was satisfactorily reduced in over 70% of the subjects (Figure 2). Only 12.5% of the subjects still had excessive plantar pressures in more than one area and 14.7% in one area only. At the examination only 6.6% of the patients did not have excessive plantar pressures, while 73.5% had excessive plantar pressures in more than one area. The measurements objectively demonstrated the reduction of pressures and additional adjustments were made to reduce them in those patients who still had excessive pressures.

CONCLUSION

In-shoe measurement of plantar pressures may be helpful at examination, but it is much more important at the time of the fitting of new shoes when it objectively demonstrates the result. When the pressures are not distributed well, additional adaptations can be made to decrease them.

References:

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