METHOD AND SOFTWARE FOR ASSESSMENT AND INTERPRETATION OF THE PLANTAR PRINT

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Abstract - The article presents the proposed method for plantar print assessment and also the afferent software SInAP for interpreting and calculation of its typical elements (plantar pressures, specific areas, specific indicators for certain diseases, etc) in a performant manner but with reduced raw materials and materials consumption. The method and the software for plantar print assessment and interpretation SInAP will be used in the medical field and will provide to the doctors working in the medical recover and medical insoles manufacture, important data referring to the following categories of diseases at the foot level: diabetical foot, spastic foot, foot statics disorders, foot with rheumatic polyarthritis and plantar fasciïta.

For these diseases it must be studied the different plantar print, must be evaluated the plantar pressures, must be prescribed medical insoles to prevent the complications (deformations, ulcerations).

Keywords: optimal forms of cushions; interpretation SInAP; siliconed rubber

1. INTRODUCTION

The article presents the proposed method for plantar print assessment and also the afferent software SInAP for interpreting and calculation of its typical elements (plantar pressures, specific areas, specific indicators for certain diseases, etc) in a performant manner but with reduced raw materials and materials consumption.

2. FIELD OF USE

The method and the software for plantar print assessment and interpretation SInAP will be used in the medical field and will provide to the doctors working in the medical recover and medical insoles manufacture, important data referring to the following categories of diseases at the foot level: diabetical foot, spastic foot, foot statics disorders, foot with rheumatic polyarthritis and plantar fasciïta.

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3. GENERAL DESCRIPTION

3.1. General description of the used method for the plantar print assessment

The method used to asses the plantar print has the following steps:

1. Model preparation

   a) Mylar plastic layer and also the carbon one are lifted in order to access the third layer: the adhesive layer. This layer is protected by a white plastic covering the adhesive surface till the using moment;

   b) the two protective parts made by white plastic are removed starting with the middle part of the insole -Figure 1.

   c) the carbon layer is put on the adhesive layer carefully. This layer setting must be done straight without waves to prevent distorting prints -Figure 2;

   d) during pressure, the Mylar plastic layer is turned round and doesn’t participate to the experiment;

   e) two parallel lines having the distance of 10 mm to each other or a square with the side of 10 mm, are used for scaling the model and must be designed in a free zone of the model active aria;

   f) after using the model (by pressure), the carbon layer is carefully removed and broken from the perforations, according to figures 3 and 4;

   g) the Mylar plastic layer is carefully put over the adhesive layer, allowing the adhesion to the adhesive surface and permanent protection for the plantar print.

   The fixing should be smooth because the waves may distort the image.
2.) Assessment of the plantar print

The model is put on the floor and the patient sitting on a chair puts his feet on the model, then he stands up, making a genoflection, then he stands up and sits again on the chair. Before taking the feet from the model, the shape of the feet must be drawn, figures 5, 6, 7, 8.
3.) Digitizing the plantar print

The plantar print will be digitized by the help of a performant scanner and will be processed and interpreted by the help of the afferent software SInAP to assess the plantar print parameters. - Figure 9

4.) Digitizing the plantar radiography

Two radiographies are done laterally and anteroposteriously (profile and front) for each plantar - figures 10 and 11. During this operation a metallic square plate with the side of 10 mm must be fixed near the feet. The plate trace will be used for scaling the radiography. These images will be also digitized by the help of a scanner for films or by the help of a performant digital camera and will be processed and interpreted by the specialized software for assessing the specific parameters.

5.) Processing and interpretation of the digital images of the plantar prints and of the radiographies; Set up the optimal configuration of the medical insoles:

All the functions and facilities of the specialized software are used to interpret the plantar print, to assess all the print characteristic elements: assessing the plantar pressure values, assessing the length, the width and the aria of plantar print, generating histograms and diagrams, counting both the body mass index and the foot arch index, to interpret the radiographies and to assess the specific parameters of the foot osteo structure (counting the foot arch high, positioning of the metatarsal etc) and also to establish the medical insoles optimal configuration.

6.) The printing:

They may be print by the color printer, format A4 or A3:
- the color images of the plantar pressure distribution;
images of the foot bone structure having positioned and counted the specific elements: intermetatarsian angles, metatarso-phalangeal angles, foot arch high;

- **optimal forms of cushions** needed to manufacture the foot insoles, over the foot shape image and the plantar pressure distributions;
- the patient clinical history.

7.) The medical insoles manufacture:

There are going to be manufactured medical insoles using new materials and performant technologies.

Thus, P3:ORTOTECH partner uses longitudinal and retrocapital cushions, Figure 12, to make the medical insoles, Figure 13.

Thus, the following materials are used:

- for support: synthetic material for insoles
- for longitudinal and retrocapital cushions: **cork or siliconed rubber**;
- for lining leather: leather or pedilin (material compatible with the skin)

8.) Recovering treatment:

The patient follows the recovering treatment and uses the medical insoles manufactured in the previous stage.

9.) Periodic check:

At one month and at 3 month from the medical insoles manufacturing and beginning of the treatment

Conclusions:

The clinical tests conclusions means an important feedback for the correct choice of the medical insoles shape or of the medical treatment for the patients

3.2. General description of the software for interpreting the plantar print - SInAP

The software for interpreting the plantar print was realised so that it would be easy to be used, intuitive, with the best number of interactive control and functions and is providing the doctors all the information they need to cure the foot diseases or to manufacture performant insoles.

As inputs, the software needs the digital images of the plantar print and also the foot radiographies images. Using these digital images and also data referring to each patient (name, age, sex, tall, weight, history and the disease stage, etc) the specialized software provides the doctors, data referring to the specific elements of the plantar print, necessary to diagnosis and treatment of the specific diseases, specific reports and the possibility to store the data for the next comparisons and also provides the necessary medical insoles to the specialists in the orthotic field.

The software for interpreting the plantar print – SInAP, was realized in Lab VIEW visual programming language.

4. THE MAIN TECHNICAL FEATURES

4.1. Technical and functional features of the equipment used with the method for assessing the plantar print

In order to verify the assessment method of the plantar print by the help of the afferent software, it is necessary to use the next equipments

- model for assessment of the plantar print;
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- lateral and anteposterior radiographies;
- performant scanner to scan the plantar print and the radiographies;
- specialized software for interpreting the plantar print characteristic elements - SInAP;
- PC with Windows 98 or XP operating system to run the specialized software;
- color printer for printing the reports
- interface for scanner- PC, printer-PC;
- materials and devices to manufacture the medical insoles.

Technical characteristics for the model for aseessment the plantar print

The support sensible to pressure is Podia Scan Mats, imported from Sensor Product Inc. company - USA and includes 3 layers: 1st made of Mylar plastic, 2nd made of carbon paper and the last made of adhesive paper.

The plantar print will be formed on the last layer of adhesive paper (in different kinds of grey, as dark as the plantar pressure grows), after charging with pressure, and it will be protected further, after taking out the carbon paper, by the Mylar plastic layer.

The plantar pressure domain, measured by the help of the specialized software, is : 0-6 kgf/cm².

To test the method and the afferent software SInAP, there where used the following equipment:

a) Scanner UMAX ASTRA 7350:
   - optical resolution 2400 DPI;
   - image surface (A4);
   - scanning way: 48 bit color;
   - interface: USB 2.0
b) PC: Atronic Pentium 4
   - processor Intel Pentium 4 ; 1,4GHz
   - memory RD RAM: 2x128MB
   - hard disk: 20GB
   - software: Windows XP PRO Engl
c) Printer HP 1220C
   - colores , ink jet
   - A3 format
d) Device for radiology
e) Etalon mass, class F1;
f) Measurement and control equipment for medical insoles: vernier callipers, protractor, square, divided line

4.2. Functions of the specialized software for plantar print interpretation - SInAP

The software for interpreting the foot print has the following functions:

- setting up files and storage files for each patient, for the disease evolution
- grouping the pacients files in 5 desesases groups that are going to be studied: diabetical foot, spastic foot, foot statics disorders, foot with rheumatic polyarthritis and plantar fasciita.
- registration of pacient specific data as follows
  - demographical data: name, surname, age, sex;
  - clinical data: heigh, weight, history, disease stage (if necessary) the simptomes score according to the subjacent pathology, pain score, disability score, the vibration perception level, the pressure perception level, sensorial score, ulcerations clasiification (if necessary), articular mobility, driving speed at the peroneal nerve level.
- overtaking of the pacients'plantar prints and radiographies digital images;
- scalling the images by using the square with the side of 10 mm from the plantar print/radiographies;
- setting up some segments on the radiographies overtook images to measure the characteristic distances and angles;
- radiography interpretation by assessing the specific parameters of the foot bone structure: counting the foot arch heigh, the intermetatarsal angle, etc.
- plantar print interpretation by:
  - assessing the plantar pressure values according to the model gray shade and equal pressure aria quantification, by the help of 7 different colours, corresponding the following domains of pressure: 0-1 kgf/cm²; 1-2 kgf/cm²; 2-3 kgf/cm²; 3-4 kgf/cm²; 4-5 kgf/cm²; 5-6 kgf/cm²; > 6 kgf/cm²;
  - display of a diagram with the used colours according to the plantar pressure domain;
  - dividing the print aria in 4 aria of interest: fingers zone, antefoot zone, the middle zone and the posterior zone (heel);
  - counting of the min, max. and medium plantar pressure on that 4 zones of interest and also at the level of the whole plantar print;
- counting the extent of that 4 zones of interest and of the whole aria;
- counting the foot length and width;
- counting the foot arch index and assessment of the foot pronation or supination degree;
- analyse the plantar pressure in the local points, by positioning the mouse;
- analyse the plantar pressure in the interest zones(circular) or on a given direction.

- generating histogrames and diagrams showing the statistical distribution of the plantar pressure on the whole zone or only in an interest zone;
- automatic or manual enlargement of some zones from the whole image, for a detailed examination of the interest zones;
- image control in 2D and 3D;
- identification of the possible ulcerate arias;
- comparation of the pre and post treatment conditions (memorising data);
- counting the body mass index IMC;
- the possibility to shape the cushions for medical insoles by positioning over the print shape, by the mouse help. The programme data basis includes the shapes of the cushions used to make the medical insoles;
- printing of some history case clinical reports, referring to a patient, including data counted by the programme
- color printing of the plantar print and the foot bone structure, taken from the radiographies;
- printing of the best necessary forms to manufacture the medical insoles;
- the possibility of sending data in Html format

5. CONCLUSIONS

After the clinical tests made by partner P2: INRMFB and P3: ORTOTECH, resulted that by applying this method in hospitals, recovering clinics and companies specialized in orthopedics-medical insoles, the quality of the diagnosis process, treatment and monitoring of the foot specific deseases will be improved and also the population health status.

REFERENCES

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