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THE COMPARISON OF THE DYNAMIC TESTS RESULTS FROM SENSORY PLATFORMS

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Abstract: The article deals with dynamic plantography, which is a popular diagnostic method focused on assessment of the foot condition during walking and to expose foot disorders. The aim of the paper is to discover whether it's possible to do dynamic analyses on short platforms by using comparison of short and long sensory platform output. To get dynamic output were used ImportaMedica platforms, specific long platform Elegance and short platform Speed. Three subjects were involved in dynamic test on both platforms. The evaluated parameters were surface of the foot, maximum and average pressure, speed and gait line. By comparing these parameters the biggest difference was discovered in adapting walking because of the correct tread on short platform. When comparing the outputs from the long and short platforms, a longer duration of the right and left footsteps was recorded for all three subjects on the short platform.

1 Introduction

Dynamic plantography is a method of examining the plantar aspect of the foot using a pressure platform, a sensory treadmill or sensory insoles for shoes. This is a measurement of the pressure distribution under the sole of the foot, usually during walking. The measurement is performed in real time, while the values of the monitored parameters change. This method has its clinical application in fields such as orthopedics, rehabilitation, neurology, prosthetics and orthotics, but also in sports medicine and training.

At present, this method of examination is increasingly sought after and there are several sensory platforms on the market of various sizes and variations enabling dynamic analysis. Nowdays, even short platforms designed for static analysis of the sole of the foot are extended with the possibility of dynamic analysis. Since it is necessary to take a step in such an analysis and obtain a record of both feet, it is speculated whether short platforms are suitable for this type of measurement. The aim of the presented article is to compare the outputs obtained from the short and long platform and to find out their coherence.

2 Methodology

The measurement was performed in cooperation with Ing. Darina Kuštánová, MiopeD s.r.o. and Impronta Medica s.r.l.

The measurement was performed on a short Speed platform (resolution 4/16 sensors / cm², sensing area dimensions 400 x 550 mm, selectable collection frequency 5-600 Hz) and a long Elegance platform (resolution 4/16 sensors / cm², sensing area dimensions 1600 x 550 mm, optional collection frequency 5-400 Hz) from Improta Medica (Figure 1).

Figure 1 Elegance long platform (top) and Speed short platform (bottom)

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Sensor platforms and walk path must be placed in the middle of the room because of the sufficient space for movement in front of and behind them. It is advisable to align these platforms with the floor for more accurate measurement and to avoid the risk of the subject adapting his gait to step on the equipment instead of walking naturally. Therefore, the inactive part of the pavement should be made of a similar material as the active one.

Three healthy subjects were evaluated (Table 1) and the monitored parameters are foot area, speed, maximum and average pressure and rolling curve.

Table 1 Basic data of measured subjects

	Gender	High (cm)	Weight (kg)	Shoe size (cm)	Age
Subject 1	Female	165	50	24	23
Subject 2	Female	162	45	25	45
Subject 3	Male	174	64	28	41

For the relevance of the measurement, it is necessary that the measured subjects are informed of certain principles before performing the test. Getting enough sleep is especially important, which is at least 6-8 hours of sleep. Subjects should undergo the measurement rested and relaxed, so they should not perform any physically or mentally strenuous activities prior to the measurement. At the time of measurement, it is important to have suitable, comfortable clothing that does not limit the natural movement.

At the beginning of the measurement, the subject is informed about the measurement process. To achieve reliable results, it is necessary for the subject to get used to walking on platforms on a 5-minute walk. It is necessary to pay attention to the footprint of the entire foot on the sensor platform, therefore it is necessary to perform test experiments during the measurement, during which the track and its beginning are individually adjusted. The subject should not know where the active platform is located so as not to adapt his step cycle to the correct tread on the platform [1].

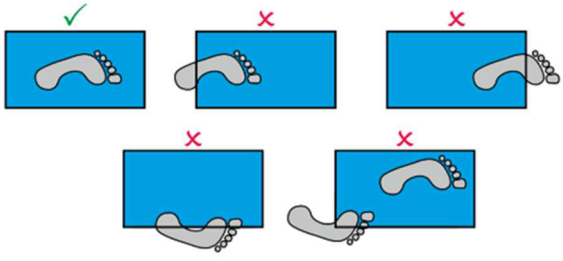

Figure 2 Examples of correct and incorrect foot position on the platform [1]

The posture of the subject should be with the hands moving freely along the body. Testing takes place during natural walking speed. The number of steps taken before the sole of the foot comes into contact with the platform is standardized, as research suggests that the number of steps performed before contact with the platform may affect the recorded pressure values [2].

If the measurement is performed on a short platform, the measurement must be performed for both feet so that the subject first performs the measurement with one foot stepped on the platform and then repeats the measurement with the other foot stepped on the platform. The subject must always step on the platform from the same side. This means that after performing the first measurement, it bypasses the platform and repeats the measurement in the same direction as the first.

3 Results

In all three cases, reports from the short and long platforms were evaluated, which contained the following monitored parameters.

3.1 Foot contact area

It is conditioned by the shape of the arch of the foot and full contact of the foot with the platform occurs in a normal foot only on the lateral tent of the sole. It can be determined as the area of active pressure points detected on the foot and is expressed in cm^2. Because of it, it is possible to determine the morphological changes of the feet, for example, flat feet. The size of the area should be similar for both feet, so the difference between the area of the left and right foot is also monitored, which indicates an uneven loading of the feet.

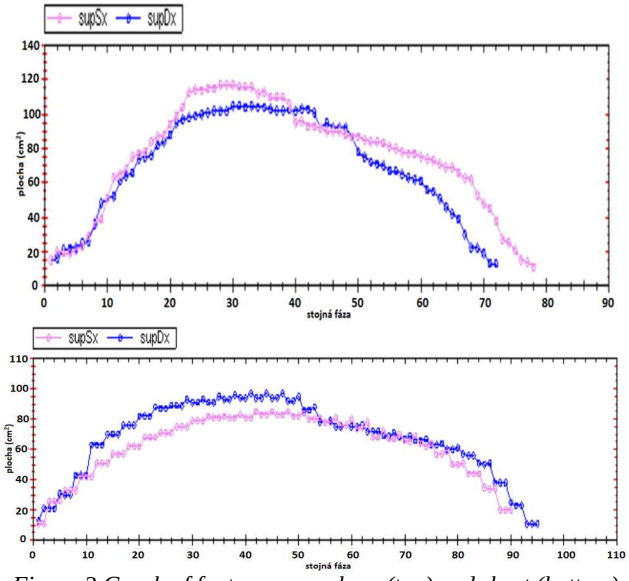

Figure 3 Graph of foot area on a long (top) and short (bottom) platform

3.2 Step velocity in the standing phase

A lower stride velocity is usually associated with the back of the foot, increases in the middle and then decreases in the front of the foot. As you lift your foot and move on to the next step, the velocity of the step increases again.

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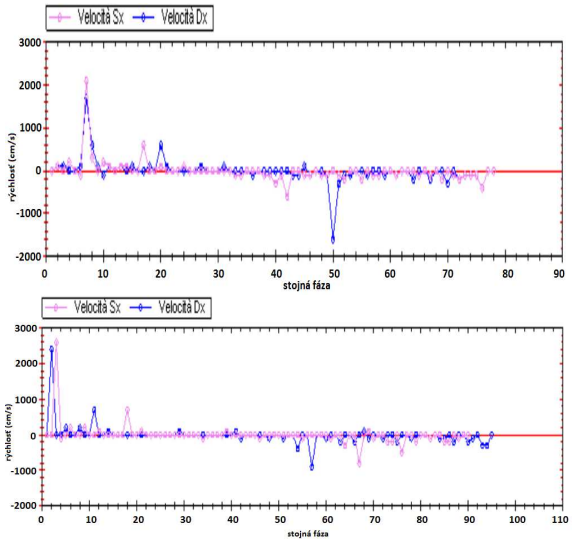

Figure 4 Graph of step velocity on a long (top) and short (bottom) platform

3.3 Maximum and average pressure

The pressure, its changes over time and its distribution in the measured area are among the basic parameters of dynamic plantography. These are directly measured parameters from which other parameters can be calculated. The maximum pressure corresponds to the value of the point with the measured maximum pressure in the sensing area. The average pressure is defined as the pressure value corresponding to the average pressure measured on the evaluated area. In the graphical display, the pressure values are displayed as a line of points of maximum load that were recorded during the dynamic analysis. The curve of this graph should rise at normal values in the middle part and slightly decrease at the end of the graph. The curve of the average pressure value shows the line of the recorded mean pressure.

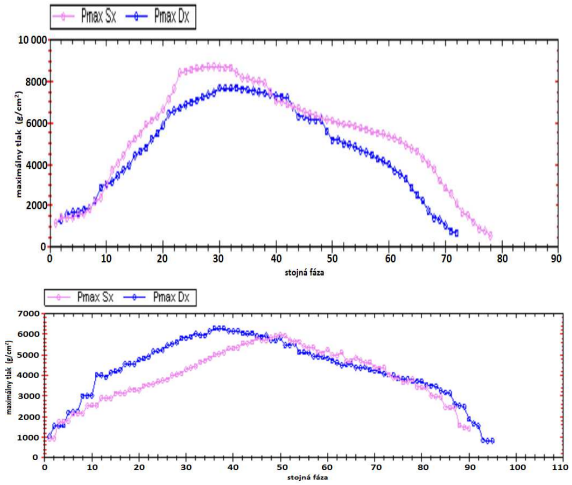

Figure 5 Graph of maximum pressure on a long (top) and short (bottom) platform

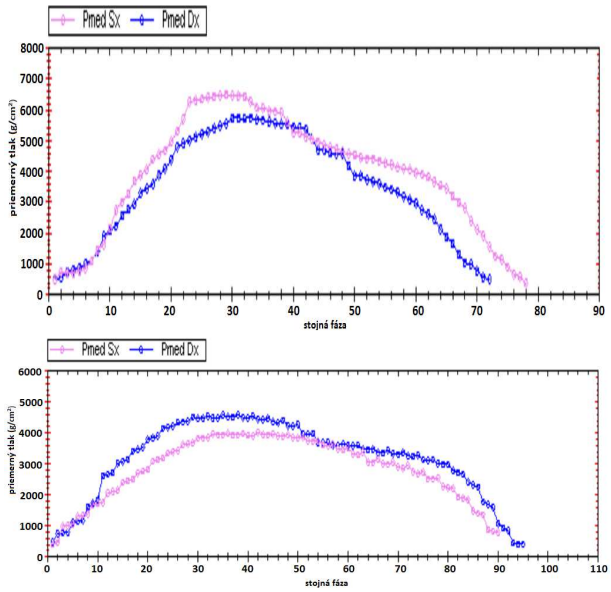

Figure 6 Graph of average pressure on a long (top) and short (bottom) platform

3.4 COP gait line

The center of pressure (COP) gait line is a visual expression of the part of gait during which the foot is in contact with the ground. It takes into account where all contact pressure points are and what their values are. It is represented by the aggregate of pressure dots which are plotted with respect to time and at a specific sample rate [3].

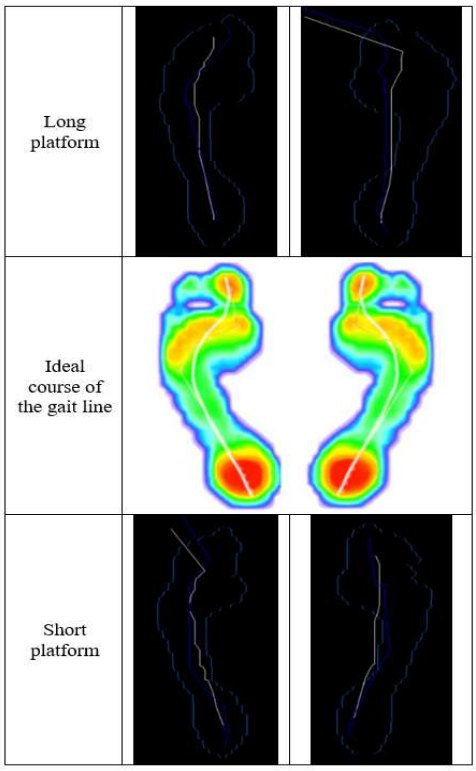

Figure 7 Recorded COP gait lines

The physiological COP gait line should be starting at the third of the rearfoot, continuing towards the 5th metatarsal, then proceeding centrally to the 4th metatarsus, then to the 3rd to 2nd metatarsi and ending at the toe of the foot, as it is the last in contact with platform.

4 Discussion

When comparing the outputs from the long and short platforms, a longer duration of the right and left footsteps was recorded for all three subjects on the short platform. The reason for this phenomenon may be the effort of the subjects to step on the platform and adapt their gait to this goal.

In the case of the 1st and 3rd subjects, a higher maximum pressure was measured on a long platform. This can cause faster walking during long platform measurements. From the comparison of the number of standing phase shots also in the case of the 2nd subject, the duration of the step of both feet on a long platform was shorter, which indicates a higher walking speed, which is associated with higher pressure on the sole of the foot. In this case, however, a higher maximum pressure was recorded on the short platform. The reason for this phenomenon may be that the curves of the maximum pressure graph are too irregular.

The short platform has significant limitations in dynamic analysis - it is not possible to evaluate basic walking parameters such as step length, step width, step cycle symmetry on the right and left side.

5 Conclusions

The aim of the presented study was to compare dynamic records obtained from 2 different sub-parametric devices. Specifically, from the long and short sensor platform, in order to verify the reality of the outputs obtained from the short sensor platform due to doubts about the possibility of correct dynamic analysis on devices designed primarily for static and stabilometric analysis.

The smallest difference between the long and short platform in the length of the step was in the 1st subject, on the contrary, the largest difference was in the 3rd subject.

A higher maximum pressure was measured on a long platform (1st and 3rd subjects).

By comparing the two platforms, higher values of the average pressure in all 3 cases were recorded on the long platform.

When comparing the rolling curves of the 1st subject, a greater instability of the foot was recorded when measuring on a short platform. Also, the end of the rolling curve of the left foot was recorded on the short platform already in the area of the 3rd metatarsal, while on the long platform the curve continued until the 2nd toe. On the plantogram from the long platform, all the fingers were clearly visible, while on the short platform the fingers are not so smoothly recorded. Also on a short platform, the pressure of the right foot is more concentrated on the heel, while on a long platform it is more in front of the foot.

In the case of both platforms, there is a similarity between the rolling curves of the 2nd subject, mainly in the back and middle part of the foot. On a long platform, the curves of both feet end more medially than in the case of a short platform. Similarly, an incorrect course of the rolling curve is recorded on both platforms. The curves obtained from the short platform have a slightly more non-linear shape, which means greater instability. Fingers are not recorded on the planks of the short platform except the thumb, while on the long platform the fingers are visible.

The 3rd subject had the smoothest course of rolling curves. Although even in this case their course differed slightly from the physiological course of the rolling curve of both platforms, there is considerable similarity between the curves from the long and short platform. Except for the thumb, the toes are only slightly present on the plantograms from both platforms.

After processing and comparing the parameters, it was found that the main shortcoming of the dynamic test on short platforms is the subject's effort to properly step on the platform, which has an impact on the natural course of walking subjects. This results in a slower gait, i.e., a longer standing phase duration and a higher recorded maximum pressure. Also, when measuring on a short platform, greater instability of the foot may occur.

Acknowledgement
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