PHYSIOLOGICAL POSTURAL STABILIZATION WITH RUGRAN PLANTAR IN ATHLETES

VINCENZO MONDA[1,§], VALENZANO ANNA[2,§], MARIA RUBERTO[3,§], INES VILLANO[1], VINCENZO RUSSO[4], MARCO LA MARRA[1], BIANCA PASTORE[1], CIBELLI GIUSEPPE[2], MONICA SALERNO[2], GISEPPE D. ALBANO[2], FRANCESCO SESSA[2], GABRIELLA MARSALA[5], ANTONIETTA MESSINA[1,*]

[1]Department of Experimental Medicine, Second University of Naples, Naples, Italy - [2]Department of Clinical and Experimental Medicine, University of Foggia, Foggia, Italy - [3]Department of Medical-Surgical and Dental Specialties Università degli Studi della Campania "Luigi Vanvitelli", Italy - [4]National Advisor FMSI, Via dei Campi Sportivi, Rome, Italy - [5]Struttura Complessa di Farmacia, Azienda Ospedaliero-Universitaria, Ospedali Riuniti di Foggia, Italy

§ Equal contribution

ABSTRACT

The foot is a complex structure with many articulations and multiple degrees of freedom that play an important role in static posture and dynamic activities. The evolutionary development of the arch of the foot was coincident with the greater demands placed on the foot as humans began to run. The movement and stability of the arch is controlled by intrinsic and extrinsic muscles.

The aim of the present study was to investigate if a medical device (plantar), called RUGRAN, can enhance muscle rehabilitation in pain syndromes muscle-tendon for the correction and stabilization postural. The static pedobarographic evaluation revealed significantly higher values in terms of forefoot peak pressure, total plantar force and total contact area in subject without RUGARN plantar, compared to subjects with RUGARN plantar. To the best of our knowledge this is the first study that analyzed the pedobarographic improvements in subjects with the RUGARN plantar. The static pedobarographic results observed while the subjects were standing revealed no difference of force distribution and contact area between forefoot and rearfoot and this finding did not support the hypothesis that the centre of the body shifts to forward because of excessive adipose tissue causing excessive forefoot loading.

Keywords*: Plantar, posture, foot, static pedobarographic.*

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Dynamic-Maturative Model

Posture can be defined as the position of the body in space at a given moment in time with the aim of maintaining the equilibrium in both dynamic and static conditions(49). It is a medical discipline which takes care of the scientific and clinical investigations of the position of the body and is associated with the psychic functions, biochemical and somatosensory individual with the purpose of maintaining and achieving the state of health(49). The ideal body posture, viewed from the frontal plane, considers that the right and left halves of the body are symmetrical, while from a side view, a plumb line should be anterior to the lateral malleolus and the knee joint, posterior to the hip joint, and extend through the bodies of the lumbar vertebrae, shoulder, and external auditory meatus. This ideal body posture is adopted as the standard international reference even if it is still a controversial issue(20, 29, 40).

Postural control is the capacity to control posture in order to maintain an upright stance during functional activities and to compensate for body perturbations, both external and internal, to prevent falls(59). A specific degree of muscle activation (i.e. the tone) is always maintained by the muscular system, and changes between tonic muscles antagonists allows the movement in order to combating and symmetrically balance the gravity force(16, 27, 55, 57). Therefore, the balance between active force induced by muscle tone and passive force induced by gravity, adjusted according to plan space and positions, determines the posture(6, 12, 14).

During dynamic activities, there is an important regulation of absorption and propulsion in which the intrinsic muscles of the foot play a key role. In the case of dysfunction of these muscles, to maintain dynamic foot control, there may be a greater demand for the remaining components within the foot core system, leading to a more rapid breakdown of these contributors and those proximal to the foot(8, 32). Almost all ethnic and age populations show foot problems. Among these problems, three types of foot deformation occur with higher prevalence: pes valgus, hallux valgus and pes cavus(3, 13, 58). Both pes cavus and pes valgus are correlated with problems in the medial longitudinal arch, while hallux valgus shows a metatarsophalangeal angle greater than 15°(33, 44).

Plantar and lower limbs alterations modify static and dynamic posture((53, 72), which can impact level cranial mandibular causing malocclusion and mandibular prognathism(7, 23, 25). Thanks to the use of orthotics, it is possible to apply appropriate corrective intervention that must determine postural correction with morphological restoration of balance and the stability of the body(4, 22), correct muscle stimulation with normalization of muscle contraction, improvement of venous and lymphatic return through stimulation of cutaneous pressoreceptors, muscle proprioception, joint proprioceptors deeper, autonomic receptors, and they must have good adaptability to all types of footwear(11, 18, 25).

Different platforms can be used to investigated postural attitude, such as force platform with the aim to evaluate sensitive receptors, weight, gait and stability, or baropodometric or dynamometric platform to analyze tonic postural system, either during static posture, either walking(19, 31, 62, 67).

These platforms devices can also be a useful tool to prevent postural disequilibrium, and to evaluate the efficacy of therapy usually employed in sports medicine(50, 54, 68). The aim of this study was to evaluate, in runners, the effects of using a plantar medical device, called RUGRAN, consisting of silver, gold, palladium, platinum, iridium, rhodium, osmium, ruthenium, and copper. In particular, our aim was to examine if these plantar can enhance muscle rehabilitation in pain syndromes muscle-tendon for the correction and stabilization postural, for the full use of body muscle strength in athletic performance and the reduction of pain caused by fatigue, stretching, muscle contracture, from asymmetries basin, by prolonged standing position and balance disorders of cervical origin.

Methods

A total of 60 healthy male volunteers were recruited for this study (age 23.5±2.01; height 170.1±4.4 cm; body weight 65.4±2.3 Kg). Subjects declare no history of injury or any postural or skeletal disorder that could affect normal posture or gait composed. All the participants were runners. They had the same shoe size (french 42), a right dominant leg, and a similar anthropometric profile. They were in good health, as defined by the absence of cardiovascular diseases, no history of endocrine disorders and they were not taking any medication.

The study was approved by the local Institutional Ethics Committee of the Second University of Naples. Possible risks and discomforts were supplied to the participants through both written and oral information. Participants were free to retire from the study at any time. All procedures conformed to the directives of the Declaration of Helsinki.

Pedobarographic evaluation

The pedobarographic assessment was performed by a Mini-Emed pedobarography device (Novel, Munich, Germany) that measures the static and dynamic sole pressure. The device consists of a Canon colour printer, monitor, pressure sensitive platform, remote control, power supply and connections between printer and platform as well as monitor and platform.

The device presents a pressure measurement (=assessment) platform with a general frame having the dimensions of 650*290*25 mm and a perceptive area having the dimensions of 360*180 mm. Three perceptive gauges are present on each cm^2. The exemplification speed of the device is 14 squares in one second, deposit interval is 20 squares, pressure interval is 2-127 N/cm^2, solubility is 1 N/cm2, accuracy rate depending on foot is 5%, heat gap is 15 C° to 40 C°, and connection power was 220/110 volt.

During the static measurements, the participants were asked some questions in order to attract their attention to other issues and to avoid directing of their body weight on a particular side. They were asked to look at a stable point on the wall at a distance of 3 meters from them to supply a balanced assessment, while standing up on the platform, step width interval was fixed as 8 cm.

For each foot, the evaluation was performed separately, and during static measurement, eight parameters were evaluated:

(1) forefoot plantar force percentage (%),
(2) rearfoot plantar force percentage (%),
(3) forefoot plantar contact area percentage (%),
(4) rearfoot plantar contact area percentage (%),
(5) forefoot peak pressure value (N/cm^2),
(6) rearfoot peak pressure value (N/cm^2),
(7) total plantar force (N),
(8) total contact area (cm^2). The evaluations of the eight different parameters were carried out on all subjects with and without the medical plantar device called RUGRAN (silver 20%, gold 20%, palladium 15%, platinum 17%, iridium 7%, rhodium 1%, osmium 9%, ruthenium 4%, copper 7%).

Statistical analysis

The R Project for Statistical Computing software (version 3.1.0) was used for statistical analyses. Means (M) and standard deviations (SD) were calculated for each of the analyzed variables. Statistical significance was set at $p<0.05$. The normal distribution of variables has been verified through the use of the Shapiro-Wilk test. T-test was used to assess differences between the posture without RUGARN and the posture with RUGARN plantar. To evaluate the postural stability and static pressure distribution, the measurements were performed in single-leg stance on both sides.

Results

The static pedobarographic evaluation revealed that there were no significant differences in plantar force percentage between subjects with and without the medical plantar device, both in forefoot plantar and in rearfoot plantar (Figure 1a). The same results were obtained from the statistical analysis of the percentage of the plantar contact area of the forefoot and the rearfoot (Figure 1b). On the other hand, compared to subjects with RUGARN plantar, in subject without RUGARN plantar, significantly higher values were revealed by the static pedobarographic evaluation in terms of forefoot peak pressure but not as far as it is concerned the rearfoot peak pressure (Figure 1c). The static pedobarographic evaluation revealed also significantly higher values for total plantar force (Figure 1d) and total contact area (Figure 1e) in subject without RUGARN plantar, compared to subjects with RUGARN plantar.

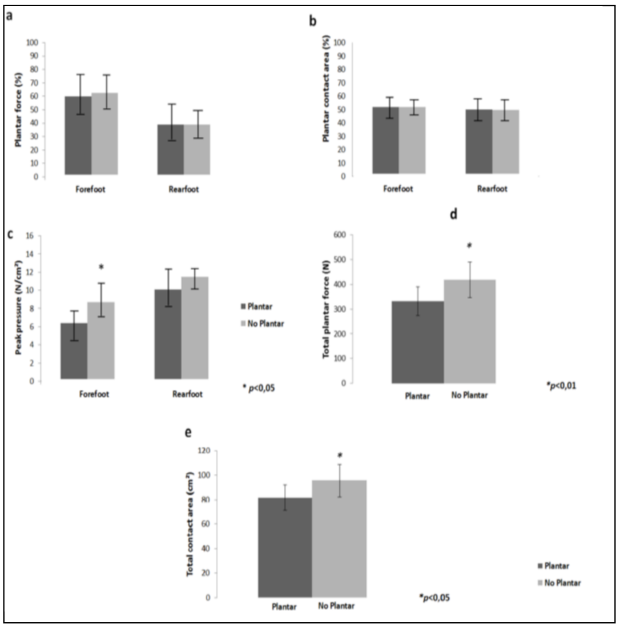

Figure 1: Comparison of static pedobarographic values of the different parameters.

Discussion

From our knowledge, this is the first study that had analyzed the pedobarographic changes in runner subjects with the use of RUGARN plantar. No difference of force distribution and contact area between forefoot and rearfoot was observed by the statistical pedobarographic evaluation while the subjects were standing. The hypothesis that body center shifts to forward in consequence of excessive adipose tissue which, in turn, causes excessive forefoot loading is not supported by these our results. Posturology is fundamental to recognize the anatomo-functional relationship between postural attitude and some pathological conditions otherwise difficult to recognize.

In the daily life of humans, the most important and basic requirements are to maintain an upright stance thanks to the ability of postural control. Postural control is able to compensate for external and internal body perturbations to prevent falls through the maintenance of a specific degree of muscle activation by the muscular system[16, 27, 34, 59].

Postural problems can arise when there is an incorrect relationship among different parts of body which produces an higher tension on retaining structure[49]. In posture control are involved sensory inputs, both visual and vestibular, as well as proprioceptive and tactile somatosensory inputs. These multisensory inputs are integrated to represent the body state (body schema); this is then utilized in the brain to generate the motion. Changes in the multisensory inputs result in postural alterations (fast dynamics), as well as long-term alterations in multisensory integration and posture control itself (slow dynamics)[15, 35, 37].

An efficient control through the nervous system is required for the mechanism of gait which involves the participation of virtually every part of the body. this control accounts for the reason for which is not possible to walk immediately after birth in humans. In fact, physiological gait is an extremely energy efficient form of locomotion, which means that any disturbance of its normal mechanisms is accompanied by enhanced energy costs and decreased muscle efficiency. These disturbances can often occur in athletes that are subjected to continuous trauma; consequently, they undergo a rehabilitation process to try to restore the normal mechanisms of physiological gait. Therefore, rehabilitation is carried out with the aim of finding and reducing the cause of the disturbance, reducing the limitation of the range of motion, control pain and come back to sport[49].

Thus when subjects in rehabilitation must learn to walk again, it is essential to conduct a thorough investigation of the existing movement abnormalities in the joints and the functional parameters of the various muscles and muscle groups[7, 9, 47]. For example, Massion et al. (2004) showed that the coordination between posture and movement are the results from two parallel controls[30, 41, 45]. They operate on multijoint motion units of the overall biomechanical system responsible for both the movement and its associated postural adjustment.

An example is ankle and hip eigenmovements during voluntary forward bending of the trunk. In this case, a critical aspect for the coordination of the two eigenmovements is their timing, which is a function of their respective inertias. When an incorrect relationship exists among different parts of body producing an higher tension on retaining structure, and body equilibrium is unpaired, postural problems may occur. Neurosensorial system, through vestibular, visual and proprioceptive mechanisms, contribute to a correct posture. Moreover, specific neurophysiologic mechanisms play an important role in maintaining a correct postural tone[10, 24, 60].

In our study, in subject without RUGARN plantar, compared to subjects with RUGARN plantar, we have found an increased in forefoot peak pressure but not as far as it is concerned the rearfoot peak pressure, during static measurement. A possible explanation of this can be due to a lower grade of obesity in our study population.

Our results have highlighted a higher total force and total contact area in subjects who did not wear the RUGARN plantar. This demonstrates that these subjects were exposed to higher loads. In fact, plantar pressure pattern can indicate the condition of the biomechanics of foot and ankle and runners or subjects with injuries in their lower extremities may benefit from the reduction in plantar loads[21]. Plantar pressure pattern is widely used for diagnosis of foot health problems[17, 39, 69]. Considering the high prevalence of the mentioned three kinds of foot deformities the human foot has two functions: weight-bearing and propulsion[11, 42, 43, 70]. The areas under the five metatarsal heads, hallux and calcaneus, are mainly load-bearing locations[36, 38, 46, 48, 71].

Consequentely, to analyze and compare plantar pressure patterns among foot types, are commonly used both the peak and mean pressure values, and the pressure time integrals and the force under these areas. The kinematic pattern of the normal movements that take place in all the joints involved in walking is similar in the sagittal plane in nearly all subjects. Inter-individual differences can be seen in kinematic analysis primarily in the frontal projection. During walking, muscle actions generate the forces that permit this movement. Muscles perform these actions by accelerating or retarding the movement of various body segments, taking into account also gravity, and momentum[72-80].

Any disturbance of this extraordinarily efficient mechanism for exploiting the force of momentum will cause a loss of energy efficiency in the gait. Therefore, when we are teaching patients to walk again, it is essential to restore the normal rhythm of gait, including the fluid movement of both lower and upper limbs. Furthermore, it is important to consider the critical role performed by the intrinsic muscles of the foot in the maintenance of the balance in both dynamic and static conditions and in the regulation of absorption and propulsion during dynamic activities.

In conclusion, considering the results of our study, the use of RUGARN plantar improves plantar pressure. Its use can reduce the risk to create disturbances to the efficient mechanism that allows our posture control and can be useful particularly in subjects, as runners, which are more frequently subjected to trauma.

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Corresponding author
ANTONIETTA MESSINA
E-mail: antonietta.messina@unicampania.it
(Italy)