

The Ks Brief Stimulator® role in postural alterations treatment: Clinical case reports

GIUSEPPE DI FABRIZIO¹ ✉, DAVIDE NEVA DI FABRIZIO², ANGELO ELISEO SBERNA³, FEDERICA MAUGERI⁴, OMAR GAETANO MARIA MINGRINO³, VINCENZO CRISTIAN FRANCAVILLA³

¹Voluntary researcher graduate in Physical Therapy, Enna, Italy

²Carlo Basilotta Hospital, Enna, Italy

³School of Engineering, Architecture, and Motor Sciences, Kore University of Enna, Enna, Italy

⁴Voluntary researcher graduated in Preventive and Adapted Motor Activity Sciences and Techniques, Caltanissetta, Italy

ABSTRACT

The aim of the study was to evaluate the modulations of the postural tonic system, observing the variations of plantar support. We worked on the restoration of the diaphragm function through respiratory gymnastics strategy that provides for the use of the KS Brief Stimulator® tool. For the study, 5 subjects between the ages of 10 and 27, male and female, were recruited, all with different postural alterations. The subjects underwent a preliminary baropodometric evaluation and then treated, on a monthly basis for a total of 5 months, with the KS brief Stimulator® technology and re-evaluated at the end of each treatment. Twice a week everyone carried out adapted physical activity protocols. At the end of each treatment the results of the baropodometric tests reported changes in terms of improvement of the pressure centre, showing a more congruous value than the concept of the centre of gravity and changes in the distribution of loads in both feet, in all subjects. Concluding, we could deduce the fundamental role of the diaphragm muscle in the global postural rebalancing and affirm that the application of the Ks brief Stimulator® technology, alongside the kinesiological work, represents the keystone for the restoration of the diaphragmatic function.

Keywords: Diaphragm; Posture; Baropodometry; Podalic Support.

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✉ **Corresponding author.** Voluntary researcher graduate in Physical Therapy, Enna, Italy.

E-mail: difa97@outlook.it

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INTRODUCTION

In healthy populations, disease prevention and health maintenance are achieved through the identification and control of risk factors and unhealthy habits that can lead to disease and disability, as well as the identification and control of environmental risk factors (Francavilla & Francavilla, 2013).

Considering postural alterations as an important risk factor for the development of acute and chronic pathologies of the musculoskeletal system, we decided to identify the role of diaphragmatic breathing in the treatment of these disorders.

The diaphragm, the main muscle involved in respiratory mechanics, assumes an important control function in the context of the tonic postural system.

In fact, its anatomical site places it in the centre of the myofascial chains. It performs from 60% to 80% of the ventilatory process (Aliverti et al, 1997).

It is the only organ that can be activated both autonomously and voluntarily, because it is regulated by both the autonomic nervous system and the central nervous system. It is the first muscle to be activated by the nervous system during an inspiratory effort (Saboisky et al, 2007).

This double peculiarity allows it to govern breathing and to assist digestion and circulation, if activated involuntarily; if activated consciously, it allows functions such as speech, equilibrium, static standing posture and interrupting the respiratory cycle (Soucard PE, 1995).

During inhalation in resting conditions, this muscle drops by about 1.5 cm; while during forced inspiration it flattens and can go down to 6-10 cm (Standring S, 2015).

The breathing muscles are continuously and simultaneously involved in the control of posture, movement, trunk stability, cranio-cervical regions and limbs. The reduction in strength and endurance of the respiratory muscles can affect many functional activities. Extreme changes in sitting posture, even in healthy people, in any of the three planes of space have a negative influence on the kinematics of breathing (Lee et al, 2010).

These respiratory muscles, like any other muscle in the body, can be strengthened, in particular the diaphragm for example, it can be made hypertrophied and stronger through resistance exercise (Souza et al, 2014).

The diaphragm has a direct anatomical connection with the vertebral column through its crural fibres, but in any case it does not have the ability to move the trunk voluntarily and through its contraction the displacement of the abdominal contents in the chest is minimized which increases spinal stability through the tension of the thoraco-lumbar belt (Kocjan J, 2018).

Kocjan J. (2018) tried to answer the doubts relating to the role played by the diaphragm muscle in maintaining static balance. Impaired diaphragm function manifested by decreased muscle thickness and limitation of movement was found to be strongly associated with balance disturbances in a clinical specimen and among healthy subjects.

A greater thickening of the diaphragm during active breathing was related to better parameters of static balance, on the contrary an atrophy or paralysis was attributable to balance disorders.

Several studies report that the diaphragm is involved in maintaining the stability of the spine, core and posture. The contraction of the diaphragm contributes to spinal stability by increasing intra-abdominal pressure regardless of the respiratory function. One study report that phrenic nerve stimulation causes an increase in intra-abdominal pressure which in turn increases stiffness at the L2-L4 level, without obvious ancillary activities of the abdominal and back muscles. Thanks to the increase in intra-abdominal pressure, it is believed that the diaphragm contributes to postural control (Hodges et al, 2005).

The diaphragm is the muscle that contributes most to the modulation of intra-abdominal pressure and plays an important role in spinal stability (Hodges et al, 1997).

In healthy subjects, the diaphragm is able to perform the dual task of stabilizing the trunk and breathing when the stability of the trunk is put to the test. The diaphragm contracts lowers and intra-abdominal pressure increases even before starting any movement of the body. This action occurs simultaneously with the activation of the transverse abdomen, as it has been found that the transverse muscle and the multifidus are constantly activated in advance in order to prepare the trunk for subsequent movements; in a shoulder flexion, the activation of the diaphragm precedes that of the deltoid by about 20 ms, simultaneously with that of the activation of the transverse. This contraction occurred regardless of the breathing phase (Hodges et al, 1997).

The central nervous system must therefore be able to anticipate movements and stabilize the entire muscle core automatically to ensure basic stability and give the muscles the ability to contract and perform the movement (Ebenbichler et al., 2001).

The stabilizing function of the diaphragm is based on the insertion of the muscle to the axial skeleton, its simultaneous ability to increase intra-abdominal pressure in conjunction with the activation of the pelvic and abdominal floor muscles (Hodges et al, 2001).

The activation of the crural fibres of the diaphragm also provides mechanical support to the upper and central regions of the lumbar spine; therefore, weakness or abnormal function of the diaphragm appears to be associated with pathomechanical aspects of low back pain (Kolar et al, 2012).

Any voluntary movement, due to the multilink structure of the human body in which one segment is connected to another, involves a postural perturbation, whereby each movement is accompanied by associated postural adjustments to compensate for these perturbations; during the execution of a gesture, the reacting forces are imposed on the spine to possibly manage or oppose the disturbances that the gesture could cause.

Janssens L. et al. (2015) analysed the effects of Inspiratory Musculature Training (IMT) on subjects suffering from non-specific low back pain (LBP), concluding that intense IMT induces an improvement in pain symptoms and an improvement in proprioceptive signals of the trunk during postural control.

Lee K. et al. (2019), based on a sample of 33 subjects with chronic Stroke outcomes, demonstrated that subjects undergoing respiratory muscle strengthening (RMT) associated with trunk stabilization exercises (TSE) developed better trunk stability, improved functions respiratory and respiratory muscles trophism compared to subjects subjected to simple TSE.

The establishment of a physiological and trained respiratory mechanics allows the diaphragm to work freely, a fundamental principle for successfully proceeding with a postural re-education.

Methodology

5 people were recruited for the study: 3 boys and 2 girls, aged between 11 and 26 years; 3 students, 1 amateur football player and 1 unemployed, with a weight which can vary from 45 kg to 85 kg and different postural alterations and all active on average.

People recruited for the study were subjected to static baropodometric tests before and after treatment, by using the baropodometric platform “*Physical Gait Software*”.

The static exam had an average of 10 seconds. The main parameters recorded by baropodometric platform were: pressures, surfaces, ground reaction force, mass of the subject, percentage of load on both feet and the front and rear load. The image obtained is given by the average of the data recorded during the acquisition period.

The treatment was carried out through the use of Ks Brief Stimulator®, a tool capable of specifically and lastingly recovering the physiology of diaphragmatic breathing, without overloading the musculoskeletal system or the cardiovascular system.

It is characterized by a base with rigid support on the ground, on which the subject is placed with bare feet. It is equipped with two anchoring systems: a series of inelastic but adjustable belts inserted in a linear and oblique way that move it on the chest and fix the shoulders to prevent the raising and antero-posterior expansion of the apical zone. A soft but strong band wraps around the waist, preventing the abdomen from moving forward.

The only structures that can respond to the expansive force of the air are ribs and the diaphragm, favouring their mobilization. Each person underwent the treatment, on a monthly basis, for the time ranging from 5 to 15 minutes. Prior to using the device, the subjects performed a walk on the proprioceptive pillow for the duration of 50 seconds.

The purpose of the walk on the pillow is to reset the pressoreceptors of the soles of the feet, that are necessary informers of the brain for the normal function of the muscle chains of the anti-gravity system which also includes the diaphragm.

For the duration of the study, the subjects underwent adopted physical activity protocols, distributed over two hours a week. Each session included awareness, mobilization, muscle rebalancing and self-stretching exercises. In particular the exercises are aimed at recruiting the same muscles used during the activity with Ks Brief Stimulator®.

CLINICAL CASE REPORTS

First clinical case

Gender: F.

Age: 10.

Objective evaluation shows the right lumbar scoliotic attitude, anteriorization of the body centre of gravity, reduction of the physiological dorsal kyphosis and increased physiological lumbar lordosis, elevation of the left half-pelvis and anterior rotation of the right half-pelvis with consequent false dysmetria of the lower limbs. The knee joint presents with increased physiological valgus, recurvatum and with bilaterally intrarotated kneecaps . Bilaterally valgus backfoot and bilaterally anatomical flat foot.

The study investigations, carried out for the subject in question, were in total four:

In the first T0 survey carried out, we can observe that the podalic load surface is clearly more present on the left forefoot assuming a value of 74%, respectively the right foot load surface corresponds to 26% (Figure 1).

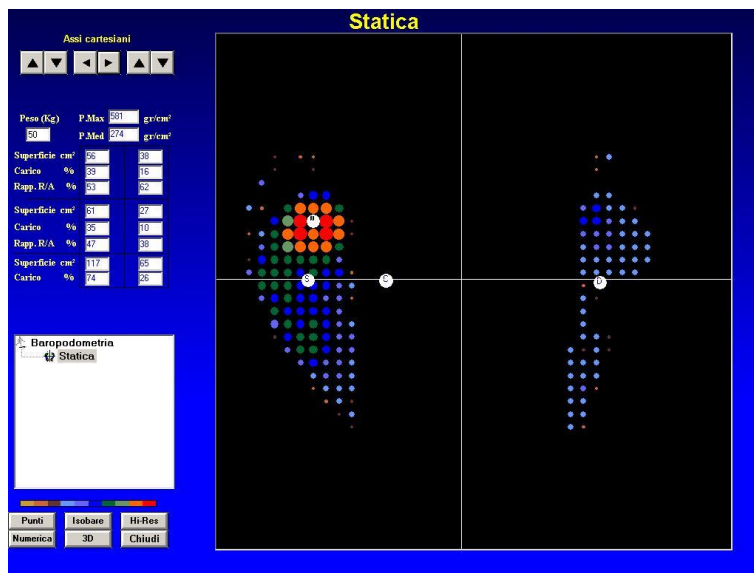


Figure 1. First clinical case - T0.

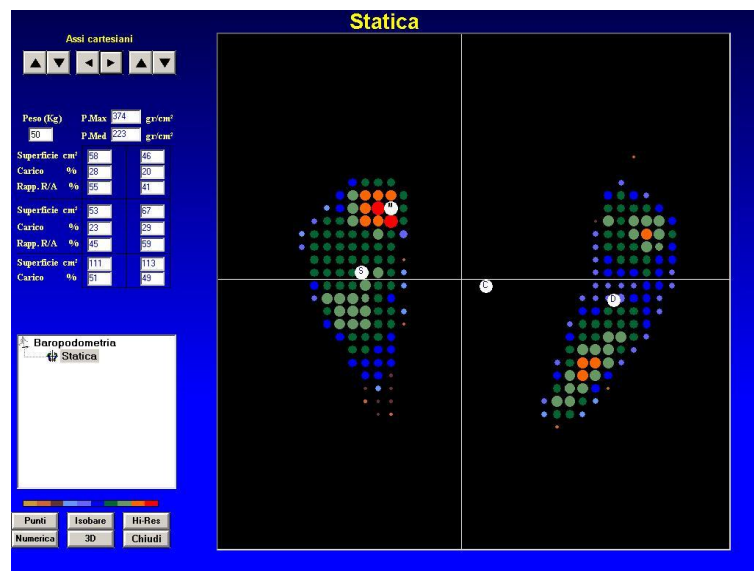


Figure 2. First clinical case - T1.

The second study survey took place 30 days apart. We proceeded with the application of the Ks Brief Stimulator® protocol for 5 minutes, followed by the baropodometric examination at the end of the treatment. In the second survey (T1) the podalic load tends to stabilize assuming the following values: 51% on the left foot versus 49% on the right foot and moving to the backfoot (Figure 2).

The third survey was carried out 30 days after T1. After the application of the Ks Brief Stimulator® protocol for the duration of 5 minutes, the data were acquired through a baropodometric examination.

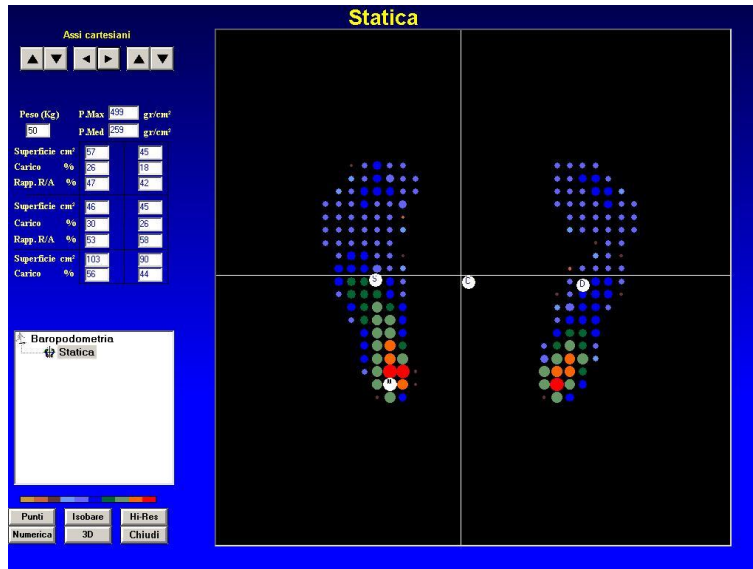


Figure 3. First clinical case – T2.

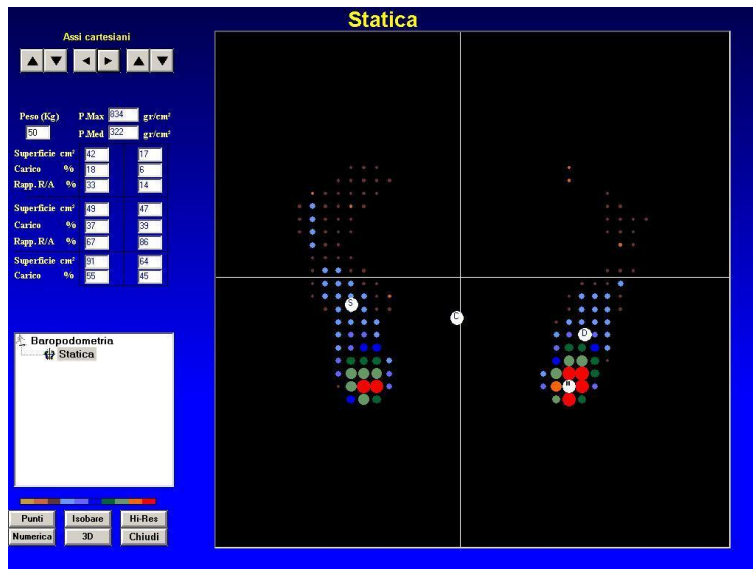


Figure 4. First clinical case - T3.

In the third survey (T2) the podalic load tends to remain stable assuming the following values: 56% on the left and 44% on the right, always on the backfoot (Figure 3).

The fourth and final survey was performed 30 days after T2 and 90 days after T0 measurement. The subject was treated for 15 min with Ks Brief stimulator ® and then a baropodometric examination.

In the fourth survey (T3) the podalic load changed definitively moving to the backfoot, assuming a value of 55% on the left foot and 45% on the right foot (Figure 4).

Second clinical case

Gender: F.

Age: 25.

There is an initial inversion in kyphosis of the physiological cervical lordosis and an increase in the physiological dorsal kyphosis. The left half-pelvis is anteriorly rotated and elevated with a misalignment between the femoral heads of about 8 mm. Knees recurvatum.

The study investigations, carried out for the subject in question, were in total four:

In the first survey T0 carried out we can observe that the podalic load surface is clearly more present on the left backfoot assuming a value of 52%, respectively the left foot load surface corresponds to 48% (Figure 5).

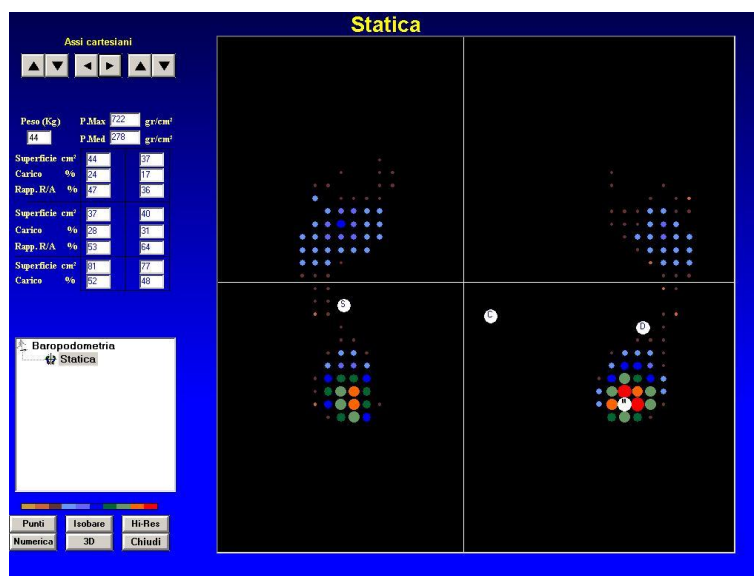


Figure 5. Second clinical case - T0.

The second study investigation was carried out 30 days after the T0 measurement. We proceeded with the application, for 5 minutes, of the Ks Brief Stimulator® protocol, followed by the baropodometric examination at the end of the treatment.

In the second survey (T1) the podalic load assumes the following values: 57% on the left foot versus 43% on the right foot, stabilizing the centre of gravity and shifting part of the load on the forefoot (Figure 6).

The third survey was carried out 30 days from T1. The Ks Brief Stimulator ® protocol was applied for a duration of 5 minutes and data acquisition through baropodometric examination.

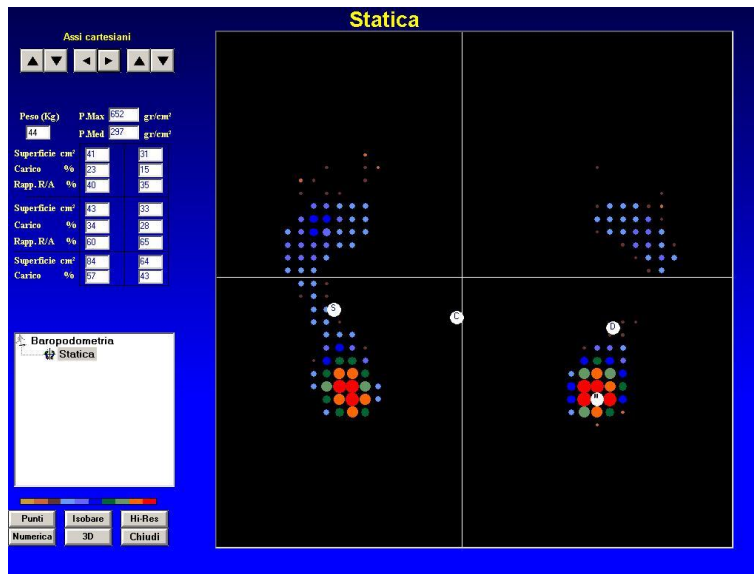


Figure 6. Second clinical case - T1.

In the third survey (T2) the podalic load tends to remain stable assuming the following values: 54% on the left foot versus 46% on the right foot, stabilizing the centre of gravity and shifting part of the load on the forefoot (Figure 7).

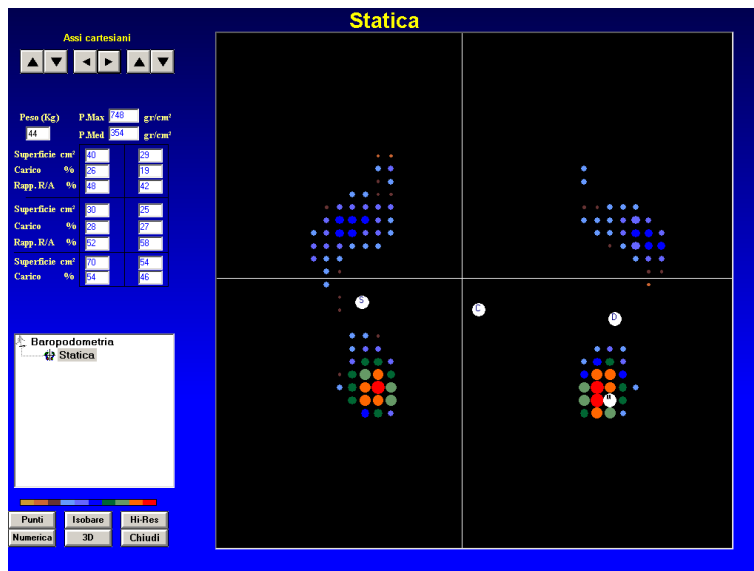


Figure 7. Second clinical case - T2.

The fourth and final survey was performed 30 days after T2 and 90 days after T0 measurement. The subject underwent treatment with Ks Brief Stimulator® for 15 minutes and then a baropodometric examination.

In the fourth survey (T3) the podalic load assumes the following values: 57% on the left foot versus 43% on the right foot, stabilizing the centre of gravity and moving even more part of the load on the forefoot (Figure 8).

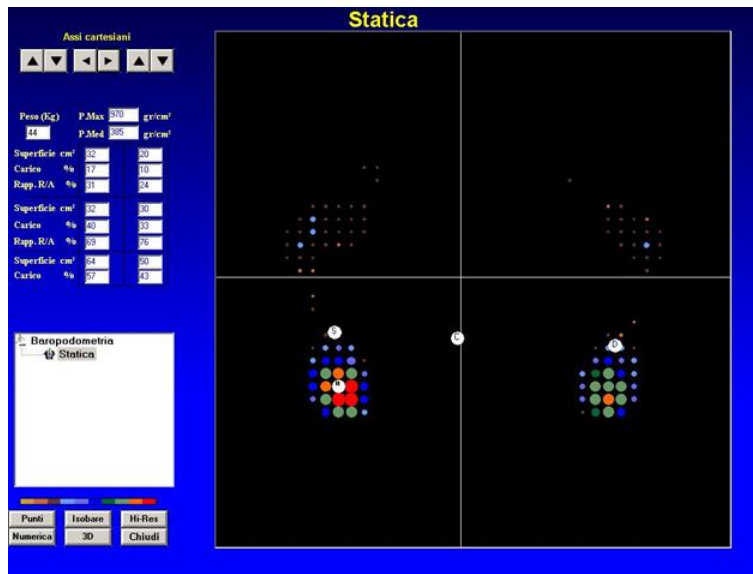


Figure 8. Second clinical case –T3.

Third clinical case

Gender: M.
Age: 26.

A scoliotic attitude is highlighted with an increase in the kyphotic curve.

The study investigations, carried out for the subject in question, were in total four:

In the first survey T0 carried out we can observe that the podalic load surface is clearly more present on the left backfoot assuming a value of 57%, respectively the right foot load surface corresponds to 43% (Figure 9).

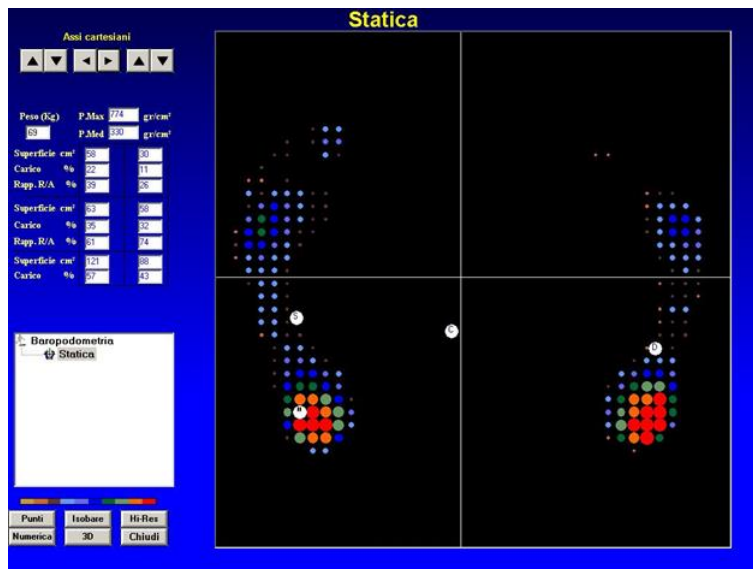


Figure 9. Third clinical case - T0.

The second study survey took place 30 days after the T0 measurement. We proceeded with the application, for 5 minutes, of the Ks Brief Stimulator® protocol, followed by the baropodometric examination at the end of the treatment.

In the second survey (T1) the podalic load assumes the following values: 55% on the left foot compared to 45% on the right foot, stabilizing the centre of gravity and shifting part of the load to the right backfoot (Figure 10).

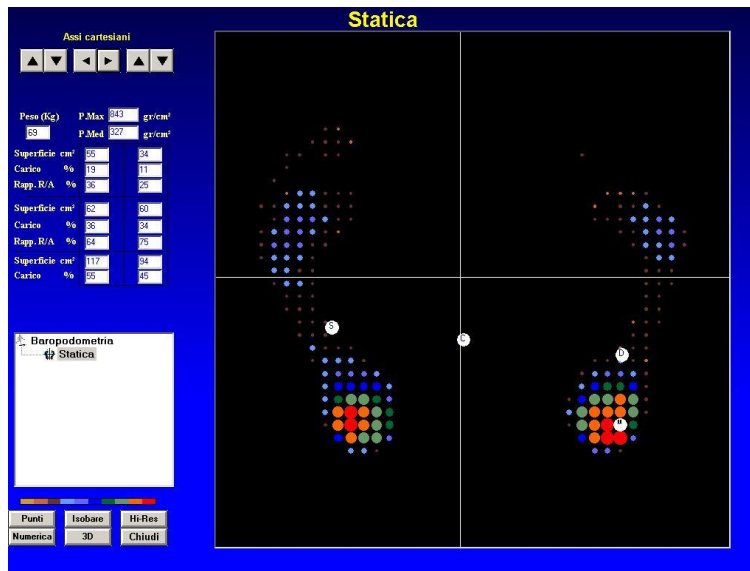


Figure 10. Third clinical case - T1.

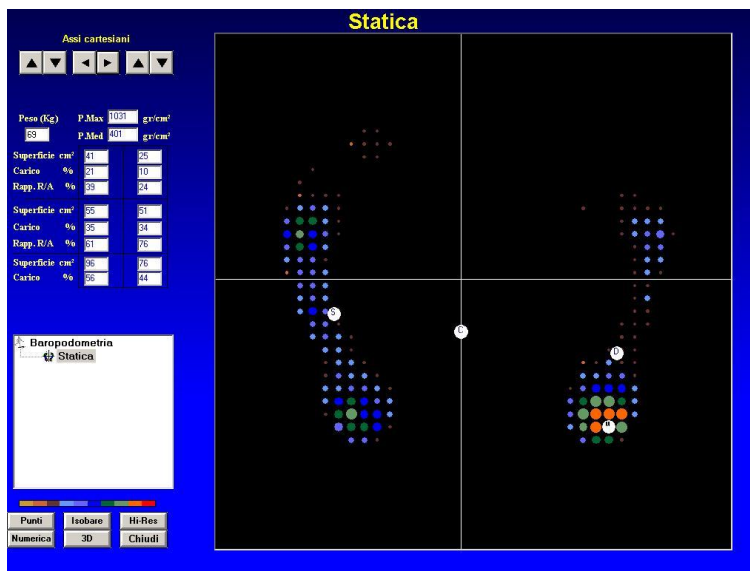


Figure 11. Third clinical case - T2.

The third survey was carried out 30 days after T1. Also, in this case the work was based on the application of the Ks Brief Stimulator® protocol for a duration of 5 minutes and data acquisition through a baropodometric examination.

In the third survey (T2) the podalic load tends to remain stable assuming the following values: 56% on the left foot and 44% on the right foot, also stabilizing part of the load on the forefoot (Figure 11).

The fourth and last survey was carried out 30 days after T2 and 90 days after T0 measurement; the subject underwent treatment with Ks Brief Stimulator® for 15 minutes and then a baropodometric examination.

In the fourth survey (T3) the breech load assumes the following values: 53% on the left foot versus 47% on the right foot, stabilizing the centre of gravity and moving even more part of the load on the forefoot (Figure 12).

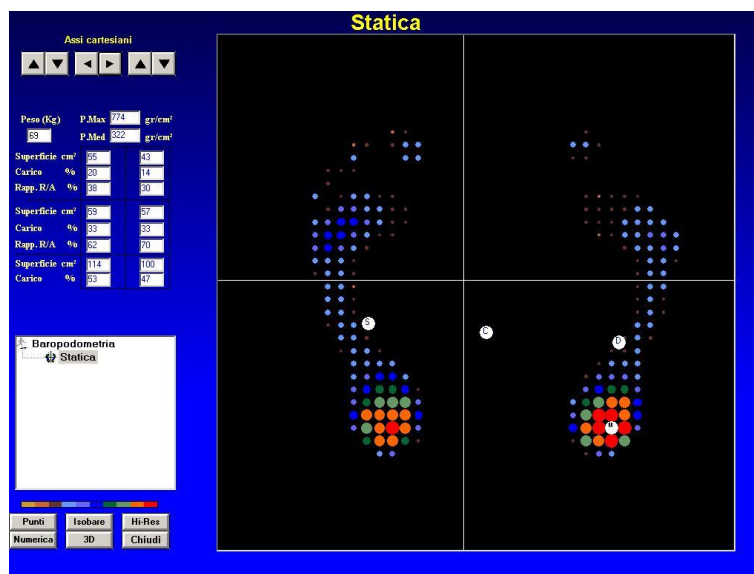


Figure 12. Third clinical case - T3.

Fourth clinical case

Gender: M.

Age: 17.

The subject has an increase in physiological dorsal kyphosis and a consequent slight increase in the lumbar lordotic curve.

The study investigations, carried out for the subject in question, were three in total:

In the first T0 survey carried out, we can observe that the podalic load surface is clearly more present on the left backfoot assuming a value of 65%, respectively the right foot load surface corresponds to 35% (Figure 13).

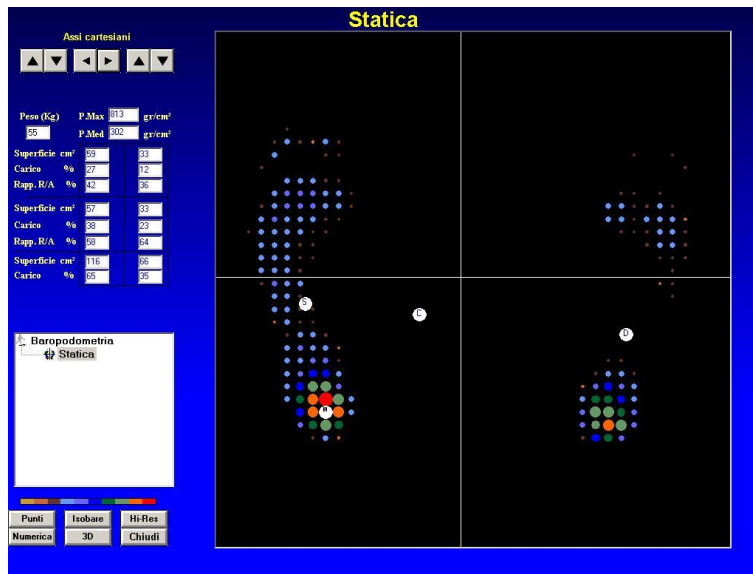


Figure 13. Fourth clinical case - T0.

The second study survey took place 30 days after the T0 measurement. We proceeded with the application, for 5 minutes, of the Ks Brief Stimulator® protocol, followed by the baropodometric examination at the end of the treatment.

In the second survey (T1) the podalic load tends to remain stable assuming the following values 64% on the left 36% with a slight change in the forefoot load (Figure 14).

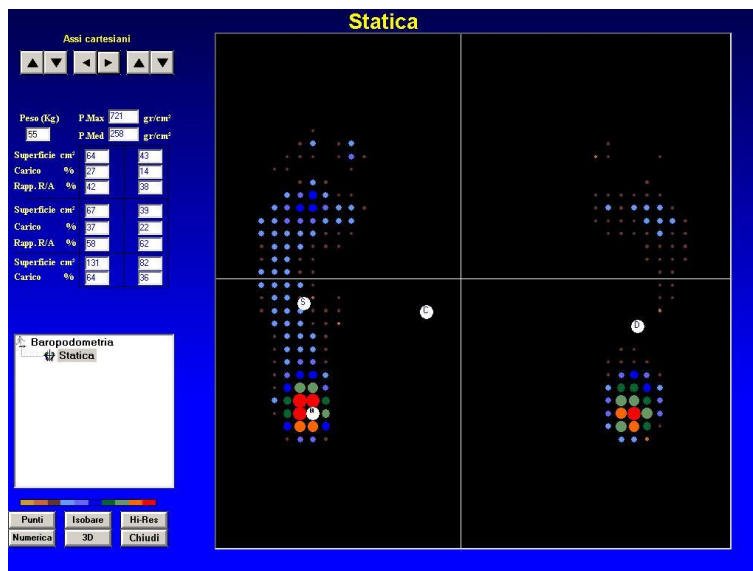


Figure 14. Fourth clinical case - T1.

The third and last survey was carried out 30 days after T1 and 60 days after T0 measurement. Also, in this case, the work was based on the administration of the Ks Brief Stimulator® protocol for a duration of 5 minutes and the acquisition of data through baropodometric examination.

In the third survey (T2) the podalic load tends to stabilize assuming the following values: 57% on the left foot versus 43% on the right foot, moving the point of maximum load to the right backfoot (Figure 15).

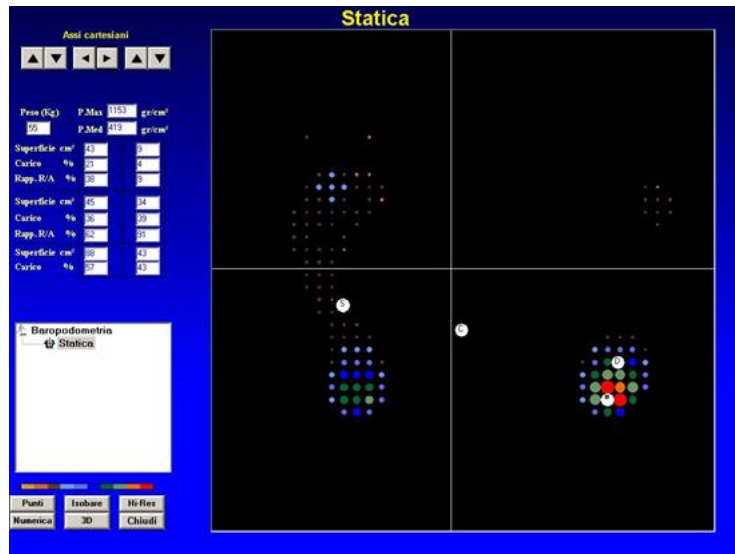


Figure 15. Fourth clinical case - T2.

Fifth clinical case

Gender: M.

Age: 14.

A bilateral gastrocnemius hypertonia and hamstring hypertonia with typical walking on the toes and difficult walking on the heels are highlighted.

The study investigations, carried out for the subject in question, were two:

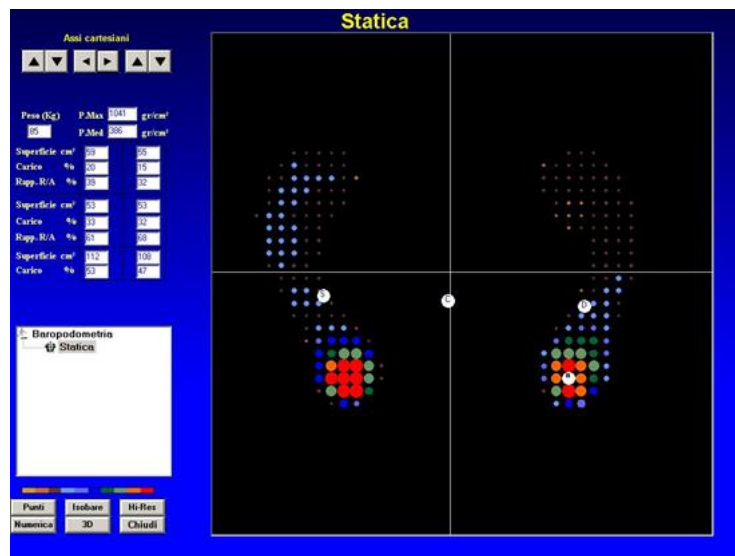


Figure 16. Fifth clinical case - T0.

In the first survey T0 carried out we can observe that the podalic load surface is clearly more present on the left backfoot assuming a value of 53%, respectively the right foot load surface corresponds to 47% (Figure 16).

The second study survey took place 30 days after the T0 measurement. We proceeded with the administration, for 5 minutes, of the Ks Brief Stimulator® protocol, followed by the baropodometric examination at the end of the treatment.

In the second survey (T1) the podalic load assumes the following values: 48% on the left foot compared to 52% on the right foot, stabilizing the centre of gravity (Figure 17).

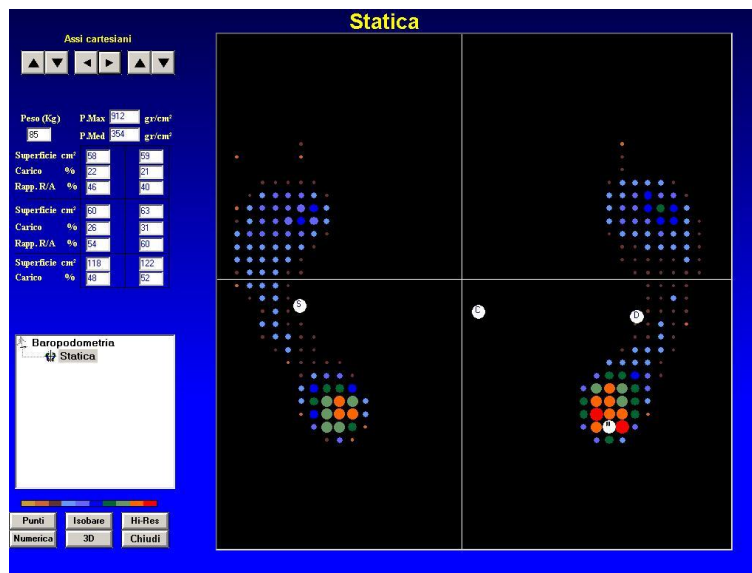


Figure 17. Fifth report case - T1.

CONCLUSION

At the end of this experimentation, based on the analysis and comparison of the data emerged, a notable improvement was found regarding the breech support in a static upright position, compared to the zero measurement data. In fact, a better weight distribution is denoted on both feet (1-19% variation in the support podalic surface), which leads to an approach of the centre of gravity to the origin of the Cartesian axes.

Shifting the focus on the distribution of loads on both feet in relation, it is observed that the difference between the examination carried out before the use of Ks Brief Stimulator® and the one after it consists essentially in the variation of the load zones.

In conclusion, this leads to confirm the hypothesis that affirms that the application of Ks Brief Stimulator® technology, as a means to induce a better Diaphragmatic mobility, together with specific protocols of personalizes postural gymnastics, represents the keystone in the treatment of postural alterations.

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