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RESEARCH ARTICLE

STUDY OF THE EVALUATION OF THE SPINE AND POSTURE WITH THE SPINAL MOUSE TO VERIFY ANY CHANGES INDUCED BY PHYSICAL EXERCISE PERFORMED WITH THE AELASTIC INSTRUMENT: A PILOT STUDY

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ABSTRACT

Background: The aeLASTIC training method is a functional training in orthostatic position. It was first described in 2016 as a mechanical application of the Lyapunov Stability (LME) law. The aeLASTIC tool allows working on muscle balance to improve postural balance. Aim of the Study: The application of aeLASTIC training can introduce a proprioception to maintain the body in a steady posture after using this training in a 20-minute workout twice a week for two weeks. **Methods:** This is a pilot study with 24 healthy students (18-25 years old of Perugia University Department of Medicine and Surgery- Sport Science, males and females) which were divided into two random groups (12 students each). Group A had been proposed a 20-minute aeLASTIC training workout twice a week for a period of two weeks. All the subjects were evaluated with a Spinal Mouse, which allows scientific respect for research: repetitiveness of the test, non-invasive, rapid execution, and immediate evaluation. The two evaluations were proposed at the beginning of the class and 45 days later. During the experiment, two measurements were examined during a Mathias test: one of the total segment in sagittal position; the other one of the lumbar segment, also in sagittal position. The data collected was compared between the two groups: group A, those who have exercised with the aeLASTIC training and group B, the control group. The data was gathered with a two-tailed Student's t-test. Variations were analyzed by paired Student's t-test. Statistical significance was accepted at a 0.05 level of probability. Data were analyzed by SPSS statistical software, version 22.0 (SPSS Inc., Chicago, IL, USA). **Results:** The comparative study of Group A (aeLASTIC training) and Group B (controls) showed a significant difference in the post test value in scores between the two at P=0.0001. There is an improvement in training in the total segment during the Mathias test. Also an improvement of the lumbar segment during the Mathias test between Group A and Group B was observed, showing an improvement in both groups. However, when comparing the data, a superior reduction of lumbar segment in Group A (aeLASTIC training) can be seen. **Conclusion:** 20 minutes of work with aeLASTIC training, twice a week for two weeks in orthostatic position, have a positive effect on the spine and posture and to activate the abdominal muscles.

INTRODUCTION

The comparison of the spine measured with the Spinal Mouse was used to verify the changes induced by exercising with aeLASTIC (Porzi, 2016) training. The activity with aeLASTIC by Silvia Porzi, is described as a mechanical application of the LME Lyapunov Stability law (Mehdizadeh, 2018). The aeLASTIC allows working on muscle balance to improve postural balance, by involving multiple physical abilities. Muscle involvement in this physical activity is complex: the involvement of multiple muscle groups simultaneously, including antagonists, results in a continuous activity of the central and peripheral nerve muscle proprioceptor system (Roll, 2002). Evaluating the influence on coordination and posture is the initial purpose of this study. Sequences of postural training in an orthostatic position are proposed in every part of the world. However, there are not any no scientific contributions to the effectiveness of these workouts to the posture.The potential relationship of proprioception is considered the right way to maintain the body in muscular activity. The aeLASTIC Method Application of aeLASTIC can introduce a body balance work (Haruyama,2017) to maintain the body in steady posture. By putting the body in an orthostatic position while applying the tool of the aeLASTIC

to the knee, ankle, pelvis and chest the proprioception is articulated. Proprioception is the kinesthetic awareness (Hasan, 1992) and sensitivity, responsible for detecting and responding in reference to position and reaction (Wise, 2002; Nithyanisha, 2020). Proprioception refers to the innate kinesthetic awareness of the body posture. When a person moves the joint, he/she acts forcefully while walking; proprioception can regulate posture or can automatically dictate accurate movement (König, 2019).

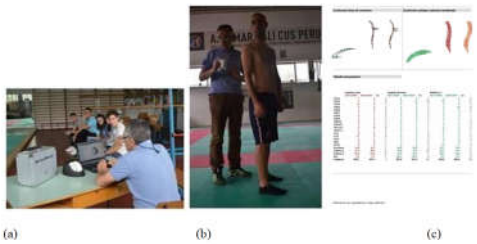
MATERIALS AND METHODS

24 healthy students were recruited (18-25 years old of Perugia University Department of Medicine and Surgery- Sport Science, males and females) and divided into two random groups (12 students each group); Group A aeLASTIC training and Group B controls. Both of the two groups get tested on the same day, with the Spinal Mouse (Ripani, 2008) during a Mathias test (Klee,1995). The total length of the spine was taken into account (TLS) in a standing position and the lumbar segment (LS) in an upright position and both of them got measured during the Mathias test. Group- A was training with the aeLASTIC tool for 20 minutes, 2 times a week for 2 weeks. Group B did not perform the training. Both the two groups were asked to come back after 45 days to perform the Spinal Mouse evaluation during a Mathias test. Regarding the group A students, the subjects were asked to do a sequence of exercises while wearing the aeLASTIC trainer. The sequence was described by the technical instructor to demonstrate the exercises to the subjects, that is how to practice using the aeLASTIC tool.

The sequence was: aeLASTIC protocol is ankle level, feet in line forefoot pushups for 30 sec and gait cycle exercises (Ignasiak, 2019) in sagittal plane alternative right and left in 2 minutes. Knee level squats for 30 sec and lunges alternating right and left in 2 minutes. Hip level, aeLASTIC in posterior position, front traction, feet in line forefoot pushups for 30 sec and gait cycle exercises in sagittal alternative right and left in 2 minutes. aeLASTIC in anterior position, rear push, feet in line forefoot pushups for 30 sec and gait cycle exercises in sagittal alternative right and left in 2 minutes. Chest level, aeLASTIC in posterior position, front traction, feet in line forefoot pushups for 30 sec and gait cycle exercises in sagittal alternative right and left in 2 minutes. A Total of 20 min training for 2 days for 2 weeks. After the training, we left the students and asked them to come back after 45 days to perform the SM test in total length of the spine (TLS) in a standing position and the lumbar segment (LS) in an upright position.

aeLASTIC Method paper: aeLASTIC is described as a mechanical application of the LME Lyapunov Stability law (Mehdizadeh, 2018; Liu, 2015), and it can be considered as a proprioceptive training Fig.1. The activity with aeLASTIC by Silvia Porzi, is described as a mechanical application of the LME Lyapunov Stability law (Mehdizadeh, 2018; Coscia, 2020) . The tool allows you to work on muscle balance to improve postural balance, by involving multiple physical abilities. Muscle involvement in this physical activity is complex, that is, it involves multiple muscle groups simultaneously including antagonists, resulting in the continuous activity of the central and peripheral nerve muscle proprioceptor system (Coscia, 2020). Evaluating the influence on coordination and posture is the initial purpose of this study.

Fig. 1. aeLASTIC training exercise



(a, Spinal Mouse evaluation system),
(b, Prof. Dott. Francesco Coscia during evaluation procedure)
(c, Spinal Mouse data analysis)

Fig. 2. Spinal Mouse program and test procedure

Sequences of postural training in an orthostatic position are proposed in every part of the world. We have no scientific contributions to the effectiveness of these workouts and the positive effects to the posture. Potential relationship of proprioception (Sumaya, 2019) is considered the right way to maintain the body in muscular activity. The aeLASTIC Method Application of aeLASTIC can introduce a body balance work to maintain the body in a steady posture. By standing in an orthostatic body position and by applying the tool to the knee, ankle, pelvis and chest we can articulate proprioception. Performing simple exercises with the aeLASTIC tool allows you to activate an anticipatory postural response (Xie, 2019; Kennefick, 2018). Shifting forward, the posterior postural chain is activated while keeping the projection of the center of the mass within the base support breech. Double closed kinetic-chain exercises (Irish, 2010) also allows to recruit many muscle fibers. The purpose of this tool is to create, in every exercise, a state of perturbation that will lead to the production of an active work on balance.(Xie, 2019).

The aeLASTIC tool allows you to work on muscle balance, performing isokinetic work in closed double kinetic chain. After placing a first part of the aeLASTIC band and a second one to guide the exercise, it has been proved the presence of a bigger muscle activity of the abdominals and the kinetic chains. In a standing posture, the aeLASTIC Method,

facilitates balancing on every plane, as posture requires. The research led to a progression of exercises that facilitate a postural active control. We apply the aeLASTIC tool in a sequence of foot balance in a standing position.

Evaluation system

The group is tested on the same day with a Spinal Mouse (SM) Fig.2. The SM is a non-invasive device that measures the curvatures of the vertebral column in the frontal and sagittal planes (Klee, 1995; Ripani, 2008). It can give detailed information about the positions of each vertebra, as well as their position relative to each other, without generating any medical risks or emitting radiation. The data obtained is transferred instantly to the computer, which connects to the device via Bluetooth. The obtained data can be easily interpreted by using the Spinal Mouse software. The measurements were taken with the SM in frontal planes and were repeated by the same doctor exactly two months later. In order to carry out the measurements in the frontal plane (Guermazi, 2006), the participants were asked to stand in a comfortable posture. The first measurement was completed by guiding the device at a constant speed over the spinous processes of the c7-s5, which were previously marked by the doctor. All measurements were recorded on a computer which had the SM software. The recorded data were analyzed using the SM program and angular deviations between each vertebra were determined in the frontal plane. Additionally, segmental results were also reported by the program software (total scores of lumbar regions during Mathias test) (Klee, 1995). To evaluate the abdominal activation that affects the upright posture, all measurements were taken into account with the total length of the spine (TLS) in a standing position with the Mathias test and the lumbar segment (LS) in an upright position with the Mathias test. We observed that the lumbar segment measurement were reduced due to the abdominal muscle activity.

Statistical Analysis:Data are expressed as mean ± SD. Statistical significance was accepted at a 0.05 level of probability. Data were analyzed by SPSS statistical software, version 22.0 (SPSS Inc., Chicago, IL, USA). Comparisons between groups were performed through the two-tailed Student's t-test. Variations were analyzed by paired Student's t-test.

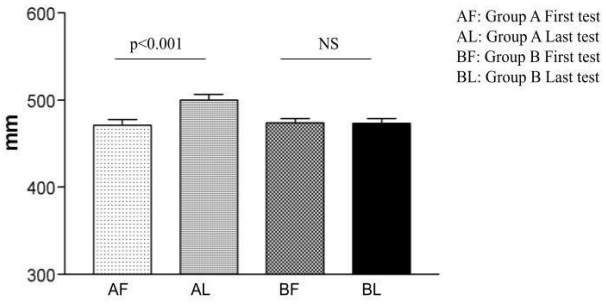
RESULTS

All subjects enrolled have been tested with the Spinal Mouse during a Mathias test. During the Mathis Test(p= 0.500), no significant differences were observed at baseline between Group A (aeLASTIC Training) and Group B (Controls) in the measurement of the spine in a standing position. The two groups were homogeneous for TLS. On the contrary, a statistically significant difference was found in lumbar segment (LS) in an upright position with the Mathias test (p=0.000). Group B (Controls) showed a smaller lumbar segment (-25.18 mm) in an upright position with the Mathias test, these value corresponding to the casual reduction of lumbar segment. For Group A, the comparison value of TLS before (470.76 mm ± 22.49 mm) and after 45 days (499.69 mm ± 24.18 mm) shows a significant difference p=0.00145. No significant difference was detected between the value of TLS before (473.57 mm ± 16.77 mm) and after 45 days (473.08 mm ± 18.45 mm) for Group B(Controls).

Table 1. Media value of thetotal length measure of the spine in a standing position with the Mathias test before and after the intervention between Group-A (aeLASTIC training) and Group-B (group of control)

Experience	First test		Last test			
	MEAN	S.D.	MEAN	S.D.	df	p
Group A	470.76	22,49	499.69	21.18	11	<0.001
Group B	473.57	16.77	473.08	18.45	11	n.s

The above table reveals the mean, standard deviation (S.D.), p-value of the Spinal Mouse test score between the First test and the Last test within Group-A, aeLASTIC training intervention and Group-B, group of control. There is a statistically high significant difference between the First test and Last test value within Group-A



Graph 1. Means TLS before and after test between Group-A ae LASTIC training and Group, B group of control

Table 1 A very interesting data is that relating to the LS. In both groups,there is a statistically significant variation of the LS parameter, but while in Group A the variation shows an improvement, in Group B it shows a notable worsening. For Group A, the comparison value of LS before (-33.04 mm ± 3.96 mm) and after 45 days (-31.90 mm ± 3.74 mm) shows a significant difference p< 0.001. For Group B, the comparison of the value of LS before (-25.18 mm ± 3.7 mm) and after 45 days (-30.00 mm ± 5.31 mm) shows a significant difference p< 0.001. Table 2. The worsening of LS in Group B is probably attributable to the inactivity of the subjects/loss of abdominal activation.

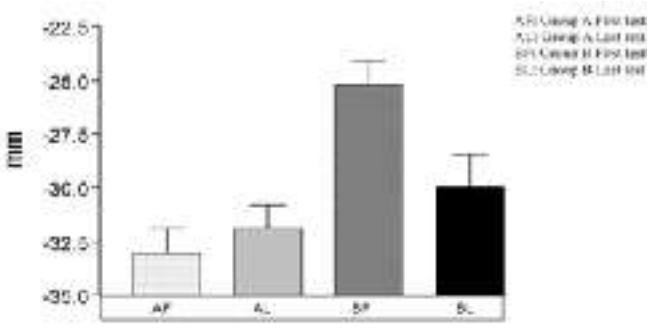
Table 2. Media value measure of the lumbar segment in a standing position with the Mathias test before and after the intervention between Group-A (aeLASTIC) training and Group-B (group of control)

Experience	First test		Last test			
	MEAN	S.D.	MEAN	S.D.	df	p
Group A	-33.04	3.96	-31.90	3.74	11	<0.001
Group B	-25.18	3.72	-30.00	5.31	11	<0.001

The above table reveals the mean, standard deviation (S.D.), p-value of the Spinal Mouse test score between the First test and the Last test within Group-A, aeLASTIC training intervention and Group-B, group of control. Both groups show a positive increase in the Last test, but the one who has the lower value is more effective than Group-A. There is a statistically high significant difference between the First test and the Last test value within Group-A

DISCUSSION

The aeLASTIC training method as a mechanical application of the Lyapunov Stability LME (Haruyama, 2017;Mehdizadeh, 2018; Liu, 2015). The aeLASTIC tool allows you to work on muscle balance performing isokinetic work in closed double kinetic chain, to improve postural balance and can introduce a proprioception to maintain the body in a steady posture.



Graph 2. Means LS value before and after test between Group-A aeLASTIC training and Group, B group of control

There is no literature on the use of the aeLASTIC instrument in a long-lasting proprioceptive training. This is the first time that the aeLASTIC has been observed for its efficacy in a study. The results with this type of measurement show that 20 minute of aeLASTIC training program of two days a week for two weeks can induce a significant increase in TLS (Graph 1) and can induce a significant decrease in LS (Graph 2), confirming the abdominal activation. In the first pilot study is observed how a few training sessions with the aeLASTIC tool induced positive effects in the postural attitude of the subject with long-lasting postural changes and it can be useful to reduce negative influenced seated position of students. Further studies are needed.

CONCLUSION

This preliminary study was conducted to compare the effect of aeLASTIC training in subjects of University age regarding the positive changes for posture. The measurement we have performed is extremely useful to see the positive effects of the aeLASTIC instrument's action. In conclusion, after observing the results and path of the two groups, is apparent that Group A has kept and improved the abdominal activation while using the aeLASTIC during a 45 days of experimentation while, comparing it to the control group, it can be observed that the subjects had lost the state of abdominal activation which could be associated with a prolonged sitting position. The goal is to check if with a few training sessions with the aeLASTIC tool, it can introduce positive effects in the postural attitude of the subject with long-lasting postural changes. The training workout with the aeLASTIC tool, which has to be done for 20 minutes twice a week for two weeks, in an orthostatic position, makes a significant postural modification in a postural way, in just a few lessons. That is why we want to mention this procedure for the COVID-19 rehabilitation too. (Sengupta, 2020). Makes an activation of the abdominal muscles and a positive effect on the spine and posture. (Maffey-Ward, 1996; Lamoth, 2012). The result of this experiment is extremely promising but it has to be checked further with future studies, which will have a bigger number of subjects and will last for a longer period of time. The aeLASTIC training, already well used during the lock down, could be very useful both for inflammatory muscular injuries, both for muscular injuries related with the neurological localisation of COVID-19.(Sengupta, 2020).

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