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Influence of Postural Training of Diaphragm on Functional Lung Capacity

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Abstract

Breathing is one of the basic life functions. High demands are placed on the respiratory system when increased value of power for example in sport. The main inspiratory muscle is the diaphragm, which performs this function in addition to other functions, mainly postural and sphincter. The aim of this study was to assess the effect on functional capacity of the lung after postural therapy. Trial involved 35 male elite athletes, 25 of which formed the experimental group and 10 was control group. Input and output measurements were identical and methodically divided into two main areas. Postural tests reported in the literature by prof. Kolar and spirometric test. The tests were carried out under constant conditions, and in the same time. The experimental group received postural training lasting six weeks. Comparing the results after completing postural training, we observed differences in postural execution like in spirometry tests in favor of the experimental group. Based on the results of our studies we suggest that postural training of diaphragm have a positive effect on the functional capacity of the lungs. Changes were not statistically significant at all endpoints. This may be caused by tested of elite athletes compared with the possible outcome of the general population. Individuality subjects and their psychosocial conditions during testing could also influence the outcome in a positive or negative direction.

Keywords: Diaphragm; Posture; Breathing; Postural training; Functional lungs volume

Introduction

Breathing is provided by skeletal muscles, but it is only partially influenced by the unwanted process. From a kinesiological point of view, it is cyclic, which consists of an active part, an inspiration and a predominantly passive part at expiration. The breathing cycle is controlled by the respiratory centers in the CNS, these respiratory neurons responsible for breathing control are located in the area of the brain stem. These neurons can be divided into less important exponential motoneurons, and more significant insulin motoneurons. Inspiratory motoneurons are more important in this regard, as they are much larger, more multi-faceted, and act as peacekeepers with spontaneous activity, as well as the removal of external stimuli similar to heart nodes. Breathing is considered to be the primary function of the diaphragm. It is estimated that the diaphragm contributes up to two-thirds. Recent studies confirm the diaphragm significantly also participates in postural activity. In the world literature, we mainly meet this topic in the contributions of the physiological society. Thus, the diaphragm has more features, of which the most are currently known as respiratory, postural and sphincter function. The diaphragm is the main inspiratory muscle as coincide by the authors [1-4]. The ratio of her work is about 60% compared to other muscles [5]. In the inspiration the diaphragm contracts and moves downwards. Expiration returns upwards. The range of movement of the diaphragm in the resting breath is about 1.5 cm, which is approximately 350 ml. It can be in the range of 6-10 cm during deep breathing. With the activity of the breathing muscles, the negativity of the interpleural pressure increases. This moment causes the forces of the chest to expand and the retraction force of the lungs not to be in equilibrium, and there is a negative pressure in the lungs relative to the external atmospheric pressure. The air is thus sucked in the direction of the pressure gradient into the lungs. So the inspiration is always active. When reducing the activity of the breathing muscles, the opposite gradient occurs and causes passive exhalation [5,6]. Bitnar [7], however, states that inspiration and expiration are dynamic actions in which breathing and exhaling muscles work in agonist-antagonistic cooperation. The diaphragm is essential for the stabilization of the spine by maintaining the abdominal pressure. The tonic function of the diaphragm has been demonstrated experimentally. The breathing and stabilizing function must be synchronized. An important aspect is the force dimension. High postural demands can occur up to the apnea pause, when the diaphragm is fully active in postural function [8]. It has also been shown that there is an abnormal position of the diaphragm in people with pathogenic lumbar spine during postural more difficult positions. Kolar tested 19 patients with chronic back pain with the result [9]. Another study by the authors proves that the diaphragm is not just a breathing muscle, it is also activated independently of breathing. MRI and EMG results have demonstrated this activation, which supports the theory that the motor activity of the frenic nerve is linked to more than just the respiratory function of the diaphragm [10]. The function of the diaphragm as an outer esophageal sphincter resonates in professional circles at present times. The function of the esophageal animal confirms the results of a study published in Desease of Esophagus in a group of 38 patients suffering from gastro-esophageal reflux [11]. The relationship of the diaphragm and the gastrointestinal tract is a bi-directional system. As Bitnar states, in case of reflux and therefore irritation of the lower part of the esophagus, the voltage of the diaphragm and the destabilization of the TH / L transition always occur. The diaphragm irritation also occurs at the stomach and intestinal tensions. On the contrary, good diaphragmatic function supports bowel motility [4,7].

The main objective of this study is to find out the extent to which the functional capacity of the lungs could be affected by postural therapy of diaphragm.

Materials and Methods

The study was attended by 35 top athletes, all of whom were male. From a 35-member group of athletes, we ranked 25 as an experimental group and 10 were used as control subjects. The mean age in the group was 23.60 ± 3.47 and average BMI was 24.31 ± 2.86. For more detailed information about groups, see the Table 1. Minimum of age between participants was 19 and maximum was 30 years.

Group	Age (years)		Height (cm)		Weight (kg)		BMI (kg/m^2)	
	AVG	SD	AVG	SD	AVG	SD	AVG	SD
Experimental group (n=25)	23.84	3.78	177.96	8.09	76.86	12.53	24.17	2.79
Control group (n=10)	23	2.83	180.95	3.95	81.4	12.82	24.67	3.27
Whole (n=35)	23.60	3.47	178.81	7.12	78.16	12.42	24.31	2.86

Table 1: Characteristics of the research file.

All probands were active athletes with intensive training of at least 3 years. The reason for the selection of athletes is the fact that they are subject to higher requirements in terms of postural activity as well as the function of the respiratory system compared to common population. At the beginning of the survey, we identified the subjects with our thoughts and introduced them into the issues of the course and methods of the study. We presented them with the benefits they can get after training in the training process, respectively at the very top performance on the races. Examinations were performed in the gym throughout the day. The subjects were spirometrically examined on Oxycon Pro device. It is an ergo-spirometry device that includes a pneumotorograph. Oxycon Pro analyzes the exhaust gases using a sensitive paramagnetic O_2 analyzer and infrared CO_2 analyzer. It has a fully automatic calibration system for gas analysis, a fully automatic calibration system for flow and volume, ventilation measurement is via a two-way digital sensor that connects directly to the mouth, the dead space is less than 30 ml. Testing was performed under laboratory, stable conditions at temperature 24.5°C and 89% humidity. Preparation of the device was performed in the same way before the tests, including calibration, before each test set. By spirometry examination, we measured the dynamic lung parameters. We chose basic dynamic parameters, which are also the most frequently measured parameters used in various studies. Based on these parameters, we were focused on the evaluation of FVC (l)- Effective vital capacity, FEV_1 (l) - Volume of vigorous exhalation per second, FVC/FEV_1 (%)-Percent vital fat capacity, PEF (l/s) MMEF 75/25 (l)- Median expense flow rate. Further probands have undergone a clinical examination through a series of special, standardized tests for postural stabilization and postural reactivity testing, including diaphragm examination and function. We used flexion and hip extension tests, hip extension test, abdominal pressure bench test, diaphragm test, upper limb upper limb test, hip joint flexion test. We've commissioned one person to investigate the test to minimize the difference in measurement. We intervened in a similar way in all subjects. Everyone was asked to practice at least three times a day and to practice at least three times a week under our supervision. At the beginning, all of them were tested by a series of postural stabilization and reactivity tests. We also used these tests as a therapeutic intervention, especially the first and second weeks. Later, we added dynamic elements to these tests, plus we chose postural and heavier locations and other positions from the developmental kinesiology of an individual to one year of life. For each subject, we tried to work in an individual way because everyone went on therapy at a different rate. It was reflective, especially with the developmental positions in the exercises, that is, their postural intensity. It also affected the number of joint exercises per week, where we endeavored to have three to four exercises per week for each subject, which was approximately 30 to 60 minutes. After such a 6-week intervention, we performed a control test of all parameters. This included spirometric and postural testing. For the statistical evaluation, we have chosen the level α=0.5, and for the statistically significant we considered the result satisfying the condition $p<\alpha$.

Results

When comparing the results of postural tests, we noticed significant changes in the quality of their performance in the experimental group. When training postural stability by positions that were in some cases identical to test positions, this is the expected result. The effect also confirms minor changes in the comparison of input and output tests for the control group.

In spirometry investigations, we have seen the following results. The measured values showed that the values measured as the statistically significant ventilation parameters FVC, FEV_1, PEF and MMEF 25-75 in the experimental group and FVC, FEV_1, FEV_1/ FVC, PEF in the control group were shown. The detailed results are shown in the Table 2. In the main monitored parameters, we noticed a more significant difference in the experimental group. Paradoxically, the better FEV_1/FCV ratio was in the control group. The differences in average values are shown in Figure 1.

Discussion

The diaphragm as part of the dorsal spine stabilization system plays an important role in regulating intraabdominal pressure. However, it must also perform a respiratory function at the same time. The diaphragm is a cross-striped muscle and as such undergoes fatigue at an excessive load, which has an impact on the performance of its functions in both qualitative and quantitative dimensions. The postural and respiratory function of the diaphragm is evidenced by the aforementioned studies [9,10]. One of the most recent studies shows the positive effect of diaphragm stretching on breathing parameters, mainly FVC and FEV [12]. Hellebrand [13] points to the interplay of respiratory and postural functions in a set of patients with obstructive respiratory disease pathogenesis. Physiotherapeutic intervention lasted for 4 months. In our study we looked at healthy individuals and the intervention lasted only 6 weeks, which would still have been enough time to bring about the desired change. Based on our results, we can say that there has been a positive change in postural function in the experimental file. We recorded a positive change to 5% level of significance in respiratory parameters as well. In contrast to postural functions, significant improvement in respiratory parameters and probands in the control group also occurred. Improvement of breathing parameters was less than in the experimental group although not significant. Based on the fact that the set was made up of top athletes, it was not possible to ensure conditions to exclude all factors that could have affected the result. Athletes at this professional level are constantly undergoing some form of preparation. At the time of testing, the same forms of preparation were performed in the experimental and control groups, which represents similar conditions for both groups. The relationship between breathing and postural function is, of course, two-sided, as Vetkas's [14] study shows that the reverse procedure is possible and thus influence postural functions by training breathing exercises.

Parametres	FVC(l)		FEV_1 (l)		FEV_1/FVC (%)		PEF (l/s)		MMEF 75/25(l)	
	before	after	before	after	before	after	before	after	before	after
AVG	6.389	6.702	5.164	5.482	81.327	82.420	8.545	9.285	5.359	6.137
SD	0.940	0.997	0.690	0.679	9.885	7.750	1.903	2.012	1.586	1.290
AVG	6.947	7.041	5.645	5.816	81.270	82.518	8.663	8.761	6.053	6.046
SD	0.510	0.579	0.508	0.609	2.742	3.566	1.204	1.250	1.455	1.445
P	3.67E+00		0.002		0.226		6.24E-03		2.71E-03	
P	0.044		0.006		0.014		2.93E-01		0.969	
differences	0.313		0.318		1.093		0.74		0.778	
difference	0.094		0.171		1.248		0.098		0.007	
Grey lines-experimental group; White lines-control group										

Table 2: Spirometry examination results.

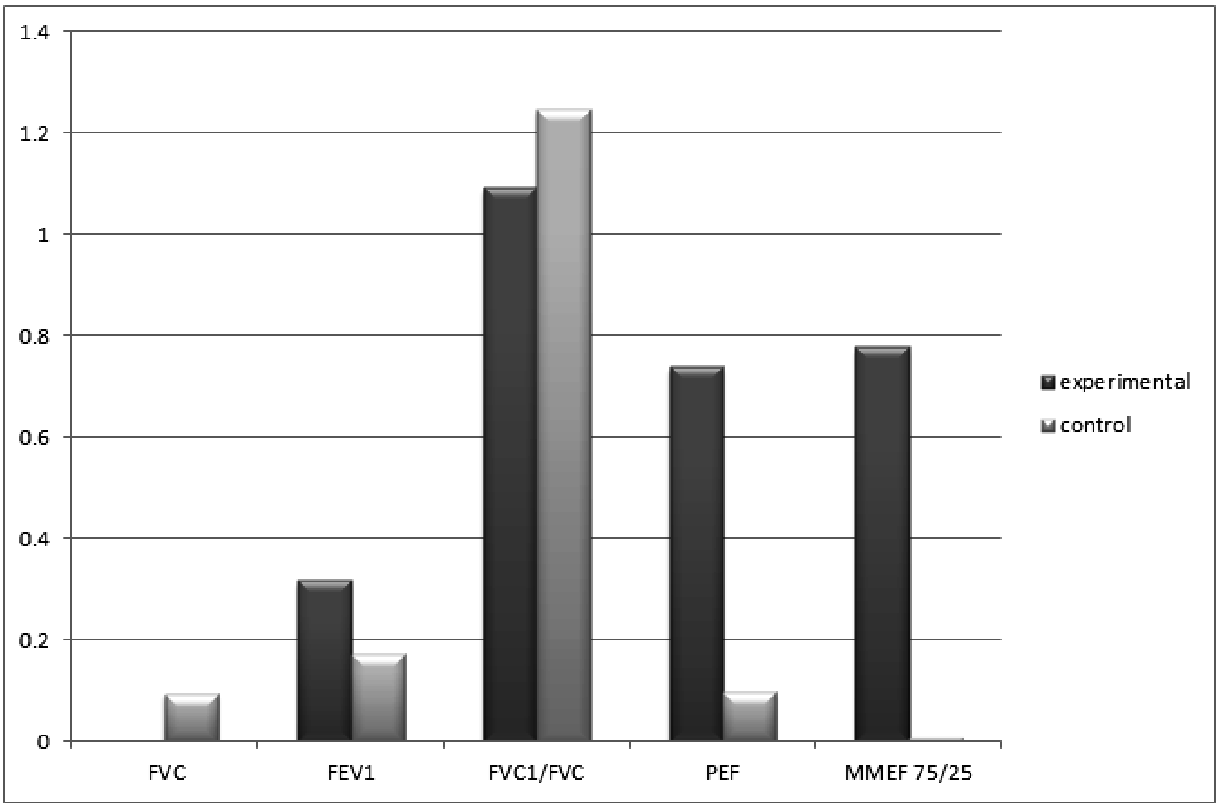

Figure 1: Differences between chosen parameters of experimental and control groups.

Conclusion

Breathing is one of the basic life functions. Positive influence on lung capacity is important for athletes in terms of increased performance, as well as for patients with respiratory diseases. The possibilities of increasing dynamic breathing parameters are different. We focused on influencing lung capacity through postural diaphragm training. Since the diaphragm, as the main inspirational muscle, also fulfills a postural function, these two functions could not be separated from each other, although physiologically they operate seemingly independently. The results of our study suggest that it is possible to improve the functional capacity of the lungs through postural training. Given the many factors that may affect the results, we suggest continuing with more probands and limiting influencing factors, such as monitoring exercise activity outside physiotherapy intervention, focusing on the greatest possible homogeneity of the set. Probands were the top athletes, representing only a small percentage of the population, and so we could not certainly generalize our results.

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