Magnetic Resonance Imaging (MRI) for evaluation of the effects of training of the muscles stabilizing spinal column. Case study.

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1. Introduction

Nowadays, lower back pain (LBP) has become a social disease. One of the causes of this problem is weakening abdominal and trunk muscles [1]. Primary stabilizers [2], are deep muscles inaccessible to testing by means of non-invasive methods. Assessment of the condition of these muscles or the effect of strengthening of them with training is possible only through magnetic resonance imaging (MRI) [3]. MRI method consists in obtaining of the image of thin layers which are called tomograms. As results from the investigations of the muscles which stabilize vertebral column, LBP pain can be often attributed to weakening of the muscles after spinal surgeries [4]. Using MRI method for examination of the athletes, it was found that LBP is likely to be caused by asymmetrical movement technique which causes increase in muscle cross-sectional areas at the side of the dominating arm [5]. The images obtained by MRI method revealed that the LBP can be also caused by the prolonged inactivity. Lying in bed causes selective muscular atrophy in m. multifidus [6]. However, properly scheduled long-term training of abdominal and trunk muscles strengthens these areas [7]. MRI examinations demonstrate that the exercises which focus on sucking in the stomach and flexing the abdominal areas contribute to a considerable increase in the thickness of the m. transversus, m. obliquus abdominis externus and reduction in cross-sectional area of the trunk [8]. MRI is a method which allows for fast and non-invasive measurement of cross-sectional areas in the muscles (muscle specific force) and muscle brightness (content of adipose tissues in the muscle). Therefore, on the one hand, there are attempts to develop the methods of diagnosis for muscles and on the other hand the exercises are selected so that they can be performed by the persons threatened with LBP or with the symptoms of this disease [9]. The goal of this study was to assess the effect of 6-week strength training program for strengthening of the muscles which stabilize vertebral column using MRI techniques.

2. Methods

The investigations covered 4 females without LBP symptoms, differentiated in terms of their age and physical activity level: two young (23) and two older (55) women. In each age group, one of the subjects was a person who preferred active lifestyle (participated in the scheduled classes in a fitness club). Measurements were taken twice: before performing of the exercise set and 6 weeks later, after completion of the training. The persons who participated in the experiment performed abdominal muscle exercises of curl-up type [9] using sets with 10 repetitions. Number of sets was adjusted to personal capacities of the subjects. The training took place 3 times a week. MRI examination was carried out using magnetic resonance by SIEMENS and the time of T2. The examination consisted in imaging of the muscles which stabilize vertebral column at the level of L3-L4. 2 measurements were taken in different position of the studied subject. The cross sectional area, and brightness in right and left side of the following muscles (Fig. 1) was measured: m. rectus abdominis (RA), m. anterolateral abdominal (IABD), m. psoas (PS), m. lumbar erector spinae (ES), m. multifidus (MF) m. quadratus lumborum (QL). Furthermore, cross sectional area, girth and brightness was calculated for the trunk muscular corset. The width of m. transversus abdominis (TA), m. obliquus abdominis internus (OAI), m. obliquus abdominis externus (OAE) was also measured.

![Fig. 1 MRI image with the area of the investigated muscles (description in the text) at the L3-L4 level.](image-url)
3. Results
The characteristics compared in this study included: relative value of cross-sectional area (CSA%), relative girth, width and brightness in 8 fundamental muscles which form spinal corset of the left and right side in four subjects before and after a 6-week training program. It is assumed that higher relative values of the cross-sectional area, girth and width of the muscles prove higher specific force values and thus improved stabilization function in these muscles. Lower muscle brightness corresponds to lower content of adipose tissue and higher content of muscle tissue.

Analysis of the results of measurements before training revealed that young persons were characterized by higher CSA% values for RA, IABD and QL muscles as compared to older persons. CSA% values for other muscles did not differ significantly. Relative muscle girth in all the investigated persons was similar. Young persons are characterized by greater widths in TA, OAI and OAE muscles.

Persons who did not exercise before the experiments were characterized by higher values of mean brightness in PS, ES, MF and QL muscles, which might be attributed to higher content of adipose tissue in the muscle. Relative girth in IABD and PS muscles was increased in the course of training in all the studied subjects. Width of OAE muscle also rose in all the persons who participated in the experiment. However, width of TA and OAI muscles was increased only in older persons. Brightness in IABD, PS, MF and QL muscles reduced in all the females.

4. Discussion
The present investigations revealed rise in cross-sectional area, girth and width of the muscles and reduction in muscle brightness after 6-week training regime for these muscles. Therefore, the executed training program has efficiently strengthen abdominal muscles and psoas muscle (trunk muscle) which is located adjacent to the vertebra. Relative girth in ES muscle rose only in the person who exercised regularly whereas MF muscle rose in all the studied subjects. Similar effect of training for MF muscle was obtained for Mayer [7]. Relative value of QL girth was improved only in older persons.

The obtained results will be verified at higher number of studied persons. Furthermore, the assessment of the effects of training for the muscles which stabilize vertebral column carried out by means of MRI will be supported with measurements of maximal muscle torque and EMG activity in trunk flexor and extensor muscles. Examination of the strength in deep spinal muscles will allow for development of safe and efficient exercises for LBP prophylaxis.

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References