Clinical Trial/Experimental Study

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The influence of pelvis reposition exercises on pelvic floor muscles asymmetry

A randomized prospective study

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Abstract

Objective: The assessment of pelvis reposition exercise efficacy in the treatment of pelvic floor muscles (PFM) asymmetry. The hypothesis was that PFM asymmetry may have a functional reason related to lumbopelvic complex misalignment.

Design: A parallel group trial with follow-up

Methods: Thirty young women were divided into 2 groups: experimental (n = 15) and control (n = 15). In experimental group one, a 15-minute trial of pelvis reposition exercise was carried out. Ober test, the Thomas test, and transabdominal PFM ultrasound measurements were performed in both groups.

Results: In the experimental group both the Ober and Thomas tests were positive at baseline in most subjects. After the exercise, improvement was noted in Ober test ($P = .005$; $d = 0.75$ on the right side, $P = .005$; $d = 0.78$ on the left side) and in the Thomas test ($P = .005$; $d = 0.66$ on the right side, $P = .005$; $d = 0.67$ on the left side). At baseline, the ultrasonographic evaluation of PFM performed during resting and during voluntary pelvic muscles contraction showed the right–left length asymmetry. The return of symmetrical PFM work after pelvis reposition exercise was observed in the experimental group. There were no statistically significant changes in the control group.s

Conclusions: We suggest that after reposition exercises, the pelvis was more symmetrically aligned in relation to body axis; therefore, the muscles of the pelvic floor have functional length and did not shorten or lengthen due to pelvis rotation. In this study, for the first time, it was presented that PFM asymmetry visible in ultrasonography may be corrected by this specific exercise. Further analysis of the causes of this asymmetry may lead to more accurate treatment of PFM dysfunctions.

Abbreviations: PFM = pelvic floor muscles, USG = ultrasonography.

Keywords: asymmetry, pelvic floor muscles, pelvis reposition exercise, ultrasonography

1. Introduction

The pelvic floor muscles (PFM) form the floor of the pelvic base and help maintain continence by actively supporting the pelvic organs. Normal continence is maintained by the complex integration of pelvic, spinal, and supraspinal factors.[1]

Some authors have described the synergy between the abdominal and PFM and all the muscle groups surrounding the abdominal cylinder. The PFM are considered to have the dual function of providing trunk stability and contributing to continence.[1,2] Current evidence also suggests that the muscles and fascia of the lumbopelvic region play a significant role in musculoskeletal function as well as continence and respiration.[2,3] It was also reported that strategies which are not optimal for posture, movement, and breathing, create failed load transfer which can lead to pain, incontinence, and breathing disorders.[1,3]

It has been also suggested that inappropriate tension in some parts of the body may be transmitted to distant parts of the musculoskeletal system leading to overload and functional restrictions.[4,5] The asymmetry in muscle work, strength and length is also considered a strong risk factor of musculoskeletal injury.[6,7] The cause of this asymmetry may be multifactorial. Zink et al[8,9] found that approximately 80% of healthy people had rotated body patterns thus, the fascial tension in specific body parts may cause the lumbopelvic complex to be more prone to asymmetry. The similar source of asymmetry was proposed by Morris et al[4] and called Torsional Upper Crossed Syndrome (TUCS). Moreover, Kouwenhoven et al[10], observed predominant rotation to the left of the high thoracic vertebrae, and to the right of the middle and lower thoracic vertebrae. This may probably be one of the reasons for the following pelvis rotation to the right side and one of the sources of pelvic floor muscle asymmetry. It should be also noted that the asymmetrical range of motion of the hip joints and pelvis may lead to changes in muscle and tendon length as well as function.[11–13]

Editor: Shogo Hayashi.

The study was performed within the project: "Center of Innovative Research in Medical and Environmental Sciences", supported by the Operational Programme Development of Eastern Poland 2007–2013, UDA-RPPK.01.03.00–18–004/12-00.

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Medicine (2019) 98:2(e13988)

Received: 8 August 2018 / Received in final form: 19 November 2018 / Accepted: 6 December 2018

http://dx.doi.org/10.1097/MD.0000000000013988

The bladder is supported by the PFM and the endopelvic fascia. When the PFM contract, the tension of the endopelvic fascia increases and produces symmetrical encroachment of the bladder wall.[2,7,14] It was reported that the PFM asymmetry visible during the ultrasound, may be due to unilateral hypertonicity or paravaginal defects in the endopelvic fascia. This asymmetry visible during resting may amplify in the case of isolated contraction.[7,14–16]

The main objective of ultrasonographic (USG) evaluation is to diagnose the source of this asymmetry, for example, hypertonicity, hypoactivity, or a structural deficit in the area of the endopelvic fascia in patients with paravaginal defects. Therefore, proper diagnosis should also include other potential factors such as pelvis alignment or muscle length. Deeper analysis of the causes of this asymmetry may lead to more accurate treatment of PFM dysfunctions.

Therapeutic exercises that promote optimal posture and neuromuscular control of the deep abdominals, diaphragm and pelvic floor were described by many authors.[7,17,21] Also, physical therapy for women with pelvic floor muscle disorders typically included many kinds of exercises, for example, biofeedback training, pelvic floor muscle strengthening, or core stability training.[18–20] However, as was underlined by Hay-Smith et al,[21] all of these studies varied in the methodological quality and content of the intervention, and there are no clear conclusions that could be drawn regarding the effect of the different exercises on PFM function. Moreover, there is a lack of studies reporting the efficacy of treatment based on 3-dimensional lumbo-pelvic-hip complex reposition. This study undertook this problem for the first time.

The aim of this study was assessment of pelvis reposition exercise efficacy in the treatment of pelvic floor muscle asymmetry. We suggest that PFM asymmetry visible in USG may have a functional reason related to lumbopelvic complex misalignment. We have hypothesized that restoring normal pelvis position would align asymmetrical PFM.

2. Materials and methods

2.1. Participants

In this study, 30 young continent and nulliparous women (25–40 years old) were divided into 2 groups: experimental (n = 15) and control (n = 15) (Fig. 1). They were recreationally active and did not engage in regular physical training. They periodically suffered from lumbar or thoracic spine pain but did not have any symptoms of urinary incontinence. They did not experience any spinal pain in the 6 months before enrolment in the study.

They were informed in detail about the research protocol and gave their written informed consent to participate in the study. The Ethical Committee of University of Rzeszow approval was obtained for this study. This study was registered in the Australian New Zealand Clinical Trials Registry (ANZCTR). Registration number: ACTRN12616000393459. The data presented in the present study are part of a wider project.

2.2. Procedures

In the experimental group, all measurements were performed twice, at baseline and after 15 minutes of pelvis reposition exercise. In the control group, measurements were carried out at baseline and after 30 minutes of rest in a seated position.

2.2.1. Functional tests[22].

The functional tests were performed by 1 trained physiotherapist who was blinded for the subjects' assignment to groups.

2.2.2. Ober test.

The patient lies on her side with the unaffected leg under the affected leg, the shoulder, and pelvis in line. The lower hip and knee can be in a flexed position to remove any lordosis of the lumbar spine. The examiner places a stabilizing hand on the patient's upper iliac crest and then lifts the upper leg, which is flexed to a 90-degree angle at the knee, extended at the hip, and then slowly lowers it toward the bottom leg, allowing the thigh to lower towards the table. The examiner must continue stabilization at the hip to ensure there is no movement. The test result is positive if the patient is unable to adduct the leg parallel to the table in a neutral position.

2.2.3. Thomas test.

The patient lies in supine position and holds the uninvolved knee to his chest while allowing the involved limb to lie flat. If the iliopsoas muscle is shortened or contracture is present, the lower extremity on the involved side will be unable to fully extend at the hip. This constitutes a positive result in the Thomas test.

2.2.4. USG of the PFM[23,24].

A diagnostic ultrasound imaging unit set in B-mode (Honda Electronics CO, LTD, HS-2100 V) with a 5 MHz convex transducer was used for transabdominal ultrasound measurements of PFM function. We followed the procedure described by Sherburn et al[14] and others[25] to measure PFM contraction.

A standardized bladder filling protocol was used before imaging ensuring that the subjects had a sufficient amount of fluids in their bladder to allow clear imaging of the base of the bladder. The evaluated women were asked to fill the bladder by consuming 700 to 800 mL of water, 1 hour before the measurement.

The USG measurement was performed in a supine position with a pillow underneath the head. The hips and knees were flexed, supported by a pillow under the knees, and the lumbar spine was in a neutral position. The ultrasound transducer was transversely placed in the midline on the suprapubic region and angled in a posterior/caudal direction. The screen was captured at rest. The patient was then asked to perform a voluntary PFM contraction; the instructions were, "draw in and lift the PFM", and the image was captured at the point of maximal displacement. The displacement of pelvic floor elevation from resting position at the end of each contraction was measured. Displacement, in millimetres, was measured as the distance between the points of maximal displacement during contraction at the right and left sides of the X/Y coordinate. The same procedure was repeated for the resting image. The difference between values during contraction and rest were analyzed. The subject held the contraction for 3 seconds. The ultrasound transducer was not moved during the testing procedure and remained constant between resting and maximal contraction.

All USG measurements were performed by 1 trained researcher who was blinded for subject group assignment. The reliability for assessment of PFM function using a transabdominal ultrasound has previously been established (ICC = 0.87).[7,25] Analysis of the USG measurements was performed using ImageJ software (National Institute of Health).

2.2.5. Exercise.

The evaluated women performed 3 steps of exercise. The aim of this treatment was pelvis reposition in relation to body axis and correction of PFM asymmetry.[17,26] The exercise lasted 15 minutes during which each subject slowly performed all 3 steps of exercise 2 to 3 times.

Pelvis reposition and breathing pattern reorganization—during the first part, exercise promoted optimal positioning of the diaphragm and lumbar spine and tuned neuromuscular control of the deep abdominals, diaphragm, and PFM. The main objective of this part was to teach the subject corrective breathing

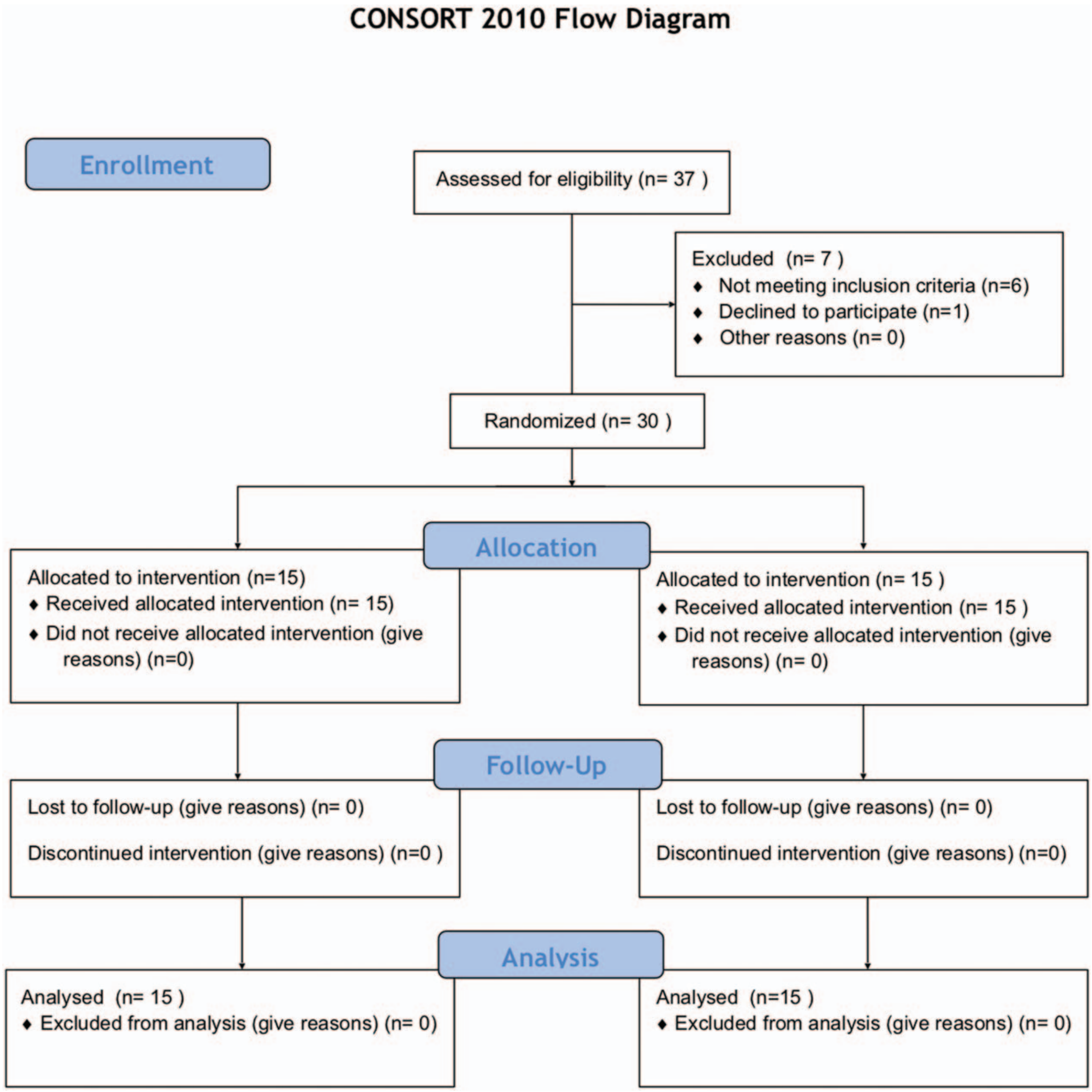

Figure 1. Consort diagram.

patterns. Dysfunctional breathing is closely related to failure in intra-abdominal pressure as well as deep stabilizer activity and also in diaphragm and PFM disorders. We have suggested that the lower back pain experienced by the evaluated woman may be related to dysfunctional breathing patterns and visible lumbo-pelvic complex asymmetry. The most important part of the performed exercise was appropriate breathing sequence. Exhaling should be full and last much longer than inhaling. Moreover, apnea after fully exhaling was very important, because it strongly stimulated the autonomic nervous system.

The woman laid on her side in a curled up position, the spine was in flexion. She performed 10 full breathing cycles according to the following sequence: inhaling through the nose and then, slowly and fully exhaling through the mouth. After the full expiration, she stayed in apnea for 4 seconds and then started the following expiration through the nose. Next, she repeated the full breathing cycle 8 times with 8 seconds of apnea after each expiration.

Muscle activation and pelvis repositioning—the aim of this step was to introduce and fix new breathing patterns with pelvis reposition. This technique was performed in a body position reinforcing rotation to the opposite direction from the misaligned resting state. It restored correct neuromuscular control and symmetry in the deep muscles of the lumbo-pelvic complex. The woman laid on her right side, the spine was extended and the head supported by a pillow in order to achieve a neutral spinal position. The right leg was bent at the knee and hip at a 90-degree angle, the left leg bent at the knee (90 degrees), and in extension and internal rotation at the hip. A pillow was inserted below the left knee, which filled the space between the knee and table. The woman performed 10 full breathing cycles.

Deep inhalation through the nose (the air should be directed to the abdomen), then long expiration through the mouth, and then 8 seconds of apnea before the next inhalation. During expiration, the left knee was pressed to the pillow, and after a few cycles, the

Table 1

The Ober and Thomas tests results at baseline and after exercises.

		Baseline	After exercises	Z	*P*	ES (d)
Ober Test L	Exp Gr	1 +/−0 (1–1)	2 +/−0 (2–2)	2,80	**,005**	0.78
	Contr Gr	1 +/−1 (1–2)	1 +/−1 (1–2)	1,65	,743	0.69
Ober Test R	Exp Gr	1 +/−0 (1–1)	2 +/− 1 (1–2)	2,52	**,005**	0.75
	Contr Gr	1 +/−0 (1–1)	1 +/−1 (1–2)	1,94	,236	0.73
Thomas Test L	Exp Gr	1 +/−0 (1–1)	2 +/−0 (2–2)	2,78	**,005**	0,67
	Contr Gr	1 +/−0 (1–1)	1 +/−1 (1–2)	1,82	,673	0,73
Thomas Test R	Exp Gr	1 +/−0 (1–1)	2 +/−0 (2–2)	2,80	**,005**	0,66
	Contr Gr	1 +/−1 (1–2)	1 +/−1 (1–2)	1,67	,594	0,69

The values are expressed as median +/− quantile range (lower quantile−upper quantile).
ES (d) = effect size, L = left, *P* = *P* value, R = right, Z = Wilcoxon test value.

pillow was removed so that the knee was pressed to the table. During each exhalation, the left leg increased hip extension.

Reciprocal muscle activation—during this step, the corrected breathing pattern was fixed. 10 full breathing cycles were performed with symmetrical pelvis and trunk alignment in relation to body axis. The woman laid on her back with her feet flat against the wall and knees and hips bent at a 90-degree angle. The tailbone was raised slightly and the lower back was flat on the table. The breathing cycle included deep inhalation through the nose (the air should be directed to the abdomen), then long expiration through the mouth, and following, 8 seconds of apnea before the next inhalation.

3. Statistical analysis

Statistical analysis was performed using STATISTICA 12.0.PL software. The Shapiro -Wilk test was conducted to assess data for normality. One-way analysis of variance (ANOVA) with repeated measures was used to determine the significance of differences in the USG measurements. The non-parametric Wilcoxon test was used to assess the significance of the differences in variables tested with Ober and the Thomas tests. The effect size was calculated using Cohen's *d*. The differences were considered as statistically significant if the level of test probability was lower than the assumed level of significance ($P < .05$). The first author of this study is certified in statistical analysis methods.

4. Results

There were no significant differences in body height and mass between the women in the experimental and control groups (165.6 ± 2.7 vs 169.2 ± 3.3 cm; 66.3 ± 4.42 vs 68.1 ± 3.9 kg) ($P > .05$).

4.1.1. Ober and Thomas tests

At baseline, in both study groups, Ober and the Thomas tests were positive at baseline in most subjects (Table 1). In the experimental group, after exercise, significant improvement was noted in both functional tests for the right as well as left side. In the control group, there were no statistically significant changes compared to baseline (Table 1).

4.1.2. USG

At baseline, in the both study groups the ultrasonographic evaluation of PFM performed during resting and voluntary pelvic muscles contraction showed right-left length of asymmetry regarding the bottom border of the bladder. After exercise in the experimental group, bladder asymmetry was significantly decreased during resting (Fig. 2A) and during voluntary contraction (Fig. 2B). There were no statistically significant changes in the control group (Fig 2A and B)

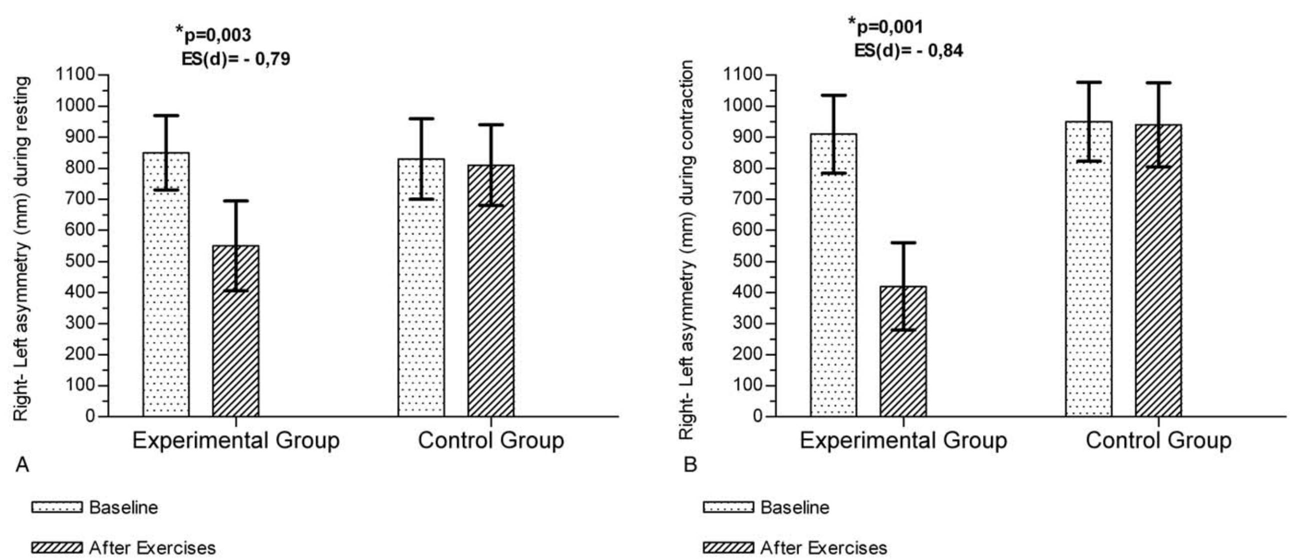

Figure 2. Right−Left length of asymmetry in bottom border of the bladder during resting (A) and during pelvic floor muscles contraction (B). *P-P* value, ES (d)—effect size. The values are expressed as mean +/− SD.

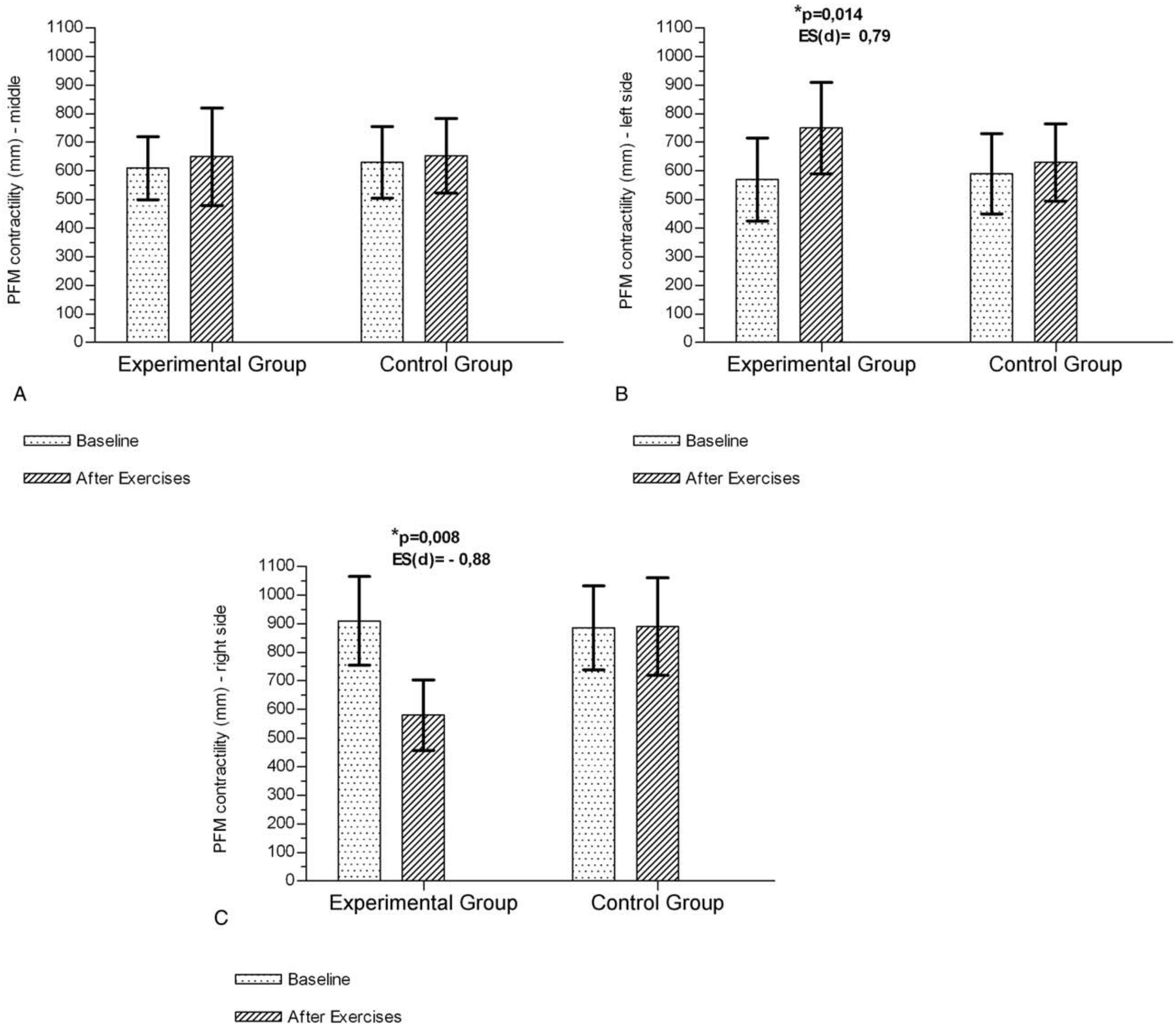

Figure 3. Pelvic floor muscles contractility in the middle of the bladder bottom (A), at the left side (B) and at the right side (C). *P*- *P* value, ES (d)—effect size. The values are expressed as mean +/− SD.

The recovery of symmetrical PFM work after pelvis reposition exercise was observed only in experimental group. PFM contractility (the displacement of the bottom border of the bladder during contraction in relation to resting state) changed after exercise compared to baseline. In the middle of the bladder bottom, there were no significant changes in PFM contractility (Fig. 3A). After exercise, the PFM contractility was significantly increased on the left side (Fig. 3B) and significantly decreased on the right side (Fig. 3C). There were no statistically significant changes in the control group (Fig 3A, B, and C)

5. Discussion

The most important information from this study is the recovery of symmetrical PFM work after pelvis reposition exercise. In the experimental group, at baseline, during resting and during voluntary pelvic muscles contraction, right-left length asymmetry in the PFM was observed. Moreover, functional tests showed excessive pelvis rotation in relation to body axis. After pelvis reposition exercise, the asymmetry was significantly decreased during resting and voluntary contraction. The observed improvement in the functional tests may suggest that after reposition exercises in a neutral position, the pelvis was more symmetrically aligned in relation to body axis. In this study, for the first time, it has been presented that PFM asymmetry visible in USG may be corrected by this specific exercise.

Because the bladder is supported by the PFM and the endopelvic fascia, during contraction the tension of the fascia increases and produces encroachment of the bladder wall, which should be symmetrical side-to-side. The asymmetry of the pelvic floor muscle tension due to hypo- or hyperactivity or due to disruption of the endopelvic fascia, are often diagnosed by ultrasound evaluation.[7,14,15,23] Therefore, proper diagnosis indicating the source of PFM asymmetry should also include other potential factors such as pelvis alignment or muscle length. Comprehensive analysis of the causes of this asymmetry may lead to more accurate treatment of PFM dysfunctions. This may have clinical significance, which is discussed in further detail below.

Asymmetrical PFM activity and inappropriate mobility of the lumbopelvic complex are related to impaired spinal and lower limb biomechanics, and also to deterioration in lumbopelvic deep muscles function.[1,3] Any disorders or deregulation of this complex mechanism result in inappropriate muscles contraction (hyper- or hypotonity),[7,27] and in changes of lumbopelvic and hip joint rotation axis.[28]

The postural torsional consequences of asymmetrical muscles and fascia tension, as well as their role in the development of body axial rotation, have been reported by some authors.[4,8,29,30] Kouwenhoven et al[10] have reported that restrictions in spinal rotation in the transverse plane may be significant in the development of lumbopelvic complex dysfunctions. They observed that the normal non-scoliotic spine demonstrated predominant rotation to the left of the high thoracic vertebrae, and to the right of the mid and lower thoracic vertebrae. It was suggested that rotation in the lower thoracic spine may be related to right sacroiliac joint pain, anterior pelvic tilt, and restriction in right hip range of motion.[10,12,28] Based on observations from the present study, we have suggested that this commonly present lower thoracic rotation may be one of the sources of pelvis rotation and asymmetrical PFM activation during contraction.

Our suggestions may be supported by other authors' observations.[8,9] They have reported that approximately 80% of healthy people have rotated body patterns due to increased fascial tension in specific parts of the body. In Zink's fascial common compensatory pattern of rotation, the pelvic girdle is rotated to the right with the upper parts of the spine contra-rotated.[8] Therefore, those observations may support our suggestion that there are some functional factors which may cause the lumbopelvic complex to be more prone to asymmetry.

Other studies have reported[7,12] that one of the potential reasons of asymmetrical pelvic floor muscle work may be sacroiliac joint subluxations and following restrictions in force closure as well as the form closure mechanism. This may change the direction and magnitude of forces transmitted through the lumbopelvic complex and may lead to muscle imbalances.[7] The form and force closure mechanisms work properly only if the hip range of motion is appropriate. With the restrictions in hip rotation and extension, the sacroiliac stabilization may be disrupted and may cause subluxation.[7,28] In our study, we have observed the restrictions in hip extension and rotation in functional tests at baseline. Hip range of motion improved after pelvis reposition exercises. Thus, we may suggest that the restricted hip range of movement caused deterioration in force transmission through the sacroiliac joints and through the whole lumbopelvic complex, which may lead to PFM imbalance and asymmetrical activity.

Moreover, as reported by other authors,[7] the asymmetrical hip joint and pelvis range of motion may lead to changes in muscle and tendon length, and to following changes in neuromuscular control regarding contraction of those muscles. Therefore, muscles on 1 side may contract in the form of unnatural lengthening and on the opposite side, in unnatural shortening. None of these situations create an optimal condition for effective contraction and force production.[31,32]

As was reported by Rubenson et al[32], a muscle that undergoes lengthening–shortening cycles generally increases force as it lengthens, while decreasing force as it shortens. If the muscle were to lengthen, there would be a mismatch between its length-dependent force-generating capacity and the in vivo force requirement. The authors have suggested that those muscles may be less suited to withstand lengthening perturbations linked to muscle injury and eccentric muscle damage, possibly as a result of non-uniform sarcomere lengthening.[31,32]

There are some limitations of this study that need to be addressed. Because the study population consisted of subjects without any symptoms of urinary incontinence, these findings may not be appropriate for extrapolation to a population with severe pelvic floor dysfunctions. We think that future studies should also include woman with PFM dysfunctions what would allow exploration of pelvis reposition efficacy more comprehensively.

6. Conclusions

The recovery of pelvic floor muscle symmetry observed in our study during resting and contraction, as well as the improvement in functional tests may suggest that pelvic reposition exercises are effective in the treatment of this kind of PFM asymmetry. We have suggested that after reposition exercises, the pelvis was more symmetrically aligned in relation to body axis; therefore the PFM have functional length and did not shorten or lengthen due to pelvis rotation.

6.1. Practical implications

In this study, it was presented for the first time that PFM asymmetry visible in USG may be corrected by pelvis reposition exercise. Further analysis of the causes of this asymmetry may lead to more accurate treatment of pelvic floor muscle dysfunctions. Based on the results of our study, we have also suggested that the proper diagnosis indicating the source of PFM asymmetry should also include other potential factors such as pelvic alignment or muscle length. It may be very important, especially in women with paravaginal defects of the endopelvic fascia qualified for surgical treatment.

Author contributions

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