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The characteristics of biofeedback techniques used in pelvic floor muscle training for healthy pregnant women – A narrative review

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REVIEW

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The characteristics of biofeedback techniques used in pelvic floor muscle training for healthy pregnant women. A narrative review

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background: Due to the location of pelvic floor muscles, training with biofeedback for this muscle group is encouraged. The aim of this study was to characterize the use patterns of various biofeedback techniques in pelvic floor muscle training in healthy pregnant women.

Material and methods: It was a narrative review study using MEDLINE database and the following keywords: 'pelvic floor', 'pregnancy' and 'biofeedback'. For the analysis we included 8 studies meeting the criteria of being experimental trials in healthy pregnant women and including the characteristics of biofeedback techniques used in pelvic floor muscle training.

Results: The most commonly used technique of biofeedback was palpation (in 4 out of 8 studies). Other techniques used a perineometer, ultrasonography, electromyography or electrostimulation. The time span between pre- and post-assessment was 27 ±21 (M ± SD) weeks and the number of biofeedback sessions varied from 1 to 12 during the intervention.

Conclusions: Because of different analyzed pelvic floor parameters and patterns of biofeedback applications, it was impossible to compare them. There are no clear guidelines for the use of biofeedback in pelvic floor muscle training.

Key words: pelvic floor muscle training, pregnancy, biofeedback, training effectiveness.

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INTRODUCTION

Pelvic floor muscles are one of the muscular groups surrounding and supporting abdominal organs. They must be very resistant because they carry the weight of the abdominal cavity content and form part of the abdominal press [2]. The pelvic floor is a complex structure, and at the same time it is very susceptible to damage. Repeated extreme changes in intra-abdominal pressure, as well as other tensions and strains, occurring mainly at the end of pregnancy, may lead to weakening of the connective tissue and pelvic membrane muscles with clinical consequences [3].

To keep pelvic floor muscles in proper condition, they should be exercised regularly. Due to their location, an assessment of the correctness of exercise is difficult. In publicly available sources of information, there are indications that the muscles of the pelvic floor should be activated in such a way as if the intention was to break the urinary stream during the micturition [4]. However, there are hypotheses that regular interruption of urination may disrupt the functioning of the bladder [5]. In order to get feedback on the technique of pelvic floor muscle exercises, a woman can put her finger in the vagina. If she feels her muscles clench around her finger, it means she has identified and activated them properly [5].

More and more often, pelvic floor muscle training is supported by specialized equipment and the so-called biofeedback. By registering and visualizing muscle work, biofeedback optimizes the work of the central nervous system and muscles. It gives an opportunity to activate the right muscle group, control the strength and duration of contraction or relaxation, and observe the progress of training or therapy objectively [5]. Biofeedback can be visual, auditory and sensory. It is commonly used to teach women how to perform conscious contractions of the pelvic floor muscles or to increase the effectiveness of the exercises [6]. The awareness of correctly done exercises improves the well-being of women and motivates them to continue [7]. Due to the beneficial use of biofeedback, they are more likely to practice alone at home.

Until now, there was no publication of recommendations on how to use biofeedback, hence in our work we decided to characterize the use patterns of various biofeedback techniques and principles of their application in pelvic floor muscle training in healthy pregnant women.

MATERIAL AND METHODS

It was a narrative review study. We used the following keywords to search the MEDLINE database: ‘pelvic floor’, ‘pregnancy’ and ‘biofeedback’ to qualify articles to analysis. We searched for reports published in English between 2001 and 2017. Two independent researchers completed the procedure between May 2017 and November 2017. In the first step, we obtained 25 studies that we analyzed for the following criteria: these were experimental trials conducted in healthy pregnant women and they included the characteristics of biofeedback technique used in pelvic floor muscle training. This left eight trials for analysis (Fig. 1). We characterized the following criteria of the use patterns of biofeedback techniques: methods of biofeedback, time between pre- and post-assessment, when biofeedback was applied, how many times biofeedback was used.

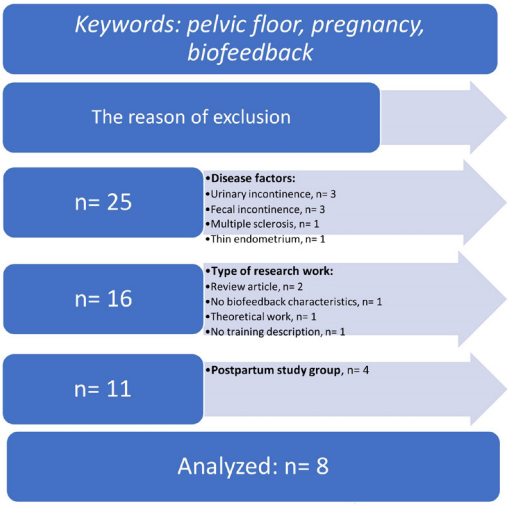

Fig. 1. The process of studies selection

Pelvic floor muscle (PFM) exercises aim to improve pelvic floor muscle strength, endurance, power, relaxation or a combination of these parameters [1]. As one of the biofeedback techniques, we considered the palpation method, which gives the participant both verbal and sensory feedback of a third person (e.g. a researcher, a physiotherapist). We also considered electrostimulation as a specific form of biofeedback. It can strengthen woman's awareness through targeted electrical stimulation of selected body parts, thus, improving the technique of their voluntary contraction and relaxation.

The following articles have not been taken into consideration due to: urinary incontinence (UI) [8–10], fecal incontinence (FI) [11–13], multiple sclerosis (MS) [14], thin endometrium [15], the lack of biofeedback characteristics [16], being reviews [5, 17], a theoretical work [18], research after delivery [19–22] or lack of pelvic floor muscle training.

RESULTS

In the 8 analyzed articles, 1120 women were examined. Five studies confirmed the improvement in the pelvic floor muscle function after biofeedback, and in three other trials no improvement was noted. The biofeedback with the use of perineometer, ultrasonography (USG), electromyography (EMG), electrostimulation (ES) or palpation examination was applied in the experiments. Perineometry was used in five studies, palpation and ultrasonography in three, electrostimulation and electromyography in only one study.

Meyer et al. [23] assessed the effect of pelvic floor education after vaginal delivery in 107 healthy primiparous women. Questionnaires to detect the appearance of urinary or anorectal symptoms were completed monthly. The pelvic floor muscle examination was conducted in pregnancy and at 9 weeks and 10 months after vaginal delivery. Each woman was then assigned to one of two groups. The control group of 56 subjects did not receive any education until the third examination conducted 10 months postpartum. The experimental group of 51 women received 6 weeks (12 sessions) of pelvic floor education that started 2 months postpartum and ended before the third examination, which was also conducted 10 months

postpartum. Each session consisted of pelvic floor exercise training, followed by 20 minutes of biofeedback and 15 minutes of electrostimulation with an electrode placed at the bottom of the vagina. Stress urinary incontinence incidence decreased in 2% of control subjects compared with 19% of women who underwent pelvic floor education (P = 0.002). The incidence of fecal incontinence (5% versus 4%, P = 0.1) and the percentage of women who recovered predelivery pelvic floor contraction strength (33% versus 41%, P =0.4) were not statistically different.

In the study by Oliveira et al. [24], 46 women up to 20 weeks of gestation were also divided into two groups: the exercise and control groups. Functional evaluation of the pelvic floor muscle was performed by digital vaginal palpation using the strength scale described by Ortiz and by a perineometer with biofeedback. First, the patient was questioned regarding her knowledge of the pelvic floor muscles. She then received information about the location and function, and on how to correctly contract this musculature. The patient was then instructed to "squeeze and lift" the pelvic floor muscles. Next, inspection, palpation, functional evaluation of the pelvic floor (FEPF), and perineometry were consecutively performed with the patient in the gynecological position. The functional evaluation of the pelvic floor muscles showed a significant increase in pelvic floor muscle strength during pregnancy in both groups (P < .001). However, the magnitude of the change was greater in the exercise group than in the control group (47.4% vs. 17.3%, P < 0.001). Pelvic floor muscle training resulted in a significant increase in pelvic floor muscle pressure and strength during pregnancy.

Ornö and Dietz [25] described the use of USG as a technique of biofeedback in fifty nulliparous women at 36–38 weeks' gestation. They analyzed the mechanism of Valsalva, which is often accompanied by pelvic floor muscle contraction. Valsalva maneuvers were recorded initially and after repeated attempts with visual biofeedback both during the maneuver and after, with the operator demonstrating findings on the ultrasound monitor, in order to prevent levator co-activation. The authors concluded that without repetition and digital, auditory or visual biofeedback, women may not perform a correct Valsalva maneuver. This investigation described and quantified a major confounder of the assessment for pelvic organ prolapse in young nulliparous women. Levator co-activation at the time of a Valsalva maneuver may significantly reduce pelvic organ descent. Biofeedback instruction and repetition may overcome this effect in some women and reduce the likelihood of false-negative findings.

Caroci et al. [26] demonstrated the use of perineometry and digital vaginal palpation at the beginning of pregnancy (up to 12 weeks), at the end of pregnancy (36 to 40 weeks) and during puerperium (48 hours and 42 to 60 days postpartum) in 110 primigravidae women. For the biofeedback, the study used an electronic perineometer, which registers the potential action of pelvic floor muscle contractions and translates their intensity from visual signals. The woman was asked to hold and maintain, for as long as possible, a voluntary contraction of the perineal muscles around the vaginal probe, in a sequence of three sessions, with an inter-session interval of 15 seconds. Although the pregnancy was progressing, there was no significant decrease in pelvic-floor muscle strength in early and late pregnancy and postpartum. The authors concluded that the use of perineometry together with the performance of perineal exercises with biofeedback is particularly important in the clinical practice.

The study by Riesco et al. [27] verifies whether there is a correlation between values of pelvic floor muscle strength obtained through digital vaginal palpation

using the Oxford scale and through perineometry performed with an electronic perineometer (which translates the strength of pelvic floor contraction to visual signs through a numerical scale). In digital vaginal palpation and perineometry they asked a woman to contract and keep the voluntary contraction of the pelvic floor muscles around a vaginal tube as long as possible in a sequence of three sessions with an interval of 15 seconds between each session. Evaluations were performed at three points in time: up to 12 weeks of pregnancy; between 36-40 weeks; and between 42–60 days postpartum. The Spearman coefficient indicated a strong positive correlation between the two assessment methods for the three evaluations ($P < 0.0001$) [27].

Batista et al. [28] described the analysis of three EMG biofeedback sessions consisting of slow and fast pelvic-floor muscle contractions in 19 nulliparous women with low risk pregnancies. The results indicated that three sessions of training with biofeedback improved pelvic floor muscle EMG activity during the second trimester. The authors stated that visual stimulation may help to perform the pelvic floor muscle contraction.

In the study by Lekskulchai's et al. [29], 219 nulliparous women pregnant between 8-12 weeks underwent transperineal ultrasound. The experimental group (n=108) was taught about pelvic floor muscle contraction using visual biofeedback by transperineal ultrasound. The control group (n=111) received routine antenatal care. The intervention exercise program comprised a series of 15 contractions. Each contraction was held for 5 seconds, with 5 seconds' rest between each contraction. Patients were asked to repeat this regimen 3 times after each meal. At the second trimester, third trimester, 3-month postpartum and 6-month postpartum, the participants in both groups were interviewed and then underwent next ultrasound assessment according to the same protocol. This study demonstrated that antenatal pelvic floor muscle exercises supported by ultrasound biofeedback education for pelvic floor muscle contraction may reduce bladder neck mobility at 6 months after childbirth.

K. van Delft et al. [30] compare the digital assessment to transperineal ultrasound during pelvic floor muscle contraction. They observed that palpation using the Modified Oxford Scale and transperineal ultrasound can both be used as tools to assess pelvic floor muscle contractility. Although the Modified Oxford Scale is a simple clinical tool without a need for any equipment, transperineal ultrasound can provide good visual biofeedback when training patients in pelvic floor muscle exercises. As transperineal ultrasound is non-intrusive, it may be a method of choice for some women. 459 assessments were performed, of which 268 were for women at around 36 weeks' gestation, and 191 were from women following delivery at 3 months postpartum. During digital palpation women were instructed to squeeze their pelvic floor muscle, and subjective assessment of pelvic floor muscle contractility was performed by the examiner. Subsequently, women underwent 3D- (to obtain images at rest) and 4D-transperineal ultrasound (to obtain images at maximum pelvic floor muscle contraction). Imaging was performed at rest and at maximum pelvic floor muscle contraction (best of three contractions).

In the analyzed studies, the most commonly used technique of biofeedback was palpation (in 4 from 8 studies); the time span between pre- and post-assessment was about 27 ±21 (M ±SD) weeks, and the number of biofeedback sessions varied from 1 to 12 during the intervention (Table 1).

Table 1. Biofeedback methods used in pelvic floor muscle training and their usage characteristics

Author Year	Methods of biofeedback	Time between pre and post assessment	When biofeedback was applied	How many times the biofeedback was used
Meyer et al. 2001	20 min biofeedback, 15 min electrostimulation	8 months	2 months after delivery	12 sessions during 6 weeks
Oliveira et al. 2007	Palpation test, Perineometer with and without biofeedback 3 times	16 weeks	1st assessment 18 and 20 wg, 2nd assessment from 36	2
Orno al. 2007	Biofeedback USG	Biofeedback applied immediately after the first assessment	36-38 wg	1
Caroci et al. 2010	Palpation test, Perineometer 3 sessions with an interval of 15 seconds between each session	About 12 months	At 12 weeks of pregnancy, between 38-40 weeks pregnant, 48 hours postpartum, 42-60 weeks after childbirth	3 times during the perinatal period
Riesco et al. 2010	Palpation test, perineometer, 3 sessions with an interval of 15 seconds between each session EMG assisting in evaluating abdominal tension	About 12 months	1st assessment to 12 weeks of pregnancy; 2nd assessment from 36 to 40 weeks; 3rd assessment between 42-60 postpartum days.	2
Batista et al. 2011	3 sessions once a week palpation test, EMG	One week	18-19 wg	1
Lekskulchai et al. 2014	USG	About 12-14 months	In the 2nd trimester, 3rd trimester, 3 months after delivery, 6 months after delivery	3
K. van Delft et al. 2015	USG, Palpation test	About 4 months	At 36 weeks' gestation and 3 months after delivery	2

EMG – electromyography, USG – ultrasonography,

DISCUSSION

Based upon our analysis, there are no clear guidelines for the use of biofeedback in pelvic floor muscle training. First, the biofeedback use patterns varied in terms of methods, time between pre and post assessment, when biofeedback was applied, how many times the biofeedback was used. Second, various parameters describing pelvic floor muscle contraction in individual studies were analyzed. Therefore, it was difficult to say which of the biofeedback use patterns was the most effective in pregnancy.

The analyzed studies provide information on the usage of perineometer, palpation, ultrasound, electrostimulation and electromyography as biofeedback

tools for pregnant women. Vaginal probe, intravaginal finger application and vaginal ultrasound are perceptual stimuli, and at the same time they provide feedback how to perform pelvic floor muscle contraction [31]. Perineometer is an instrument used to measure the strength of voluntary muscle contractions of the pelvic floor [1]. Electrostimulation activates the muscles, but in the case of weakened muscles, the contraction caused by an artificial external stimulus is usually bigger and stronger than the natural contraction [32]. Electromyography is a study of the muscle function through analysis of the electrical signals emanated during muscular contractions, leading to the results being recorded [32].

All articles included in our analysis related to healthy pregnant women but the use of biofeedback can be applied widely. In our review, the extensive use of biofeedback and its effectiveness on the pelvic floor muscles functions has been demonstrated. Our analysis is in line with the Cochrane review by Herderschee et al. [33]. They summarized that feedback or biofeedback, as an addition to pelvic floor muscle training, may benefit women with various types of urinary incontinence. When biofeedback is considered as an adjunct to pelvic floor muscle training, the preferences of women and the therapist are important in the decision about which form to use. Availability, cost effectiveness and the woman's perception of the invasiveness of the procedure are important factors that may influence this decision. A therapists would do well to consider the purpose of adding biofeedback, and on this basis consider how often biofeedback is given; it seems a few (one or two) occasions may be as effective as many biofeedback applications [33].

In most of the analyzed studies biofeedback was used at the initial stage of the intervention to present to the study participants the pelvic floor muscles' location and the correctness of their contraction. According to Opara et al. [6], biofeedback is especially useful in cases of uncoordinated movements and spasms, excessive muscle tension and a weakened ability to initiate motion. Bo et al. [1] recommend using biofeedback especially on the sign of a non-contracting or non-relaxing pelvic floor. It would apply to a situation in which there is no pelvic floor muscle action, neither upon instruction nor as an automatic response to the increase in intra-abdominal pressure. Herderschee et al. [34] summarized their systematic review that biofeedback may add benefit to pelvic floor muscle training, but the observed effect could well be related to another variable, such as the amount of health professional contact rather than the biofeedback per se. We would also add that any standard on the use patterns, e.g. when and how many times to use biofeedback, would be important for the training effects.

Riesco et al. [27] also concluded that several devices and evaluation methods and also a lack of standardized parameters to classify the pelvic floor function are observed in the literature, which limit the comparison of results of different studies. They suggest that this is a topic that warrants further investigation and debate. In our review, we observed that the variety of existing research methods makes it difficult to develop clear recommendations on biofeedback application in pelvic floor muscle training, both in terms of individual techniques and time intervals used. Based on other studies and practical experience, one may speculate that the application of biofeedback sessions in a few time points (e. g. at the end of the first, second and third trimesters and three months after childbirth) may positively influence the effects of pelvic floor muscle training in healthy women in the perinatal period. The effectiveness of such

a program should be evaluated in experimental studies comparing the use of various biofeedback techniques. In other studies, Nahas et al. [35] recommend that an addition of aerobic exercise to biofeedback assisted Kegel exercises should improve PFMs' strength and thickness than biofeedback-assisted Kegel exercises only. Another interesting research issue, considered only in one of the analyzed studies [25], is the acute effect of biofeedback on the performance of pelvic-floor muscle contraction. These studies show that it would be worth looking at in the future which biofeedback will best affect the contraction of the pelvic floor muscles in combination with aerobic exercises.

CONCLUSIONS

The use of biofeedback with perineometer, palpation, ultrasound, electrostimulation and electromyography and its effectiveness on the pelvic floor muscles functions in pregnancy has been demonstrated in the reviewed studies. However, due to different patterns of biofeedback applications and pelvic floor parameters analyzed, it was impossible to compare them.

There are no clear guidelines for the use of biofeedback in pelvic floor muscle training during gestation (e.g. on the recommended timepoints during gestation, time between them or the number of sessions to be applied). Recommendations to use biofeedback in a training program should be designed for pregnant women in order to condition their pelvic floor muscles and develop preventive measures for pelvic floor disorders.

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