Barzak et al.
Medical Journal of Cell Biology 2024
DOI: 10.2478/acb-2024-0011
Received: 12.08.2024
Accepted: 20.09.2024

Urinary incontinence due to pregnancy – the impact of hormones and biofeedback therapy

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Abstract
In this article, attention is drawn to the serious problem of the occurrence of urinary incontinence because of pregnancy. The condition is problematic mainly in the elderly, as well because of the first and each subsequent pregnancy. Urinary incontinence can be a reason for social and professional exclusion, psychological problems and rising medical costs worldwide. Pregnancy as a complex process is a major factor in the occurrence of urinary incontinence in women at a younger age, consisting of hormones and all the procedures associated with childbirth. The physiotherapist has many tools that clearly affect how quickly the patient will recover, and one of them is biofeedback therapy. The process of treating incontinence needs further research and improved guidelines, as the condition is one of the most common complications of pregnancy, with a high risk of recurrence.

Running title: Pelvic floor biofeedback therapy

Keywords: pelvic floor, biofeedback, rehabilitation, hormones, childbirth, pregnancy

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Introduction

Urinary incontinence (UI), defined as the involuntary leakage of urine through the urethra, is a common and often underestimated female health problem [1,2]. This condition can exclude patients from sporting activities, occupational and social responsibilities, significantly affecting their quality of life, psychological and physical well-being [3,4]. Although primarily associated with older women, UI is also a significant issue among younger women, especially after pregnancy and childbirth [1,5]. Studies show that the estimated prevalence of UI ranges from 14 to 45% in all women in the first year after childbirth, while 65% remember that their first episode of urinary loss occurred during pregnancy or postpartum [6-8].

Pregnancy and childbirth are the main risk factors for pelvic floor (PF) dysfunction, which can lead to UI and pelvic organ prolapse [9]. Other factors include pre-pregnancy medication, body mass index (BMI), weight gain, smoking, type of birth, use of forceps, duration of the first and second stages of labour, practice of perineal incisions and use of epidurals. Non-modifiable risk factors include age at delivery, fetal position and head circumference of the newborn, weight of the newborn, and the presence/existence of perineal injuries [10,11]. Primary caesarean section reduces the risk of pelvic floor disorders, as women who give birth vaginally are 2.8 times more likely to suffer from stress urinary incontinence and 5.5 times more likely to experience pelvic organ prolapse, but it cannot be used as a general preventive measure against these problems [2,11]. The course of pregnancy can cause damage to the nerves, connective tissue and muscles of the pelvic floor, leading to their weakness and reduced function [12,13].

Physiotherapy and pelvic floor muscle training (PFMT) play a fundamental role in the prevention and treatment of UI [14,15]. Regular pelvic floor muscle strengthening exercises can reduce the risk of urinary incontinence by 62% in late pregnancy and by 29% in the 3-6 months postpartum [16,17]. As suggested by the International Continence Society (ICS), pelvic floor muscle training is considered a first-line treatment to provide support to the pelvic organs and assist in effective contraction of the urethral sphincter muscles, resulting in improvements in urinary incontinence [18-20]. Clinicians can assess the myoelectric activation of the pelvic floor muscles and train them using electromyographic biofeedback (EMG-BF). Biofeedback therapy can be considered an adjunct to PFMT and is designed to assess muscle integrity and allow both the patient and physiotherapist to observe normal PFM contraction and diastole, thus facilitating neuromuscular learning or re-adaptation in cases of pelvic floor dysfunction [21]. Improving pelvic floor muscle function not only helps prevent UI, but also contributes to the overall health and quality of life of women after pregnancy and childbirth [22,23]. The aim of this research paper is to bring together existing knowledge on the effects of hormones on the functional status of pelvic floor muscles and the impact of biofeedback therapy for urinary incontinence due to pregnancy.

Materials and methods

This section provides a systematic review of studies, articles and books related to the anatomy, diagnosis and therapy of urinary incontinence. The literature collected covers the period from January 1984 to June 2024.

Data sources and search strategy

The data sources used to identify scientific articles were Web of Science, PubMed, and the Cochrane Library. Searches were conducted from June to August 2024. We used the following keywords to search for scientific papers: Pelvic floor, biofeedback, rehabilitation, hormones, childbirth, pregnancy.

Hormones that affect tissues during pregnancy/birth

Unlike other smooth muscle, uterine muscle is largely under hormonal control. Of these, the steroid hormones, progesterone and oestrogen, play a dominant role in terms of uterine growth, maintenance of quiescence during pregnancy and preparation of the uterine tissues for labour and delivery. In addition to the steroid hormones, there are several factors that modulate uterine muscle contractility (oxytocin, prostaglandins, endothelin, platelet-activating factor) and relaxation (corticotropin-releasing hormone, prostacyclin, nitric oxide [24-26].

Progesterone is secreted by the corpus luteum of the ovary during the first ten weeks and later by the placenta as pregnancy progresses. The shift in progesterone production from the corpus luteum to the placenta generally occurs after the tenth week. The placenta is sufficiently developed to secrete hormones between ten and twelve weeks of gestation. [27,28]. As the due date approaches, progesterone levels in the blood range from 100-200 ng/ml and the placenta produces around 250 mg/day. Almost all the progesterone produced by the placenta goes directly to the placenta, unlike oestrogen. Progesterone is produced independently of factors such as foetal status or the presence of precursors, among others. At the beginning of pregnancy, the level of 17 a-hydroxyprogesterone (hydroxylase 17a) in the mother increases, which signifies the activity of the corpus luteum. This happens to prevent preterm birth. Progesterone is also important in suppressing the mother's immune response to foetal antigens, thus preventing maternal rejection of the trophoblast. And, of course, progesterone pre-

pares and maintains the endometrium to allow earlier implantation by the tenth week of pregnancy, this compound returns to baseline levels, indicating that the placenta has little 17a hydroxylase activity. However, from about week 32 onwards there is a second, more gradual increase in 17a-hydroxyprogesterone due to the placenta's use of fetal precursors. [29,30]. Progesterone (P4), acting through its receptor (PR), is essential for the maintenance of pregnancy. P4 acts by suppressing uterine contractility and the expression of contraction-associated proteins (CAPs) such as connexin 43 (Cx43). P4 levels must be decreased, or its actions blocked to allow increased CAP gene expression and initiation of labour [31,32].

The placenta is the main source of oestrogen, and oestrogen concentrations increase in the maternal circulation with gestational age. The oestrogen/progesterone ratio begins to favour oestrogen [33,34]. Oestrogen alone does not cause uterine contractions during labour but promotes a number in muscle tissue including an increase in prostaglandin receptors, oxytocin receptors and upregulation of enzymes responsible for muscle contractions (myosin light chain kinase, calmodulin) [31], which enhance the ability of the myometrium to generate contractions. The synthesis of connexin 43 and the formation of gap junctions in the myometrium, enable the uterus to make synchronised contractions. Oestrogens also control cervical maturation, through the regrouping and realignment of collagen [34,35].

An increase in oestrogen activity and a decrease in progesterone activity at term leads to a few subtle changes leading to increased prostaglandin synthesis and mainly to an increase in oxytocin receptor concentrations in the uterine myometrium and the decidua. Oxytocin from the foetal and maternal side stimulates contractions in the myometrium and prostaglandin synthesis in the decidua leading to the onset of labour. As cervical dilation progresses, prostaglandin synthesis is further stimulated; these prostaglandins together with increased plasma oxytocin levels in the second stage of labour lead to foetal expulsion. After delivery, prostaglandin synthesis in the placenta leads to placental detachment and expulsion. [33,36] Oxytocin is a peptide hormone that plays a key role in the regulation of the female reproductive system, including during labour and lactation. It is produced primarily in the hypothalamus and secreted by the posterior pituitary gland. Oxytocin can also be administered as a drug to initiate or intensify uterine contractions [37,38]. Oxytocin is a potent and specific stimulator of uterine contractions. Oxytocin receptor expression in the uterine muscles, measured as specific binding of radioactive oxytocin to cell membrane fractions, increases approximately 12-fold from early pregnancy (13-17 weeks) to term, with a further increase occurring during labour [24]. During labour, there is increased pulsatile oxytocin secretion by the pituitary gland and increased expression and affinity for oxytocin in the uterine myometrium and the temporum. Circulating oxytocin does not increase towards the end of pregnancy, but the concentration of oxytocin in the uterus increases towards the end of pregnancy, so that oxytocin acts more efficiently as labour progresses. Placental oxytocin acts directly on the uterine muscle to cause contractions and indirectly by regulating the production of prostaglandins, especially prostaglandin F2 (PGF2) by the endometrium. PGF2, on the other hand, is mainly produced by the uterus by the temporalis and acts on the uterine muscle by regulating the use of oxytocin to contract the uterine muscle.

Prostaglandins play a major role in the mechanism of labour, the reason for this appears to be the 3-fold action of prostaglandins: stimulation of uterine muscle contractions, softening of the cervix, and induction of gap junctions. In addition, prostaglandins produced in the placenta play a major role in the mechanism of placental separation and expulsion [33].

Relaxin has multiple effects on the reproductive system, including vascularization of the endometrium and connective tissue remodelling leading to structural changes associated with joint and tendon relaxation and cervical softening in preparation for labour. Circulating relaxin is a product of the corpus luteum of pregnancy, which is present in the ovary throughout pregnancy. However, relaxin is also a product of the placenta and the fossa and acts locally [34].

Biofeedback therapy

Biofeedback therapy is an innovative approach in the rehabilitation of weakened pelvic floor structures that are often damaged by childbirth. With the ability to monitor and visualise muscle function, biofeedback supports patients in learning and improving pelvic floor muscle (PFM) control [39,40]. This therapy accurately reproduces correct muscle contractions, crucial for the rehabilitation process after childbirth. Biofeedback makes it possible to record muscle activity using various technologies, such as sEMG (surface electromyography) or ultrasonography [3,41]. Muscle potential sensors (sEMG) placed in the pelvic floor area record the electrical signals generated by muscle contractions, allowing them to be visualised in real time. This allows patients to observe and improve the quality of their muscle contractions, increasing their awareness and control of their muscles [42,43]. Ultrasound, used as an adjunctive method of biofeedback, additionally allows real-time visualisation of anatomical structures. With transabdominal imaging (TAUS), both conscious and reflex activation of the pelvic floor muscles can be assessed. This technique is non-invasive and allows the observation of changes in muscle tone during different activities, such as coughing or sneezing, which is particularly important for the assessment of muscle support functions

[44]. Biofeedback therapy is particularly effective in treating pelvic floor muscle dysfunctions, such as urinary and faecal incontinence, which often occur in women after childbirth. Studies have shown that training the pelvic floor muscles using biofeedback can lead to significant improvements in the control of these muscles, resulting in a reduction in incontinence symptoms [45]. For example, in a study of patients with postpartum pelvic girdle pain, the use of biofeedback in combination with stabilisation exercises led to significant reduction in pain and disability [46].

Review of research

One of the largest studies on the treatment of urinary incontinence following pregnancy using biofeedback is that by Hagen et al. At the start of the study, 600 women, over 18 years of age, diagnosed with stress or mixed urinary incontinence were included. The control group received pelvic floor muscle training (PFMT, n=225) at home while the study group received PFMT and biofeedback exercises at home (n=235). Participants in both groups were offered six face-to-face meetings (weeks 0, 1, 3, 6, 10 and 15) with a therapist. Improvements in incontinence were observed in both groups included in the study, with 8% of women in each group reporting a cure, while after 24 months, 60% in the biofeedback group and 63% in the PFMT group reported improvement. The results demonstrated no statistically significant or clinically meaningful difference in the severity of incontinence after 24 months. The authors report that the routine use of electromyographic biofeedback with PFMT should not be recommended, and other treatments for urinary incontinence should be sought [47].

In the study by Hirakawa et al. 46 female participants suffering from stress urinary incontinence were divided into two groups – the PFMT group (control group) and the PFMT group with biofeedback therapy (study group). All patients visited the same physiotherapist five times, at the beginning of the study, at weeks 2, 4, 8 and 12. The women in the study were given verbal and written instructions to perform the exercises at home, asking them to do them twice a day. The home programme included ten sustained maximal muscle contractions with tension held for 5 seconds and relaxation for 10 seconds, followed by ten rapid maximal contractions with 2-second tension and 4-second relaxation. These exercises took the form of strength and endurance training, performed twice with a 1-min rest break. Each woman in the study group received an individual EMG-assisted home training device. The study found no differences between groups in King's Health Questionnaire parameters (measuring incontinence-related quality of life) after 12 weeks [48].

Fitz et al. conducted a study comparing the results of incontinence therapy using PFMT with Biofeedback therapy (study group – BF group) and PFMT alone (control group – PFMT group). A total of 72 women participated in the study and were divided into two groups. Patients were assessed at the start of treatment, after three months of supervised treatment and after nine months of follow-up. The study observed a decrease in interest in exercise among the patients in the period after the 3-month supervised treatment. The study showed no statistically significant differences between the groups, and the researchers emphasise the need for further research [49].

In a study conducted by Özlüet al. 53 women with stress urinary incontinence were examined and treated. In the first group (n=18), a carefully prepared PFMT set was used at home, in the second group (n=17) the participants underwent PFMT therapy at home with additional perineal biofeedback therapy in an outpatient setting, while the third group (n=18) used a PFMT exercise programme at home and a hospital-supervised PFMT exercise programme assisted by perineal EMG-BF. The results of the study show the superiority of biofeedback exercises, while therapies using perineal biofeedback or vaginal pressure biofeedback were similarly effective and can be used as acceptable alternatives and should be considered as reasonably conservative treatments [50].

Sahin et al. conducted a study comparing the effectiveness of vaginal cone PFMT versus biofeedback PFMT incontinence therapy. The study involved 40 women, diagnosed with stress urinary incontinence, who were allocated to two groups. The first group (n=20) used PFMT with a vaginal cone at home while the second group (n=20) used PFMT with EMG biofeedback in hospital. Measurement of incontinence severity using the 1-hour pad test, assessment of social activity using the Social Activity Index (SAI), assessment of incontinence-specific quality of life, manual measurement of pelvic floor muscle strength and assessment of satisfaction with treatment were carried out in the pre- and post-intervention periods (after 3 and 6 months). Improvements were observed in the pad test, muscle strength, SAI, quality of life and treatment satisfaction measure compared with the pre-treatment period while no statistically significant differences were found between treatments [51].

Conlcusions

Biofeedback is a valuable tool in the rehabilitation of pelvic floor muscles after childbirth. It enables patients to better understand, and control weakened structures, which can lead to an improvement in the function of these muscles and a reduction in symptoms such as incontinence. Although biofeedback therapy has some limitations, its use in combination with other therapies can bring significant benefits to postpartum patients.

Ethical approval
This study is not related to either human or animal use.

Acknowledgments
Not applicable.

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Conflict of interest
The authors declare no conflict of interest.

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