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CAN MAXIMAL VOLUNTARY PELVIC FLOOR MUSCLE CONTRACTION REDUCE VAGINAL RESTING PRESSURE AND RESTING EMG ACTIVITY?

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Effect of pelvic floor muscle contraction on resting muscle activity.

ABSTRACT

Objective: The purpose of the present study was to assess whether attempts of a maximal voluntary pelvic floor muscle contraction can reduce vaginal resting pressure (VRP), and surface EMG activity in women with and without provoked vestibulodynia (PVD).

Study Design: An assessor blinded comparison study included 35 women with and 35 women without PVD. VRP and PFM strength were measured with a high precision pressure transducer connected to a vaginal balloon (Camtech AS, Sandvika Norway). Pelvic floor muscle activity was measured before and after three MVCs with surface EMG (NeuroTrac ETS™ , Verity Medical Ltd, UK). Paired sample T-test was used to analyze difference within groups and independent sample T-test to analyze differences between groups. P-value was set to <0.05

Results: Mean age of the participants was 24.3 years (SD 4.7) and mean BMI was 22.0 kg/m^2 (SD 2.6). There were no significant differences between the groups in any background variables. PFM contraction lead to a statistically significant reduction of VRP in both the PVD (p=0.001) and the control group (p=0.027). Surface EMG activity was significantly reduced in the PVD group only (p=0.001).

Conclusion: Young, nulliparous women with PVD had significantly lower vaginal resting pressure and sEMG activity after three maximum contractions of the PFM. The results indicate that attempts of voluntary maximal contractions may be investigated as a method to reduce PFM hypertonicity.

Key words: contraction-relaxation method, hypertonicity, muscle activity, pelvic floor muscle, provoked vestibulodynia, vaginal resting pressure

Brief summary:

Maximal voluntary contraction of the pelvic floor muscles significantly reduced vaginal resting pressure and sEMG activity in young, nulliparous women with provoked vestibulodynia.

INTRODUCTION

The ICS/IUGA joint report of conservative management of female pelvic floor dysfunction has defined pelvic floor muscle (PFM) hypertonicity as “an increase in muscle tone related to the contractile and the viscoelastic components that can be associated with either elevated contractile activity and/or passive stiffness in the muscle” [1]

Hypertonicity of the PFM is difficult to assess and quantify, and there is no consensus of a specific cut off point for the condition. Manometry and dynamometry, assessing vaginal resting pressure (VRP) and resting surface EMG (sEMG) have been suggested as methods to assess the condition. It has been claimed that PFM hypertonicity is associated with bladder pain, defecation disorders and chronic pelvic pain [2]. In addition, "vaginal overactivity", lack of pelvic floor muscle strength and “restriction of the vaginal opening” have been hypothesized to be associated with Provoked vestibulodynia (PVD) [3;4]. To date there are few studies assessing these variables in women with PVD compared to controls and the reported findings on hypertonicity of the PFM are contradictory [4-9].

In clinical practice, physical therapists may use different methods, e.g. manual techniques, such as stretching and massage or PFM contractions with or without biofeedback in attempts to reduce muscle tonicity [1]. A commonly used intervention is the “contract –relax” method [10]. Sherman et al refers that this method is based on the theory that a reduction in excitability occurs after a muscle contraction, and that this reduction in excitability allows the muscle fibers to elongate. [11]. However, we have not been able to find studies measuring the effect of this method on the PFM.

The purpose of the present study was to assess if there is a reduction in VRP and sEMG activity after PFM contraction, and to compare a possible difference in women with PVD and asymptomatic controls.

MATERIAL AND METHODS

This was an assessor blinded comparison study, thirty-five cases diagnosed with PVD were compared to a group of 35 healthy controls. The applied terminology follows recommendations from the International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for the conservative and non-pharmacological management of female pelvic floor dysfunction except when specifically noted [1;12]. Study approval was obtained from the regional Committee for Medical and Health Ethics South-East (REK South-East D) (2010/3257-1). All subjects gave written informed consent.

Participants

Women between 18–38 years of age were recruited for the study via gynecologists at the Oslo University Hospital and in private practice. Controls were recruited via the internet, advertising and through friends of women with PVD and colleagues at the university.

Inclusion criteria for the case group were being nulliparous, diagnosed with PVD according to the International Society for the Study of Vulvovaginal Disease (ISSVD) 2003, provoked discomfort and/or pain triggered by sexual or nonsexual contact (intromission, clothing pressure, tampon insertion, fingertip pressure, q-tip pressure) and ability to understand Scandinavian languages. Detailed information about the study participants was described in Næss & Bø [8]. Inclusion criteria for the control group were being nulliparous and age <38 years and exclusion criteria was any history of vaginal/genital pain. Inclusion criterion for both groups were the ability to perform a correct PFM contraction.

Procedure

Ability to perform a correct PFM contraction, defined as a squeeze around the pelvic openings and a lift of the perineum, was first assessed by observation and vaginal palpation by one trained pelvic floor physical therapist (IN). The actual measurement with manometry and sEMG were done by one of two other trained pelvic floor physical therapist blinded to group affiliation. Only contractions involving inward movement of the perineum were considered valid PFM contractions [13]. The measurements were analyzed off line at a later stage.

Vaginal pressure measurement was performed first, followed by sEMG. After insertion of the manometry probe the participants were asked to relax till a stable line was visualized on the screen.

They were then asked to perform three MVC contractions. The two first MVCs lasted of approximately 8 seconds, the third contraction lasted approximately 10-12 seconds, with at least 10 seconds resting time in between each contraction. The off line measurement was done at five to six seconds after each PFM contraction and a mean of three resting values was calculated. The same procedure was repeated with sEMG, allowing at least 5 minutes resting period due to change of apparatus and insertion of the new probe. Data were collected in one physical therapy outpatient clinic in Oslo, Norway. All measurements were done at the first consultation, and only newly referred patients were included.

Primary outcome measures

Manometer

Measurement of tonicity was done with a high precision pressure transducer connected to a balloon catheter, balloon size 6.7 × 1.7 cm, (Camtech AS, Sandvika Norway). The ICC for intra- and interrater reliability of VRP has been found to be ICC >0.90 [14]. The balloon was placed with the center of the balloon 3.5 cm from the introitus [13]. All measurements were done in supine crook-lying position (patient on her back-with flexed knees and hips and feet on the bench). VRP was measured as the difference between atmospheric pressure and the vaginal pressure at rest, without any voluntary PFM contraction and registered as cm H_2O [15].

Surface Electromyography (sEMG)

Intravaginal surface EMG (sEMG) was used to measure electrical activity (generated at the cell membrane of the muscle fibers) in the PFM. PFM activity, was measured in microvolt (µV) with a NeuroTrac ETS™ sEMG signal processing unit (Verity Medical Ltd, UK).

The sEMG probe used was the Anuform™ anal probe, provided by Neen, Mobilis Health Care Group, United Kingdom. The Anuform™ anal probe is a single-patient probe. Due to reported discomfort during insertion of a vaginal probe [6], a smaller anal probe was chosen.

The anal probe was inserted vaginally with the electrodes placed in the 3 and 9 o'clock positions and the ring in a vertical position.

sEMG assessment has demonstrated good test-retest reliability in healthy women [16]. All measurements were done in supine crook-lying position.

Statistical analysis

The Statistical Package for Social Science (SPSS), version 20.0 (SPSS Inc., Chicago, IL, USA), was used for statistical analyses. Background variables and symptoms of PVD are reported as numbers of women with percentages or means with standard deviation (SD). Difference between groups in background variables are tested with the Independent sample T-test. PFM variables are reported as means with SD. The Paired sample T-test was used to analyze change in VRP (manometry) and muscle activity (sEMG) within groups. The P-value was set to <0.05.

RESULTS

Background variables of the participants have been presented in detail in Næss & Bø [8]. There were no statistically significant differences in demographic, pelvic floor exercising habits or health variables between the groups.

Manometer

Table 1 presents vaginal resting pressure before the first contraction and after three maximal voluntary contractions. There was a significant reduction of vaginal resting pressure in both the PVD ($p = 0.001$) and the control group ($p = 0.027$) after PFM contraction.

Surface EMG

sEMG activity was significantly reduced in the PVD group after PFM contraction (p = 0.001) whereas no statistically significant difference was found in the control group. (Table 1)

DISCUSSION

This study found a significant reduction of vaginal resting pressure in both the PVD and the control group after PFM contraction. sEMG activity significantly reduced in the PVD group whereas no statistically significant difference was found in the control group on this variable. Why the sEMG activity was not changed in the control group is difficult to understand. Maybe such changes cannot be expected in healthy young women. The control group had higher activation than the PVD group before and during the PFM contraction and also had better PFM endurance as reported in a previously published study [8]. This may have influenced the sEMG, but it is difficult to understand why it did not affect the manometry data in the same way, and the phenomenon needs further investigation.

To date, we have only been able to find two studies using vaginal pressure/manometry [8;17] and three studies using sEMG [3;5;9] to measure PFM function in women with PVD. Some studies exploring women with PVD have reported differences in PFM activity, contractility and tender pelvic muscles, [3;7;18;19] but there are also studies reporting no difference or contradictory results [6;8;17;20]. Different findings may be due to differences in the populations studied and use of different assessment methods [21]. Some of the research groups mentioned above have used vaginal palpation. In general, the responsiveness, reliability and validity of vaginal palpation have been questioned and may be one explanation for the different findings [22]. In a recent published study, Morin et al compared 56 women with and 56 without PVD using dynamometer and sEMG, and found greater PFM resting forces and stiffness measured with a dynamometric speculum in the group with PVD [9]. In a former reported 4D ultrasound study they also found that women with PVD had a significantly smaller levator hiatus area, a smaller anorectal angle and a larger levator angle plate at rest compared with controls, suggesting that this may have been caused by an increased PFM tone[23]. Observed increased resting pressure or activity in women with PVD may be linked to “the guarding response” described by Reissing et al. [4]. However, the study designs of the above mentioned studies do not allow for determination of causality, and we still do not know whether pain causes hypertonicity or whether hypertonicity causes pain [24].

In a systematic review Morin et al [21] found that physical therapists used a myriad of different treatment modalities such as PFM contraction and relaxation with or without biofeedback, dilators, stretching, massage, trigger point treatment and general body relaxation techniques to reduce PFM tonicity and treat PVD. Relaxation has been defined as "the ability to control muscle activity such that muscles not specifically required for a task are quiet, and those that are required are fired with the minimal level needed to achieve the desired results" [1]. Relaxation techniques can be general (a technique that involves the whole body, e.g. Jacobsen) [10] or local: a technique involving one muscle or a muscle group, e.g. proprioceptive neuromuscular facilitation technique [11]. The contract-relax method and the contract-relax-antagonist-contract method are frequently used techniques that has shown to be effective in increasing range of motion [25]. Autogenic inhibition, causing relaxation after contraction of the target muscle, has long been the explanation for the positive effect of the contract- relax technique. However, to date, although proven to be effective, this neurophysiological explanation is debated [25]. In the present study we investigated whether applying the contract relax method on the PFM, would cause PFM relaxation. Our study showed a statistically significant reduction in vaginal resting pressure and muscular activation after three MVCs in both the PVD and in resting pressure in the control group. The control group showed no significant reduction in sEMG.

To date there are only few published studies evaluating the effect of physical therapy modalities on PVD. In a systematic review Morin et al [21] found seven RCTs, but most of these studies had a high risk of bias, mainly associated with an insufficient sample size, use of non-validated outcomes, non-standardized interventions and ongoing treatments. Most of the interventions included multi-model physical therapy and none evaluated whether a PFM contraction reduced PFM tonicity. We have only been able to find one published study utilizing the contract –relax technique as the intervention. Chmielewska et al [26] included healthy, continent nulliparous women to perform PFM strength training with biofeedback. They found a significant reduction in PFM resting activity measured with sEMG in standing and supine lying after six weeks of training, and indicated that PFM biofeedback training may enhance PFM relaxation. [26]. Their study showed a larger reduction in sEMG than what was found in the present study [8]. However, Chmielewska et al [26] investigated the effect of a six-week program, did not include a control group and assessors were not blinded. We hypothesize that contracting the PFM can be used as a muscle relaxation technique, but there is a need for randomized controlled trials of high methodological quality applying this technique in women with diagnosed hypertonicity to explore this question.

One strength of the present study is that we included a sample of homogenous women, all nulliparous and at same age. The participants were diagnosed to have PVD by gynecologists according to current guidelines [8] and the measurements were done by blinded assessors. The two physical therapists assessing the patients had long experience in assessing pain patients and followed a strict procedure. In addition, we used a high-precision pressure transducer found to be responsive, reliable and valid [13;27]. Results from test-retest reliability studies have found a high ICC using the same sEMG device and anal probe as in our study [28]. However, in spite of acceptable reliability, the validity of sEMG can be questioned, mostly due to the high risk of cross-talk from nearby muscle groups [29]. However, in the present study the participants were instructed to avoid co-contractions of the gluteal, hip adductor and abdominal muscles and all participants had thorough instruction, with vaginal palpation, in how to perform the contractions before the assessments. If co-contractions were observed, practice continued until no co-contraction was occurred.

Limitations of the study are the age ranging only from 18 – 38. Hence the results can not be generalized to other age groups. As the case group included women with PVD we did not collect any data on pain before and after the PFM contractions. In addition, this study assessed only the acute effect of contractions of the PFM on resting pressure and resting tone. Future randomized controlled trials to assess the effect of PFM contractions to reduce tone over time are warranted. It is also essential to evaluate the effect of such a program on pain and to correlate a possible reduction in tone with a reduction of pain.

CONCLUSION

Young, nulliparous women with PVD had significantly lower vaginal resting pressure and sEMG activity after contraction of the PFM. Randomized controlled trials are needed to assess the effect of this relaxation technique on PFM tonicity and pain.

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Table 1. Manometry measures the vaginal resting pressure (VRP) and surface EMG measures the vaginal resting activity (VRA) before and after 3 maximum voluntary contractions (MVC) N=70 (69) in women with Provoked Vestibulodynia (PVD) and controls. Means with standard deviations (SD).

	VRP before first contraction (manometry)	VRP after 3 MVC (manometry)	P-value
PVD N=35 cm H_2O(SD)	20.6(7.1)	17.7(5.9)	0.001
Controls N=35 cm H_2O(SD)	17.8(4.4)	16.1(4.4)	0.027
	VRA before first contraction (sEMG)	VRA after 3 MVC (sEMG)	
PVD N=34 µV(SD)	13.5(7.1)	11.1(7.9)	0.001
Controls N=35 µV(SD)	16.9(16.4)	12.8(7.2)	0.162