Electrostimulation and pelvic floor muscle training: immediate effect after one single session

Eletroestimulação e treinamento dos músculos do assoalho pélvico: efeito imediato após uma sessão

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Abstract

Introduction: Pelvic floor muscle training (PFMT) and neuromuscular electrical stimulation (NMES) are physiotherapeutic conservative treatments to prevent and to treat pelvic floor dysfunctions. **Objective:** To investigate the immediate effect of one session of PFMT versus NMES associated to pelvic floor muscle (PFM) contraction on the PFM function in nulliparous women. **Methods:** This is a cross-sectional experimental study. Twenty women were randomized into the "PFMT Group" and "NMES Group". PFM function evaluation was performed by vaginal palpation and manometry before and after a single session. PFMT was composed by one series of eight sustained contractions of 6 seconds and one series of four fast contractions, in four different positions. NMES parameters were: biphasic pulsed current; frequency: 50 Hz; pulse duration: 0.7 ms; cycle on:off 4:8s; rise/decay: 2/2s, time: 20 minutes; and intensity: participant' sensibility. Data was analyzed by the ANOVA two-way for repeated measures to verify the difference between groups, within group and the interactions for PFM function. A 5% probability was considered in all tests. **Results:** There were no significant differences between groups. At intra-group analysis, there was a significant decrease in the maximal voluntary contraction ($p = 0.01$), by manometry, between pre- and post-session for both groups. **Conclusion:** The immediate effects of a single session of PFMT and NMES associated with voluntary PFM contraction are similar on PFM function, that is, no difference was found between groups.

Keywords: Electric stimulation. Endurance training. Muscle fatigue. Muscle strength. Pelvic floor.

Resumo

Introdução: *O treinamento dos músculos do assoalho pélvico (TMAP) e estimulação elétrica neuromuscular (EENM) são recursos fisioterapêuticos utilizados para prevenir e reabilitar de forma conservadora as disfunções do assoalho pélvico.* ***Objetivo:*** *Investigar o efeito imediato de uma sessão de TMAP versus EENM associada à contração dos músculos do assoalho pélvico (MAP) sobre a função dos MAP em mulheres nulíparas.* ***Métodos:*** *Estudo experimental transversal. Vinte mulheres foram randomizadas em "Grupo TMAP" e "Grupo EENM". A avaliação da função dos MAP foi realizada por palpação vaginal e manometria, antes e após uma única sessão. O TMAP foi composto por uma série de oito contrações sustentadas de 6 segundos e uma série de quatro contrações rápidas, em quatro posições diferentes. Os parâmetros de EENM foram: corrente bifásica pulsada; frequência: 50 Hz; duração do pulso: 0,7 ms; ciclo on:off 4:8s; subida/descida: 2/2s; tempo: 20 minutos; e intensidade: sensibilidade da participante. O teste de ANOVA two-way para medidas repetidas foi aplicado para verificar a diferença intra e entre grupos e as interações para as variáveis da função dos MAP. Considerou-se nível de significância de 5% em todos os testes.* ***Resultados:*** *Não houve diferenças significativas na comparação entre grupos. Na análise intragrupo houve diminuição significativa da variável contração voluntária máxima (p = 0,01), por manometria, entre pré e pós-sessão para ambos os grupos.* ***Conclusão:*** *Os efeitos imediatos de uma única sessão de TMAP e EENM associados à contração voluntária dos MAP são semelhantes na função dos MAP, ou seja, nenhuma diferença foi observada entre os grupos.*

Palavras-chave: *Estimulação elétrica. Treinamento de endurance. Fadiga muscular. Força muscular. Assoalho pélvico.*

Introduction

The pelvic floor muscles (PFM) are subdivided into superficial and deep muscles. Therefore, PFM works as an unit and act together in order to promote the support of pelvic organs, sexual function and maintenance of urinary and fecal continence.[1] When PFM are integrated, PFM contract and relax voluntarily and involuntarily. A correct contraction of PFM results in an "up and in" movement of the pelvic cavity.[2] During a voluntary contraction, there is a recruitment of connective tissues, fascias and ligaments that reinforce the contraction movement, supporting the pelvic organs and softening the impact of intra-abdominal pressure.[3]

An incorrect PFM contraction is associated to an incomplete PFM recruitment, which may be related to the prevalence of dysfunctions.[4] Previous studies already indicated many physiotherapeutic techniques to treat and to prevent PFM dysfunctions. Among them, the pelvic floor muscles training (PFMT) is indicated as the first-line to treat urinary incontinence (UI).[5]

In addition, neuromuscular electrical stimulation (NMES) is a technique that aim to strength the PFM by stimulating the efferent motor fibers of the pudendal nerve, which causes the direct contraction of PFM or the striated periurethral musculature, enabling the mechanism of urethral sphincter closure.[6] NMES can be applied by the insertion of an intravaginal device that will directly stimulate the PFM to contract and relax.[7] Moreover, NMES can be associated to voluntary PFM contraction: concomitantly to the passage of electrical stimulation current, the physiotherapist may encourage the woman to perform voluntary PFM contractions. However, it is still inconclusive if the association of both methods is efficient to treat urinary symptoms.[8]

PFMT and NMES are considered conservative and preventive treatments for PFM dysfunctions.[8,9] In addition, both techniques may be applied to increase body and PFM awareness, which may be related to the improvement of PFM function.[10] However, previous studies only aimed to investigate the effect of both techniques in a long-term when treating some PFM dysfunction, especially UI.[8,9] It is still not known if a single session of either therapy may be associated to a PFM function improvement. Thus, the aim of the present study was to investigate the immediate effect of one session of PFMT versus NMES associated to PFM contraction on the PFM function in nulliparous women.

Methods

Study design

This is a cross-sectional study conducted according to the guidelines of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE), performed at the Women's Health Research Laboratory, Department of Physical Therapy, Federal University of São Carlos (UFSCar). This study was approved by the Ethics and Research Committee of UFSCar, CAAE: 23038019.2.0000.5504. All participants received an explanation about the study and gave their written informed consent.

Participants

Participants were recruited by social media, newspaper and folders. Women were included if they had 18 years old or more and if they were sexually active. They were excluded if they were pregnant or if they were in the postpartum period; had some vaginal infection and/or urinary tract infection; were unable to perform a voluntary PFM contract; had neurological disease, motor or neurological deficit of lower limbs; had been submitted to a previous surgical procedure in pelvic or abdominal region; had presence of pelvic organ prolapse that reached and/or exceeded the vaginal opening; intolerance to vaginal palpation or introduction of the manometer probe or the vaginal electrostimulation electrode; had difficulty in understanding the evaluations and the treatments techniques; were in physical therapy treatment for PFM dysfunctions.

Sample size calculation and randomization

The sample size calculation was performed using the G*Power 3.1.9.2 software, with a significance level of 5% and test power of 80%, resulting in a total of 20 participants. Participants were randomized into two groups: PFMT and NMES associated to PFM contraction.

The allocation of the participants was conducted by a blinded examiner (Physiotherapist A) who was not involved with the physical evaluation and the treatment of the participants. The randomization, with an allocation rate of 1:1, was conducted with a brown envelope. Twenty pieces of paper in a rectangular shape of two different colors (10 of each color) corresponding to both treatment techniques were used. Participant were encouraged to take one piece of paper from the envelope and then Physiotherapist A wrote down the color chose.

Questionnaires

To investigate the urogynecological historic of the participants, Physiotherapist A conducted a subjective evaluation by filling a questionnaire produced by the researchers. This questionnaire contained questions related to the personal, sociodemographic and urogynecological history. Sequentially, in order to investigate the degree of discomfort related to PFM dysfunctions, the Pelvic Floor Distress Inventory (PFDI-20), translated and validated into Brazilian Portuguese[11] was applied.

The questionnaire consists of questions from three different instruments (Pelvic Organ Prolapse Distress Inventory, POPDI-6; Colorectal-Anal Distress Inventory, CRADI-8; Urinary Distress Inventory, UDI-6) and assesses 20 symptoms of urinary, intestinal, and vaginal tract disorders. There are six items in the questionnaire that assess the symptoms of prolapse, eight questions related to anorectal symptoms and six questions for urinary symptoms. Affirmative answers are rated on a scale from 1 to 4 (1 = no discomfort; 2 = little; 3 = moderately; 4 = a lot). Each sub-questionnaire has a score from 0 to 100 and the highest score indicates the greatest discomfort related to the symptoms. The final score is obtained by adding the scores of the sub-questionnaires and ranges from 0 to 300, with the highest score indicating the greatest discomfort.[11]

PFM assessment

The PFM function was assessed by vaginal palpation and manometry. The second examiner, Physiotherapist B, who was blinded to the participant's allocation and to the subjective assessment, conducted the physical assessment before (pre-treatment) and 10 minutes (post-treatment) after the intervention.

Participants remained in the supine position with the hips and knees flexed at 45°.[12] During the evaluation, participants were instructed about how to perform a PFM contraction by the following verbal commands: 1. "Contract the pelvic floor muscles as if you were holding urine"; 2. "Make a movement with the muscles upwards and inwards"; 3. "Try not to contract the abdomen, gluteus or leg muscles while contracting the pelvic floor muscles"; 4. "Inhale when your muscles are relaxed and exhale when you are contracting your muscles".

During vaginal palpation, the physiotherapist assessed the PFM function by the maximal voluntary contractions (MVC) and endurance of PFM. Gloves and lubricant gel were used by the Physiotherapist B during the assessment. The reliability of bidigital vaginal palpation, conducted by the same examiner who performed the PFM assessment at the present study, was reported in a previous study and is considered substantial (κw = 0.75).[13] Three MVC with an interval of 1 minute between each contraction were requested and were classified by the Modified Oxford Scale (MOS)[14] (0 = absence of contraction; 1 = flicker; 2 = weak; 3 = moderate; 4 = good; 5 = strong). The mean obtained from the three measurements was considered for analysis.

To evaluate the endurance, the examiner requested a sustained MVC and counted in seconds how long women were able to maintain the PFM contraction with the same degree of contraction that they presented in the MVC assessment. Time was counted in seconds and the maximal time considered were ten seconds. Three sustained voluntary contractions were request, with one minute of rest between them. The average obtained from the three measurements was included in data analysis.

Five minutes after vaginal palpation, MVC were evaluated by the Peritron® manometer (Cardio Design Pty Ltd, Oakleigh, Victoria, Australia), graded from 0 to 300 cmH_2O, with a vaginal probe (28 x 55 mm) attached. The probe was involved by a condom and lubricating gel was added to the probe before the insertion. The participants remained at the same position adopted during vaginal palpation. The device's vaginal probe was inserted 3.5 cm into the vagina, the place with highest pressure.[15] Three repetitions of the MVC were performed with three seconds duration, with an interval of one minute of rest between them. For analysis, the average of the three contractions was used.

Intervention

Both interventions were individual, occurred in a single session and were supervised by the Physiotherapist C, who was not involved with randomization and evaluations. To perform the PFMT, a supervised protocol was adapted from Bø et al.,[16] with 20 minutes of duration. During the PFMT, four different positions were adopted: (1) supine position with the hips and knees flexed at 45°; (2) on the knees; (3) sitting on the Swiss ball with the feet resting on the floor; (4) standing against the wall with feet parallel and semi-bent knees. For each of the adopted positions, one series of eight repetitions of sustained contractions of six seconds was performed, with 6 seconds of rest between them. After the series of sustained contraction, four fast contractions of one second were requested. This single session was composed by 32 sustained contractions of 6-seconds contractions and 16 fast of 1-second each of them.

The description of the parameters of NMES is in accordance with the instructions suggested by Barbosa et al.[17] NMES was applied by using a biphasic not polarized pulsed current with a rectangular waveform. Intravaginal probes were used, 19 cm long and 2 cm in diameter, with four metal rings, from the Dualpex 961 device from Quark® (Brazil). During the session, the Physiotherapist C fixed manually the intravaginal probe into the participant's vaginal canal to hold and to maintain the probe inside the vaginal canal during the entire time of electrostimulation. The parameters adopted are presented in Table 1.[18,19]

Table 1 - Neuromuscular Electrical Stimulation parameters

Neuromuscular Electrical Stimulation group parameters	
Frequency (Hz)	50
Pulse duration (ms)	0.7
Cicle on:off (s)	4/8
Time (min)	20
Rise/Decay (s)	2/2
Intensity (mA)	Participant' sensibility

Note: Hz = hertz; ms = milliseconds; s = seconds; min = minutes; mA = milliamperes.

During NMES application, participants were instructed to contract PFM simultaneously to the NMES during time ON, concomitantly with the current passage. Women performed approximately 75 sustained voluntary contractions following the NMES. Participants at the NMES groups did not performed fast contractions. To perform the NMES, the position adopted by the participant was the same requested during PFM assessment.

Statistical analysis

Data was analyzed using software R version 3.4.1 for Windows. The qualitative variables were analyzed according to the frequency and percentage and quantitative variables were assessed by mean and standard deviation. The normality of the data was tested by the Shapiro-Wilk test. The two-way ANOVA test for repeated measures was applied to verify the differences between groups (PFMT Group and NMES Group), intragroup differences (pre- and post-intervention) and the interactions of the variables related to the MVC (assessed by vaginal palpation and manometry) and endurance. In all tests, a 5% probability was considered.

Results and discussion

The present study aimed to assess the immediate effect of the PFMT versus the NMES associated to the PFM contractions on PFM function, evaluated by vaginal palpation and manometry. Previous studies aimed to assess the effects of protocols of intervention of PFMT alone or in combination to the NMES on the quality of life, urine loss and others variables, while treating women with PFM dysfunctions.[8,9] Although, for the author's knowledge, this is the first study to assess the immediate effect of one single intervention on PFM function, which makes difficult to compare the results of the present study with the previous literature.

Twenty nulliparous women were included in the present study. The sample characterization is in Table 2.

At NMES group, none participants reported adverse effects after the session and the initial and final intensity varied on average of 13.3 ± 4.5 and 21.9 ± 7.5, respectively. The study flowchart is presented in Figure 1. No differences were found between PFMT and NMES groups (between groups analysis) for PFM function variables after one session of intervention.

At the intra-group comparison (within groups), there was a significant decreased and significant difference at MVC assessed by manometry for both groups, which suggests a possible fatigue of PFM at the post-session evaluation. No other significant differences were found at intra-analysis for either MVC or endurance, assessed by vaginal palpation. Results are presented in Table 3.

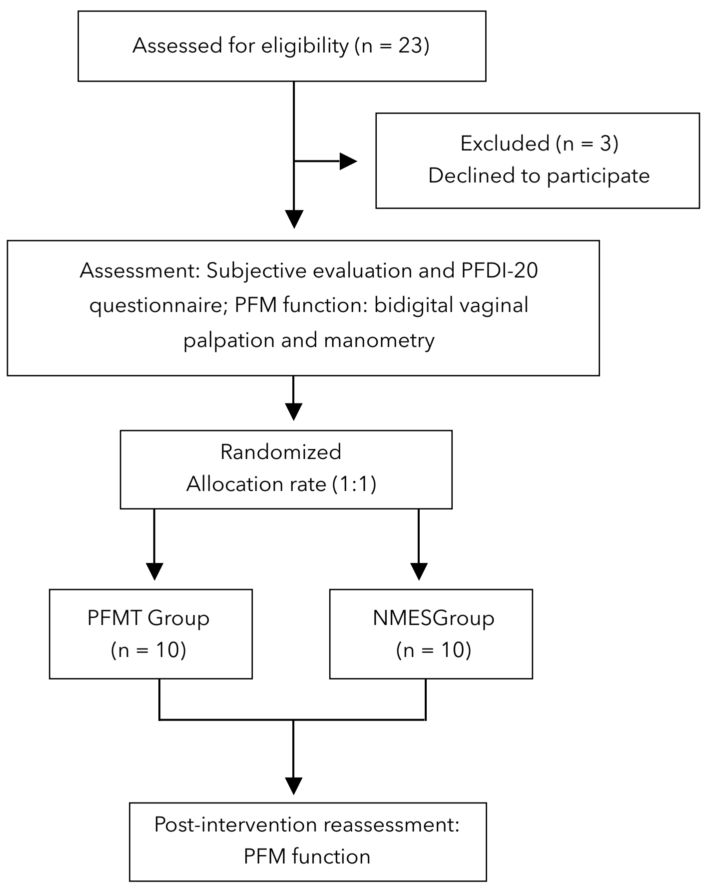

Figure 1 - Study flowchart.

Note: PFDI-20 = Pelvic Floor Distress Inventory; PFM = pelvic floor muscles; PFMT = pelvic floor muscles training; NMES = neuromuscular electrical stimulation.

Table 2 - Sample characterization

Variables	PFMT Group (n = 10)	NMES Group (n = 10)
Age mean (SD)	27.50 (3.83)	26.80 (4.15)
Age mean (SD)	27.50 (3.83)	26.80 (4.15)
Weight (kg) mean (SD)	65.17 (11.45)	61.41 (18.36)
Height (m) mean (SD)	1.61 (0.05)	1.63 (0.05)
Body Mass Index (kg/m²) mean (SD)	24.95 (3.93)	23.00 (6.07)
Occupation	**n (%)**	**n (%)**
Bachelor student	7 (70)	4 (40)
Physiotherapist	3 (30)	5 (50)
Public occupation	0 (0)	1 (10)
Education level	**n (%)**	**n (%)**
Complete graduation education	4 (40)	5 (50)
Incomplete graduation education	2 (20)	1 (10)
Postgraduate education	4 (40)	4 (40)
Ethnics	**n (%)**	**n (%)**
Mixed/Multiple ethnic	2 (20)	1 (10)
African	0 (0)	1 (10)
Caucasian	7 (70)	8 (80)
Not declared	1 (10)	0 (0)
Marital status	**n (%)**	**n (%)**
Single	8 (80)	8 (80)
Married	2 (20)	2 (20)
Physical activity	**n (%)**	**n (%)**
Practice	6 (60)	7 (70)
Do not practice	4 (40)	3 (30)
Menarche	**n (%)**	**n (%)**
11 years	3 (30)	4 (40)
12 years	5 (50)	1 (10)
13 years	1 (10)	2 (20)
14 years	0 (0)	3 (30)
16 years	1 (10)	0 (0)
Colorrectal symtoms	**n (%)**	**n (%)**
Constipation[a]	1 (10)	2 (20)
Anal incontinence[b]	2 (20)	2 (20)
Urinary symptoms	**n (%)**	**n (%)**
Urgency urinary incontinence[c]	0 (0)	1 (10)
Stress urinary Incontinence[d]	2 (20)	1 (10)
PFDI-20 mean (SD)	17.40 (23.62)	19.06 (20.45)
POPDI-6 mean (SD)	3.75 (7.97)	4.58 (7.97)
CRADI-8 mean (SD)	7.81 (7.34)	9.06 (8.65)
UDI-6 mean (SD)	5.83 (11.15)	5.42 (8.34)

Note: SD = standard deviation; PFMT = pelvic floor muscles training; NMES = neuromuscular electrical stimulation; PFDI-20 = Pelvic Floor Distress Inventory; POPDI-6 = Pelvic Organ Prolapse Distress Inventory; CRADI-8 = Colorectal-Anal Distress Inventory; UDI-6 = Urinary Distress Inventory. [a] PFDI-20 question 7; [b] PFDI-20 question 11; [c] PFDI-20 question 16; [d] PFDI-20 question 17.

Table 3 - Analysis of variance and comparisons between and within groups for pelvic floor muscles function before (pre) and after (post) treatment

	PFMT Group		NMES Group		ANOVA p-value		
	Pre	Post	Pre	Post	Between groups	Within group	Interaction
MVC (MOS)*	3.0 (0.86)	2.8 (0.77)	2.8 (0.65)	2.8 (0.83)	0.77	0.17	0.48
Endurance*	5.2 (2.81)	5.6 (2.18)	5.3 (2.38)	5.8 (2.29)	0.89	0.33	0.89
MVC (manometry)*	49.5 (26.96)	42.8 (24.56)[a]	43.8 (20.74)	38.9 (20.87)[a]	0.65	0.01	0.63

Note: PFMT = pelvic floor muscles training; NMES = neuromuscular electrical stimulation; MVC = maximal voluntary contraction; MOS = Modified Oxford Scale; *Mean (standard deviation); [a]Significant difference between pre and post within group.

The results of the present study showed that the immediate effects on PFM function after a single session of PFMT and NMES associated to PFM contraction are similar in women that voluntary contract PFM, with no differences between groups. In addition, the intra-group analysis showed that MVC decreased at manometry evaluation on both groups. According to these results, a single intervention is not able to improve PFM function. However, it is known that a single muscle contraction causes a co-contraction of the urethral sphincter due to the increased in urethral closure pressure, which lead to a reduction in the area of the levator ani by 25%, keeping the pelvic floor elevated and stabilized.[20] Moreover, to identify this contraction, methods such as electromyography or ultrasound should be applied. Therefore, to prevent and to treat PFM dysfunctions, a long-term intervention is necessary, as the repetition of PFM voluntary contractions leads to hypertrophy of muscle fibers, recruitment of motor neurons[19] and increased of the tone of PFM, with a consequent increase on the support of the bladder neck, which leads to the improvement of PFM function, especially to the continence during daily activities.[18]

Both PFMT and NMES are conservative methods that are indicate to treat or prevent PFM dysfunctions, especially UI.[8,9] Based on PFM voluntary contractions, PFMT is recommended as first choice of pelvic floor disorders treatment and is considered the gold standard for UI treatment.[9] NMES can be used when women are unable to contract PFM as the electrical stimulus may help woman to understand the contraction mechanism[21] and may improve the awareness of women who do not contract PFM voluntary during verbal commands.[22]

However, although the aimed of the present study was to compare the immediate effect of two single interventions, the NMES group was encouraged to perform PFM contractions simultaneously to the NMES application. Therefore, according to the results of a previous systematic review, the effect of the combination of NMES and other techniques as PFMT to treat UI is still inconclusive as studies have a high heterogeneity of protocols and there is a lack of studies that evaluate the general efficacy of both techniques.[8] It is still not possible to conclude that the NMES associated to the PFMT contraction are effective or not to improve PFM function according to the results of the present study, however, the combination of both techniques did not showed different benefits than the PFMT applied alone, right after one session.

Thus, the results of the present study may help women and physiotherapists to choose the resources that may be applied at the beginning of the physiotherapy treatment. At this time point, techniques that are related to self-efficacy are needed, as the physiotherapist expect that women follow the treatment and do not give up. Therefore, the physiotherapist must decide if an invasive technique will be used at the beginning of the treatment if the patient already know how to perform a correct PFM contraction.

According to the results of the present study, the PFMT performed without the intravaginal NMES is not different from the PFMT with an invasive technique, such the NMES. Moreover, the application of electrostimulation can generate pain and discomfort to the patient, which may disadvantage the indication of the technique during the treatment of urinary symptoms.[23] However, it is worth to highlight that NMES has benefits and it is indicated especially for patients who are unable or have difficulties to contract the PFM voluntary and need to learn how to contract the group muscle.

A voluntary PFM contraction is associate to a squeeze and inward lift of the PFM associated to a urethral closure, stabilization and resistance to downward movement.[24] According to a previous study that aimed to analyze the effect of the association of NMES to a grip muscular contraction, the NMES effects in combination with muscular contraction was not different from the muscular contraction alone.[25] In addition, Bø and Talseth[26] concluded that a PFM voluntary contraction is twice more effective than NMES alone to increase urethral pressure. In addition, the literature affirmed[27] that NMES associate to a muscular contraction may benefit individuals that are in extreme fatigue or individuals with some neurological or musculoskeletal diseases, as NMES facilitates the recruitment of additional muscle fibers and may increase the strength production. Therefore, in healthy individuals that are able to perform a voluntary contraction, NMES does not seem to increase strength production.[27]

The association of PFMT and NMES may cause muscle fatigue, indicated by the significant decreased in MVC assessed by manometry after a single session application. According to the previous literature, PFM are more rapidly fatigued than limb muscles, which can be associated to the reduction in the ability to activate the muscles during a MVC.[28] In the present study, women were contracting PFM during both interventions, which may lead to a muscles fatigue. Musculoskeletal fatigue refers to a decreased in strength or energy production in response to contractile activity, which can occur in response to intensity exercises of concentric, eccentric or isometric contractions.[29] PFM are composed by striated muscle fibers, 70% of which are Type I (slow contraction) and 30% are Type II (fast contraction).[29] When the exercise intensity increases and Type I motor units reach fatigue, there is a progressive involvement of Type II motor units which are fast-twitch fibers that quickly fatigue.[1]

This study has some limitations. The first one is related to the small sample size. In addition, the evaluation of the PFM with electromyography was not conducted. Although the results of the present study suggest that the protocols lead to a possible muscular fatigue, it was not possible to measure it. Nonetheless, other methods indicated to assess objectively the PFM function, such as ultrasound, were not applied and perhaps some changes related to the reduction in the area of the levator ani during contraction were not evaluated. However, vaginal palpation and manometry are often used in clinical practice, considered easy to apply and cheaper compared to other methods of evaluation. Therefore, we decided to conducted our data collection according to the methods often available in clinical practice.

Moreover, a control group was not included in the study design and women that were included in the present study were young, most of them were physiotherapists and were able to contract PFM voluntary, which make not possible to conclude that one single intervention of PFMT or PFM contraction associated to NMES improved self-perception or muscles recruitment.

Future researchers must investigate the effect of one singe intervention of PFMT or PFMT associated to NMES on PFM function of women that have different ages from the participants included in the present study, women that already had previous pregnancies and childbirth experience and women without pelvic awareness or low perception of PFM contraction. In addition, future studies should investigate the muscles fatigue caused by different PFM contraction protocols and techniques, such a NMES and PFM, applied alone or in concomitantly, by using other methods of evaluation (e.g., ultrasound).

Conclusion

The immediate effects of a single session of PFMT and NMES associated with voluntary PFM contraction are similar on PFM function. Both groups showed a significant decreased in MVC assessed by manometry immediately after one treatment session, which may suggest possible muscle fatigue.

Authors' contributions

JFP and PD have substantially contributed to the conception and design of the research. JFP, KKAP and JBS conducted the research and collected data, and JFP analysed it. All authors were responsible for drafting and critically revising the article for important intellectual content, as well for the final version here published.

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