Repercussions of circulatory electrical stimulation on quality of life, lubrication and pelvic floor muscles: a pilot study

Repercussões da eletroestimulação circulatória na qualidade de vida, lubrificação e musculatura pélvica: um estudo piloto

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Abstract

Introduction: The climacteric is one of the transition periods in the life cycle of women between the reproductive and non-reproductive phase, and it is characterized by various metabolic, psychological and social changes, either by psychic disorders or sexual dysfunctions promoting changes in quality of life. **Objective:** To analyze the repercussions of electrical stimulation on quality of life, lubrication and myoelectric activity of pelvic floor muscles in postmenopausal women. **Methods:** This was a pilot study in which the sample consisted of ten menopausal volunteers aged 48-60 years. We used the Female Sexual Function Index questionnaire to determine the improvement in lubrication and the WHOQOL-BREF questionnaire to assess quality of life. The pelvic floor muscles were evaluated by electromyography with an intracavitary electrode. The protocol used was: phasic contraction evaluated by three contractions of two seconds and six of rest; three tonic contractions for ten seconds with ten-second rest; and endurance for thirty seconds. The intervention was performed by another researcher, through circulatory stimulation with the Dualpex 961 Quark®. **Results:** Electromyography after circulatory stimulation showed statistically significant results with an increase in Fast Fourier Transform in tonic and phasic contractions, obtaining a positive effect on the perception and awareness of contractions due to increased blood flow. Also, there was improvement in lubrication and quality of life in all areas. **Conclusion:** Circulatory stimulation had repercussions on pelvic floor muscles in menopausal women in both muscle physiology and lubrication, with an influence on the quality of life of volunteers.

Keywords: Electrical stimulation. Electromyography. Lubrication. Menopause. Quality of life.

Resumo

Introdução: *O climatério constitui um dos períodos de transição no ciclo vital da mulher entre a fase reprodutiva e a não reprodutiva, caracterizado por várias alterações metabólicas e psicológicas, seja por distúrbios psíquicos ou disfunções sexuais, promovendo alterações na qualidade de vida.* ***Objetivo:*** *Analisar as repercussões da eletroestimulação na qualidade de vida, lubrificação e atividade mioelétrica dos músculos do assoalho pélvico em mulheres menopausadas.* ***Métodos:*** *Trata-se de um estudo piloto no qual a amostra foi composta por dez voluntárias em menopausa com idade entre 48 e 60 anos. Para avaliar a melhora da lubrificação foi utilizado o questionário Female Sexual Function Index. Quanto à qualidade de vida, utilizou-se o questionário WHOQOL-bref. Já para a avaliação dos músculos do assoalho pélvico, utilizou-se a eletromiografia com eletrodo intracavitário. O protocolo utilizado foi: contração fásica avaliada por três contrações de dois segundos e seis de repouso; três contrações tônicas sustentadas por dez segundos com repouso de dez segundos;* endurance *durante trinta segundos. A intervenção foi realizada por outra pesquisadora, através de estimulação circulatória com o aparelho Dualpex 961 Quark®.* ***Resultados:*** *A eletromiografia pós-estimulação circulatória obteve resultados significativos, com aumento na* Fast Fourier Transform *nas contrações tônicas e fásicas, obtendo efeito positivo na percepção e conscientização das contrações devido ao aumento do fluxo sanguíneo. Houve, também, melhora na lubrificação e na qualidade de vida em todos os domínios.* ***Conclusão:*** *A estimulação circulatória apresentou repercussões nos músculos do assoalho pélvico em mulheres menopausadas tanto na fisiologia muscular quanto na lubrificação, influenciando a qualidade de vida das voluntárias.*

Palavras-chave: *Eletroestimulação. Eletromiografia. Lubrificação. Menopausa. Qualidade de vida.*

Introduction

Climacteric is one of the transition periods in a woman's life cycle between the reproductive and non-reproductive phases, characterized by various metabolic, psychological and social changes. It is a natural and physiological period, in which there is a reduction in the level of estrogen and, consequently, structural and functional changes in the ovarian follicles, thus causing amenorrhea with systemic and potentially pathological consequences. It is characterized by hormonal changes, menopause, changes in physical aesthetics, and psychological and social changes, impacting the genitourinary system.[1]

These changes can be physiological, causing extragenital disorders such as decreased libido, complaints of urinary incontinence, changes in muscle tone, and weakness of the pelvic floor muscles (PFMs), among others, which can lead to sexual dysfunction. It can also generate psychic disturbances, such as hot flashes, irritability, increased sweating, tiredness, weakness, and depression, among others, which can lead to reduced self-esteem and to insecurity.[1,2]

Any change in the pelvic PFMs can cause dysfunction, negatively interfering with female sexual function, causing repercussions in the phases of sexual response - desire, excitement, orgasm and resolution, thereby resulting in the emergence of sexual dysfunctions. Through various methods and techniques, physiotherapy has increasingly stood out in the safe and effective treatment and prevention of these disorders. One of the main evaluation methods is surface electromyography (EMG), and as a treatment, there is electrical stimulation.[3]

EMG is a resource that aims to assess myoelectric activity, that is, the triggering of action potentials in the musculature. The muscles are evaluated both at rest and during voluntary contraction, whether they are tonic contraction muscles, with a predominance of type I, slow, fatigue-resistant and deep fibers, or fast contraction, with a predominance of type II, phasic fibers, which are fatigable, acting on the superficial PFMs. EMG also assesses endurance, which is the endurance capacity of type I muscle fibers.[4,5]

Electrical stimulation is a feature of the electro-therapeutic arsenal, which offers local proprioception and tones the PFMs by emitting electrical stimuli to local nerve endings. Circulatory stimulation, a type of function present in the electrical stimulation equipment used in this study increases blood flow to the urethra and PFMs and reestablishes neuromuscular connections, improving the function of muscle contraction and performing passive contraction of the perineal muscles.[6] The equipment used has therapeutic parameters that correspond to pulse width, current intensity and the stimulus time applied, acting on type I and II muscle fibers. There are several types of currents, but the one used in this study was the biphasic, symmetric current, whose therapeutic action occurs at low frequency.[7-9]

Thus, the aim of this study was to analyze the repercussions of circulatory electrical stimulation on quality of life, lubrication and myoelectric activity of pelvic floor muscles through surface EMG in postmenopausal women.

Methods

This was a pilot study carried out from July 2018 to July 2019 and approved by the Ethics and Research Committee on Humans of the Catholic University of Pernambuco (UNICAP), No. 2009.800. Data collection was carried out at the Corpore Sano Physiotherapy School-Clinic, linked to UNICAP. All volunteers signed an informed consent form.

We used a convenience sample consisting of 10 women who were seen twice a week for a period of five weeks, totaling ten appointments. Initially, in an evaluative way, the WHOQOL-BREF and Female Sexual Function Index (FSFI) questionnaires were administered, and EMG was then performed. After completion of the assessment, electrical stimulation was applied in an interventional manner. Only electrical stimulation was performed in the following sessions. In the last and tenth visit, at the end of five weeks, a reassessment was carried out using the same evaluation criteria. Electrical stimulation and EMG were collected by different authors of the present study to preserve data reliability.

The study included postmenopausal women with sexual dysfunction who were between 48 and 60 years old. Women with diabetes mellitus, severe osteomyoarticular diseases, urinary incontinence, or urinary and gynecological infections, patients with psychiatric disorders and those with neurological and cognitive disorders were excluded.

The WHOQOL-BREF questionnaire is an abbreviated Portuguese version of the World Health Organization (WHO) quality of life assessment instrument, the WHOQOL-100. It consists of 26 questions in total, with two general questions about quality of life, and it is divided into facets and four domains: physical, psychological, social relationships and environment, with each facet being evaluated by one question. At the end, the average of the results of each facet is given by the sum of the interview values divided by the number of participants, evaluating the final average.[10] The higher the score, the better the quality of life is.

The FSFI, proposed by Rosen et al.[11] in 2000 was also applied. Although the FSFI assesses the female sexual response in six domains, in this study only the domain of vaginal lubrication was used, which is equivalent to questions 7 to 10. The total score is obtained in each domain multiplied by a specific value assigned to each dimension. Higher scores indicate better levels of sexual functioning. Each domain is individually evaluated to identify possible dysfunctions. Both questionnaires were administered on the first day of care for assessment and again on the tenth day.[11,12]

To determine the myoelectric activity of the PFMs, a surface electromyograph, Miotool Uro Miotec®, was used, and two EMG channels were used to record this activity, based on SENIAM standards (acronym for the European consortium Surface EMG for the Non-Invasive Assessment of Muscles). In the first channel, an intracavitary probe was used, which was placed in the vaginal canal with water-soluble gel, and in the second channel, two 3M™ disposable self-adhesive surface electrodes were applied to the right external oblique muscle, to verify synergy with PFMs. Finally, a reference electrode was fixed on the right anterosuperior iliac spine through a self-adhesive surface electrode, also 3M™.[13,14]

The women were in supine decubitus, with a pillow under their head and semi-flexed legs supported by a foam support. The lights were turned off to avoid any kind of interference from electromagnetic waves. Initially, the maximum voluntary contraction was evaluated, and subsequently, initial rest, phasic contraction, tonic contraction, endurance and final rest. The phasic contraction was evaluated through three 2-second contractions, with a rest of 6 seconds between them. The tonic contraction was determined through three sustained contraction for 10 seconds and with a rest between them for 10 seconds. Endurance was evaluated through a sustained contraction for 30 seconds. EMG was performed in the first appointment for evaluation and in the last appointment for re-evaluation of the PFMs at the end of the fifth week.

After collection, the electromyographic results were submitted to the application of a bandpass digital filter with a minimum cutoff frequency of 20 Hz and a maximum of 500 Hz. Next, we determined the root mean square (RMS), mean value of the square root, evaluating the level of EMG signal activity.[13,14]

For data analysis, initial rest, final rest, median frequency (MF) (it is the characteristic frequency that

demonstrates changes in fiber conduction velocity), phasic, tonic and endurance contractions, as well as the Fast Fourier Transform (FFT) were used for data analysis, which is the average for the analysis of frequencies involving the determination of the fatigue process, fiber conduction speed, fiber type and synchronization of motor units under normal or pathological conditions.[13] We selected the second contraction of the described protocol (phasic and tonic fibers) of each contraction made because it is considered more reliable.

Interventionally, after EMG, electrical stimulation was applied using the same intravaginal electrode and the same positioning. Electrical stimulation was performed using Dualpex 961 electrical stimulation equipment from Quark with biphasic, symmetric current, and whose therapeutic action occurs at low frequency. The parameters used were: circulatory electrical stimulation mode, frequency of 4 Hz and pulse width of 400 μs, with 20 minutes duration and amperage (AmP) adjusted according to the patient's sensitivity, with an initial average of 7 mA and having an average increase of 2 mA during the sessions according to the patient's comfort, not exceeding 30 mA. The appointments were carefully and consecutively followed twice a week for five weeks.

Data analysis was performed after reassessment with the questionnaires and EMG. Statistical analysis was performed using Microsoft Office Excel 2007 and GraphPad Prism 4 software. Data normality was evaluated using the Shapiro Wilk test. Comparison between means was done using the paired t-test, and between the medians, the Wilcoxon test for paired samples. All conclusions were drawn at a significance level of 5%.

For the dependent samples t-test, the calculation of the sampling power was performed a posteriori by the G*power 3.1.9.4 program, considering $\alpha = 0.05$ and effect size between 11 and 18.1% (considering the percentage of the differences in the means in the fields of quality of life). Based on these data, the estimated power ranged between 9 and 13.2%.

Results

The present study had 14 women as its initial sample, four of whom dropped out due to lack of time, ending in 10 volunteers with a mean age of 53.4 ± 3.9. Regarding the prevalent profile of volunteers, 70% had higher education, 50% were divorced and 70% had one or more deliveries (Table 1).

Table 1 - Profile analysis of the patients (n = 10)

Profile analysis of the patients		
	n (%)	**p-value**
Marital status		
Divorced	5 (50)	
Married	4 (40)	0.3556
Single	1 (10)	
Education		
Higher education	7 (70)	0.1534
High school	3 (30)	
Number of deliveries		
None	3 (30)	
One	3 (30)	
Two	2 (20)	0.6961
Three	1 (10)	
Four	1 (10)	
Race		
Black/brown	5 (50)	1.000
White	5 (50)	

Note: Numbers are expressed as mean ± standard deviation or frequency (%). T-test, chi-square test and Fisher's exact test.

Regarding quality of life, there was an increase in all domains of the post-intervention WHOQOL-BREF questionnaire, especially in the psychological domain, which includes self-esteem, negative and positive feelings, beliefs, and body image, among others; some of these factors are related to depression. The initial score was 3.58 ± 0.58, going to 4.11 ± 0.66. The domain of personal relationships, which encompasses sexual activity and personal relationships, had an initial score of 3.7 (2.3 - 3.7) and a final score of 4.0 (3.6 - 4.4), proving that through the applied therapy there was an improvement in the quality of life of these women (Table 2).

With regard to the FSFI questionnaire, all volunteers in the sample had sexual dysfunction; however, there was a statistically significant increase in the lubrication domain after circulatory stimulation (from 1,740 ± 1.78 to 2,550 ± 2.22), showing the effectiveness of electrical stimulation in lubrication (Table 3).

Regarding the electromyographic analysis (Table 4), the only parameter that showed a statistically significant difference was the FFT in tonic and phasic fibers after therapeutic intervention. When observing the EMG mean, despite not having obtained a significant value, a reduction in values could be observed in relation to rest,

showing that there was a difference in the initial and final relaxation. The phasic and tonic fibers showed a slight increase in mean contractions when compared to the initial and final contractions. On the other hand, MF in tonic fibers, rest and endurance declined.

Table 2 - Domains of WHOQOL-BREF questionnaire evaluated before and after intervention

Domains of WHOQOL-BREF questionnaire			
	Before	**After**	**p-value**
Physical	3.30 (2.8 - 3.7)	3.70 (3.6 - 4.3)	**0.0090***
Psychological	3.58 ± 0.58	4.11 ± 0.66	**0.0336****
Social relations	3.70 (2.3 - 3.7)	4.00 (3.6 - 4.4)	**0.0059***
Environmental	3.20 (2.8 - 3.6)	3.80 (3.1 - 3.9)	**0.0022***

Note: *Wilcoxon test - data are expressed as median (25 - 75% percentiles) for non-parametric variables. **Paired t-test - data are expressed as mean ± standard deviation for parametric variables. Values in bold indicate statistical difference ($p < 0.05$).

As for MF, although no statistically significant changes were seen, there was relevance in the findings; demonstrating a reduction in phasic and tonic contractions, when compared to the initial and final contractions, which were initially 165.6 ± 28.57 Hz (tonic fibers) and 177.5 ± 45.9 Hz (phasic fibers) to 157.2 ± 35.07 Hz (toned fibers) and 169.2 ± 48.9 Hz (phasic fibers).

Table 3 - Female Sexual Function Index questionnaire before and after the intervention

Female Sexual Function Index			
	Before intervention	**After intervention**	**p-value**
Lubrification	1.740 ± 1.78	2.550 ± 2.22	**0.0320**

Note: Paired t-test and Wilcoxon test. Values in bold indicate statistical difference ($p < 0.05$).

Table 4 - Electromyography values before and after treatment

Electromyography mean 9uv)			
	Initial	**Final**	p-value
Initial rest	8.20 (6.0 - 19.1)	9.00 (6.8 - 14.7)	0.6953*
Tonic fibers	21.56 ± 12.54	23.02 ± 10.13	0.7086**
Phasic fibers	20.70 ± 11.65	24.56 ± 10.40	0.2155**
Endurance	21.89 ± 12.44	21.26 ± 11.73	0.8658**
Final rest	8.90 (6.4 - 27.5)	10.60 (7.0 - 18.5)	0.2754*
Electromyography median frequency (Hz)			
Initial rest	214.50 ± 27.21	195.40 ± 28.54	0.1231**
Tonic fibers	165.50 ± 28.57	157.20 ± 35.07	0.5577**
Phasic fibers	177.50 ± 45.90	169.20 ± 48.90	0.4989**
Endurance	174.60 ± 35.78	169.30 ± 46.41	0.7802**
Final rest	206.60 ± 26.80	196.50 ± 36.59	0.4789**
Fast Fourier Transform of electromyography (Hz)			
Tonic fibers	64.33 ± 27.31	86.56 ± 29.02	**0.0102****
Phasic fibers	229.10 ± 68.10	278.60 ± 56.25	**0.0469****

Note: *Wilcoxon test – data are expressed as median (25-75% percentiles) for non-parametric variables. **Paired t-test – data are expressed as mean ± standard deviation for parametric variables. Values in bold indicate statistical difference ($p < 0.05$).

Discussion

The pelvic floor is composed of several muscles that have the function of maintaining urinary and fecal continence and supporting the pelvic organs, and that consist of 70% type I fibers and 30% type II fibers. With menopause, the pelvic muscles weaken, reducing muscle tone and favoring the onset of dysfunctions.[5,15]

To improve circulation, low-frequency neuromuscular electrical stimulation had effective and significant repercussions, demonstrated in EMG, questionnaires and descriptively through the reports of the participants in this study, where they reported improvement in lubrication and sexual desire, reduced sensation of vaginal discomfort and, consequently, the sensation of relaxation in the vagina after the intervention.

Despite the scarcity of articles related to circulatory electrical stimulation that may support our findings, similar studies were found, such as the one by Nappi et al.,[16] which investigated the use of electrical stimulation in the vestibular area and vaginal introitus in women complaining of sexual pain. The therapy has shown improvement in muscle contractile capacity, resting capacity, intensity and current increase. In the questionnaires used, there was a significant improvement, and four out of nine women with vaginismus returned to sexual activity.

Alves et al.[17] compared medium- and low-frequency neuromuscular electrical stimulation in women with stress urinary incontinence (SUI) and found that there was no significant difference between the evaluated groups, and concluded that both medium and low frequency were effective in the treatment of SUI.

In relation to lubrication, it was shown in the present study that circulatory electrical stimulation resulted improvement, obtaining a final total mean of 2,550 ± 2.22, indicating a higher score than the initial one; the maximum vaginal lubrication score in postmenopausal women would be six. Santos et al.[18] saw in their study that the use of TENS generated an increase in blood flow, with vasodilation and improvement in local tissue perfusion, in agreement with the present study, thus showing that electrical stimulation promotes lubrication and consequently reduces the discomfort during sexual intercourse.[18] With results similar to those found in this study, Magno et al.[19] evaluated the strength of the PFMs and then applied the FSFI questionnaire, demonstrating that the greater the force of contraction, the higher the scores obtained.

Santos et al.[20] used the FSFI questionnaire to determine which sexual dysfunction is more common among climacteric women. In their results, they observed that the domains desire, excitement, orgasm and lubrication together gave a percentage of 63.33%, which may pose possible risks of sexual dysfunctions.

As for quality of life, there was an increase in all domains after the application of electrical stimulation, especially in the psychological domain, which went from regular (3.58), according to the questionnaire score listed from one to five, to good (4.11), demonstrating that a positive effect was obtained for to this aspect. Likewise, the domain of personal relationships, initially regular (3.7), showed a significant improvement, resulting in a score of 4.0 (good) after the intervention. The environmental and physical domains, on the other hand, remained regular, but with an initial and final difference. Thus, there is evidence of a positive and relevant clinical difference in the quality of life of postmenopausal women and women with sexual dysfunction after the applied therapy.

From this perspective, Nazarpour et al.[21] examined the relationship between the quality of life and sexual function of postmenopausal women and found that 61% of the participants had sexual dysfunction. The FSFI scores were related to the WHOQOL-BREF, showing the importance of the sexual function in the quality of life of postmenopausal women.

Cabral et al.[22] evaluated the determinants of sexual dysfunction in middle-aged women using the FSFI, the WHOQOL-BREF and two other questionnaires. The authors found that about 67% of the participants had sexual dysfunction in the older age group; that is, menopausal women and women with more intense climacteric manifestations had low quality of life and greater disposition to develop sexual dysfunctions.

Nagib et al.[23] describe EMG as the most accurate method to measure neuromuscular integrity. The data presented in this study, in relation to EMG, demonstrated that there was an increase during the analysis of frequencies in the conduction velocity of tonic and phasic fibers, mainly the former. Thus, it is believed that there was a substantial synchronization of the motor units, which can be explained physiologically, because by increasing the local blood flow through

electrical stimulation, the oxygenation of the muscle fibers is increased, facilitating muscle contraction and tonicity of the PFMs.

The findings of Dias et al.[24] are in line with the present study, emphasizing that the increase in oxygen in muscle fibers causes physiological changes and affects myoelectric activity. According to the data presented, it was found that electrical stimulation has a positive effect on muscle oxygenation, facilitating lubrication and reducing some of the symptoms of the genitourinary menopause syndrome, providing women with a better quality of life.

It is believed that the mean of tonic fibers showed a slight increase, despite not being statistically significant, as the mean is valid when associated with the FFT result, which showed an increase, since the pelvic floor has a predominance of tonic fibers essential for the function of sustaining and maintaining continence. Tonic contraction fibers are oxidative, which makes it clear that the increase in local circulation generates changes in muscle fibers. Similarly, the same process occurs with the mean of the phasic fibers. Resende et al.[25] observed an increase in the recruitment of motor units during repeated maximal or sustained submaximal contractions to maintain the required strength level.

Although there were no statistically significant differences, the data regarding FM were relevant, which tended to show the highest frequency in fast contractions and lower frequency in tonic contractions.[25] There was a linear relationship between FM and fiber conduction velocity depending on the strength and diameter of the musculature. The smaller the muscle diameter, the lower the conduction velocity and, consequently, the lower the FM. The shorter the muscle, the greater the capacity to generate force, and therefore, the greater the driving speed and the greater the FM. [26]

The reduction in the median frequency in the phasic and tonic fibers in this study demonstrated that there were signs of fatigue in the musculature, as a result of the PFMs not being actively trained during the consultations and submitted to the electromyographic evaluation protocol. These data also suggest that there was a predominance of intermediate or tonic fibers, in agreement with the data presented in the FFT. Silva et al.[27] also found a significant reduction in FM when performing fatigue induction protocols. Burti et al.[28] observed that the signals for a fatigue protocol with tonic fibers can be identified with an increase in amplitude signals, a reduction in fiber conduction velocity and a reduction in FM.

Limitations of the study

The main limiting factor of the study was the small sample size, due to the reluctance of the volunteers to join the research. As it is an intravaginal method, many women reported embarrassment and shyness as factors for not participating, which leads us to reflect on how necessary it is to make discussion of the female body more fluid and natural. In addition, the study application time could have been longer to have obtained even more effective and significant results, thus generating a scope for further research along this line.

Conclusion

This study showed that circulatory electrical stimulation had positive effects on lubrication, the myoelectric activity of the pelvic floor muscles and the quality of life of postmenopausal women, especially in the psychological domain, which includes factors related to self-perception, anxiety and talking about sexuality and menopause.

Surface electromyography (EMG) improved the conduction velocity of the tonic fibers in the pelvic floor muscles , thus causing changes in the pelvic floor support muscle fiber. More scientific evidence is needed to corroborate these findings, so further studies should be conducted to go deeper into the proposed themes.

Authors´ contributions

All authors were responsible for the research, data collection and conceptualization of the article. EMAS carried out the writing of the manuscript, data collection and analysis, and development of the methodology, and worked on the results and discussion. SMMU, advisor, assisted in the methodology, preparation and revision of the manuscript in its different stages and provided guidance on data collection and analysis. ALM participated in the data collection and text revision and helped support the research planning. LQA collaborated in the research review and analysis.

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