Original Clinical Article

Does pelvic floor muscle maximum voluntary contraction improve after vaginal pelvic organ prolapse surgery? A prospective study[1]

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Abstract

Aims: to assess pelvic floor muscle maximum voluntary contraction (MVC) before and after surgical treatment for pelvic organ prolapse (POP). **Methods:** This was a prospective observational study with women scheduled for surgical correction of POP. Assessments occurred 15 days before and 40 days after surgery. The primary outcome was pelvic floor muscle (PFM) MVC measured using the manometer Peritron^{TM}. The average strength of PFM contraction was also measured. Secondary outcomes were assessed using the Pelvic Organ Prolapse Quantification (POP-Q) score. The Student paired t-test was used for quantitative data. For the pre and postsurgery comparisons of PFM strength in relation to POP-Q value we used the nonparametric Kruskal-Wallis test for dependent variables. The level of significance adopted was $p < 0.05$. **Results:** Sixty-seven women were recruited, 65 (97%) completed the study. The mean age of participants was 62±10.2. There was no difference (1.9 cm H_2O±12.9; *p*=0.22) between MVC before (27.1 cm H_2O±17.0) and after surgery (29 cm H_2O±17.8). The average contraction was higher after surgery (2.3 cmH_2O±8.6; $p = 0.03$). The higher the severity of pre and postsurgery POP, the worse the MVC. **Conclusions:** There was no difference in MVC pre and postsurgery, however we found an improvement in PFM average contraction strength postsurgery.

Keywords: Pelvic floor muscle, Strength, Pelvic organ prolapse, Surgery

Introduction

Pelvic organ prolapse (POP) is a condition in which the uterus, vagina, bladder and/or rectum bulge into or outside of the vagina.[1] Pelvic floor disorders represent a significant problem in terms of public health for the female population, having a negative social and economic impact. The prevalence of POP ranges from 2 to 94% depending on the studied population and definition used.[2,3]

The pelvic floor muscles (PFM) are considered an important part of the pelvic organ support system.[4] Chen et al.[4] have shown with increased POP there is increased tension on ligaments and PFM support. It is plausible that POP could represent an overload to the PFM, therefore once the genital prolapse is repaired the PFM function may improve.[5]

While there is good evidence to support pelvic floor muscle training (PFMT) as a conservative therapy to treat POP[6], findings from trials to date indicate there is insufficient evidence to recommend peri-operative PFMT as an adjunct to POP surgery.[7] Studies in that review provided some data of PFM function measured at 3 – 12 months post-operatively, however the authors considered it was impossible to draw valid conclusions for PFM function due to heterogeneity among the studies[7], and the lack of raw data of PFM function presented for the control groups limits interpretation of the impact of surgery on the PFM. It is important to understand the specific effect of POP surgery on the function of the PFM in the early healing phase, and without the influence of PFMT. If the natural response in the PFM following surgery is inhibition, weakness or atrophy, this early post-operative time becomes crucial for pelvic floor protection and optimal recovery. An inverse association between pre-operative POP severity and PFM strength has been documented[8] and one study has reported weak PFM strength as a risk factor for post-operative measures of POP surgery failure.[9] One small pilot study has shown a slight reduction in PFM contraction pressure (strength) at 4 – 6 weeks post-operatively[10], however two prospective studies found an improvement in PFM maximum voluntary contraction (MVC) three months after surgery assessed using surface EMG.[5,11] Knowledge of the impact of POP surgery on PFM strength in the short-term is sparse and further data will assist our understanding of the natural recovery in muscular support.

There is no gold standard method to assess PFM strength. Surface EMG is a measure of the ability of the muscle to contract, however manometry is considered a better measure of strength.[12] PFM manometry has established reliability as a method to assess PFM MVC in various populations of women with and without PFM dysfunction, pregnant, and eldery.[13,14,15] Although no cut-off values of normal resting or squeeze pressure have been established in the literature this tool has been extensively used and recommended as a valid outcome measure to quantify the PFM contraction.[12]

Our aim was to assess MVC using manometry pre and postsurgery treatment for correction of POP. Our hypothesis was that MVC would improve forty days post POP surgery and that the higher the severity of POP presurgery, the worse the MVC would be postsurgery.

Material and Methods

Study Design

This was an observational prospective study that received approval from the Institutional Review Board of the *Hospital das Clínicas*, Ribeirão Preto Medical School at University of São Paulo number 5872/2014.

Setting and Participants

This study recruited women attending the Urogynecology Clinic of *Hospital das Clínicas* at Ribeirão Preto Medical School from January 2014 to April 2016, who met the following criteria: age between 40 and 80 years; literate, PFM strength with score ≥ 1 using the modified oxford grading scale (MOGS) evaluated using vaginal palpation;

symptomatic POP; POP stages II, III or IV[1]; medical indication of vaginal surgery to repair any combined or isolated (anterior, apical or posterior) defects, women without prior pelvic surgery for POP; no previous vaginal or urinary infection. An exclusion criteria was intolerance to PFM evaluation.

One assistant researcher contacted women who met the inclusion criteria to participate in this research. After being informed about the research and consenting to participate, women were scheduled to be assessed at the time points described below.

Time points and outcome measures

The participants were assessed at two time points: two weeks presurgery and 40 days postsurgery. An initial interview to obtain demographic data was undertaken by one assistant researcher who gave the questionnaires to women and was blinded to the results of PFM assessment. The main researcher performed all PFM assessment and was blinded to the results of the questionnaires. Standard postsurgery care did not include advice to perform PFM training.

The primary outcome of the study was PFM strength assessed using the Peritron™ manometer (Cardiodesign, Melbourne, Australia) and MOGS.[13,16]

The Peritron™ measures vaginal squeeze pressure through a cylindrical sensor covered with a medical silicone rubber sheath. The sensor is connected to a handheld microprocessor via a latex tube. Measurement of vaginal squeeze pressure was recorded in centimeters of water (cmH_2O). Peritron™ has been found to have good intra-rater and moderate inter-rater reliability.[12,13] The MOGS quantifies pelvic floor muscle function as 0, no contraction; 1, flicker; 2 weak; 3 moderate; 4 good; 5 strong.[12]

Secondary outcomes were assessed using the Pelvic Organ Prolapse Quantification (POP-Q) score.[17]

Procedures

Following the initial interview, women had their PFM function assessed. The assessment was performed with the participants in a supine position with semi-flexed hips and knees.[16] The participants were informed about PFM anatomy and function using illustrations and explanations. They were asked to contract their PFM as strongly as possible as if they wanted to prevent the escape of gas or urine.[16]

Digital palpation was performed with one finger, by a physiotherapist with eight years of experience in women's health. The participants were in the same position. First the PFM contraction strength was estimated using the MOGS. Five minutes after the vaginal palpation was performed, the probe of the Peritron™ (Cardio-Design, Australia) was covered with a latex condom coated with aqueous lubricating gel and the full extension of the compressible portion was inserted above the level of the hymenal ring until 1cm of the sheath remained visible outside the vaginal introitus. Three MVC were requested, with a 30-second interval between them. In all measurements, the inward movement of the probe and the perineum were used as an indicator that the participant was performing a correct PFM contraction. Women were instructed to contract their PFM as strongly as they could and to relax as soon as they felt they had performed their MVC. Co-contraction of hip adductors and the gluteus muscle was discouraged as was the Valsalva maneuver.[13]

After five minutes the POP was classified using the POP-Q system.[16] The maximum extent of the prolapse was clinically measured during the Valsalva maneuver and confirmed by the most distal protrusion observed. The participants were assessed and reassessed at the same time of the day by the same physiotherapist who was trained by an expert urogynecologist.

Power calculation and Data Analysis

We performed the sample size calculation using the results of manometry of a pilot sample of 14 women. We found a difference between the pre- and postsurgery μd = 2.5 cmH_2O and SD = 6.5. From this information we found a variance of approximately 43. We set the significance level at $p<0.05$ and an 80% study power. Considering a difference of 2.5 cmH_2O between pre and postsurgery score the minimum sample size calculation indicated that 54 women were required. We increased the sample size by 25% to account for attrition of participants, therefore a sample size of 67.5 was sought, rounded up to 68.

In the analysis of the manometry we considered the following measures and terminology: 1- Peak of MVC (we used the mean of the highest values given by the device obtained during three different measurements); 2- duration of MVC (time in seconds from the beginning of PFM contraction to relaxation); 3- Average (the area under curve/duration).

The ability of the women to execute a PFM lift was assessed using the MOGS. We dichotomized the ability to lift as a score below 3 indicating no lift. The detection of the lift component of a PFM contraction by digital palpation has been shown to correlate with findings on imaging.[17]

The data were analyzed using SAS™ software, version 9 (Cary, NC, USA). Initially, we used a descriptive analysis of the data presented in graphs and tables. The Student paired t-test was used for quantitative data. For the pre and postsurgery comparisons for PFM strength in relation to POP-Q value we used the nonparametric Kruskal-Wallis test.

Results

Figure 1 shows the flow of participants in the study. A total of 67 women were included in the study. Two women were lost of follow-up in the postsurgery evaluation.

Insert Figure 1

All women had transvaginal repair of symptomatic POP without the use of mesh. The majority (61%) underwent anterior colpoperineoplasty, while 26.6% underwent a combination of anterior and posterior colpoperineoplasty. The remainder underwent posterior colpoperineoplasty (7.6%) and hysterectomy (4.6%).

The mean age of the sample included in this study was 62.0 ±10.2 **years old** and BMI was 28.7 ±5.2 **kg/m^2.** Table 1 shows other demographic variables of the sample.

Insert Table 1

We did not find a statistically significant difference in MVC nor duration of MVC pre and postsurgery. A statistically significant difference was found in the average value. Table 2 shows the manometry **values** pre and post POP surgery.

Insert Table 2

Table 3 shows PFM function assessed using the MOGS pre and postsurgery. In the presurgery evaluation 40% (n = 26) of women received a score <3 in the MOGS. In the postsurgery evaluation, only 21.5% had a score < 3. Among the participants with MOGS score < 3 presurgery (n=26), 16.9% remained unchanged postsurgery, and 23% changed to a score ≥ 3with statistical significance. Postsurgery 55.3% of women who had a MOGS score ≥ 3 at baseline remained unchanged, and only 4.6% of the participants initially with a score ≥ 3 presurgery exhibited a score < 3. The McNemar test showed a significant difference in the MOGS score pre and postsurgery (*p* = 0.00).

Insert Table 3

Table 4 shows that the higher the severity of pre and postsurgery POP, the worse the MVC. In addition, the higher the POP severity presurgery, the poorer the duration of

PFM contraction. Although lower values of average contraction were found in women with higher severity of POP pre and postsurgery, no statistically significant differences were found.

Insert Table 4

Discussion

This study aimed to evaluate PFM MVC pre and post POP surgery and to investigate if the higher the severity of POP, the worse the MVC would be postsurgery.

According to our results MVC measured using manometry remained unchanged postsurgery therefore our hypothesis was refuted. However the average contraction and PFM function assessed using the MOGS[15] improved 40 days after surgery.

A possible explanation for not finding a statistically significant improvement in MVC in our sample postsurgery may be the fact that 41.5% of our sample presented with Stage II POP and only 6.1% had the highest severity of POP. This suggests the need for future studies including only women with more advanced POP. It is suggested in the literature that any vaginal surgery could contribute to a worse PFM performance after surgery due to several variables including damage to pelvic floor innervation and pelvic fibromuscular structures during surgery and altered anatomic position of the pelvic organs.[18] However, Chen et al.[5] hypothesize that the removal of the overload may improve the PFM function and strength. We need to consider that the lack of change found in this study could be a result of the interaction between factors leading to an impaired muscle function after surgery and those that could improve muscle performance after the removal of the overload represented by POP.[5] In support of the theories claiming an improvement post POP surgery we found an improved average contraction measured by manometry, indicating that women postsurgery generated an increased mean pressure following instruction to perform the PFM contraction. However, the clinical importance of the magnitude of our finding (2.3 cmH_2O) is uncertain; this slight increase may reflect a small learning effect from the pre and postsurgery instructions to contract. Surgical removal of the prolapse alone may not be enough to improve PFM function, specific therapies targeted to the PFM may be required. There is strong evidence that PFM strength training is a low-cost, low-risk, effective intervention to improve PFM function[6].

The literature investigating PFM strength pre and post POP surgery is scarce and lacks sufficient statistical and clinical interpretations of findings. We found only one pilot study assessing the vaginal pressure of 21 women early postsurgery with a water-perfused balloon catheter and an external pressure transducer taped to the pubic symphysis. The MVC was assessed only in the sitting position and the authors found a small decrease in vaginal pressure six weeks after surgery, although no statistical analysis was provided.[10]

Considering the results of the control groups without PFMT of the RCTs included in the systematic review of Zhang et al.[7], it is not possible to conclude if PFM strength changes postsurgery. Only two studies verified a small decrease in manometry values 3 months post POP surgery with no statistical analysis available. None of these had the primary aim to investigate PFM MVC postsurgery and they were not powered to answer this question. Considering PFM strength measured by the MOGS some authors verified a decreased function 3 months postsurgery [19,20] and others found an improvement at 3 months[21] and 6 months postsurgery.[22] However, the statistical and clinical relevance of these changes are not provided in most of these studies.

The present study found an improvement in MOGS scores postsurgery. A significant percentage of women presenting with a score below 3 demonstrated an improved lift component of their PFM postsurgery, resulting in a score equal to or above 3 on this scale. However, it is not possible to guarantee that these women did not perform better because they had already undergone a presurgery examination and had received preoperative instructions. The absence of a control group is a limitation of our study. Despite this, the results of the prospective controlled study conducted by Chen et al.[8] also reported an increase in MOGS, however their evaluation was conducted only 3 months postsurgery. These authors had the primary aim to evaluate PFM function in patients with POP pre and postsurgery using the MOGS and surface electromyography (sEMG). They analyzed two groups, one of which included 74 patients with POP who underwent pelvic reconstructive surgery and a control group including 30 patients who did not have POP. Vaginal palpation showed a significant increase in PFM strength in the POP group postsurgery, although it was still lower than the values in the control group. The electrical activity of the PFM also increased significantly in the POP group postsurgery. An increase in sEMG was also found in another prospective un-controlled study that assessed PFM 3 months after surgery in patients with POP after Prolift procedure.[11] The authors concluded that restoration of the pelvic anatomy may explain the improvement in the function and electrical activity of PFM in patients with POP.[11] The RCT conducted by Pauls et al.[21]found a small decrease in rapid PFM contraction average sEMG 3 months post POP surgery but this study do not provide a statistical analysis of this result.

The outcome measure used in these studies was different from ours. The assessment of PFM function with sEMG has limitations including the inability to assess a specific muscle activity in isolation, the cross-talk effect, artifact motion, and the movement of probes during contractions.[23] Furthermore, none of these studies performed data normalization as recommended to minimize discrepancies, allowing comparisons of values.[24]

There is not a single gold standard tool able to assess all PFM function. One limitation of the MOGS is that it is a subjective tool and reproducibility is related to examiner's experience.[13] One strong point of our study is that only one experienced physiotherapist performed all assessments pre and postsurgery. Several studies have indicated that manometry measurement of MVC is more reliable than digital palpation assessment.[12,13]

In this study we performed PFM assessment before the POP-Q and it is uncertain if this could in some way alter the accuracy of POP-Q measurement, however we found no guidelines or studies which have investigated this.

The present study has contributed to a better understanding of the impact of POP on PFM function and appears to be the first with the primary aim of evaluating PFM strength 40 days post POP surgery.

Conclusion

We can conclude that forty days postsurgery women did not show an improved MVC of the PFM based on our primary outcome measure, however we found improvement in the average contraction and a better muscle function performance indicated by a higher percentage of those able to lift their PFM indicated by a MOGS. Future larger prospective controlled studies are needed to confirm these findings.

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Abbreviations

MVC	Maximum voluntary contraction
POP-Q	Pelvic organ prolapse quantification
POP	Pelvic organ prolapse
PFM	Pelvic floor muscle
PFMT	Pelvic floor muscle training
EMG	Electromyography
cmH_2O	Centimeters of water
MOGS	Modified oxford grading scale
BMI	Body mass index

Table 1 Demographic characteristics

Variables		n	%
Marital status	With partner	45	69.2
	Without partner	20	30.7
Occupation	remunerated	15	23.0
	non-remunerated	43	66.1
	retired	7	10.7
Ethnic group	White	43	66.1
	non-white	22	33.8
Literacy (year)	1	8	12.3
	< 9	45	69.2
	≥ 9	12	18.4
	No	18	27.6
Current physical exercise	Some	14	21.5
	None	51	78.4
Reproductive status	Premenopausal	9	13.8
	Postmenopausal	56	86.1
Prior knowledge of PFM	Yes	18	27.6
	No	47	72.3
Previous PFMT	Yes	6	9.23
	No	59	90.7
Active sexual life	Yes	27	41.5
	No	38	58.4
Parity	nulliparous	1	1.5
	≥5	24	36.9
	<5	40	61.5
Vaginal deliveries	More than 1	57	87.6
	1	5	7.6
	None	3	4.6
Cesarean	None	43	66.1
	≥1	22	33.8
Episiotomy	Yes	46	73.0
	No	17	26.9

Table 2 Pelvic floor muscle strength before and after POP surgery measured using the Peritron manometer

Manometry (mean ± SD)	Before	After	Difference
Peak of the MVC (mean ± SD) (cmH2O)	27.1 ± 17	29.0 ±17.8	1.9 ±12.9; p=0.22
Duration of MVC (mean ± SD) (seconds)	5.4 ±3.4	5.7 ±2.8	0.3 ±2.8; p=0.38

Average (mean ± SD) (cmH2O)	19.7 ±13.1	22.1 ±14.4	2.3 ± 8.6; p=0.03*

SD Standard Deviation
MVC Maximum Voluntary Contraction
*Statistically significant difference ($p < 0.05$)

Table 3 Pelvic floor muscle function before and after surgery assessed using the Modified Oxford Grading Scale

Oxford Modified Scale	Before n (%)	After n (%)
1	10 (15.3)	2 (3)
2	16 (24.6)	12 (18.4)
3	32 (49.2)	24 (36.9)
4	5 (7.6)	22 (33.8)
5	2 (3)	5 (7.6)

Table 4 Severity of POP according to POP-Q in relation to maximum voluntary contraction measured using Peritron® before and after surgery.

			MVC scores (cmH_2O)				**Duration (seconds)**			**Average (cmH_{2O})**		
			n	**Mean**	**SD**	**p-value**	**Mean**	**SD**	**p-value**	**Mean**	**SD**	**p-value**
		II	27	33	18.5		6.7	4.3		22.9	15.4	
Before	POP-Q	III	34	23.5	15.3	0.01*	4.2	1.9	0.00*	18.0	11.3	0.10
		IV	4	17.3	3.4		6.0	3.4		12.5	2.4	
		0	22	27.3	15.8		5.8	3.0		19.8	12.3	

After	POP-Q	I	39	31.5	19.2	0.04*	5.7	2.8	0.47	24.5	15.6	0.06
		II	4	14.6	1.1		4.4	1.1		11.0	1.7	

POP-Q Pelvic Organ Prolapse Quantification
MVC Maximum Voluntary Contraction
***Statistically significant difference ($p < 0.05$)**

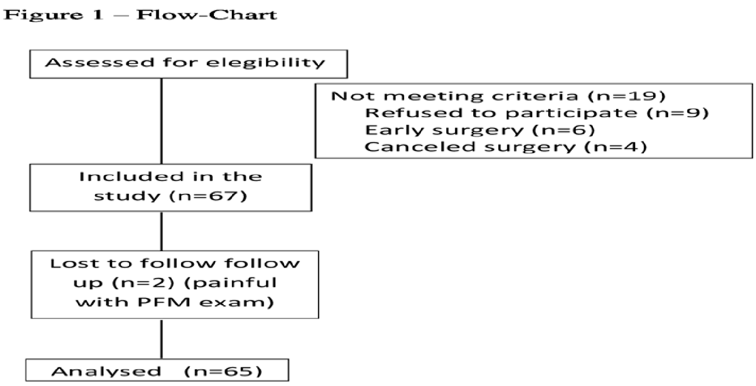
Figure 1 – Flow-Chart
Assessed for elegibility
Not meeting criteria (n=19)
Refused to participate (n=9)
Early surgery (n=6)
Canceled surgery (n=4)
Included in the study (n=67)
Lost to follow follow up (n=2) (painful with PFM exam)
Analysed (n=65)

Figure 1 .