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Original Research

Characterizing Pelvic Floor Muscle Function and Morphometry in Survivors of Gynecological Cancer Who Have Dyspareunia: A Comparative Cross-Sectional Study

Marie-Pierre Cyr, MPT, MSc[1,2,*], Chantale Dumoulin, PT, PhD[3,4], Paul Bessette, MD[5,6], Annick Pina, MD, FRCSC, MSc[7,8], Walter H. Gotlieb, MD, PhD[9,10], Korine Lapointe-Milot, MD[5,6], Mélanie Morin, PT, PhD[1,2]

[1]School of Rehabilitation, Faculty of Medicine and Health Sciences, University of Sherbrooke, Sherbrooke, Quebec, Canada
[2]Research Center of the Centre Hospitalier Universitaire de Sherbrooke, Sherbrooke, Quebec, Canada
[3]School of Rehabilitation, Faculty of Medicine, University of Montreal, Montreal, Quebec, Canada
[4]Research Center of the Institut Universitaire de Gériatrie de Montréal, Montreal, Quebec, Canada
[5]Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Faculty of Medicine and Health Sciences, University of Sherbrooke, Sherbrooke, Quebec, Canada
[6]Research Center of the Centre Hospitalier Universitaire de Sherbrooke, Sherbrooke, Quebec, Canada
[7]Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Faculty of Medicine, University of Montreal, Montreal, Quebec, Canada
[8]Research Center of the Centre Hospitalier de l'Université de Montréal, Montreal, Quebec, Canada
[9]Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Faculty of Medicine, McGill University, Montreal, Quebec, Canada
[10]Lady Davis Institute of the Jewish General Hospital, Montreal, Quebec, Canada

*Address all correspondence to Dr Morin at: melanie.m.morin@usherbrooke.ca

Abstract

Objective. More than one-half of gynecological cancer survivors are affected by pain during sexual intercourse, also known as dyspareunia. Oncological treatments may result in pelvic floor muscle (PFM) alterations, which are suspected to play a key role in dyspareunia. However, to our knowledge, no study has investigated PFM function and morphometry in this population. The aim of the study was to characterize and compare PFM function and morphometry between gynecological cancer survivors with dyspareunia and asymptomatic women.

Methods. Twenty-four gynecological cancer survivors with dyspareunia and 32 women with a history of total hysterectomy but without pelvic pain (asymptomatic women) participated in this comparative cross-sectional study. PFM passive forces (tone), flexibility, stiffness, maximal strength, coordination, and endurance were assessed with an intra-vaginal dynamometric speculum. Bladder neck position, levator plate angle, anorectal angle, and levator hiatal dimensions were measured at rest and on maximal contraction with 3D/4D transperineal ultrasound imaging.

Results. Compared with asymptomatic women, gynecological cancer survivors showed heightened PFM tone, lower flexibility, higher stiffness, and lower coordination and endurance. At rest, they had a smaller anorectal angle and smaller levator hiatal dimensions, indicating heightened PFM tone. They also presented fewer changes from rest to maximal contraction for anorectal angle and levator hiatal dimensions, suggesting an elevated tone or altered contractile properties.

Conclusions. Gynecological cancer survivors with dyspareunia present with altered PFM function and morphometry. This research therefore provides a better understanding of the underlying mechanisms of dyspareunia in cancer survivors.

Impact. Our study confirms alterations in PFM function and morphometry in gynecological cancer survivors with dyspareunia. These findings support the rationale for developing and assessing the efficacy of physical therapy targeting PFM alterations in this population.

Keywords: Body Image Distress, Dynamometric Speculum, Dyspareunia, Gynecological Cancer Survivors, Pelvic Floor Muscles, Psychological Distress, Sexual Distress, Sexual Dysfunction, Ultrasound Imaging, Vaginal Length

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Introduction

Gynecological cancer is one of the most prevalent cancers affecting women.[1,2] Endometrial and cervical cancers are commonly treated with surgery, radiation therapy, or chemotherapy and have high 5-year survival rates in developed countries.[1,2] With the advances of oncological treatments, there is a growing number of women surviving beyond their diagnosis who live with long-term adverse effects.[1,2] Several studies reported that gynecological cancer survivors are more likely to have depressive symptoms, anxiety, and body image distress.[3–5] In addition to pelvic floor disorders,[6,7] they are more prone to experience sexual dysfunction and distress.[8,9] Cohort studies showed that 55% to 67% of gynecological cancer survivors have pain during sexual intercourse, also known as dyspareunia.[7,10,11] Thereby, this prevalence largely exceeds that of women with no history of cancer, with 15% of women affected.[12–14]

According to a recent consensus, pelvic floor tissue changes associated with oncological treatments are considered as an iatrogenic cause of dyspareunia.[15] Vaginal stenosis, loss of tissue elasticity, and vaginal dryness following surgery[16–20] or radiation therapy[10,11,21,22] can contribute to experiencing vulvovaginal pain during sexual intercourse. It can be hypothesized that altered pelvic floor muscle (PFM) function, such as heightened PFM tone, may play a crucial role in the etiology of dyspareunia in cancer survivors. However, to date, there are no data available regarding PFM function in gynecological cancer survivors with dyspareunia. The current evidence is limited to the effects of oncological treatments on the PFMs in gynecological cancer survivors presenting urinary incontinence. One study compared cancer survivors affected by urinary incontinence with asymptomatic women who had no urinary symptoms and had undergone a total hysterectomy for benign conditions.[23] The authors used an intra-vaginal dynamometric speculum to demonstrate a heightened PFM tone and altered contractile properties.[23] These alterations may contribute to pain during intercourse in cancer survivors given that several studies have shown this association in non-oncological populations.[24,25] Therefore, there is a significant gap in knowledge regarding the underlying mechanisms of dyspareunia in cancer survivors.

As combining dynamometry with ultrasound imaging would enable a comprehensive assessment of PFM alterations in gynecological cancer survivors with dyspareunia,[26] the primary aim of this study was to characterize and compare PFM function and morphometry between gynecological cancer survivors suffering from dyspareunia and women with a history of total hysterectomy but without pelvic pain (asymptomatic women). The secondary aim was to compare the 2 groups on psychosexual and pelvic floor disorder outcome measures.

Methods

Study Design

This comparative cross-sectional study was conducted in Sherbrooke and Montreal, Canada. The institutional ethics committee approved the study, and informed consent was obtained from all participants.

Participants

Women were recruited through posters and brochures in public health care facilities, newspaper advertising, referrals by health care providers, and opt-out letters inviting women to contact the research team before 3 weeks after mailing date. If they had not opted out within 3 weeks, the research team called them to discuss the study. In total, 24 gynecological cancer survivors with dyspareunia and 32 asymptomatic women enrolled in the study. Cancer survivors were included if they had had a total hysterectomy with or without brachytherapy, external beam radiation therapy, or chemotherapy for endometrial or cervical cancer. They had to report a new incidence of vulvovaginal pain during sexual intercourse after oncological treatments for at least 3 months.[27] They also had to report pain in more than 80% attempts of vaginal penetration with a minimal intensity of 5 on an 11-point numeric rating scale from 0 (no pain) to 10 (worst pain).[28] A gynecologic oncologist performed a standardized exam to rule out other conditions that may cause pain (eg, vaginitis, cystitis, or dermatitis).[29] Gynecological cancer survivors were excluded if they had another primary pelvic cancer or pelvic pain unrelated to intercourse. Asymptomatic women had to have undergone a total hysterectomy for benign conditions (eg, abnormal bleeding or fibroma) and had no history of pelvic pain, no difficulties with sexual activity, and no history of cancer. These women were selected to control the potential effect of surgery. The exclusion criteria for the 2 groups of women were (1) severe vaginal atrophy or stenosis preventing the insertion of the intra-vaginal dynamometric speculum; (2) severe pelvic organ descent (stage III or more) based on the Pelvic Organ Prolapse–Quantification; (3) active urinary or vaginal infection; (4) chronic constipation[30]; (5) previous physical therapy treatment in the last year; (6) hormone replacement therapy changes in the last 6 months; and (7) other medical conditions likely to interfere with the study procedures (eg, psychological, cardiovascular, or neurological conditions).

Procedures

Participants were assessed by an experienced physical therapist. Sociodemographic characteristics and medical history were collected, including the average pain intensity during sexual intercourse on the 11-point numeric rating scale. Information pertaining to cancer history and oncological treatments were retrieved from participants' medical records. Validated self-administered questionnaires were then completed. Prior to conducting the PFM assessment, instructions and digital palpation were used to teach the participant how to perform adequate contraction and relaxation. PFM function and morphometry were assessed in the supine position after the participant had emptied her bladder. All measurements except for the flexibility parameter were assessed without soliciting pain. This was ascertained by asking women at each measurement if they were experiencing any pain using the numeric rating scale.

PFM Function

PFM function was measured with an intra-vaginal dynamometric speculum (further details are available elsewhere).[31–36] The PFM parameters assessed were selected based on their psychometric properties.[32–36] To assess PFM tone, passive forces (N) were measured at rest, at the minimal vaginal aperture (when the 2 speculum branches were closed), and at the maximal vaginal aperture. This maximal aperture (mm), used to characterize flexibility, was obtained by separating the 2 branches to increase the anteroposterior (AP) diameter

following women's tolerance. Five stretch-relax cycles (separation of the branches until maximal aperture) were performed at a constant speed of 5 mm/s, and the following parameters were extracted and averaged for cycles 3 to 5: (a) passive forces (N) at an aperture of 15 mm; (b) passive elastic stiffness (change in forces/change in vaginal aperture; N/mm) at an aperture of 15 mm; (c) vaginal aperture (mm) at a force of 2 N; and (d) hysteresis (ie, the area between the lengthening and shortening curve in N × mm). The women were then asked to strongly contract their PFMs for 10 seconds with the speculum set at a 5-mm aperture. Maximal strength (N) was calculated by subtracting the initial passive forces from the maximal force produced by the PFMs. To assess coordination, participants were instructed to contract as strong and as fast as possible while relaxing between each contraction for 15 seconds, and the number of contractions was recorded. Endurance (% × s) was computed from a 90-second maximal contraction by calculating the normalized area under the force curve between 10 and 60 seconds ([area/maximal force] × 100).

PFM Morphometry

PFM morphometry was assessed with a Voluson E8 Expert BT10 Ultrasound (GE Healthcare, Mississauga, ON, Canada) with a 3D/4D transperineal probe (RM6C next-generation matrix) placed on the perineum in the midsagittal plane. The following parameters, described in detail elsewhere,[37–41] were measured at rest and on maximal contraction. In the midsagittal plane, the bladder neck position was evaluated on the *y*-axis and *x*-axis (cm) using the inferior and posterior margin of the pubic symphysis as the reference point. The levator plate angle formed by a horizontal reference line at the same reference point of the pubic symphysis intersecting a line from this margin to the anorectal angle, as well as the anorectal angle shaped by a longitudinal axis of the anal canal and the posterior rectal wall, were also measured. In the axial plane, the levator hiatal area (cm^2), AP, and left–right (LR) diameters (cm) were taken at the level of minimal hiatal dimensions. To assess PFM morphometric changes from rest to maximal contraction, bladder neck cranial displacement ($y\text{-axis}_{contraction} - y\text{-axis}_{rest}$), ventral displacement ($x\text{-axis}_{contraction} - x\text{-axis}_{rest}$) and ventrocranial displacement ($\sqrt{}$[cranial displacement^2 + ventral displacement^2]), excursion of levator plate and anorectal angles ($angle_{rest} - angle_{contraction}$), levator hiatal area narrowing, levator hiatal AP, and LR diameter reduction ([$measurement_{rest} - measurement_{contraction}$]/$measurement_{rest}$ × 100) were calculated. Previous studies have shown good psychometric properties for all ultrasound imaging parameters.[38,41] In addition to ultrasound imaging, the total vaginal length (cm) at rest was measured based on the Pelvic Organ Prolapse–Quantification system.[42]

Psychosexual Outcome Measures

Sexual function was assessed with the Female Sexual Function Index, with higher scores indicating better sexual function.[43–45] Moreover, the Female Sexual Distress Scale-Revised was used to evaluate sexual distress, with higher scores representing more sexually related distress.[46,47] As for body image distress, the Body Image Scale was administered, with higher scores pointing out greater body image distress.[48,49] The Beck Depression Inventory-II provided information on depression symptoms, with higher scores indicating higher depressive symptoms.[50,51] The State–Trait Anxiety Inventory was used to evaluate anxiety, with higher scores reflecting more anxiety.[52,53]

Pelvic Floor Disorder Outcome Measures

Urinary, vaginal, and bowel symptoms were evaluated using the International Consultation on Incontinence Questionnaire (ICIQ) modules. The ICIQ-Urinary Incontinence Short Form was used for urinary symptoms, with higher scores indicating greater symptom severity[54]; the ICIQ-Vaginal Symptoms for vaginal symptoms, with higher scores representing greater vaginal symptoms or sexual matters[55]; and the ICIQ-Bowel for bowel symptoms, with higher scores corresponding to greater bowel symptoms or impact on quality of life.[56]

Statistical Analyses

Statistical analysis was performed with IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA). The normality of data distribution was checked using visual inspection and the Shapiro–Wilk test.[57] Continuous variables were expressed as mean (SD) or median (first quartile [Q1] – third quartile [Q3]), and categorical variables as number of participants (n) (percentage of the total group). Student's *t* tests or Mann–Whitney U tests for continuous data and chi-square tests for categorical data were used to compare the 2 groups on baseline characteristics. Student's *t* tests or Mann–Whitney U tests were conducted to compare the groups for PFM function and morphometry, psychosexual, and pelvic floor disorder outcome measures, followed by analyses of covariance (ANCOVAs) to adjust for relevant characteristics (ie, the time since oncological treatments or total hysterectomy). Logarithmic transformation was applied to the ICIQ-Urinary Incontinence Short Form score to comply with ANCOVA assumptions. $P < .05$ was considered statistically significant, and effect sizes calculated from ANCOVAs were reported as partial eta-squared (η^2): .01 indicated a small effect, .06 a medium effect, and ≥.14 a large effect.[58]

Role of the Funding Source

The funding sources played no role in the design, conduct, or reporting of this study.

Results

Table 1 shows the characteristics of gynecological cancer survivors with dyspareunia and asymptomatic women. The 2 groups were similar for all baseline characteristics, except for time since oncological treatments or total hysterectomy and the type of surgery. Of the 24 gynecological cancer survivors with dyspareunia, 19 (79.9%) had endometrial cancer and 5 (20.8%) had cervical cancer. Cancer stages were I (15; 62.5%), II (4; 16.7%), or III (5; 20.8%) based on the International Federation of Gynecology and Obstetrics staging. Regarding the oncological treatments, 9 (38%) had only the surgery, 5 had surgery + brachytherapy (21%), 2 (8%) had surgery + chemotherapy, 1 (4%) had surgery + external beam radiation therapy, and 7 (29%) had surgery + brachytherapy + external beam radiation therapy. The median pain intensity during sexual intercourse was 7.8/10 (5.6–8.0).

The differences in PFM function between gynecological cancer survivors with dyspareunia and asymptomatic women are summarized in Table 2. Cancer survivors demonstrated

Table 1. Participant Characteristics[a]

Characteristics	Gynecological Cancer Survivors With Dyspareunia (n = 24)	Asymptomatic Women (n = 32)	*P*
Age (y), mean (SD)	56.0 (10.0)	53.1 (5.3)	.19[b]
Body mass index (kg/m^2), mean (SD)	28.38 (3.98)	26.57 (5.44)	.18[b]
Race/ethnicity, n (%)			1.00[c]
White	23 (95.8)	30 (93.8)	
Hispanic or Latino	1 (4.2)	1 (3.1)	
Black or African American		1 (3.1)	
Religion, n (%)			.18[c]
Catholic	22 (91.7)	32 (100.0)	
Other	2 (8.3)		
Level of education, n (%)			.15[c]
High school	5 (20.8)	6 (18.8)	
Vocational	4 (16.7)	6 (18.8)	
College	6 (25.0)	10 (31.3)	
Undergraduate	4 (16.7)	10 (31.3)	
Master	4 (16.7)		
Doctorate	1 (4.2)		
Approximate annual income, n (%)			.51[c]
$10,000–39,999	9 (37.5)	12 (37.5)	
$40,000–79,999	11 (45.8)	18 (56.3)	
$80,000 and more	4 (16.7)	2 (6.3)	
Civil status, n (%)			.92[c]
Single (not officially engaged in a relationship)	1 (4.2)	2 (6.3)	
Single (engaged in a relationship)	6 (25.0)	7 (21.9)	
Common law	5 (20.8)	9 (28.1)	
Married	12 (50.0)	14 (43.8)	
Pregnancy, mean (SD)	1.4 (1.3)	2.0 (1.2)	.11[b]
Vaginal delivery, mean (SD)	1.6 (.8) n = 10	1.7 (.8) n = 25	.69[b]
Hormone replacement therapy, n (%)	4 (16.7)	11 (34.4)	.22[c]
Time since oncological treatments or total hysterectomy (mo), median (Q1–Q3)	43.0 (9.0–73.8)	84.0 (47.5–110.5)	.003[d]
Surgery, n (%)			<.001[c]
Total hysterectomy	1 (4.2)	15 (46.9)	
Total hysterectomy + USO		2 (6.3)	
Total hysterectomy + BSO	23 (95.8)	15 (46.9)	
Surgical approach, n (%)			.43[e]
Abdominal	10 (41.7)	17 (53.1)	
Vaginal ± laparoscopy	14 (58.3)	15 (46.9)	

[a]BSO = bilateral salpingo-oophorectomy; USO = unilateral salpingo-oophorectomy. [b]Student's *t* tests. [c]Fisher exact tests. [d]Mann–Whitney U test. [e]Pearson chi-square test.

higher PFM passives forces at the minimal aperture, suggesting a heightened tone. They also showed a smaller maximal aperture, indicating lower flexibility. The resistance at the maximal aperture was thereby assessed at a smaller aperture in cancer survivors, which explains the lower forces recorded in concordance with the force-muscle length relationship.[36] During dynamic stretches, cancer survivors with dyspareunia showed greater passive forces and passive elastic stiffness at a 15-mm aperture, in addition to a lower aperture at 2 N and hysteresis. They also performed a lower number of rapid contractions, which is suggestive of altered coordination, and had lower endurance than asymptomatic women. All statistically significant differences were preserved after controlling for time since oncological treatments or total hysterectomy ($P < .03$), with medium to large effect sizes ($\eta^2 \geq .09$). However, no significant difference was found between the 2 groups for PFM maximal strength ($P = .68$).

Table 3 illustrates the differences in PFM morphometry between both groups. Gynecological cancer survivors with dyspareunia presented smaller hiatal dimensions and smaller anorectal angle at rest, implying a heightened PFM tone. On maximal contraction, the levator hiatal area and LR diameter were smaller in these women. Nonetheless, they showed fewer changes from rest to maximal contraction, which could be related to the status of the PFMs at rest (eg, elevated tone) or to alterations in contractile properties. Results also revealed a shorter total vaginal length in cancer survivors with dyspareunia (median 7.0; Q1 6.5−Q3 8.0) compared with asymptomatic women (median 8.5; Q1 8.0−Q3 8.5) ($P < .001$; $\eta^2 = .35$). All group differences described above were still significant in the ANCOVAs ($P < .05$; $\eta^2 \geq .07$, indicating medium to large effect sizes). Additionally, the bladder neck position defined in the *y*-axis on maximal contraction became significant when controlling for time since oncological treatments or total hysterectomy in the analysis, revealing a lower location of the bladder neck in cancer survivors with dyspareunia. Although ventrocranial displacement was significantly lower in these women, its significance was lost with the ANCOVAs.

Regarding the psychosexual outcome measures (Tab. 4), gynecological cancer survivors with dyspareunia had a lower sexual function according to the total and subscale scores compared with asymptomatic women. Furthermore, the former showed higher sexual and body image distress. No

Table 2. PFM Function Using the Intra-Vaginal Dynamometric Speculum[a]

Parameters	Gynecological Cancer Survivors With Dyspareunia (n = 24) Mean (SD)	Asymptomatic Women (n = 32) Mean (SD)	P^b	P^c	Effect Size[d] (η^2)
Initial passive resistance at minimal vaginal aperture					
Passive forces (N)	1.50 (0.68)	1.00 (0.43)	.003	.003	.153
Passive resistance at maximal vaginal aperture					
Passive forces (N)	9.25 (4.81)	11.92 (3.46)	.03	.04	.075
Maximal aperture (mm)	22.84 (9.08)	35.66 (5.29)	<.001	<.001	.478
Dynamic stretches during lengthening and shortening cycles					
Force at common aperture of 15 mm (N)	1.91 (0.80)[e]	1.33 (0.70)	.01	.004	.148
Passive elastic stiffness at common aperture of 15 mm (N/mm)	0.38 (0.19)[e]	0.24 (0.12)	.01	.001	.187
Vaginal aperture at common force of 2 N (mm)	16.30 (2.59)[e]	19.58 (4.51)	.003	.002	.163
Hysterisis (N × mm)	65.09 (57.42)	137.82 (59.82)	<.001	<.001	.282
Maximal strength test (10 s)					
Maximal strength at 5-mm aperture (N)	4.80 (3.06)	4.91 (2.06)	.89	.68	.003
Speed test (15 s)					
No. of contractions	5.9 (1.9)	7.4 (2.1)	.01	.03	.090
Endurance test (90 s)					
Endurance on 50 s (% × s)	1814.68 (932.58)	2341.78 (613.44)	.01	.02	.105

[a]ANCOVAs = analyses of covariance; PFM = pelvic floor muscle. [b]Student's *t* tests. [c]ANCOVAs. [d]Effect sizes presented as partial eta-squared from ANCOVAs. [e]Data was corrupted for 1 participant, misleading analysis interpretation.

Table 3. PFM Morphometry Using 3D/4D Transperineal Ultrasound Imaging[a]

Parameters	Gynecological Cancer Survivors With Dyspareunia (n = 24) Mean (SD)	Asymptomatic Women (n = 32) Mean (SD)	P^b	P^c	Effect Size[d] (η^2)
Rest					
Bladder neck position—*y*-axis (cm)	3.05 (0.47)	3.24 (0.42)	.13	.06	.065
Bladder neck position—*x*-axis (cm)	−0.25 (0.40)	−0.07 (0.48)	.15	.41	.013
Levator plate angle (°)	22.98 (6.13)	20.02 (6.06)	.08	.22	.028
Anorectal angle (°)	106.78 (9.40)	111.99 (7.44)	.02	.01	.109
Levator hiatal area (cm^2)	13.87 (3.79)	17.74 (3.44)	<.001	<.001	.210
Levator hiatal AP diameter (cm)	5.19 (0.89)	5.64 (0.60)	.03	<.05	.072
Levator hiatal LR diameter (cm)	3.53 (0.46)	4.19 (0.45)	<.001	<.001	.345
Maximal contraction					
Bladder neck position—*y*-axis (cm)	3.18 (0.51)[e]	3.44 (0.46)	.05	.03	.089
Bladder neck position—*x*-axis (cm)	−0.76 (0.47)[e]	−0.83 (0.51)	.60	.68	.003
Levator plate angle (°)	31.79 (6.60)[e]	30.52 (8.09)	.54	.61	.005
Anorectal angle (°)	100.87 (7.39)[e]	101.54 (6.86)	.73	.33	.018
Levator hiatal area (cm^2)	10.87 (2.78)[e]	12.47 (2.34)	.03	.01	.115
Levator hiatal AP diameter (cm)	4.28 (0.76)[e]	4.50 (0.50)	.21	.12	.047
Levator hiatal LR diameter (cm)	3.38 (0.48)[e]	3.71 (0.46)	.01	.01	.125
Excursion					
Cranial displacement—*y*-axis (cm)	0.16 (0.19)[e]	0.21 (0.16)	.32	.27	.023
Ventral displacement—*x*-axis (cm)	−0.52 (0.41)[e]	−0.76 (0.47)	.05	.20	.031
Ventrocranial displacement (cm)	0.59 (0.40)[e]	0.84 (0.41)	.03	.11	.050
Levator plate angle excursion (°)	8.86 (6.35)[e]	10.50 (4.95)	.29	.53	.007
Anorectal angle excursion (°)	5.85 (5.50)[e]	10.45 (6.65)	.01	.03	.091
Levator hiatal area narrowing (%)	20.13 (8.87)[e]	28.78 (10.52)	.002	.02	.107
Levator hiatal AP diameter reduction (%)	16.40 (10.27)[e]	20.05 (7.58)	.14	.42	.012
Levator hiatal LR diameter reduction (%)	4.32 (3.60)[e]	11.37 (6.98)	<.001	<.001	.234

[a]ANCOVAs = analyses of covariance; AP = anteroposterior; LR = left–right transverse; PFM = pelvic floor muscle. [b]Student's *t* tests. [c]ANCOVAs. [d]Effect sizes presented as partial eta-squared from ANCOVAs. [e]Data was corrupted for 1 participant, misleading analysis interpretation.

Table 4. Psychosexual and Pelvic Floor Disorder Outcome Measures[a]

Questionnaires	Gynecological Cancer Survivors With Dyspareunia (n = 24) Median (Q1–Q3)	Asymptomatic Women (n = 32) Median (Q1–Q3)	P^b	P^c	Effect Size[d] (η^2)
Female Sexual Function Index (/36)	20.8 (12.8–24.1) n = 16[e]	28.7 (25.7–31.9) n = 31[e]	<.001	<.001	.471
Desire (/6)	2.4 (1.2–3.5)	3.6 (3.0–4.8)	.002	.001	.177
Arousal (/6)	3.6 (3.0–5.0) n = 16[e]	5.1 (4.5–5.4) n = 31[e]	.01	.01	.165
Lubrication (/6)	4.2 (2.0–5.6) n = 16[e]	5.1 (4.5–6.0) n = 31[e]	.01	.01	.154
Orgasm (/6)	3.2 (1.7–4.8) n = 16[e]	5.2 (4.4–5.6) n = 31[e]	.002	<.001	.243
Satisfaction (/6)	3.6 (3.2–4.2)	4.4 (3.6–5.6)	.01	.03	.089
Pain (/6)	1.8 (1.2–3.2) n = 16[e]	6.0 (6.0–6.0) n = 31[e]	<.001	<.001	.660
Female Sexual Distress Scale-Revised (/52)	27.0 (18.0–34.8)	8.0 (1.5–12.8)	<.001	<.001	.387
Body image scale (/30)	5.0 (1.0–9.8)	1.0 (0–4.0)	.001	.01	.114
Beck Depression Inventory-II (/63)	10.0 (3.3–16.0)	6.0 (3.0–10.8)	.07	.14	.041
State–Trait Anxiety Inventory: State (/80)	33.5 (25.3–44.8)	29.0 (24.0–36.8)	.20	.40	.014
State–Trait Anxiety Inventory: Trait (/80)	36.5 (28.0–42.0)	33.0 (26.3–40.0)	.27	.63	.004
ICIQ-Urinary Incontinence Short Form (/21)	1.0 (0–9.0)	0 (0–0)	.001	.01[f]	.460[f]
ICIQ-vaginal symptoms (/53)	15.0 (8.5–19.8)	4.5 (2.0–7.8)	<.001	<.001	.368
ICIQ-sexual matters (/58)	41.5 (33.3–49.0) n = 16[e]	0 (0–9.0) n = 31[e]	<.001	<.001	.625
ICIQ-Bowel (bowel pattern) (/21)	4.0 (3.0–5.0)	2.0 (2.0–4.0)	.002	.03	.093
ICIQ-Bowel (bowel control) (/28)	7.0 (2.0–10.0)	1.5 (1.0–4.0)	<.001	.002	.176
ICIQ-Bowel (quality of life) (/26)	2.0 (1.0–7.0)	1.0 (0–3.5)	.04	.38	.015

[a]ANCOVAs = analyses of covariance; FSFI = Female Sexual Function Index; ICIQ = International Consultation on Incontinence Questionnaire. [b]Mann–Whitney U tests. [c]ANCOVAs. [d]Effect sizes presented as partial eta-squared from ANCOVAs. [e]Having had sexual activities in the month preceding the evaluation was required to answer to FSFI and ICIQ-Sexual Matters. Since some participants did not have any sexual activity in the last month, they did not fill out the questionnaire. [f]ANCOVA with logarithmic transformation of ICIQ-Urinary Incontinence Short Form score to meet assumptions to execute parametric statistical tests. The *P* value and the effect size were extracted from the analysis.

statistical difference was found for depression symptoms and anxiety between the 2 groups. Moreover, cancer survivors reported having greater urinary, vaginal, and bowel symptoms and related impact on quality of life as well as greater sexual matters as assessed with the ICIQ modules (Tab. 4).

Discussion

The main findings reveal that gynecological cancer survivors suffering from dyspareunia have altered PFM function, notably heightened tone, lower flexibility, higher stiffness, and lower coordination and endurance, compared with asymptomatic women who had no history of pelvic pain and had undergone a total hysterectomy for benign conditions. PFM morphometric differences between the 2 groups also concur with PFM function findings and are suggestive of heightened tone and altered contractility.

Significant differences in PFM function and morphometry found between gynecological cancer survivors suffering from dyspareunia and asymptomatic women remained statistically significant after controlling for time since oncological treatments or total hysterectomy.[59] Data available on PFM function and morphometry related to cancer and dyspareunia are limited to the present study in which heightened tone, lower flexibility, higher stiffness, and lower coordination and endurance were shown in gynecological cancer survivors with dyspareunia. Compared with other studies investigating pelvic floor disorders in cancer survivors, our results corroborate those of Bernard et al.[23] They showed that gynecological cancer survivors with urinary incontinence presented heightened PFM tone and lower coordination compared with asymptomatic women. In contrast to our study, Bernard et al[23] showed a lower PFM maximal strength in gynecological cancer survivors. Their findings are not surprising since urinary incontinence is associated with lower strength.[60,61] Their sample also had undergone surgery and brachytherapy in combination,[23] which may have further aggravated the PFMs due to a cumulative effect of oncological treatments.[62–64] Interestingly, Bernard et al[23] did not find a difference in PFM endurance. Their small sample size and, hence, the lack of statistical power may explain this discrepancy. Extending the scope of interpretation beyond our findings to populations with no history of cancer, similar alterations in PFM function and morphometry were observed in comparative cross-sectional studies involving young women suffering from vulvar pain during sexual intercourse (provoked vestibulodynia). These women showed heightened PFM tone and lower coordination and endurance.[24,25] Moreover, the shorter vaginal length may suggest smaller vaginal dimensions in our sample. Restricted vaginal dimensions could contribute to vulvovaginal pain during intercourse, by pulling on the tissues, and prevent complete vaginal penetration.[65] Overall, the PFM alterations found in our sample are plausibly the result of an intricate and cumulative combination of oncological treatment effects, as found in cancer survivors with other conditions.[23] It should also be highlighted that PFM alterations could be both a cause or a consequence of chronic pain, as suggested in non-oncological women with provoked vestibulodynia.[24,25] These findings emphasize the complexity of dyspareunia in cancer

survivors and the need to assess the underlying physiological mechanisms by which PFM alterations contribute to pain.

Furthermore, gynecological cancer survivors with dyspareunia had a significantly lower sexual function than asymptomatic women. Supporting the clinical relevance of this finding, the average score of the Female Sexual Female Scale was lower than the cut-off of 26.6, characterizing sexual dysfunction.[45] Cancer survivors with dyspareunia also showed higher average score for sexual distress, which was above the clinical relevance cut-off score (11.5),[46] as well as higher average score for body image distress. These results are consistent with other studies conducted in cancer survivors[3,8,9] and in women with no history of cancer affected by dyspareunia.[66–69] Depression symptoms and anxiety did not significantly differ between the 2 groups. These conclusions contrast with those of other studies on sexual dysfunction and dyspareunia.[70–72] Nevertheless, our eligibility criteria could explain this result since we excluded women with significant psychological conditions interfering with the study procedures, which could temper the group differences. Lastly, the present study demonstrated greater pelvic floor disorder symptoms and related impact on quality of life in gynecological cancer survivors. This was expected as this population has a high risk of having these disorders.[6,7] Even though our sample did not have significant urinary and bowel symptoms, they could have contributed to lower sexual function.

This comparative cross-sectional study is the first to our knowledge to thoroughly examine PFM function and morphometry among cancer survivors with dyspareunia using dynamometry and ultrasound imaging, respectively. Based on these robust technologies, our work fills a gap in knowledge about the involvement of the PFMs in gynecological cancer survivors suffering from dyspareunia, which remains an understudied condition. This research therefore provides a better understanding of the underlying mechanisms of dyspareunia that is crucial to guide the development of effective treatment for cancer survivors.

Limitations

Some limitations should be acknowledged. Asymptomatic women (ie, without dyspareunia) who had undergone a total hysterectomy for benign conditions were selected as the comparison group. This group enabled us to control the potential effect of surgery but does not allow us to assess the relative contribution of cancer and dyspareunia on the outcome measures. The selection of another comparison group, such as cancer survivors without dyspareunia, would have introduced a significant bias as the majority have other severe pelvic floor disorders (eg, incontinence) known to affect PFM function and morphometry.[60,61] Cancer survivors had different treatments than asymptomatic women, namely total hysterectomy with or without radiation therapy (brachytherapy or external beam radiation therapy). These interventions, mostly used in combination, prevent us from investigating the differential effects of these treatments on the outcomes. Further research is needed to discriminate against the contribution of each oncological treatment in dyspareunia. The 2 groups also differed in the proportion of women having had a total hysterectomy with bilateral salpingo-oophorectomy, which could not be controlled due to statistical assumption violation. There is, however, conflicting evidence that estrogen deficiency provoked by the removal of ovaries impairs PFM function.[73,74]

In conclusion, our results advance our understanding of dyspareunia in gynecological cancer survivors. These women present with altered PFM function and morphometry, lower sexual function, higher sexual and body image distress, and more significant pelvic floor disorder symptoms. These findings provide a strong basis for developing and assessing the efficacy of physical therapy in this population as it targets these PFM alterations. Furthermore, treatment modalities focusing on sexual dysfunction, sexual and body image distress, and pelvic floor disorder symptoms may have important implications for women who have developed dyspareunia after a gynecological cancer.

Author Contributions

Concept/idea/research design: M.-P. Cyr, M. Morin, C. Dumoulin, P. Bessette, W. H. Gotlieb
Writing: M.-P. Cyr, M. Morin, C. Dumoulin, P. Bessette, A. Pina, W. H. Gotlieb, K. Lapointe-Milot
Data collection: M.-P. Cyr, P. Bessette, A. Pina, W. H. Gotlieb, K. Lapointe-Milot
Data analysis: M.-P. Cyr, M. Morin
Project management: M.-P. Cyr, M. Morin, C. Dumoulin
Fund procurement: M.-P. Cyr, M. Morin, C. Dumoulin, P. Bessette, W. H. Gotlieb
Providing participants: M.-P. Cyr, P. Bessette, A. Pina, W. H. Gotlieb, K. Lapointe-Milot
Providing facilities/equipment: M. Morin, C. Dumoulin
Providing institution liaisons: M. Morin, C. Dumoulin, P. Bessette, A. Pina, W. H. Gotlieb, K. Lapointe-Milot
Clerical/secretarial support: M.-P. Cyr, M. Morin
Consultation (including review of manuscript before submitting): M.-P. Cyr, M. Morin, C. Dumoulin, P. Bessette, A. Pina, W. H. Gotlieb, K. Lapointe-Milot

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Ethics Approval

All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Ethics approval was granted by the Comité d'éthique à la recherche du CIUSSS de l'Estrie—CHUS (Project #MP-31-2016-1322) on 6 May 2016.

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Disclosures

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

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