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ORIGINAL ARTICLE

Prevalence of diastasis recti abdominis in a urogynecological patient population

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Abstract A urogynecologist's examination typically includes assessment of the abdominal musculature, including the determination of whether a diastasis recti abdominis (DRA) is present. The purposes of the current study were to examine the (1) prevalence of DRA in a urogynecological population, (2) differences in select characteristics of patients with and without DRA, and (3) relationship of DRA to support-related pelvic floor dysfunction diagnoses. A retrospective chart review was conducted by an independent examiner. Fifty-two percent of the patients examined presented with DRA. Patients with DRA were older, reported higher gravity and parity, and had weaker pelvic floor muscles than patients without DRA. Sixty-six percent of all the patients with DRA had at least one support-related pelvic floor dysfunction (SPFD) diagnosis. There was a relationship between the presence of DRA and the SPFD diagnoses of stress urinary incontinence, fecal incontinence, and pelvic organ prolapse.

Keywords Diastasis recti abdominis · Urogynecological diagnosis · Support-related pelvic floor dysfunction · Stress urinary incontinence · Fecal incontinence · Pelvic organ prolapse

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Abbreviations

DRA	diastasis recti abdominis
UI	urinary incontinence
SUI	stress urinary incontinence
FI	fecal incontinence
POP	pelvic organ prolapse
MPP	Myofascial pelvic pain
PFD	pelvic floor dysfunction
SPFD	support-related pelvic floor dysfunction
OR	odds ratio
CI	confidence interval

Introduction

A urogynecologist's initial examination of a patient with complaints suggestive of pelvic floor dysfunction (PFD) typically includes assessment of the abdominal musculature [1]. In particular, the presence of a diastasis recti abdominis (DRA), defined as an impairment characterized by a midline separation of the rectus abdominis muscle along the linea alba [2, 3], is assessed during the examination. Screening for impairments of the abdominal muscles is conducted because the pelvic floor and abdominal muscles were reported to function synergistically, such that each muscle group enhances the effectiveness of the other during contraction [4–6]. Because of the synergistic relationship between the pelvic floor and abdominal muscles, a decrease in abdominal muscle function associated with DRA [7] could affect the performance of the pelvic floor musculature. Loss of the support-related function of the pelvic floor muscles was implicated in the diagnoses of stress urinary incontinence (SUI) [8], fecal incontinence (FI) [9] and

Table 1 Definitions for conditions

Condition	Definition
Pelvic floor dysfunction	Diagnoses that affect the function of the pelvic floor region and include myofascial pelvic pain, urinary incontinence of any kind, fecal incontinence, and pelvic organ prolapse.
Support-related pelvic floor dysfunction	Diagnoses that are related to the supportive function of the pelvic floor and include stress urinary incontinence, fecal incontinence, and pelvic organ prolapse.
Myofascial pelvic pain	Pain to palpation over an area of skeletal muscle or fascia in the region of the pelvic floor musculature.
Stress urinary incontinence	Loss of urine when coughing, sneezing, laughing, or executing some other provocative maneuver.
Prolapse	A protrusion of the vagina or uterus due to loss of support.
Pelvic organ prolapse	Prolapse of any pelvic organ with a resultant change in the topography of the vagina.
Fecal incontinence	Loss of solid or liquid stool noted as soilage.

pelvic organ prolapse (POP) [10, 11]. Thus, DRA may play an important role in the development, persistence and recurrence of conditions related to impairments of the pelvic floor region, in particular, impairments affecting the support-related function of the pelvic floor muscles.

Prior literature suggests that DRA occurs during pregnancy and resolves in a large percentage of the population within the first year postpartum [7, 12]. Few investigators, however, have studied the prevalence of DRA beyond the childbearing year, and no one has examined the relationship of DRA to other clinical conditions. We hypothesize that DRA persists beyond the childbearing year and that there is a potential relationship between the presence of DRA and diagnoses related to support-related pelvic floor dysfunction (SPFD), specifically, SUI, FI, and POP. The aim of the current study, therefore, was to examine the (1) prevalence of DRA in a urogynecological population, (2) differences in characteristics of patients who present with DRA vs those who do not, and (3) relationship between the presence of DRA and SPFD diagnoses.

Materials and methods

Clinical chart review

A retrospective review was performed of the medical charts from a cohort of patients who presented to a university-based urogynecological medical practice across a 2-year time span (July 1996 through June 1998). Patients came into the office seeking evaluation for PFD, including any of the following conditions: (1) myofascial pelvic pain (MPP), (2) UI, (3) FI, and (4) POP. One physician conducted the standardized urogynecological examinations. An independent reviewer, trained by the primary author, performed the chart reviews. A standardized data collection form, which allowed for collection of data related to demographics, urogynecological and medical history, clinical examination findings and diagnoses assigned, was used. Diastasis recti abdominis was operationally defined as a separation in the rectus abdominis muscle 1 in. above or below the umbilicus palpated during a head lift maneuver [2]. All patients were tested for the presence of DRA while supine with the hips and knees flexed and feet flat on the support surface. DRA was graded by the number of fingerbreadths (approximately 1.5 cm per fingerbreadth) between the medial edges of the bellies of the rectus abdominis muscle [2].

The physician's impressions at the end of the initial examination were recorded as the diagnosis for each patient. Definitions for all diagnoses assigned are provided in Table 1.

Data analysis

Data analysis was performed using Systat version 10.0 for Windows (SPSS, Chicago, IL). Descriptive statistics were calculated for patient characteristics. Frequency distributions and percentages were calculated for all categorical data. Chi-square goodness of fit analyses was conducted to test for associations between DRA and categorical variables. The Mann–Whitney *U* test was used to test for associations between DRA and ordinal level variables. Chi-square tests of independence and independent sample *t* tests were performed to test for differences between patients with and without DRA for categorical and ratio scale variables, respectively. Odds ratios (OR) and the associated 95% confidence intervals (CI) were calculated to index the magnitude of the association between DRA and various PFD diagnoses assigned (MPP and SPFD). The exposure variable in the OR calculations was DRA, presence or absence, and the outcome variable was PFD, presence or absence. Odds ratios and CIs were calculated separately for each of the following PFD diagnoses: (1) MPP, (2) SUI, (3) FI, and (4) POP.

Results

A total of 547 charts were reviewed. Five hundred and forty-one of the 547 (99%) charts included information regarding the presence or absence of DRA and whether a

Table 2 Descriptive statistics for characteristics of all patients and results of tests of differences in characteristics of patients with and without diastasis recti abdominis

Characteristic	All patients[a]	Diastasis recti abdominis status		Statistical and probability value
		Present	Absent	
Mean (SD) age in years (*N*=539)[b]	52.45 (16.65)	54.81 (15.53)	49.90 (17.46)	**t=-3.45, p<0.01**
Race (%) (*N*=425)[b]				
Caucasian	84.94	57.50	42.50	**χ^2=8.10, p<0.01**
African American	13.65	32.76	67.24	**χ^2=6.90, p<0.01**
Asian[c]	0.94	75.00	25.00	
Other[c,d]	0.47	50.00	50.00	
Nulliparous (%) (*N*=514)[b]	14.78	35.00	65.00	**χ^2=13.61, p<0.01**
Mean (SD) parity (*N*=514)[b]	2.32 (1.71)	2.55 (1.68)	2.05 (1.71)	**t=-3.36, p<0.01**
Mean (SD) gravity (*N*=514)[b]	2.91 (2.10)	3.14 (21.11)	2.65 (2.10)	**t=-2.65, p<0.01**
Delivery type (%);(*N*=518)[b]				
Vaginal	66.70	51.60	48.40	χ^2=0.29, p>0.05
Forceps	20.20	57.00	43.00	χ^2=1.67, p>0.05
Cesarean	7.40	62.50	37.50	χ^2=2.00, p>0.05
Suction	2.80	33.33	66.67	χ^2=1.33, p>0.05
Combination of procedures[c]	2.80	100.00	0	
Menopausal[e] (%) (*N*=541)[b]	57.86	65.13	34.88	**χ^2=12.67, p<0.001**
Using hormone replacement (%) (*N*=541)[b]	34.69	67.91	32.09	**χ^2=29.94, p<0.001**
Documented medical conditions (%)				
Gastrointestinal disease; (*N*=540)[b]	14.63	54.43	45.57	χ^2=0.62, p>0.05
Pulmonary disease (*N*=541)[b]	11.64	57.14	42.86	χ^2=1.29, p>0.05
Endometriosis (N=539)[b]	4.45	45.83	54.17	χ^2=0.17, p>0.05
Cardiac disease (*N*=541)[b]	0.74	25.20	74.80	**χ^2=30.25, p<0.01**
Surgical history (%)				
Abdominal[f] (*N*=541)[b]	57.30	65.13	34.88	**χ^2=14.63, p<0.001**
Cardiac (*N*=541)[b,c]	47.78	50.39	49.61	
Spine (*N*=541)[b]	2.59	64.29	35.71	**χ^2=5.33, p<0.05**
Breast (*N*=541)[b]	2.22	16.67	83.33	χ^2=0.02, p>0.05
Gynecological[g] (*N*=540)[b]	0.74	75.00	25.00	χ^2=1.14, p>0.05

Entries in bold indicate a significant effect

[a]All patients who had information about the presence or absence of diastasis recti abdominis available in chart (541/547; 99% of sample)

[b]Values in parentheses indicated the total number of patients on which statistics were calculated for each specific variable

[c]Statistical test not conducted due to insufficient data or insufficient variability in data

[d]The race category of "other" includes Hispanic and Native American

[e]Menopausal status was assigned by one of two methods: (1) age greater then 60 or (2) specific documentation in the medical record. The physician utilized the definition of menopause as the lack of menstruation for 1 year due to loss of ovarian function after the age of 40

[f]Abdominal surgery includes abdominal hysterectomy, cesarean section, and surgeries for the organs in the abdominal cavity

[g]Gynecological surgery includes tubal ligation, vaginal hysterectomy, and other surgical procedures for the vagina or uterus

PFD diagnosis was assigned. The six charts without information related to DRA and PFD diagnosis were excluded from further analysis. The charts excluded were from patients who were unable to participate in a complete examination due to various medically related issues. For example, one chart was excluded, because during the initial examination the patient developed acute cardiac distress and was sent to the emergency room.

Table 3 Frequency distribution for different grades of the size of a diastasis recti abdominis

	Number of fingerbreadths[a]						
	0.5	1	1.5	2	3	4	5
Diastasis recti abdominis (*N*=281)[b]	10	84	12	106	48	20	1

[a]Palpation of the separation in the rectus abdominis muscle 1 in. above or below the umbilicus during a head lift maneuver, graded by finger breadths (approximately 1.5 cm per fingerbreadth) between the medial edges of the bellies of the rectus abdominis muscle [2]

[b]Total number of women with diastasis recti abdominis in sample

Table 4 Distribution of grades of contraction of the pelvic floor muscles for patients with and without a diastasis recti abdominis

Grades of contraction of pelvic floor muscles[a] (N=514)[b]	Diastasis recti abdominis status[c]	
	Present (%)	Absent (%)
0	13.13	16.27
1	28.83	19.139
2	30.66	22.01
3	12.04	16.75
4	9.49	12.92
5	5.84	12.92

Pelvic muscle strength is graded on an ordinal scale with 0 = no contraction to 5 = strong contraction [36]

[a] Median grade of pelvic muscle strength is 2 with a range of 5

[b] Value in parentheses indicate the total number of patients on which statistics were calculated

[c] The distribution of muscle strength grades is different for patients with and without a diastasis recti abdominis (U=32,193.50, p<0.01). A larger percentage of patients with diastasis recti abdominis have lower grades of muscle strength compared to patients without diastasis recti abdominis

Characteristics of the patients included in the analyses are provided in Table 2.

Patient characteristics

Two hundred and eighty-one of the 541 patients (52%) examined presented with DRA. Eighty of the 541 patients (15%) of the women were nulliparous. Twenty-eight (35%) of the 80 women who were nulliparous had a DRA. The numbers of patients who presented with different sizes (0–5 fingerbreadths) of DRA are provided in Table 3. The patients with DRA (1) were older, (2) reported higher parity and gravity levels, and (3) had weaker pelvic floor muscles than the patients without DRA (Table 4). Compared to the patients without DRA, a larger percentage of patients with DRA were (1) Caucasian or Asian, (2) menopausal, (3) using hormone replacement therapy, and (4) had surgery in the region of the abdomen. On the other hand, a smaller percentage of patients with DRA compared to the patients without DRA were (1) African American, (2) had documented cardiac disease, or (3) had a history of breast surgery. The differences in characteristics of patients with and without DRA are provided in Table 2.

Pelvic floor dysfunction diagnoses

A larger percentage of patients with DRA (66%) had one or more of the SPFD diagnoses (SUI, FI, POP) compared to the patients who were without DRA (53%) (Table 5). Compared to patients without DRA, a larger percentage of patients with DRA were diagnosed with each of the following individual diagnoses: (1) MPP (33 vs 29%) (2) SUI (48 vs 42%), (2) FI (7 vs 3%), and (4) POP (19 vs 9%) (Table 6). Finally, there was a relationship between the presence of DRA and the number of SPFD diagnoses assigned to an individual patient. In comparison to the patients without DRA, the percentage of patients with DRA increased with increasing numbers of SPFD diagnoses assigned (Table 7).

Discussion

Key findings

The results of our retrospective study indicate that more than 50% of the women seeking urogynecological examination during the study period presented with DRA. The majority of patients with DRA were menopausal, and, therefore, well beyond the childbearing year. Diastasis recti abdominis was also present in nulliparous women and in women who had a history of abdominal surgery. Women with DRA were older, reported higher parity and gravity and decreased pelvic floor muscle strength compared to women without DRA. In addition, the presence of DRA was found to be associated to varying degrees with the SPFD diagnoses of SUI, FI, and POP. In particular, patients with DRA tended to have a greater number of SPFD diagnoses than the patients without DRA. Currently, no other study has documented the (1) prevalence of DRA in a urogynecological population or (2) relationship between DRA and many of the patient-related variables and PFD (MPP and SPFD) diagnoses we have examined.

Table 5 Relationship between diastasis recti abdominis and support-related pelvic floor dysfunction

Diastasis recti abdominis status	Support-related pelvic floor dysfunction[a]	
	Present[b] (N=324)[c]	Absent (N=217)[c]
% Present (N)	66.55 (187)	33.45 (94)
% Absent (N)	52.69 (137)	47.30 (123)

Support-related pelvic floor dysfunction is defined as the presence of one or more of the following diagnoses: stress urinary incontinence, fecal incontinence, or pelvic organ prolapse

[a] The relationship between the presence of diastasis recti abdominis and one or more support-related pelvic floor diagnoses was significant (χ^2=10.79, OR=1.79, 95% CI 1.25–2.55, p<0.001)

[b] "Present" was assigned if the patient had at least one of the three diagnoses of interest

[c] Value in parentheses equals the total number of patients in each subcategory

Table 6 Relationships between diastasis recti abdominis and pelvic floor dysfunction diagnoses

Diagnosis	Diastasis recti abdominis status		Chi-square statistical and probability value, OR (95% CI)
	Present (%)	Absent (%)	
Myofascial pain (N=166)	32.74 (92)	29.13 (74)	χ^2=0.81, p>0.05 1.18 (0.81–1.73)
Stress incontinence (N=242)	47.69 (134)	41.54 (108)	χ^2=2.07, p>0.05 1.28 (0.9–1.82)
Pelvic organ prolapse (N=150)	18.69 (100)	9.35 (50)	**χ^2=16.72, p<0.001** 2.25 (1.51–3.37)
Fecal incontinence (N=26)	6.76 (19)	2.76 (7)	**χ^2=4.63, p<0.05** 2.56 (1.04–6.31)

Entries in bold face indicate a significant effect
Values in parentheses indicate the total number of patients with specific PFD diagnosis

Age

The primary population in which the prevalence of DRA has been reported has been women under the age of 35 years who are postpartum [12–15]. Several studies documented that DRA develops during pregnancy [12–15]. One study documented that the presence of DRA was associated with increased maternal age [15]. In the current study the mean age of the women with DRA (54.81± 15.53 years) was considerably higher than the age documented in previous studies. The population examined in the current study, however, differs from previous studies; all women in the current study were seeking examination from a urogynecologist for symptoms related to their urogenital system. It is interesting to note that common urogenital impairments such as UI, FI, and POP are associated with increased age [16, 17]. Thus, persistence of DRA in women beyond the childbearing year and the increased incidence of DRA in women seeking urogynecological examination suggest a possible relationship between DRA and the development of UI, FI, and POP as women age.

Race

In the current study, DRA was found to be more prevalent in Caucasian females compared to other races. Prior studies examining issues related to DRA have not reported on the racial distribution of the samples studied [12–15]. Because DRA is considered a mechanical impairment of the fascia of the rectus abdominis muscle [3], the differences among races found in the current study related to prevalence of DRA may be related to racial differences in connective tissue. It is interesting to note that the SPFD diagnoses (SUI, FI, and POP) were also associated with fascial deficits of the pelvic floor [11, 18, 19]. In addition, urodynamically confirmed SUI has been reported to be more prevalent in Caucasian females [16].

Parity

Our finding that women with DRA had a higher parity level than women without DRA is consistent with other reports in the literature [15, 20]. For example, Lo et al. [15] have reported an increased risk for developing DRA in multiparous pregnant women. Chiarello et al. [20] have reported that DRA was more likely to develop in women who were nonexercising and had a mean parity level of 2.3. It is possible that multiple pregnancies, as well as other factors such as lack of exercise, may contribute to cumulative mechanical stress to the connective tissue of the abdominal wall contributing to the development of a DRA. To date, however, most studies examining DRA have focused on primiparous populations [7, 12, 14]. To examine the effects

Table 7 Relationship between diastasis recti abdominis and number of support-related pelvic floor dysfunction diagnoses

Diastasis recti abdominis status	Number of support-related pelvic floor dysfunction diagnoses (%)			
	0	1	2	3
% Present (N=281)[a]	33.45 (94)	45.55 (128)	18.51 (52)	2.49 (7)
% Absent (N=260)[a]	49.23 (128)	41.15 (107)	9.23 (24)	0.39 (1)

Significant relationship between the number of support-related pelvic floor diagnoses (stress urinary incontinence, fecal incontinence, pelvic organ prolapse) and the presence of diastasis recti abdominis (U=29151.5, p<0.001)
[a] Value in parentheses equals total number of patients in each subcategory

of multiparity on DRA, future studies could focus on comparing the prevalence of DRA in a primiparous population vs a multiparous population.

The finding of a DRA impairment in nulliparous women has not previously been reported. It is interesting to note that DRA in men is thought to be associated with activities or characteristics that have the potential to contribute to mechanical stress on the connective tissue at the linea alba, induced by stimuli such as sit ups, prolonged increases in abdominal pressure, or obesity [21–23]. Thus, factors other than those associated with pregnancy could potentially contribute to the development of DRA in nulliparous women.

Menopausal status

The current study is the first to document the presence of DRA in a population that is predominantly menopausal. The hormonal changes associated with pregnancy are believed to predispose women to develop DRA. The persistence of DRA beyond the childbearing year and how DRA impairment may be related to a woman's hormonal cycle, however, have not been examined. Changes in the elasticity of connective tissue due to aging may assist in explaining why once DRA has developed, if not addressed surgically or with exercise, will persist into menopause.

Hormone replacement therapy

In our sample, the majority of women who had DRA were receiving hormone replacement therapy (HRT). To our knowledge, there are no studies that have examined the relationship between DRA and HRT. Similar to DRA, PFD can be considered an impairment of the supporting connective tissue. Recent reports have documented that the use of HRT in postmenopausal women appears to increase the risk of developing UI [24, 25]. Conversely, HRT has been consistently used for treatment of PFD [26–28]. The effect of HRT on PFD is currently considered controversial [25]. Considering that the effect of HRT on connective tissue has not been fully explored, we can draw no conclusions regarding the relationship between DRA and HRT documented in the current study.

Abdominal surgery

DRA in this study was found to be more prevalent in individuals with a prior history of abdominal surgery. There have been no other studies examining DRA that have included people with a history of abdominal surgery [7, 12, 13]. These types of people were excluded in the past because the rectus abdominis muscle can be disrupted to varying degrees depending on the type of abdominal surgery [29]. Because of the potential effects of different surgical procedures on the integrity of the rectus abdominis muscle, it is not surprising that, in the current study, there were larger proportions of patients with a history of abdominal surgery who also had a DRA compared to the patients without a DRA.

Myofascial pelvic pain

Based on the OR obtained in the current report, there was only a weak positive association between DRA and MPP (Table 6). Several authors, however, have proposed that abdominal muscle structure and function is important to assess and potentially treat in women who have MPP in the pelvic floor region [30–32]. Because the impairments that can potentially contribute to MPP syndrome are often multifaceted [31], it appears that further investigation of the relationship of DRA and MPP in the pelvic floor region may be warranted.

Diastasis recti abdominis and support-related pelvic floor dysfunction diagnoses

Through a number of different analyses, the current study supports the hypothesis of a potential relationship between DRA and various SPFD diagnoses. The OR indexing the relationship between DRA and the presence of one or more SPFD diagnoses (Table 5) indicates that the patients with DRA were 1.79 times more likely to present with one or more SPFD diagnoses than patients without DRA. The OR quantifying the relationship between DRA and (1) SUI, (2) FI, and (3) POP were each greater than 1. These values reveal that, to varying degrees, patients with DRA were more likely to have each of the three SPFD diagnoses of interest (Table 6) when compared to patients without DRA. Specifically, when compared to patients without DRA, patients with DRA were (1) 2.56 times more likely to present with FI, (2) 2.25 times more likely to present with POP, and (3) 1.28 times more likely to present with SUI. In addition, the size of the 95% CIs associated with the ORs for POP and SUI indicate a precise estimate of the OR for each relationship. Although the CI for FI is wider than that for POP and SUI, this is likely due to the smaller numbers of patients with FI compared to those with POP or SUI. Finally, we identified a relationship between DRA and the numbers of SPFD diagnoses assigned to individual patients (Table 7). Specifically, the percentages of patients with increasing numbers of SPFD diagnoses were larger for patients with DRA compared to the percentages for patients without DRA. Together, the findings from these three sets of analyses suggest that an impairment of the abdominal musculature, evidenced as a DRA, may be an important contributing factor to the development of different SPFD diagnoses.

There have been only a few studies that suggest a relationship between abdominal muscle function and the SPFD diagnoses of interest in the current study. Three case reports of outcomes after an abdominoplasty documented resolution of UI [33–35]. In a study of children who had hypoplastic abdominal walls (prune belly syndrome), those who underwent an abdominoplasty procedure reported improvement in bowel and bladder voiding [34]. These studies, when taken together, suggest that repair of impairments of the abdominal muscles results in an improvement in symptoms of UI and FI. To our knowledge, however, there have been no studies specifically examining the relationship of DRA and SPFD diagnoses.

Limitations

There are some limitations to the current study. One potential limitation is that our study is a retrospective chart review and subject to a number of biases at various stages of the study. However, we implemented a number of methods to control for the sources of bias that could be introduced. First, the same physician examined and diagnosed all patients. Second, a person independent of the study was recruited to review and record the data from the charts, and the procedures were operationally defined for all aspects of the chart review. Finally, the examining physician also followed a standardized system of (1) examination in which various procedures and responses to examination items were operationalized and (2) definitions for diagnoses assigned (Table 1).

Conclusion

A large percentage of the patients seeking urogynecological examination had DRA. Diastasis rectus abdominis was present well beyond the childbearing year in a large proportion of the women examined. Compared to the women without DRA, a larger percentage of women with DRA were also diagnosed with SPFD. The findings from the current study suggest a need for further prospective examination of the prevalence of DRA and for study of potential associated clinical sequelae.

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