









# Is There a Precise Correlation between the Lengths of the Peritoneal Reflection and the Middle Rectal Valve?

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## Abstract

**Introduction** Pelvic anatomy remains a challenge, and thorough knowledge of its intricate landmarks has major clinical and surgical implications in several medical specialties. The peritoneal reflection is an important landmark in intraluminal surgery, rectal trauma, impalement, and rectal adenocarcinoma.

**Objectives** To investigate the correlation between the lengths of the middle rectal valve and of the peritoneal reflection determined with rigid sigmoidoscopy and to determine whether there are any differences in the location of the peritoneal reflection between the genders and in relation to body mass index (BMI) and parity.

**Design** We prospectively investigated the location of the middle rectal valve and of the peritoneal reflection via intraoperative rigid sigmoidoscopy in colorectal cancer patients undergoing elective colorectal surgery.

**Results** We evaluated 38 patients with a mean age of 55.5 years old (57.5% males) who underwent colorectal surgery at the coloproctology service of the Hospital Santa Marcelina, São Paulo, state of São Paulo, Brazil. There was substantial agreement between the lengths of the middle rectal valve and of the peritoneal reflection ( $Kappa = 0.66$ ). In addition, the peritoneal reflection was significantly lower in overweight patients ( $p = 0.013$  for women and  $p < 0.005$  for men) and in women with  $> 2$  vaginal deliveries ( $p = 0.009$ ), but there was no significant difference in the length of the peritoneal reflection between genders ( $p = 0.32$ ).

**Conclusion** There was substantial agreement between the lengths of the peritoneal reflection and of the middle rectal valve, and the peritoneal reflection was significantly lower in overweight patients and in women with more than two vaginal deliveries.

## Keywords

- ▶ peritoneal reflection
- ▶ rectal valve
- ▶ rigid sigmoidoscopy
- ▶ obesity
- ▶ parity

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## Introduction

Pelvic anatomy remains a challenge for the surgeon. The pelvis contains intestinal, urological, gynecological and vascular organs, and neural structures enclosed in the musculoskeletal space, which requires a great deal of expertise, with major clinical and surgical implications in several medical specialties.<sup>1</sup>

The rectum and its relations to the pelvis and to the peritoneal reflection are of considerable clinical significance – and although the word rectum comes from the Latin *rectum*, meaning straight, in humans it is a tubular structure that has curves adapting to the shape of the sacrum and of the coccyx.<sup>2,3</sup> Both the proximal and distal limits of the rectum are controversial: the rectosigmoid junction is considered by surgeons to be located at the sacral promontory, but at the level of the third sacral vertebra by anatomists, and the distal limit is considered by surgeons as being the muscular anorectal ring, and the dentate line by anatomists. Moreover, the transition from the sigmoid colon to the rectum is a useful landmark characterized by the absence of taeniae and epiploic appendices.<sup>2–6</sup>

The rectum has lateral curves that provide useful anatomic landmarks in relation to the anal verge. These curves correspond intraluminally to the folds or valves of Houston. The 2 left-sided folds are usually observed at between 7 and 8 cm and at between 12 and 13 cm from the anal verge, respectively, and the one on the right is generally at between 9 and 11 cm. The middle valve (Kohlrausch plica) is the most consistent in location and corresponds to the level of the anterior peritoneal reflection, which is lower in females.<sup>1,7</sup>

However, the number and location of these valves may vary; roughly 46% of patients have 3 valves, 33% have 2, 10% have 4, 2% have none, and the remaining percentage has from 5 to 7 valves.<sup>8</sup>

The upper third of the rectum is anteriorly and laterally invested by peritoneum; the middle third is covered by the peritoneum on its anterior aspect only, and the lower third of the rectum is entirely extraperitoneal. Thus, these curves and reflections can increase resection margins during rectal mobilization by up to 5 cm.<sup>9</sup>

The length of the peritoneal reflection is an important anatomic landmark in intraluminal surgery, intra- or extraperitoneal rectal trauma,<sup>10</sup> penetrating trauma caused by gunshot wounds, stab wounds or impaling objects, and rectal adenocarcinoma amenable to neoadjuvant therapy.<sup>11</sup>

In the present study, we aimed to investigate the correlation between the lengths of the middle rectal valve and the peritoneal reflection determined via rigid sigmoidoscopy and to determine whether there are any differences in the location of the peritoneal reflection between genders and in relation to body mass index (BMI) and parity.

## Materials and Methods

### Patients and Study Design

We prospectively investigated the location of the middle rectal valve and of the peritoneal reflection via intra-

operative rigid sigmoidoscopy in colorectal cancer patients who underwent abdominal colorectal surgery at the coloproctology service of the department of general surgery of the Hospital Santa Marcelina (HSM, in the Portuguese acronym), São Paulo, state of São Paulo, Brazil.

Laparotomy was performed with the patient in the Lloyd-Davies position and the distance from the anal verge to the middle rectal valve and to the anterior peritoneal reflection was measured using a rigid sigmoidoscope with the surgeon accurately determining the location of the peritoneal reflection.

The exclusion criteria were history of pelvic surgery, symptoms of fecal incontinence, inability to accurately locate the middle rectal valve via rigid sigmoidoscopy due to tumor infiltration or stenotic lesions, and unwillingness to provide written consent to participate in the study.

The following variables were evaluated: gender, age, weight, height, BMI, body type, parity, preoperative radiotherapy, and the lengths of the middle rectal valve and of the peritoneal reflection.

### Statistical Analysis

The Student *t*-test and the Fisher exact test were used for univariate analysis of BMI, gender, parity, body type, and length of the peritoneal reflection and of the middle rectal valve. Data were considered statistically significant if  $p < 0.05$ , with a 95% confidence interval (CI), and all analyses were performed using IBM SPSS Statistics for Windows, version 22.0 software (IBM Corp., Armonk, NY, USA).

## Results

Forty patients with a mean age of 55.5 years old (range: 30–84 years old) underwent colorectal surgery at the coloproctology service of the HSM over a 4-month period. Twenty-three patients (57.5%) were men and 94.1% of the women had an obstetric history, with an average of 3.4 children (range: 1–7 children). The tumors were distributed equally on the right colon (32.5%), in the left colon (35%), and in the rectum (32.5%).

Nineteen patients (47.5%) had no comorbidities and 7 (17.5%) had diabetes mellitus. Six patients (15%) received neoadjuvant therapy for nonstenosing middle and low rectal cancers.

The mean weight of the patients was 70.75 kg (range: 40–130 kg), and their mean height was 164 cm (range: 140–182 cm), for a mean BMI of 26.05 kg/m<sup>2</sup> (range, 13.9–40.4 kg/m<sup>2</sup>).

When the height of the middle rectal valve in a cut of 8.0 cm in relation to the anal margin was analyzed, it was observed that it was significantly lower in patients with BMI > 25 kg/m<sup>2</sup> of both genders, and the difference was more pronounced in male ( $p < 0.005$ ) than in female ( $p = 0.013$ ) patients (– **Table 1**). In addition, the peritoneal reflection was significantly more caudal in women with > 2 vaginal deliveries ( $n = 15$ ; median height of the middle valve = 10.8 cm) than in women with < 2 deliveries ( $n = 2$ ; median height of the middle valve = 9.0 cm) ( $p = 0.009$ ).

**Table 1** Correlation between the height of the middle rectal valve and body mass index

	BMI < 24.9 kg/m <sup>2</sup>	BMI > 25.0 kg/m <sup>2</sup>
Middle rectal valve ≤ 8cm	0 patients	6 patients
Middle rectal valve > 8cm	27 patients	7 patients

Abbreviation: BMI, body mass index.

The mean lengths of the middle rectal valve and of the peritoneal reflection were 9.57 cm and 11.02 cm, respectively, and in 7 patients (17.5%) the 2 landmarks had the same length. The peritoneal reflection could not be measured in one patient due to tumor invasion.

There was substantial agreement (Kappa = 0.66, 95%CI: 0.69–0.184) between the lengths of the peritoneal reflection and of the middle rectal valve determined with the rigid sigmoidoscope before and after laparotomy, although the sensitivity between measurements was 56.4% with a difference margin of 1 cm.

The distribution of patients with equal measurements for the peritoneal reflection and the middle rectal valve was similar between genders. The mean lengths of the middle rectal valve and of the peritoneal reflection were 9.53 cm (range: 7–11 cm) and 10.59 cm (range: 9–14 cm) in females and 9.6 cm (range: 8–11 cm) and 11.58 cm (range: 9–17 cm) in males, respectively (► **Table 2**).

## Discussion

Despite the importance of accurately identifying the peritoneal reflection in intraluminal rectal surgery, surgical management of rectal trauma secondary to penetrating trauma caused by gunshot wounds, stab wounds, impaling objects, and rectal adenocarcinoma amenable to neoadjuvant therapy, the precise location of the peritoneal reflection has not been extensively studied.

Najarian et al.<sup>12</sup> investigated the location of the peritoneal reflection in 50 patients undergoing laparotomy. Similarly to the current study, the distance from the peritoneal reflection to the anal verge was measured via intraoperative proctoscopy and intra-abdominal visualization of the peritoneal reflection after laparotomy.

In that study, the mean lengths of the anterior peritoneal reflection were 9.0 cm and 9.7 cm in females and males, respectively, and the difference between genders was not statistically significant. Even though the distance to the anal verge estimated during laparotomy in our study was longer, we also found no significant difference in the length of the peritoneal reflection between genders ( $p = 0.32$ ) and there was substantial agreement between the measurements (Kappa = 0.66).

Yun et al.<sup>2</sup> intraoperatively evaluated the surgical length of the rectum in 23 males (mean age, 59.4 years old) and 23 females (mean age, 55.9 years old). The length of the peritoneal reflection measured from the anal verge was

**Table 2** Mean lengths (±SD) of the middle rectal valve and of the peritoneal reflection in male and female patients ( $p = 0.32$ )

	Males	Females
Middle rectal valve	9.6 ± 1.09 cm	9.53 ± 1.12 cm
Peritoneal reflection	11.58 ± 1.89 cm	10.59 ± 1.37 cm

Abbreviation: SD, standard deviation.

8.8 ± 2.2 cm in females and 8.1 ± 1.7 cm in males ( $p = 0.263$ ), and similar results were observed for mean age and length of the peritoneal reflection between genders in the present study.

The location of the peritoneal reflection has not been extensively studied in living patients. In our study, the peritoneal reflection was more caudal in obese patients, which can be explained by the considerably higher intra-abdominal pressures in these patients, especially morbidly obese ones, compared with nonobese adults.<sup>13–16</sup> However, unlike our study, Yun et al.<sup>2</sup> found no direct correlation between peritoneal reflection and BMI.

Ballard et al.<sup>16</sup> showed that the intra-abdominal pressure is between ~ 5 and 7 mmHg in nonobese adults and between ~ 9 and 14 mm Hg in morbidly obese patients. Moreover, it has been shown that obesity is a potentially modifiable risk factor for pelvic organ prolapse and that this risk is increased by up to 2.5 times in patients with BMI > 30 kg/m<sup>2</sup>.<sup>17–19</sup>

The high intra-abdominal pressure combined with the reduced external anal sphincter tone may explain the increased prevalence of inadvertent escape of flatus and feces observed in class II and III morbidly obese patients referred to bariatric surgery, as demonstrated by Neto et al.<sup>20</sup> Thus, our findings support previous research showing that obesity is a statistically significant direct or indirect risk factor for pelvic floor dysfunction in a population whose prevalence rates of obesity have greatly increased worldwide in the last decades.<sup>21</sup>

Chengyu et al.<sup>6</sup> reported that the anterior peritoneal reflection is lower in obese women, especially in those who are short, because the fat accumulation makes the mesorectum thick and the peritoneum at the anterior and lateral walls hangs loosely into the pelvic cavity.

Another interesting finding of our study was the more caudal location of the peritoneal reflection in women with higher parity; the peritoneal reflection was significantly lower in women with > 2 deliveries than in women with < 2 deliveries ( $p = 0.009$ ); also, through a search in PubMed with the term *anterior peritoneal reflection*, no article was found correlating BMI and parity with this anatomical repair.

The substantial agreement between the lengths of the middle rectal valve and of the peritoneal reflection is of clinical significance, especially in cases in which these anatomical landmarks may affect the choice of treatment modality in penetrating trauma caused by stab wounds, gunshot wounds and impaling objects, cancer in the middle rectum, and clinical situations in which visualization is limited on imaging exams, particularly magnetic resonance imaging (MRI) of the pelvis.

Yiqun et al.<sup>11</sup> evaluated the usefulness of MRI in the staging of rectal cancers in 283 patients and found that the mean distance from the anal verge to the peritoneal reflection was  $10.4 \pm 1.1$  cm in females and  $10.0 \pm 1.2$  cm in males. The authors reported that the accuracy of predicting the location of the rectal tumor in relation to the peritoneal reflection was of 83%, and of 98.2% in patients with a tumor located below the peritoneal reflection.

A substantial agreement was found between the Kappa value of the location in relation to the anterior peritoneal reflection determined by MRI and intraoperative findings (Kappa = 0.678). In addition, visualization of the anterior peritoneal reflection was affected by age ( $p = 0.049$ ), thickness of the subcutaneous fat ( $p = 0.002$ ), filling of the bladder ( $p = 0.001$ ), and the uterine position in females ( $p = 0.001$ ).<sup>11</sup>

Paparo et al.<sup>22</sup> compared the diagnostic performance of MRI with rigid rectoscopy in assessing the location of intra- and extraperitoneal rectal cancers using the findings obtained during abdominal surgery as the reference standard. The sensitivity and specificity were 98.15% and 100%, respectively, for MRI, and 100% and 76.92%, respectively, for rigid rectoscopy. The authors concluded that rigid rectoscopy is still the main means of assessing the level of a rectal tumor from the anal verge, but MRI has value in determining the level of the tumor in relation to the peritoneal reflection.

The length of the middle rectal valve and, therefore, the anatomy of the rectum, can also be determined with either flexible colonoscopy or sigmoidoscopy. Tanaka et al.<sup>23</sup> determined the accuracy of flexible colonoscopy in assessing the height of the distal edge of rectal cancer from the anal verge in 173 patients with rectal adenocarcinoma and compared the results with those of rigid proctoscopy. The authors found that flexible colonoscopy provided remarkably similar tumor locations to those measured by rigid proctoscopy ( $p = 0.001$ ).

The main limitations of our study were the small number of patients and the lack of postoperative anal ultrasound and anorectal manometry studies in patients with a more caudal peritoneal reflection, which could have provided not only topographic but also functional and anorectal anatomy information. Nevertheless, our findings provide further evidence that obesity and parity are anatomical risk factors for pelvic floor dysfunction that affect the location of the peritoneal reflection, concurrently with advanced age, estrogen deficiency, diabetes mellitus, pelvic radiotherapy, and orifice surgery,<sup>24–27</sup> although we found no significant correlations between the length of the peritoneal reflection and classical risk factors associated with the location of this important surgical anatomical landmark, such as female gender and patient height. Moreover, and importantly, we used a standardized protocol in living patients rather than in cadavers, unlike most anatomy studies.

## Conclusion

In our study, it was observed that there was substantial agreement between the lengths of the peritoneal reflection

and of the middle rectal valve, and that the peritoneal reflection was significantly lower in overweight patients and in females with more than two vaginal deliveries.

## Conflict of Interests

The authors have no conflict of interests to declare.

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