Received: 22 January 2023 | Revised: 16 August 2023 | Accepted: 22 August 2023

DOI: 10.1002/ijgo.15109

CLINICAL ARTICLE

Gynecology

Horizontal versus vertical direction of posterior vaginal wall suture after eradication of rectovaginal endometriosis: A multicenter study

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Abstract

Objective: To compare safety and effectiveness of two-different directions of suturing the posterior vaginal breach (horizontal [Ho] vs vertical [Ve]) in women undergoing recto-vaginal endometriosis (RVE) nodule resection.

Methods: A multicenter, retrospective, observational, cohort study was performed including all women of reproductive age undergoing RVE nodule resection between March 2013 and December 2018 at our tertiary centers. Patients included in the present study were divided into two groups based on the direction in suturing the posterior vaginal fornix defect, for comparisons in terms of rate of postoperative complications, pain relief, pain and anatomical recurrence, and length of hospital stay. Univariate comparisons were performed adopting the *t* test or the Mann–Whitney test for continuous data and the chi-square test or the Fisher exact test for categorical data, with a significant *P* value set to <0.05.

Results: A total of 101 women were included: 67 in the Ho-group and 34 in the Ve-group. The two groups did not significantly differ in length of hospital stay (6.7 ± 6.9 vs 6.6 ± 3.3 days; $P = 0.95$), overall postoperative complications (32.8% vs 14.7%; $P = 0.05$), pain recurrence (35.8% vs 26.5%; $P = 0.34$) and anatomical recurrence rate (19.4% vs 23.5%; $P = 0.62$). Conversely, grade III complications were significantly more common in the Ho-group than in the Ve-group (22.7% vs 20%, $P = 0.009$), while pain relief in terms of deep dyspareunia, dyschezia, dysuria and chronic pelvic pain was more consistent in the Ve-group patients ($P = 0.04$, 0.04, 0.05, 0.004, respectively).

Conclusion: In symptomatic women undergoing RVE nodule resection, Ho suturing of the vaginal breach appears more commonly associated with severe postoperative complications and a worse pain control.

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KEYWORDS
deep infiltrating endometriosis, DIE, minimally invasive, morbidity, surgery, suture

1 | INTRODUCTION

Endometriosis is defined as the presence of endometrial tissue outside the uterine cavity.[1] It represents an important cause of morbidity in reproductive-aged women, resulting in pelvic pain, pelvic masses and infertility.[2,3] The most severe manifestation of the disease is deep infiltrating endometriosis, defined as endometriosis lesions infiltrating pelvic organ wall or retroperitoneal structures.[4–7] Vaginal endometriosis is defined as infiltration of the vaginal wall by endometrial stroma and glands. It can be isolated or involving adjacent structures, especially the recto-sigmoid tract (recto-vaginal endometriosis [RVE]).[4,8] RVE incidence is estimated from 4% to 37% among women with endometriosis.[9–11] While hormonal therapy can improve pain symptoms in 30% of women with RVE, surgical eradication is required in cases of nonrespondent women, bowel or urinary obstruction, or infertility after assisted reproductive technology attempts.[6,7,12] Moreover, RVE surgical eradication needing partial colpectomy is commonly associated with a high risk of major postoperative complications, especially urinary and colorectal ones.[13,14] RVE with vaginal mucosa infiltration can be excised using total laparoscopic or vaginal-assisted laparoscopic route, with no significant differences between the two routes in terms of safety and efficacy.[9,11,14–19]

Conversely, in patients affected by RVE, there is no evidence about what is the best direction in suturing the posterior vaginal fornix defect after the nodule resection: horizontal (i.e., along the transversal latero-lateral axis; Ho) versus vertical (i.e., along the longitudinal ventro-caudal axis; Ve). Therefore, in the present study, we sought to compare safety and effectiveness in terms of pain and anatomical recurrence of the two different directions of suturing the posterior vaginal breach in women affected by symptomatic RVE with vaginal mucosa infiltration and scheduled for minimally invasive surgery.

2 | MATERIALS AND METHODS

2.1 | Study protocol and patient selection

This multicenter, observational, retrospective, cohort study was designed according to an a priori defined study protocol. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines and checklist were followed for reporting the whole study.[20]

The medical records and clinical electronic databases were reviewed for all consecutive women of reproductive age who underwent minimally invasive complete macroscopic eradication for symptomatic RVE with vaginal mucosa infiltration between March 2013 and December 2018 at the Department of Gynecologic Oncology, Gemelli Molise SpA, Campobasso, Italy; the Department of Woman and Child Health and Public Health, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Rome, Italy; and the Division of Gynecology and Human Reproduction Physiopathology, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Bologna, Italy.

Exclusion criteria were: (1) women <18 and >50 years; (2) history of RVE surgical treatment or hysterectomy; (3) previous or ongoing oncological gynecologic diseases.

The patients were divided into two groups based on the direction in suturing the posterior vaginal fornix defect after the nodule resection (Ho-group vs Ve-group) for comparisons in terms of postoperative data. In particular, in case of vertical suture vaginal synthesis was done through vaginal approximation, while in case of horizontal one vagina was sutured to the cervix.

2.2 | Study outcomes

Study outcomes consisted of the differences in postoperative data between the Ho-group and the Ve-group. In particular, postoperative data assessed were rate of postoperative complications occurring within 30 days from surgery, length of hospital stay, pain relief, and pain and anatomical recurrence. In detail, pain recurrence was defined as reappearance of at least one mild–severe pain symptom, while anatomical recurrence was defined as reappearance of an endometriotic lesion at imaging or clinical evaluation or diagnostic evaluation/pathologic examination after secondary surgical excision.

2.3 | Patient management

Before surgery, demographic features and pain symptoms (chronic pelvic pain, dysmenorrhea, deep dyspareunia, dysuria, dyschezia) were assessed. The severity of the pain was evaluated using a 11-point numerical rating scale (NRS) and considered "severe" when a value equal to or higher than 5 was noted.[21]

All women underwent bimanual and speculum examinations as well as transvaginal and transabdominal ultrasonography performed

by skilled operators. When necessary, additional preoperative imaging methods, including multi-detector computerized tomography enteroclysis, urography or magnetic resonance imaging, were performed to plan surgery.[22]

Surgical procedures were performed by expert surgeons as previously described.[11,23–25] After total laparoscopic or vaginally-assisted laparoscopic (i.e., combined vaginal approach) removal of the vaginal nodule, the vaginal breach was sutured in Ho or Ve direction with an absorbable thread specifically polyglactin 910 (Vicryl; Ethicon).[26,27] The suturing direction performed was chosen on a case by case basis according to the surgeon's intraoperative choice. In particular, the suture used upon physician preference was preferentially continuous when performed vaginally and interrupted when performed laparoscopically.

Endometriosis was classified according to the revised American Society for Reproductive Medicine (rASRM) classification.[28]

Postoperative complications were assessed using Clavien-Dindo classification.[29]

For each patient, pain scores and surgical complications were evaluated at the last follow-up evaluation.

2.4 | Statistical analysis

Continuous data are expressed as mean ± standard deviation (SD) or as median and range. Categorical variables are expressed as absolute numbers and percentages. Univariate comparisons were performed adopting the *t* test or the Mann–Whitney test for continuous data and the chi-square test or the Fisher exact test for categorical data. All reported *P* values were two-sided, and a *P* value of less than 0.05 denoted a statistically significant difference.

Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) software version 24.0 (IBM Corp.).

2.5 | Ethical statement

The study was carried out according to the principles of the Helsinki Declaration and received approval by Institutional Review Board (INTRAMURAL ID: CICOG-31-10-18/180).

Written informed consent was obtained from all the subjects in the study and all data were anonymized.

3 | RESULTS

3.1 | Study groups

During the study period, 101 women who met the selection criteria were included in the study: 67 (66.3%) in the Ho-group and 34 (33.7%) in the Ve-group.

TABLE 1 Preoperative data of the study groups: Ho-group (Ho) and Ve-group (Ve).

	Ho (67)	Ve (34)	*P* value
Age (years), mean ± SD	35.9 ± 5.6	35.5 ± 5.3	0.74
Body mass index (kg/m^2), mean ± SD	21.7 ± 3.3	23 ± 3.4	0.08
Parity ≥ 1, *n* (%)	21 (31.3)	12 (35.3)	0.69
Previous surgery for endometriosis, *n* (%)	32 (47.8)	12 (35.3)	0.23
Ovarian endometriosis	20/32 (62.5)	9/12 (75)	0.67
Deep infiltrating endometriosis	12/32 (37.5)	3/12 (25)	
Stage of disease according to rASRM, *n* (%)			
Stage III	18/67 (26.9)	7/34 (20.6)	0.49
Stage IV	49/67 (73.1)	27/34 (79.4)	
Preoperative pain symptoms assessed with NRS, median (Q1–Q3IQR)			
Dysmenorrhea	8 (7–10)	8 (6–10)	0.72
Dyschezia	6 (0–8)	6 (0–8)	0.92
Dysuria	0 (0–0)	0 (0–3)	0.62
Dyspareunia	6 (2–8)	6 (2–8)	0.19
Chronic pelvic pain	0 (0–7)	5 (0–7)	0.23
Preoperative medical therapy, *n* (%)	45 (67.2)	29 (85.3)	0.052
Estro-progestinic	30/45 (66.7)	20/29 (69)	0.5
Progestinic	13/45 (28.9)	6/29 (20.7)	
GnRH agonist	2/45 (4.4)	3/29 (10.3)	

Abbreviations: GnRH agonist, gonadotropin-releasing hormone agonist; *n*, number; NRS, numerical rating scale; Q1–Q3: first and third quartile; IQR; interquartile range; rASRM, revised American Society for Reproductive Medicine; SD, standard deviation.

Pathology confirmed endometriosis in all women. The two groups were comparable in terms of demographic and preoperative clinical data (Table 1).

The surgical details are reported in Table 2. The two groups were similar in terms of operative time, estimated blood loss, laparotomic conversion rate and concomitant procedures. The combined vaginal approach excision, which consists of the incision and isolation of the vaginal nodule through a vaginal approach before laparoscopic entry, was more common in the Ho-group than in the Ve-group (38.8% vs 8.8% $P = 0.002$).[11] The mean size of the removed vaginal nodule was 2.2 ± 1.1 versus 2.4 ± 1.1 cm, with no significant difference between the two groups ($P = 0.62$).

3.2 | Study outcomes

Postoperative data are reported in Table 3. Median follow-up time was 61 (Q1–Q3, 49–97) months in the Ho-group and 48 (Q1–Q3, 34–66) months in the Ve-group ($P = 0.08$).

TABLE 2 Surgical data of the study groups: Ho-group (Ho) and Ve-group (Ve).

	Ho (67)	Ve (34)	*P* value
Operative time (min), mean ± SD	210 ± 89.6	176.4 ± 73.5	0.06
EBL (mL), mean ± SD	163.4 ± 133.6	158.8 ± 80.2	0.85
Laparotomic conversion, *n* (%)	6 (9.0)	0 (0.0)	0.09
Combined vaginal approach, *n* (%)	26 (38.8)	3 (8.8)	**0.002**
Laparoscopic vaginal suture *n* (%)	35 (52.2)	29 (85.3)	**0.001**
Adenomyosis, *n* (%)	32 (47.8)	16 (47)	0.95
Associated surgical procedures, *n* (%)			
Adhesiolysis	64 (95.5)	32 (94.1)	1
Hysterectomy	2 (3.0)	0 (0.0)	0.55
Excision of endometrioma	31 (46.3)	15 (44.1)	0.84
Monolateral	25/31 (80.6)	8/15 (53.3)	0.05
Bilateral	6/31 (19.3)	7/15 (46.7)	
Salpingectomy	17 (25.4)	4 (11.8)	0.13
Monolateral	10/17 (58.8)	1/4 (25)	0.31
Bilateral	7/17 (41.2)	3/4 (75)	
Excision of peritoneal endometriosis	39 (58.2)	17 (50)	0.43
Uterosacral ligament nodule removal	39 (58.2)	17 (50)	0.43
Monolateral	28/39 (71.8)	6/17 (35.3)	**0.01**
Bilateral	11/39 (28.2)	11/17 (64.7)	
Ureteral surgery	56 (83.6)	33 (97.1)	0.05
Ureterolysis	36 (53.7)	19 (55.9)	0.84
Monolateral	12/36 (33.3)	4/19 (21)	0.53
Bilateral	24/36 (66.7)	15/19 (79)	
Nodule removal	20 (29.8)	14 (41.2)	0.25
Recto-sigmoid nodule removal	48 (71.6)	26 (76.5)	0.6
Shaving	22 (45.8)	12 (46.1)	0.98
Segmental resection	26 (54.2)	14 (53.8)	
High/medium	14 (53.8)	7 (50)	0.82
Low/ultra-low	12 (46.1)	7 (50)	
Ileostomy	11 (42.3)	5 (35.7)	0.68
Partial cystectomy for urinary bladder nodule	14 (20.9)	5 (14.7)	0.45
Lateral parametrial nodule	22 (32.8)	17 (50)	0.09
Maximum size of vaginal nodule (cm), mean ± SD	2.2 ± 1.1	2.4 ± 1.1	0.62
Maximum size of posterior deep nodule (cm), mean ± SD	4.2 ± 1.4	4.5 ± 1.3	0.43

Abbreviations: EBL, estimated blood loss; *n*, number; SD, standard deviation. Significant *P* value was set to <0.05.

The length of hospital stay did not significantly differ between the groups (6.7 ± 6.9 vs 6.6 ± 3.3 days; $P = 0.95$).

Twenty-seven patients experienced postoperative complications within 30 days. Although overall postoperative complications rate was not significantly different between the two groups (32.8% vs 14.7%; $P = 0.05$), grade III complications were significantly more common in the Ho-group than in the Ve-group (22.7% vs 20%, $P = 0.009$). In particular, grade III complications in the Ho-group were as follows: one rectal perforation, one rectovaginal fistula, two ureteral stent dislocations that required cystoscopic removal, and one vaginal breach suture dehiscence. Otherwise, only one bowel perforation was observed in the Ve-group.

Assessment of pain symptoms at the last follow-up visit by NRS scale showed more consistent pain relief in deep dyspareunia, dyschezia, dysuria and chronic pelvic pain in the Ve-group patients than in those of the Ho-group ($P = 0.04$, 0.04, 0.05, 0.004, respectively).

Regarding recurrence, both pain and anatomical relapse did not significantly differ among the groups. In particular, pain relapsed in 24 (35.8%) women in the Ho-group and in nine (26.5%) in the Ve-group ($P = 0.34$), while anatomical recurrence was noticed in 13

TABLE 3 Postoperative data of the study groups: Ho-group (Ho) and Ve-group (Ve).

	Ho (67)	Ve (34)	*P* value
Length of hospital stay (days), mean ± SD	6.7 ± 6.9	6.6 ± 3.3	0.95
Complications (Clavien-Dindo classification), *n* (%)	22 (32.8)	5 (14.7)	0.05
Grade I/II	17/22 (77.3)	4/5 (80.0)	1
Grade III	5/22 (22.7)	1/5 (20.0)	**0.009**
Follow-up (months), median (Q1–Q3IQR)	610 (498–97 120)	48 (324–660)	**0.081**
Pain symptoms assessed with NRS at last follow-up, median (Q1–Q3IQR)			
Dyspareunia	0 (0–6)	0 (0–0)	**0.04**
Dysmenorrhea	0 (0–4)	0 (0–0)	0.25
Dyschezia	0 (0–4)	0 (0–0)	**0.04**
Dysuria	0 (0–1)	0 (0–0)	0.05
Chronic pelvic pain	0 (0–2)	0 (0–0)	**0.004**
Recurrence, *n* (%)			
Symptom (at least one symptom with NRS > 5)	24 (35.8)	9 (26.5)	0.34
Mild/severe dyspareunia (NRS > 5)	17 (25.4)	4 (11.8)	0.13
Anatomical (ultrasound, re-surgery, speculum, MRI)	13 (19.4)	8 (23.5)	0.62
RVE anatomical (ultrasound, re-surgery, speculum, MRI)	4 (6)	6 (17.6)	0.08

Abbreviations: IQR, interquartile range; MRI, magnetic resonance imaging; *n*, number; NRS, numerical rating scale; Q1–Q3, first and third quartile; RVE, recto-vaginal endometriosis; SD, standard deviation. Significant *P* value was set to <0.05.

(19.4%) and eight (23.5%) women, respectively ($P=0.62$). Similarly, no difference was noted regarding the rate of mild–severe dyspareunia and RVE anatomical recurrence.

4 | DISCUSSION

The present study showed that in women who undergo minimally invasive RVE nodule resection, suturing the posterior vaginal fornix defect in a horizontal direction may be more commonly associated with severe postoperative complications and worse pain control at long-term follow-up evaluation. On the other hand, overall postoperative complications and recurrence rates appear similar. Symptom relapses are often associated with anatomical recurrence, which is not always detectable with gynecological examination, instrumental tools or re-surgery.[30]

RVE surgical eradication needing partial colpectomy is a challenging surgery, with a high risk of major postoperative complications, particularly urinary and colorectal.[13,14]

Several studies have previously compared surgical outcomes in women who underwent minimally invasive surgery for RVE with different surgical approaches (vaginal-assisted laparoscopy or total laparoscopic).[14–17,31] A total laparoscopic approach can be performed using a traditional or reverse technique.[14] Kondo et al. compared surgical outcomes of standard and reverse laparoscopic techniques in women undergoing surgery for RVE with bowel involvement. The two groups were comparable in terms of blood loss, major intraoperative complications, operative time, laparotomic conversion rate, minor postoperative complications and hospital stay. Nevertheless, the authors found a significantly lower major complication rate in the reverse technique group compared to the standard one (5% vs 22.9%, respectively, $P=0.002$). Moreover, Kondo et al. found a limited range of movements and narrow working space in the standard technique.[14,32]

Raimondo et al. saw no significant difference in terms of feasibility and safety comparing vaginal assisted and total laparoscopic routes in women with symptomatic RVE involving vaginal mucosa.[11] These results are in contrast with the findings of Zanetti-Dallenbach et al. who concluded that the combined approach for RVE and rectal nodule removal significantly decreased hospitalization time, and complication and re-hospitalization rates.[9] In a retrospective, comparative study, Roman et al. assessed that the combined approach for large RVE could reduce the risk of postoperative bladder atony probably due to a better preservation of the pelvic splanchnic nerves.[31] However, postoperative bladder dysfunction rates vary in the literature and depend on several factors, such as endometriotic infiltration of the lateral and posterior parametria and relative surgical procedures on the parametria.[33]

Noteworthy, while several studies assessed different surgical routes for RVE excision, direction in suturing the posterior vaginal fornix defect after the nodule resection has been poorly investigated.

In our study, we found a higher rate of severe postoperative complications and worse pain control in women who underwent suturing of the posterior vaginal fornix defect in a horizontal direction after RVE nodule resection. These findings might be explained by stronger tension forces on the stitches due to a reduction of length of the vagina. In fact, a shorter vaginal length (median loss of 10% of length) appeared to be associated with horizontal sutures in a recent meta-analysis of five randomized trials including

patients who underwent total hysterectomy for several gynecological disease.[34–39]

Furthermore, a possible shorter vaginal length might also underlie the better clinical outcomes of the Ve-group. Indeed, in a randomized clinical trial assessing the effect of hysterectomy for several pathologies on lower urinary tract function, vaginal length, and dyspareunia, Polat et al. reported that patients who developed postoperative dyspareunia had a significant shortening of total vaginal length after colpotomy.[40]

Conversely, in reference to the radicality of the surgery, direction of suturing appeared not differ in the outcomes. In fact, as we found no significant difference in terms of RVE relapse in the two study groups, the two techniques did not seem to impact on the persistence of micro or macroscopic ectopic cells residuals.

Moreover, a higher rate of open conversion was observed in the Ho group compared to the Ve group. We reviewed reasons for laparotomy conversions and found that they were related to anesthesiologic reasons (4/67, 6%) and the need for securing blood vessels in case of intractable intraperitoneal hemorrhage (2/67, 3%). In particular, all cases of open conversions occurred after vaginal suture and were not related to the direction of vaginal suture.

However, additional studies are necessary to confirm our findings and further investigate the field.

4.1 | Strengths and limitations

To the best of our knowledge, this may be the first study which has evaluated the safety and effectiveness of the two different directions of suturing the posterior vaginal breach in women who undergo minimally invasive RSE nodule resection. Moreover, our results also appear to be supported by a long-term follow-up.

Conversely, some limitations might limit the generalizability of our findings, such as the retrospective study design, different follow-up period between the two groups, the tertiary center setting with experienced surgeons and the possible selection bias due to surgeons' preference for vaginal breach suture direction. Lastly, the absence of data on length of vagina before and after surgery meant we were unable to verify our hypothesis in explaining the difference among the groups.

5 | CONCLUSION

In symptomatic women affected by RVE with vaginal mucosal infiltration requiring surgery, horizontal suturing of the vaginal breach after nodule resection seems to be more commonly associated with severe postoperative complications and worse pain control.

Further studies are needed to confirm these findings.

AUTHOR CONTRIBUTIONS

Luigi Carlo Turco: study conception, study design, study methods, statistical analyses, manuscript preparation. Diego Raimondo: study conception, study design, study methods, statistical analyses, manuscript preparation, methods supervision. Antonio Raffone: study conception, study design, study methods, statistical analyses, data analysis, manuscript preparation. Ivano Raimondo: study conception, study design, study methods, statistical analyses, data analysis, manuscript preparation. Virginia Vargiu: study conception, study design, study methods, data analysis, manuscript preparation. Arianna Raspollini: study conception, data extraction, data analysis, manuscript preparation. Antonio Travaglino: study conception, study design, study methods, data analysis, manuscript preparation. Raffaele Tinelli: study conception, study design, study methods, data analysis, manuscript preparation. Enrico Zanetti: study conception, study design, study methods, data analysis, manuscript preparation. Gabriella Ferrandina: study conception, study design, methods supervision, manuscript revision, whole study supervision. Renato Seracchioli: study conception, study design, methods supervision, manuscript revision, whole study supervision. Paolo Casadio: study conception, study design, methods supervision, manuscript revision, whole study supervision. Giovanni Scambia: study conception, study design, methods supervision, manuscript revision, whole study supervision. Francesco Cosentino: study conception, study design, methods supervision, manuscript revision, whole study supervision. All authors approved of the final of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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REFERENCES

1. Giudice LC, Kao LC. Endometriosis. *Lancet*. 2004;364(9447):1789-1799. doi:10.1016/S0140-6736(04)17403-5
2. Seracchioli R, Montanari G, Mabrouk M, Nassif J. Endometriosis: novel models, diagnosis, and treatment. *Biomed Res Int*. 2014;2014:140413.
3. Koninckx PR, Meuleman C, Demeyere S, Lesaffre E, Cornillie FJ. Suggestive evidence that pelvic endometriosis is a progressive disease, whereas deeply infiltrating endometriosis is associated with pelvic pain. *Fertil Steril*. 1991;55(4):759-765.
4. Chapron C, Chopin N, Borghese B, et al. Deeply infiltrating endometriosis: pathogenetic implications of the anatomical distribution. *Hum Reprod*. 2006;21(7):1839-1845.
5. Chapron C, Fauconnier A, Vieira M, et al. Anatomical distribution of deeply infiltrating endometriosis: surgical implications and proposition for a classification. *Hum Reprod*. 2003;18(1):157-161.
6. Cosentino F, Vizzielli G, Turco LC, et al. Near-infrared imaging with indocyanine green for detection of endometriosis lesions (Gre-Endo Trial): a pilot study. *J Minim Invasive Gynecol*. 2018;25(7):1249-1254.
7. Vercellini P, Buggio L, Somigliana E. Role of medical therapy in the management of deep rectovaginal endometriosis. *Fertil Steril*. 2017;108(6):913-930.

8. Tarjanne S, Sjöberg J, Heikinheimo O. Rectovaginal endometriosis-characteristics of operative treatment and factors predicting bowel resection. *J Minim Invasive Gynecol*. 2009;16(3):302-306.
9. Zanetti-Dällenbach R, Bartley J, Müller C, Schneider A, Köhler C. Combined vaginal-laparoscopic-abdominal approach for the surgical treatment of rectovaginal endometriosis with bowel resection: a comparison of this new technique with various established approaches by laparoscopy and laparotomy. *Surg Endosc*. 2008;22(4):995-1001.
10. Riazi H, Tehranian N, Ziaei S, Mohammadi E, Hajizadeh E, Montazeri A. Clinical diagnosis of pelvic endometriosis: a scoping review. *BMC Womens Health*. 2015;15:39.
11. Raimondo D, Turco LC, Cosentino F, et al. Feasibility and safety of two different surgical routes for the eradication of recto-vaginal endometriosis with vaginal mucosa infiltration (Endo-Vag-r study). *Acta Obstet Gynecol Scand*. 2020;99(8):1050-1056.
12. Turco LC, Scaldaferri F, Chiantera V, et al. Long-term evaluation of quality of life and gastrointestinal well-being after segmental colorectal resection for deep infiltrating endometriosis (ENDO-RESECT QoL). *Arch Gynecol Obstet*. 2020;301(1):217-228.
13. Zilberman S, Ballester M, Touboul C, et al. Colpectomy is a risk factor for urologic complications of colorectal resection for endometriosis. *J Minim Invasive Gynecol*. 2013;20(1):49-55.
14. Kondo W, Bourdel N, Jardon K, et al. Comparison between standard and reverse laparoscopic techniques for rectovaginal endometriosis. *Surg Endosc*. 2011;25(8):2711-2717.
15. Chapron C, Jacob S, Dubuisson JB, Vieira M, Liaras E, Fauconnier A. Laparoscopically assisted vaginal management of deep endometriosis infiltrating the rectovaginal septum. *Acta Obstet Gynecol Scand*. 2001;80(4):349-354.
16. Angioli R, De Cicco Nardone C, Cafà EV, et al. Surgical treatment of rectovaginal endometriosis with extensive vaginal infiltration: results of a systematic three-step vagino-laparoscopic approach. *Eur J Obstet Gynecol Reprod Biol*. 2014;173:83-87.
17. Angioni S, Peiretti M, Zirone M, et al. Laparoscopic excision of posterior vaginal fornix in the treatment of patients with deep endometriosis without rectum involvement: surgical treatment and long-term follow-up. *Hum Reprod*. 2006 Jun;21(6):1629-1634.
18. Matsuzaki S, Houlle C, Botchorishvili R, Pouly JL, Mage G, Canis M. Excision of the posterior vaginal fornix is necessary to ensure complete resection of rectovaginal endometriotic nodules of more than 2 cm in size. *Fertil Steril*. 2009;91(4 Suppl):1314-1315.
19. Boersen Z, Aalders CIM, Klinkert ER, Maas JWM, Nap AW. Vaginal cuff dehiscence after endometriosis surgery. *JSLS*. 2019;23(3):e2019.00018.
20. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet*. 2007;370(9596):1453-1457.
21. Bourdel N, Alves J, Pickering G, Ramilo I, Roman H, Canis M. Systematic review of endometriosis pain assessment: how to choose a scale? *Hum Reprod Update*. 2015;21(1):136-152.
22. Savelli L, Manuzzi L, Coe M, et al. Comparison of transvaginal sonography and double-contrast barium enema for diagnosing deep infiltrating endometriosis of the posterior compartment. *Ultrasound Obstet Gynecol*. 2011;38(4):466-471.
23. Seracchioli R, Poggioli G, Pierangeli F, et al. Surgical outcome and long-term follow up after laparoscopic rectosigmoid resection in women with deep infiltrating endometriosis. *BJOG*. 2007;114(7):889-895.
24. Seracchioli R, Ferrini G, Montanari G, Raimondo D, Spagnolo E, Di Donato N. Does laparoscopic shaving for deep infiltrating endometriosis alter intestinal function? A prospective study. *Aust N Z J Obstet Gynaecol*. 2015;55(4):357-362.
25. Mabrouk M, Raimondo D, Altieri M, et al. Surgical, clinical, and functional outcomes in patients with rectosigmoid endometriosis in the gray zone: 13-year long-term follow-up. *J Minim Invasive Gynecol*. 2019;26:1110-1116.
26. Uccella S, Ghezzi F, Mariani A, et al. Vaginal cuff closure after minimally invasive hysterectomy: our experience and systematic review of the literature. *Am J Obstet Gynecol*. 2011;205(2):119.e1-119.e12.
27. Kettle C, Dowswell T, Ismail KM. Continuous and interrupted suturing techniques for repair of episiotomy or second-degree tears. *Cochrane Database Syst Rev*. 2012;11(11):CD000947.
28. Revised American fertility society classification of endometriosis: 1985. *Fertil Steril*. 1985;43(3):351-352.
29. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg*. 2009;250(2):187-196.
30. Meuleman C, Tomassetti C, D'Hoore A, et al. Surgical treatment of deeply infiltrating endometriosis with colorectal involvement. *Hum Reprod Update*. 2011;17(3):311-326. doi:10.1093/humupd/dmq057
31. Roman H, Desnyder E, Pontré J, et al. Combined vaginal-laparoscopic approach vs. laparoscopy alone for prevention of bladder voiding dysfunction after removal of large rectovaginal endometriosis. *J Visc Surg*. 2021;158(2):118-124.
32. Cabrera R, Tessmann Zomer M, Larrain D, Bourdel N, Canis M, Kondo W. Laparoscopic reverse technique for posterior rectovaginal deep endometriosis nodule step by step. *J Minim Invasive Gynecol*. 2020;27(3):577-578. doi:10.1016/j.jmig.2019.07.018
33. Ianieri MM, Raimondo D, Rosati A, et al. Impact of nerve-sparing posterolateral parametrial excision for deep infiltrating endometriosis on postoperative bowel, urinary, and sexual function. *Int J Gynaecol Obstet*. 2022;159(1):152-159.
34. Pergialiotis V, Daskalakis G, Thomakos N, Haidopoulos D, Loutradis D, Rodolakis A. Impact of vertical versus horizontal vaginal cuff closure on vaginal length following hysterectomy: a meta-analysis of randomized trials. *Int Urogynecol J*. 2019;30(8):1239-1245.
35. Hill AM, Davis KM, Clark-Donat L, Hammons LM, Azodi M, Silasi DA. The effect of vertical versus horizontal vaginal cuff closure on vaginal length after laparoscopic hysterectomy. *J Minim Invasive Gynecol*. 2017;24(1):108-113.
36. Vassallo BJ, Culpepper C, Segal JL, Moen MD, Noone MB. A randomized trial comparing methods of vaginal cuff closure at vaginal hysterectomy and the effect on vaginal length. *Am J Obstet Gynecol*. 2006;195(6):1805-1808.
37. Cavkaytar S, Kokanali MK, Topcu HO, Aksakal OS, Doganay M. Effects of horizontal vs vertical vaginal cuff closure techniques on vagina length after vaginal hysterectomy: a prospective randomized study. *J Minim Invasive Gynecol*. 2014;21(5):884-887.
38. Tower AM, Clark Donat L, Azodi M, Silasi DA. The effect of vertical versus horizontal vaginal cuff closure on vaginal length after laparoscopic hysterectomy. *J Minim Invasive Gynecol*. 2015;22(6S):S77.
39. Uçar MG, İlhan TT, Şanlıkan F, Çelik Ç. Sexual functioning before and after vaginal hysterectomy to treat pelvic organ prolapse and the effects of vaginal cuff closure techniques: a prospective randomised study. *Eur J Obstet Gynecol Reprod Biol*. 2016;206:1-5.
40. Polat M, Kahramanoglu I, Senol T, Senturk B, Ozkaya E, Karateke A. Comparison of the effect of laparoscopic and abdominal hysterectomy on lower urinary tract function, vaginal length, and dyspareunia: a randomized clinical trial. *J Laparoendosc Adv Surg Tech A*. 2016;26(2):116-121.

How to cite this article: Turco LC, Raimondo D, Raffone A, et al. Horizontal versus vertical direction of posterior vaginal wall suture after eradication of rectovaginal endometriosis: A multicenter study. *Int J Gynecol Obstet*. 2023;00:1-7. doi:10.1002/ijgo.15109