

Unidirectional barbed versus single layer conventional suture for vaginal cuff closure in robotic hysterectomy: retrospective single-center study

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Abstract

Objective: Successful vaginal cuff suturing remains a major challenge in robotic hysterectomy. This study compared the vault closure time by using Vicryl (polyglactin 910) and barbed (V-Loc) sutures.

Material and Methods: This retrospective study included patients undergoing robotic hysterectomy for benign disease over three years. Patients were grouped according to the suture used for vaginal vault closure. Surgical videos and hospital records were reviewed to obtain operative details, perioperative outcomes, and postoperative complications.

Results: A total of 297 patients were included in final analysis with 106 (35.7%) patients in the Vicryl group and 191 (64.3%) patients in the barbed suture group. In the barbed compared to Vicryl group, the robotic vault closure time (6.84 ± 1.42 vs. 9.93 ± 2.77 minutes), average number of stitches used for vault closure (5.02 ± 0.57 vs. 5.61 ± 0.75), and time taken per stitch (1.36 ± 0.3 vs. 1.75 ± 0.43 minutes) were significantly lower. Operative time, anesthesia duration, and hospital stay were also significantly lower in the barbed group. On multivariable linear regression analysis, barbed suture use remained independently associated with shorter vault closure time ($\beta = 8.47$ minutes, 95% confidence interval 5.46-11.48; $p < 0.001$), while age, body weight, body mass index, parity, and preoperative anemia were not independently associated with vault closure time. On sexual function assessment, the overall score of female sexual function index in barbed (29.02 ± 4.85) was significantly higher than the Vicryl (27.39 ± 7.35) suture group ($p = 0.049$).

Conclusion: Barbed sutures may represent a feasible and time-efficient option for robotic vaginal vault closure; however, prospective randomized studies with longer follow-up are required to confirm their safety, and impact on functional outcomes. [J Turk Ger Gynecol Assoc. 2026; 27(3): 157-64]

Keywords: Minimally invasive, robotic surgery, hysterectomy, vault closure time

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Introduction

Hysterectomy represents one of the most commonly performed operative procedures involving the female reproductive tract in gynecologic practice. Data from the World Health Organization indicate that approximately 1.54 million hysterectomies were

performed worldwide in 2016. In India, the prevalence of hysterectomy is estimated to be around 11.35%, with abnormal uterine bleeding (AUB) and uterine fibroids being the predominant indications (1). The procedure is most frequently undertaken for excessive menstrual bleeding (28.94%), fibroid uterus (24.29%), uterine prolapse (15.99%), uterine disorders



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(8.30%), postpartum hemorrhage (4.59%), malignancy (2.15%), and other causes (9.02%).

A major advance in gynecologic surgery over recent decades has been the shift from open surgery to minimally invasive techniques. The introduction of the da Vinci Surgical System and its approval by the US Food and Drug Administration (FDA) in 2005 marked a significant milestone in this evolution (2,3). Initially adopted in specialties such as urology and cardiac surgery, robotic-assisted techniques have gained widespread acceptance in gynecology. Despite ongoing concerns regarding cost and healthcare resource utilization, robotic surgery has seen rapid expansion due to its technical advantages and favorable patient outcomes (4,5).

Robotic-assisted hysterectomy offers several benefits for both surgeons and patients. Enhanced three-dimensional visualization, tremor filtration, improved ergonomics, and greater instrument articulation allow for precise surgical maneuvers with reduced tissue trauma. These features contribute to decreased intraoperative blood loss, lower postoperative pain, faster recovery, shorter hospitalization, and improved quality of life. Consequently, robotic platforms have been approved and widely utilized for a variety of gynecologic procedures, including hysterectomy, myomectomy, radical hysterectomy, prolapse repair, tubal anastomosis, and surgery for endometriosis (5-7).

Despite these advantages, closure of the vaginal cuff remains one of the technically demanding steps in robotic hysterectomy. Minimally invasive approaches are associated with a higher incidence of vaginal cuff-related complications, particularly vaginal cuff dehiscence, compared with abdominal or vaginal routes (8). Vaginal cuff dehiscence is defined as a full-thickness separation of the vaginal cuff and has been reported in 1.0-4.1% of minimally invasive hysterectomies performed using conventional suturing techniques (9,10). Several patient-related factors, including smoking, diabetes mellitus, advanced age, immunosuppression, and gynecologic malignancy, have been implicated in increasing this risk (10). In addition, the use of thermal energy during colpotomy may result in tissue necrosis, delayed healing, cuff cellulitis, and subsequent dehiscence (11-13).

Barbed sutures, characterized by unidirectional barbs along the suture line, maintain tissue approximation without the need for knot tying. Emerging evidence suggests that barbed sutures are comparable to conventional sutures in terms of safety and tolerability, while potentially reducing operative time during minimally invasive vaginal cuff closure (14). The present study aimed to compare the safety and efficacy of unidirectional barbed (V-Loc) sutures versus conventional polyglactin 910 (Vicryl) sutures for robotic vaginal vault closure, using a single-layer continuous suturing technique performed by the same surgeon.

Material and Methods

Study design

This was a retrospective study done in patients who underwent robotic hysterectomy for benign disease at our institution over three years from March 2018 to July 2021. This retrospective study was conducted after approval from the Institutional Ethics Committee of All India Institute of Medical Sciences, Rishikesh (approval no.: AIIMS/IEC/19/1165; date: November 29, 2019). As all data were collected from existing records, the requirement for individual informed consent was waived by the committee, and all patient information was anonymized to ensure confidentiality. Records were obtained from the surgical videos (for various surgical timings) and hospital database, comparing unidirectional barbed suture (V-Loc) and polyglactin 910 (Vicryl) suture for the closure of the vaginal vault in patients with total robotic hysterectomy for benign pathologies (Figure 1).

As per the standard closure technique using two different materials, patients were segregated and divided into two groups, a barbed group and a Vicryl group, depending on type

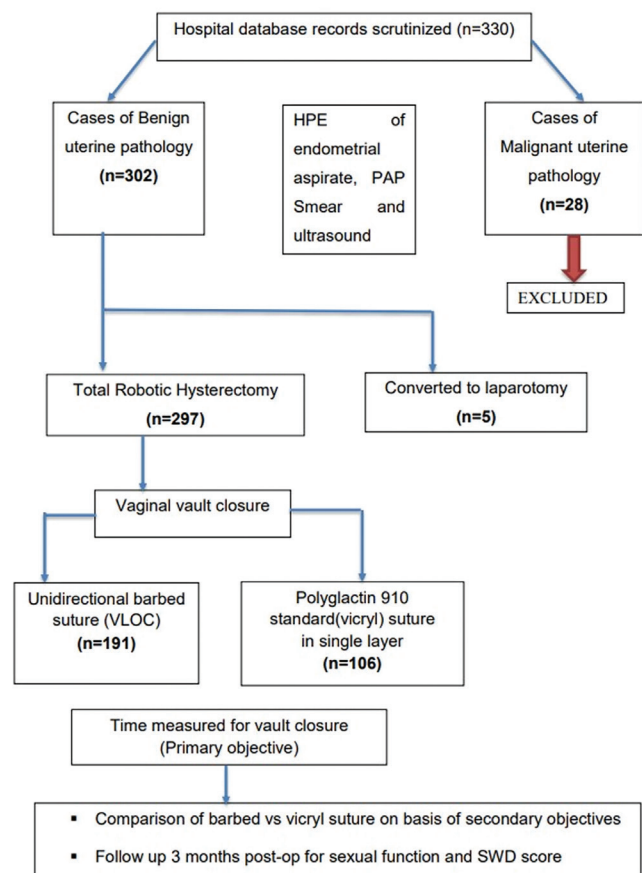


Figure 1. Flowchart of the study population

HPE: Histopathological examination, PAP: Papanicolaou smear/test, SWD: Satisfaction with decision

of suture used for vault closure after robotic hysterectomy. Technique and material by necessity were not blinded to the surgeon. Any record lacking vital information was excluded. Through the hospital database records, operative notes, discharge summaries, the entire details of intraoperative and postoperative complications were obtained. All data and records generated during this study were anonymized and kept confidential as per Institutional policies on subject privacy and data and records would not be used for any purpose other than conducting the study. Every record was reviewed to ascertain whether the subject was eligible for the study, "enrolled" and met the enrolment criteria and had the necessary data to be included in the analysis was "evaluable."

Outcome measures

The primary objective analysed was the measurement of cuff closure time by use of unidirectional barbed (V-Loc) suture vs polyglactin 910 (Vicryl) sutures for vaginal vault closure. Various secondary objective measures analysed included intraoperative measures such as average blood loss, operative time, number of stitches, and hospital stay, and postoperative measures like vaginal vault dehiscence, vault hematoma, and also sexual function assessment at three months postoperatively, using the female sexual function index (FSFI) tool.

Duration of anesthesia was defined as the duration from induction of anesthesia until reversal from anesthesia and it included docking time, console time, vault closure time, and time required for specimen extraction and skin suturing and reversal from anesthesia. Operative time was the duration from incision time until port closure time and was the time taken for the hysterectomy procedure. Vaginal spotting was defined as bloody vaginal discharge that resolves spontaneously without requiring special interventions. In contrast, vaginal bleeding was defined as postoperative bleeding from the vaginal stump necessitating extra outpatient visits, transfusions, or additional sutures. Vaginal cuff dehiscence as a visually confirmed opening of the vaginal stump, potentially with or without herniation of visceral organs. The 3-month post-operative sexual function assessment was elicited. The satisfaction with the decision was assessed using the satisfaction with decision (SWD) score.

Statistical analysis

Data were entered into Microsoft Excel, and statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), version 21.0 (IBM Inc., Armonk, NY, USA). Categorical variables are summarized as frequencies and percentages. Continuous variables are expressed as mean $\pm$ standard deviation (SD) or as median with interquartile range, as appropriate. Comparisons of continuous variables were carried out using the independent t-test, while categorical variables

were analyzed using the chi-square test or Fisher's exact test. To account for baseline differences and potential confounding due to the retrospective and non-randomized design, a multivariable linear regression analysis was performed. Adjusted beta coefficients with 95% confidence intervals (CIs) were calculated. A p-value <0.05 was considered statistically significant.

Results

Baseline characteristics

The present study was conducted at a tertiary care centre and 302 patients who had undergone robotic total hysterectomy without any other simultaneous procedure for a benign cause with uterine size <12 weeks meeting inclusion criteria were retrospectively analysed. Five cases were excluded as they were converted to laparotomy. Thus 297 cases were included in the final analysis (Figure 1). Surgical details regarding the type of suture and time required for surgery were obtained by the video database. Various demographic details of the study population are presented in Table 1.

In the majority [191 (63.25%)] of patients, the type of suture used was barbed, with 106 (35.10%) patients in the Vicryl group, and for five patients' surgery was converted to laparotomy. A significant difference was seen in weight (kg) between the barbed group and the Vicryl group [64.33 ± 8.66 and 61.87 ± 9.1 ($p=0.017$)]. No significant difference was seen in the mean age, height, body mass index (BMI), menopausal status, parity, and previous history of cesarean deliveries between the two groups. The proportion of patients with anemia was significantly higher in the barbed group compared to the Vicryl group [15.71% vs. 6.60% respectively ($p=0.023$)]. The distribution of other significant co-morbidities was comparable between the two groups. Moreover, the distribution of indication for hysterectomy and final histopathology were comparable between barbed group and Vicryl groups. The most common indication for hysterectomy in our study was AUB due to fibroid uterus ($n=145$) followed by adenomyosis ($n=66$) and adnexal masses ($n=28$) (Table 2).

Outcome measures

The mean $\pm$ SD of vault closure time (minutes) in the Vicryl group was 9.93 ± 2.77 which was significantly higher when compared to the barbed group (6.84 ± 1.42) ($p<0.001$). The mean $\pm$ SD of the number of stitches taken for vault closure in the Vicryl group was 5.61 ± 0.75 and was also significantly greater compared to the barbed group (5.02 ± 0.57) ($p<0.001$). Mean $\pm$ SD of time taken per stitch (minutes) in Vicryl group was 1.75 ± 0.43 and significantly longer compared to barbed group (1.36 ± 0.3) ($p<0.001$). Mean operative time, duration of

anesthesia, and length of hospital stay were also significantly longer in Vicryl group compared to the barbed group, whereas mean blood loss and blood transfusion rates were not different between two groups (Table 3).

On multivariable linear regression analysis, barbed suture use was independently associated with vault closure time ($\beta = 8.47$ minutes, 95% CI 5.46-11.48; $p < 0.001$). Age, body weight, BMI, parity, and preoperative anemia status were not independently associated with vault closure time.

Various perioperative (intraoperative and postoperative) complications in both the groups are given in Table 4. There

was no significant difference in perioperative complications between the two groups.

On sexual function assessment using the FSFI at three months postoperatively, a significant difference was seen in the lubrication score, pain score, and total score in favor of barbed sutures between the barbed group and Vicryl group ($p < 0.05$) (Table 5). Mean $\pm$ SD of SWD scale at post-operative three months in the barbed group was 27.58 ± 4.46 and Vicryl group was 26.9 ± 3.21 with no significant difference between them ($p = 0.165$). However, preoperative baseline sexual function data were not available for comparison.

Table 1. Demographic characteristics of the study population

Demographic characteristic	Barbed n=191 n (%)	Vicryl n=106 n (%)	Total n=297 n (%)	p-value
Age (years)*	45.14 $\pm$ 6.15	45.16 $\pm$ 6.5	45.15 $\pm$ 6.27	0.98
Weight (kg)*	64.33 $\pm$ 8.66	61.87 $\pm$ 9.1	63.45 $\pm$ 8.88	0.017
Height (cm)*	156.06 $\pm$ 6.02	155.75 $\pm$ 4.72	155.95 $\pm$ 5.58	0.58
Body mass index (kg/m ²)*	26.5 $\pm$ 3.85	25.58 $\pm$ 4.15	26.17 $\pm$ 3.98	0.055
Menopausal status				0.329
Premenopausal	172 (90.05)	99 (93.40)	271 (91.25)	
Postmenopausal	19 (9.95)	7 (6.60)	26 (8.75)	
Parity*	2.93 $\pm$ 1.39	3 $\pm$ 1.25	2.95 $\pm$ 1.34	0.652
Previous cesarean section				0.488*
None	180 (94.24)	102 (96.23)	282 (94.95)	
One	7 (3.66)	4 (3.77)	11 (3.70)	
Two	4 (2.09)	0 (0)	4 (1.35)	
Co-morbidities				
Anemia	30 (15.71)	7 (6.60)	37 (12.46)	0.023
Diabetes mellitus	8 (4.19)	6 (5.66)	14 (4.71)	0.566
Hypertension	17 (8.90)	8 (7.55)	25 (8.42)	0.687
Hypothyroidism	13 (6.81)	9 (8.49)	22 (7.41)	0.595
Others	3 (1.52)	6 (5.66)	9 (3.03)	
Indications for hysterectomy				0.177**
Leiomyoma	94 (49.21)	51 (48.11)	145 (48.82)	
Adenomyosis	45 (23.56)	21 (19.81)	66 (22.22)	
Adenomyosis with leiomyoma	1 (0.52)	2 (1.89)	3 (1.01)	
Endometrial polyp	10 (5.24)	6 (5.66)	16 (5.39)	
Postmenopausal bleeding	13 (6.81)	5 (4.63)	18 (6.06)	
AUB (E)	5 (2.62)	8 (7.55)	13 (4.38)	
Adnexal mass	17 (8.90)	11 (10.38)	28 (9.43)	
UV descent	6 (3.14)	2 (1.89)	8 (2.69)	
Procedures performed				<0.001*
TRH	20 (10.47)	21 (19.81)	41 (13.80)	
TRH + bilateral salpingectomy	103 (53.93)	30 (28.30)	133 (44.78)	
TRH + bilateral salpingo-oophorectomy	68 (35.60)	55 (51.89)	123 (41.41)	

*Mean $\pm$ SD, **Fisher's exact test, #chi-square test, TRH: Total robotic hysterectomy, SD: Standard deviation, AUB: Abnormal uterine bleeding, UV: Uterovaginal

Discussion

This retrospective analysis evaluated patients who underwent robotic hysterectomy for benign indications at our institution between March 2018 and July 2021. The findings demonstrate that the use of barbed sutures for vaginal vault closure was associated with a significant reduction in vault closure time, overall operative duration, anesthesia time, and length of hospital stay when compared with conventional Vicryl sutures. The association between suture material and vault closure time remained significant after adjustment, suggesting an independent effect. Nonetheless, residual confounding cannot be completely excluded. In addition, postoperative sexual function outcomes appeared more favorable in the barbed

suture group, however these findings should be considered exploratory. The higher postoperative FSFI scores observed in the barbed suture group may reflect differences in postoperative recovery or unmeasured baseline factors rather than a direct effect of suture material.

Several published studies have examined vaginal cuff closure following robotic or laparoscopic hysterectomy, primarily focusing on complications, such as vaginal cuff dehiscence (8,10-13). However, literature specifically analyzing the impact of different suture materials on vault closure time and its contribution to total operative duration remains limited. In our study, barbed sutures reduced vaginal vault closure time by approximately 3.09 minutes compared with Vicryl sutures, a finding that aligns with previously published reports.

Table 2. Distribution of final histopathology of the study population

Final histopathology	Barbed n=191 n (%)	Vicryl n=106 n (%)	Total n=297 n (%)	p-value
Leiomyoma	92 (48.17)	43 (40.57)	135 (45.45)	0.087*
Adenomyosis	40 (20.94)	21 (19.81)	61 (20.54)	
Proliferative endometrium	18 (9.42)	10 (9.43)	28 (9.43)	
Endometrial polyp	11 (5.76)	8 (7.55)	19 (6.40)	
Endometriosis	9 (4.71)	7 (6.60)	16 (5.39)	
Leiomyoma + adenomyosis	2 (1.05)	7 (6.60)	9 (3.03)	
Simple endometrial hyperplasia	3 (1.57)	3 (2.83)	6 (2.02)	
Atrophic endometrium	4 (2.09)	1 (0.94)	5 (1.68)	
Hemorrhagic cyst	2 (1.05)	2 (1.89)	4 (1.35)	
Disordered endometrium	0 (0)	3 (2.83)	3 (1.01)	
Cystic teratoma	3 (1.57)	0 (0)	3 (1.01)	
Normal endomyometrium	3 (1.57)	0 (0)	3 (1.01)	
Adenocarcinoma endometrium	2 (1.05)	0 (0)	2 (0.67)	
Cystic glandular hyperplasia	0 (0)	1 (0.94)	1 (0.34)	
Mucinous cystadenoma	1 (0.52)	0 (0)	1 (0.34)	
Benign Brenner tumor	1 (0.52)	0 (0)	1 (0.34)	

*Fisher's exact test

Table 3. Various intraoperative parameters of two study groups

Perioperative parameters (mean ± SD)	Barbed n=191	Vicryl n=106	Total n=297	p-value
Vault closure time (in minutes)	6.84±1.42	9.93±2.77	7.95±2.49	<0.001
Number of stitches taken for vault closure	5.02±0.57	5.61±0.75	5.23±0.7	<0.001
Time taken per stitch (minutes)	1.36±0.3	1.75±0.43	1.5±0.4	<0.001
Operative time (minutes)	60.81±13.44	66.26±19.28	62.75±15.96	0.011
Duration of anesthesia (minutes)	90.43±13.01	107.98±17.15	96.7±16.85	<0.001
Average blood loss (mL)	65.42±36.8	65.94±24.15	65.61±32.81	0.883
Blood transfusion rate	0.31±0.74	0.17±0.58	0.26±0.69	0.074
Length of hospital stay (days)	3.87±1.34	4.79±1.26	4.2±1.38	<0.001

SD: Standard deviation

Kim et al. (14) reported significantly shorter cuff closure times using V-Loc sutures compared to Vicryl in laparoscopic hysterectomy patients (8.84 ± 2.18 vs. 11.66 ± 1.74 minutes). Similarly, Ardovino et al. (15) demonstrated a marked reduction in closure time with bidirectional barbed sutures compared to conventional sutures (3.9 vs. 6.2 minutes). In contrast, Einarsson et al. (16) found no statistically significant difference in vaginal cuff closure time between the two suture types in a randomized study. A systematic review by Smith and Caceres (17) reported reductions in both total operative time and vault closure time with barbed sutures, suggesting that time savings may offset their higher cost.

The observed reduction in suturing time with barbed sutures can be attributed to the elimination of knot tying and the absence of a need for constant traction to maintain suture tension. However, proper handling of barbed sutures, including passage of the needle through the terminal loop, requires

specific technical proficiency and may involve a learning curve that influences operative efficiency. Given that vaginal cuff closure is a critical step in robotic hysterectomy, multiple techniques and materials have been explored to optimize outcomes and minimize complications. Unlike conventional sutures, barbed sutures do not require an assistant to maintain tension and allow uniform tissue approximation without knots. In the present study, patients in the Vicryl group experienced a significantly longer hospital stay compared with those in the barbed suture group. Similar reductions in length of hospital stay with barbed sutures have been reported by Kim et al. (14) and Nawfal et al. (18). Although the median difference between groups was approximately one day, hospital stay is influenced by multiple factors, including baseline comorbidities, operative duration, and postoperative recovery.

Due to the retrospective design of this study, preoperative sexual function could not be assessed. Nevertheless, postoperative

Table 4. Various perioperative complications of the study groups

Complications	Barbed n=191 n (%)	Vicryl n=106 n (%)	Total n=297 n (%)	p-value
Intra-operative complications				
Bladder injury	2 (1.05)	1 (0.94)	3 (1.01)	1.000
Uterine perforation	2 (1.05)	0 (0)	2 (0.67)	0.539
Rectosigmoid injury	1 (0.52)	0 (0)	1 (0.34)	1.000
Post-operative complications				
Fever	5 (2.62)	7 (6.60)	12 (4.04)	0.095
Urinary tract infections	2 (1.05)	4 (3.77)	6 (2.02)	0.191
Vaginal spotting/discharge	3 (1.57)	5 (4.72)	8 (2.69)	0.139
Vaginal bleeding	0 (0)	0 (0)	0 (0)	-
Vaginal dehiscence	0 (0)	1 (0.94)	1 (0.34)	0.357
Post-op ureterovaginal fistula	0 (0)	1 (0.94)	1 (0.34)	0.357
Subcutaneous emphysema	1 (0.52)	0 (0)	1 (0.34)	1.000
Readmission rate	2 (1.05)	4 (3.77)	6 (2.02)	0.191

Table 5. Comparison of female sexual fertility index (after three months postoperatively) between the two groups

Female sexual fertility index (mean $\pm$ SD)	Barbed n=191	Vicryl n=106	Total n=297	p-value
Desire score	4.7 ± 1.03	4.42 ± 1.33	4.59 ± 1.16	0.072
Arousal score	4.45 ± 0.96	4.45 ± 1.15	4.45 ± 1.03	0.996
Lubrication score	4.61 ± 0.8	4.22 ± 1.28	4.47 ± 1.02	0.007
Orgasm score	4.78 ± 1.06	4.59 ± 1.4	4.71 ± 1.2	0.203
Satisfaction score	5 ± 0.73	4.9 ± 1.22	4.97 ± 0.94	0.46
Pain score	5.48 ± 0.71	4.81 ± 1.47	5.23 ± 1.1	<0.001
Overall score	29.02 ± 4.85	27.39 ± 7.35	28.43 ± 5.93	0.049
No preoperative baseline FSFI data were available. Results should be interpreted with caution and regarded as hypothesis-generating only SD: Standard deviation, FSFI: Female sexual function index				

evaluation at three months using the FSFI demonstrated significantly higher overall scores in the barbed suture group. In contrast, Einarsson et al. (16) found no significant differences in sexual function outcomes between barbed and conventional suture groups when assessed both pre- and post-operatively. These discrepancies highlight the need for prospective studies with baseline assessments to better understand the relationship between vault closure technique and sexual function.

Robotic surgery has become an integral component of contemporary gynecologic practice since the FDA approval of the da Vinci system in 2005 (3). Compared with conventional minimally invasive approaches, robotic platforms provide enhanced dexterity through seven degrees of freedom, surpassing the natural range of human hand movements (2). This improved maneuverability contributes to greater surgical precision, reduced surgeon fatigue, and improved operative efficiency. From a patient standpoint, robotic surgery is associated with less blood loss, reduced postoperative pain, shorter hospitalization, faster recovery, and improved cosmetic outcomes.

Study limitations

A key strength of this study is the precise measurement of suturing times using surgical video recordings rather than operative notes, enhancing the accuracy of intraoperative data. In addition, all procedures were performed by a single experienced surgeon proficient in both suturing techniques, minimizing inter-operator variability. The primary limitation remains the retrospective design, with reliance on medical records for perioperative and postoperative data. The retrospective design and surgeon-dependent choice of suture material introduce the possibility of selection bias. Although multivariable regression was used to adjust for measurable confounders, unmeasured variables may still influence outcomes. The imbalance in concomitant procedures between groups, particularly bilateral salpingo-oophorectomy, may have influenced operative outcomes. As procedure type was not included in the multivariable analysis, residual confounding remains possible. A key limitation of this study is the absence of preoperative FSFI assessment. Consequently, the observed postoperative differences in FSFI scores should be interpreted cautiously and cannot be conclusively linked to the type of suture used. Another important limitation of this study is the relatively short follow-up duration of three months. This limits the ability to evaluate longer-term outcomes, such as delayed vaginal cuff dehiscence, sustained vaginal cuff integrity, and long-term sexual function. Therefore, conclusions regarding safety and durability are restricted to the early postoperative period.

Conclusion

The findings of this study suggest that the use of unidirectional barbed sutures for vaginal vault closure during robotic hysterectomy was associated with shorter vault closure time, reduced duration of anesthesia, and a shorter hospital stay when compared with conventional Vicryl sutures. Barbed sutures may represent a feasible and time-efficient option for robotic vaginal vault closure. However, prospective randomized studies with longer follow-up and appropriate adjustment for confounders are required to confirm their safety, durability, and impact on functional outcomes.

Ethics

Ethics Committee Approval: This retrospective study was conducted after approval from the Institutional Ethics Committee of All India Institute of Medical Sciences, Rishikesh (approval no.: AIIMS/IEC/19/1165; date: November 29, 2019).

Informed Consent: As all data were collected from existing records, the requirement for individual informed consent was waived by the committee, and all patient information was anonymized to ensure confidentiality.

Footnotes

Author Contributions: Surgical and Medical Practices: A.B., M.A., R.M., L.S., L.C., A.H., Concept: A.B., M.A., R.M., L.S., L.C., A.H., Design: A.B., M.A., R.M., L.S., L.C., A.H., Data Collection or Processing: M.A., L.S., A.H., Analysis or Interpretation: A.B., M.A., R.M., Literature Search: A.B., M.A., R.M., L.C., Writing: A.B., M.A., R.M., A.H.

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