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*Original Article*

# Vaginal Cuff Closure After Laparoscopic Total Hysterectomy

## Fechamento da Cúpula Vaginal em Histerectomia Total Laparoscópica

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**ABSTRACT**

Vaginal cuff dehiscence after hysterectomy is not a common postoperative complication but can be potentially serious. With the introduction and popularization of the laparoscopic approach to hysterectomy for benign gynecological disease, it appear that there has been an increase in the number of vaginal cuff dehiscences compared with abdominal total hysterectomy and vaginal hysterectomy. In this paper the authors review technical details of vaginal cuff closure after laparoscopic total hysterectomy.

**Key words**: Laparoscopy. Total laparoscopic hysterectomy. Vaginal cuff closure. Vaginal dehiscence.

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## INTRODUCTION

Vaginal cuff dehiscence following hysterectomy is an uncommon postoperative complication, but can be potentially serious.[1] When associated with partial or total evisceration, peritonitis, sepsis, or acute mesenteric ischemia may develop, often requiring bowel resection.[2]

The main risk factors for vaginal cuff dehiscence after hysterectomy include vaginal atrophy, radiation therapy, early resumption of sexual activity, infection, postoperative hematoma, and increased intra-abdominal pressure (coughing, vomiting, straining when defecating). In most cases, however, there is no identifiable predisposing condition.[3-6] Other individual characteristics which may be implicated in the genesis of this complication, include smoking, diabetes, advanced age, and the chronic use of corticosteroids.[5,7,8]

Recently, minimally invasive access routes for performing hysterectomy for benign diseases have gained popularity.[9-11] With the growth in the number of minimally invasive procedures, several articles have suggested that vaginal cuff dehiscence is more common after laparoscopic total hysterectomy than after abdominal total hysterectomy or vaginal hysterectomy.[4,12]

The incidence of this complication after laparoscopic hysterectomy appears to vary between 0.3% and 3.1%.[2,4,7,12-16] It has been postulated that thermal injury from the use of electrosurgery during colpotomy could be one of the factors responsible for the increase in the rate of vaginal cuff dehiscence.[4,17] Several authors have shown that it also could be due to the closure technique,[18] while others suggest that the rapid recovery after the laparoscopic procedure with an earlier return to daily activities predisposes to early resumption of sexual activity.[8,19]

In this article we review the technical details of vaginal cuff closure in laparoscopic total hysterectomy.

## WOUND HEALING AND INFLAMMATORY REACTION

To better understand the process that encompasses vaginal cuff closure, it is helpful to have

some knowledge of the basic concepts of the mechanisms of wound healing. Wound healing is a complex process that involves a cascade of cellular and molecular events which interact to bring about the restoration of the structure and function of the tissue.[20] The healing process can be divided into three phases which, to a certain degree, can overlap: inflammatory, proliferative and remodeling.[21]

The inflammatory phase begins after tissue injury and involves a vascular response characterized by blood coagulation and platelet aggregation for hemostasis, as well as cellular events including the migration of polymorphonuclear cells, macrophages, lymphocytes, and fibroblasts with varying functions in the release of cytokines that initiate the proliferative response to repair the wound.[20,21]

During the proliferative phase, angiogenesis and granulation tissue formation involving the proliferation of fibroblasts, the formation of extracellular matrix, and the deposition and alignment of collagen fibers predominate, resulting in increased tensile strength along the edges of the wound.[20,21]

Once the new tissue is formed, the remodeling phase begins to restore the tissue's integrity and functional competence.[21] During this phase the maturation and renewal of collagen fibers, formation of new larger caliber capillaries, formation of new epithelium, and remodeling of collagen fibers occur.

There are several factors that influence the healing process, including age, hypoxia, use of immunosuppressants (corticosteroids and chemotherapy drugs), diabetes, and malnutrition.[22] With regard to the surgical technique, delicate handling of the tissues, careful hemostasis, and attention to excessive use of electrocautery and excessive force when tying knots – in order to avoid ischemia, necrosis and wound infection – are all critically important.[20]

Particularly in the case of laparoscopic hysterectomies, bipolar coagulation for hemostasis should be sufficient to promote the coagulation of arterial bleeding, while venous bleeding should be preferably controlled with sutures, so there is no excessive thermal damage of the vaginal cuff. An experimental study carried out in pigs compared the thermal damage of laparoscopic colpotomy using ultrasonic, bipolar, and monopolar energy, and found that all forms of energy caused tissue damage, but the damage was greatest with bipolar energy and least with ultrasonic energy.[23]

## EFFECTS OF FOREIGN BODIES AND EXCESSIVE INFLAMMATION ON WOUND HEALING

**Efeito dos corpos estranhos e do excesso de inflamação na cicatrização**

The presence of foreign bodies – including the presence of suture thread – in wounds induces an excessive inflammatory response that diminishes the body's defense mechanisms against infection and interferes with the proliferative phase of wound healing, and thus may lead to a lower strength of the wound closure due to the excessive formation of scar tissue.[24]

Whenever there is a surgical trauma to the body, a healing process starts that necessarily involves the inflammation phase. In the presence of suture material in the wound, the tissue inflammatory reactions persist as long as the suture material (foreign body) remains in the tissue. The degree of tissue reaction depends on the chemical nature and physical characteristics of the various suture materials.[24]

## CLASSIFICATION AND CHARACTERISTICS OF SUTURE MATERIALS

There are several ways to classify suture materials. Several characteristics are of fundamental importance in the choice of suture thread to be used in a surgical procedure:[24]

- Suture caliber
- Tensile strength
- Absorbable versus non-absorbable suture
- Configuration (monofilament versus multifilament)
- Rigidity versus flexibility
- Smooth versus barbed

**Suture caliber**

All types of sutures are available in various sizes. Currently, there are two standard ways to describe the caliber of the suture: the United States Pharmacopoeia (USP) nomenclature and the European Pharmacopoeia (EP) nomenclature. The USP standard uses a combination of two numerals, a positive integer followed by a zero (e.g. 3-0). The larger the first number, the smaller the diameter of the suture. The larger the size of the suture, as one might expect, the greater its tensile strength.[24]

**Tensile strength**

In surgical procedures the thread of the suture bears most of the forces which might rupture the healing tissue. Because the degree of force and time required for healing varies according to the type of tissue, suture threads should vary in their tensile strength profile.[24]

Each suture material has a known tensile strength that, for a specific size of thread, corresponds to the breaking load, which corresponds to the weight (in pounds or kilograms) required to cause rupture of thethread, measured both for the thread intact and with the thread tied.

**Absorbable versus non-absorbable**

As mentioned earlier, any foreign body induces some degree of tissue reaction which impedes wound healing. The longer the suture material remains in the body, the greater the chance of it becoming a setting for an undesirable tissue reaction that may delay and/or interfere with the normal tissue healing.[24]

Therefore, the ideal suture material will maintain adequate tensile strength during the healing process and disappear after with minimal associated inflammatory reaction. What defines the choice of suture material is to determine the optimal balance between the tensile strength of the suture to tissue while it provides healing versus the detrimental effects of inflammation.

The absorbable sutures have complete loss of tensile strength in less than two to three months and non-absorbable threads maintain the tensile strength beyond that period.[25]

The most commonly used absorbable sutures are:

• Catgut: organic thread obtained from the submucosa of sheep small intestine or bovine serosa. It is a thread that is absorbed rapidly. Simple catgut is absorbed faster (8 days) while chromic catgut (a variant treated with chromic acid salts) is absorbed more slowly (20 days).

• Poliglecaprone: synthetic monofilament with good flexibility and knot security.

• Polydioxanone: synthetic monofilament with a slower absorption. Maintains tensile strength longer. Suitable for wounds in that heal slowly.

• Polyglycolic and poligalactic acid: synthetic multifilament sutures which are absorbed in 60 to 90 days. Its tensile strength is greater than that of catgut..

## CONFIGURATION (MULTI VERSUS MONOFILAMENTAR)

The suture configuration refers to the number of layers that compose it. [20] From the viewpoint of wound healing, there would be no advantages of using a multifilament compared with a monofilament. [24] Multifilament threads promote more microtrauma as they pass through tissues,[26] more inflammatory reaction, and generate a larger volume knot,[27,28] as well as having greater capillary action (with the possibility of increased transport and spread of microorganisms).[29]

However, there are other characteristics of the suture that should be considered when choosing whether to use a monofilament or multifilament. In particular, currently available multifilament threads tend to offer better handling and flexibility than monofilament materials, which may facilitate the suturing process especially during laparoscopic surgery.

**Rigidity and flexibility**

These characteristics determine the suture material's feel and ease of handling. The rigidity of the suture generates its memory and determines the ease with which knots can be tied. The rigidity is also associated with mechanical irritation of the surrounding tissues.

**Smooth versus barbed**

*Smooth Thread*

Tying a knot is central to any surgical procedure. When using a smooth thread in a continuous suture there is a heterogeneous distribution of tension in the wound. Although the tension in a sutured wound often appears to be homogeneously distributed, it is invariably greater in the vicinity of the knots compared to the rest of the suture line. This gradient of pressure can interfere with the uniformity of the healing and its remodeling.[24]

Regardless of the configuration of the knot, the weakest point of the suture is the knot and the segment immediately adjacent to the knot, mainly due to the effect of slippage of the suture material and stretching of the thread.[24] The surgical knot is also the point with the greatest quantity and density of foreign body along the suture line and the intensity of the local inflammatory reaction is directly related to the knot's volume.[30]

One should also remember that knots tied too tightly can be harmful to the tissue causing tissue necrosis, reduced fibroblast proliferation, and excessive tissue overlay, resulting in with a weaker scar. [31]

**Barbed Thread**

Barbed threads eliminate the need for anchoring the end of the thread with a knot and were developed in order to overcome several limitations and difficulties posed the need for surgical knots when using smooth threads.

In 2004 the Food and Drug Administration (FDA) approved the first polydioxanone bidirectional barbed suture, from Quill Medical. In 2009, a poligliconate unidirectional barbed suture with a loop at the end (V-Loc™ from Covidien) was approved by the FDA.

The bidirectional barbed suture offers several theoretical advantages over smooth sutures. The self-anchoring barbed suture eliminates the need for a knot, resulting in a suture line without weak points. In addition, the absence of knots reduces in the quantity of foreign body, decreasing tissue reaction. Tension in the wound is distributed more uniformly along the suture line.[24] Not having to tie knots is especially appreciated in laparoscopic procedures, where it has the greatest potential to reduce operating time, the learning curve for some procedures, and costs.[32,33]

On the other hand, it is unclear whether with the use of unidirectional barbed suture, with its terminal anchoring loop, tissue necrosis at that end of the loop will compromise the stability of the unidirectional suture in the initial phases of the healing process.[24]

## CHOOSING THE SUTURE THREAD

The ideal suture thread should have the following properties:[20,24]

- Tensile strength suitable for the tissue in question to heal, while assuring a secure knot;
- Minimal tissue reactivity
- Easy to handle (malleable and flexible)
- Uniform and predictable performance characteristics, especially with regard to the the absorption of the suture/thread
- Smooth passage through tissue
- Not conducive to bacterial growth
- Easily sterilized
- Non-electrolytic, free of capillary action, non-allergenic, non-carcinogenic.

Despite our growing knowledge about biomaterials, the ideal suture material for all situations has yet to be identified.

## CLOSING THE VAGINAL CUFF

The closure of the vaginal cuff after total hysterectomy is a biomechanically complex procedure. Bacterial contamination of the vaginal cavity is the leading cause of febrile morbidity and of infectious complications. It is worth noting that even in the absence of infection, the vaginal cuff is subject to the formation of granulation tissue that can generate persistent discharge and postoperative bleeding.[24]

As already mentioned, there are multiple factors that may negatively influence the healing of the suture line of the vaginal cuff: coughing, sneezing, vomiting, and constipation.[3-6] In addition, coitus is a factor to be considered in the postoperative period.[8,19] The use of a rigid suture can create another area of irritation.[24]

With the introduction of minimally invasive surgical techniques for hysterectomies performed for benign diseases, there has been a tendency to use thermal energy at the time of colpotomy in lieu of cold cutting. When energy is used incorrectly, it may result in a smaller quantity of viable tissue at the edges of the cuff, which can delay healing.[4,17]

## SUTURE IDEAL FOR VAGINAL CUFF

The ideal suture thread for closure of the vaginal cuff should:

- Inhibit bacterial growth
- Provoke minimal tissue reactivity
- Be flexible and malleable
- Be absorbable, but maintain reasonable tensile strength for at least 2 to 4 weeks.

Chromic catgut is associated with increased postoperative formation of granulation tissue.[34]

A multifilament polyglycolic acid suture may be selected when taking into consideration the flexibility but not the capillary action of the thread. Monofilament materials with delayed absorption – such as polydioxanone or poligliconate – can be chosen if the objective is to minimize inflammation. Whenever a slowly absorbed monofilament is used, all knots and

edges of the suture should be kept intra-abdominal.[24]

A study by Duckett and Patil evaluated the early postoperative morbidity in patients who underwent surgery for pelvic organ prolapse.[35] The vaginal suturing was performed using one of two different threads: polyglycolic acid (1-0 Vicryl®) and polyglecaprone 25 (2-0 Monocryl®). Use of the multifilament polyglycolic acid suture was associated with higher rates of postoperative vaginal discharge, vaginal bleeding, and vaginal pain.

With the advent of barbed sutures, a new paradigm has been introduced because, in theory, when this type of suture is employed, tension along the suture is distributed more evenly along the length of the suture rather than just in the knots at the ends of the suture when using a smooth suture. [16]

Einarsson et al[16] confirmed the safety of bidirectional barbed sutures in the vaginal cuff closure of 117 laparoscopic hysterectomies. The bi-directional barbed thread facilitated the suturing and prevented thread slippage (and subsequent loosening of the suture line). It also permitted a continuous suture without a need for anchoring or another surgeon securing the line of suturing to maintain tension between the needle passes.[16]

In an experimental sheep model, the barbed suture facilitated suturing of the myometrium. The rate of adhesion formation and the severity of adhesions was comparable to that when polyglactin sutures were used.[36]

Neubauer et al[37] compared two methods of closing the vaginal cuff in robotic hysterectomies: continuous suturing with an absorbable synthetic monofilament secured with a clip made of absorbable thread at the angles and tied in the middle (n = 58) and continuous suturing with 2-0 unidirectional barbed suture (n = 76). Spotting occurred in 12% and 13% of cases, respectively. No vaginal cuff dehiscence occurred. Similar findings were reported in the study by Nawfal et al.[38] There was no difference in complication rates with vaginal cuff closure in robotic hysterectomy with Vicryl® (n = 133) and V-Loc® (n = 69). Surgical time was shorter and estimated blood loss less when barbed sutures were used.

Siedhoff et al[13] observed a lower incidence of vaginal cuff dehiscence, postoperative bleeding, presence of granulation tissue and of cellulitis when bidirectional barbed suture was used in the laparoscopic vaginal suturing after hysterectomy and trachelectomy. These promising findings are tempered by several case reports of small bowel volvulus and obstruction following the use of barbed sutures in laparoscopic gynecologic procedures.[39-42]

## VAGINAL CUFF CLOSURE TECHNIQUE

Continuous (Figures 1 and 2) versus interrupted (Figure 3)

In a study by Blikkendaal et al there was no difference in the rate of vaginal cuff dehiscence when the laparoscopic suturing of the vaginal cuff after hysterectomy was performed with separated or continuous sutures (3.3% vs. 2.4%).[1]

### One Plane versus Two Planes

The vaginal cuff can be sutured in one plane (Figure 3) or in two planes. When two planes are sutured, the first suture line includes the vaginal wall and the second suture line Halban's fascia[43] anteriorly and the uterosacral ligaments and the peritoneum of the pouch of Douglas posteriorly (Figure 4).

Shen et al[44] compared three surgical techniques during laparoscopically assisted vaginal hysterectomy in 427 women: suturing the vaginal cuff in one plane (n = 147), vaginal cuff suturing in two planes (n = 138), and open vaginal cuff closure (n = 142). There was no statistically significant difference with regard to operative time, intraoperative blood loss, postoperative febrile morbidity, postoperative hematocrit, length of hospital stay, and the rates of pelvic infection and urinary tract infection, dyspareunia, postcoital spotting, and morbidity related to vaginal cuff (cellulitis, abscess formation, bleeding, hematoma, dehiscence). The frequency of granulation tissue formation in the vaginal wall and vaginal discharge was higher in the group whose suturing was in a single plane.

In reviewing three cases of vaginal cuff dehiscence of a total of 248 women who underwent hysterectomy (1.2%), Jeung et al[15] observed no advantage in using continuous suture in two planes compared with "figure 8" suturing in a single plane.

### Vaginal versus laparoscopic

The widespread implementation of minimally invasive techniques as been accompanied by a striking increase in the incidence of vaginal cuff dehiscence after laparoscopic total hysterectomies.[4,12] Recent

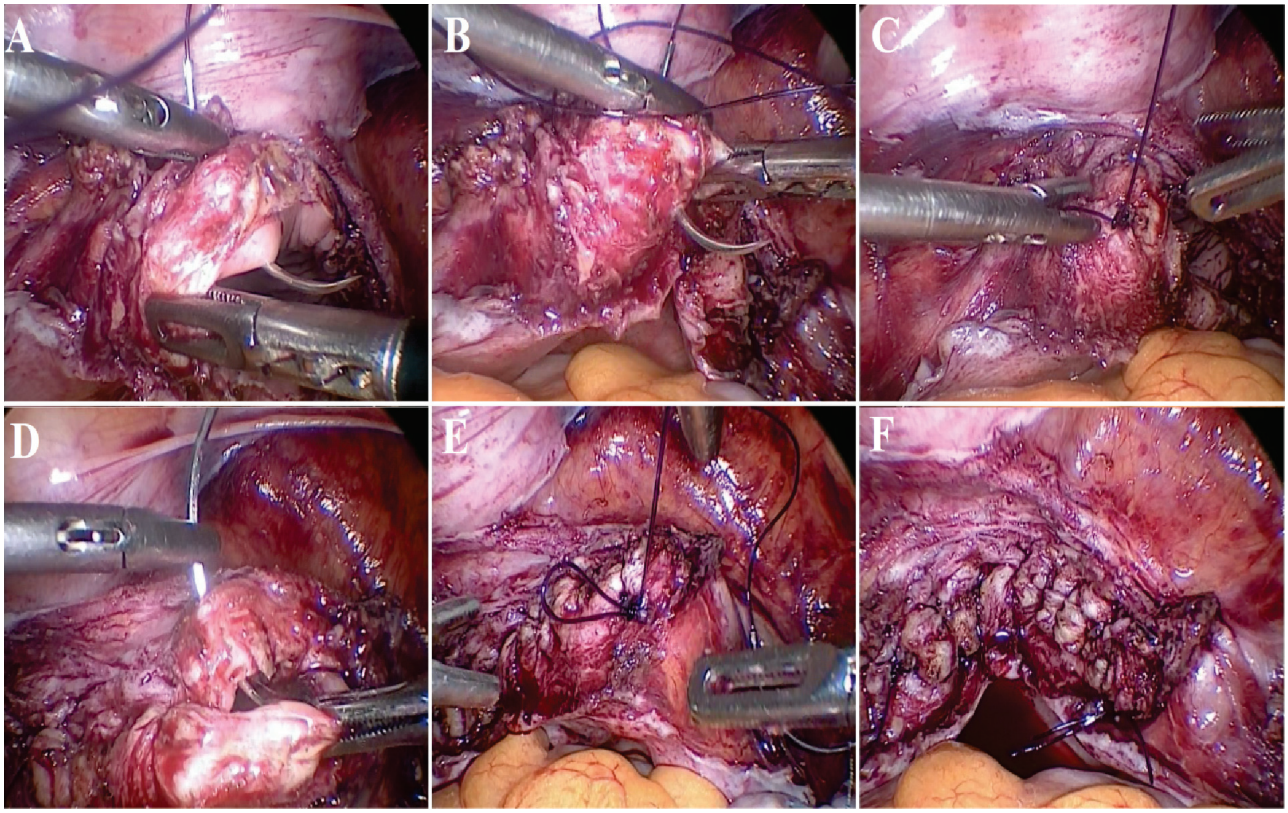


***Figure 1 -*** *(A to C) Initiating the continuous suturing with Caprofil® suture, with tying of the knot. (D) Continuous suturing. (E) Tying the knot at the end of the line of the vaginal suturing. (F) Final appearance of the vaginal sutures.*

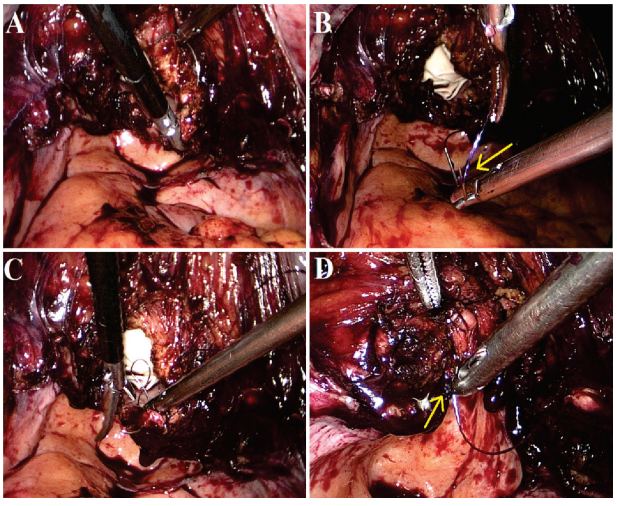


***Figure 2 -*** *(A) Initiating the suturing with barbed V-Loc® thread. (B) Passing the needle through the loop of the V-Loc® (Yellow arrow). Passagem da agulha na alça do V-Loc®. (C) Continuous suture of the vaginal cuff. (D) Passing the needle parallel to and against the line of suturing to finalize it without the need for a knot (Yellow arrow).*

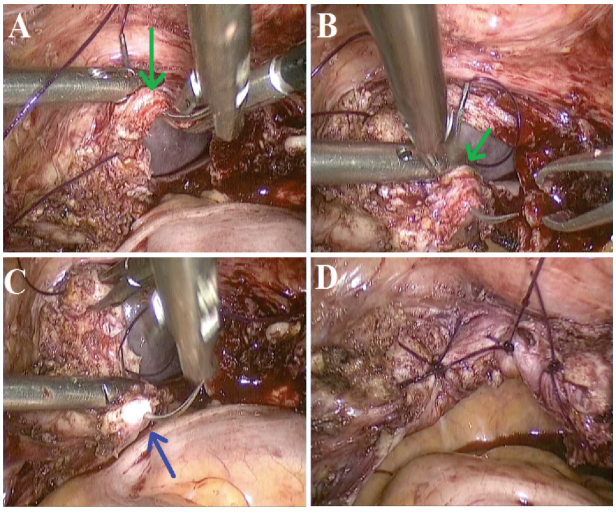


***Figure 3 -*** *(A to C) Suturing of the vaginal cuff in a single plane with interrupted sutures. (D) Final appearance of the sutures. Green arrow = vagina; Blue arrow = uterosacral ligament.*

studies suggest that the rate of vaginal dehiscence is strongly influenced by path of surgical access, with laparoscopic or robotic-assisted laparoscopic hysterectomies associated with a higher rate of complications when compared to conventional abdominal or vaginal procedures.[1,3,6,7]

Characteristics that are peculiar to laparoscopic surgery such as the technical difficulty

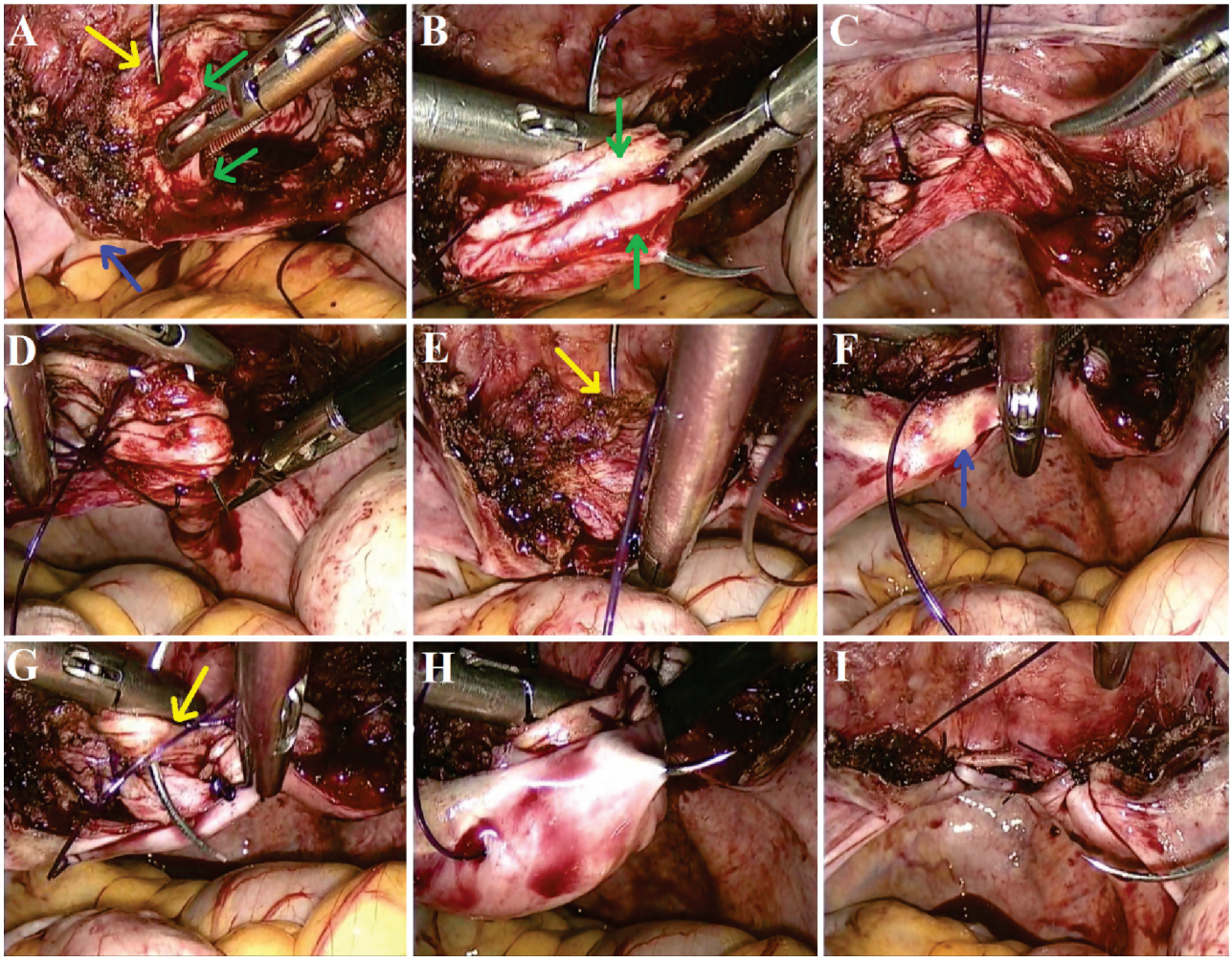


***Figure 4 -*** *Suturing of the vaginal cuff in two planes using separated sutures. (A to D) First line of sutures including the vagina. (E to H) Second line of sutures including Halban's fascia (anteriorly) and the uterosacral ligaments and the peritoneum of the posterior fornix (posteriorly). (I) Final appearance of the sutures. Yellow arrow = Halban's fascia; Green arrow = vagina; Blue arrow = uterosacral ligaments.*

of the procedure, the complexity of performing the suturing, and an insufficient quantity of tissue incorporated in the suturing have been suggested as reasons for the increased incidence of vaginal cuff dehiscence.[12-14,19]

Hur et al[4] evaluated 7286 hysterectomies (7039 total and 247 supracervical) performed via abdominal, vaginal, laparoscopic-assisted vaginal and laparoscopic approaches. The cumulative incidence of vaginal cuff dehiscence after total hysterectomy was 0.14%. This cumulative incidence of vaginal cuff dehiscence by mode of hysterectomy was 4.93% for laparoscopic total hysterectomy, 0.29% for vaginal total hysterectomy, and 0.12% for abdominal total hysterectomy. The relative risk of vaginal cuff dehiscence after laparoscopic total hysterectomy compared with vaginal hysterectomy and abdominal total hysterectomy was 21 and 53.2, respectively. In this study, the activity that triggered the complication was sexual activity in 6 of 10 (60%) cases. The authors postulated that the use of thermal energy at the moment of the colpotomy associated with other factors unique to laparoscopic surgery may be responsible for the higher rate of dehiscence.

In their series of 665 laparoscopic total histerectomias with transvaginal colporrhaphy, Uccella et al.[12] reported only two vaginal cuff dehiscences, a rate of 0.3%. The authors performed a systematic review of the literature and found 91 dehiscences in 13,030 cases, a rate of 0.66%. The incidence of vaginal cuff dehiscence was lower when the suturing was performed via a transvaginal approach (0.18%)

rather than a laparoscopic approach (0.64%) or robotically (1.64%).

The risk of dehiscence was lower with laparoscopic closure than with the robotic (OR = 0.38). Therefore, in this article transvaginal colporrhaphy after laparoscopic total hysterectomy was associated with a three-fold and nine-fold reduced risk of vaginal cuff dehiscence as compared with laparoscopic and robotic suturing, respectively.

The influence of different surgical approaches in hysterectomy and of various techniques for suturing the vaginal cuff on the risk of vaginal cuff dehiscence was studied in a multi-institutional analysis encompassing 12,398 patients who underwent hysterectomy for benign and malignant diseases between 1994 and 2008.[18] The rates of vaginal cuff dehiscence were 0.64%, 0.20% and 0.16% for the laparoscopic total hysterectomy (n = 3573), abdominal hysterectomy (n = 4291) and vaginal hysterectomy (n = 4534), respectively. Laparoscopic total hysterectomy was associated with a higher incidence of dehiscence compared with abdominal hysterectomy (0.64% vs. 0.21%) and vaginal hysterectomy (0.64% vs. 0.13%). Within the endoscopic group, the patients with vaginal cuff closure with laparoscopic suturing has higher rates of dehiscence than with vaginal suturing (0.86% vs. 0.24%).

When colporrhaphy was performed transvaginally after laparoscopic hysterectomy, there was no statistically significant difference in the rate of dehiscence compared with abdominal total hysterectomy (0.24% vs. 0.21%) or with vaginal hysterectomy (0.24% vs. 0.13%). Thus, we can conclude that the most important factor in the rate of vaginal cuff dehiscence is probably the colporrhaphy technique used. The use of energy when performing the colpotomy was not a factor that influenced the rate of dehiscence.

On the other hand, other articles have shown comparable incidences of dehiscence vaginal cuff after laparoscopic total hysterectomy compared with other approaches. Iaco et al[5] reviewed the cases of transvaginal evisceration after hysterectomy in 3593 cases (63.5% abdominal total hysterectomy, 33% vaginal hysterectomy, and 3.5% laparoscopic hysterectomy). Ten patients (0.28%) returned to the emergency department with vaginal evisceration. There were no statistically significant differences in rates of evisceration according to surgical approach. The authors suggested that in young women the resumption of sexual activity before complete healing of the vaginal cuff should be considered as the principal event that triggers this complications, while in elderly patients evisceration is a spontaneous event. Two other authors compared vaginal and laparoscopic colporrhaphy after laparoscopic total hysterectomy and found similar rates of postoperative vaginal cuff dehiscence.[1,14]

Several potential advantages of suturing the cuff laparoscopically compared to the vaginal approach include:

· Greater vaginal length with laparoscopic suturing.[45]

· Adequate visualization and incorporation of the uterosacral ligaments in the suturing, resulting in more effective vaginal suspension.[46]

· With the laparoscopic approach the sutures are not exposed to the vaginal flora, which can reduce the chance of infection[45]

· When the laparoscopy team is experienced, less time is needed to close the vaginal cuff laparoscopically than with the vaginal approach because there is no time lost doing the vaginal suturing with the change in the position of the surgeon, exchange of instruments, and reestablishing the pneumoperitoneum.[45]

## CONCLUSION / FINAL CONSIDERATIONS

Vaginal cuff dehiscence is an uncommon – but potentially serious complication – after hysterectomy. The rate of vaginal cuff dehiscence after laparoscopic total hysterectomy seems to be greater than or equal to the rate after vaginal or abdominal total hysterectomy, especially when the suturing is performed laparoscopically.

This may, however, only be a reflection of the quality of laparoscopic vaginal cuff closure during the learning curve of the surgeons. Regarding the type of suture to be used, one should preferentially use a monofilament (polyglecaprone 25 or polydioxanone) in a single plane or two planes, either in continuous or interrupted sutures. Barbed thread seems to be an option for continuous suturing and awaits more studies to establish its superiority to smooth threads.

**RESUMO**

A deiscência de cúpula vaginal após histerectomia é uma complicação pós-operatória pouca frequente, mas que pode ser potencialmente grave. Com a popularização da via de acesso laparoscópica para a realização de histerectomia para doenças benignas, parece ter ocorrido um aumento do número de deiscências de cúpula vaginal, comparado com a histerectomia total abdominal e a histerectomia vaginal. Neste artigo revisamos os detalhes técnicos de fechamento da cúpula vaginal em histerectomia total laparoscópica.

**Palavras-chave**: laparoscopia, histerectomia total laparoscópica, fechamento de cúpula vaginal, deiscência de vagina.

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