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Role of Barbed Sutures in Gynaecological Laparoscopic Surgery - Evidence and Implementation

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ABSTRACT

Barbed sutures have emerged as a significant advancement in gynecological laparoscopic surgery, offering a knotless and efficient alternative to conventional suturing techniques. Their unique self-anchoring mechanism ensures continuous tension distribution, eliminates the need for intracorporeal knots, and simplifies suturing in confined pelvic spaces. Over the past decade, numerous clinical and comparative studies have demonstrated that barbed sutures reduce operative and suturing times, minimize blood loss, and improve surgical ergonomics without increasing complication rates. Their use has been widely adopted in procedures such as total laparoscopic hysterectomy, laparoscopic myomectomy, and pelvic organ prolapse repair, where consistent tissue approximation and hemostasis are critical. The safety profile of barbed sutures is well established, with reported complications such as bowel obstruction or suture extrusion being rare and largely preventable through proper surgical technique. Additionally, barbed sutures contribute to improved cost-effectiveness by reducing operative duration, anesthesia time, and hospital resource utilization. In India, adoption is steadily increasing, driven by favorable outcomes and growing surgeon familiarity, though barriers such as cost and limited training remain. Despite strong evidence supporting their clinical utility, research gaps persist regarding long-term fertility outcomes, uterine scar integrity, and region-specific cost analyses. Future studies should focus on multicentric, randomized trials and standardized training protocols to optimize safety and implementation. Overall, barbed sutures represent a practical, safe, and efficient innovation that aligns with the goals of modern minimally invasive gynecologic surgery.

KEYWORDS: Barbed sutures, Gynecological laparoscopy, Hysterectomy, Myomectomy, Surgical efficiency.

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INTRODUCTION

Minimally invasive surgery has brought a significant transformation in the field of gynecology, offering patients faster recovery, less postoperative pain, reduced hospital stays, and improved cosmetic outcomes. Despite these benefits, laparoscopic suturing remains one of the most technically challenging components of minimally invasive surgery due to limited instrument mobility and the difficulty of intracorporeal knot tying. To address these challenges, barbed sutures were introduced as a knotless alternative that can facilitate efficient tissue closure in laparoscopic procedures [1]. Barbed sutures are specialized surgical threads that have tiny, evenly spaced projections (barbs) along their length, allowing them to anchor themselves into tissue without the need for knots. These barbs provide unidirectional or bidirectional tension distribution, depending on the design, which ensures uniform wound closure and reduces the risk of suture loosening [2]. The innovation behind barbed sutures lies in their ability to maintain tension automatically, thereby enhancing precision, minimizing operating time, and reducing surgeon fatigue—particularly important in laparoscopic gynecological procedures where intracorporeal manipulation is technically demanding [3]. In gynecological laparoscopic surgery, barbed sutures have become particularly relevant in procedures such as total laparoscopic hysterectomy, laparoscopic myomectomy, and pelvic organ prolapse repair. In these surgeries, suturing efficiency and secure tissue approximation are essential for preventing postoperative complications such as vaginal cuff dehiscence, bleeding, and infection. The use of barbed sutures eliminates the need for knot tying, thereby simplifying intracorporeal suturing and improving the overall flow of surgery [4]. The most commonly used commercial variants in gynecology include V-Loc™, Stratafix™, and Quill™, which are available in both absorbable and non-absorbable forms, depending on surgical requirements [5].

The barbed suture mechanism allows surgeons to perform continuous suturing with less technical strain. In traditional suturing, every throw requires precise knot placement to maintain tissue approximation. However, with barbed sutures, each segment of the thread grips the tissue independently, preventing backward slippage. This allows surgeons to work more efficiently, especially during laparoscopic procedures where instrument angles are restricted [6]. Moreover, the distribution of mechanical tension across the wound minimizes localized stress, improving wound healing outcomes and potentially reducing the risk of tissue ischemia [7]. A growing body of evidence supports the clinical advantages of barbed sutures in laparoscopic gynecology. Several comparative and randomized studies have demonstrated that the use of barbed sutures significantly reduces operative and suturing time while maintaining comparable safety outcomes to conventional sutures. Reports indicate that vaginal cuff closure during total laparoscopic hysterectomy is faster, with decreased blood loss and similar or lower complication rates [8]. Similarly, in laparoscopic myomectomy, barbed sutures have been associated with reduced suturing time, less intraoperative bleeding, and

shorter overall operative duration [9]. These findings underscore the clinical utility of barbed sutures as an effective alternative to conventional materials in minimally invasive gynecologic surgery.

From a surgical ergonomics standpoint, barbed sutures also help overcome the steep learning curve associated with laparoscopic suturing. The simplicity of knotless continuous closure allows less experienced surgeons to perform complex procedures with increased confidence and efficiency. This has been particularly beneficial in teaching institutions and training programs where laparoscopic suturing is a critical skill [10]. The use of barbed sutures enables trainees to achieve acceptable closure quality with fewer errors and in less time compared to traditional knot-tying techniques. In addition to efficiency, the safety profile of barbed sutures has been a key focus of research. Most studies have found complication rates to be equivalent to, or lower than, those seen with conventional sutures. Vaginal cuff dehiscence, bleeding, and infection rates are similar, and many authors report improved healing and reduced granulation tissue formation at the vaginal cuff site [11]. However, isolated complications have been reported in the literature. The most concerning among these are rare cases of small bowel obstruction or volvulus due to entanglement of exposed barbed ends with adjacent tissues. These events, though infrequent, emphasize the importance of meticulous surgical technique—specifically, cutting suture ends flush with tissue and burying barbs to prevent adhesion formation [12].

Biomechanically, barbed sutures provide stable wound closure without the need for external tension adjustment. Experimental and histological studies have demonstrated that the presence of barbs allows better distribution of tensile stress across the tissue, minimizing the risk of tearing or ischemia at the suture line [13]. Furthermore, absorbable barbed sutures degrade at predictable rates, maintaining strength during the critical early healing phase and subsequently resorbing, which reduces long-term foreign-body reaction. Non-absorbable varieties, though less commonly used in gynecology, have specific applications in procedures requiring permanent support. From an economic perspective, barbed sutures initially appear costlier per unit compared to conventional materials. However, when operative time savings, reduced anesthesia duration, and faster postoperative recovery are considered, they are often found to be cost-effective overall [14]. Hospitals and surgical centers benefit from increased operating room efficiency and reduced fatigue-related errors, contributing to both clinical and financial improvements. Particularly in high-volume centers, even a few minutes saved per case can translate into substantial resource optimization.

The implementation of barbed sutures in India is gaining momentum, especially in tertiary care hospitals and teaching institutions. However, the cost of the suture material, lack of widespread availability in public sector hospitals, and limited training exposure have slowed universal adoption. Indian studies comparing barbed and conventional sutures during laparoscopic hysterectomy have demonstrated results consistent with international findings—reduced suturing time, lower technical difficulty, and equivalent safety outcomes. The inclusion of barbed sutures in surgical training curricula and workshops could accelerate skill dissemination and promote broader clinical use [15]. The aim of this paper is to review and synthesize current evidence on the role of barbed sutures in gynecological laparoscopic surgery, focusing on their mechanism of action, clinical efficacy, safety profile, cost-effectiveness, and implementation feasibility, with special attention to their adoption and applicability in the Indian healthcare setting.

EVOLUTION OF BARBED SUTURES IN MINIMALLY INVASIVE GYNECOLOGIC SURGERY

The advancement of minimally invasive surgery has been one of the most remarkable developments in modern gynecology. It has transformed the approach to surgical management by minimizing tissue trauma, reducing postoperative pain, shortening hospital stays, and expediting patient recovery. However, despite these clear advantages, laparoscopic surgery presents unique technical challenges, particularly in intracorporeal suturing and knot tying. Traditional laparoscopic suturing requires precision, dexterity, and time, often prolonging operative duration and increasing surgeon fatigue. To overcome these limitations, the concept of barbed sutures was introduced, marking a significant milestone in the evolution of surgical techniques within gynecology [16].

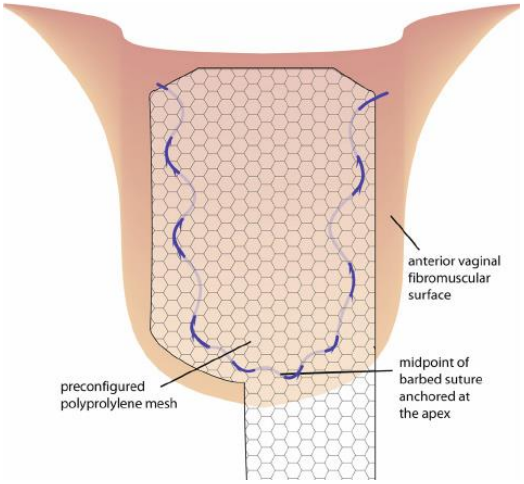


Figure 1: Barbed suture used to secure the mesh in place [16]

Barbed sutures are self-anchoring threads designed with microscopic barbs cut into the suture surface. These barbs allow tissue approximation without the need for knots, thereby eliminating one of the most time-consuming aspects of laparoscopic suturing. Each barb engages the tissue and resists backward movement, distributing tension evenly along the suture line. This unique feature simplifies closure and provides stable wound approximation, even in confined spaces where knot tying is difficult. The introduction of this innovation has allowed surgeons to perform complex laparoscopic procedures more efficiently, improving both technical precision and surgical outcomes [17]. Initially developed for use in cosmetic and plastic surgery, barbed sutures demonstrated their ability to provide even tissue tension and minimize scar formation. Over time, their use expanded into gastrointestinal, urologic, and gynecologic surgery. The adaptation to gynecologic laparoscopy was driven by the increasing prevalence of minimally invasive hysterectomy, myomectomy, and pelvic floor repair, where efficient suturing plays a critical role. Traditional monofilament or braided sutures required multiple knots to maintain tension and prevent slippage, whereas barbed sutures provided a continuous, secure closure without knotting. This transition represented a paradigm shift from time-intensive techniques toward more ergonomic and efficient surgical practice [18].

The design of barbed sutures has evolved over the past two decades to improve handling characteristics and tissue compatibility. Early barbed sutures were made from non-absorbable materials, limiting their use in delicate tissues such as the vaginal cuff or uterine wall. Modern absorbable materials—such as polyglyconate, polydioxanone, and glycolide-trimethylene carbonate copolymers—now provide predictable absorption rates and maintain tensile strength during the critical wound healing phase. These materials dissolve over time, reducing the risk of foreign-body reaction and eliminating the need for suture removal. The development of unidirectional and bidirectional configurations further enhanced versatility, allowing surgeons to choose a design suited to specific anatomical and procedural requirements [19]. Unidirectional barbed sutures have barbs oriented in one direction and typically include an anchoring loop at the terminal end to secure the starting point. The suture is passed through tissue in one continuous direction until the wound is closed. Bidirectional sutures, on the other hand, have barbs that face opposite directions from a central midpoint, allowing closure from the center toward both ends. This dual-directional design provides balanced tension across the wound and is particularly advantageous for long or deep closures. In gynecologic procedures such as laparoscopic myomectomy, where multilayer closure of the uterine wall is essential, bidirectional sutures have been shown to simplify the process and maintain uniform tissue approximation throughout the repair [20].

The evolution of barbed suture use in gynecology has been driven by clinical need and supported by technological advancement. As the field of minimally invasive surgery matured, surgeons recognized the limitations of conventional sutures in restricted pelvic spaces. The barbed suture's ability to anchor itself within tissue without slippage allowed surgeons to maintain constant traction without the assistance of an additional grasper or surgical assistant. This not only reduced operative time but also improved surgeon ergonomics. In high-volume surgical centers, such efficiency translates into shorter anesthesia exposure, decreased intraoperative blood loss, and improved operating room turnover, thereby enhancing hospital productivity [21]. Several pivotal studies over the last decade have established the safety and efficacy of barbed sutures in gynecological laparoscopy. Comparative analyses between barbed and conventional sutures consistently demonstrate reduced operative time and similar or lower complication rates. The most profound impact has been observed in total laparoscopic hysterectomy, where barbed sutures have nearly halved vaginal cuff closure time. Similarly, in laparoscopic myomectomy, barbed sutures have facilitated multilayer uterine repair, reduced intraoperative bleeding, and minimized the need for additional hemostatic interventions. These outcomes underscore how barbed sutures have contributed not only to improved surgical efficiency but also to standardizing the quality of minimally invasive gynecologic procedures [22].

An equally important milestone in the evolution of barbed sutures has been their impact on surgical education and skill acquisition. Laparoscopic suturing traditionally required a long learning curve, posing challenges for novice surgeons. The simplified mechanics of barbed sutures requiring no knot tying and providing self-locking tension—have helped trainees gain confidence and competence in suturing earlier in their careers. Consequently, surgical residency programs and hands-on laparoscopic training workshops have increasingly incorporated barbed suturing techniques into their curricula. This integration has democratized access to advanced laparoscopic skills, enabling more surgeons to perform complex procedures safely and efficiently [23].

MECHANISM OF ACTION AND TYPES OF BARBED SUTURES

The mechanism of action of barbed sutures represents a fundamental advancement in surgical closure technology. Unlike conventional smooth sutures, which rely on knots to secure tissue approximation, barbed sutures utilize microscopic projections or barbs along their surface to anchor directly into the tissue. These barbs are precisely angled and spaced to allow forward movement of the suture through tissue while resisting backward slippage. This one-way locking property ensures that tension is evenly distributed along the suture line, eliminating the need for knots and providing a more uniform wound closure. The innovation of barbed sutures lies in their ability to maintain stable tissue approximation with minimal manual adjustment, a feature that has greatly simplified laparoscopic suturing techniques [24]. The principle behind the barbed suture is biomechanical. Each barb acts as an independent anchoring point that engages the tissue at a specific angle, generally between 8° to 15°, depending on the suture design. When the suture is advanced, the barbs flatten temporarily, allowing forward passage. Once tension is released, they spring back into position, embedding themselves in the tissue matrix and preventing retrograde movement. This self-locking mechanism distributes the tensile load over multiple barbs, thereby reducing stress concentration at any single point. The result is a closure with consistent tension, improved strength, and less tissue distortion compared to knotted sutures [25].

In laparoscopic gynecological surgery, this mechanism offers particular advantages. The restricted movement of laparoscopic instruments often makes knot tying technically difficult and time-consuming. Barbed sutures remove this barrier by providing secure tissue fixation without the need for intracorporeal knotting. As a result, surgeons can achieve efficient, continuous suturing even in anatomically constrained spaces such as the vaginal cuff, uterine wall, or pelvic floor. The elimination of knots also

reduces the bulk of suture material within the operative field, minimizing foreign-body response and improving postoperative tissue healing [26].

Barbed sutures are broadly classified into two types based on the orientation of their barbs: unidirectional and bidirectional. Both designs follow the same mechanical principle but differ in their functional configuration and application in surgical practice.

Unidirectional Barbed Sutures

Unidirectional barbed sutures have barbs cut in a single direction along the length of the suture. The distal end typically contains an anchoring loop or tab that secures the starting point of the suture line. As the suture is drawn through the tissue, the barbs engage and lock progressively, maintaining even tension without requiring knots. This design is particularly advantageous for linear closures, such as the vaginal cuff after total laparoscopic hysterectomy, or for single-layer suturing of surgical defects. The suture is advanced in one direction until the wound edges are completely approximated, after which the free end is trimmed close to the tissue surface. In gynecologic laparoscopy, unidirectional barbed sutures have been widely adopted for vaginal cuff closure, where they significantly reduce suturing time and improve consistency in closure strength. Because each barb independently grips the tissue, the risk of suture loosening or "back-sliding" is eliminated, leading to enhanced security of the closure and reduced operator stress during surgery [27].

Bidirectional Barbed Sutures

Bidirectional barbed sutures have barbs oriented in opposite directions from a central, unbarbed midpoint. This midpoint often serves as the anchoring zone, allowing the surgeon to close tissue from the center outward in two directions simultaneously. This configuration offers balanced tension on both sides of the incision and is especially beneficial for long or deep closures, such as those encountered during laparoscopic myomectomy or multi-layer uterine repairs. By working from the midpoint toward both ends, the surgeon can achieve even distribution of tension and maintain hemostasis without the need for knots or assistance to hold the suture line taut. Bidirectional designs provide greater control over wound closure dynamics and minimize the risk of tissue inversion or uneven tension distribution. Their ability to maintain hemostasis with minimal manipulation also reduces the risk of intraoperative bleeding. This makes them particularly useful in procedures requiring precise layer-to-layer approximation, such as myometrial closure after enucleation of fibroids, where tissue integrity must be preserved for future fertility [28].

Material Composition and Absorption Characteristics

The functionality and biocompatibility of barbed sutures depend heavily on the material from which they are manufactured. Most modern barbed sutures used in gynecology are absorbable monofilaments, designed to maintain strength during the critical healing phase and then degrade naturally through hydrolysis. Common materials include polyglyconate, polydioxanone (PDO), and glycolide-trimethylene carbonate copolymer. The choice of material determines both the duration of tensile strength and the rate of absorption.

- Polyglyconate-based sutures typically retain approximately 60–70% of their tensile strength for 2–3 weeks and are fully absorbed in about 180 days.
- Polydioxanone (PDO) sutures maintain tensile strength longer—up to 6 weeks—and are absorbed over 6–8 months, making them suitable for tissues requiring prolonged support.
- Glycolide-trimethylene carbonate copolymer sutures provide intermediate properties, balancing strength and absorption rate.

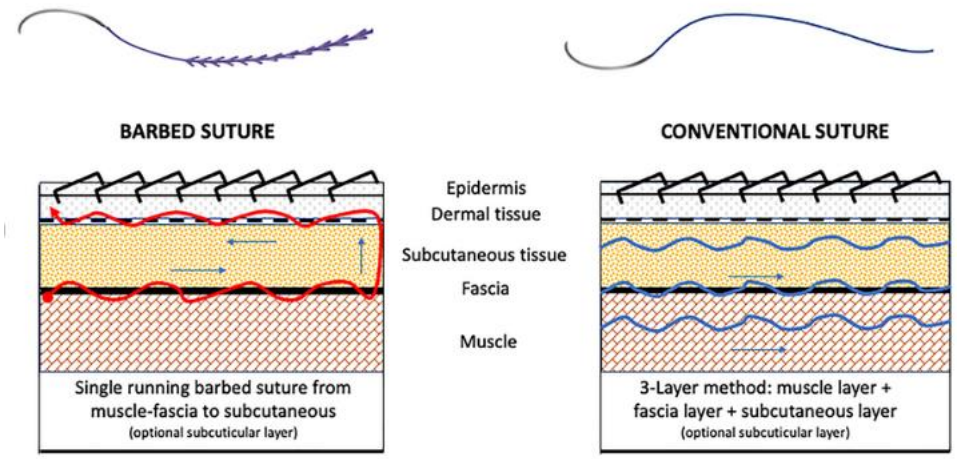
The absorbable nature of these materials ensures that they do not require removal and minimizes chronic inflammation or suture granuloma formation. Their smooth monofilament construction also reduces bacterial adherence compared to braided sutures, further decreasing infection risk [29].

Advantages of Knotless Closure

One of the key advantages of barbed sutures is the elimination of knot tying, which is traditionally considered a weak point in conventional suturing. Knots can create localized areas of high tension, leading to ischemia, tissue necrosis, or delayed wound healing. Additionally, knots add bulk to the closure site and may serve as a nidus for infection. By eliminating knots, barbed sutures provide a more uniform distribution of mechanical forces along the wound and reduce tissue strangulation. This property is particularly valuable in laparoscopic surgery, where secure knot tying is difficult and time-consuming due to limited instrument motion. The continuous, self-anchoring design of barbed sutures allows surgeons to maintain a steady flow during closure, reducing operative time by up to 30–40% in several procedures. The knotless system also enhances precision by preventing slippage during suturing, which improves tissue alignment and cosmetic results [30].

Comparative Outcomes: Barbed versus Conventional Sutures

The introduction of barbed sutures into gynecological laparoscopic surgery has prompted extensive comparison with traditional smooth sutures to evaluate their safety, efficiency, and overall clinical outcomes. Conventional sutures, such as polyglactin 910 and polydioxanone, have been widely used for decades and require secure knot tying to maintain tissue approximation. However, intracorporeal knot tying during laparoscopy is time-consuming, technically demanding, and prone to variability in tension, which can affect wound healing and operative efficiency. In contrast, barbed sutures offer a self-anchoring, knotless system that distributes tension evenly along the wound, potentially improving closure consistency and reducing surgical duration. Over the last decade, multiple clinical studies, randomized trials, and meta-analyses have compared the outcomes of barbed versus conventional sutures in various gynecological procedures, including total laparoscopic hysterectomy, myomectomy, and pelvic floor reconstruction [31].



Schematic depiction of the barbed versus conventional suture technique. A single barbed suture is used to secure the muscle-fascial layer together with the subcutaneous layer. In conventional wound closure, at least three layers (muscle, fascia and subcutaneous) need to be closed independently before subcuticular and epidermal suture is performed

Figure 2: Schematic depiction of the barbed versus conventional suture technique [31]

The most prominent advantage consistently reported in the literature is the significant reduction in suturing and overall operative time when barbed sutures are used. In laparoscopic hysterectomy, the vaginal cuff closure represents one of the most technically demanding steps. Studies have demonstrated that barbed sutures shorten the time required for this step by eliminating knot tying and maintaining constant tension during continuous suturing. This advantage translates into overall shorter surgical duration without compromising the security of the closure. On average, vaginal cuff suturing with barbed sutures takes 30–50% less time compared to conventional sutures, a finding that has been reproduced across multiple surgical settings [32]. Reduced suturing time not only enhances operative efficiency but also contributes to lower anesthesia exposure and improved patient safety. In addition to time efficiency, surgical ease and ergonomics have been reported as significant advantages of barbed sutures. Traditional sutures require one hand to maintain traction while the other performs intracorporeal knot tying, a task that can be fatiguing and difficult in limited laparoscopic spaces. The self-locking mechanism of barbed sutures eliminates this requirement, enabling single-operator closure without assistance. This simplification improves surgeon comfort and consistency, particularly among less experienced laparoscopic surgeons. It also contributes to the flattening of the learning curve, allowing trainees to acquire suturing skills more quickly. The ergonomic benefits of barbed sutures thus play an important role in improving surgical performance and standardizing outcomes across surgeons with different levels of experience [33].

When evaluating clinical outcomes, several key parameters have been compared: blood loss, postoperative pain, wound healing, infection rates, and vaginal cuff integrity. Across multiple studies, barbed sutures have demonstrated comparable or superior outcomes relative to conventional sutures. In laparoscopic hysterectomy, barbed sutures are associated with significantly lower intraoperative blood loss due to more uniform tissue compression along the suture line. Continuous locking of the tissue provides consistent hemostasis and reduces the need for additional coagulation. Patients in the barbed suture group also tend to experience less postoperative pain, which may be attributed to decreased tissue trauma and reduced manipulation during closure. Importantly, the incidence of major postoperative complications such as vaginal cuff dehiscence, infection, or bleeding has been reported to be similar between the two suture types, reinforcing the safety of barbed sutures [34]. In laparoscopic myomectomy, barbed sutures have been found to provide equally secure uterine closure with added benefits. The multilayer repair of the myometrial defect is typically a time-intensive task when using conventional sutures, as each layer requires knot tying and tension maintenance. Barbed sutures simplify this process by providing continuous tension throughout the closure, ensuring adequate hemostasis and alignment of tissue planes. Studies have shown reductions in both suturing and overall operative time, as well as decreased blood loss, without an increase in postoperative complications. Additionally, barbed sutures have demonstrated superior consistency in achieving watertight closure of the uterine cavity, which is important for minimizing postoperative adhesions and preserving uterine integrity in patients desiring future fertility [35].

Another area of comparative analysis has been postoperative healing and tissue response. The knotless design of barbed sutures eliminates bulky knots, which are often considered a focal point for inflammation or infection. The uniform distribution of tension minimizes tissue ischemia, enhancing wound healing. Histological studies have shown no significant difference in tissue inflammatory response between barbed and conventional sutures. In clinical settings, patients receiving barbed sutures have reported similar rates of wound healing, vaginal cuff granulation, and postoperative discomfort compared to those with conventional sutures. In fact, some studies have indicated a lower rate of vaginal cuff granulation tissue formation in barbed suture closures, potentially due to smoother tissue alignment and reduced suture material bulk [36]. The safety profile of barbed sutures has been a subject of particular focus in comparative studies. While their advantages in speed and efficiency are clear, rare complications have been reported, primarily involving small bowel obstruction or suture extrusion due to exposed barbs. These complications, however, are preventable with proper technique. When the suture tail is cut flush with the tissue and the barbs are buried adequately, the risk of adhesion or obstruction is minimal. No significant increase in postoperative infection, abscess formation, or dehiscence has been observed in large comparative series. These findings confirm that the safety of barbed

sutures is equivalent to conventional sutures when appropriate surgical care is taken [37].

Application of Barbed Sutures in Gynecological Procedures

The introduction of barbed sutures has revolutionized several aspects of gynecological laparoscopic surgery, particularly those requiring intricate tissue closure in confined anatomical spaces. The unique design and self-anchoring mechanism of barbed sutures make them particularly suitable for procedures where conventional knot-tying is technically challenging or time-consuming. Their utility has been extensively studied across a wide range of gynecologic laparoscopic interventions, including total laparoscopic hysterectomy, laparoscopic myomectomy, pelvic organ prolapse repair, and endometriosis-related surgeries. Each of these applications highlights the versatility, efficiency, and safety of barbed sutures within minimally invasive gynecology [38].

Total Laparoscopic Hysterectomy (TLH)

Total laparoscopic hysterectomy is one of the most common gynecologic procedures performed worldwide. The closure of the vaginal cuff following uterus removal represents a critical step that influences postoperative healing, infection risk, and sexual function. Conventional suturing requires intracorporeal knot tying, which is technically demanding and prolongs the duration of surgery. Barbed sutures simplify this step by eliminating knots and maintaining uniform tension along the suture line. Clinical evidence consistently demonstrates that the use of barbed sutures during vaginal cuff closure significantly reduces suturing time and overall operative time compared with conventional polyglactin or monofilament sutures [39]. The continuous self-locking design of barbed sutures maintains equal tension throughout the closure, ensuring better approximation of the vaginal mucosa and deeper fascial layers. This contributes to improved hemostasis and may reduce postoperative vaginal bleeding. Additionally, the smooth transition of the suture through tissue minimizes trauma and ensures even distribution of tension, thereby reducing localized ischemia. Studies have also reported a lower incidence of vaginal cuff granulation tissue and similar or decreased rates of vaginal cuff dehiscence with barbed sutures compared to traditional sutures. These findings indicate that barbed sutures provide not only technical advantages but also favorable clinical outcomes in TLH [40].

Laparoscopic Myomectomy

Laparoscopic myomectomy is a demanding procedure requiring meticulous suturing of the uterine wall to ensure hemostasis and restoration of myometrial integrity. Achieving adequate closure of the uterine defect is essential to prevent postoperative complications such as hematoma, adhesions, and uterine rupture in future pregnancies. Conventional suturing in laparoscopic myomectomy involves multiple layers of interrupted or continuous knots, which prolongs the procedure and increases surgeon fatigue. Barbed sutures have significantly improved this process by enabling continuous, knotless multilayer closure of the myometrial incision. The barbed suture's self-anchoring mechanism provides constant tension during suturing, allowing each bite to remain stable without the need for an assistant to maintain traction. This feature ensures better approximation of tissue layers and consistent compression of bleeding vessels. Clinical evaluations have shown that barbed sutures reduce suturing time, total operative duration, and intraoperative blood loss compared with conventional sutures, while maintaining equivalent postoperative outcomes. Moreover, the even distribution of pressure across the wound promotes secure closure and reduces the risk of cavity distortion or hematoma formation. These advantages are particularly beneficial when multiple or large fibroids are removed, as the need for prolonged suturing is reduced [41].

Pelvic Organ Prolapse Repair

Pelvic organ prolapse, including apical and vaginal vault prolapse, often requires laparoscopic or robotic-assisted reconstructive procedures such as sacrocolpopexy, uterosacral ligament suspension, or colposuspension. These surgeries demand durable and tension-controlled fixation of mesh or native tissue to achieve long-term anatomical support. The introduction of barbed sutures has simplified this aspect of pelvic floor repair. Their knotless property provides a secure, even fixation of graft materials to the vaginal wall or sacral promontory, reducing the need for constant tension adjustment during suturing. The continuous nature of barbed suturing helps ensure smooth, flat mesh placement without puckering or folding, which is essential to prevent mesh erosion or recurrence of prolapse. Reports have demonstrated a decrease in operative time and intraoperative blood loss with barbed sutures compared to conventional sutures, without compromising anatomical or functional outcomes. In addition, the self-retaining feature minimizes suture slippage, allowing surgeons to perform complex pelvic reconstructions more efficiently and with improved precision [42].

Laparoscopic Repair of Endometriosis and Adhesiolysis

Barbed sutures are increasingly being used in laparoscopic repair procedures following extensive endometriosis excision or adhesiolysis. After removal of deep infiltrating endometriotic lesions, tissue planes often require reconstruction or defect closure, which can be difficult in narrow pelvic cavities. The knotless, continuous suturing offered by barbed sutures allows for smooth approximation of delicate tissues, minimizing further trauma and maintaining hemostasis. The use of barbed sutures in these procedures has been shown to reduce closure time, improve accessibility in deep pelvic spaces, and enhance the overall safety of the operation by decreasing intraoperative bleeding and surgical manipulation. Furthermore, the even tension provided by barbed sutures minimizes the risk of postoperative adhesions, as it ensures precise reapproximation of tissue edges and limits tissue devascularization. The simplification of suturing in complex cases of endometriosis also reduces surgeon fatigue and allows for greater procedural consistency across different operators. These advantages have led to a growing preference for barbed sutures in advanced endometriosis management [43].

Other Emerging Applications in Gynecology

Beyond hysterectomy, myomectomy, and prolapse repair, barbed sutures have found application in other laparoscopic gynecologic procedures, such as ovarian cystectomy, metroplasty, and tubal reanastomosis. In ovarian cystectomy, barbed sutures

help achieve rapid hemostasis and secure closure of the ovarian capsule without excessive manipulation, thereby preserving ovarian tissue. In metroplasty and uterine reconstructive surgeries, the uniform tension and hemostatic properties of barbed sutures contribute to enhanced surgical precision and reduced operation time. Recent developments in robotic-assisted gynecologic surgery have also expanded the use of barbed sutures. Robotic platforms, which provide enhanced dexterity and precision, pair well with barbed sutures since their self-anchoring mechanism complements the robotic system's ability to execute controlled movements. The combination allows for faster suturing and reduced reliance on an assistant for tension maintenance. This synergy has been especially beneficial in robotic hysterectomy and sacrocolpopexy, where barbed sutures streamline workflow and improve reproducibility of results [44].

Safety Profile and Reported Complications

The safety profile of barbed sutures in gynecological laparoscopic surgery has been extensively evaluated over the past decade. Overall, evidence supports that barbed sutures are safe and effective for tissue closure, with a complication rate comparable to, and in some cases lower than, that of conventional sutures. Their self-anchoring design allows for secure, uniform tension distribution without knot tying, which not only simplifies the surgical process but also minimizes the risk of uneven closure or tissue ischemia. However, as with all surgical materials, potential complications have been documented, including rare but noteworthy events such as bowel obstruction, tissue tearing, and suture extrusion [45]. The most frequently discussed safety concern with barbed sutures is small bowel obstruction resulting from exposed or inadequately trimmed suture tails. When barbed ends are left unburied, they can adhere to adjacent structures such as bowel loops or mesentery, leading to mechanical obstruction or volvulus. Although rare, such events have been reported in both laparoscopic and robotic gynecologic surgeries. Proper surgical technique—specifically, ensuring the barbed ends are cut flush with tissue and buried within the wound—has been shown to prevent these complications effectively. In large clinical studies, the overall incidence of such adverse events remains extremely low, highlighting the importance of meticulous handling rather than material-related risk [46].

Another potential issue involves tissue tearing or over-tightening, particularly in friable or delicate tissues. The anchoring action of the barbs can, in theory, exert excessive localized tension if the suture is pulled too tightly. However, this complication is seldom encountered in practice. The even distribution of tensile forces along multiple barbs generally prevents focal stress concentration. Moreover, the absorbable nature of modern barbed sutures reduces the long-term risk of tissue irritation or chronic inflammation compared to non-absorbable materials [47]. Vaginal cuff complications have also been closely monitored in hysterectomy cases. The incidence of vaginal cuff dehiscence following closure with barbed sutures is comparable to or lower than with conventional sutures. The knotless, continuous design of barbed sutures facilitates better tissue approximation and stable closure, which may reduce mechanical stress on the healing cuff. Some studies have even reported fewer occurrences of postoperative cuff granulation and infection, likely due to reduced foreign-body reaction and the absence of bulky knots that can harbor bacteria [48]. Adhesion formation has been another concern because of the barbed surface design. Experimental and clinical studies, however, demonstrate no significant increase in adhesion rates with barbed sutures compared to smooth sutures. Adhesion development appears to be more closely related to surgical technique, tissue handling, and the extent of peritoneal trauma rather than to the suture type itself. The absorbable monofilament composition of commonly used barbed sutures further reduces adhesion risk by minimizing prolonged foreign-body presence within the peritoneal cavity [49].

Suture extrusion or palpable suture ends have occasionally been noted postoperatively, particularly when barbed tails are inadequately buried. These cases typically present as minor discomfort or vaginal spotting rather than serious complications. Proper trimming and careful closure technique eliminate this risk in nearly all cases. Importantly, the rate of infection or wound breakdown does not appear to increase when barbed sutures are used, reaffirming their safety in clean-contaminated surgical fields such as gynecologic laparoscopy [50]. When compared to conventional sutures, barbed sutures show no increase in infection, abscess formation, or wound dehiscence. The monofilament construction and even tension distribution minimize tissue trauma, which enhances healing. Postoperative outcomes, including pain scores and return to normal activity, are also equivalent or superior to those achieved with traditional sutures. Furthermore, most reported complications can be attributed to improper handling or inexperience rather than to intrinsic flaws in the suture design [51]. The safety record of barbed sutures in gynecological laparoscopic surgery is well established. Their benefits—knotless closure, consistent tension, and reduced operative time—outweigh the minimal risk of complications when used correctly. Adherence to recommended surgical techniques, such as cutting the suture ends flush, burying barbs within tissue, and maintaining moderate tension, effectively prevents most adverse events. Therefore, barbed sutures can be considered both safe and reliable for routine use in laparoscopic gynecology, provided proper procedural guidelines are followed. The available literature confirms that complications are rare, manageable, and largely preventable, making barbed sutures a dependable innovation in modern minimally invasive surgical practice [52].

Cost-Effectiveness and Operative Efficiency

The cost-effectiveness and operative efficiency of barbed sutures in gynecological laparoscopic surgery have been key factors supporting their increasing clinical adoption. Although the unit price of barbed sutures is higher than that of conventional smooth sutures, their ability to reduce suturing and overall operative time has been consistently demonstrated in multiple clinical evaluations. Time saved during surgery translates into shorter anesthesia duration, improved surgical throughput, and reduced operating room occupancy, all of which contribute to overall healthcare cost savings. Therefore, the economic assessment of barbed sutures must consider not only their material cost but also their broader impact on surgical efficiency and hospital resource utilization [53]. The major contributor to cost-effectiveness is the significant reduction in operative time achieved when barbed sutures are used. In laparoscopic gynecologic procedures such as total laparoscopic hysterectomy, myomectomy, and pelvic organ prolapse repair, closure steps—especially those involving intracorporeal knot tying—are often time-consuming. Barbed sutures eliminate this requirement by providing a continuous, self-anchoring closure mechanism. Studies consistently demonstrate that

barbed sutures reduce suturing time by 30–50% and total operative time by approximately 15–25%. This reduction is particularly valuable in high-volume surgical centers, where even small time savings per procedure can cumulatively improve overall operating room productivity and patient turnover [54].

Another factor contributing to cost-effectiveness is reduced surgeon fatigue and improved ergonomics. The knotless nature of barbed sutures minimizes the need for repeated instrument exchanges, tension maintenance, and complex wrist movements during laparoscopic suturing. This simplifies workflow, allowing surgeons to perform closures more efficiently and with less physical strain. The ergonomic advantage not only enhances surgeon performance but also reduces operative errors associated with fatigue and prolonged operating times. This, in turn, contributes to improved patient outcomes and lower postoperative complication rates, which have indirect cost-saving implications for healthcare systems [55]. From a hospital management perspective, reduced surgical time also results in better resource utilization. Shorter operations allow for more procedures to be performed within the same time frame, improving operating room scheduling efficiency. Furthermore, shorter anesthesia exposure contributes to faster patient recovery and earlier discharge, which lowers hospitalization costs. When these indirect benefits are factored in, barbed sutures are often more economical than conventional sutures despite their higher purchase price. In many analyses, the overall procedural cost using barbed sutures is found to be equivalent to or lower than that of conventional suturing methods when total time, anesthesia, and equipment use are accounted for [56]. The implementation of barbed sutures has also demonstrated economic benefits in training and workforce efficiency. The simplified technique shortens the learning curve for laparoscopic suturing, allowing less experienced surgeons to achieve proficiency more quickly. This has significant implications for surgical education and cost containment, as it reduces training time and the need for extensive supervision. As a result, the efficiency of operating teams improves, leading to further cost reductions at institutional levels [57].

While cost-effectiveness is generally favorable, certain factors influence its extent. These include the type of procedure, case complexity, and institutional workflow. In simple cases with short closure times, the difference in cost between barbed and conventional sutures may be minimal. However, in complex procedures such as myomectomy or reconstructive prolapse surgery, where extensive suturing is required, barbed sutures provide substantial savings by shortening operative duration and minimizing the need for additional surgical assistance. Hence, their economic advantage is most pronounced in procedures demanding prolonged or multilayer closures [58]. The cost-effectiveness of barbed sutures in gynecological laparoscopy extends beyond material price considerations. Their ability to significantly reduce suturing and operative times, improve surgeon efficiency, and enhance hospital workflow contributes to measurable economic and clinical benefits. When all indirect savings—such as reduced anesthesia time, quicker recovery, and higher operating room throughput—are taken into account, barbed sutures emerge as a financially and operationally efficient choice for modern minimally invasive gynecologic surgery. The accumulated evidence confirms that the integration of barbed sutures into laparoscopic practice aligns with both cost-containment goals and the broader objectives of surgical innovation and patient-centered care [59].

Table 1: Summary of Evidence and Research Gaps on Barbed Sutures in Gynecological Laparoscopic Surgery

Key Focus Area	Summary of Evidence / Findings	Research Gaps / Future Directions	References
Clinical Efficacy	Barbed sutures consistently reduce operative and suturing time across total laparoscopic hysterectomy, myomectomy, and pelvic organ prolapse repair; improve ergonomics and workflow efficiency.	Further evaluation needed in diverse surgical settings, including low-resource and high-volume centers.	[60]
Safety Profile	Comparable safety to conventional sutures; no significant increase in infection, adhesion formation, or vaginal cuff dehiscence.	More data on rare complications (bowel obstruction, extrusion) across larger populations.	[61]
Tissue Healing and Hemostasis	Self-anchoring design maintains even tension, promotes better hemostasis, and reduces localized ischemia; leads to fewer cases of granulation tissue and better wound healing.	Long-term histopathological studies on tissue response and adhesion formation required.	[62]
Cost-Effectiveness	Despite higher suture cost, overall procedure cost reduced through shorter operative time, anesthesia savings, and increased surgical throughput.	Need for multicentric cost-benefit analysis within the Indian healthcare framework.	[63]
Fertility and Uterine Integrity	Limited data suggest effective uterine wall healing after myomectomy with barbed sutures.	Insufficient long-term evidence on uterine scar strength and reproductive outcomes.	[64]
Training and Standardization	Simplifies laparoscopic suturing; reduces learning curve and improves reproducibility among surgeons.	Development of standardized training modules and operative protocols needed for uniform outcomes.	[65]

CONCLUSION

Barbed sutures have transformed the landscape of gynecological laparoscopic surgery by simplifying suturing, enhancing precision, and improving overall operative efficiency. Their knotless design allows uniform tension distribution and secure tissue approximation, significantly reducing operative time while maintaining excellent safety and healing outcomes. Across multiple gynecologic procedures, including hysterectomy, myomectomy, and prolapse repair, barbed sutures consistently demonstrate

comparable or superior clinical performance relative to conventional sutures. Although their upfront cost is higher, the overall procedural efficiency and shorter operative times translate into meaningful economic benefits. Reported complications remain rare and can be effectively avoided with correct surgical technique and adequate training. In the Indian context, increasing clinical experience and accessibility are driving wider adoption, though cost and training remain barriers in public healthcare systems. Future research should focus on long-term outcomes, fertility implications, and standardized national training protocols. Overall, barbed sutures represent a safe, cost-effective, and time-efficient advancement that enhances the quality and sustainability of gynecological laparoscopic surgery.

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