REVIEW

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Laparoscopic pectopexy for the treatment of pelvic organ prolapse (POP): how, why, when: a narrative review of the literature

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ABSTRACT

Background: Pelvic organ prolapse (POP) is a common gynaecological condition that can have an adverse impact on women's quality of life. Apical prolapse refers to the descending of the vaginal apex, uterus or cervix. Nowadays, laparoscopic sacropexy (LS) is the gold standard surgical method for the treatment of apical prolapse. However, defecation and urinary problems are often detected in patients who underwent LS. Laparoscopic pectopexy (LP) is a newer procedure for apical prolapse correction that uses the iliopectineal ligaments as fixation point for the surgical mesh.

Objectives: To review the current evidence of the effectiveness and safety of LP and compare outcomes with other commonly used techniques for apical prolapse treatment.

Methods: A literature search was carried out in MEDLINE, PubMed and ClinicalTrials.gov databases. The search was restricted to humans, female patients and currently used surgical procedures.

Main Outcome Measures: The current recommendations from leading global scientific associations and prevailing trends in accepted clinical protocols.

Results: LP was found to have shorter learning curve and operating times, better improvement in quality of life scores including sexual function and low complication rates.

Conclusions: LP appears to be a viable alternative to LS. However, further prospective, comparative studies are necessary to evaluate its long-term effectiveness and morbidity.

What is New? This review summarises the evidence and current role of LP in the treatment of POP.

Keywords: Apical prolapse, laparoscopic pectopexy, laparoscopic sacropexy, pelvic organ prolapse, pelvic organ prolapse treatment, pelvic organ prolapse surgery, hysteropexy, sacrospinous ligament fixation

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Introduction

Pelvic organ prolapse (POP) is a very common medical condition and is defined as the protrusion or herniation of the pelvic organs through the vaginal walls and pelvic floor, a condition that affects many women and their quality of life worldwide.[1,2] The prevalence of POP based on the existence of symptoms appears to be 3-6% and up to 50% when based on vaginal examination results, which refer only to the anatomical changes and not the symptoms or severity of the prolapse.[3] According to the compartment which is involved in POP, it can be divided into POP of the anterior, posterior or apical vaginal compartment, with the first one being the most common. However, it must be noticed that POP is caused due to a global pelvic floor dysfunction which affects all three compartments.[4,5]

There are several risk factors which weaken the pelvic floor connective tissue. Increased age is strongly associated with higher prevalence rates of pelvic floor disorders. The proportion of women who suffer from POP is significantly increasing from 6.3% in women aged 20-29 years to 31.6% in those aged 50-59 years and to 52.7% for women 80 and older.[6] Furthermore, parity and the mode of delivery seem to be very important predisposing factors to POP. Multiparous women show an increased likelihood of developing POP compared with nulliparous women.[7] Although parity is an established risk factor for POP, it does not influence the development of recurrence.[8] Regarding delivery mode, it has been shown that vaginal delivery and mostly the first and second delivery can lead to damage of the pelvic floor and POP.[9] On the other hand, caesarean section appears to be protective in the absence of prior vaginal delivery.[10] Increased risk for POP is also reported in women with instrumental delivery, especially with forceps delivery.[11] Other childbirth-related factors for POP are high infant weight, prolonged second stage of labour and maternal age less than 25 years at the first delivery.[12] Furthermore, patients who underwent hysterectomy show an increased risk of expressing pelvic floor prolapse, especially of the central compartment, compared with those with *in situ* uterus.[13] High body mass index (BMI), comorbidities which increase the intrabdominal pressure and menopause due to the low levels of systemic oestrogens and their effect on the collagen of pelvic floor predispose to POP.[14-18] Nevertheless, it is widely recognised that a genetic predisposition to POP does exist. A history of POP in the family leads to an 2.5-fold increased prevalence of POP in comparison with the general population (Figure 1).[19,20]

The pelvic organ prolapse quantification system (POP-Q) and Baden-Waker scoring system are used worldwide for the evaluation of the degree of POP, with the first being recommended by the leading societies.[21]

Treatment of Pelvic Organ Prolapse

Treatment of POP includes non-surgical and surgical options. The conservative management of POP consists of lifestyle modifications, application of topical oestrogen, pelvic floor physiotherapy and utilisation of mechanical devices (pessaries).[22-24] Surgical management of POP is mainly suggested to symptomatic women who decline non-surgical treatments or no improvement with these strategies. Important aspects which must be considered before deciding the optimal type and route of surgery are the following: the location and the severity of the defect, frequency and severity of symptoms, patient's health condition and comorbidities, patient's preference, desire to have children, coexisting incontinence and of course surgeon's expertise.[25] Patients with prolapse extending beyond the hymen appear to lack adequate support of the vaginal apex, making its surgical repair of great importance in the treatment of women with severe prolapse.[26,27] Apical support in general seems to be the foundation of pelvic floor support. Elliott et al.[28] demonstrated that as the severity of cystocele increases, the likelihood of apical prolapse also increases. Therefore, patients who underwent anterior and/or posterior vaginal wall repair require rarely a POP reoperation.

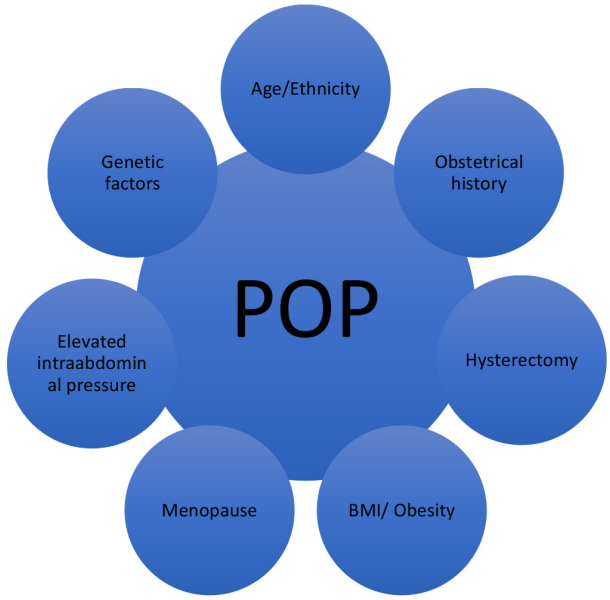

Figure 1. Risk factors for POP.

There are many different procedures for apical suspension which can be mainly divided into restorative and obliterative. Obliterative procedures such as colpocleisis are usually applied to women who are elderly, with many comorbidities and are no longer sexually active. The restorative procedures can be approached transvaginally and transabdominally. Sacrospinous ligament fixation (SSLF) is one of the most commonly performed native tissue transvaginal procedures for the treatment of apical prolapse. However, sacrocolpopexy is the gold standard procedure for correction of apical defects and can nowadays be performed using laparoscopic or even robotic-assisted techniques. In addition to sacrocolpopexy, pectopexy is another type of procedure which has been widely used in the treatment of apical prolapse.

Laparoscopic Pectopexy

Banerjee and Noé[29], presented, a new laparoscopic technique for prolapse surgery, called pectopexy. This new method was at first designed especially for obese patients and for situations where access to the sacrum, to the longitudinal ligament, or the lesser pelvis was limited. In this difficult surgical field setting, pectopexy seems to be an easier and more safe therapeutic option. In pectopexy, the bilateral mesh fixation points of the prolapsed structures are the lateral parts of the iliopectineal ligament.[29]

Technique

Ten patients with prolapse and obesity (BMI >30 kg/m^2) and two with past diverticulitis underwent pectopexy.[29] The method was indicated in patients with a POP-Q stage higher than I with a difficult surgical field. Preoperative bowel preparation was not undertaken. The steps of the procedure were:

• Step one: preparation of the patient

The preferred position for the procedure was the dorsal lithotomy position with the patient's arms placed by her side. A 16-F urinary catheter with continuous drainage system was used. All procedures were carried out under general anaesthesia.

• Step two: insertion of the endoscope

A 12-mm access post was used to introduce the laparoscope after performing an incision of the inferior margin of the umbilicus. Then follows the insufflation of the abdomen with CO_2 up to 12 mmHg intraabdominal pressure. Three further access ports were used during pectopexy; two 5 mm ones placed 2-4 cm medial and inferior to the anterior iliac spines and one 5 mm access port placed 2-3 cm superior to the symphysis.

• Step three: intraperitoneal survey and preparation of the iliopectineal ligaments

During this step, the round ligaments of the uterus were identified. These structures provided the anatomic landmark for a 4 cm^2 region, concluding the iliopectineal ligament and defined by the iliac vessels (cranial/ventral) and the obturator nerve (dorso-caudal). The iliopectineal ligaments were prepared by incising superficially the peritoneum next to the round ligament. A blunt dissection of the soft tissue of pelvic floor followed until the iliopectineal ligaments were visualised taking care of the iliac vessels during dissection, which was extended up to the area of the obturator nerve on both sides.

• Step four: peritoneal and vaginal apex/cervical stump preparation

Superficial extension of the peritoneal incisions on both sides by blunt dissection using a bipolar clamp and a blunt forceps was conducted. This extension followed an imaginative line between the physiological axis of the pectineal line and the cervical stump or the vaginal apex, remaining superficial during the dissection in order to avoid an accidental injury of deeper nerves and vessels. The insertion of the central part of the mesh depends on the existing structures. In the first presentation of the method, Banerjee and Noé[29] preferred a fixation on the cervical stump accompanying pectopexy with a laparoscopic supracervical hysterectomy (LASH). In patients with a past history of complete hysterectomy the mesh was fixed directly on the vaginal apex after dissecting the peritoneum. This step ends with the lower insertion area corresponding to the peritoneal incisions.

• Step five: mesh fixation

A polyvinylidene fluoride (PVDF) monofilament mesh (e.g. DynaMesh® PVDF, 3x15 cm) and a suture (non-absorbable suture, 2-0 with attached needle) is inserted via the 12 mm access port. The one small end of the mesh was fixed with two simple interrupted sutures to the left and right iliopectineal ligaments. A biomechanical analysis by Sauerwald et al.[30], has demonstrated that placement of a single suture was not inferior to a bilateral approach although there are no randomised trials comparing one versus two sutures. The needle was then removed and a new suture (in the case of vaginal apex fixation with polydioxanone suture PDS®, in the case of cervical stump

fixation with a non-absorbable suture, 2-0 with attached needle) was inserted. After elevating the cervical stump or vaginal apex to the expected tension free position it was fixed with 2-4 stiches (simple interrupted or continuously) to the central part of the mesh.

• Step six: closure of the peritoneum

The peritoneum was sutured with a 2-0 absorbable suture 35 cm long with attached needle. At the end of this step the needles were removed via the 12 mm access port. The urinary catheter was removed. Insertion of pelvic drainage was not considered obligatory.

Surgical Anatomy of Pectineal Ligaments During Pectopexy

An in-depth understanding of the iliopectineal ligament and the anatomic structure near this ligament is of key importance towards improving the outcomes and minimising the complications of pectopexy. The iliopectineal ligament, also known as the Cooper ligament, is located on the lateral part of the prevesical and paravaginal space, defining the posterior border of the femoral canal and has a great proximity with the external iliac vessels (Figure 2).[31] Furthermore, the pubic vein or the anastomosis between the inferior epigastric artery and obturator artery (corona mortis) is close to the ligament. The obturator area, consisting of obturator nerve, obturator vessels and many anastomoses, is found on the inferolateral side of pectineal ligament.

Familiarity with these landmarks is vital for surgeons conducting pectopexy in order to prevent complications. Pulatoğlu et al.[32] investigated the proximity of these important anatomical structures to the pectineal ligament in seven fresh female cadavers and demonstrated that the nearest anatomic structure on both sides was the external iliac vein. Corona mortis was shown to be also in close distance with pectineal ligament suturing point, making this anastomotic vessel an important anatomic landmark during accession to the retroperitoneum through the pelvic cavity.

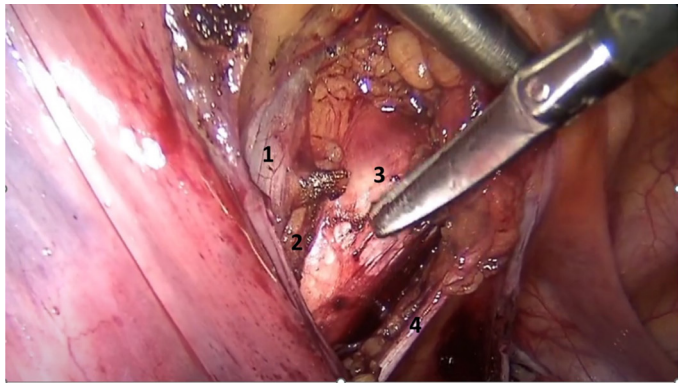

Figure 2. The anatomical landmarks for the exposure of the iliopectineal ligament. 1) External iliac vein, 2) psoas muscle, 3) iliopectineal ligament, 4) obliterated umbilical ligament.

In summary, an understanding of the anatomy and a careful surgical approach while suturing the mesh onto the pectineal ligament during pectopexy is of great importance to avoid inadvertent injury to the external iliac vein.[32]

Biomechanical Analysis of Laparoscopic Pectopexy

Due to the high potential benefit of this alternative surgical method of apical prolapse treatment, it is important to optimise the technique by testing its functional stability.[30] Lamers et al.[33] investigated, in an *in vitro* cadaver study, the use of a single suture/mesh iliopectineal ligament fixation as an alternative option to the most commonly used continuous suturing. This study showed that a single 'interrupted' suture, bearing an ultimate load of 35N, was not inferior to a continuous suture and it could be an adequate option for mesh fixation during pectopexy. Nevertheless, the usage of two single sutures may result in an improvement of the ligamentous fixation. However, suturing in general appears to have no important influence on the overall stability, as the surgical mesh remains the limiting factor.[33] After this in *in vitro* cadaver study Sauerwald et al.[30] proceeded to a dynamic *in vitro* analysis of pectopexy in order to evaluate the time needed until function stability was reached and showed that there was no need for fear of global fixation failure while remaining within the load envelope of below 25N.

Comparative Analysis of Laparoscopic Pectopexy and Laparoscopic Sacropexy

Complications

Sacropexy was first described by Lane[34] in 1962. This technique has been considered to be the gold standard for the treatment of apical prolapse. Sacropexy can be performed both transabdominally and laparoscopically. Abdominal sacropexy has been shown to be associated with long operating-, recovery times and high costs.[35] These disadvantages, in addition to its higher morbidity, have led to the development of new, minimally invasive, approaches (laparoscopic and robotic-assisted sacropexy) with better outcomes and shorter hospitalisation time. In the early 1990s, the first laparoscopic sacropexy (LS) was reported by Nezhat et al.[36]

There have been numerous studies which have tried to investigate the differences in perioperative complications and outcomes of pectopexy versus the gold standard method of sacropexy. In sacropexy the anchoring point for the mesh is the longitudinal ligament at the height of the second vertebra (S2), while many surgeons have modified this technique by using the promontory as fixing point in order to avoid the difficult surgical field of the ventral side of the sacrum. This modification leads to changing the direction of the abdominal wall at the vaginal axis.[37,38] Many studies have reported high *de novo* stress incontinence rates (SUI) after sacropexy,[39,40] while others, favouring the classical fixation point (S2 level), reported extremely lower rates of SUI. Classic anchor point usage is recommended in order to avoid traction at the urethral entrance of the bladder. *De novo* SUI and urgency rates seem to have no significant difference between patients who underwent sacropexy (classical fixation point) and those who underwent pectopexy according to Noé et al.[41] The same seems to apply for the axis deviation.[41] On the other hand, Yang et al.[42] showed in a prospective cohort study that urinary symptoms recurrence rate is higher after pectopexy.

The placement of the mesh between the sacrum and the vagina/cervix leads to space restriction of the pelvis which has been shown to cause defecation disorders, expressed mostly in form of constipation. This pelvic cavity narrowing may also lead to post-inflammatory changes of the sigmoid. Furthermore, during the preparation of the anterior sacral bone, there is a great risk of injuring the hypogastric nerves. On the other hand, in pectopexy there are no such disorders to be expected as the mesh follows natural structures (round and broad ligaments) and it is positioned in an organ-free area, without influencing the pelvic space or interfering with the ureter, the bowel or the autonomous nerves. Due to its fixation point, it has been proven to contribute in preserving the natural vaginal axis. Cosson et al.[43] demonstrated that pectineal ligament is statistically significantly stronger than the sacrospinous ligament and the arcus tendineus of the pelvic fascia.

Recurrence

Noé et al.[41] have shown, in a prospective, randomised, comparative clinical trial with a long follow-up (21.8 months for pectopexy and 19.5 months for sacropexy) that there are no *de novo* lateral defects in pectopexy, compared to sacropexy (12.5%). There was no significant difference in recurrence rates of apical prolapse, *de novo* central- or lateral- defect cystocele and *de novo* rectocele for both groups. Furthermore, regarding *de novo* defecation disorders, a great difference was demonstrated between the two groups (0% in the pectopexy vs 19.5% in the sacropexy group). The two methods revealed similar anatomic outcomes, intraoperative blood loss and hospitalisation duration, while operation time in pectopexy is proven to be shorter.

Quality of Life

Several studies have investigated the influence of pectopexy on the quality of women's life (QOL) compared with sacropexy. QOL has been evaluated by using the Pelvic Floor Distress Inventory (PFDI-20) and the Incontinence QOL (I-QOL) questionnaires pre- and post-operatively. Both techniques resulted in a significant improvement in QOL, with pectopexy having a greater impact on QOL than sacropexy.[44] Pectopexy also had also a statistically significant positive influence on sexual life of the patients.[45]

Learning Curve

The learning curve is also an important aspect of both techniques, being in the center of many researchers' interests. Chuang et al.[45] used cumulative analysis to evaluate the learning curve of laparoscopic pectopexy (LP) and compare it with LS. This study demonstrated that the learning curve of LP, according to the duration of the operation, had a turning point at the 12th case. The fewer cases needed for reaching this turning point in LP compared to LS may be a result of the anatomical differences in the surgical field. In LP the most important anatomical landmarks while dissecting the pectineal ligament, as already mentioned, are only the external iliac vessels, the obturator nerve and the corona mortis. However, the obturator nerve is not so close to the pectineal ligament and corona mortis can be easily cauterised if this seems important for the unobstructed mesh fixation. Only the external iliac vessels appear to have a great proximity to the dissection area, but are easily detectable due to their obvious colour and pulsation. LP is shown to have a steep learning curve, which in the case of LS appears to be really challenging for a novice.[46] Furthermore, LS seems to be an operation of great difficulty in obese patients due to the challenging retroperitoneal dissection and identification of the important anatomical structures. High BMI also causes problems in achieving an adequate surgical field while balancing sufficient abdominal pressure and ventilation.

On the contrary, LP's surgical field is not directly influenced in obese patients because it's limited in the anterior pelvis.[46,47]

Comparative Analysis of Laparoscopic Pectopexy and Vaginal Sacrospinous Ligament Fixation

SSLF was first described by Amreich in 1950. In 1968, Richter modified the technique. SSLF has been commonly used for the treatment of apical prolapse, due to its high cure rates.[48,49]

Cosson et al.[43] demonstrated that the sacrospinous ligament and the arcus tendineus of the pelvic fascia seem to be statistically weaker than the Cooper ligament. Brasoveanu et al.[50] compared SSLF and LP in relation to their treatment rates and complications. The cure rates of both procedures were similar high with also similar anatomical results. Astepe et al.[51] showed in their study that there was no statistically significant difference in apical regression rates for both techniques, although patients who underwent SSLF seem to have a greater risk of *de novo* cystocele compared to those who underwent LP. This result may be understood by the fact that in SSLF the vaginal axis appears to have a deviation to the right and posterior side of the pelvis and the body's centre of gravity is also anteriorly shifted, which leads to the placement of greater weight on the anterior compartment. On the other hand, no differences in the rates of *de novo* rectocele have been mentioned. The laparoscopic technique seemed to have a better impact on the post-operative sexual function. This may be due to the presence of vaginal scar after a vaginal procedure. According to Vitale et al.[52] the postoperative sexual life of women could be improved by performing a bilateral sacrospinous fixation.

Both techniques (SSLF and LP) seem to be safe and effective in the treatment of apical prolapse providing a high satisfactory rate. SSLF preserves its role in apical prolapse treatment due to the increasing importance of native tissue repair after the reclassification of surgical mesh for transvaginal usage in the treatment of POP by Food and Drug Administration. In general, LP is a very promising procedure in the field of POP therapy. However, more multicentre studies appear to be still needed in order to investigate the long-term outcomes of the procedure.[51,53]

Combined Laparoscopic Pectopexy with Native Tissue Repair

Nowadays, there seems to be a great deal of concern regarding the use of vaginal meshes, leading to an increased interest in native tissue repair. Although, native tissue repair has been thought to be an insufficient treatment for POP in the past, there are many publications which suggest that this kind of repair seems to be associated with better long-term outcomes, compared with meshes. In a prospective international multicentre pelvic floor study, Noé et al.[54] investigated the efficacy of sufficient apical support through LP or LS combined with the traditional native tissue repair. This study demonstrated that the procedure, including apical repair with LP with a PVDF mesh (PVDF PRP 3x15 Dynamesh), was associated with very high overall success (96.9%), accompanied by almost total reduction of pelvic pressure and pain, as long as no procedure-related major or minor adverse events. The patients also expressed a very high rate of satisfaction, estimated by pre-designed questionnaires. In a sub-analysis of the forementioned trial, the investigators compared laparoscopic versus vaginal native tissue repair combined with LP and demonstrated that both therapeutic options showed satisfactorily comparable results and concluded that both surgical alternatives could be utilised by surgeons, depended on their skills, expertise and preference. What's interesting is that the only difference reported between the two comparison arms is the presence of vaginal scar, which should be further evaluated in future randomised trials.[55]

Yu and Liu[56], conducted a study that enrolled 49 patients with POP stage III or IV who underwent a LP with combined vaginal native tissue repair and evaluated the efficacy of this procedure, regarding POP stage and symptom's severity regression. According to the investigators, the primary outcome of the study was the anatomical cure, defined as less than stage I, as scored by POP-Q system and secondary outcomes were symptom severity and quality of life estimates by the PFDI-20, and Pelvic Floor Impact Questionnaire (PFIQ-7) scores. At 3-month follow up period, POP stage showed statistically significant improvement at all point measurements and both questionaries elucidated also statistically significant improvement (the median value of the preoperative PFDI-20 score was 79.62 ± 35.69, and the post-operative score was 9.97 ± 10.73, $P<0.001$, and preoperative and postoperative median PFIQ-7 scores were 89.69 ± 60.05 and 11.7 ± 10.16, respectively, $P<0.001$).

Hysteropexy - Laparoscopic Pectopexy with Uterine Preservation

Hysterectomy has been a part of the procedures performed for the treatment of POP for many decades,

as it appears to have a low rate of risk. In the early 1960s, Heidenreich et al.[57] revised the indications for hysterectomy, so that only a 24.3% of the patients who underwent a surgical treatment for POP, had simultaneously also a hysterectomy. As it was shown, there was no important advantage in the long-term success in the POP procedures. In 1992, DeLancey[58] had already understood the important role of paracervical structures in the prevention of cystocele and rectocele. However, no disadvantages were reported when the uterus was conserved.

Experts should always considerate the patient's desire to preserve her uterus. Korbly et al.[59] had investigated this patient's preference for uterus preservation and showed that only 20% of them also desired a simultaneous hysterectomy. Jefferis et al.[60] evaluated the outcomes of 507 patients who underwent hysteropexy in a period of 10 years. An extremely low complication occurrence (1.8%), the absence of mesh erosion and the very high rate of patient's satisfaction with the POP outcome postoperatively are the most important aspects of this study.[61] Concomitant hysterectomy does not improve the outcome of POP procedures and appears to be rather disadvantageous, as longer operating times and higher rates of mesh exposure, especially in total hysterectomy, have been reported.[61] Thus, hysterectomy should only be performed if there is a clinical indication.

Noé et al.[61] first described the combination of LP with a hysterectomy. However, hysteropexy can also be performed in this technique. The typical mesh (DynaMesh PRP 3 × 15) used in LP can also be used in hysteropexy for the fixation of the uterus (anteriorly). The fixation can also be done with PVDF thread without peritonealisation as the thread and mesh are of the same material, which prevents the provocation of adhesions. The lateral arms of the mesh are passed through a small window in the broad ligament and then typically fixed laterally. On the other hand, an extended mesh (DynaMesh PRP 3 × 18) should be used when the uterus is larger (fixation dorsally for preventing retroflexion).

Conclusion

LP appears to be a safe technique with comparable anatomic success to sacropexy, lower complication and morbidity rates, and possibly better improvement in QOL, including sexual life. It provides a steady, tension-free replacement of the descended apical compartment, as the iliopectineal ligament is a more stable structure than the sacrospinous ligament, especially in patients with a difficult operating field and limited access to lesser pelvis and anterior longitudinal ligament due to obesity or adhesions. LP seem to have a shorter learning curve and operating times. It is important to note that there are also some other alternatives to pectopexy methods in the literature, such as the Mulayim and Sendag[62] technique and unilateral pectineal suspension, that also need to be evaluated in clinical trials' setting.[63] In conclusion, LP appears to be a very good alternative to the LS. However, further prospective comparative studies as well as long-term follow-up data are necessary towards evaluating the long-term safety and efficacy of the method.

Footnotes

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Authorship Contributions

Surgical and Medical Practices: A.P., A.D., Concept: A.P., A.D., F.G., A.P., Design: A.D., A.P., Data Collection or Processing: A.P., F.G., Analysis or Interpretation: A.P., A.D., Literature Search: A.P., F.G., Writing: A.P., A.D., A.P.

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