Chapter

Total Vaginal Hysterectomy for Unprolapsed Uterus

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Abstract

Vaginal hysterectomy was the first method to extract the uterus. Vaginal hysterectomy goes back a long way into the history of medicine. Although the first hysterectomy was carried out by Themison of Athens in the year 20 B.C., the idea of extracting the uterus through the vagina was first mentioned in 120 B.C. by Soranus of Ephesos, a distinguished obstetrician. *The first elective vaginal hysterectomy* was performed by J. Conrad Langenbeck in 1813. The patient was a 50-year-old multipara, who suffered from chronic pelvic pain attributed to a prolapsed uterus with a hard, bleeding tumor. The operation was carried out in challenging conditions, without anesthesia, proper instruments, or surgical assistants. Until the early 1950s, vaginal hysterectomy was the method of choice for removing the uterus. With the widespread introduction of general anesthesia and antibiotic therapy, the site of vaginal hysterectomy was taken over by abdominal hysterectomy. With the introduction of minimally invasive surgery in gynecology, vaginal hysterectomy has regained its place. Harry Reich performed the first total laparoscopic hysterectomy in 1989, being one of the most renowned vaginal surgeons, and he still claims at the beginning of the 21st century that ... *when the first choice of approach for hysterectomy is possible, is the vaginal route*. This chapter presents the relevant anatomy from the point of view of the vaginal surgeon and the standard technique used by the author in over 5,000 vaginal hysterectomies. All intraoperative drawings and photographs are original.

Keywords: pelvic anatomy, vaginal hysterectomy, surgical technique

1. Introduction

1.1 The uterus

The uterus is an organ with a particular anatomic situation localized with the uterine body intraperitoneally, the isthmus extra-peritoneally, and the cervix can be considered visible intravaginal organs. The uterine body is coated by the visceral peritoneum, which intimately adheres to its sides. In front, the visceral peritoneum reflects it on the bladder and in the back to the rectum. On the lateral side, the visceral uterine peritoneum detaches from the two sides of the uterus into two sheets that are joined to each other but are anatomically distinct and surgically separable, forming *broad ligaments*.

The uterus is maintained in anatomical position inside the pelvis by two systems: a *suspension and orientation system* for its intra-abdominal part and by a *supporting system* for the retroperitoneally part of the isthmus, cervix, and upper vagina. (Yabuky).

2. The suspension and orientation system of the uterus

The suspension and orientation system of the uterus consists of *broad ligaments, round ligaments*, *infundibulopelvic ligaments,* and the *parietal peritoneum*.

Round ligaments play a minor supporting role, the main one being the orientation of the uterus. Round ligaments are active elements that contain an essential contingent of smooth muscle fibers. The anatomic origin is located cranially at the level of the uterine fundus, under the insertion of uterine tubes. Each round ligament engages through the homologous inguinal canal, to be inserted into the thickness of the labia majora.

Broad ligaments result in the lateral reflection of the pelvic parietal peritoneum on each side to the two sides of the uterus. After the peritoneal sheets detach from the pelvic walls, they re-join and form two peritoneal folds cranially suspended by the round ligaments. Frontally, broad ligaments are trapezoidal, with a caudally located base. The orientation of the plan containing the broad ligaments depends on the position of the uterus (ante- or retroversion).

The *pelvic parietal peritoneum* is an essential support for the uterine body, which becomes visible, particularly in vaginal hysterectomy. Access to the superior connective-vascular pedicle (round ligament, utero-ovarian ligament, and superior uterine pedicle) is profoundly difficult if the peritoneum of the broad ligaments is not sectioned as far as possible so that it loses contact with the pelvic parietal and visceral peritoneum. The tensile strength of the peritoneum and the perforation strength of broad ligaments are outstanding. Even if the uterus is disconnected from its primary support, it is held in the pelvis by the peritoneal connections.

Infundibulopelvic ligaments indirectly suspend the uterus via the ovary and utero-ovarian ligaments. Infundibulo pelvic ligaments have a mesenteric structure with a vascular and nerve fiber content that generally does not exert a suspension tension on the uterus. In pathological situations that cause their shortening and retraction generates resistance to the tendency to caudal traction of the uterus.

3. The supporting system of the uterus

The supporting system reunites all the elements that work together to maintain the uterus in its intrapelvic anatomical position and resist the descending tendency generated by the weight of the intestines at rest or under effort.

Biomechanical studies show that the support of the uterus and the upper part of the vagina are provided by the *four-wire system*, where the *cardinal ligaments* anchor the pericervical ring vertically and *uterosacral ligaments* dorsally.

The supporting system anchors the uterus and vagina to the pelvic brim: the *pubocervical ligaments* anteriorly and the *transverse cervical ligament (cardinal ligaments)* cranially and *uterosacral ligament* posteriorly. All these ligaments converge to the pericervical ring. The pericervical ring of the uterus is the insertion area for the supporting structures, and it forms a virtual delimitation between the intraperitoneal and extraperitoneal parts of the uterus. Pericervical ring also offers support for a vaginal vault.

Transverse cervical ligaments (cardinal ligaments) are oriented vertically. They are formed by two segments: a fibroconnective structure that joins the uterosacral ligaments close to the pericervical ring and a mesenteric structure containing blood, lymphatic vessels, and nerves as a distal segment. In the cardinal ligament, the deep uterine vein delimits a cranial segment containing vessels and a caudal one containing nerves (**Figure 1**).

Cardinal ligaments provide reliable support for the vascular and lymphatic axes that converge or emerge in the uterus. Their fibers dissipate in the

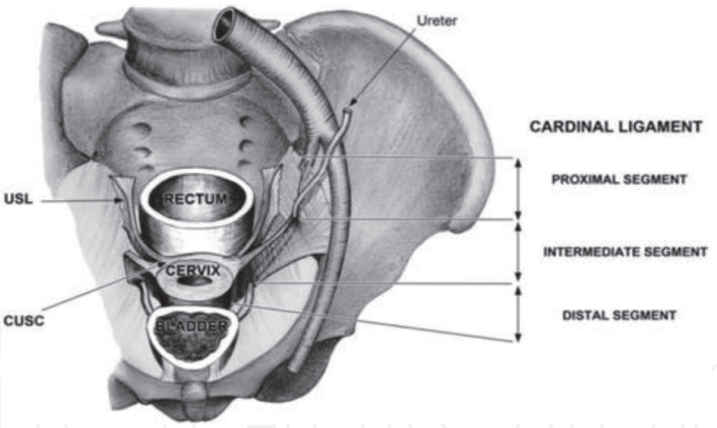

Figure 1.
The cardinal ligament consists of three segments: Proximal and intermediate segments containing the mesenteric elements and the terminal ureter and a common segment with the homologous uterosacral ligament, which is the main support element of the pericervical ring.

pubocervicovesical fascia towards the cervix uteri and superior vagina at the level of the cervical ring, and the fascial and areolar structures towards the pelvic walls, structures that cover the pelvic diaphragm, the obturator pelvic fascia, and the tendinous arch of the pelvis (arcus taendineus fascia pelvis-ATFP). (Campbell).

The sacrouterine ligaments have their origin in the posterior part of the pericervical ring and the posterior-lateral portion of the vaginal fornices, structures that continue the cardinal ligaments. Posteriorly, the uterosacral ligaments insert into the presacral fascia at the level of the sacroiliac joints S2-S4. Utero-sacral ligaments run in the supra levator part of the vagina, forming with the infra levator segment at an angle of 130°. (Chen) (**Figure 2**).

Like the cardinal ligaments, the uterosacral ligaments defined three segments: a proximal segment that merges with the cardinal ligament, an intermediate segment that represents the structure that can be used as a suspension element, and a distal segment that merges with the presacral fascia. Sacrouterine ligaments contain nervous

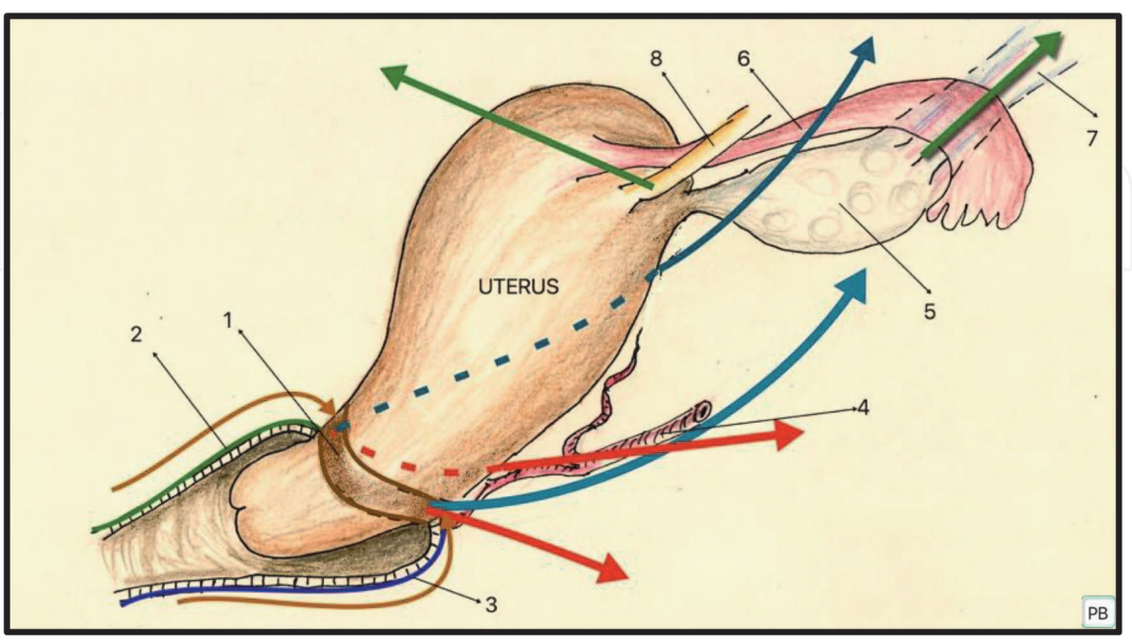

Figure 2.
Orienting-supporting *system of the uterus* supporting system*: 1 = pericervical ring. Spatial orientation of the cardinal (blue arrow) and uterosacral ligaments (red arrow): 4 = uterine artery 5 = ovary, 6 = fallopian tube, 2 = pubocervical fascia, 3 = rectovaginal septum.* Orienting system *(green arrow): 8 = round ligament, 7 = infundibulo-pelvic ligament.*

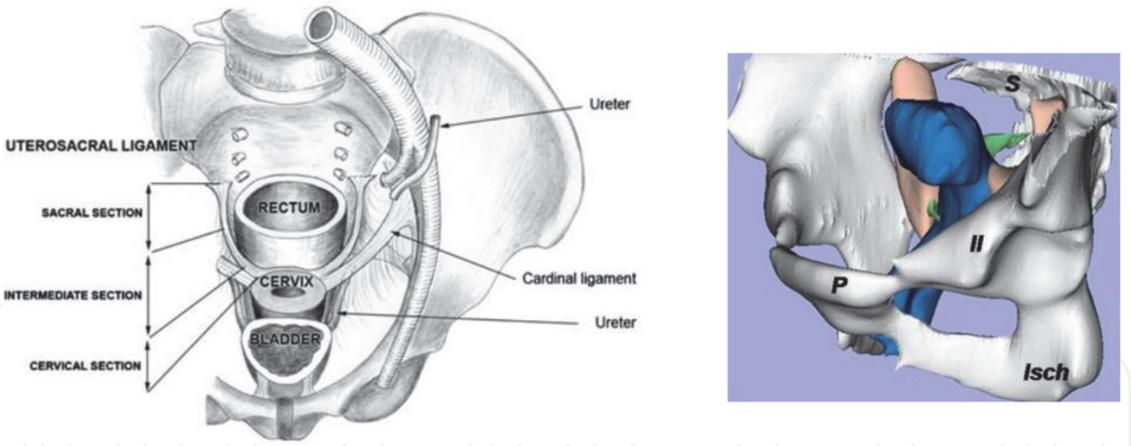

Figure 3.
Definition of three segments of uterosacral ligaments. MRI reconstruction -spatial disposition of posteriorly oriented uterosacral ligaments (in green) and cardinal ligaments oriented vertically (in beige yellow), P = pubis arch, Isch = ischion, Il = ilion, S = sacrum.

fibers from the superior hypogastric plexus. Those innervating the urinary bladder are of particular importance in nerve-sparing surgery for cervical cancer (**Figure 3**).

4. The connective-vascular pedicles of the uterus

Vaginal hysterectomy consists of disconnection from below of all elements that maintain the uterus in anatomical position.

From the vaginal point of view, the uterus suspension-supporting system consists of three main connective-vascular pedicles; lower, middle, and upper pedicles.

like abdominal hysterectomy, where the lower pedicle is most difficult to approach, vaginal hysterectomy solves this operative step as the first maneuver of the disconnection of the uterus.

a. Lower Pedicle

On the caudal side, the cervix and uterine isthmus provide insertion for two fibrous-connective structures: anteriorly, *the vesicouterine ligaments* (bladder pillars), and posteriorly, the *uterosacral ligaments*. In the sagittal plane, the two ligaments are located approximately at the same level. When the uterus is not prolapsed, it can be treated as a single pedicle with an anterior division and a posterior one, the superior vagina remaining anchored even after its disconnection. The natural connections of these pedicles with the superior vagina must be preserved regardless of the hysterectomy method because this is the most efficient method to prevent post-hysterectomy vaginal vault prolapse.

The vesicouterine ligaments join the bladder walls with the anterolateral edges of the cervix. During the vaginal hysterectomy, the bladder pillars can be visualized by cranial retraction of the bladder with a Breisky-Navratil retractor after the *cervicovesical ligament* has been sectioned and the bladder has been detached from the cervix, opening the vesicouterine space.

The juxta vesical ureter, surrounded by fatty tissue, is located in the thickness of each pillar. The *vesicouterine* ligaments have a medial and a lateral part. To be able to release the ureter, the two parts must be sectioned at the level of their cervical insertion. The vesicouterine ligaments contain the superior vascular-nervous pedicles of the urinary bladder.

The *uterosacral ligaments* are the most robust structures supporting the uterus. The confluence of the uterosacral ligaments on the uterus forms a small depression known as the *torus uterinus,* always situated at the level of uterine isthmus regardless of the length of the cervix. Torus uterinus marks the area where the visceral uterine peritoneum conjoins with the rectum at the level of the pouch of Douglas. Before the opening of the rectouterine peritoneal fold, we will see a variable amount of fatty tissue, which forms the *yellow line* that announces to the surgeon the dissection layer and the imminent appearance of the underlying rectum. *The fat belongs to the rectum and not to the vaginal wall.*

The uterosacral ligaments on the lateral sides, towards their sacral insertion, are flanked by the hypogastric nerve, which, along with the pelvic nerves, will be part of the inferior hypogastric plexus. For this reason, sectioning the uterosacral ligaments in radical vaginal hysterectomy as close as possible to the sacral insertion bears the risk of urinary disorders occurring through bladder denervation. Laterally and caudally, the uterosacral ligaments continue with the superior paracolpium, and a division of them achieves the upper level of suspension of the vagina (Delancey).

Campbell identified three distinct histologic regions of the uterosacral ligament. At the cervical attachment, the ligament was made up of carefully packed bundles of smooth muscle, abundant medium-sized and small blood vessels, and small nerve bundles. The intermediate third of the ligament was composed of predominantly connective tissue and only a few scattered smooth muscle fibers, nerve elements, and blood vessels. The sacral third was almost entirely composed of loose strands of connective tissue and intermingled fat, few vessels, nerves, and lymphatics.

The mechanical strength of the uterosacral ligaments is remarkable. The cervical and intermediate portions of the uterosacral ligament supported more than 17 kg of weight before failure. (Nichols) (**Figure 4**).

b. Middle Pedicle

The middle connective-vascular pedicle consists of the cardinal ligaments and a variable contingent of fibers that are part of the uterosacral ligaments. Vaginally, each cardinal ligament has a fibrous-connective segment consisting of inferior fibers of the uterosacral ligament and a cranially located vascular segment, which consists of the superior bundle of the cardinal ligament and uterine vascular pedicle. The two segments can be surgically treated as a single pedicle or as separate depending on the thickness and insertion area of the uterine edge (Shiff).

On its cranial aspect, the cardinal ligament is crossed by the ureter under the crossing-point with the uterine artery. The distance between the lateral side of the cervix and isthmus and the wall of the pelvis is approximately 4–5 cm. The ureter crosses the cardinal ligament halfway, approximately 2–2.5 cm from the cervix. The ureteral risk is reduced in vaginal hysterectomy because, once the lower pedicle is cut, the cardinal ligament is elongated, removing the ureter from the operator's field. (Kovak) (**Figure 5**).

c. Upper Pedicle

The upper pedicle consists of *round ligaments*, *uterine tubes*, and *utero-ovarian ligaments*. The tubes and ovaries are indirectly supported by the *infundibulopelvic ligament*, which offers support to the pelvic wall. The upper

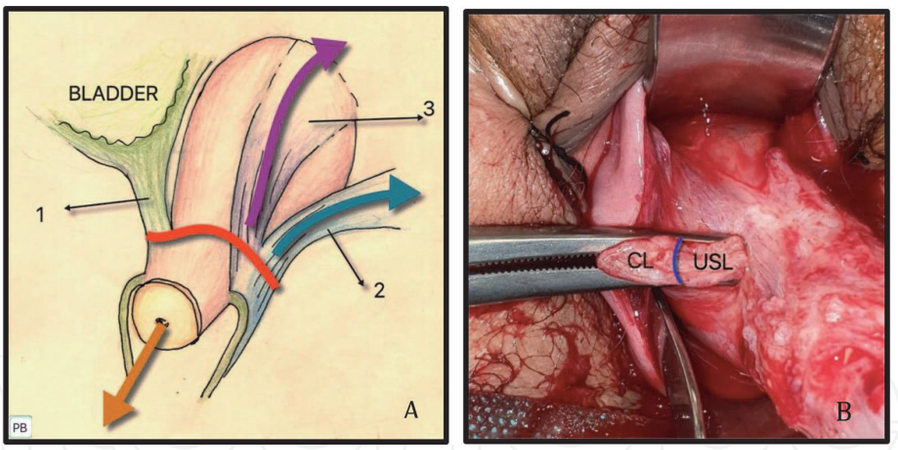

Figure 4.
A. Lower connective-vascular pedicle (cardinal uterosacral complex -CUSC the first pedicle in vaginal hysterectomy). 1 = cervicovesical ligament, 2 = uterosacral ligaments, 3 = cardinal ligament. Redline mark where the same pedicle might secure bladder pillar, uterosacral ligaments, and cardinal ligaments. B. Lower connective pedicle at vaginal hysterectomy with distinct uterosacral ligament (USL) and cardinal ligament (CL) in the same pedicle.

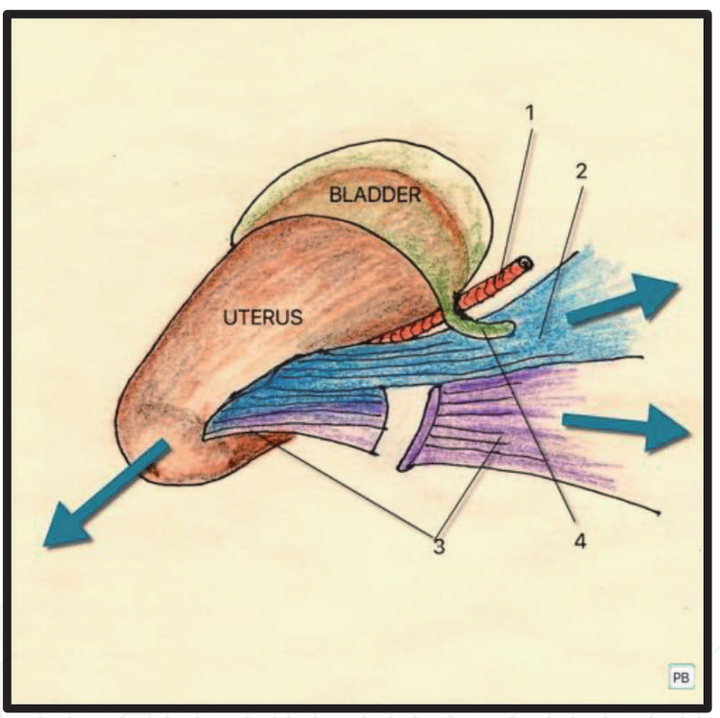

Figure 5.
Middle pedicle. 1 = uterine artery, 2 = cardinal ligament, 3 = inferior pedicle cut, 4 = parametrial ureter. Once cut, the uterosacral ligament's traction on the cervix makes the cardinal ligament elongated and removes the ureter from the surgical field.

pedicle, which does not have a significant supporting role, maintains the uterus in anatomical position and stands against the force that tends to push it through the pelvic opening. During the vaginal hysterectomy, the upper pedicle is the most problematic one in terms of strategy regarding the extraction of the uterus from the pelvic cavity.

The primary vascular element of the upper pedicle is the *Tubo ovarian arch*, contained in the thickness of the *mesosalpinx*. The infundibulopelvic pedicle becomes the main vascular element when an adnexectomy is an option. The resistance of the superior pedicle to traction is due to the intrinsic elasticity of the connective elements in the ligament structures and the resistance of the

leaf of broad ligaments. Chronic inflammatory processes may cause the adhesion of ovaries to the posterior leaf of broad ligament or parietal peritoneum of fossa ovaries, which leads to the fixation of the adnexa to the walls of the pelvis. Vaginal adnexectomy is difficult in these cases.

5. Uterine blood supply

The uterus is a highly vascular organ with two arterial and two venous systems intertwined.

The primary arterial system is composed of the *uterine* and *vaginal arteries*, which originate from the hypogastric artery. *The ovarian arteries*, which originate from the aorta on each side and the *funicular artery*, from the external iliac artery, form the second arterial system. The two systems communicate through *utero-ovarian anastomotic* vessels.

Between the *uterine artery* and the *vaginal artery*, there are many anastomotic branches, and simple occlusion of the uterine and ovarian artery is not enough to stop blood flow in the uterine body.

The venous system is composed of the *uterine veins* (superficial and deep), which drain the blood in the *hypogastric veins* on each side, and *the ovarian veins* which drain on the right side into the vena cava inferior and on the left side into the left renal vein.

5.1 Arterial blood supply

The arterial blood supply is provided by three different sources: the *uterine artery*, the *utero-ovarian artery,* and the *vaginal arteries.*

a. *The uterine artery* is the primary blood supply source for a uterus in a reasonable condition. During pregnancy, the utero-ovarian artery becomes the second significant source, doubling its diameter. In non-pregnant women, the diameter of the left uterine artery is 1.6 mm, and for the right artery, it is 1.4 mm. The diameter of the uterine artery may vary for large uteri, up to 5 mm.

The origin of the uterine artery can be encountered most often in a common trunk with the umbilical artery, which arises as to the terminal branch from the previous division of the hypogastric artery. However, there is also the anatomic variant of direct origin from the hypogastric artery. From its origin, the uterine artery follows a 3–5 cm intrapelvic trajectory, approaching the cervix at a constant distance of approximately 2–2.5 cm without coming into contact.

The level where the uterine artery enters the uterine body, regardless of the shape or size of the uterus, corresponds to the level of the internal cervical orifice (**Figure 6**).

In its trajectory, the uterine artery has three distinct segments: *a parietal segment*, a *transversal one*, and a *lateral-uterine* one.

In the *parietal segment*, the uterine artery is in contact with the pelvic wall and is located on the side of the ureter, which crosses it in places, underneath and medially. In this segment, the artery is rectilinear and is accompanied by the uterine veins, which can be injured during maneuvers to identify its original ligation.

The *transversal segment* or (intra-parametrial segment) of the uterine artery is approximately 3 cm long. In this segment, the artery has the most important relation to the ureter, which is located outside of it. There is a cleavage space between

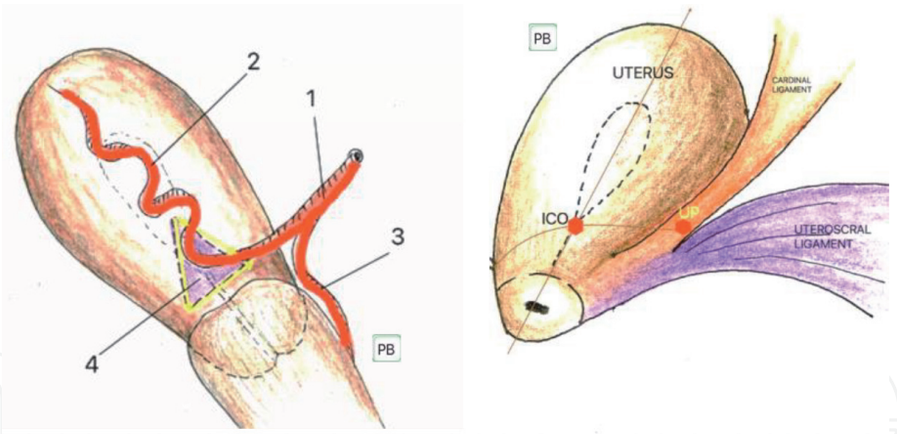

Figure 6.
The point where the uterine artery reaches the uterus is constant at the level of the internal cervical orifice. ICO = internal cervical orifice, UP = uterine point. 1 = main uterine artery, 2 = ascending branch of the uterine artery, three = descending branches of the uterine artery. 4 = Beliaeva triangle.

the ureter and the artery. At this level, the uterine artery emits a nutritional branch for the corresponding ureteral segment. During maneuvers to release the uterus in case of radical hysterectomy, this branch "holds" the ureter in the surgeon's attempt to move it caudally. The ligation or coagulation of this vessel is necessary because subserosa ureteral hematoma may appear, which can compromise the viability of the ureter on this segment.

The uterine artery reaches the uterus in a triangular zone near the isthmus (Beliaeva triangle) situated at the base of the broad ligaments at three o clock for the right side and nine o clock for the left side (from the vaginal point of view). The descending uterine artery supplies the isthmus, cervix, and upper vagina. The ascending uterine artery supplies the body of the uterus. The ascending uterine artery is tortuous and gives rise to 10–12 arcuate arteries that course between the outer and middle thirds of the myometrium.

The crossing point of the uterine artery with the ureter is located sideways, approximately 20 mm away from the cervix and 10–12 mm cranially from the lateral vaginal fornix. At this level, there are two venous currents, one in front and another in the back of the ureter, which is predisposed to bleed during maneuvers to unroof the parametrial ureter (**Figure 7**).

The *lateral-uterine segment* of the uterine artery starts from the crossing point and emits an *ascending branch* that borders the whole uterine edge up to the horn, as well as a *descending branch*, from which the cervicovaginal (superior vaginal branch) arteries arise. The ascending branch is tortuous and intimately adhered to the uterine edge-front-side and is accompanied by the uterine veins.

Between the right and left sides of the uterine body, the arcuate arteries are anastomosed by collateral and small, direct branches. At the uterine fundus, approximately 15 mm away from the insertion of the tube, the ascending uterine artery divides into two branches: *the fundic artery*, which supplies the fundus of the uterus on each side, and the *internal tubal artery*, which is routed under the utero-ovarian ligament, into the mesosalpinx.

a. *The ovarian artery* included in the *infundibulopelvic* ligament, after crossing the external iliac artery and vein, emits two branches, a tubal and an ovarian one, which is anastomosed between them by short arteries. The uterine artery provides the primary blood flow, but in particular conditions, such as after uterine embolization or in pregnancy, more than 80% of blood flow can be provided by the ovarian artery.

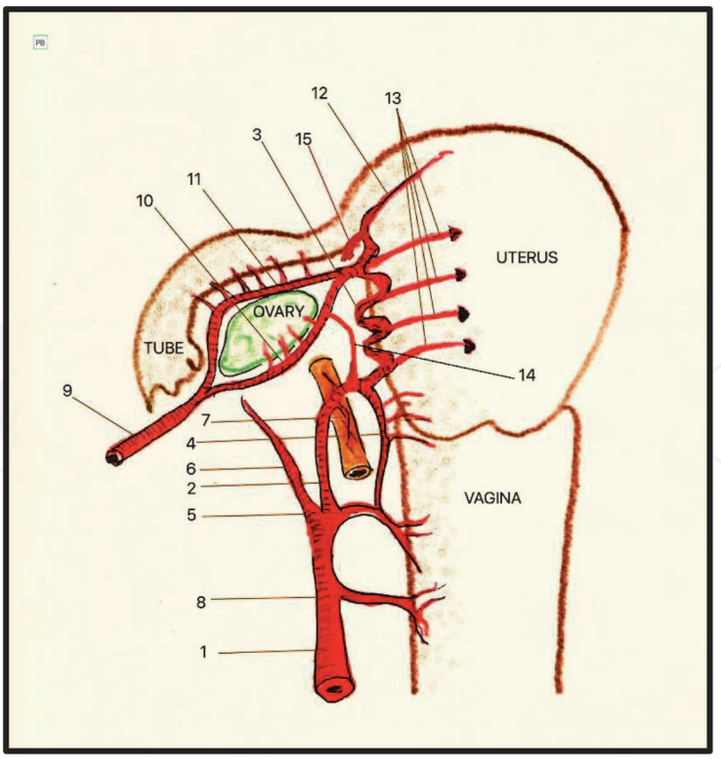

Figure 7.
Arterial supply of uterus and vagina. 1 = arterial trunk of hypogastric artery, 2 = Main trunk of the uterine artery, 3 = the ascending branch of the uterine artery, 4 = the descending branch of uterine artery (superior vaginal artery), five = inferior vaginal artery, 6 = umbilical vesical artery, 7 = ureteral branches from the uterine artery, 8 = middle hemorrhoidal artery, nine = ovarian artery, ten = ovarian arch between ovarian and uterine branches, 11 = tubal arch between ovarian and uterine branches, 12 = fundal branch of the uterine artery, 13 = arcuate arteries from right side, 14 = anastomotic branch between the uterine artery and ovarian arch, 15 = funicular branch (round ligament) artery.

b. *Vaginal arteries*, in more than 90% of cases, have their origin in the descending branch of the uterine artery, but they may also come directly from the hypogastric artery. Arterial blood flow of the vagina has three primary sources:

- A branch from the uterine artery.
- The vaginal artery.
- The middle hemorrhoidal artery.

The source of the uterine artery is composed of vesicovaginal and cervicovaginal branches and ensures the blood flow for the upper part of the vagina. The correct vaginal artery (lower vaginal artery or large vaginal artery) originates from the hypogastric artery. The artery from both sides anastomose in the midline and forms the longitudinal artery from the cervix to the vulva named the *azygos artery of the vagina*. The hemorrhoidal artery emits some branches for the posterior side of the vagina.

a. The *funicular artery* (artery of the round ligament) is an auxiliary blood supply source that can become a significant source in case of bilateral ligation or embolization of the hypogastric artery.

b. The *anastomotic branch* between the ovarian and ascending branches of the uterine artery can be found in broad ligaments.

The bilateral ligature of the anterior trunk of hypogastric arteries cannot stop the blood flow into the pelvis. Two primary sources ensure arterial collateral circulation of the pelvis:

Branches of the hypogastric artery

- Iliolumbar arteries
- Lateral sacral arteries
- Middle hemorrhoidal arteries

Systemic circulation

- Lumbar arteries
- Middle sacral artery
- Superior hemorrhoidal arteries

5.2 Venous blood supply

Venous blood from the uterine body comes from the veins located in the thickness of the myometrium, which is venous sinuses with reduced endothelial cover. Venous blood drains into two collecting veins on each side of the uterus, with anastomoses in between. The collateral venous blood supply is significant concerning the alternative route for blood flow in case of significant obstruction of main venous branches.

Collateral venous circulation of the uterus can be done in three main ways:

- The *veins of the round ligament* drain into the superficial epigastric vein and femoral vein.
- The *utero-ovarian veins* are arranged in an anterior plane in the mesosalpinx and in a posterior plane that is a satellite of the utero-ovarian ligament. On the external extremity of the broad ligament, these two venous networks are anastomosed, forming the *pampiniform plexus* that is part of the constitution of *infundibulopelvic* ligaments. These plexuses go up through the lumbar region and drain into the inferior vena cava on the right and into the left renal vein on the left.
- The *uterovaginal veins* are organized in two planes, a preureteral one and a retroureteral one, which is anastomosed with the perivesical, perivaginal plexus and drain into the hypogastric veins.

The venous blood supply of the vagina consists of veins that come from each side of the vagina and anastomose on the median line on the same path as the azygos arteries. The blood flow is oriented to uterine veins at the level of the cervix.

Veins are mainly located on the sides of the vagina and anastomose each other at the extremities of the vaginal canal. In the middle region of the vagina, anastomoses are carried out in the azygous arteries draining the blood to the uterine veins at the level of the cervix. The uterine veins are anastomosis with the average hemorrhoidal veins, which, in turn, communicate with the upper hemorrhoids, forming at this level a porta-cave anastomose. The *long vaginal vein* is the artery satellite of the same name when it exists, and it flows into the hypogastric vein.

6. Local hemodynamic changes during vaginal hysterectomy

- Vaginal hysterectomy has as its first step the disconnection of the upper vagina from the cervix and uterine body. As a result, the anastomotic flow between the uterus and vagina is interrupted.

- After the middle pedicles are cut, due to caudal traction of the cervix in the vaginal canal, the transversal segment of the uterine artery elongates, and it can be secured by occluding both the ascending and descending branch. After that, all the maneuverers in the uterus, until the upper pedicles, are bloodless.

- If the diameter of the uterus exceeds the lower pelvic brim, as the uterus is released, the bleeding is stopped by compressing the vessels on the hard plane of the pelvis.

- After extracting a large uterus, important bleeding may occur, caused by either ligature sliding or from the tearing of veins in the broad ligament.

- Many vaginal hysterectomies may result in insignificant bleeding as compared to those in abdominal hysterectomies.

Unlike abdominal hysterectomy, regardless of the method, open or laparoscopic, vaginal hysterectomy produces a particularly favorable effect by reducing bleeding, especially in the case of large uteri due to special hemodynamic conditions. During a vaginal hysterectomy, a series of hemodynamic events occur concerning the uterine circulation, especially for a large uterus:

Traction exerts on the cervix of a large uterus almost throughout the operation, so that blood flow is significantly diminished. After the bilateral ligature of the uterine arteries, which can affect both the ascending and the descending branches, the blood flow is completely stopped, allowing maneuvers for dimensional reduction of the uterus with no risk of significant bleeding.

During the vaginal hysterectomy, after the ligature of uterine arteries, visible bleeding does not come from vascular pedicles but from blood stored in the myometer.

7. Basic technique for vaginal hysterectomy

In cases where labia minora are hypertrophic and hinder access to the vaginal introit, they are anchored laterally by suture or by using the Richter retractor. The surgical area is bounded by a set of fields isolating the anterior vulval-perineal region (**Figure 8**).

8. Infiltration of vaginal wall

The course of the future colpotomy is infiltrated submucosally with a vasoconstrictive solution. (1/200,000 epinephrine, 4 ml of ropivacaine, and up to 20 ml of saline solution). When there are contraindications for administering the epinephrine, saline solution alone may be used. Through infiltration with saline solution, a hydric dissection of the tissues is achieved, which determines the opening of the cleavage spaces, and the local anesthesia blocks the nervous transmission from the receptor level.

Accidental intravascular injection should be avoided.

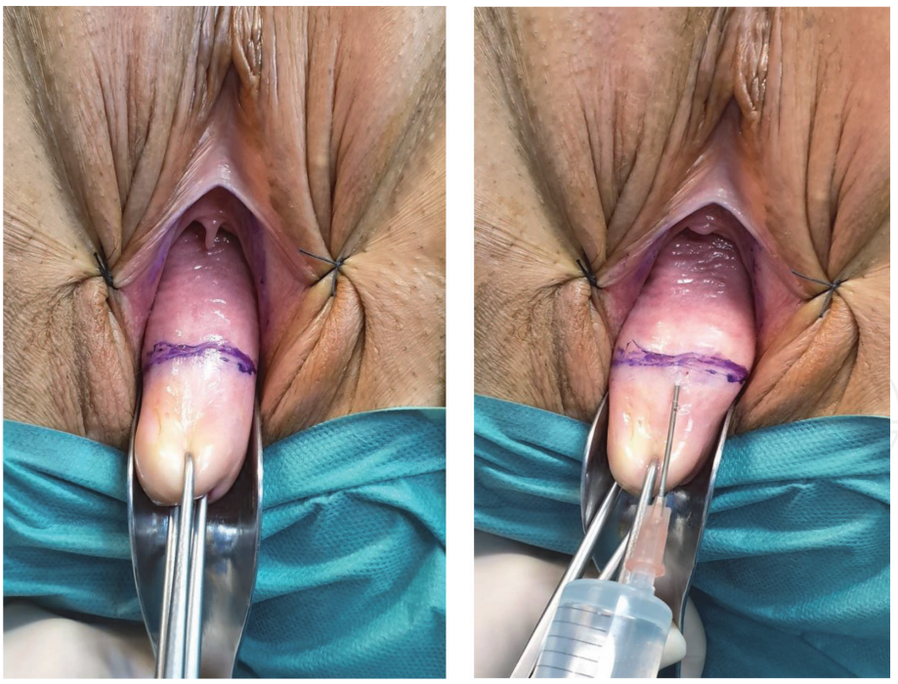

Figure 8.
Pericervical infiltration with saline solution. The cervix is grasped with 2 Pozzi clamps, and a magenta dye marks the limit of the anterior and posterior incision. Infiltrating is strictly submucosal.

8.1 Incision of the vagina around the cervix

The incision of the vaginal wall can be done with a cold or electric scalpel.

The incision of the vagina around the cervix is circular, with the anterior limit in the first transversal fold of the vaginal mucosa from its insertion into the cervix (*sulcus vesicalis*). The posterior limit should exceed the level of the cervical insertion of the two uterosacral ligaments (*torus uterinus*) in providing the closest access to open the pouch of Douglas. (see Chapter 6).

The incision includes the entire thickness of the vaginal wall, anteriorly and posteriorly. Laterally only the epithelium is interested. In this way, with the ligature of the first pedicle, the vagina will remain anchored sideways to the uterosacral ligaments, ensuring the prevention of the vaginal vault prolapse (**Figure 9**).

8.2 Developing anterior cleavage space (dissection of the bladder)

Entry into the anterior cleavage space starts with opening the vesicouterine space by cutting the *cervico-vesical septum.* After that, the vesicouterine space is entered digitally. In cases where there are scars after cesarean sections, it is recommended that the detachment be done with the scissors advancing less in the cervical plane or by "lateral window" (see Chapter 6) (**Figures 10** and **11**).

The peritoneal vesicouterine fold remains up as long as the uterus keeps its connections with the superior connective vascular pedicle. For this reason, its opening is not an immediate objective once the bladder has been detached from the uterus.

8.3 Opening the vesicouterine fold (anterior Colpoceliotomy)

In our basic technique, opening the vesicouterine pouch becomes extremely simple after the disconnection of the inferior pedicle if the uterus is not enlarged or deformed. After sectioning the inferior pedicle, the uterus descends 3–4 cm, where the white-pearly transversal fold of the peritoneal vesicouterine fold can be

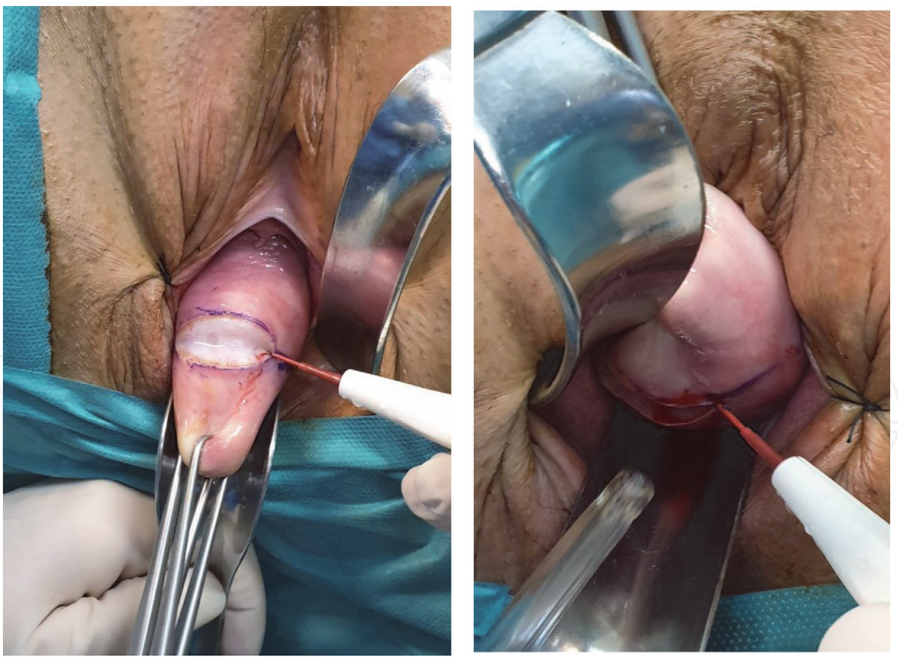

Figure 9.
The incision of the anterior wall of the vagina 1.5–2 cm away from the external cervical orifice includes the entire thickness of the vaginal wall. Posteriorly, the incision is placed at the level of the first posterior rugae of the vaginal wall.

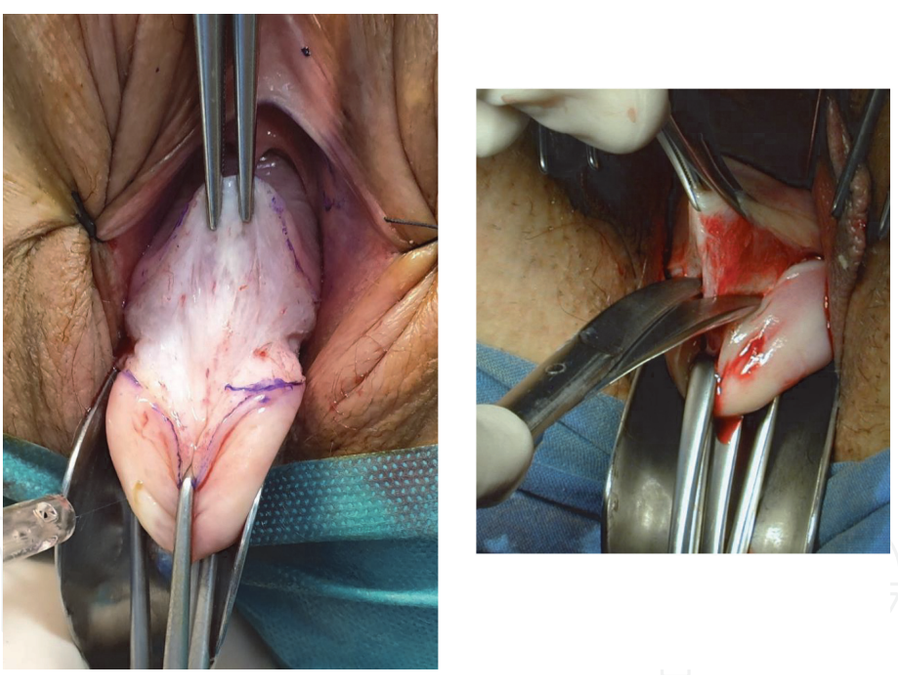

Figure 10.
To expose the cervico-vesical septum, the cervix is pulling down and the cutting edge of the vaginal wall in the opposite direction. The sectioning of the cervicovesical septum is done with scissors facing the mass of the cervix.

observed. It is grasped with a clamp and cut where it enters the pelvis. The surgeon digitally explores the anterior side of the uterus and inserts a Briesky-Navratil retractor in this space, discharging the bladder upward (**Figure 12**).

8.4 Developing rectovaginal space and opening the pouch of Douglas (posterior Colpoceliotomy)

Unlike with anterior colpoceliotomy, entering the rectovaginal cleavage space and opening the pouch of Douglas can be done at the same time. The level of

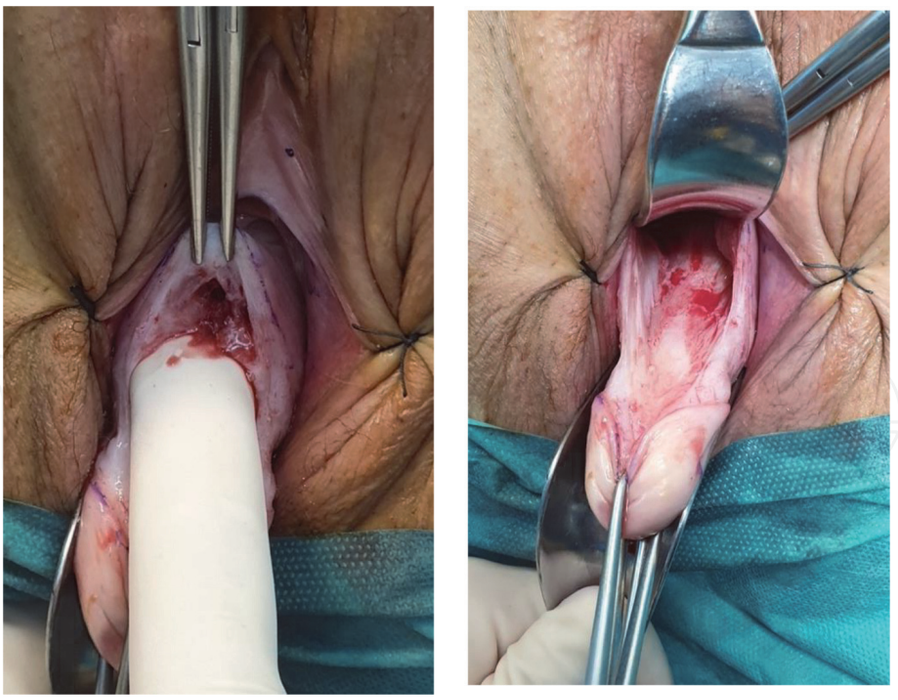

Figure 11.
The anterior cleavage space is open. Bladder pillars delineate the spatial side of anterior cleavage space. The dissection of the vesicouterine space is done by the progression of the index on the median line.

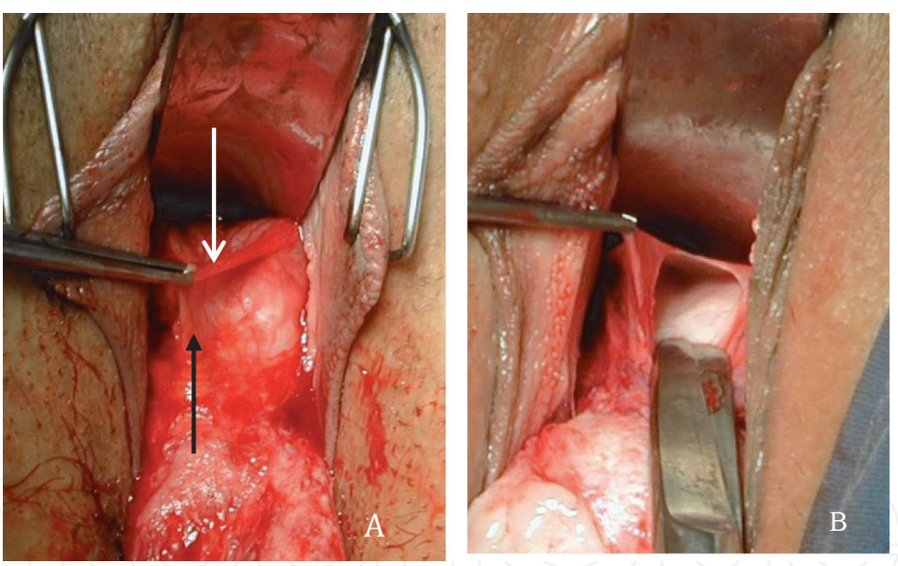

Figure 12.
A. Identifying and opening the real vesicovaginal fold (white arrow). The black arrow marks the cervical insertion of the peritoneal fold (false fold). B. the vesicovaginal fold opens.

posterior vaginal incision described above is significant to ensure a good entry into the rectovaginal space. The edge of the posterior vaginal wall incision is grasped with Allis clamps, and the rectovaginal space is entered by sharp or blunt dissection. After entering the rectovaginal space and pressing the rectum down, the peritoneal cul-de-sac may be observed swelling when the cervix is moved in or out. After opening the pouch of Douglas, the posterior side of the uterus, uterosacral ligaments, and the posterior leaf of the broad ligaments can be explored digitally (**Figures 13** and **14**).

In difficult cases, a particular variant can be used to avoid the creation of an excessively sizeable retroperitoneal space between the vagina and the rectum. (see Chapter 6).

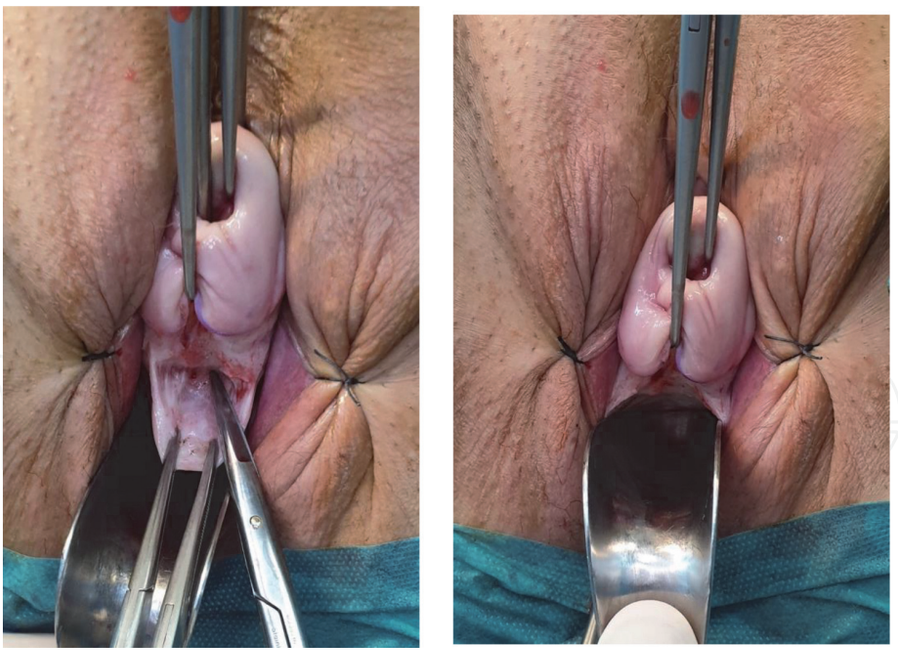

Figure 13.
Developing rectovaginal cleavage space. Allis clamps grasp the vaginal cutting edge, and the space is open by sharp dissection. The posterior aspect of the cervix is pulled upward, and the dissection is carried out using a Sims retractor.

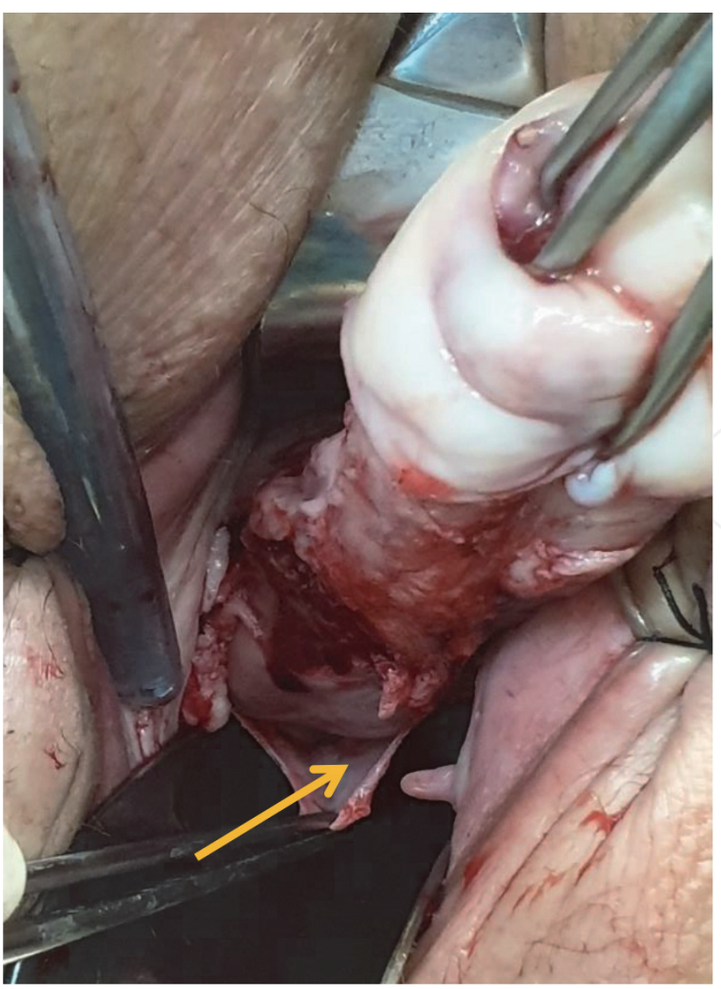

Figure 14.
The rectovaginal fold is open, and the posterior side of the uterus is visible. (arrow).

8.5 Disconnection of lower connective-vascular pedicle

The lower pedicle is represented by the uterosacral ligament posteriorly and the vesicouterine ligament anteriorly. For the disconnection of the inferior pedicle, it is not mandatory to open the rectouterine pouch, and the maneuver can be done extra-peritoneally.

The bladder is removed cranially with a Briesky-Navratil retractor, placing the two vesical pillars under tension, and the rectum is depressed with a posterior Sims retractor (**Figures 15** and **16**).

Using a Wertheim clamp, one of the uterosacral ligaments and the homologous bladder pillar are loaded together, after which, the pedicle is cut and ligated. The maneuver is repeated on the opposite side. In many situations, after cutting the pedicle, the pouch of Douglas opens spontaneously near the uterine edge.

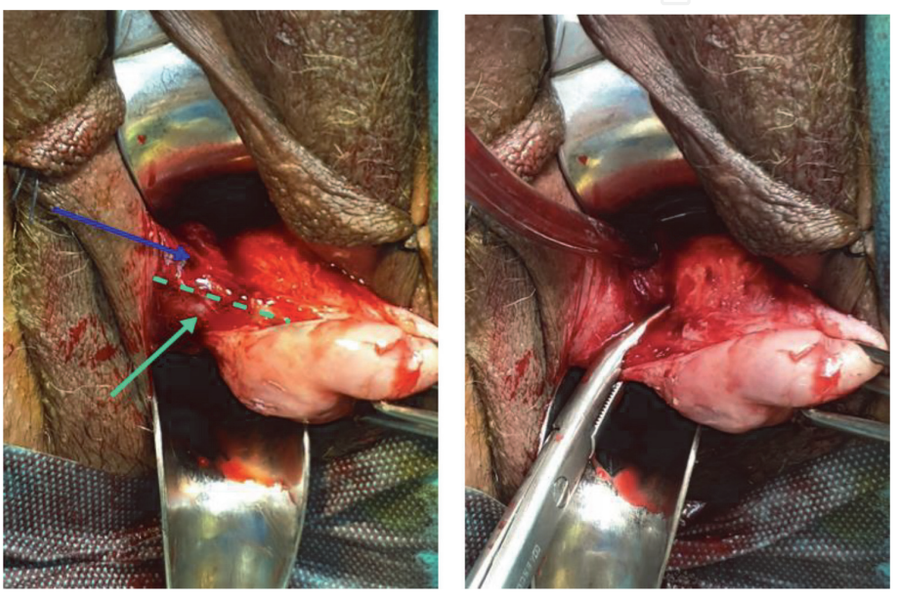

Figure 15.
Right lower pedicle. A dotted line separates the bladder pillar (blue arrow) from the uterosacral ligament (blue light arrow). Clamping the inferior part of the bladder pillar and uterosacral ligament together form the right lower pedicle.

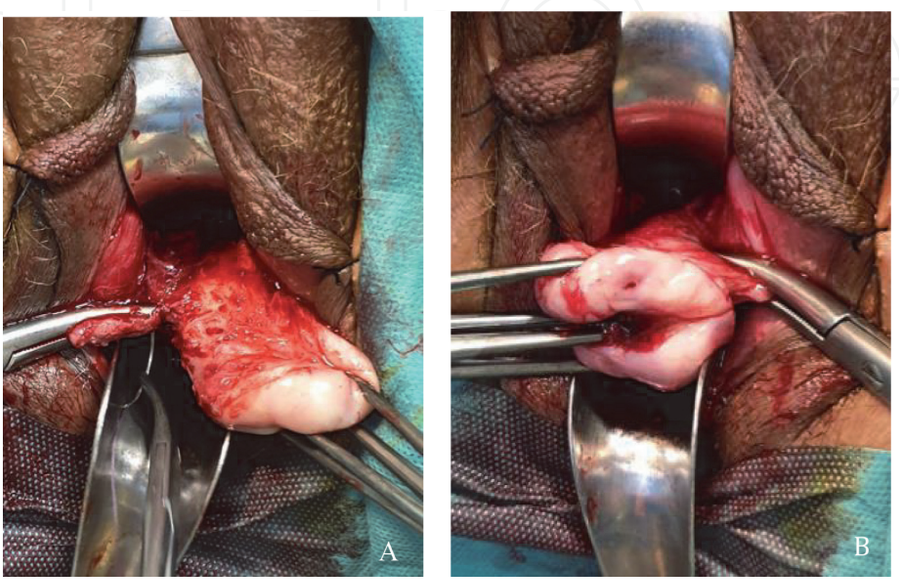

Figure 16.
A. Right lower pedicle secured by Vicryl 2/0. B. the left lower pedicle is clamped prepared to cut.

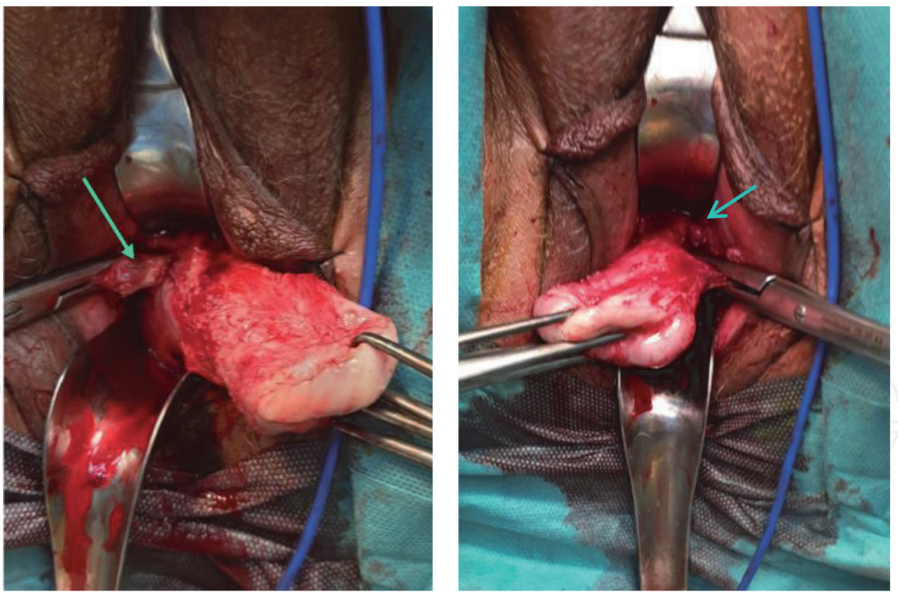

Figure 17.
Right middle pedicle formed by cardinal ligament and uterine artery and veins clamped and cut. Left middle pedicle clamped. Arrow mark the uterine artery. In our technique, the pediculisation of uterine vessels is not useful as long as the clamping of the pedicle is done strictly parallel to the uterine side. The risk to the ureter's damage is reduced if the lower pedicle is previously sectioned. (see chapter 2).

8.6 Disconnection of middle connective-vascular pedicle

The middle pedicle is represented by the cardinal ligament that contains the main uterine vascular supply for the uterus and cervix. By caudal traction on the cervix, the vascular pedicle has a parallel direction on the uterine edge, removing the ureters from the surgical field (**Figure 17**).

For this reason, during the vaginal hysterectomy, the urethral risk is lower than with the abdominal approach. After clamping, the pedicle is cut and ligated with 2–0 Vicryl.

In some situations, the cardinal ligament can be well represented and cannot be clamped at a single time. In this case, a second clamping and cutting should be cautiously be done. There is the risk of clamping and cutting a part of the superior pedicle and, in the maneuver, tilting the uterus. If so, the latter might break, causing some unwanted bleeding.

9. Disconnection of superior connective-vascular pedicle

For vaginally delivering the uterus, securing the superior connective vascular pedicle is the most important and sometimes the most difficult step of vaginal hysterectomy.

In most cases, the superior pedicle can be brought into the surgical field by tilting the uterus. The uterus can be tilted anteriorly (Doderlain-Kronig maneuver) or posteriorly (Heaney maneuver).

When the uterus is highly mobile and small, its release from the pelvis can also be done without tilting.

For the uterus weighing up to 200–280 g, access to the superior pedicle is done by tilting, a maneuver that brings the superior pedicle into the surgical field, which consists in anatomical order of the round ligament, fallopian tube, and homologous utero-ovarian ligament. This pedicle includes the anastomotic branch of the uterine artery and the tubo-ovarian vascular arch.

The main disadvantage of the tilting maneuvers is that it forces the vaginal opening through which the uterus is pulled, which can lead to the slipping of ligatures placed on the anteriorly cut and ligated connective vascular pedicles (**Figures 18–20**).

9.1 *Anterior tilting* (Doderlain-Kronig maneuver)

Anterior tilting (Doderlain-Kronig maneuver) is recommended in the case of a small uterus with a short superior pedicle or for a prolapsed uterus. The most common examples are those selected for vaginal subtotal hysterectomy. Anterior tilting is the quickest route to access the pedicle, but it cannot be used successfully with a large uterus (**Figure 21**).

The cervix is forcefully pulled caudally to expose as much as possible the anterior side of the uterus. Using a Pozzi clamp, the mass of the uterine body is clamped on the median line as high up as possible. It is gradually pulled, without sudden moves that lead to the rupture of the myometrium. At the same time, the cervix is left free without traction or pushed cranially and posteriorly with the Pozzi clamp. Along with the uterus's progress into the surgical field, using another Pozzi clamp, the mass of the uterine tissue is escalated as high up as possible until the uterine fundus and one or two superior pedicles appear in the surgical field. At this time, the cervix is pulled cranially to place the pedicle under tension. The index finger of the surgeon's left hand cranially and caudally loads the superior uterine pedicle, while the right-hand loads the pedicle into the arms of the Wertheim clamp.

After clamping and cutting, the pedicle is ligated, and the ends of the threads are kept as benchmarks. For the contralateral side, the maneuver for clamping the pedicle simplifies because, by pulling onto the cervix, the pedicle will be well exposed. Cutting and ligating the pedicles gives rise to the extraction of the uterus.

Figure 18.
Disconnection of upper pedicle by posterior tilting (Heaney maneuver).

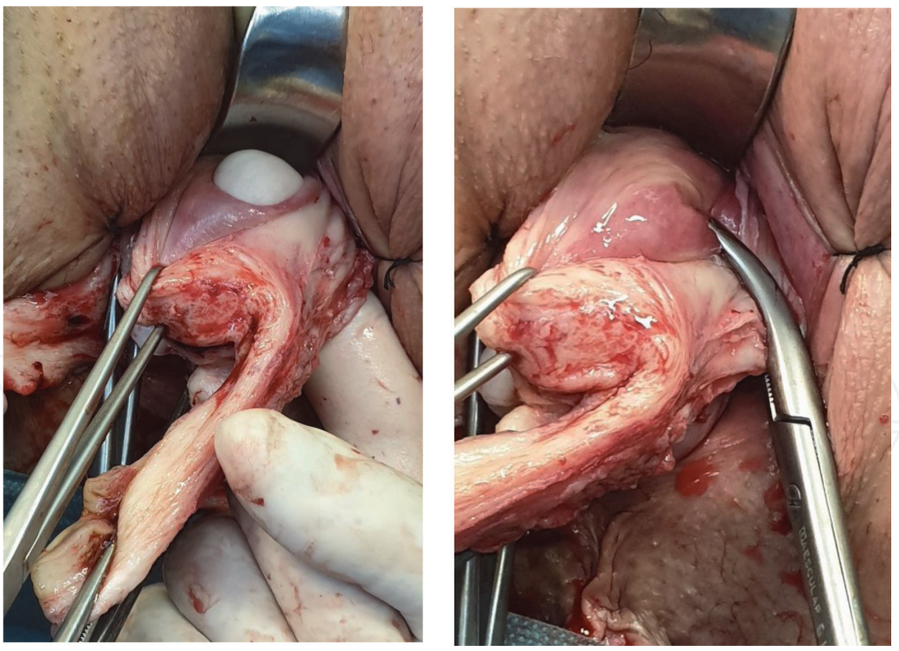

Figure 19.
Disconnection of the superior pedicle. In this case, the uterus is hemisected previously. The pedicle is hooked by the index finger and then clamped.

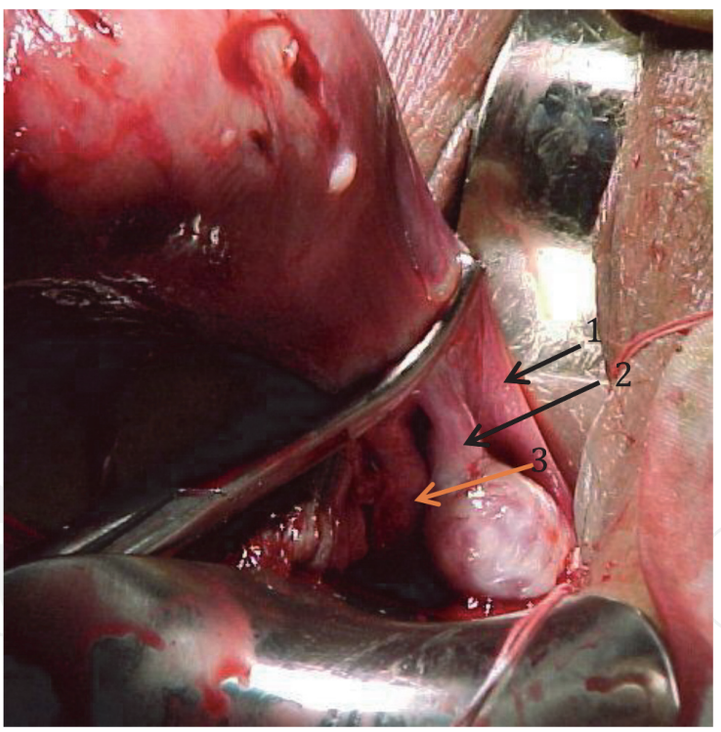

Figure 20.
Clamped left upper pedicle. We can see what it is made of 1 = round ligament, 2 = utero-ovarian ligament, 3 = tube.

The pedicle can be completely clamped or the round ligament isolated when one aims to perform the adnexectomy.

9.2 Posterior tilting (Heaney maneuver)

Posterior tilting (Heaney maneuver) is the most frequently used maneuver to access the superior pedicle for non-prolapsed uteruses weighing more than 180 g.

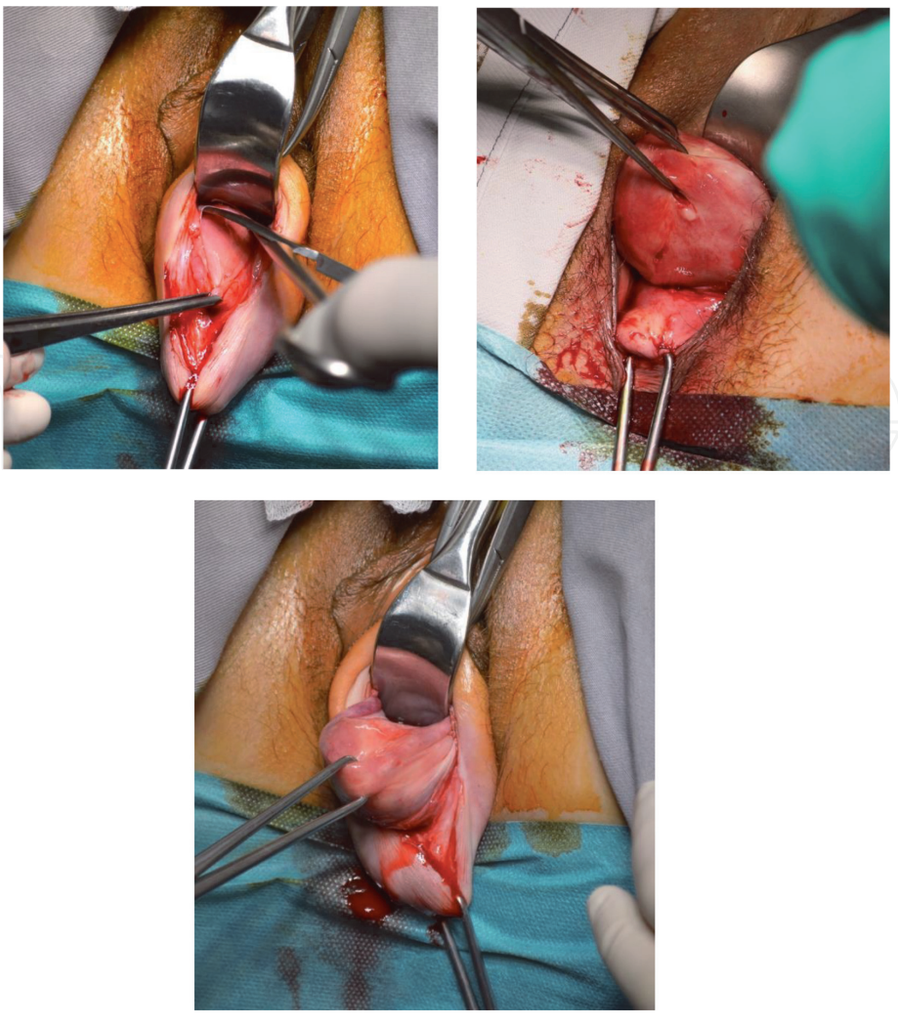

Figure 21.
Anterior tilting (Doderlain-Kronig maneuver). After anterior colpoceliotomy, the anterior side of the uterus is evident. Using Pozzi forceps, the uterine fundus is extracted, and the superior pedicle can be clamped and cut.

Posterior tilting has the main advantage of being able to rotate the uterus in a much larger space, represented by the sacral concavity.

The cervix is forcefully pulled cranially while the assistant depresses the rectum using a Sims retractor to reveal as much as possible of the posterior side of the uterus. The surgeon places a Pozzi clamp on the dorsal middle bottom of the uterus, as close as possible to the uterine pouch. Relaxing the tension exerted on the cervix, it is pulled progressively by the clamp while the assistant tries to extract the uterus using the posterior retractor. When uterus progression is observed, the position of the uterus pulling clamp is changed to become as cranial as possible, and the releasing maneuvers are continued until the uterine fundus appears in the surgical field (**Figures 22** and **23**).

Unlike anterior tilting, the superior pedicle does not become visible. To be able to identify it, the surgeon places a Briesky retractor in the area between the lateral wall of the vagina and the uterine horn, usually on the left side, where access is more accessible. As an aiding maneuver, the clamp anchoring the uterine fundus is repositioned as close as possible to the externalized uterine horn. Thus, by simultaneously pulling the cervix and uterine fundus and maneuvering the Briesky-Navratil retractor laterally, the superior pedicle is revealed at its insertion into the uterus. With the medius of the left hand, the surgeon loads the pedicle in a cranial position to clamp the pedicle in a caudal place with the right hand using a Wertheim clamp.

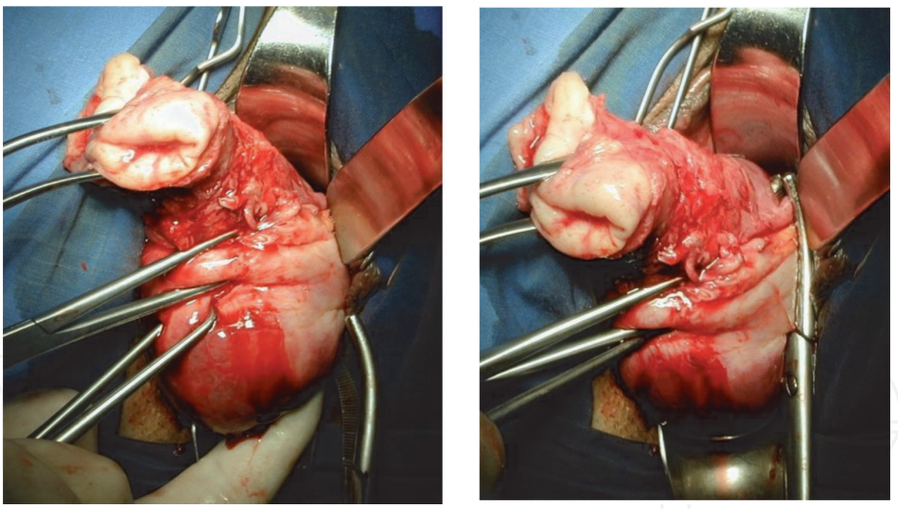

Figure 22.
Posterior tilting (Heaney maneuver). Clamping the left superior pedicle. The cervix is pulled cranially at the same time that the uterine fundus is pulled hard caudally.

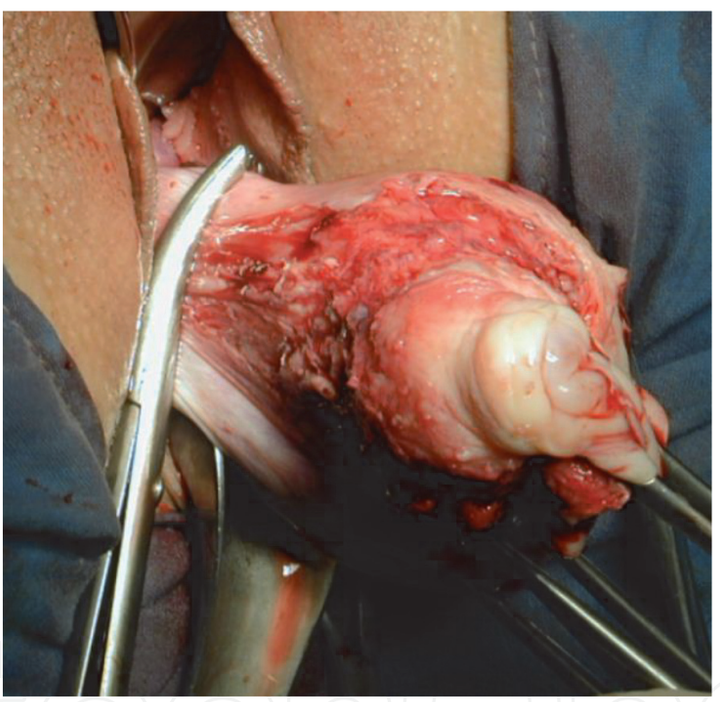

Figure 23.
The Heaney maneuver. The right pedicle is clamped "a la Vue easily. ".

9.3 Uterus release without tilting

In certain situations (early endometrial cancer, interventions under local anesthesia), it is necessary to release the uterus with minimum trauma, without tilting or morcellation. Direct access to the superior pedicle is possible mainly in multiparous women with perineal relaxation and small uteruses with a weakly represented bearing system. In these cases, clamping and section of the pedicle are done without any difficulties. Clamping the superior pedicle can be done safely by successively escalating the elements included in the utero-adnexal pedicle.

9.4 Bleeding control

After extracting the uterus, gauze is inserted through the vaginal opening and into the pelvic cavity, pushing the bowels and leaving the pelvic-subperitoneal

space open to view. The posterior wall of the vagina is retracted with an auto-static retractor. The vesicouterine peritoneum is revealed using a Briesky-Navratil retractor. The basis of the parameter is shown on the appropriate side, pulling the thread locating the superior pedicle. Bleeding at the end of the intervention is usually profuse, and its primary source is the vaginal cutting edges. In the case of active arterial bleeding from parameters, the surgical field is flooded, and the primary sources, such as the uterine arteries or the utero-ovarian arches, are to be found immediately.

At the end of a vaginal hysterectomy, the surgical field is rarely "dry" until the vaginal cuff is closed.

9.5 Treatment of vaginal cuff

In the technique we used for a vaginal hysterectomy for a non-prolapsed uterus, we adopted the Wertheim manner of closing the peritoneal cavity and the remaining vaginal edges. The main drawback of this maneuver is the closing of the surgical field without controlling the hemostasis until the end of the operation. We modified the technique, closing down the pelvic-peritoneal space and anchoring the superior vagina to the remaining cuffs of the inferior pedicle containing the most substantial elements of suspension – the uterosacral ligaments. With this procedure, the prevention of vaginal vault prolapse is done like the McCall procedure.

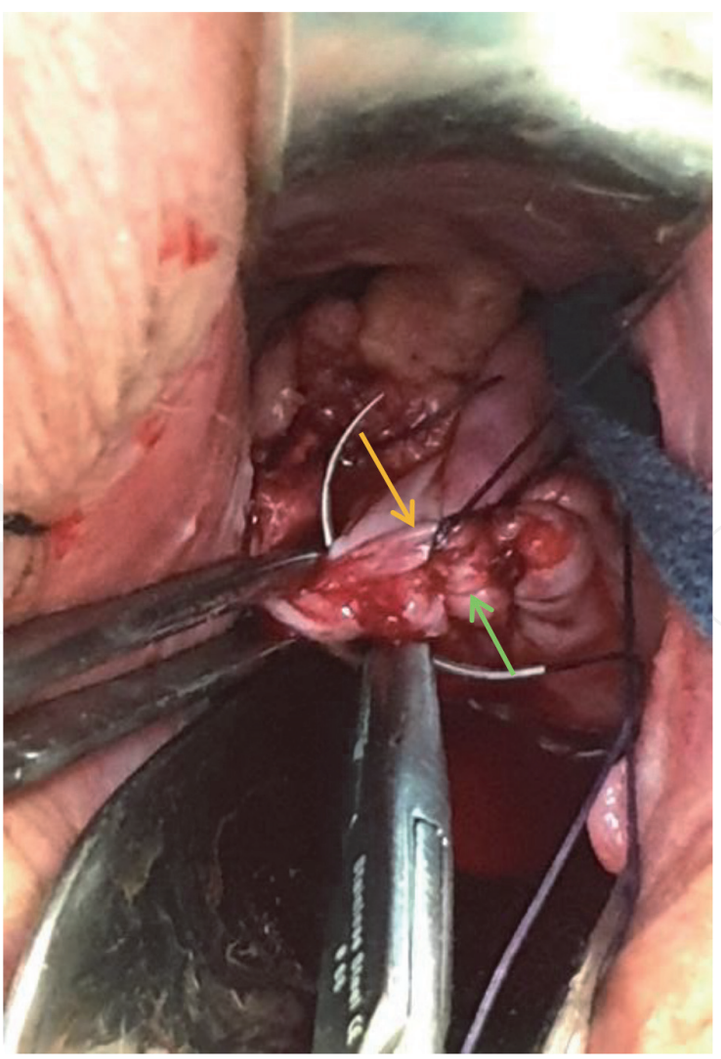

Figure 24.
Closing the posterior pelvic-subperitoneal space by running suture. The edge of the vagina (green arrow) is sutured together with the visceral posterior peritoneum (yellow arrow).

The manner we proposed is done in three distinct times:

- Closure of the pelvic-subperitoneal posterior space
- Closure of the pelvic-subperitoneal anterior space
- Full closure of the vaginal cuff

a. Closure of the pelvic-subperitoneal posterior space

Closing down the pelvic-subperitoneal space is done by running a suture with Vicryl nr. 0 to close the edge of the vagina and the posterior visceral peritoneum, starting from the lower pedicle on one side to the similar pedicle on the other side (**Figure 24**).

b. Closure of the pelvic-subperitoneal anterior space

This step usually is not necessary, but when the dissection of the bladder wall is difficult or in the case of an inadvertent wound, closing the space between the bladder and vagina is the best alternative. By joining the wall of the vagina with the visceral vesical peritoneum using a running suture, space is closed down.

c. Full closure of the vaginal cuff

The vaginal cuff can be fully closed by sutures with separate suture points. The closure of the vaginal cuff is done with Vicryl 0 and with

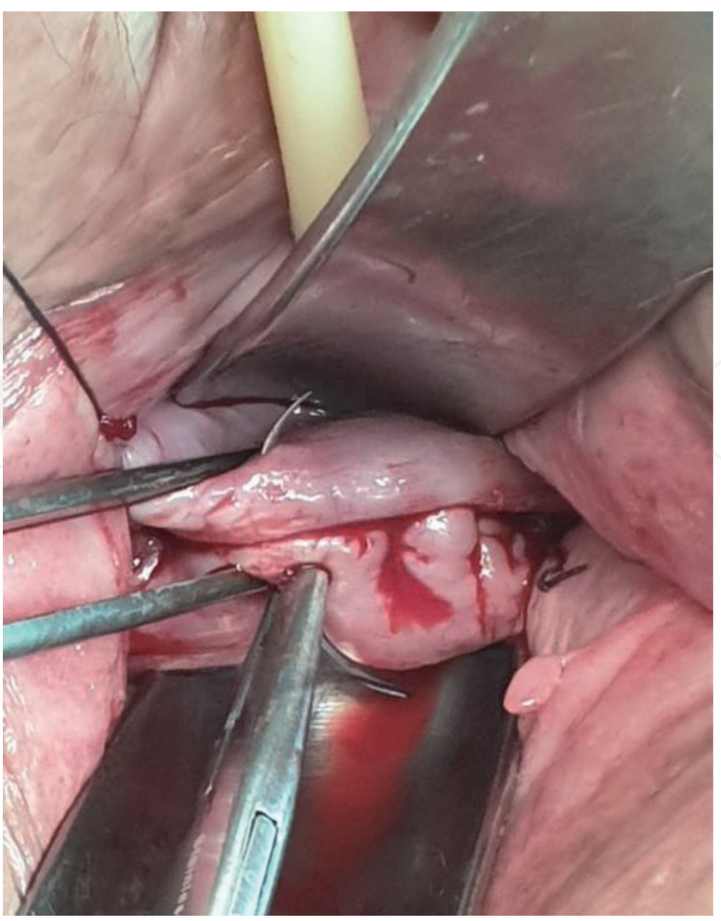

Figure 25.
The final closing of the vaginal vault by separate suture points, from middle to lateral.

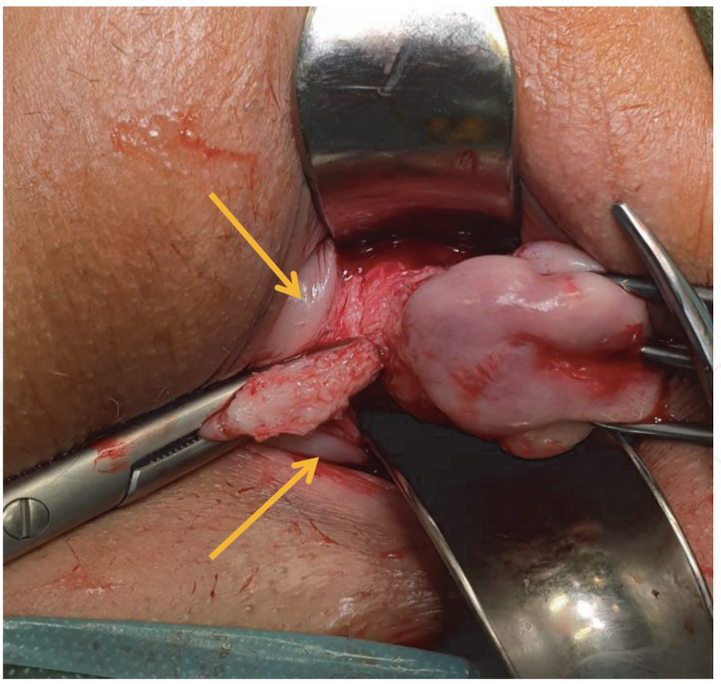

Figure 26.
Superficial incision of the lateral aspect of the vagina allows the section of the lower connective vascular pedicle to anchor the vaginal wall to uterosacral ligaments making prophylaxis of vaginal vault prolapse. (yellow arrows – Vaginal wall).

suture points in a figure of eight that starts at the center of the section and goes out towards each lateral vaginal commissure (**Figure 25**).

d. Prophylactic apical support

The technique described above refers to the unprolapsed uterus where post-hysterectomy vault prolapse occurs very rarely. For this reason, we do not include in the operative procedure an appropriate step addressed for it. The prevention of vaginal vault prolapse is necessary in case of an association of early forms of uterovaginal prolapse. By the technique described by us, the means of suspension of the upper vagina are preserved as long as the circular (**Figure 26**).

The incision in the cervix is of interest only to the vaginal mucosa. For cases where early apical prolapse is present, McCall culdoplasty is an excellent way to resuspend the upper vagina at the first level (DeLancey).

10. Conclusions at the end of the operation

The presented technique of vaginal hysterectomy resulted from combining several variants tried by authors over the years of more than 4500 vaginal hysterectomies. From each variant of the technique, we chose the most efficient and safe method to achieve each operator time as a confirmation of the validity of the succession of operating times proposed by us, the International Society of Endoscopic Surgery (ISGE) published in 2020 a set of recommendations on the technique of vaginal hysterectomy on the unprolapsed uterus.

Six recommendations were established similar to the standard technique proposed by us:

1. Circular incision at the level of the cervical-vagina junction is recommended (grade IC).

2. Posterior peritoneum should be opened first (grade IC).

3. Clamping and cutting the uterosacral and cardinal ligaments before or after getting access to the anterior peritoneum are recommended (grade IC).

4. Routine closure of the peritoneum during vaginal hysterectomy is not recommended (grade IB).

5. Vertical or horizontal closure of the vaginal vault following vaginal hysterectomy is recommended (grade IC).

6. To insert the vaginal plug following vaginal hysterectomy is not recommended (grade IB).

.., *Vaginal hysterectomy for a non-prolapsed uterus should be the preferred route for removing the uterus when hysterectomy is indicated. The ISGE provides evidence-based practical guidelines on how vaginal hysterectomy for non-prolapsed uterus should be undertaken. All efforts should be directed towards teaching the surgical technique of vaginal hysterectomy during residency.*

There is no standard technique for vaginal hysterectomies. Every case poses different strategical problems. It is not necessary to follow every step of the operation in order as described elsewhere in literature or even in this chapter. The surgeon can treat every operation as a distinct one with a specific strategy.

The disconnection of the leading vascular pedicles causes fewer problems than delivering the uterus from the upper connective vascular pedicle. For large uteri, this operative step is time-consuming and challenging to work for the surgeon.

If during the first steps of the operation, incidental bleeding begins that cannot be managed, the surgeon should not hesitate to convert the vaginal operation to an open abdominal or laparoscopic one. Every minute lost means 250 ml of blood lost from each uterine artery.

In many cases, there is significant blood loss until the uterus is released, and after that, the drama begins. In some cases, the abrupt withdrawal of the uterus from the pelvis causes the sliding of ligatures from a uterine artery. If the bleeding seems to be to one side, you have to look for it on the opposite side.

The most important thing is to finish this partially blind operation without any doubt regarding the safety of the patient.

Suggested reading

[1] Nichols DH, Randal CL. Vaginal Surgery. third ed. Williams &Wilkins; 1989

[2] Kovac SR, Zimmerman CV. Advances in Reconstructive Vaginal Surgery. Wolters Kluver, Lippincott, Williams & Wilkins; 2007

[3] Seth SS. Vaginal Hysterectomy. second ed. London: Jaypee Brothers Medical Publishers (P); 2014

[4] Cosson M, Querleu D, Dargent D. Vaginal Surgery. Taylor & Francis Group LLC; 2005

[5] Geller EJ. Vaginal hysterectomy: The original minimally invasive surgery. Minerva Ginecologica. 2014;**66**(1):23-33

[6] Bretschneider CE, Jallad K, Paraiso MFR. Minimally invasive hysterectomy for benign indications: An update. Minerva Ginecologica. 2017; **69**(3):295-303. DOI: 10.23736/ S0026-4784.17.04017-5

[7] Chia KV, Tandon S, Moukarram H. Vaginal hysterectomy is made easier with ERBE Biclamp forceps. Journal of Obstetrics and Gynaecology. 2007; **27**(7):723-725. DOI: 10.1080/ 01443610701612789

[8] Purohit RK. Purohit technique of vaginal hysterectomy: A new approach. BJOG. 2003;**110**(12):1115-1119

[9] Rachaneni S, Dua A. Interventions to reduce morbidity from vault hematoma following vaginal hysterectomy: A systematic review and meta-analysis. International Urogynecology Journal. 2019;**30**(7):1061-1070. DOI: 10.1007/ s00192-018-3829-6

[10] Von Theobald P, Grosdemouge I. Hystérectomie vaginale: technique opératoire caennaise Vaginal hysterectomy: operative technique used at Caen. Journal de Gynecologie, Obstetrique et Biologie de la Reproduction. 2002;**31**(6):589-596

[11] Chrysostomou A, Djokovic D, Edridge W, van Herendael BJ. Evidence-based practical guidelines of the International Society for Gynecologic Endoscopy (ISGE) for vaginal hysterectomy. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2020;**252**

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