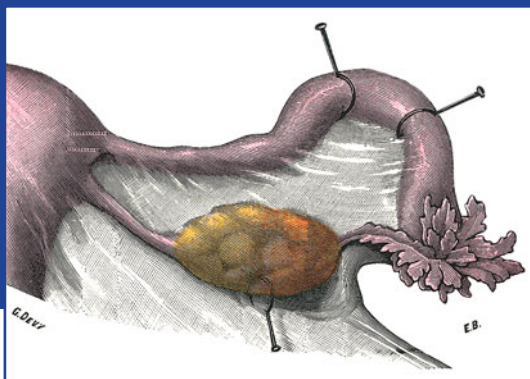


Anatomy and Radioanatomy of the Pelvis and the Perineum and Anatomical Locations of Pelvic and Perineal Masses

2



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Diagnosis of the origin of a pelvic mass is one of the most common and difficult problems encountered in pelvic imaging.

Precise location of the mass is one of the fundamental steps in the radiological diagnosis of a pelvic mass. A precise knowledge of the anatomy of the pelvis (topographic and descriptive) with anatomical sections in the different planes (axial, coronal and sagittal) is essential to localize precisely a pelvic mass and eventually according to the nature of the mass (especially in case of malignant tumor) to precise its extension. Knowledge of the anatomy can only be understood with a precise knowledge of embryology of the genital organs, the genital tract and the external female genitalia [1] but also of the peritoneum, and the urinary tract (mainly the ureters and the bladder), and of the GI tract (small bowel and colon and rectosigmoid) which can be involved in different pathologic processes of the gynecological organs.

The topographic diagnosis is different according to the exclusively or mainly cystic nature of the mass, or its mixed, mainly solid or exclusively solid nature.

2.1 Anatomy and Radioanatomy of the Pelvis and the Perineum

2.1.1 Female Genital Tract Is Situated in the Pelvis and in the Perineum

2.1.1.1 The Pelvis Is Limited By

- Upward by the plane passing through the promontory of the sacrum, the arcuate line of the ilium, the iliopectineal line, and the posterior surface of the pubic crest.
- Laterally, the pelvic wall formed above the arcus tendineus (which is a thickening of the aponeurosis of the internal obturator) by the obturator internus above, and the levator ani below.
- Backward the piriformis covered by fascia over piriformis and the sacrum covered by the presacral fascia
- Downward the pelvic floor is formed by the levator ani covered by the fascia of the pelvic diaphragm;
- Levator ani and coccygeus form the pelvic diaphragm and delineate the lower limit of the true pelvis.

2.1.1.2 The Perineum Is Limited By

- Anteriorly, the pubic symphysis and its arcuate ligament
- Posteriorly, by the coccyx.
- Anterolaterally, the ischiopubic rami and the ischial tuberosities
- Posterolaterally, the sacrotuberous ligaments

- The deep limit of the perineum is the inferior surface of the pelvic diaphragm, its superficial limit the skin.
- An arbitrary limit joining the ischial tuberosities divides the perineum into an anterior urogenital triangle and a posterior anal triangle.

Female genital tract is composed of:

1. The ovary, which is only related by a thin mesovarium to the posterior part of the broad ligament and although entirely not covered by peritoneum, is considered as an intraperitoneal organ, because it lies in the peritoneal cavity.
2. Derivatives of the Muller duct, which give rise to the tubes, the body of the uterus, the cervix, and the upper vagina (see Chap. 1), which lie under the peritoneum of the bottom of the pelvic cavity, and therefore are subperitoneal.
3. The lower part of the vagina, which arises from the vaginal plate (see Chap. 1.1.3.1). During embryologic development this part will give rise to two portions:
 - An upper portion which migrates upward to fuse with the upper part of the vagina (which arises from the Muller duct). These two parts will form the subperitoneal segment of the vagina.
 - A lower portion under the hymeneal membrane which lies in the perineum and opens into the vestibule. This portion will form the perineal segment of the vagina.

These organs, intraperitoneal, subperitoneal, and perineal, present anatomical relationships with:

- The extraperitoneal space lateral to the parietal pelvic peritoneum
- The retroperitoneal space, mainly via lymphatic and nervous structures

Moreover, in radiological practice:

- Masses of the female genital tract can be difficult:
 - To differentiate from extra female organs, GI tract, urinary tract, peritoneum, broad ligament, extraperitoneal, retroperitoneal nervous structures, and even in uncommon cases from parietal masses
 - To precisely locate as ovarian, tubal, uterine in origin, or in case of a double location contiguous or separated to precise the organ of origin

2.1.2 The Different Anatomical Spaces of the Female Genital Tract and Perineum

2.1.2.1 Definitions

Peritoneum [2]: a single layer of flattened mesothelial cells, lying on a layer of loose connective tissue

The mesothelium usually forms a continuous surface, but in some areas may be fenestrated; neighboring cells are joined by junctional complexes but probably permit the passage of macrophages.

The submesothelial connective tissue may contain macrophages, lymphocytes, and adipocytes (in some regions).

Mesothelial cells may transform into fibroblasts, which may play an important role in the formation of peritoneal adhesions after surgery or inflammation of the peritoneum.

Peritoneal cavity: a virtual space lying between the parietal peritoneum and the visceral peritoneum. It may contain physiologically a small amount of peritoneal fluid (<30 cc).

After ovulation, secondary to rupture of the dominant follicle, a little more of fluid is seen in the Douglas.

During menstruation, blood may escape from the uterine tubes into the pelvic peritoneal cavity.

Intraperitoneal organ: although not situated in the peritoneal cavity (between the two layers of peritoneum), an organ entirely (small bowel, appendix, cecum, sigmoid) or almost entirely covered with visceral peritoneum (like in the abdomen, liver, stomach, spleen).

Retroperitoneal organ: an organ situated behind the posterior parietal peritoneum.

Organ lying in the peritoneal cavity: an organ situated in the peritoneal cavity, almost entirely not covered by peritoneum like the ovary (but only connected to the posterior leaf of the broad ligament by the mesovarium).

Meso is composed of the apposition of twofolds of visceral peritoneum (except for the transverse mesocolon which has fourfolds, two from the foregut, two from the midgut).

Root of peritoneum is the area of reflection and attachment of the meso on the posterior parietal peritoneum.

Extraperitoneal tissue (transversalis fascia) separates the parietal peritoneum from the muscle layers of the abdominal wall.

2.1.2.2 The Different Anatomical Spaces

The Intraperitoneal Space

The *intraperitoneal space* containing the intraperitoneal segments of the GI tract, covered by visceral peritoneum:

1. Small bowel attached by the mesentery to the posterior parietal peritoneum along its root extending from the duodenojejunal junction to the ileocecal junction
2. Cecum usually suspended by a short mesentery and appendix with its short mesoappendix connecting it to the lower part of the ileal mesentery
3. Sigmoid with the mesosigmoid connected to the posterior parietal peritoneum by its two roots:

The primary root from the inferior angle of the aorta bifurcation to the posterior junction of the rectosigmoid junction

The secondary root from the origin of the primary one, descending obliquely along the primitive and external left iliac artery

The Subperitoneal Space

The Roof: The Broad Ligament (Figs. 2.1, 2.2, and 2.3)

Peritoneal Folds

1. Mesosalpinx (Fig. 2.4a–c)

It covers the tube except the fimbriae of the tubal infundibulum which project from its free lateral end into the peritoneal cavity. It is attached laterally to the suspensory ligament of the ovary and medially to the ovarian ligament.

It contains vascular anastomoses between the uterine and ovarian vessels, the epoophoron (Fig. 2.4d), the paroophoron, and the proximal part of the Gartner canal.

Fig. 2.1 Anterior view of the broad ligament.

1 Uterus, 2 cervix, 3 vagina, 4 left ovary, 5 utero-ovarian ligament, 6 tube with its infundibulum, 7 tubo-ovarian ligament, 8 Morgagni hydatid, 9 round ligament, 10 broad ligament with its anterior (a), middle (b), and posterior (c) wings; 11 posterior leaf of the broad ligament, and 12 infundibulopelvic ligament

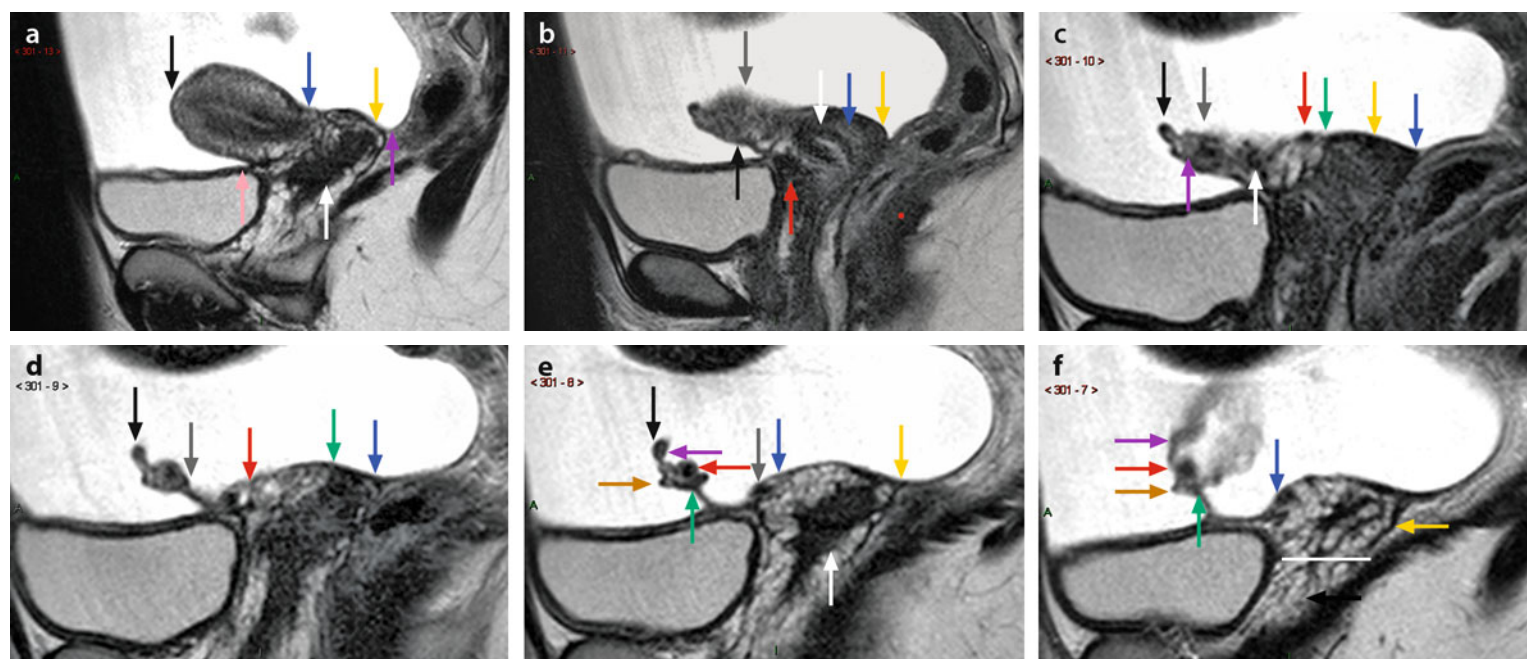
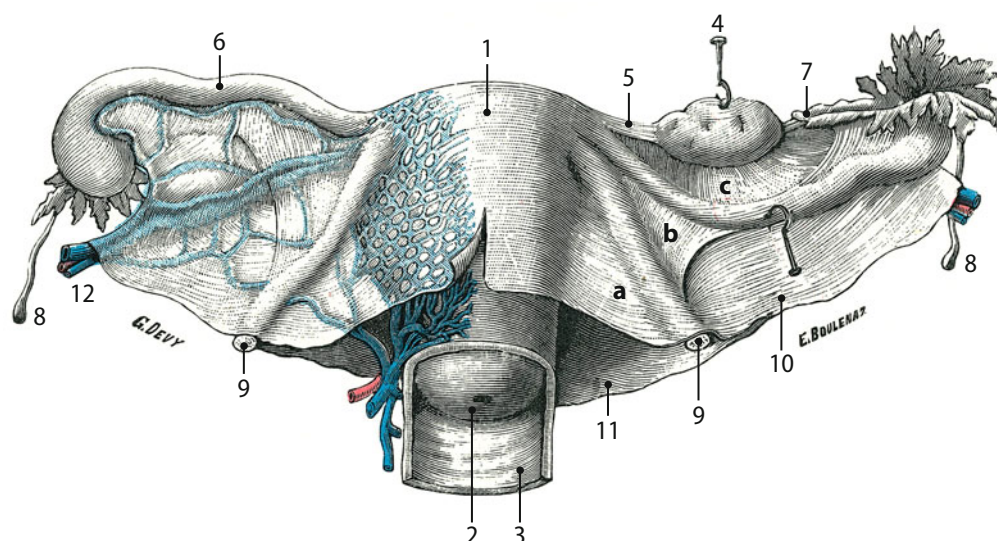


Fig. 2.2 Landmarks: Contiguous sagittal sections of the broad ligament from the midline (black landmark) to the left pelvic wall (purple landmark) (cervix in the middle sagittal plane, uterus body oriented to the right) (last figure with bars). (a) Section through the middle sagittal plane of the uterus body (black landmark). Uterus body (between black arrow and blue arrow), right paracervix (between blue and yellow arrows), right vaginal wall (white arrow), vesicouterine pouch (pink arrow), Douglas (purple arrow). (b) Section at the junction of the left lateral border of the uterus and the mesometrium (red landmark). Myometrium (black arrow), mesometrium (gray arrow), cervix inner stroma (white arrow), external stroma (blue arrow), vesicouterine septum (red arrow), posterior fornix of the vagina (yellow arrow). (c) Section through the inner mesometrium (green landmark). Mesosalpinx (between black and gray arrows) containing the medial branch of the tubal artery (black arrow), the tube (purple arrow). Mesometrium above the Mackenrodt's ligament (between gray and red arrows) containing vessels particularly the ascending segment of the uterine artery (white arrow). Uterine artery (red arrow) at the junction of Mackenrodt's ligament and mesometrium. Mackenrodt's ligament (between red and green arrows). External cervix lateral stroma (yellow arrow), posterior fornix of the vagina

(blue arrow). (d) Section through the inner Mackenrodt's ligament (purple landmark). Mesosalpinx (between black and gray arrows), mesometrium above the Mackenrodt's ligament (between gray and red arrows), Mackenrodt's ligament (between red and green arrows), posterior fornix of the vagina (blue arrow). (e) Section just lateral to the previous one (yellow landmark). Mesosalpinx (between black and green arrow), containing medial tubal artery (purple arrow), and uterine artery (red arrow), round ligament containing its artery (brown arrow), mesometrium above the Mackenrodt's ligament (between green arrow and blue arrow). Uterine artery in its latero uterine segment (gray arrow), Mackenrodt's ligament (between blue and yellow arrows), vagina lateral wall (white arrow). (f) Section at the level of the medial face of the ovary (brown landmark). Mesosalpinx with anastomoses between uterine and ovarian arteries (red arrow), tubal artery with a low signal (purple arrow) along the tube. Round ligament (brown arrow) containing its low signal artery. Mesometrium between the green arrow and the blue arrow. White line at the level of the lower part of the cervix. Mackenrodt's ligament between the blue arrow and the yellow arrow, above the white line. Below the white line, paravaginal subperitoneal tissue (black arrow)

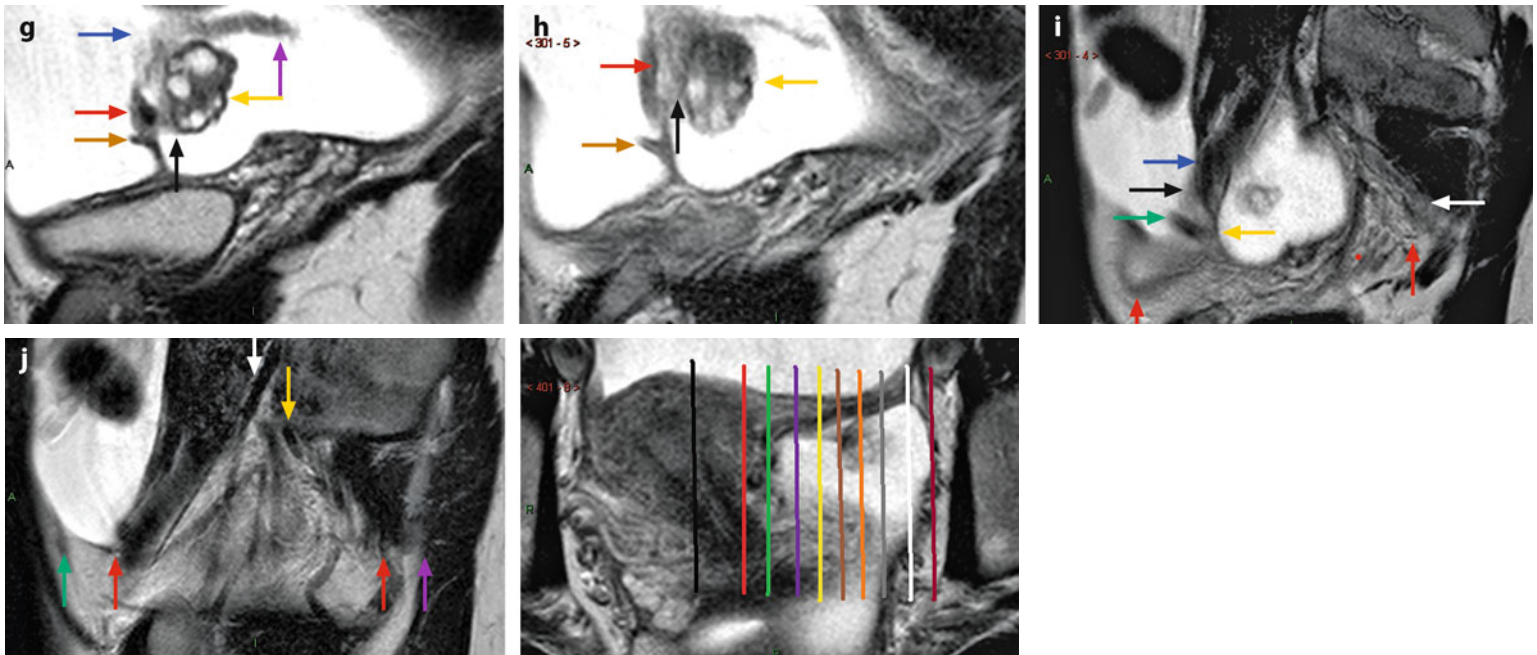


Fig. 2.2 (continued) (g) Section through the middle part of the ovary at the level of change in direction of the salpinx (orange landmark). Round ligament (brown arrow), mesosalpinx containing uterine artery (red arrow), mesovarium (black arrow), ovary (yellow arrow), tube with ampullary portion (blue arrow) and infundibulum (purple arrow). (h) Section through the mesovarium (gray landmark). Infundibulopelvic ligament contains ovarian artery (red arrow), mesovarium (black arrow), ovary lateral third (yellow arrow), round ligament (brown arrow). (i) Section through the junction of the lateral part of the broad ligament and the extraperitoneal space (white landmark). Medial part of the extraperitoneal space (blue arrow) containing the left external iliac

vein. Anterior (black arrow) and posterior (yellow arrow) peritoneal leaves of the mesometrium close to their attachment to the extraperitoneal space. Round ligament at the beginning of its extraperitoneal segment (green arrow). Anterior and posterior subperitoneal spaces (between red arrows). Retroperitoneal space (white arrow). (j) Section through the extraperitoneal space (Bordeaux red landmark). Anterior subperitoneal space (between green arrow and anterior red arrow), extraperitoneal space (between red arrows), retroperitoneal space (between posterior red arrow and purple arrow), external iliac artery and vein (white arrow), arterial and venous branches of the hypogastric artery and vein (yellow arrow)

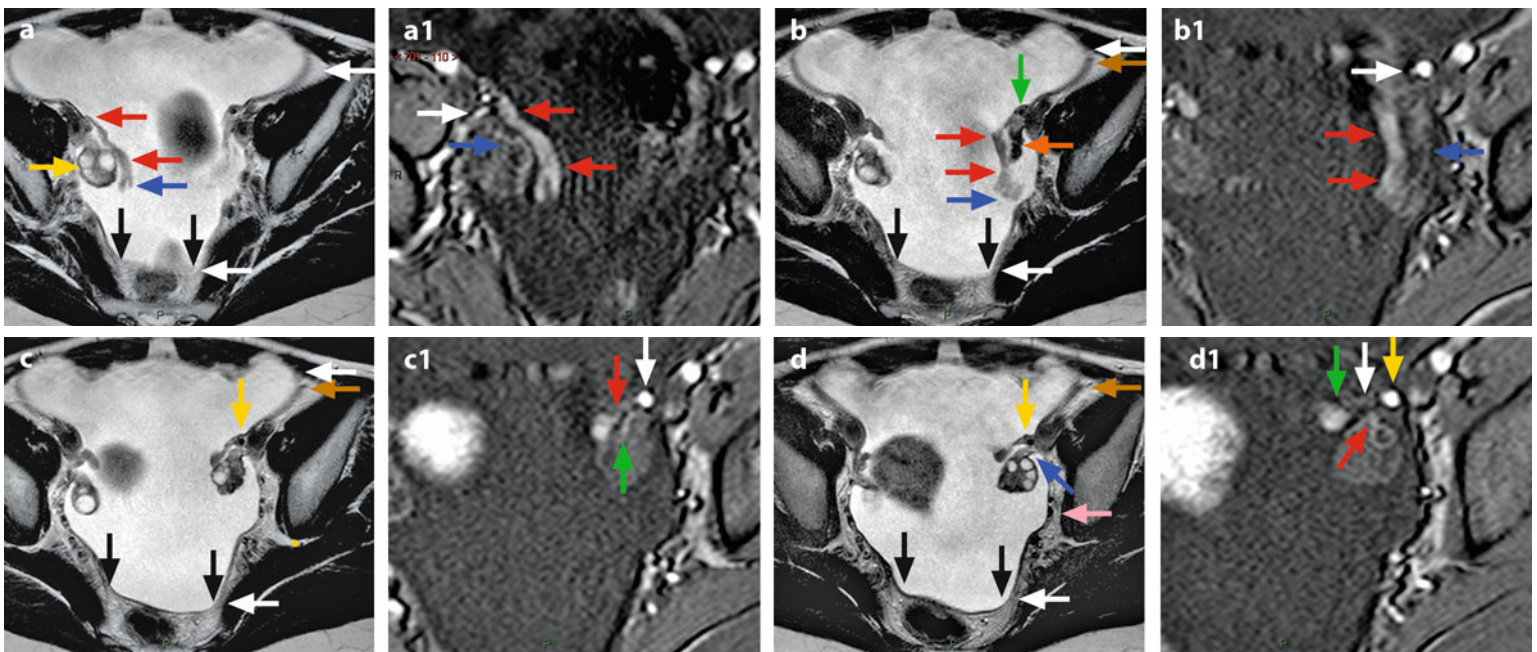


Fig. 2.3 Landmarks: Contiguous axial sections of the broad ligament from the top (black landmark) to the pelvic floor (lower purple landmark) using axial T2 and DMR (at the arterial phase) sequences at the same level (last figure with bars). (a) Section (axial T2), through the right adnexa (black landmark). Right ovary (yellow arrow), right tube ampulla (between red arrows), infundibulum (between the more distal red arrow and blue arrow). Extraperitoneal space (between white arrows), retroperitoneal space (between black arrows). Round ligament (brown arrow). (a1) Same section (DMR, arterial phase): right ovarian artery (white arrow) and intraovarian branches (blue arrow), tubal arteries (red arrows). (b) Section (axial T2) through the left adnexa (red landmark): infundibulo pelvic ligament containing the low signal intensity ovarian artery (green arrow), left superior ovarian cortex (orange arrow), left tube ampulla (between red arrows) infundibulum (between the more distal red arrow and blue arrow). Extraperitoneal space (between white arrows), retroperitoneal space (between black arrows). Round ligament (brown arrow). (b1) Same section (DMR, arterial phase): left ovarian artery (white arrow)

and intraovarian branches (blue arrow), tubal arteries (red arrows). (c) Section (axial T2) through both adnexa (green landmark). Left infundibulopelvic ligament containing the ovarian artery (yellow arrow). Extraperitoneal space (between white arrows), retroperitoneal space (between black arrows). Round ligament (brown arrow). (c1) Section (DMR, arterial phase): left ovarian artery (white arrow) and intraovarian branches (green arrow), lateral tubal artery (red arrow). (d) Section (axial T2) (purple landmark) junction between the isthmus and the ampulla. Ovarian artery (yellow arrow) mesovarium with lateral leaf in continuity with the posterior leaf of the parietal pelvic peritoneum (blue arrow) uterine artery in its extraperitoneal segment (pink arrow). Retroperitoneal space (between the two black arrows), junction between the retroperitoneal space and the extraperitoneal space (white arrow), round ligament (brown arrow). (d1) Section (DMR, arterial phase): ovarian artery (yellow arrow) lateral tubal branch of the ovarian artery (white arrow) anastomosis between ovarian artery and tubal artery (green arrow), intraovarian arteries (red arrow)

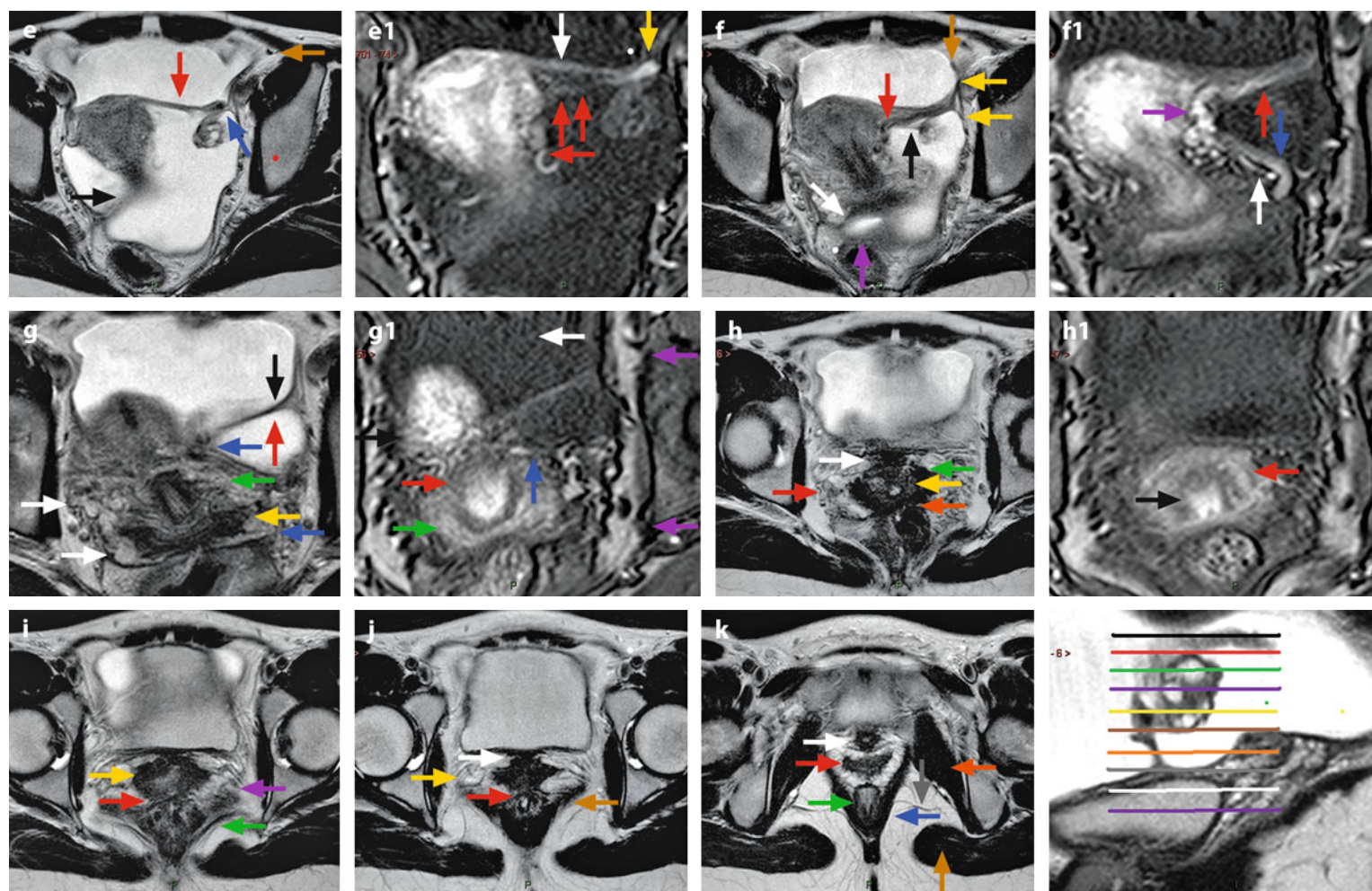


Fig. 2.3 (continued) (e) Section (axial T2) (yellow landmark). Round ligament at the beginning of its extra peritoneal location (brown arrow). Isthmic portion of the tube and mesosalpinx in its superior portion (red arrow), mesosalpinx (blue arrow), right uterosacral ligament (black arrow). (e1) Section (DMR, arterial phase). Uterine artery: ascending segment in the mesometrium along the lateral border of the uterus body (horizontal red arrow), uterine artery in the mesosalpinx (vertical red arrows), medial tubal branch (branch of division of the uterine artery in the superior portion of the mesosalpinx) (white arrow). Terminal portion of the uterine artery in the mesosalpinx (yellow arrow) anastomosing with the ovarian artery. (f) Section (axial T2) through the ovarian ligament (brown landmark). Ovarian ligament indicating the inferior part of the mesosalpinx (black arrow), uterine artery in the mesosalpinx (red arrow), round ligament in its proximal portion (brown arrow), anterior and posterior leaves of the broad ligament joining the lateral parietal peritoneum (yellow arrows), right uterosacral ligament (white arrow), Douglas (purple arrow). (f1) Section (DMR, arterial phase): uterine artery in its transverse segment (white arrow) at its ascending segment (purple arrow) in the mesosalpinx (red arrow), superior uterine vein lateral and below the transverse segment of the uterine artery (blue arrow), ureter crosses between uterine artery and vein, not visualized on this sequence. (g) Section (axial T2) (orange landmark), anterior (black arrow) and posterior (red arrow) leaves of the mesometrium clearly defined by fluid in the peritoneal cavity containing the low signal intensity of the round ligament, Mackenrodt's ligament (between blue arrows) with its paracervical portion (green arrow) and para-

vaginal portion lateral to the fornix (yellow arrow). On the right side lateral limit between Mackenrodt's ligament and the extraperitoneal space (white arrows). (g1) Section (DMR, arterial phase): fluid in the peritoneal cavity (white arrow); artery of the round ligament just behind white arrow. Transverse segment of the uterine artery (blue arrow), intrauterine arteries (black arrow), cervical arteries (red arrow), vaginal arteries (green arrow), arteries of the extraperitoneal space (between purple arrows). (h) Section (axial T2) (gray landmark) through the lower part of the Mackenrodt's ligament: uterovesical septum (white arrow), lateral fornix (green arrow), lower part of the cervix (yellow arrow), junction of the Mackenrodt's ligament and the extraperitoneal space (red arrow), rectovaginal septum (orange arrow). (h1) Section (DMR, arterial phase): cervical arteries (black arrow), vaginal arteries (red arrow). (i) Section (axial T2) (white landmark): uterovesical septum (black arrow), vaginal wall (yellow arrow), rectovaginal septum (red arrow), paravagina (purple arrow), iliococcygeus muscle (green arrow). (j) Section through the top of the rectovaginal septum (lower purple landmark), vesicovaginal septum (white arrow), paravagina (yellow arrow), rectovaginal septum (red arrow), iliococcygeus muscle (brown arrow). (k) Section through the lower part of the subperitoneal space just above the pelvic floor, urethra (white arrow), vagina (red arrow), lower part of the rectum (green arrow) just above the rectoanal junction, iliococcygeus muscle lower part (blue arrow) just above the puborectal muscle, obturator internus (orange arrow), gluteal maximus (brown arrow), posterior perineum: ischioanal fossa (gray arrow)

2. Mesovarium (Fig. 2.4a–c)

It projects from the lower and lateral part of the posterior fold of the mesosalpinx to the hilum of the ovary. All the rest of the ovary is devoid of peritoneum.

It carries vessels and nerves to the ovary.

The ovarian ligament attaches the inferomedial extremity of the ovary to the lateral angle of the uterus posteroinferior to the uterine tube. The ovarian ligament is continuous with the medial border of the round ligament.

The upper pole of the ovary is connected to the posterior part of the infundibulum of the tube by the tubo-ovarian ligament.

3. Mesometrium or Parametrium of Virchow (3) (Figs. 2.4a, b and 2.5)

It is the largest part of the broad ligament.

(a) It is limited by:

Upward, the lower part of the mesosalpinx.

Downward, the subperitoneal tissue covering the pelvic floor.

Medially, the lateral border of the uterus and the vagina until the introitus.

Laterally, upward the suspensory or infundibulopelvic ligament, which is attached to the upper part of the lateral face of the ovary; below this ligament.

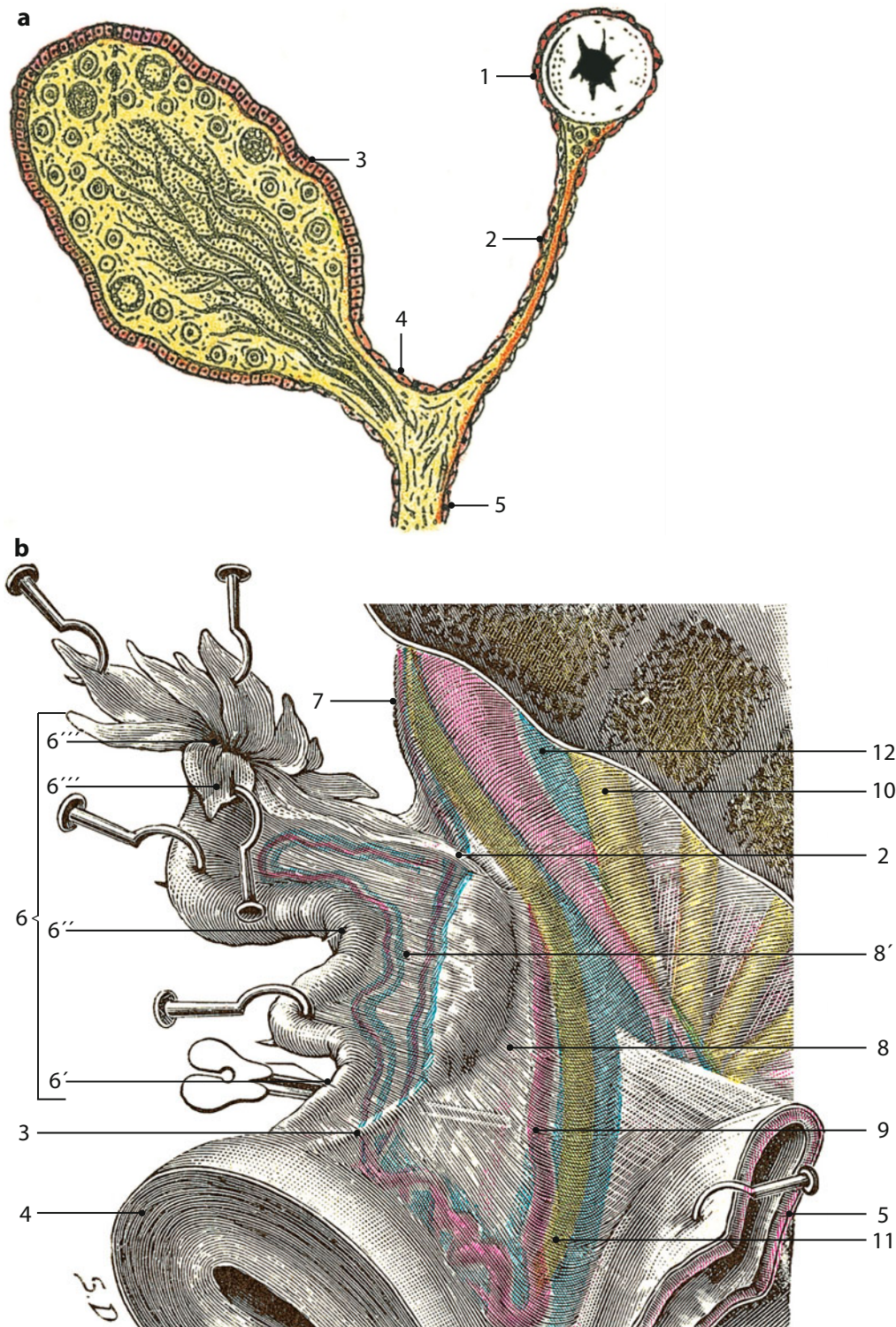


Fig. 2.4 (a) 1 tube, 2 mesosalpinx, 3 ovary, 4 mesovarium, 5 mesometrium. (b) 1 Ovary, 2 Tuboovarian ligament, 3 Ovarian ligament, 4 Uterus, 5 Rectum, 6 Tube with 6' isthmus, 6'' ampulla, 6''' infundibulum, 7 Suspensory or Infundibulopelvic ligament containing in its thickness the ovarian artery and vein and lymphatics, 8 Mesometrium, 8' Mesosalpinx, 9 Uterine artery, 10 Sacral plexus, 11 Ureter, 12 Internal iliac vein

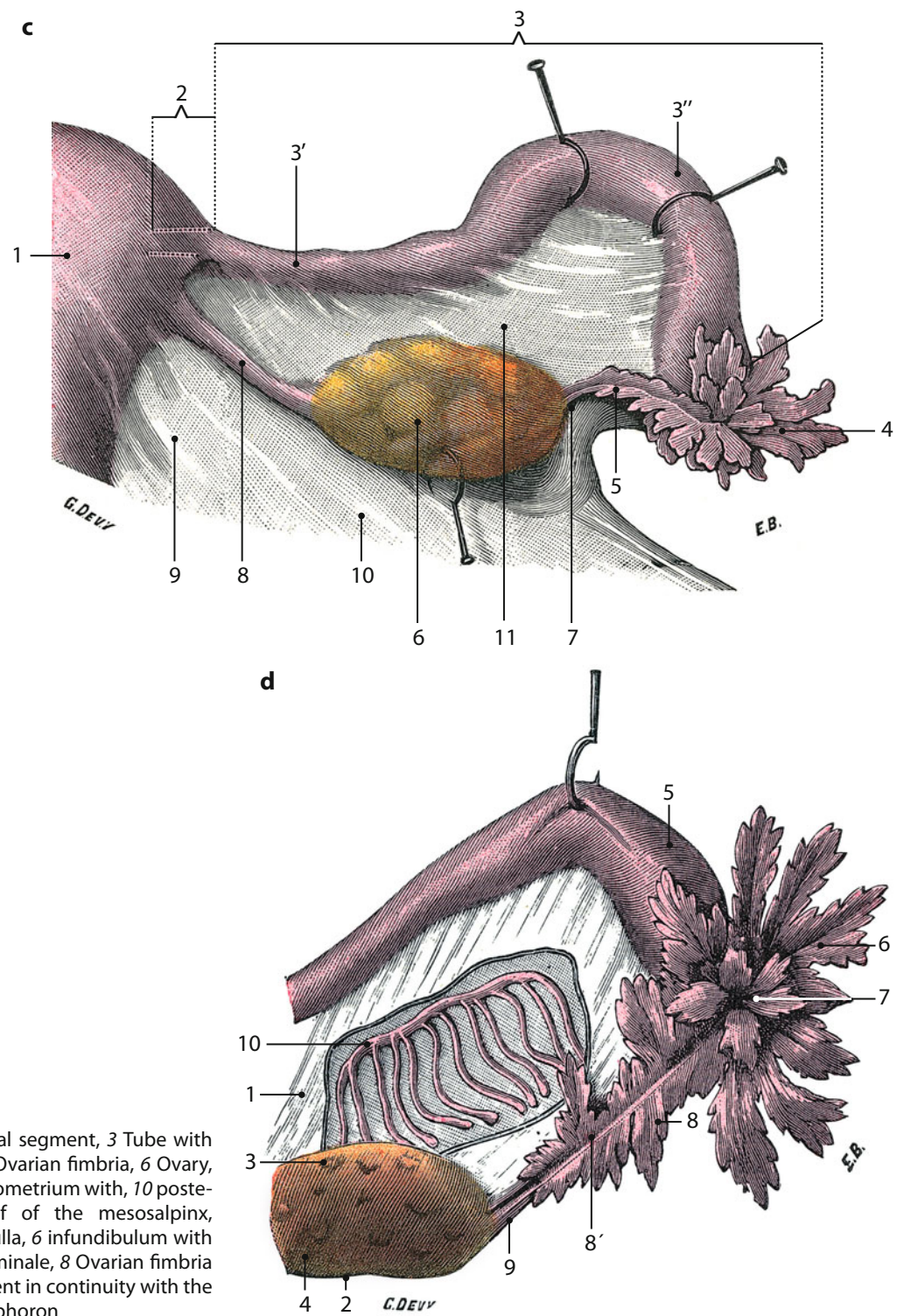


Fig. 2.4 (continued) (c) 1 Uterus, 2 Tube intramural segment, 3 Tube with 3' Isthmic portion, 3" Ampulla, 4 Infundibulum, 5 Ovarian fimbria, 6 Ovary, 7 Tuboovarian ligament, 8 Ovarian ligament, 9 Mesometrium with, 10 posterior leaf, 11 Mesosalpinx. (d) 1 Posterior leaf of the mesosalpinx, 2 Ovary with 3 De Graaf's follicles, 4 Scars, 5 Ampulla, 6 infundibulum with two concentric circles of fimbriae, 7 Ostium abdominale, 8 Ovarian fimbria with 8' its longitudinal gutter, 9 Tuboovarian ligament in continuity with the longitudinal gutter of the ovarian fimbria, 10 Epooophoron

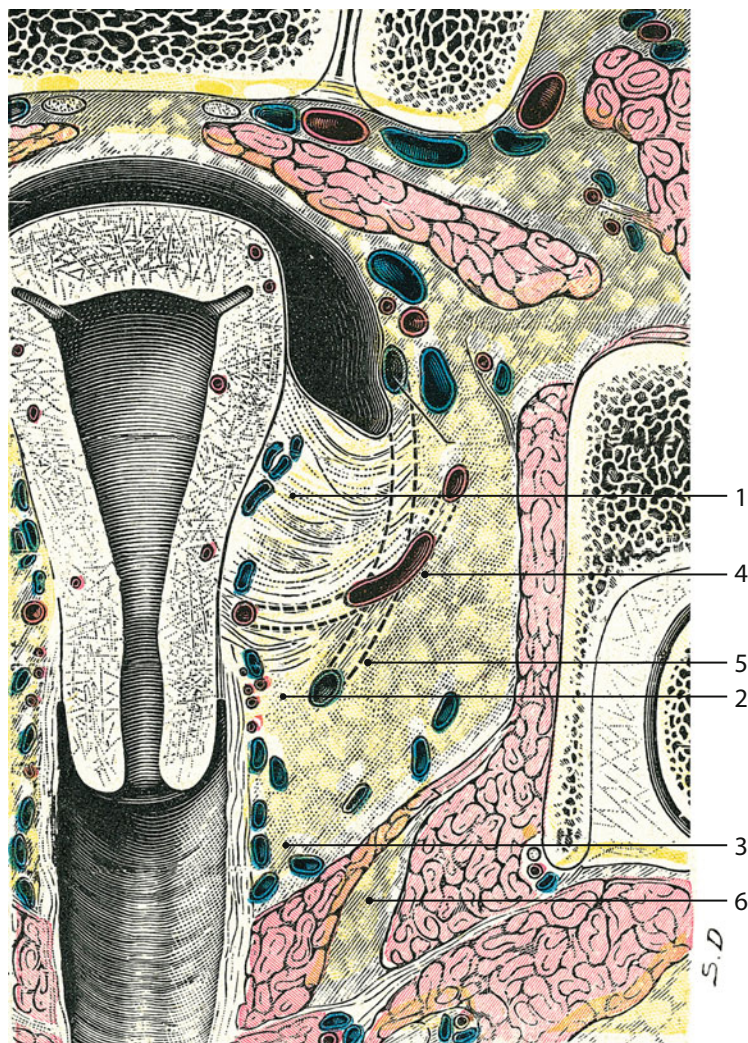


Fig. 2.5 Coronal section through the middle of the broad ligament.
1 Mesometrium, 2 paracervix, 3 paravagina, 4 uterine artery, 5 ureter, 6 levator ani

Forward the anterior peritoneal fold:

- Medially, descends on the anterior face of the uterus body until the isthmus, reflects onto the bladder forming the uterovesical fold
- Laterally, is heightened by the proximal part of the round ligament which inserts on the uterus just below the uterine tube

Backward, the posterior peritoneal fold descends over the posterior face of the uterus body, the upper cervix, the posterior fornix until the lower border of the posterior lip of the exocervix then reflects on to the front of the rectum to form the Douglas pouch.

(b) It contains:

Loose connective tissue and smooth muscle
The uterine artery
The ureter

1. Uterovesical fold at the level of the isthmus (Fig. 2.6) The continuum with the anterior parietal peritoneum raised by:
On the midline, the median umbilical ligament (obliteration of the lumen of the urachus, derivative of allantois) (see Chap. 1.1.1)
Laterally, the medial umbilical folds over the obliterated umbilical arteries

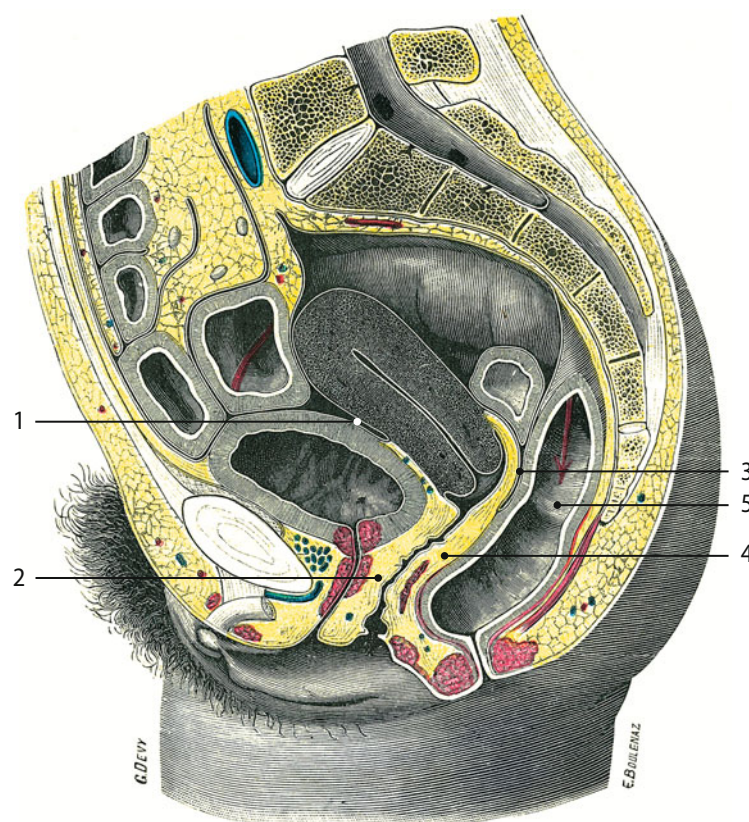


Fig. 2.6 Sagittal view through the middle part of the uterus.
1 Vesicovaginal cul de sac, 2 vesicovaginal septum, 3 Douglas pouch, 4 rectovaginal septum, 5 rectum

2. Douglas pouch:

The top is at the level of the torus (Fig. 2.6:1121 p 353).

The anterior leaf covers the posterior part of the cervix, than reflects over the posterior fornix.

The bottom is at the level of the inferior border of the posterior lip of the cervix.

The posterior leaf reflects over the anterior and lateral borders of the rectum until the rectosigmoid junction.

The lateral parts (called the ring of Waldeyer) are arciform heightened by the subperitoneal uterosacral ligaments.

Ligaments

1. Round Ligament (Fig. 2.1)

As the ovarian ligament with which it is continuous, the round ligament is issued from the gubernaculum of the embryo (see Chap. 1).

Near the uterus, it contains much smooth muscle, which progressively diminishes until the terminal part which is purely fibrous

1. In the Mesometrium

It starts from the uterus body just below and anterior to the lateral cornua.

It passes diagonally down and laterally within the mesometrium.

2. It crosses the obturator nerve and vessels, the obliterated umbilical artery.

Just before the deep inguinal ring, it passes over the epigastric artery.

3. It traverses the inguinal canal.

4. It terminates on the mons pubis.

2. Uterosacral Ligaments (Fig. 2.7)

They arise from the posterior surface of the cervix on both sides of a little transverse protrusion the torus uterinus. The ligaments go backward around the lateral faces of the rectum and are attached to the front of the sacrum. They constitute the roof of the sacrorectovaginal septum. They contain fibrous tissue and smooth muscle.

3. Ligaments of Mackenrodt (Fig. 2.5)

It is limited by:

The superior part of the cervix with the transverse segment of the uterine artery immediately below

Inferiorly: the inferior border of the lateral fornix of the vagina

Medially: lateral wall of the uterine cervix, lateral fornix of the vagina

Laterally: is continuous externally with the fibrous tissue which surrounds the pelvic blood vessels of the pelvic wall.

Forward: the supravaginal part of the cervix is

Backward: the uterosacral ligaments

It contains:

The ureter crossing the inferior part of the transverse segment of the uterine artery, the uterine vein (superior and lateral branch as it passes below the ureter, above the vaginal artery)

Cervicovaginal artery, superficial and deep uterine veins

Lymphatics

4. Pubocervical Ligament

From the anterior part of the cervix and the upper vagina, diverge around the urethra attach to the posterior aspect of the pubic bones.

The Floor

The Levator Ani (See Figures Chap. 37)

Comprises two parts: a superolateral part, the iliococcygeus muscle; and an inferomedial part, consisting of the puborectalis and the pubovisceralis

1. A superolateral part: the iliococcygeus muscle

- (a) Origin: the ischiatic spine; the arcus tendineus, which is a thickening of the obturator fascia covering the medial and upper part the obturator internus muscle (a little lower than its superior border) extending from the ischiatic spine behind, running along the inferior border of the obturator canal, to the body of the pubis in front.

The pubis body is 1 cm lateral to the pubic symphysis and 5 mm above its lower border

- (b) Direction: its general direction is inward and downward; its inferior and medial attachment is on the horizontal puborectalis.

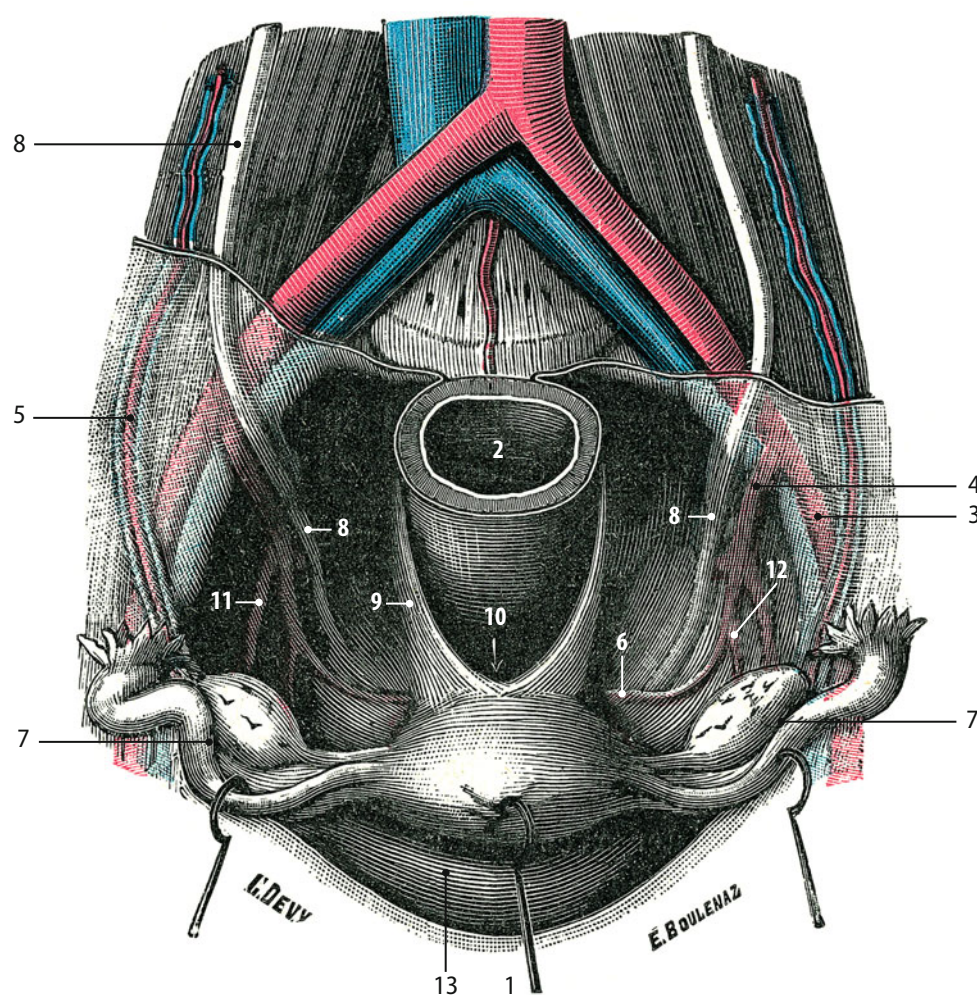


Fig. 2.7 Frontal view of the posterior part of the broad ligament. 1 Uterus, 2 rectum, 3 external iliac vessels, 4 internal iliac vessels, 5 utero-ovarian vessels, 6 uterine artery, 7 ovary and tube, 8 ureter, 9 utero-sacral ligaments, 10 Douglas, 11 obturator artery, 12 vesicovaginal artery, 13 bladder

- (c) End: The more anterior fibers intersect with those of the opposite side forming sort of a strap around the 3/4 posterior of the rectum.

The middle and posterior fibers end for some of them with the tip of the coccyx, but mainly with the anococcygeal raphe. This raphe is continuous with the fibroelastic anococcygeal ligament, which is applied and partly attached to its inferior surface.

2. An inferomedial part comprising the puborectalis and the pubovisceralis

The puborectalis

- (a) Origin: the posterior face of the body of the pubis just above the lower border, slightly lateral to the midline

- (b) Direction: anteroposterior, almost horizontal slightly backward and downward, roughly 1 cm height; its upper portion is directly in contact with the lower border of the iliococcygeus

- (c) End: a sling dorsal to the anorectal junction

The pubovisceral comprises three different fascicles:

1. The pubovaginalis

- Origin: the body of the pubis just above the lower border, medial to the puboperinealis
- End: Posterolateral vaginal wall at the level of the mid-urethra

2. The puboperinealis

- Origin: the body of the pubis, lateral to the previous one
- End: perineal body

3. The puboanalis

- Origin: the body of the pubis (higher than the previous ones) medial to the insertion of the iliococcygeus
- Direction: slightly oblique backward and downward; immediately after its insertion, goes between the puborectalis and the puboperinealis, then follows the medial border of the puborectalis
- End: the lateral border of the anal canal and the intersphincteric space

The ischiococcygeus muscle does not belong to the levator ani. It lies just in contact with the most posterosuperior portion of levator ani; it is a small muscle which extends from the ischiatic spine to the lateral margin of the coccyx and the fifth sacral segment along the sacrospinous ligament, closing the pelvic floor between the piriformis and the posterior part of the iliococcygeus.

The Piriformis

It mainly arises from the anterior face of the sacrum from the anterior parts of S2, S3, S4 by three digitations, which are attached to the bone between the pelvic sacral foramina, and to the grooves leading from foramina. The muscle passes out of the pelvis through the greater sciatic foramen. It inserts into the medial side of the upper border of the greater trochanter.

Obturator Internus

This muscle and the fascia over its upper inner surface form part of the anterolateral wall of the true pelvis. The lateral part of obturator internus is attached to the structures surrounding the obturator foramen, and to the medial part of the obturator membrane. This muscle is covered on its medial part by a thick fascial layer; this parietal pelvic fascia is well differentiated as the obturator fascia. This fascia arches below the obturator vessels and nerve, investing the obturator

canal, and is attached anteriorly to the back of the body of the pubis. A thickening of this fascia, the tendinous arch of the levator ani gives a firm attachment to the levator ani (see above).

The Content

From the front to the back

In Front, the Urinary Axis

In front, the urinary axis with the bladder (which arises from the urogenital sinus except the trigona which arises from the mesonephric ducts) and the upper half of the urethra (which arises from the urogenital sinus) (see Chap. 1).

Below the Bladder the Urethra

Female urethra is 4 cm length, 6 mm in diameter.

The urethra has:

1. Origin: internal urethral orifice, the middle of the symphysis pubis. It runs anteroinferiorly in front of the anterior vaginal wall, with a slight anterior curve from its origin to its end.

2. Mainly a subperitoneal segment: Above the inferior fascia of the pelvic diaphragm

Anteriorly: in the normal female, the bladder neck (which is the internal urethral orifice) sits above the pelvic floor supported predominantly by the pubovesical ligaments (fibromuscular tissue extending from the bladder neck to the inferior aspects of the pubic body), the endopelvic fascia of the pelvic floor, and levator ani; these support the urethra at rest. With elevation of intra-abdominal pressure, the levators contract, increasing urethral closure pressure to maintain continence.

This anatomical arrangement alters after parturition and with increasing age, such as the bladder neck lies beneath the pelvic floor particularly when the intra-abdominal pressure rises. The mechanism described above fails to maintain continence (stress incontinence as a result of urethral hypermotility).

Posteriorly: the anterior vaginal wall

3. A short perineal segment

In the deep perineal space: crosses medially the perineal membrane posteriorly to its anterior attachment to the pubourethral ligament of Henlé (transverse perineal ligament) and to the arcuate ligament (both of them forming the *sus urethral lamina* of Testut)

In the superficial perineal space: runs between the anterior aspect of the bulbs of the vestibule immediately behind their anterior junction (the *commissura bulborum*)

4. End: urethral meatus

In the vestibule of the vulva

Anterior to the tubercle of the anterior wall of the vagina

c. 2.5 cm behind the glans clitoridis

Relationships:

Backward: the anterior vaginal wall

The wall consists of an outer muscle coat and an inner mucosa.

In the Middle, the Genital Axis

In the middle, the genital axis with the derivatives of the Muller duct (see Chap. 1) tubes, uterus body, cervix, and vagina with two parts (one issued from the Muller duct and the other above the hymeneal membrane issued from the urogenital sinus).

In the Back, the GI Tract Axis

In the back, the GI tract axis with the rectum (which arises from the hindgut). In fact the rectum has two segments:

1. The intraperitoneal segment
2. The subperitoneal segment enclosed in perirectal fascia and separated from it by the mesorectum

The Vesicovaginal Septum

The vesicovaginal septum (Fig. 2.6) between posterior wall of the bladder and the anterior wall of the vagina.

The Rectovaginal Septum

The rectovaginal septum (Fig. 2.6) between the posterior wall of the vagina and the anterior perirectal fascia.

Laterally

Posteriorly, the sacrorectogenital fasciae (see Chap. 17)

The roof is formed by the uterosacral ligament. The floor is at the level of the levator ani

Anteriorly and laterally:

- (a) The peritoneum forms:
 - The median umbilical fold covering the urachus
 - The medial lateral folds covering the obliterated umbilical arteries
- (b) In front and below these folds is the subperitoneal space of Retzius defined as:
 - The apex: the umbilicus
 - The floor: the pelvic fascia covering the anterior part of levator ani immediately behind pubic symphysis
 - Anteriorly: the fascia transversalis covering the inner part of the anterior abdominal wall
 - Posteriorly: the peritoneum with the median and medial umbilical folds
 - Laterally: a cellular sheet, which is a condensation of subperitoneal issue heightened by the umbilicovesical arteries called by Testut the umbilicovesical aponeurosis

Vascularization (Fig. 2.8)

The Extraperitoneal Space

This anatomical space is the compartment lateral to the lateral pelvic parietal peritoneum. Although it is not individualized in anatomic textbooks, it is isolated here because it is a particular space concerning the pathways of extension.

In front, it is limited by the pubis.

Backward, it is limited by the ischiatic spine.

It is in continuity with the subperitoneal and retroperitoneal spaces.

Medially it is limited by the lateral parietal peritoneum.

It contains from inside to outside:

1. The parietal pelvic ureter. It is adherent to the lateral part of the peritoneum. It lies close the uterine artery and behind it, behind the posterior leaf of the mesometrium, before entering the Mackenrodt ligament.
2. The hypogastric gain of Faraboeuf raised by the hypogastric branches of the hypogastric artery and veins. The hypogastric artery gives from the front to the back:
 - (a) The vesical arteries
 - (b) The uterine artery (usually with a common trunk with the umbilical artery at its origin) and its branches

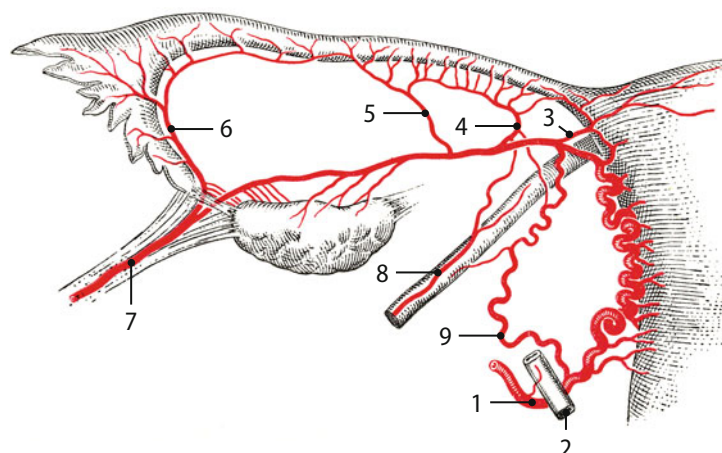


Fig. 2.8 1 Uterine artery, 2 ureter, 3 artery of the fundus, 4 medial tubal artery, 5 middle tubal artery, 6 lateral tubal artery, 7 ovarian artery and suspensory ligament of the ovary, 8 artery of the round ligament, 9 anastomose between the uterine artery and its terminal portion (From EZES)

- (c) The middle hemorrhoidal artery (which will give the inferior hemorrhoidal artery, also called the pudendal artery). Lymph nodes in a space limited by:
 1. In front, the posterior part of the iliac external vein; backward the pelvic parietal ureter; and outward the obturator nerve. In oncologic surgery, this space is the fundamental area of lymphadenectomy
 2. The nervous plane with the obturator nerve

The Retroperitoneal Space (Fig. 2.9)

From the back to the front:

1. *The sacrum*
2. *Immediately in front of the sacrum, parietal pelvic fascia:* a plane formed by the presacral fascia and immediately laterally in contact, the fascia over piriformis
 - (a) *The presacral fascia*

Its limits are as followed:

 - Above, the promontory
 - Below, the posterior part of the anorectal junction
 - Laterally, the posterior part of the tendinous arches of the pelvic fascia(a thick white band extending from the lower part of the symphysis pubis to the inferior margin of the spine of the ischium).
 - Behind the fascia: the presacral veins*
 - In front of the fascia: the right and left hypogastric nerves,* coming from the superior hypogastric plexus
 - (b) *Immediately laterally Fascia over piriformis*

It is very thin and fuses with the periosteum in front of the sacrum at the margins of the anterior sacral foramina. It ensheathes the *sacral anterior primary rami* which lies behind the fascia (GRAY 1360) [2].

The internal iliac vessels lie in front of the fascia over piriformis, and their branches draw out sheaths of the fascia and extraperitoneal tissue into the gluteal region.
3. *In front, the hindgut with the end of the sigmoid and the rectum*
 - (a) From the promontory to the inferior part of the primary root of the mesosigmoid (usually S3), the sigmoid with its posterior meso and laterally the posterior parietal peritoneum.

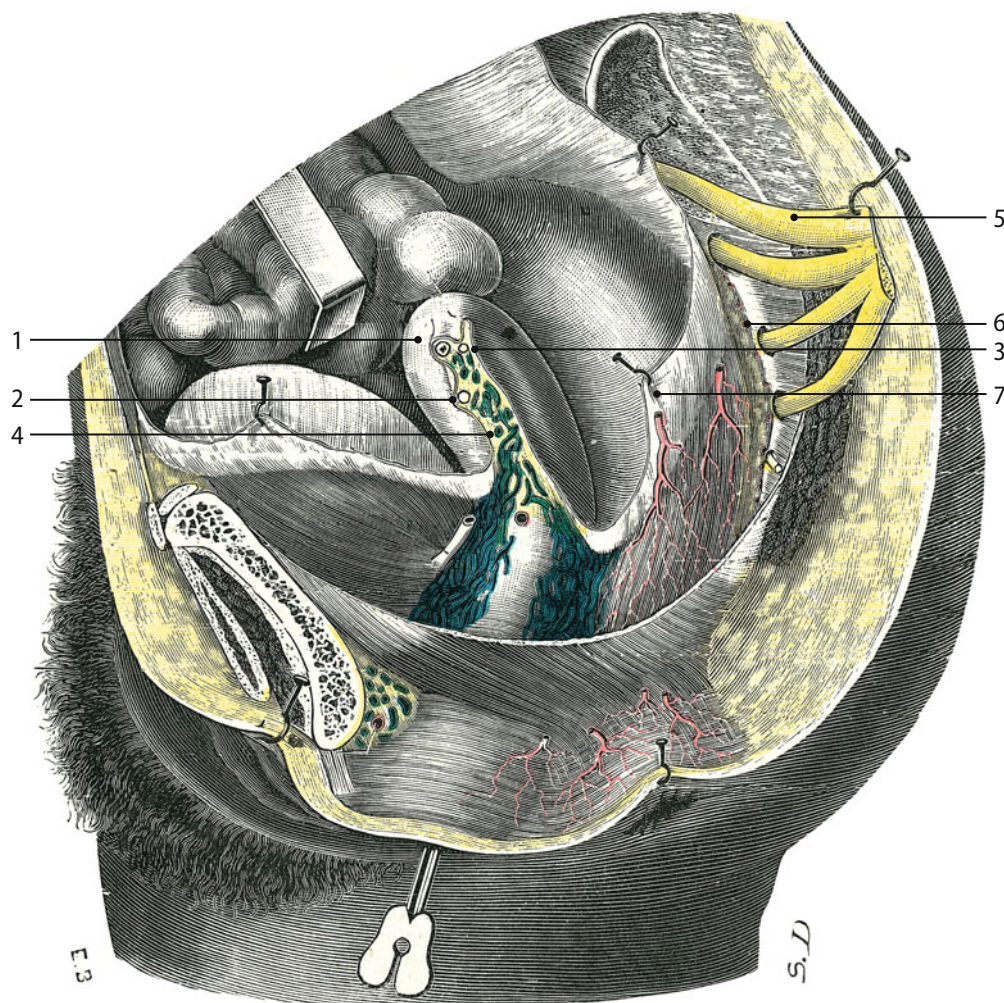


Fig. 2.9 Lateral view of the inner part of the broad ligament and of the retroperitoneal space. 1 Tube, 2 round ligament, 3 utero-ovarian ligament, 4 venous plexus, 5 sacral plexus, 6 fascia of piriformis, 7 posterior parietal peritoneum

(b) Below this level, the peritoneum covers the anterior part of the rectum until the bottom of the Douglas and ascends from this bottom posteriorly, according to an obliquely line until the inferior part of the primary root of the mesosigmoid, and from that part, continues with the posterior parietal pelvic fascia. At this level, the rectum is considered as intraperitoneal.

Laterally, it is in continuity with the posterior parietal peritoneum. Below this level, visceral fascia ensheathes the rectum until the anorectal junction. The rectum is subperitoneal with its visceral mesorectal fascia.

The Perineal Space (Figs. 2.10 and 2.11)

Perineal space is the anatomical compartment below the pelvic floor and is diamond shaped.

It is limited by:

- The deep limit: the inferior surface of the pelvic diaphragm (formed by levator ani and coccygeus) covered with the deep fascia lining the inferior surface of the levator ani, which is continuous at its lateral origin with the fascia over obturator internus below the attachment of levator. It lines the deep portion of the ischioanal fossa and its lateral walls
- The superficial limit: the skin which is continuous with that of the medial aspects of the thighs and the lower abdominal wall

- Anteriorly: pubic symphysis and arcuate ligament, the transverse ligament of Henle
- Posteriorly: coccyx
- Anterolaterally: isciopubic rami and the ischial tuberosities
- Posterolaterally: sacrotuberous ligaments

Perineum

Perineum is divided by a line joining the ischial tuberosities into an anterior genital triangle and a posterior genital triangle.

It contains:

1. The posterior anal triangle
2. The urogenital triangle from the deep part to the skin. This urogenital compartment contains:
 - The deep perineal space (deep limit: the inferior surface of the pelvic diaphragm)
 - The superficial perineal space (superficial limit: the superficial perineal fascia)
 - The vulva or pudendum or female external genitalia (the upper limit, the superficial perineal fascia; the lower limit, the skin)

In the middle of the line joining the ischial tuberosities is the **PERINEAL BODY**

It is a poorly defined aggregation of fibromuscular tissue located at the junction between the anal and urogenital triangles.

It is attached to many structures in both the deep and superficial urogenital spaces:

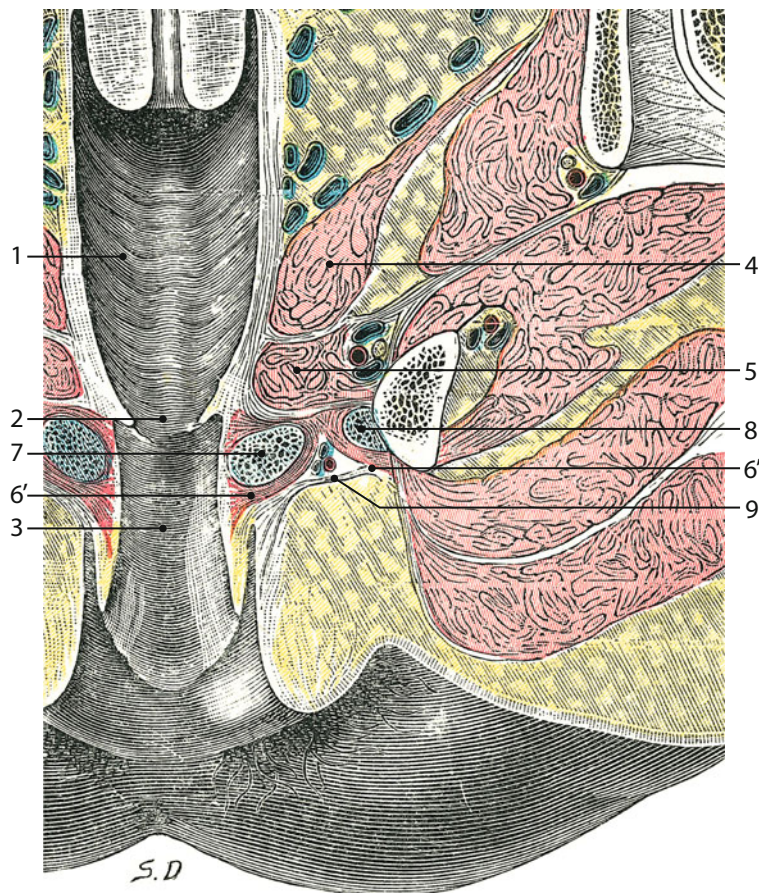


Fig. 2.10 Coronal section through the middle part of the vagina. 1 Subperitoneal vagina, 2 vaginal introitus, 3 vestibular vagina, 4 levator ani, 5 deep transverse muscle, 6' bulbospongiosus muscle, 6'' ischiocavernous muscle, 7 bulb of vestibule, 8 crus of clitoris, 9 superficial aponeurosis of perineum (From Testut)

- Posteriorly fibers from the middle part of the external anal sphincter and the conjoint longitudinal coat
- Superiorly the rectovaginal septum including fibers from levator ani (puborectalis and pubovaginalis)
- Anteriorly the deep transverse perinei, the superficial transverse perinei, the bulbospongiosus
- The perineal body is continuous with the perineal membrane and the superficial perineal fascia.

Anal Triangle [2, 3] (Fig. 2.10)

It is limited by:

- (a) Superficially: superficial fascia continuous with the superficial fascia of the perineum, thighs and buttocks.
- (b) Deeply: deep fascia lines the inferior surface of the levator ani and is continuous at its lateral origin with the fascia over the obturator internus below the attachment of levator. It lines the deep portion of the ischioanal fossa and its lateral walls.

It contains

- (a) Ischioanal fossa limited by:
 - Laterally:
 - Anterolaterally, the deep fascia over obturator internus deeply, and ischial tuberosities more superficially
 - Posterolaterally, the lower border of gluteus maximus and the sacrotuberous ligament

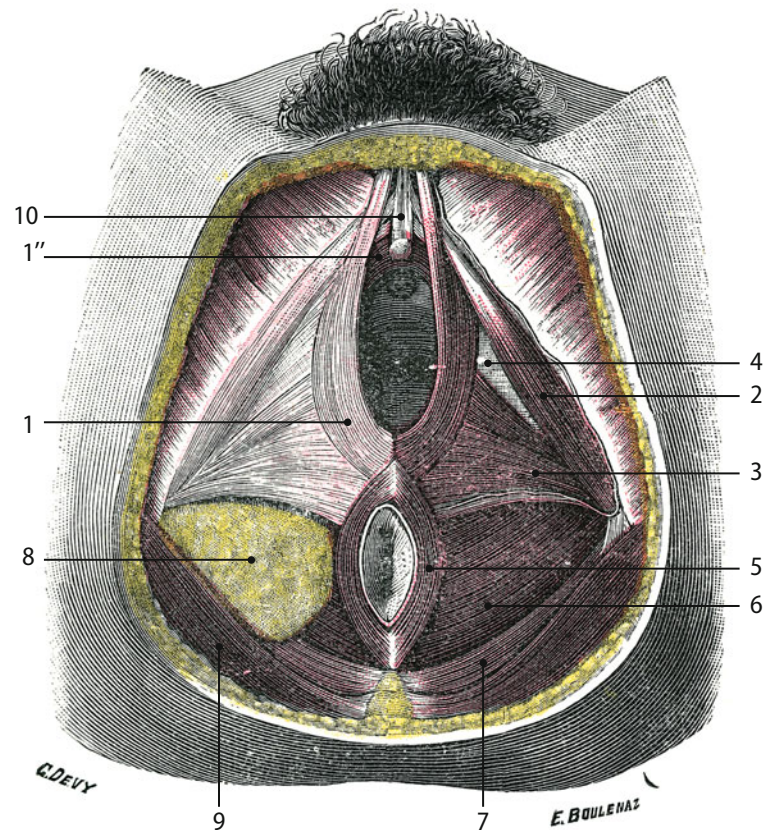


Fig. 2.11 Superficial perineal space. On the left side superficial fascia or Colles' fascia has been removed. 1 Bulbospongiosus muscle, 1' internal fascicle, 1'' external fascicle, 2 ischiocavernous muscle, 3 superficial transverse perinei, 4 perineal membrane, 5 external anal sphincter, 6 evator ani, 7 ischiococcygeus muscle, 8 adipose tissue of the ischio rectal fossa, 9 gluteus maximus, 10 clitoris (From Testut)

- Anteriorly:
- Superficially the posterior aspect of the urogenital triangle. Deep to this there is no fascial boundary between the fossa and the tissues deep to the perineal membrane as far anteriorly as the posterior surface of the pubis below the attachment of levator ani.

(b) Anal canal

The anal canal has a mucosa, a submucosa, an internal anal sphincter, and an external anal sphincter separated by a longitudinal layer.

1. Internal anal sphincter: It is a well defined ring of obliquely oriented smooth muscle fibers continuous with the circular muscle of the rectum, terminating at the junction of the superficial and subcutaneous components of the external sphincter.
2. External anal sphincter: It is an oval-shaped complex of striated muscle fibers.
 - The uppermost fibers blend with the lowest fibers of the puborectalis; anteriorly some of these upper fibers decussate into the superficial transverse perineal muscles; posteriorly some fibers are attached to the anococcygeal ligament.
 - The majority of middle fibers surround the lower part of the internal sphincter; this portion is attached anteriorly to the perineal body, posteriorly to the anococcygeal ligament
 - The lower fibers lie below the level of the internal anal sphincter and are separated from the lowest anal epithelium by submucosa

3. Longitudinal layer is situated between the internal and external sphincters.

- It contains the conjoint longitudinal coat and the intersphincteric space with its connective tissue components
- The conjoint longitudinal coat has two components: an upper muscular and a lower fibroelastic component
- The muscular component is formed by the fusion of striated muscle fibers from puboanalis with smooth muscle from longitudinal muscle of the rectum.
- The layer then becomes completely fibroelastic, and splits into septa. The most peripheral septa extend through the external sphincter into the ischioanal fossa; the most central septa pass through it

(c) Anococcygeal ligament

It runs between middle portion of the external anal sphincter and the coccyx. The lowest portion of the presacral fascia lies above the deep part of the ligament and between the two lie the most posterior fibers of the raphe of the iliococcygeus

Urogenital Triangle

Urogenital triangle [2, 3] (Figs. 2.10 and 2.11): extends from the inferior surface of the pelvic diaphragm to the lower limit of the labia and mons pubis. It is divided into two parts by a strong perineal membrane: the *deep perineal space* and the *superficial perineal space*

Deep Perineal Space

(a) Is limited by

- Deeply: the endopelvic fascia of the pelvic floor
- Superficially: the perineal membrane
- Medially: it leaves passage to the urethra and the vagina

(b) It contains from deeply to superficially:

1. The endopelvic fascia of the pelvic floor
2. The deep perineal space between the endopelvic fascia and the fascia over deep transverse perineal. It is filled with adipose tissue. It is the narrow continuation of the ischioanal fossa extending until the body of the pubis
3. The fascia above deep transverse perineal (superior sheet of the middle aponeurosis from Testut)
4. The transverse perineal
5. The perineal membrane

Superficially: the perineal membrane (inferior fascia of the urogenital diaphragm)

This membrane is triangular, attached:

- Laterally to the periosteum of the ischiopubic rami
- The posterior border: is fused with the deep part of the perineal body and is continuous with the fascia over the deep transverse perineal. The upper sheet is continuous posteriorly with the lower part of the rectovaginal septum
- Anteriorly at the apex: fascia over transverse perineal and the perineal membrane join to form very tight aponeurotic fibers, the transverse ligament of Henlé also called the pubourethral ligament. Its apex is attached the arcuate ligament of the pubis

It is divided almost in two halves by the vagina and urethra such that it forms a triangle on each side of these structures which join anteriorly the pubourethral ligament of Henlé (just behind the arcuate ligament) links the two sides anteriorly

(c) It contains: the deep transverse perineal superficial to the transverse perineal: the urethral sphincter mechanism the urethral sphincter mechanism consists of intrinsic striated and smooth muscle of the urethra and the pubourethral component of the levator ani. It surrounds the middle and lower thirds of the urethra.

- Under: compressor urethra, arises from ischiopubic rami of each side by a small tendon. Fibers pass anteriorly to meet with their contralateral counterparts in a flat band anterior to the urethra, below sphincter urethrae
- Under: sphincter urethrovaginalis: arises from the perineal body pass on each side of the vagina and urethra to meet their contralateral counterparts in a flat band anterior to the urethra, below compressor urethra

(d) The perineal membrane is divided almost in two halves by the vagina and urethra crossed by:

- On the midline: the urethra 2–3 cm behind the inferior border of the symphysis pubis, the vagina
- Behind the pubis the pubourethral ligament, the deep dorsal vessels, and nerves of the clitoris
- Anterior to the transverse perineal, the posterior labial vessels and nerves

Superficial Perineal Space [2, 3] (Table 2.1) (See Chap. 34)

(a) Is limited by:

- Deeply: the perineal membrane the deep perineal fascia is attached to the ischiopubic rami and to the posterior margin of the perineal membrane and perineal body over the membranous layer. In front, it fuses with the suspensory ligament of the clitoris and the fasciae of external oblique and the rectus sheath.
- Superficially: the superficial perineal fascia also called Colles' fascia is attached to:
 - Posteriorly: the fascia over the superficial transverse perineal and the posterior limit of the perineal membrane
 - Laterally: the margins of the ischiopubic rami and the ischial tuberosities. From here it runs more superficially to the skin of the urogenital triangle, lining the external genitalia and then in continuity with the fascia of Scarpa of the anterior abdominal wall.

(b) It contains:

1. The deep perineal fascia is attached to the ischiopubic rami and to the posterior margin of the perineal membrane and perineal body over the membranous layer. In front, it fuses with the suspensory ligament of the clitoris and the fasciae of external oblique and the rectus sheath.
2. Superficial transverse perineal: laterally is attached to the medial and anterior aspect of the ischial tuberosity, medially the perineal body

Table 2.1 Components of the vulva

Anatomical compartment		
Anatomical structures	Vulva	Superficial perineal space
1. Labial formations		
Mons pubis	Mons pubis	
Labia majora	Labia majora	
Labia minora	Labia minora	
2. Erectile organs		
<i>Clitoris</i>		
Corpora cavernosa		Corpora cavernosa
Corpus clitoridis	Corpus clitoridis (1/2 anterior)	Corpus clitoridis (1/2 posterior)
Glans	Glans	
<i>Bulbs of the vestibule</i>		
	Bulbs of the vestibule (anterior part: join to the posterior part of corpus clitoridis)	Bulbs of the vestibule (posterior and middle part)
3. Glands		
<i>Greater vestibular glands</i>		
	Greater vestibular glands (anterior part)	Greater vestibular glands (posterior and middle part)
Ducts	Ducts	
<i>Skene's glands</i>		
Skene's ducts	Skene's ducts	Skene's ducts
4. Vestibule (between labia minora)		
<i>Urethra</i>		
	Urethral meatus (in vestibule)	Urethra (perineal portion)
<i>Vagina</i>		
	Vaginal orifice (in vestibule)	Vagina (part of perineal portion)
	Hymen	

3. Bulbospongiosus attaches to the perineal body; on each side is separate; covers the superficial part of the vestibular bulbs; and greater vestibular glands run anteriorly on each side of the vagina to attach to the corpora cavernosa clitoridis
 4. Ischiocavernosus attaches on the ischiopubic ramus on both sides of the corpus clitoridis ends in an aponeurosis attached to the sides and under surface of the of the crus
- (c) Between the medial parts of the bulbospongiosus muscles, cross:
- The lower part of the urethra
 - The lower part of the vagina

Vulva or Pudendum or Female External Genitalia [3] (Table 2.1) (See Chap. 34)

Definition: Anatomical compartment of the perineum situated below the superficial perineal space of the anterior genital triangle limited by:

- Deeply: the superficial perineal fascia
- Superficially: the skin
- In fact this anatomical space contains two types of anatomical structures: structures which entirely belong to this space (labial formations, vestibule), structures which belong to the superficial perineal space (bulbs of the vestibule) or both (clitoris)

It contains:

1. Labial formations: Mons pubis, labia majora, labia minora

2. In its middle part: Vestibule

The vestibule contains vaginal orifice (Introitus) hymen vaginae

External urethral orifice also called: External urethral meatus

3. Erectile organs: the clitoris and the bulbs of vestibule

Clitoris: Posterior portion of the corpus clitoridis and its two corpora cavernosa covered superficially by ischiocavernosus muscle lie in the superficial perineal space

Anterior portion of corpus clitoridis and the glans belong to the pudendum

Bulbs of vestibule (posterior portion) are covered superficially by bulbospongiosus muscles in the medial part of the superficial perineal space; the anterior portion of the bulbs are thin in the vestibule.

4. Glands

The greater vestibular glands or Bartholin's glands are situated in the superficial perineal space; each opens into the vestibule by a duct of c. 2 cm in the groove between the hymen and a labium minus

The Skene's glands are situated all along the subperitoneal and the perineal portions of the urethra. Small glands and minute recesses or lacunae open into the urethra. Near the lower end of the urethra, number of these glands group together and open into a duct, named the paraurethral duct. Each runs down into the submucous tissue of the urethra and ends in a small aperture on the lateral margin of the external urethral orifice.

2.2 Anatomical Locations of Pelvic Masses

2.2.1 Gynecologic Pelvic Masses

2.2.1.1 Ovary (Fig. 2.12)

Typical findings in favor of a location to the ovary are reported in Table 2.2.

2.2.1.2 Tube (Figs. 2.13 and 2.14)

Typical findings in favor of a location to the tube are reported in Table 2.3

2.2.1.3 Uterine Masses Distorting the Contour of the Uterus

1. *Mainly subserous leiomyoma (sessile or pedunculated)*

Anatomy:

Continuity with the uterus or visualization of the pedicle

Differential diagnosis:

1. Ovarian fibrothecoma
2. Carcinoma of the ovary

As far as vascularization of subserous leiomyoma, it is mainly furnished by the large marginal segment of the uterine artery and of ovarian tumors by the thin ovarian artery and the tubo-ovarian artery, vascular findings, and contrast uptake of these processes are quite different. Vascularization and contrast uptake are reported in Table 2.4 (Fig. 2.15 and 2.33).

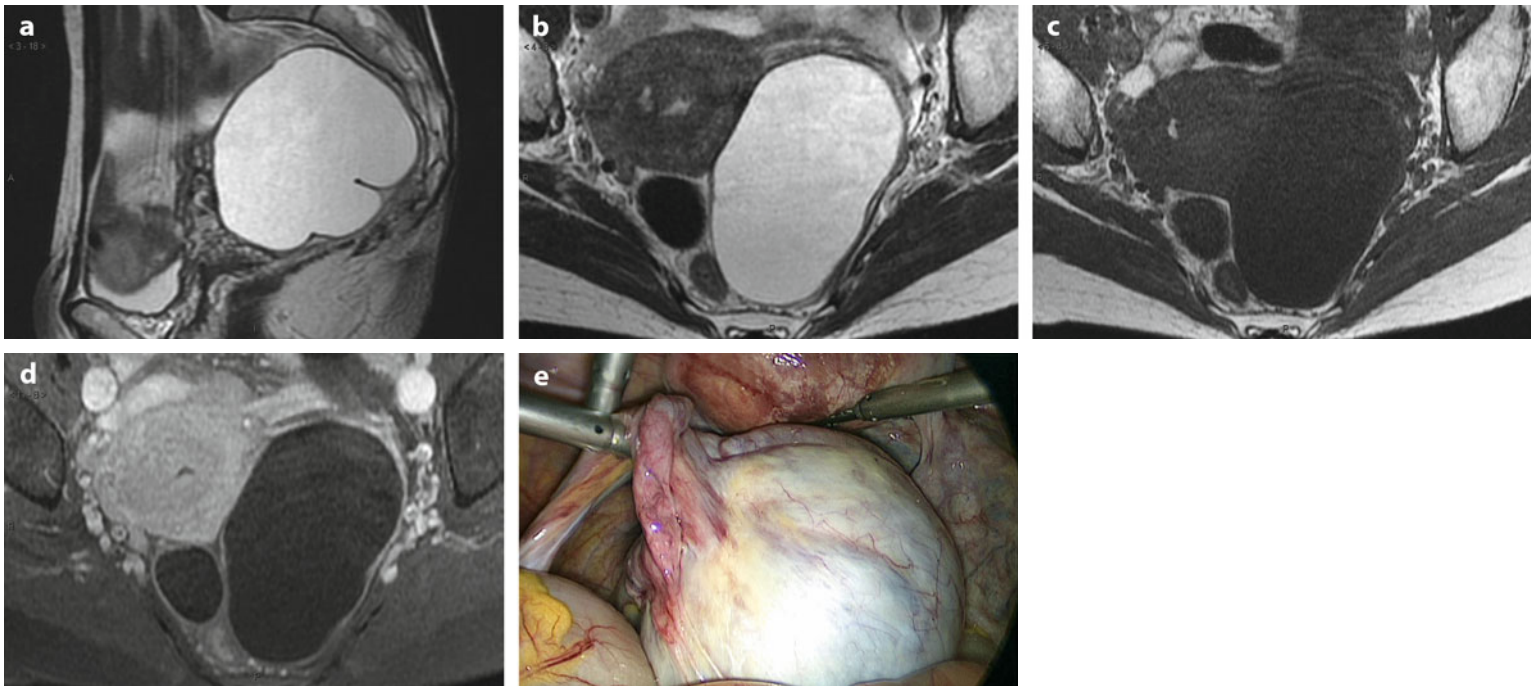


Fig. 2.12 Unilocular mucinous cystadenoma. Fifty-three-year-old woman. MR Sagittal T2 (a) and axial T2 (b) T2 display a unilocular cystic mass, with convoluted inferior border which discusses a possibility of hydrosalpinx. Visualization of the normal right ovary, while a normal left ovary independent of the mass is not visualized and the fact as the tumor is completely surrounded by a low intensity rim are in favor of an ovarian origin. On axial T1 (c) signal intensity is slightly superior to urine. On fat suppression after injection (d) a contrast uptake around the mass is in favor of an ovarian mass. Prospective diagnosis: ovarian cystic benign tumor. A hydrosalpinx is much more unlikely. Coelioscopy (e): confirms the mass is ovarian in origin. Microscopy: mucinous cystadenoma (cellular type not précised)

Table 2.2 Findings in favor of a location to the ovary

1. Anatomy
Usually in the ovarian fossa, limited in front by the external iliac vein, behind by the uterine artery and the pelvic ureter; may be in front, behind, inward, higher
Separated from the uterus (may be adherent)
Infundibular ligament and tubo-ovarian vessels arrive in the mass
2. Shape and structure
Round or oval
External cortex, hypoechogenic, low signal on T2 (related to high concentration of collagen)
When small or benign surrounded by ovarian parenchyma
After contrast (CT MR), a ring of contrast surrounds completely the mass
3. Differential diagnosis
(a) Cystic: hydrosalpinx, paraovarian cyst, inclusion peritoneal cyst, Tarlov cyst
(b) Solid masses
Benign: fibrothecoma versus subserous leiomyoma
Malignant: ovarian carcinoma versus leiomyoma

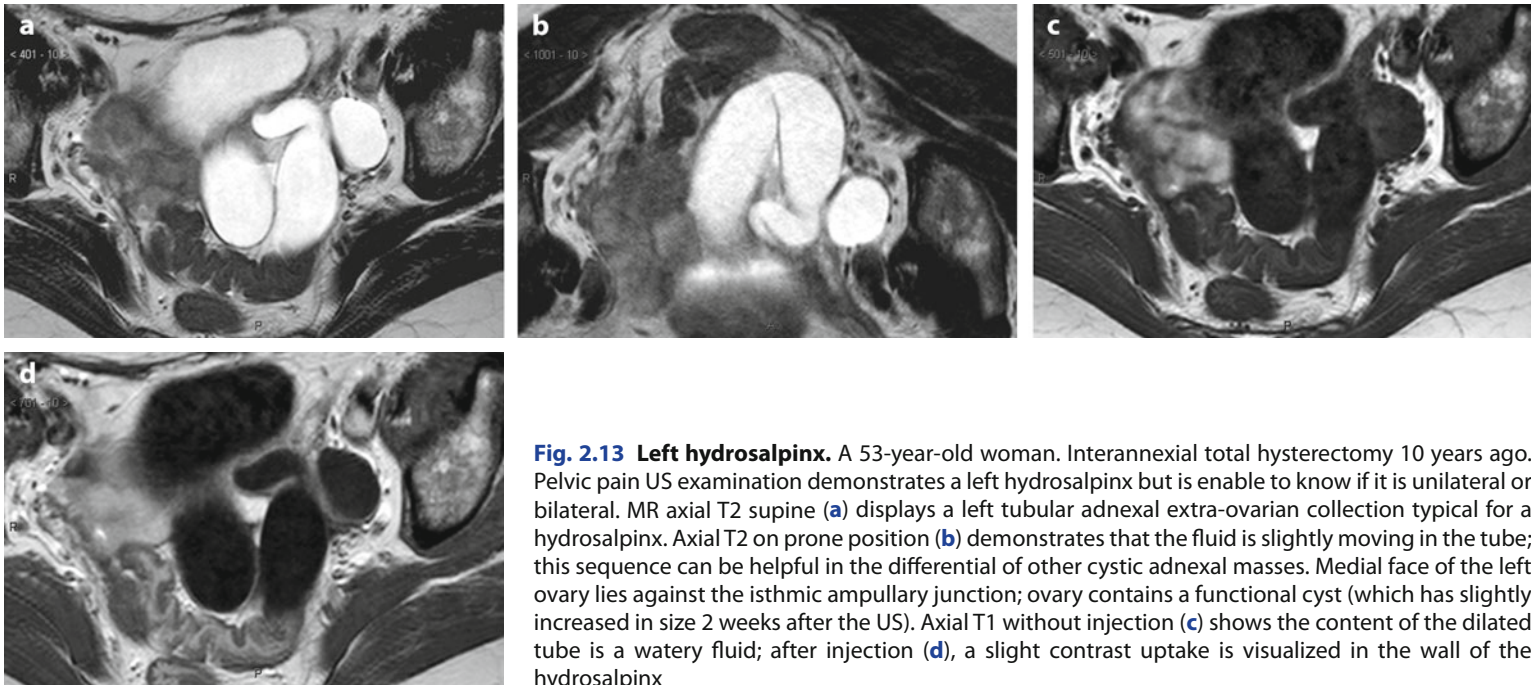


Fig. 2.13 Left hydrosalpinx. A 53-year-old woman. Interannexial total hysterectomy 10 years ago. Pelvic pain US examination demonstrates a left hydrosalpinx but is unable to know if it is unilateral or bilateral. MR axial T2 supine (a) displays a left tubular adnexal extra-ovarian collection typical for a hydrosalpinx. Axial T2 on prone position (b) demonstrates that the fluid is slightly moving in the tube; this sequence can be helpful in the differential of other cystic adnexal masses. Medial face of the left ovary lies against the isthmus ampullary junction; ovary contains a functional cyst (which has slightly increased in size 2 weeks after the US). Axial T1 without injection (c) shows the content of the dilated tube is a watery fluid; after injection (d), a slight contrast uptake is visualized in the wall of the hydrosalpinx

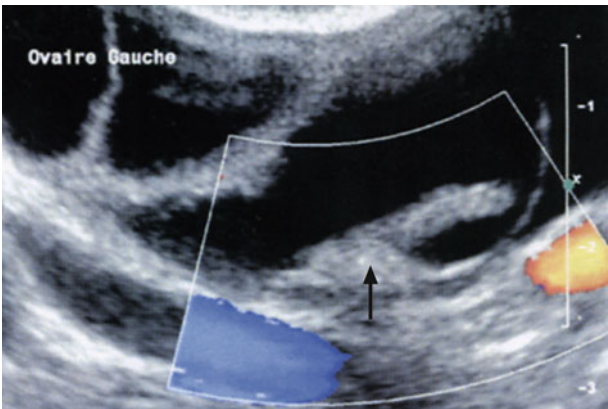


Fig. 2.14 Plica in a hydrosalpinx. In a tubular shape cystic adnexal mass related to an hydrosalpinx, localized tissular portion can simulate a papillary projection. When the digitiform shape and the oblique orientation are present like in this case, these morphologic findings are very helpful to distinguish it from a papillary projection in an ovarian cyst and to diagnose a plica (arrow). However, in some cases, the plicae can be smaller and round, impossible to distinguish from an endocystic papillary projection

Table 2.3 Findings in favor of a location to the tube

1. Anatomy
Subperitoneal in the upper part of the broad ligament, except the infundibulum which is intraperitoneal. Ampulla and infundibulum medial to the ovary
2. Shape and structure
Tubal shape with increasing diameter toward the periphery. Particular shape of the infundibulum
Foldings of the outer wall, plicae of the inner wall with the possibility of the very suggestive cogwheel sign
3. Differential diagnosis
(a) Cystic hydrosalpinx, paraovarian cyst, inclusion peritoneal cyst, Tarlov cyst
(b) Solid benign and malignant most in a hydrosalpinx

2.2.2 Broad Ligament

2.2.2.1 Paratubal or Paraovaian Cysts (Fig. 2.16)

According to the embryologic origin, there are two types: paramesonephric and mesonephric cysts.

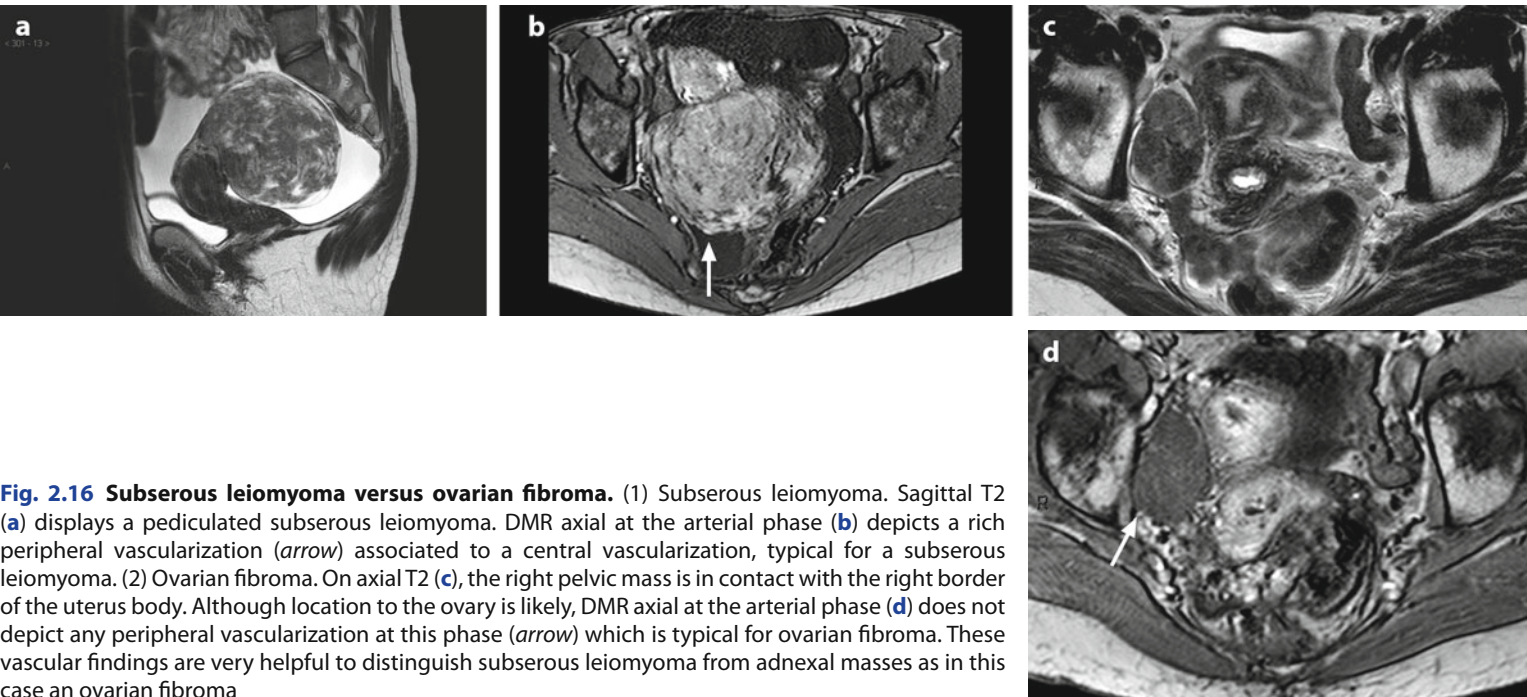


Fig. 2.16 Subserous leiomyoma versus ovarian fibroma. (1) Subserous leiomyoma. Sagittal T2 (a) displays a pediculated subserous leiomyoma. DMR axial at the arterial phase (b) depicts a rich peripheral vascularization (arrow) associated to a central vascularization, typical for a subserous leiomyoma. (2) Ovarian fibroma. On axial T2 (c), the right pelvic mass is in contact with the right border of the uterus body. Although location to the ovary is likely, DMR axial at the arterial phase (d) does not depict any peripheral vascularization at this phase (arrow) which is typical for ovarian fibroma. These vascular findings are very helpful to distinguish subserous leiomyoma from adnexal masses as in this case an ovarian fibroma

Table 2.4 Findings in favor of a location to the uterus

	Subserous leiomyoma	Ovarian fibrothecoma	Ovarian carcinoma
Artery (Doppler, DCT, DMR)	Peripheral, circular	Central	Central Tumoral thin and irregular
Contrast uptake (DCT, DMR)	High, mainly at the periphery	Low, on the delayed phase straight	High and heterogeneous

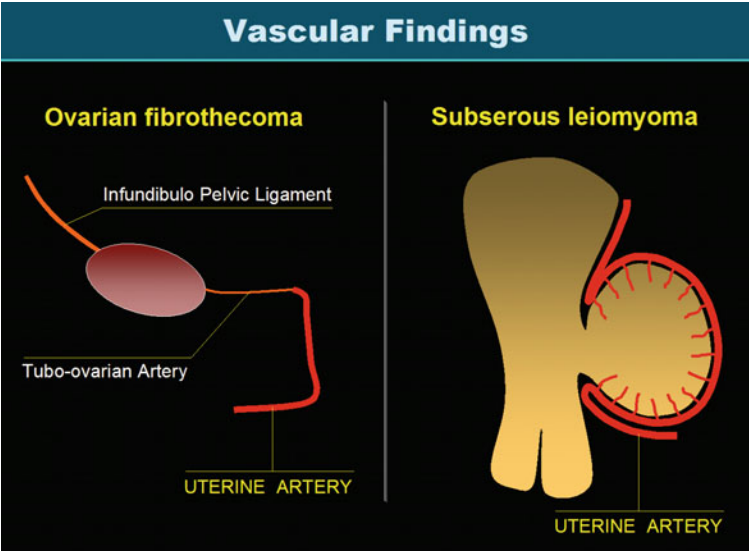


Fig. 2.15 Vascularization of ovarian fibrothecoma versus vascularization of subserous leiomyoma. Vascularization of a fibrothecoma is produced by the ovarian artery and the tubo-ovarian artery of the uterine artery which are of small caliber so that vascularization is poor and mainly central. On the opposite, vascularization of a subserous leiomyoma is produced by the marginal segment of the uterine artery and its branches (the arcuate arteries and the perforating arteries) with a characteristic peripheral vascularization more or less associated with a central vascularization

The main findings of paramesonephric cysts are reported in Table 2.5.

The main findings of mesonephric cysts are reported in Table 2.6.

Table 2.5 Paramesonephric cysts (arise from Mullerian structures)**Definition**

Lined by an epithelium which contains numerous ciliated cells. Some cysts may have papillary infoldings similar to endosalpingeal folds

The Hydatid of Morgagni is by far the most common

Definition

It is lined by ciliated and nonciliated cells and may have small epithelial

Findings

Dangling from one of the fimbriae

Ovoid or round

2–10 mm in diameter

Cystic: serous content

Table 2.6 Mesonephric cysts (arise from Wolffian structures)**Definition**

Lined by an epithelium which contains only a few or no ciliated cells
May have a prominent muscular coat

Anatomy**2.1. Epoophoron, paroophoron (mesonephric tubules)**

In the mesosalpinx

Easy to localize when clearly separated from the ovary; may be in contact with the ovary and in this case impossible to distinguish from an ovarian cyst arising in the ovarian cortex

2.2. Appendix vesiculosa, Gartner duct (mesonephric duct)

In the medial part of the mesometrium either lateral to the body of the uterus, more commonly in the paracervix or the paravagina

Shape and structure

Round or oval

Usually purely cystic, may contain papillary projection

Table 2.7 Findings in favor of location to the mesometrium**Anatomy**

Mass separated from the lateral border of the uterus, moving apart the anterior and posterior leaves of the broad ligament

Round ligament, more rarely uterosacral ligament pushed upward by the mass

Lateral extension until the pelvic wall

Inward displacement of the lateral wall of the bladder

Downward extension until the pubic symphysis

Mass effect on the pelvic ureter in its parametrial portion

Vascularization mainly by branches of the uterine and ovarian artery

Shape and structure

Mainly solid

2.2.3 Peritoneal Masses**2.2.3.1 Peritoneal Inclusion Cyst**

(Figs. 2.18 and 2.19) (See Chap. 16)

Peritoneal pseudocyst occurs in different circumstances, all of them related to peritoneal adhesions: (1) after pelvic surgery, (2) after PID, (3) after endometriosis

Definition: It is defined histologically by an inner sheet of peritoneal flat cells of mesothelial type.

These cells usually secrete clear fluid responsible for the development of the cyst. But in some circumstances, different kinds of fluid may be encountered.

Findings in favor of peritoneal inclusion cysts are reported in Table 2.8.

2.2.3.2 Splenic Parenchyma**Splenosis**

Definition: implantation of splenic tissue on the peritoneum after splenectomy

2.2.2.2 Cystic and Solid Masses (Fig. 2.17) of the Mesometrium

The main findings of cystic and solid masses of the mesometrium are reported in Table 2.7.

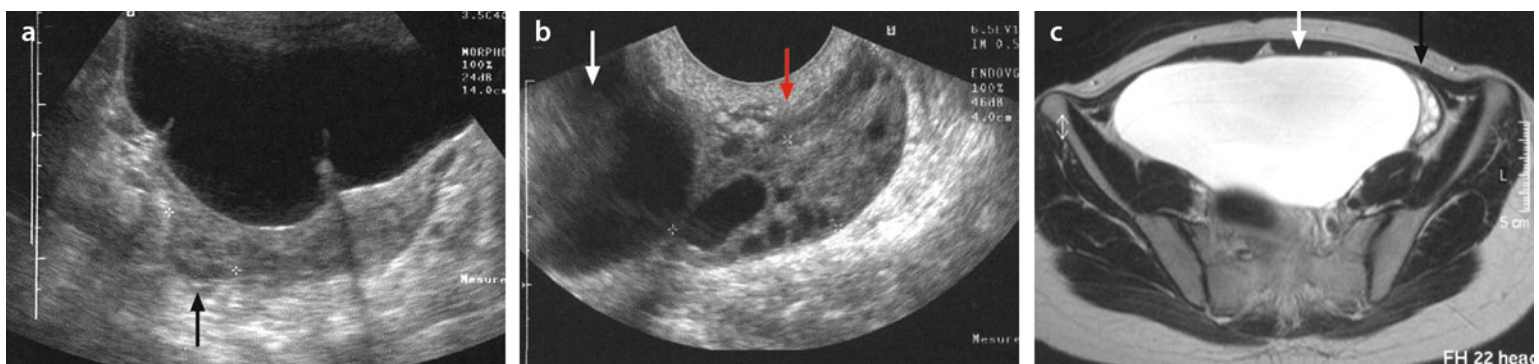


Fig. 2.17 Transverse TAS (a) displays a unilocular cystic mass with bosselated borders anterior to the uterus; a normal right ovary is depicted (arrow). Examination with the endovaginal probe in the lateral portion of left flank (b) depicts the left normal ovary (red arrow) pushed laterally by the cyst

(white arrow). (c) MR axial T2 confirms the extra-ovarian location of the cyst (white arrow) in contact with the left normal ovary (black arrow). Coelioscopy: resection of the cyst. Microscopy: left paraovarian cyst

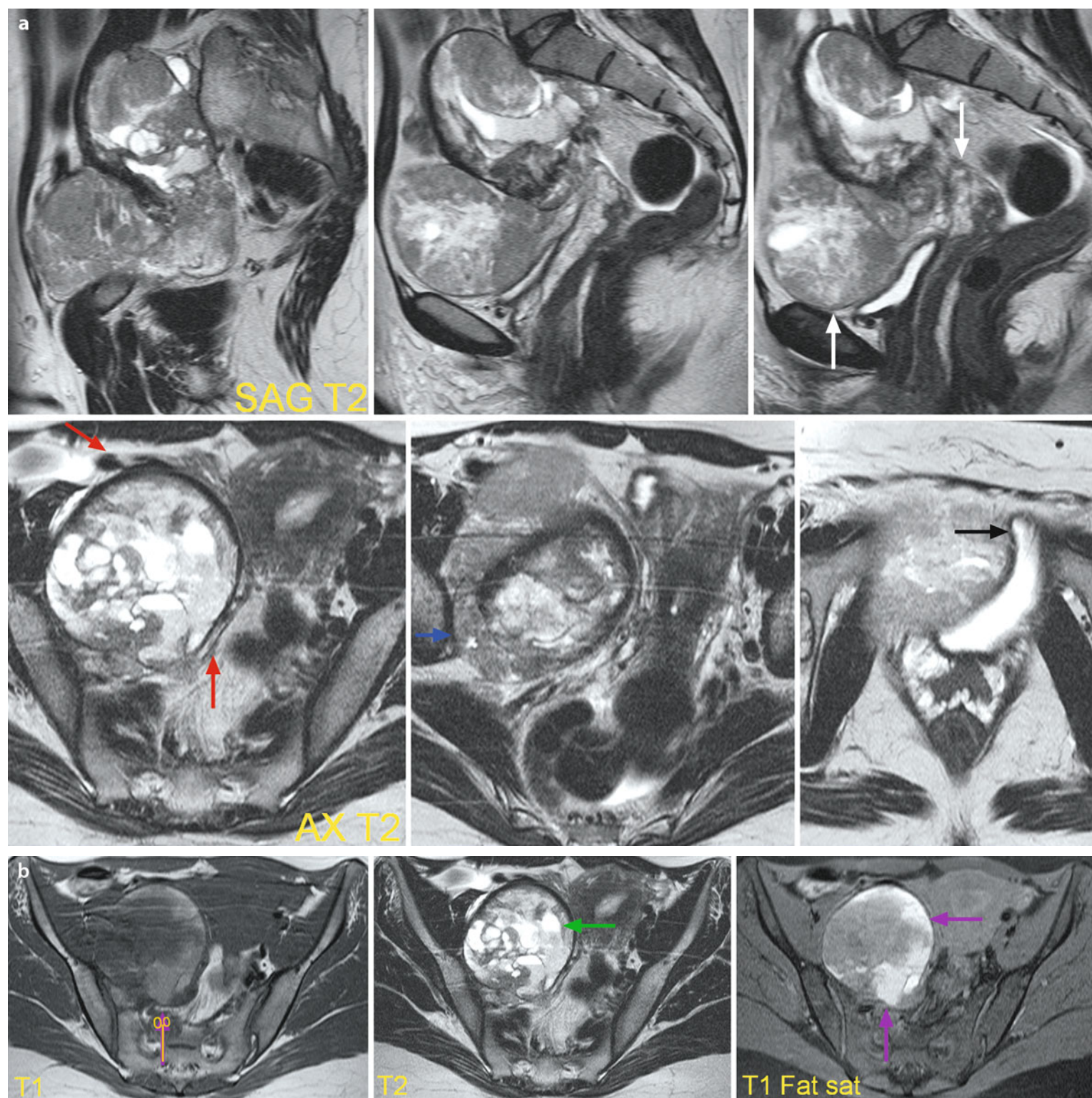


Fig. 2.18 High-grade synoviosarcoma of the broad ligament. (a): MR sagittal T2 (in three contiguous planes) displays a well delineated mass moving apart the anterior and posterior leaves of the broad ligament (white arrows). On Axial T2 at three different levels, the mass (1) pushes inward and upward the round ligament (anterior red arrow) and backward the posterior leaf of the broad ligament (posterior red arrows), (2) extends laterally until the pelvic wall (blue arrow) (3) extends downward until the pubic symphysis

pushing inward the lateral wall of the bladder (black arrow). (b): On axial T2, the mass contains solid tissue of intermediate signal with multiple cystic spaces (green arrow). On axial T1 (pink arrow) and on fat suppression (purple arrow), the solid portions contain hemorrhagic areas. Prospective diagnosis; tumor of the broad ligament. Cystic cavities and hemorrhagic changes suggest the possibility of a sarcoma. Definite diagnosis: high-grade synoviosarcoma of the broad ligament

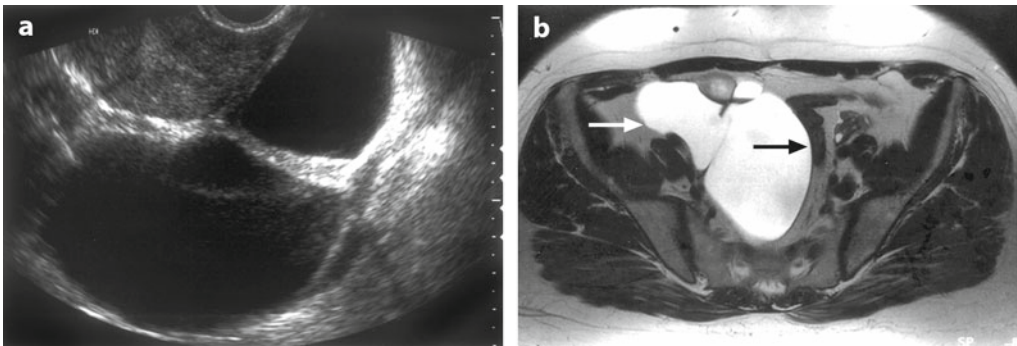


Fig. 2.19 High-grade synoviosarcoma of the broad ligament. (a): MR sagittal T2 (in three contiguous planes) displays a well delineated mass moving apart the anterior and posterior leaves of the broad ligament (*white arrows*). On Axial T2 at three different levels, the mass (1) pushes inward and upward the round ligament (*anterior red arrow*) and backward the posterior leaf of the broad ligament (*posterior red arrow*), (2) extends laterally until the pelvic wall (*blue arrow*) (3) extends downward until the pubic symphysis

pushing inward the lateral wall of the bladder (*black arrow*). (b): On axial T2, the mass contains solid tissue of intermediate signal with multiple cystic spaces (*green arrow*). On axial T1 (*pink arrow*) and on fat suppression (*purple arrows*), the solid portions contain hemorrhagic areas. Prospective diagnosis; tumor of the broad ligament. Cystic cavities and hemorrhagic changes suggest the possibility of a sarcoma. Definite diagnosis: high-grade synoviosarcoma of the broad ligament

Table 2.8 Findings of mucocele

Anatomy: medial border of the cecum usually
Morphologic findings: elongated cystic mass
Differential diagnosis: hydrosalpinx

*Mucocele of the appendix may be associated with a mucinous ovarian tumor

Peritoneal nodules, ranging from punctuate to 7 cm in diameter, are scattered widely throughout the abdominal and less the peritoneal cavity (Fig. 2.20). Splenic tissue in the pelvis has the same echogenicity, density on CT, or signal on MR as the nodules situated in the left subphrenic space.

Pelvic Accessory Spleen

Exceptionally, pelvic accessory spleen can be present (Fig. 2.21).

2.2.4 Extraperitoneal Masses

Lymph node metastases of pelvic carcinoma is the major cause of masses in this space; a fundamental finding to differentiate them from intraperitoneal masses particularly ovarian masses is the peritoneum lying medial to these extraperitoneal masses (Fig. 2.22). Cystic masses in this space are mainly related to lymphoceles.

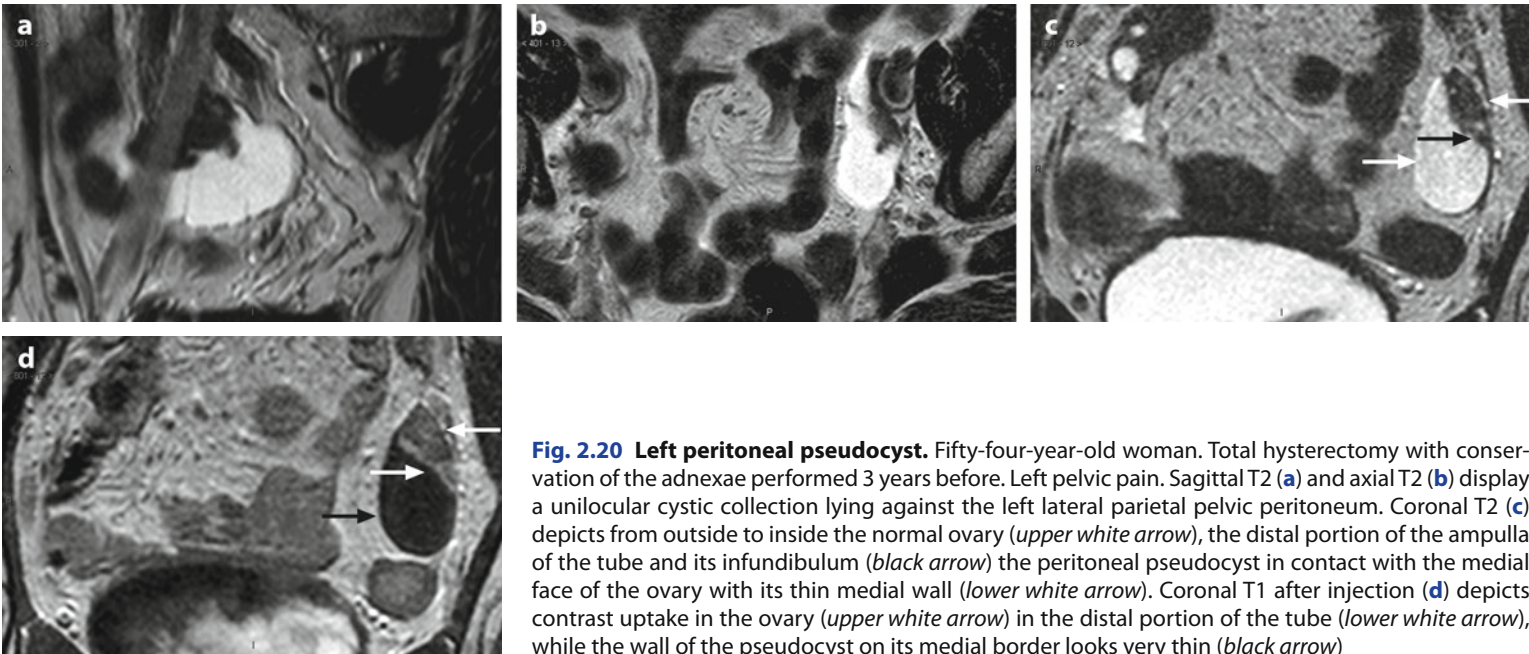


Fig. 2.20 Left peritoneal pseudocyst. Fifty-four-year-old woman. Total hysterectomy with conservation of the adnexae performed 3 years before. Left pelvic pain. Sagittal T2 (a) and axial T2 (b) display a unilocular cystic collection lying against the left lateral parietal pelvic peritoneum. Coronal T2 (c) depicts from outside to inside the normal ovary (*upper white arrow*), the distal portion of the ampulla of the tube and its infundibulum (*black arrow*) the peritoneal pseudocyst in contact with the medial face of the ovary with its thin medial wall (*lower white arrow*). Coronal T1 after injection (d) depicts contrast uptake in the ovary (*upper white arrow*) in the distal portion of the tube (*lower white arrow*), while the wall of the pseudocyst on its medial border looks very thin (*black arrow*)

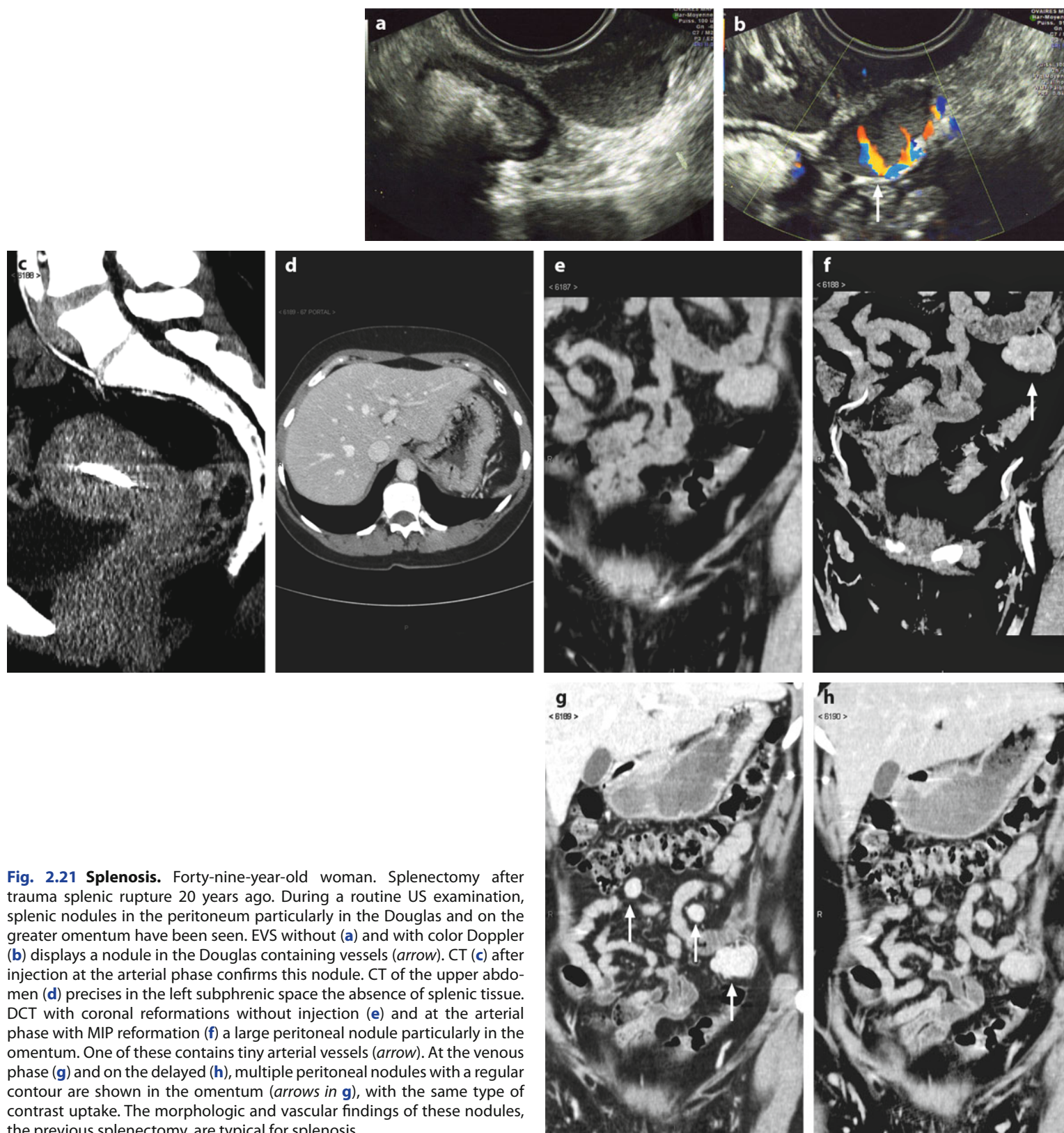


Fig. 2.21 Splenosis. Forty-nine-year-old woman. Splenectomy after trauma splenic rupture 20 years ago. During a routine US examination, splenic nodules in the peritoneum particularly in the Douglas and on the greater omentum have been seen. EVS without (a) and with color Doppler (b) displays a nodule in the Douglas containing vessels (arrow). CT (c) after injection at the arterial phase confirms this nodule. CT of the upper abdomen (d) precises in the left subphrenic space the absence of splenic tissue. DCT with coronal reformations without injection (e) and at the arterial phase with MIP reformation (f) a large peritoneal nodule particularly in the omentum. One of these contains tiny arterial vessels (arrow). At the venous phase (g) and on the delayed (h), multiple peritoneal nodules with a regular contour are shown in the omentum (arrows in g), with the same type of contrast uptake. The morphologic and vascular findings of these nodules, the previous splenectomy, are typical for splenosis

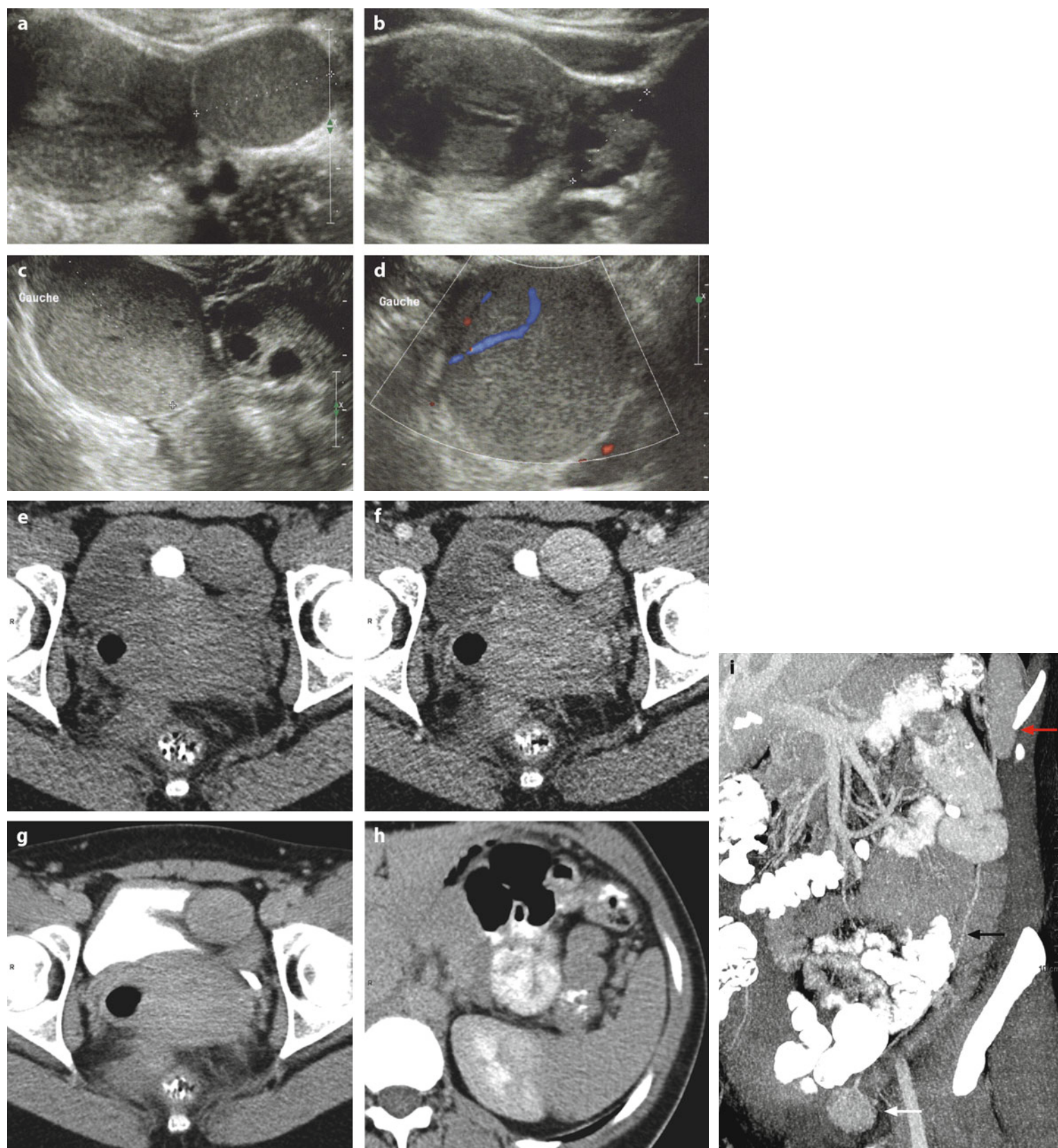


Fig. 2.22 Pelvic accessory spleen. EVS (a–c) displays a round echogenic homogeneous mass, separated from the uterus in (a) and from the ovary in (b, c), containing vessels on color Doppler (d). DCT without injection (e) and at the arterial phase (f) display a round mass with an early and homogeneous contrast uptake; on the delayed (g), contrast uptake is identical to the

spleen (h). CT with oblique coronal reformation and MIP (i) depicts the accessory spleen (white arrow) related by a cord (black arrow) to the lower pole of the spleen (red arrow). Prospective diagnosis: pelvic accessory spleen. Coelioscopy confirmed the diagnosis

2.2.5 GI Tract Pelvic Masses

1. Sigmoid (Figs. 2.23 and 2.24)
 2. Small bowel:
 - Mobility of the mass
 - Presence of air within the mass (Fig. 2.25)
 3. Appendiceal Mucocele (Fig. 2.26)
- Findings of mucocele are reported in Table 2.9.

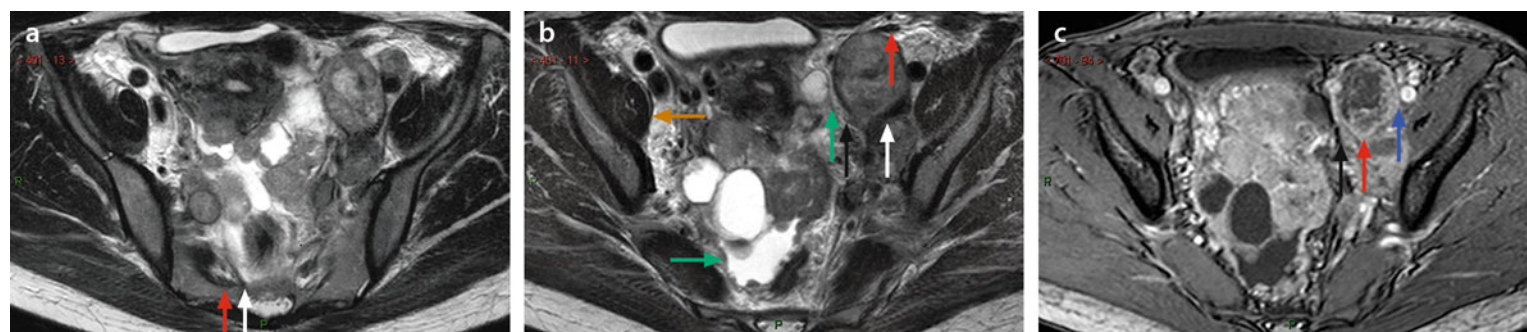


Fig. 2.23 Undifferentiated carcinoma of the ovary with lymph node metastases. MR axial T2. (a) (1) piriform fascia (white arrow), (2) anterior sacral ramus (red arrow). (b) (1) Lymph node metastases (white arrow), (2) extraperitoneal space (black arrow), (3) round ligament (red arrow) pushed forward by the lymph node, (4) left parietal pelvic peritoneum (vertical green arrow), (5)

right parietal pelvic peritoneum (horizontal green arrow) lined by ascites, (6) parietal fascia (brown arrow). (c) MR axial, arterial phase displays in the left extraperitoneal space from inward to outward: 1 peritoneum (black arrow), 2 a metastatic lymph node (red arrow) (an ovarian mass could not be in this location), 3 the extraperitoneal space lateral to the iliac vessels (blue arrow)

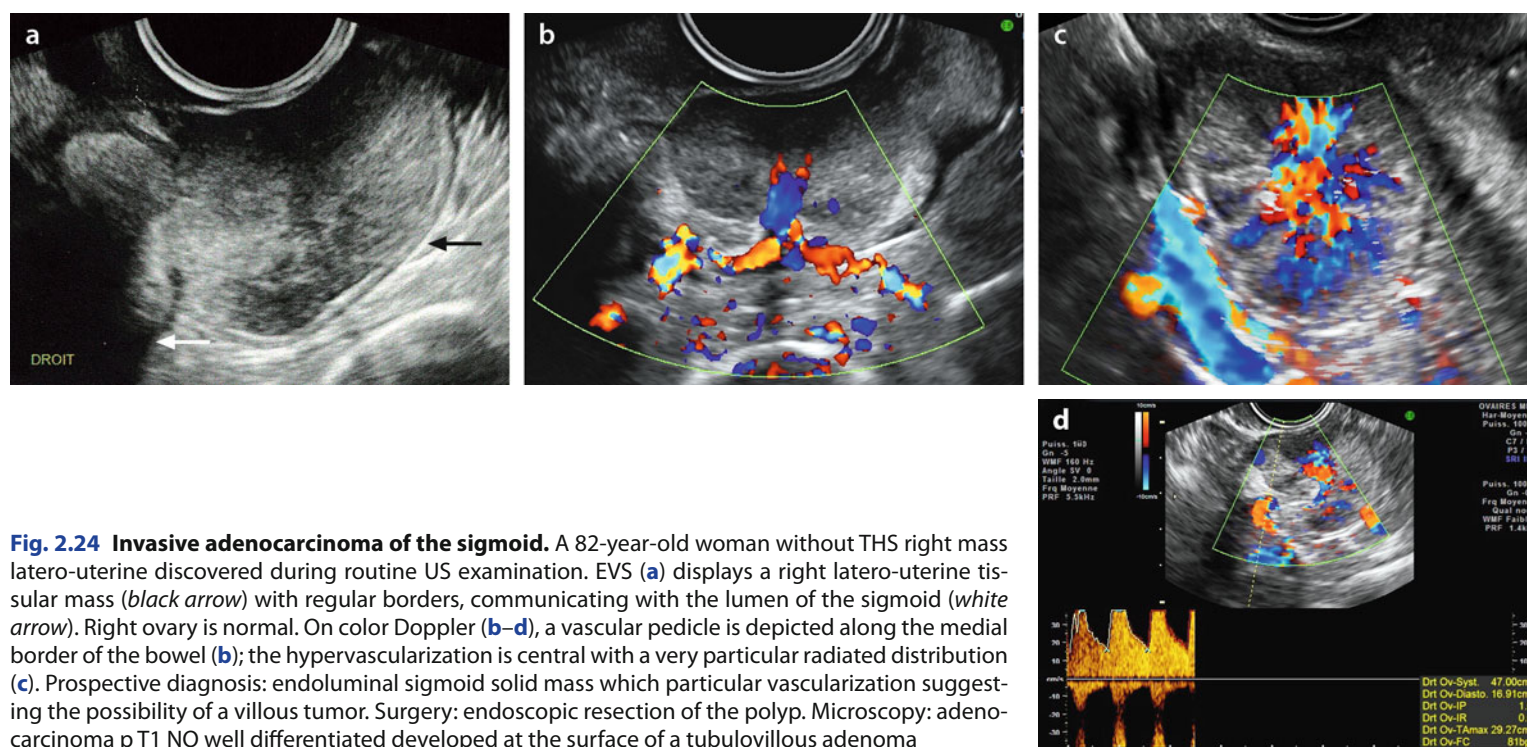
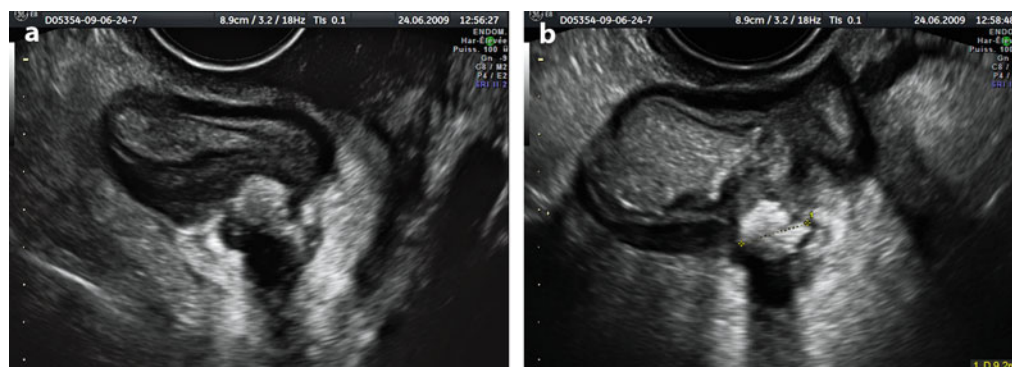


Fig. 2.24 Invasive adenocarcinoma of the sigmoid. A 82-year-old woman without THS right mass latero-uterine discovered during routine US examination. EVS (a) displays a right latero-uterine tissular mass (black arrow) with regular borders, communicating with the lumen of the sigmoid (white arrow). Right ovary is normal. On color Doppler (b–d), a vascular pedicle is depicted along the medial border of the bowel (b); the hypervascularization is central with a very particular radiated distribution (c). Prospective diagnosis: endoluminal sigmoid solid mass which particular vascularization suggesting the possibility of a villous tumor. Surgery: endoscopic resection of the polyp. Microscopy: adenocarcinoma p T1 NO well differentiated developed at the surface of a tubulovillous adenoma

Fig. 2.25 Fifty-five-year-old woman; left pelvic pain CRP 108. EVS (a, b) display (1) a thickening of the sigmoid wall, (2) a diverticulum, and (3) an echogenic thickening of the mesosigmoid. These findings help to differentiate inflammation or an abscess of the sigmoid from a pelvic inflammatory disease with salpingitis



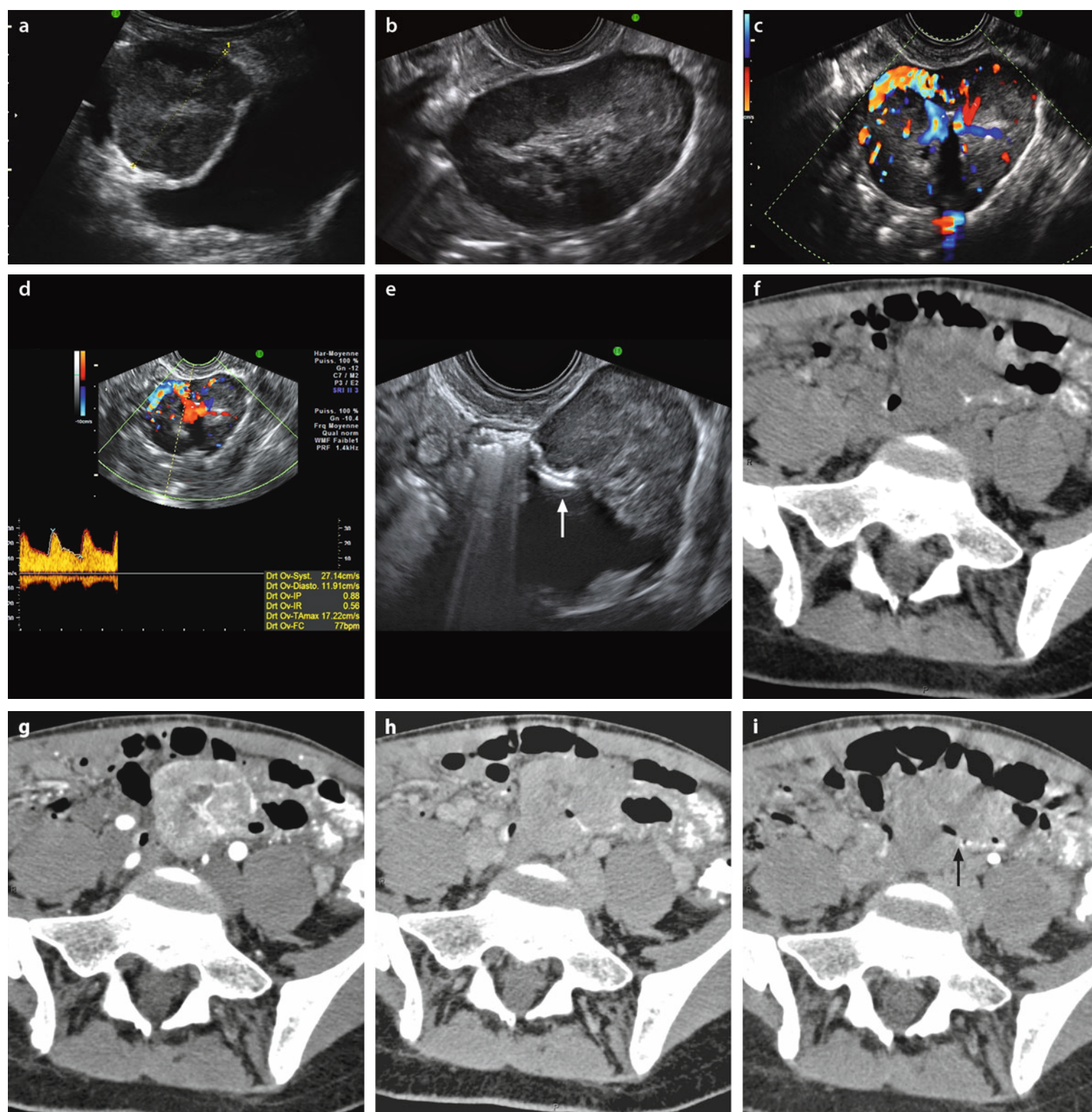


Fig. 2.26 GIST of the small bowel. Thirty-two-year-old woman. During a routine examination, a pelvic mass is discovered. TAS (a), a 4-cm mass in the left portion of the pelvis, close to the bladder is visualized; left kidney lies in the left lumbar fossa and is normal. EVS (b) (1) demonstrates that the mass is extra-ovarian, (2) better depicts the oval shape and the structure of the mass, particularly a central echogenic area. On color Doppler (c), a large pedicle and a high degree of central vascularization are displayed, with a high velocity on pulsed Doppler (d). On (e), gas is entering into the mass

(arrow). DCT without injection (f) displays that the mass is in front of the sacrum. At the arterial phase (g), a large vascular pedicle and rich peripheral and central vascularization are depicted. At the venous phase (h), an important washout is shown. On (h) and the delayed (i), presence of air and GI contrast uptake are going into the mass proving the mass is small bowel in origin (arrow). Surgery resection of the tumor with termino-terminal anastomosis. Pathology: GIST

Table 2.9 Surgical and radiologic findings of peritoneal inclusion cysts**Common**

Size: usually between 4 and 10 cm
 Mainly or exclusively cystic
 Wall and septa thin and regular
 Solid tissue can be present (related to inflammatory tissue)
 Usually not round, conforming to surrounding structures
 Lying against the peritoneum
 Most commonly multilocular, may be unilocular
 Adhesions to surrounding structures very common (bladder, sigmoid)

Uncommon

May resemble simple free peritoneal fluid
 Small papillae present (exceptionally)

Differential diagnosis

1. Mainly hydrosalpinx (which can be associated)
2. More rarely cystic ovarian mass or paraovarian cyst

2.2.6 Urinary Pelvic Masses

Pelvic kidney is the main differential (Fig. 2.27)

2.2.7 Neurogenic Masses**2.2.7.1 Tarlov Cyst**

Tarlov cyst (Fig. 2.28 and 2.32) may be confused with an ovarian cyst on US.

On MR, the posterior location and the communication with a sacral foramen are typical for this type of cyst.

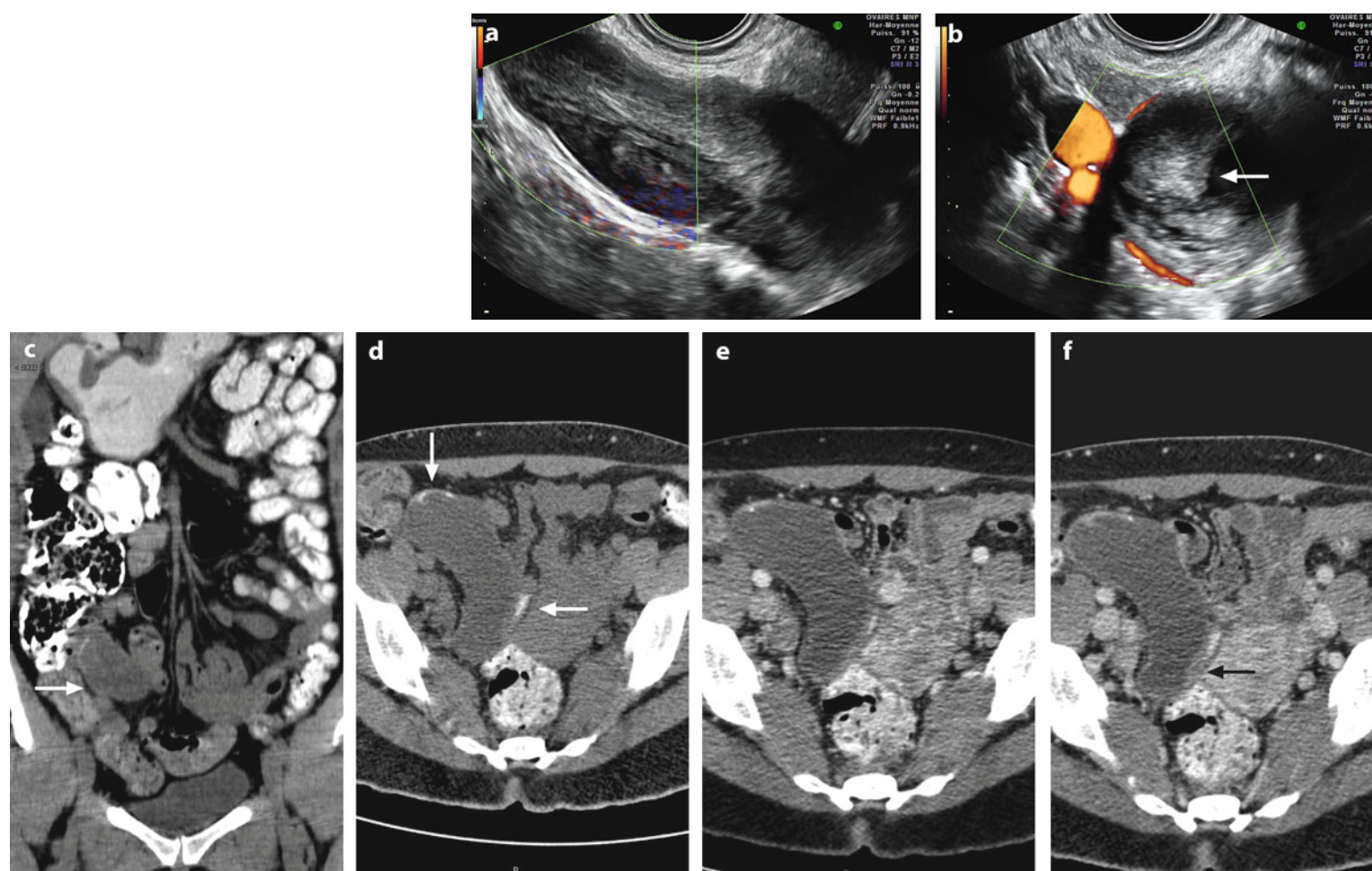


Fig. 2.27 Borderline mucinous tumor of the appendix. Forty-five-year-old woman. Right pelvic pain and sensation of a mass in the right iliac fossa. EVS longitudinal (a) and transverse (b) display an echogenic tubular mass in the right iliac fossa, with a regular vessel in the wall, containing an echogenic material without color flow (arrow). Location of the mass close to the cecum and the tubular shape suggest an appendicular origin. CT without

injection and with coronal reformation (c) clearly displays the mass is appendicular (arrow). The transverse view without injection (d) depicts calcification in the wall (arrow). On DCT at the arterial phase (e) and at the venous phase (f) below a calcification, a slight contrast uptake is visualized in a localized thickening of the wall (arrow)

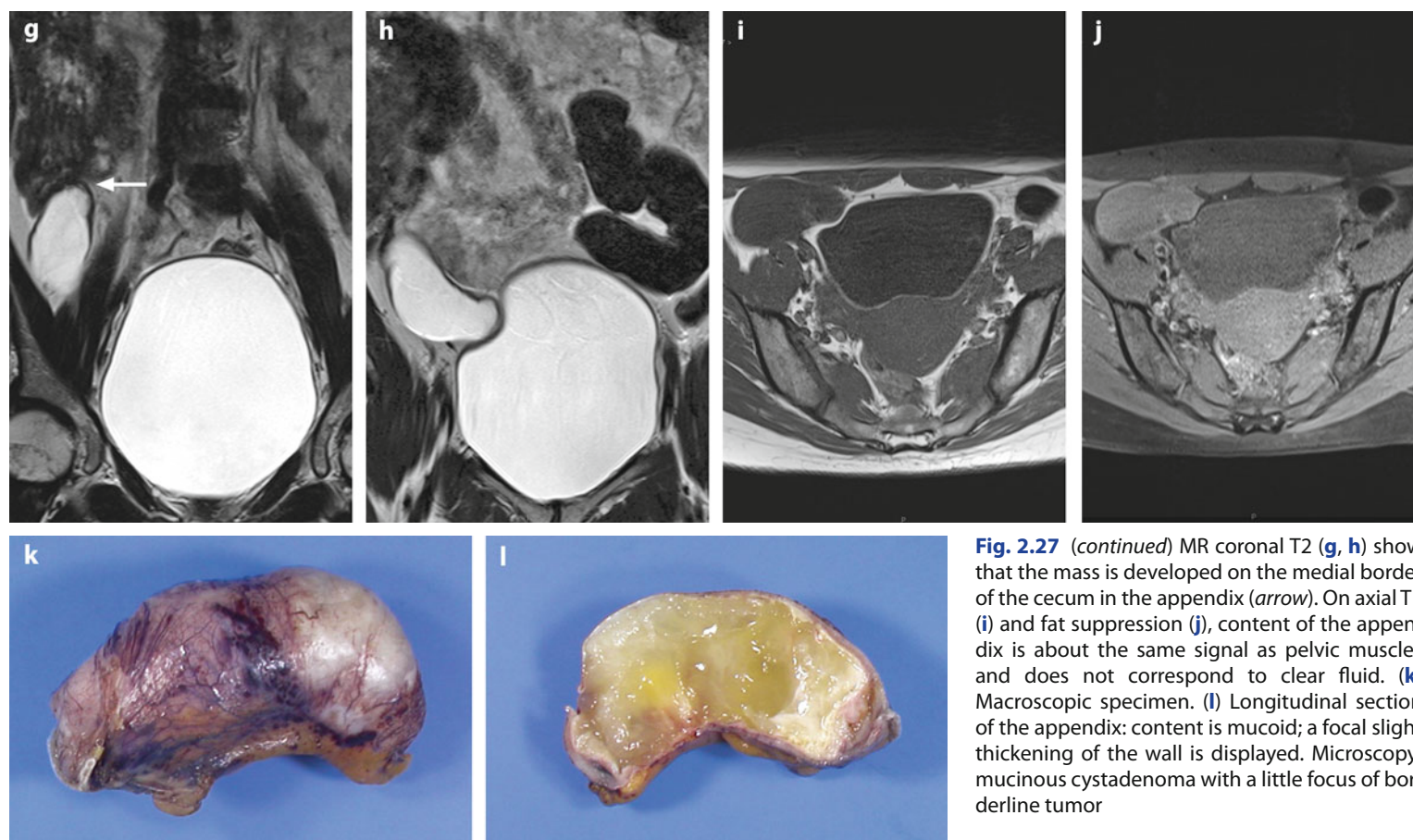


Fig. 2.27 (continued) MR coronal T2 (g, h) show that the mass is developed on the medial border of the cecum in the appendix (arrow). On axial T1 (i) and fat suppression (j), content of the appendix is about the same signal as pelvic muscles and does not correspond to clear fluid. (k) Macroscopic specimen. (l) Longitudinal section of the appendix: content is mucoid; a focal slight thickening of the wall is displayed. Microscopy: mucinous cystadenoma with a little focus of borderline tumor

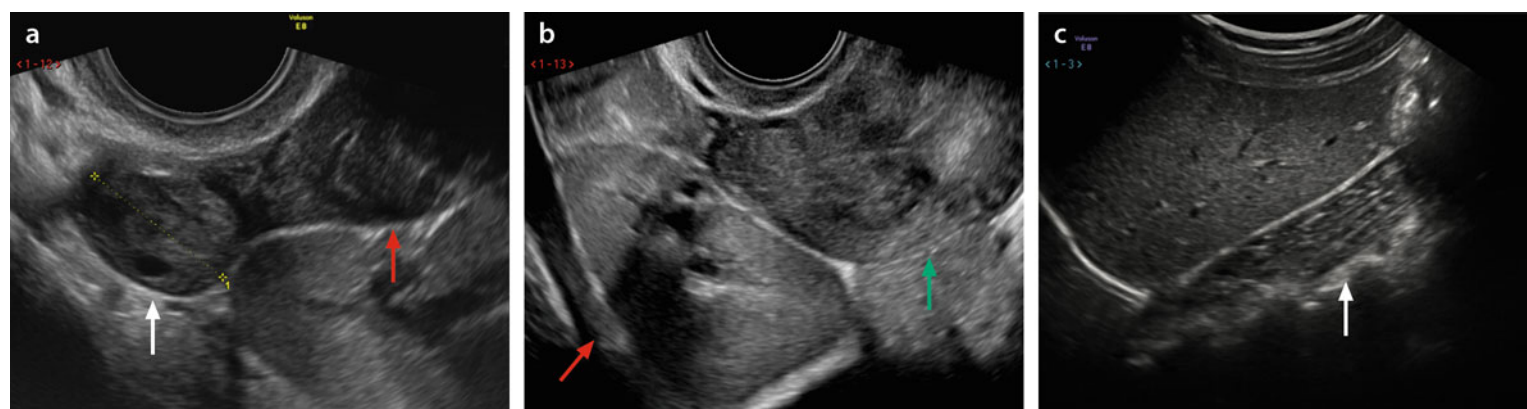


Fig. 2.28 Right pelvic kidney. EVS (a) right pelvic mass (red arrow) separated from normal right ovary (white arrow). EVS (b) right pelvic mass with a kidney shape in the pelvis (red arrow), separated from the uterus (green arrow). TAS (c) of the right lumbar fossa (arrow) does not display any kidney

2.2.7.2 Cystic Neurinoma (Fig. 2.29)

1. Morphologic and vascular findings
Shape: round
Solid patterns: highly vascularized, may be cystic
2. Topography: back to the presacral fascia

2.2.8 Perineal Masses

Cystic (diverticula of the urethra (Fig. 2.31), vaginal cysts, cysts of the greater vestibular glands) can be easily located in the perineum (see Chap. 35).

Location and extension of solid masses of the perineum are clearly depicted on MR (see Chap. 36).

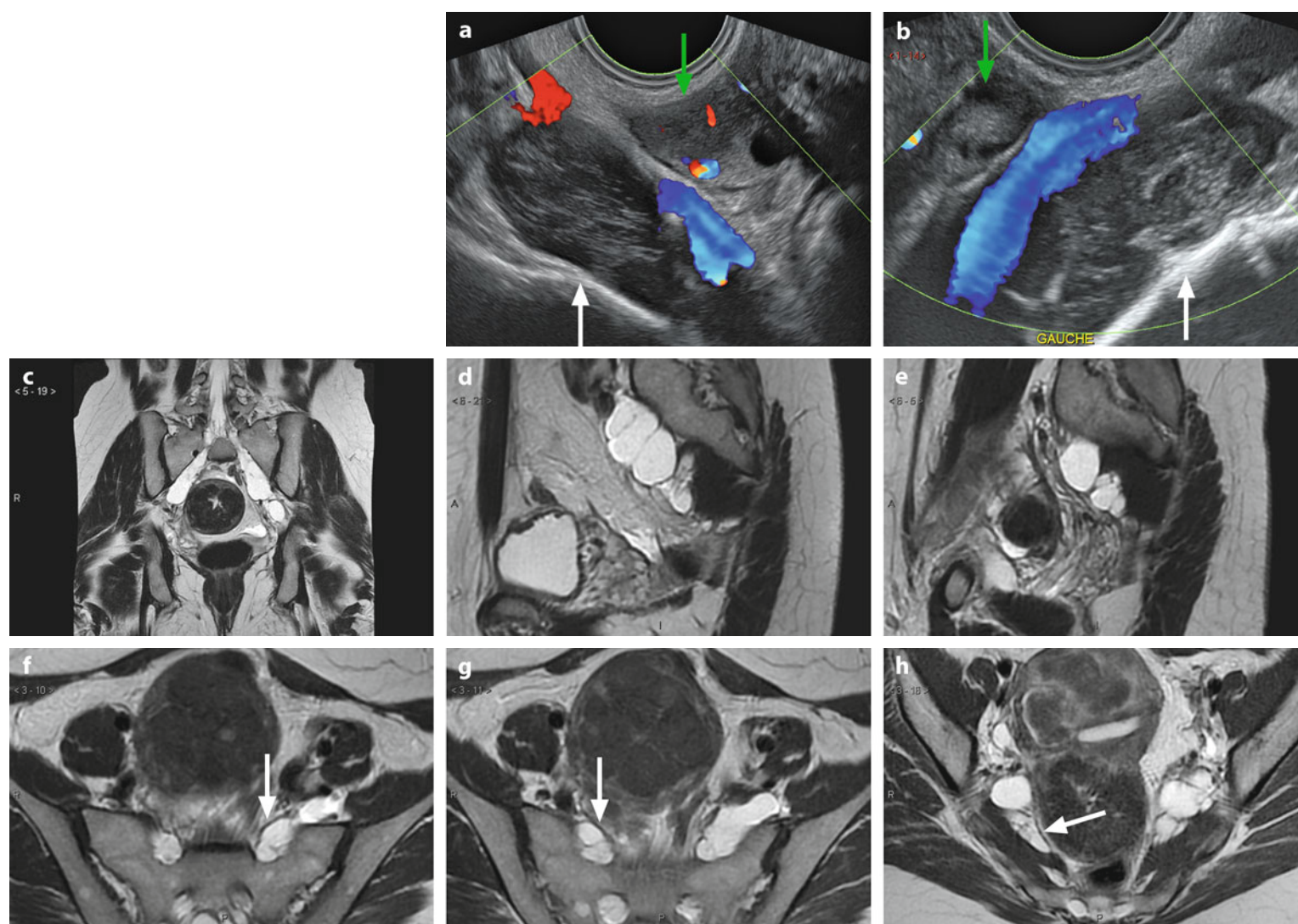


Fig. 2.29 Bilateral Tarlov's cysts. EVS displays behind external iliac pedicles, on the right (**a**) and the left sides (**b**) extra-ovarian low echogenic ovoid cystic masses (white arrows). Normal right ovary (green arrow in **a**) and left ovary (green arrow in **b**) are displayed medial to the external iliac vessels. MR coronal T2 (**c**), right parasagittal T2 (**d**), and left parasagittal T2 (**e**) show that these oblong collections are coming out from the sacral foramina and are typical for Tarlov's cysts. On axial T2 (**f-h**), the fascia over piriformis (white arrows in **f, g, h**), which is situated in front of the sacral plexus, is pushed forward by the collections. This anatomical landmark allows to localize these structures which are nervous in origin

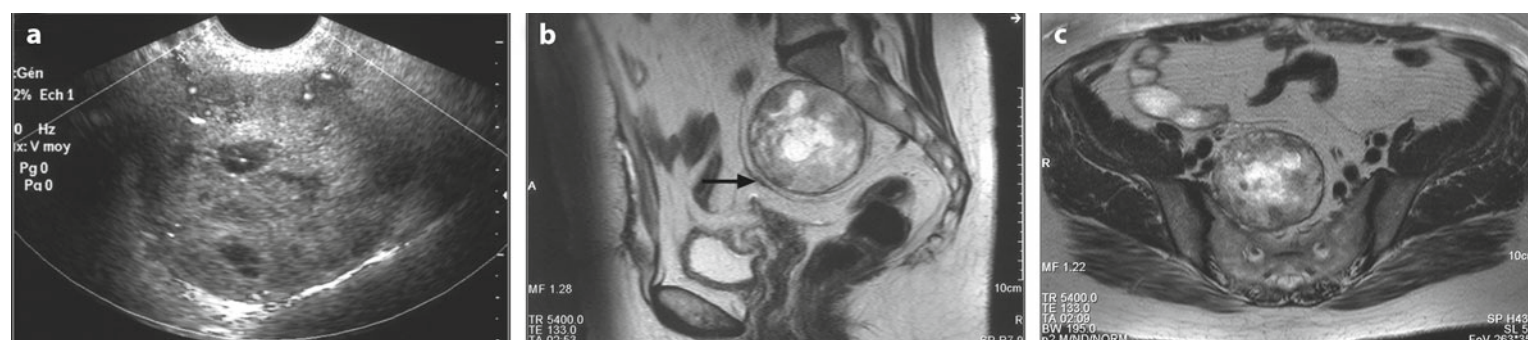


Fig. 2.30 US (**a**) mixed echogenic mass considered as a uterine leiomyoma. MR sagittal T2 (**b**) and axial T2 (**c**) display the presacral fascia pushed forward by the mass (arrow in **b**) proving its neurogenic origin. Pathology: neurinoma

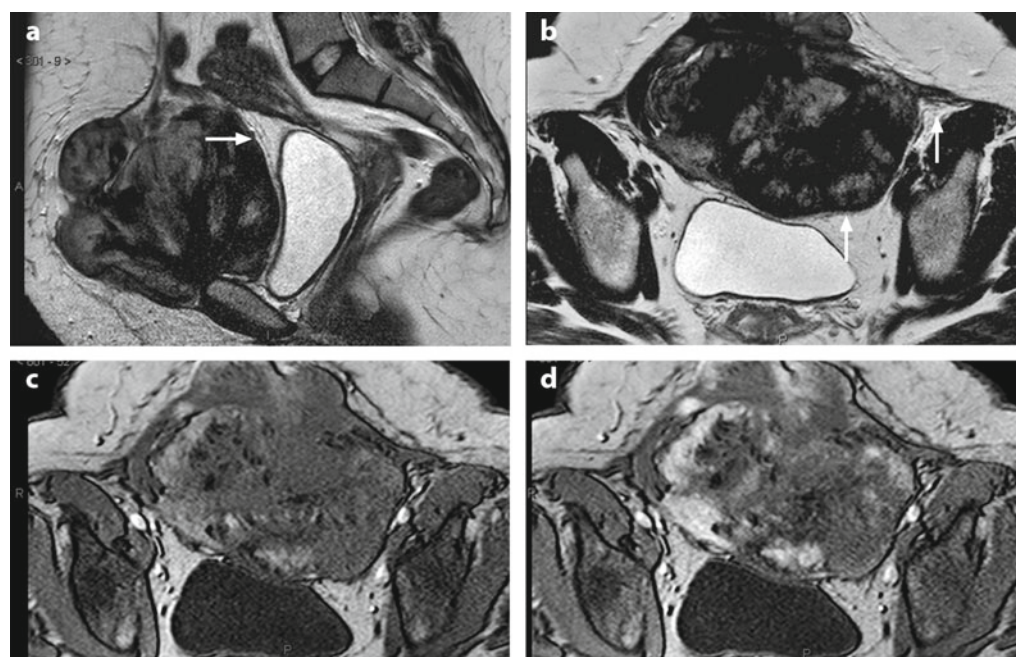


Fig. 2.31 Desmoid tumor of the anterior abdominal wall. MR sagittal (a) and axial T2 (b) display a parietal mass arising in the anterior abdominal wall extending anteriorly in the subcutaneous tissue and posteriorly pushing backward the fascia transversalis (arrows) and the anterior subperitoneal space particularly the anterior of the bladder. On DMR at the arterial phase (c), arterial vessels are mainly located at the periphery of the tumor, and at the venous phase (d), a significant contrast uptake in the same location was visualized. Resection of the mass was performed. Pathology: desmoid tumor

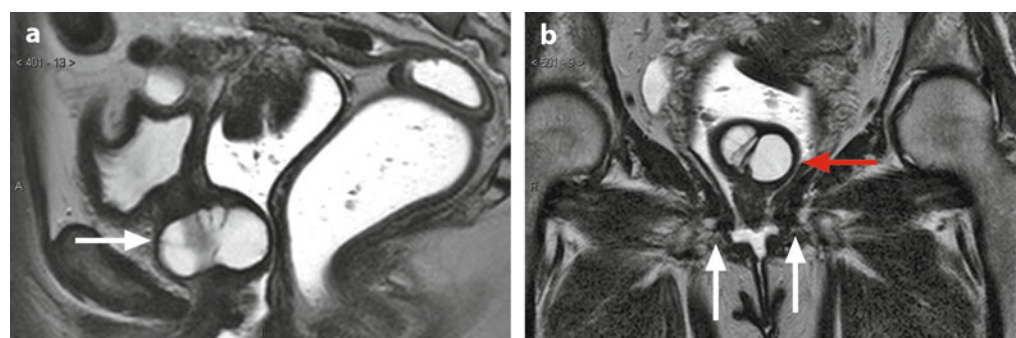


Fig. 2.32 Urethral diverticulum. MR sagittal T2 (a) displays a collection (white arrow) around the urethra, very suggestive of a diverticulum, which seems to be situated in the upper half of the urethra and therefore in the subperitoneal space. On coronal T2 (b) the collection (red arrow) is situated above the deep transverse perineal muscle (white arrows), definitely allowing to precise its subperitoneal location

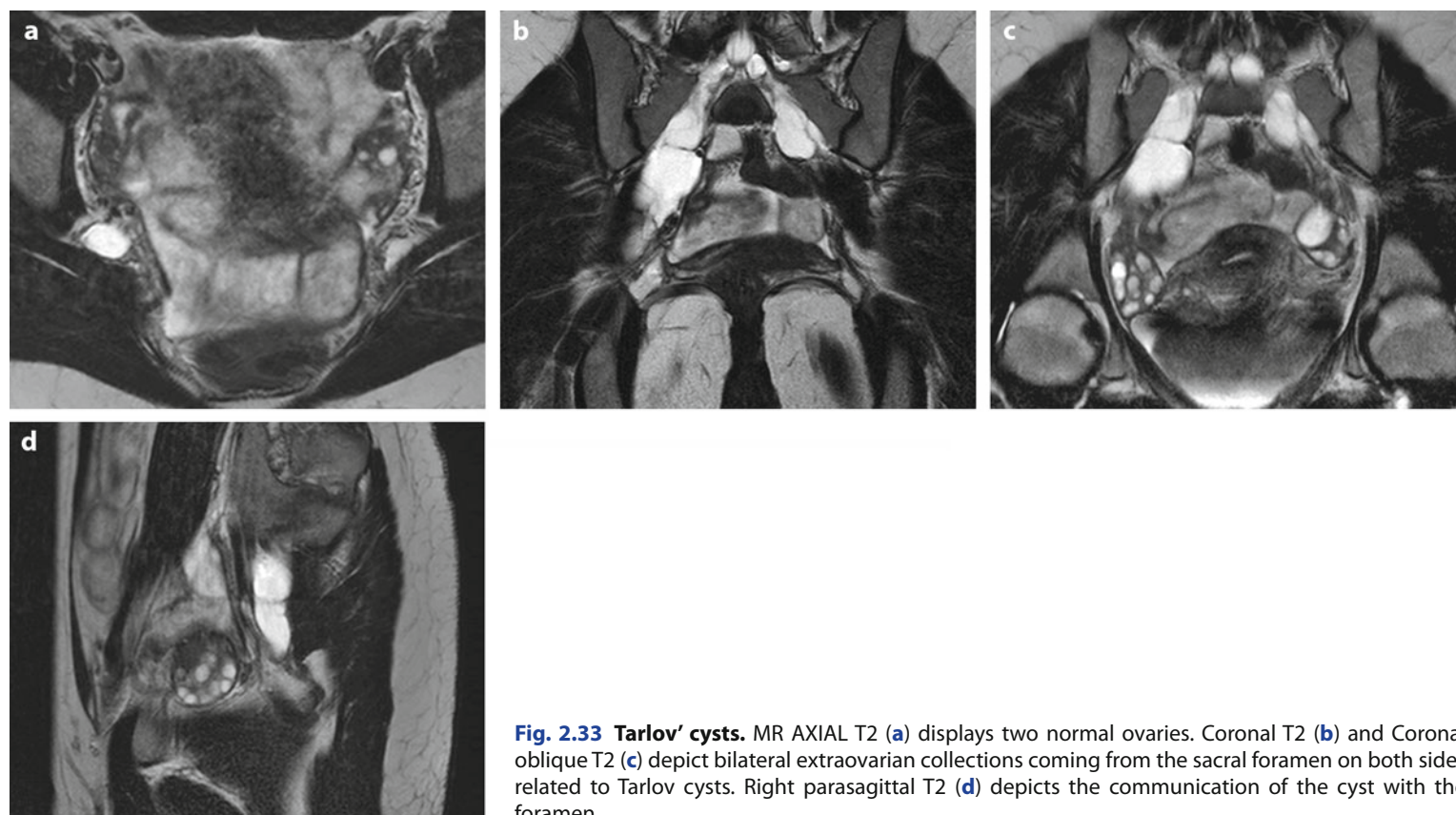


Fig. 2.33 Tarlov cysts. MR AXIAL T2 (a) displays two normal ovaries. Coronal T2 (b) and Coronal oblique T2 (c) depict bilateral extraovarian collections coming from the sacral foramen on both sides related to Tarlov cysts. Right parasagittal T2 (d) depicts the communication of the cyst with the foramen

2.2.9 Parietal Masses

As far as anatomy of the abdominal wall, of the fascia transversalis and parietal peritoneum is clearly depicted, MR gives precise pre-surgical informations about the topography and pelvic extension of these masses (Fig. 2.30).

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