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Abstract	Pelvic leak points are responsible for reflux and visible varicose veins in 8.3% of all cases, as found in a nonpublished series of 4.411 CHIVA treatments, where the author found 366 cases of pelvic reflux: 90% of them in women (free of pelvic congestion syndrome). Analysing the pathway, six well-defined parietal pelvic leak points (PLPs) may be detectable on each side: the perineal point (PP), the inguinal point (IP), the obturator point (OP), the gluteal points (superior, SGP, and inferior, IGP) and the clitoridian point (CP). Perineal and inguinal points (PP and IP) represented 97% of all treated PLP in women. The PLPs are detectable, thanks to accurate duplex imaging assessment, and selected for surgery when refluxing at Valsalva test. They can be treated with mini-invasive surgery under local anaesthesia.	Q2

AUTHOR QUERIES

Q1 Please check if “Minimal” should be changed to “Minimally.”

Q2 All occurrences of “obturatory point” have been changed to “obturator point.” Please check if okay.

8 Minimal Invasive Surgical Treatment of Pelvic Leak Points

Roberto Delfrate and Erika Mendoza

8.1 Anatomy of the Pelvic Venous System

The pelvic venous system is a complex venous network of vessels interconnecting parietal and visceral veins and draining extra-pelvic superficial veins as perineal, vulvar, round ligament whose refluxes can extend to the great and small saphenous networks. Indeed, the venous pelvic system consists of avalvulated venous trunks (hypogastric, common iliac, caval and renal veins), inconstantly valvulated veins (ovarian veins) generally valvulated parietal veins (gluteal veins, obturator veins inferior gluteal veins) [1] and visceral collectors (internal pudendal vein, uterine vein) connecting vertically and horizontally throughout avalvulated plexuses. This vascular network represents a functional pelvic venous unit, an extremely important bypass path in case of obstructed drainage of a primary venous trunk like the left renal vein (nutcracker syndrome) or even of a common iliac or inferior cava vein. Whilst the right ovarian vein is valvulated, the left one can be without any valve in 50% of cases. The pudendal vein is generally valvulated [2], whilst the uterine vein is generally avalvulated [3–6]. So, a large amount of the pelvic venous system is free of valves. There is no muscle pump applying to the pelvic venous net. Flow is maintained, thanks to the gradient of pressure towards the inferior cava vein and the right heart and breathing suction effect. The presence of valve in the common femoral veins and in the saphenous femoral junctions as well as in the parietal collateral veins of the hypogastric vein (obturator veins, round ligament veins, pudendal veins and also the labial veins) and the spermatic veins with the only exception of the left one is necessary to ensure the correct drainage towards the caval vein and the right heart.

During pregnancy, a valvular damage may occur in consequence of the increase in pelvic blood volume and the vein peripheral resistances and so of the venous transmural pressure. This is caused by the increase of the uterus size, hormonal balance variation with connective tissue compliance variations, as well as the placenta hyperdebit (the placenta works like an arteriovenous fistula). During pregnancy, labial veins and pudendal network connected to the obturatorian and the epigastric veins will have a volume overload followed by restoration after delivery or permanent valvular damage.

The venous valve damage in the presence of a favourable gradient of pressure is the condition necessary to create a refluxing venous path draining towards the legs, either via subcutaneous collaterals or via the tributaries of the

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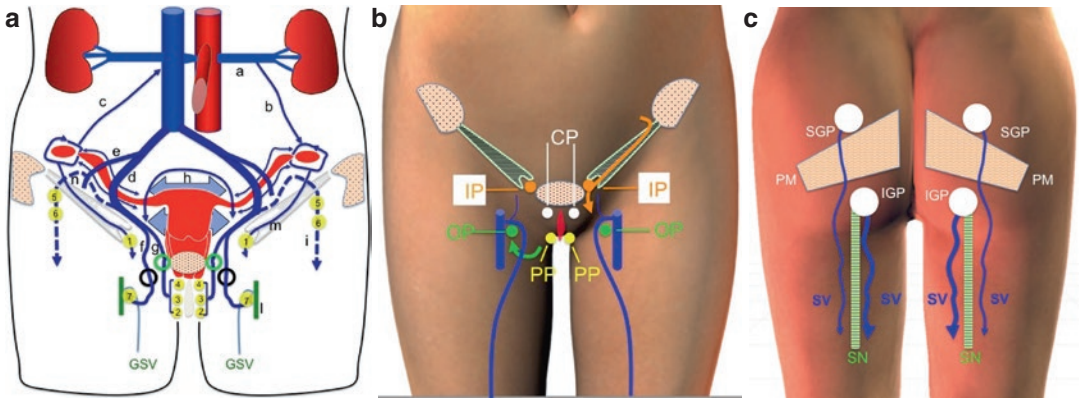

AU3 **Fig. 8.1** (**a**) a-Left renal vein, b-left ovarian vein, c-right ovarian vein, d-hypogastric vein, e-external iliac vein, f-obturator vein, g-internal pudendal vein, h-pelvic venous plexuses, i-sciatic vein, m-round ligament plexus, n-gluteal veins, green circle Alcock canal and black circle obturator canal, 1-inguinal point, 2-perineal point, 3-intermediate perineal point, 4-clitoridian point, 5-superior gluteal point, 6-inferior gluteal point. (**b**) Pelvic leak points in the ventral part of the body. Ventral vision of a female pelvis with bones (rose) and the inguinal ligaments (white), the common femoral vein (blue, thick) and the saphenous vein (blue thin). IP: Inguinal point, lateral to the mons pubis and at the medial end of the inguinal duct, through which the reflux will be emerging. On the left side of the image is a schematic representation of blood flow. CP: Between the mons pubis and the labia, we find the clitoridian point; in analogy in the men, we find this point at the base of the penis. PP: Between the labia and the proximal inner end of the thigh, we find the perineal point (see Fig. 8.9). OP: Obturator point to be found at the sapheno-femoral junction, emerging from medial and dorsal into the SFJ. Flow direction is represented in green. (**c**) Pelvic leak points at the dorsal part of the body—*SGP* superior gluteal point, *PM* piriformis muscle, *IGP* inferior gluteal point, *SV* sciatic vein, *SN* sciatic nerve sciatic veins, representing the refluxing venous path from the gluteal points

sapheno-femoral junction. The consequence might be an involvement of reflux of the lower limb venous system: chronic venous insufficiency and varicose veins of the lower limb of pelvic origin [7–12]. Every refluxing PLP leads to ipsilateral or contralateral varicose veins.

8.2 Diagnostic Approach to the Pelvic Leak Points

To complete a diagnostic investigation of reflux in leg veins, also the pelvic leak points should be investigated with duplex ultrasound, especially in case of competent terminal valve and Valsalva positive reflux in the sapheno-femoral junction or more distally in saphenous vein or tributaries.

8.2.1 General Approach

During the ultrasound exploration of patients with reflux in superficial leg veins, the investigation of pelvic leak points must be performed, when a Valsalva positive reflux is found in any vein. Even when an incompetent terminal valve is responsible for Valsalva positive reflux, an additional inguinal or perineal leak point could be present in addition.

During the exploration of the sapheno-femoral junction, the obturatorian vein is in the focus. AU4 The probe can then be moved cranially from the sapheno-femoral junction to explore the inguinal region (I-Point) and medially to it the clitoridian point (C-Point) (see Fig. 8.1b). Perineal points are best found starting at the inner aspect of the proximal thigh and moving cranially, softly to avoid a compression of the very superficial veins. In case of difficulty of the patient separating the legs, the explored leg can be put, the foot on an elevated platform to give the probe space. Afterwards the patient is asked to turn around to investigate the posterior aspect of the thigh using the sciatic nerve as a B-mode mark and investigating reflux signs next systematically with a Valsalva test (see Fig. 8.2).

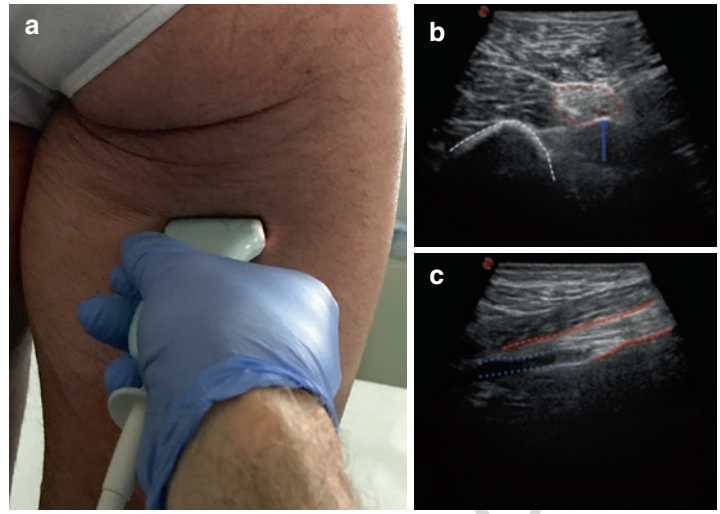

Fig. 8.2 (**a**) Photo of the back of a leg with the position of the probe on the skin. (**b**) B-mode ultrasound of the sciatic nerve as landmark for the evaluation of pelvic leakage points; transversal image blue arrow, sciatic vein; red dashed line, the sciatic nerve; white dashed line, the bone. (**c**) Longitudinal image of the sciatic nerve between the red dashed lines and the vein between the blue dashed lines

A linear probe (7.5–12 MHz) is used first, but a convex or micro-convex one (5 MHz) may be necessary in overweight patients. It's important that the patient properly performs the Valsalva test. A simple way is to ask the patient to blow into a straw that was closed at one end (Cremona Manoeuvre, see Sect. 3.2.2) [7, 9, 13].

A short outward flow of less than 1 s through leakage points shortly after a provocation manoeuvre is normal; it represents the natural drainage pathway for these vessels. A long-lasting flow after a provocation manoeuvre or permanent during Valsalva is demonstrative of a pathologic situation with pelvic reflux.

8.2.2 Spontaneous Flow Through a Pelvic Leak Point

If a spontaneous reflux on any of the pelvic leak points is detectable with the patients in upright position, a pelvic hypertension must be suspected, and it must be investigated, if a pelvic leak does represent the escape point of an open bypassing shunt (see Sect. 3.7.3) (see Fig. 8.3). This would be the case, if there is any obstruction in the deep venous system forcing the blood to find a bypass through the pelvic network, the network serving as a drainage for other vessels, as happens in the pelvic congestion syndrome. When finding a permanent flow in upright position through a PLP, examination is continued with the patient lying down on the bed. If the spontaneous reverse flow continues also in recumbent position, the existence of an open vicarious shunt due to pelvic venous hyperpressure is highly likely. In this case, the PLP must be preserved, and further abdominal haemodynamic and chemistry investigations are

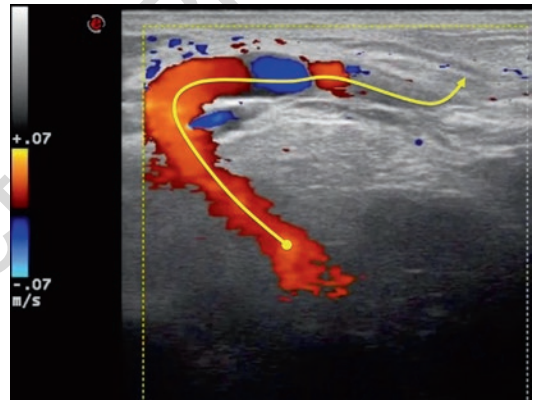

Fig. 8.3 Spontaneous inguinal point reflux in a patient in standing position without any breath variation. The probe is positioned over the right inguinal ligament in transverse position, showing the flow through the inner ring (yellow arrow) running from the deep network into the inguinal canal

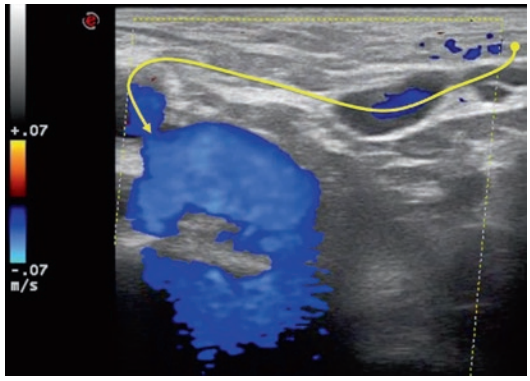

Fig. 8.4 Image of the same patient as in Fig. 8.3 in recumbent position. The reflux has stopped and an inward flow is detectable (yellow arrow)

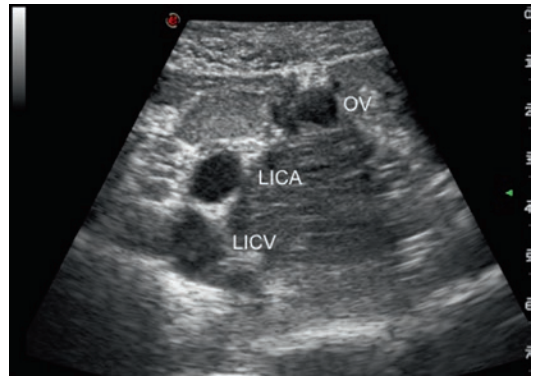

Fig. 8.5 Typical image of an enlarged left ovarian vein, next and laterally to the left iliac common artery (LICA) and left iliac common vein (LICV), best found in a transverse image performed with a 5 MHz probe positioned between the anterior and superior iliac spine and the xifopubic line on the skin

needed (left renal vein evaluation, left ovarian or spermatic vein pressure evaluation, urine tests to detect microscopic haematuria and proteinuria). If the PLP reflux disappears in the lying position, the mini-invasive surgical treatment of the escape point may be possible, because of a deep draining path existence, but not before ensuring that there is another deep draining path. This is best done with further duplex investigation of the abdomen or second-level investigations (see Chap. 5) (Fig. 8.4).

8.2.3 Pole Test to Evaluate the Pressure in the Left Ovarian Vein

In any case the haemodynamic evaluation of the flow in the left ovarian vein is useful to sort out pelvic congestion syndrome. The left ovarian vein is easy to identify with a convex probe in transverse view and laterally to the left iliac vessels, without any necessity of full bladder and in longitudinal (Fig. 8.5).

We find a permanent flow in case of pelvic congestion syndrome—breath modulation of the flow is a favourable prognostic sign, whilst on the contrary, continuous reflux without any modulation isn't. Venous pressure is an important clinical parameter. It can estimate checking flow variations in the left ovarian vein by changing the bed inclination angle as encoded by the pole test [14, 15]. The pole test method considers the flow hydrostatic pressure resistance induced by elevation of a checked point of a vessel, searching for the flow stop. When ovarian reflux stops, the height (in centimetres) from the point checked of the ovarian vein and the horizontal line passing through the heart is converted in mmHg; this value represents the venous ovarian pressure. Assuming the density of blood to be 1.055 g/cm^3 and that of mercury 13.54 g/cm^3, the pressure unit, 1 cm blood above the heart, is equal to 0.78 mmHg (10 mm × 1.055/13.54 = 0.78 mmHg).

8.3 General Considerations to the Treatment of Pelvic Leakage Points

Thanks to Claude Franceschi pelvic leakage point ultrasound identification and anatomical description [16–18], a minimally invasive strategy of treatment of varicose veins fed by pelvic reflux can be performed. The surgical procedure is minimally invasive under local anaesthesia. Pelvic endovascular treatment remains only necessary in case of pelvic congestion syndrome in women.

Perineal and inguinal points account for 97% of all PLPs treated in women. The favourable

feature of perineal and inguinal point but even clitoridian point is the well-defined anatomical position easy to reach with a mini-invasive surgical dissection. Their depth ranges from 3 mm for the perineal point to 30 mm for the inguinal point. The treatment is possible under local anaesthesia and needs a perfect B-mode preoperative skin marking using a 10–18 MHz linear probe. To detect the flow, the pulse repetition frequency (PRF) is set between 0.75 and 1 KHz, suitable for detecting low-speed flow, even less than 10 cm/s. Skin marking is performed in the operation field without further changes of position of the patient.

Local anaesthesia consists of a mixture of lidocaine (2%) and ropivacaine (7.5 mg/mL), and a mild sedation may be useful. The author recommends finishing the surgical procedure with a rifampicin solution washing inside the wound, without systemic antibiotic therapy. Perineal skin incisions are closed with cyanoacrylate glue, without any need of plasters. Discharge is possible few hours after the intervention. The treatment is completed with daily elastic stockings for 4 weeks and low-molecular-weight heparin in prophylactic dose for 10 days.

8.4 Complications of Surgery of Pelvic Leakage Point

In the author's experience of 366 PLP-treated patients, no deep vein thrombosis, pulmonary thromboembolism or deaths were observed, nor any bruises, subcutaneous inguinal or perineal haemorrhage, neuralgia, wound infection or superficial phlebitis, except one immediate postoperative inguinal bleeding after the treatment of the inguinal point.

On the contrary, endovascular procedures are more invasive and might provoke serious complications [19]. A main venous access is needed, including subclavian, brachial, femoral or transjugular approaches. The patient and the staff are exposed to radiation. Complications due to deep venous puncture as well as to embolization like haematoma, pneumothorax, closure of nontarget vessels, coils migrations, pulmonary embolism and stroke had been described [19].

8.5 The Female Inguinal Leak Point (IP)

The IPs represent the 36% of all the pelvic leak points treated by the author in women. The inguinal point (IP) is the superficial ring of the inguinal canal crossed by the mons veneris veins which connects to the uterine round ligament vein. The latter is a venous plexus running across the inguinal canal close to the round ligament, crossing the deep ring of the inguinal canal to reach the ovarian, fallopian and uterine plexuses. The IP is located just above and medially to common femoral vein (see Fig. 8.6).

Using a linear probe 7.5–12 MHz starting from the femoral junction, the IP is detectable tilting the probe upward focussing on the inguinal canal. The superficial ring of the inguinal canal is clearly detectable as an interruption of the oblique external muscle fascia. Once a skin marking has been done, it's easy to recognise with the tip of a finger the superficial ring of the inguinal canal laterally to the pubic tubercle (see Fig. 8.6).

The surgical procedure is possible with a little skin incision after an accurate mapping marking the I-Point on the skin (see Fig. 8.7). In case of incontinence of the terminal valve and added reflux from the ipsilateral IP, the skin marking considers both the escape points, and the skin incision can be done between both.

Dissection of the I-Point: Once the skin has been engraved and the surface layer of the subcutaneous tissue dissected, the subcutaneous fascia appears. This fascia should not be confused with the oblique internal muscular fascia, which is deeper, white and shiny. The finger-tip is helpful to search the superficial ring of the inguinal canal. Once the content coming out the superficial ring is detected (Fig. 8.8a), the genitocrural nerve must be distinguished from the vascular bundle (Fig. 8.8b). The nerve is isolated as well as the venous plexus of the round

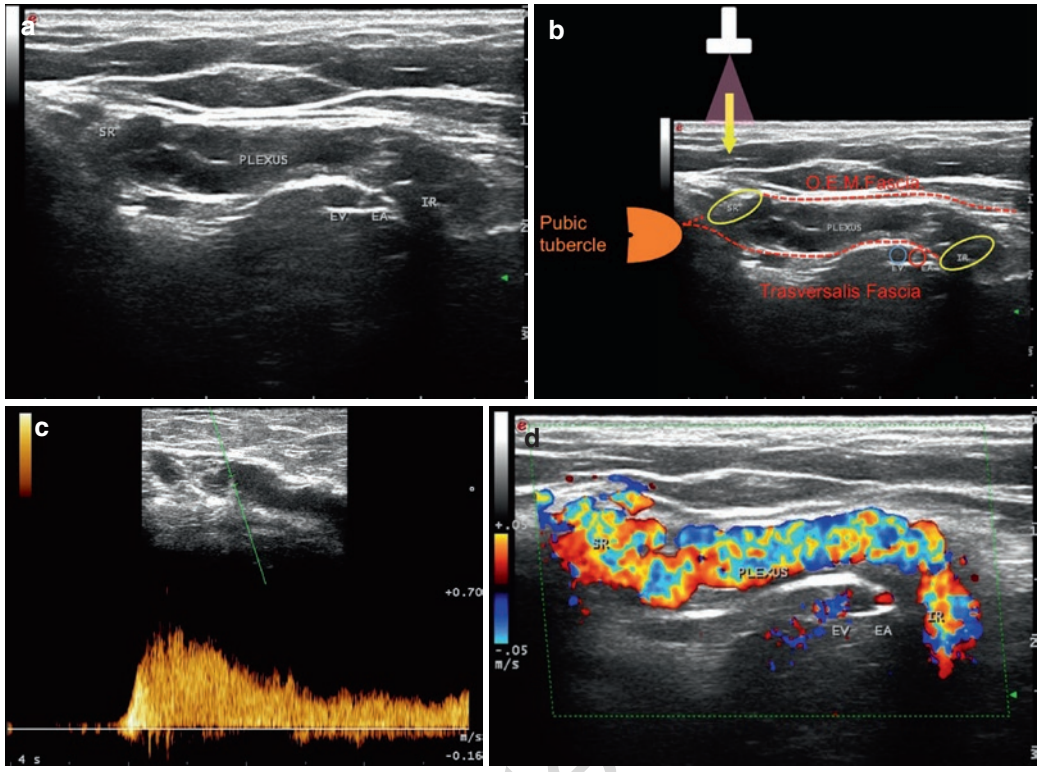

Fig. 8.6 (**a**) B-mode appearance of the left inguinal canal, the probe is transversely on the inguinal fold. The venous plexus of the round ligament has a hypo-echogenic appearance with hyper-echogenic lines inside (PLEXUS). The superficial ring (SR) and the internal ring (IR) of the canal are visible, as the inferior epigastric vein (EV) and epigastric artery (EA). Immediately above and below the round ligament, the hyper-echogenic lines corresponding to the oblique muscle fascia and the fascia transversalis are visible. Medially there is the un-echogenic image of the pubis. (**b**) Same image as (**a**) with schematic description of the anatomy with the probe position to mark the incision in the preoperative mapping (white inverted T with yellow arrow). Medially we find the tuberculum pubis (orange) and the superficial ring of the inguinal canal (yellow ring at the left, underneath the arrow). This is the inguinal point (IP), where the fascia of the oblique external muscle is discontinued and we no longer see it as a white line in the image, marked with OEM fascia in the image and red dotted line. The vein "plexus" runs between this fascia and the fascia transversals, the deeper white line (red dotted), and its lateral end is the yellow circle "IR" marking the internal ring of the inguinal canal. (**c**) Pulsed wave Doppler measuring in the venous plexus running through the inguinal canal, at the same site than images (**a**) and (**b**). Reflux demonstration during the Valsalva test. (**d**) Same image as (**a**) and (**b**) with colour-coded duplex under Valsalva manoeuvre. The flow emerges through the inner ring, runs medially through the inguinal canal and becomes superficial at the superficial ring

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ligament, the latter surrounded with a silicone loop as to avoid injuries to the nerve. The venous plexus is cleaned and ligated with non-absorbable braided coated suture (Fig. 8.8c) before being severed (Fig. 8.8d). Then the stumps are sutured with a transfixed polypropylene stitch, the deeper folded up into the inguinal canal and sutured to oblique external muscle fascia (Fig. 8.8e) so that the proximal stump is not in front of the distal one. The polypropylene stitch prevents bleeding from the stump, whilst folding the proximal stump is useful to avoid recurrence due to neovessels going from one stump to the other. Proximal or

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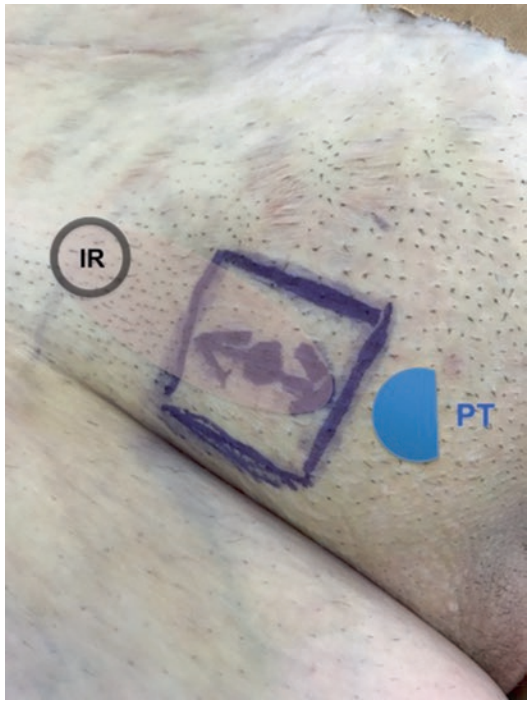

Fig. 8.7 Image of the right groin crease with preoperative mapping on the skin with the exact position of the superficial ring with a point; the arrows show the direction of the incision and of the inguinal canal. *IR* internal ring, *PT* pubic tubercle

distal ligation without ligation at the very IP level has shown to fail either immediately or after a time due to the large anastomoses in this region (see Fig. 8.1). Only once in the experience of the author, in an overweight patient, the oblique external muscle had to be opened to reach the venous plexus inside the inguinal canal. Usually this extension of the incision is not necessary so to reduce postoperative discomfort.

8.6 The Perineal Leak Point (PP)

The posterior perineal points (PPs) represented 61% of all the female PLPs treated by the author. The perineal point (PP) is the superficial perineal fascia hole crossed by the posterior labial vein. The draining order is as follows: the superficial perineal veins (epifascial) drain into the vulvar venous plexus and then into the perineal vein. The latter crosses the deep transverse perineal muscle to connect with the internal pudendal vein.

The PP, one for each side, is located posterolaterally to the labia majora about 1 cm anteriorly with respect to the origin of the frenulum labia minora (see Fig. 8.9). The perineal escape point can be responsible for ipsilateral or contralateral varicose veins. The diameter of the posterior labial vein crossing the vulvar facial hole ranges from 1.8 to 3 mm. Variations in the localisation of the perineal point are possible: the intermediate perineal point (IPP) is located about 1 cm anteriorly to the PP, but even a position in the middle between the anterior and posterior commissure is possible, as well as one single posterior labial vein (see Fig. 8.9). If more than one escape point is present, they can be treated through one incision, but only a very accurate preoperative marking can help to identify them. In ultrasound both perineal points can be represented in one image applying the transducer perpendicular to the labia (see Fig. 8.9a).

Surgical dissection of the P-Point: The patient is in gynaecological position. After preoperative marking of the point on the skin under ultrasound guidance, accurate preparation of the operative field with a clear sterile drape on the skin (see Fig. 8.10a). The surgical procedure starts with a little skin incision of 10 mm length (see Fig. 8.10b). Dissection of the collaterals joining into the posterior labial veins and ligation of the posterior labial vein with a 3 zero non-absorbable braided coated suture before being severed (see Fig. 8.10c). The labial vein is gently pulled and dissected to highlight the vulvar fascia hole (see Fig. 8.10d) and is then ligated at the vulvar fascia hole level (see Fig. 8.10e). The last mandatory surgical manoeuvre is the closure of the vulvar fascia hole with a six zero polypropylene stitch, so to definitively separate to different venous compartments: the subcutaneous and the vulva

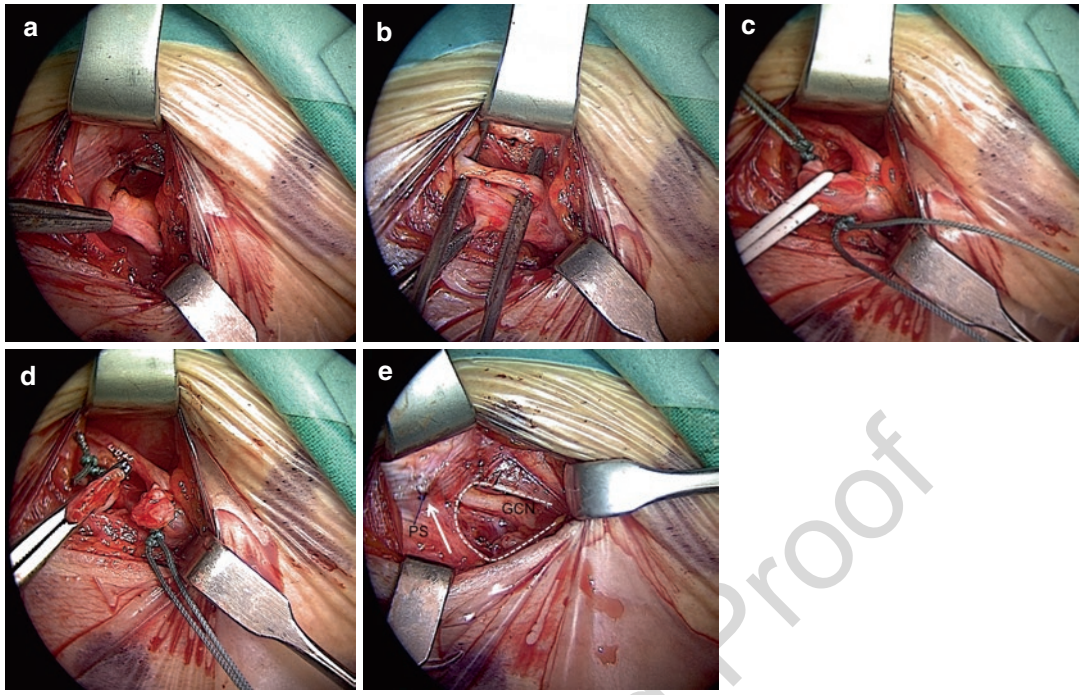

Fig. 8.8 (**a**) Deep down the oblique external muscle fascia, it can be detected as the round venous plexus together with the genitocrural nerve and connective tissue arising from the subcutaneous ring. (**b**) The genitocrural nerve has been isolated. (**c**) Ligation of the round ligament veins with non-absorbable braided overcoated suture. (**d**) The stump emerging the superficial ring is folded up and fixed to the fascia with a transfixing suture (PS, polypropylene stitch). The genitocrural nerve is visible in the upper part of the surgical field. (**e**) The surgical procedure is finished. The genitocrural nerve has been spared. The white line highlights the superficial ring of the inguinal canal without any visible vein. On the left, the transfixed polypropylene stitch fixing the proximal plexus stump is visible (arrow)

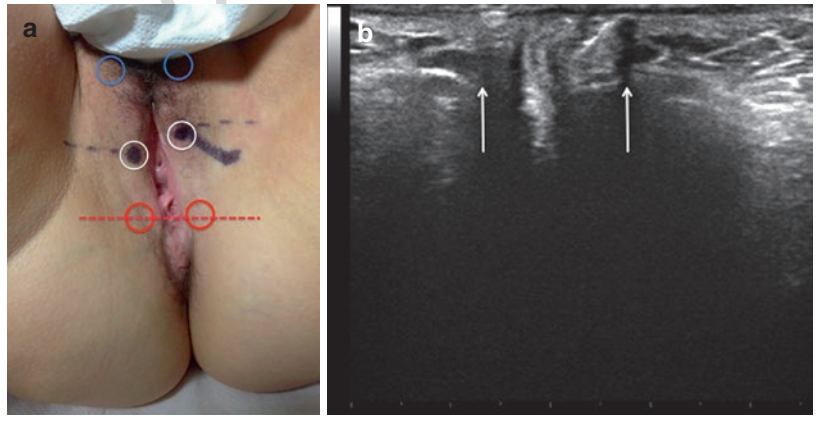

Fig. 8.9 (**a**) This image shows the position of the PP (red ring), the CP (blue ring) and the intermediate PP (white ring). The red dotted line shows the position of the transducer used to create the image shown in (**b**). (**b**) B-mode representation of the PP at both sides of the labia (see red dotted line in **a**). The white arrows show the fascia holes: P-Points

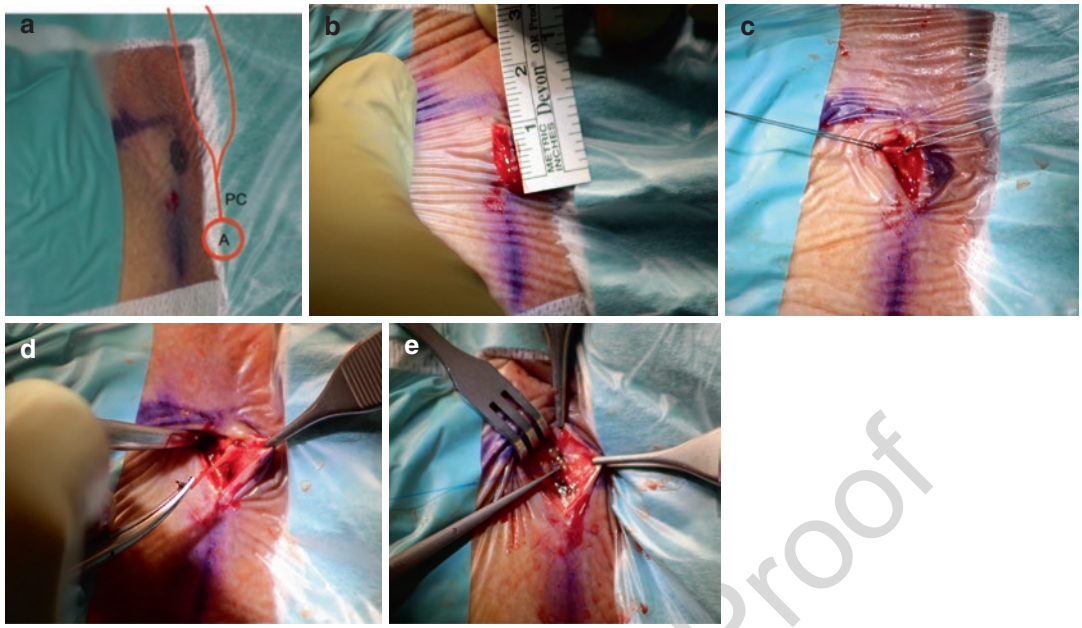

Fig. 8.10 (**a**) Appearance of the operative field. A clear sterile drape is on the skin. The black marker on the skin represents the PP. The horizontal and the longitudinal black lines are the skin markers drawn in the first step of the marking procedure. The red lines highlight the anatomical structure of the region, particularly the posterior commissure (PC) and anus (A). (**b**) 10 mm length skin incision and gentle dissection, paying attention to fine nervous branches of the pudendal nerve: minimally invasive surgery. (**c**) The posterior labial vein is ligated with a 3 zero non-absorbable braided coated suture before being cut. (**d**) Gentle posterior labial vein traction to highlight the vulvar fascia hole. (**e**) Ligation of the posterior labial vein at the vulva fascia hole level paying attention to avoid pudendal nervous branch ligation, and closure of the fascia hole with a six zero polypropylene stitch. The forceps thin tips at the suture level

plexuses. The operative field is washed with a rifampicin solution, the subcutaneous tissue sutured and the skin repaired with a cyanoacrylate surgical glue.

8.7 The Clitoridian Point (CP)

The clitoris is a complex structure attached to the mons pubis and labia and ventrally to the urethra and vagina. It's composed by an erectile body, composed of a pair of bulbs, and the glans that represents the most superficial part of it. The glans is a non-erectile structure well provided of nervous fibres, and for this reason, a surgical dissection at this level can be dangerous and should not be recommended. Alternatively, a sclerotherapy could be considered.

The venous path of the clitoris represents a connection between the deep venous system of the internal pudendal vein and the external pudendal vein, the former communicating with the hypogastric vein and the latter with the saphenous femoral junction. The veins of the external layers usually drain into the great saphenous veins, whilst the venous flow of the body and glans normally runs into the internal pudendal vein. There is an extensive venous communication between the clitoris veins and the subcutaneous mons veneris venous path.

The clitoris leak point (CP) (see Figs. 8.1b and 8.9a) is the anastomotic plexus between the bulbar vein and the superficial dorsal clitoris vein through which the flow reaches the external pudendal vein and runs into the great saphenous vein (see Fig. 8.11).

8.8 Male Pelvic Leak Points

Pelvic escape points can also be detected in men. These are the inguinal point (male IP), which is different from a female inguinal point, and a second point located medially from the root of the penis called the C-Point (male CP), sharing the same name as that used for females in the analogous position. These escape points may be the cause of ipsilateral as well as contralateral varicose veins and are generally the consequence of the increased venous pressure in the pampiniform plexus in case of varicocele.

8.8.1 Male Inguinal Point (IP)

The veins of the superficial and deep penile venous plexuses surrounding the urethra and penis connect the right and left pampiniform plexuses and so do the scrotal veins [2]. The pampiniform plexus consists of an anterior and a posterior group of veins, with the deferent duct between them. The anterior group, surrounding the spermatic artery in the inguinal canal, drains into the renal vein on the left and the inferior cava vein on the right side. The posterior group of veins drains the epididymis head and body, mainly into the epigastric inferior vein, and is detectable with the echo-duplex scan in the terminal third of the spermatic cord in the subcutaneous tissue which goes through the subcutaneous fascia, joining the saphenous femoral junction.

Through these veins, a reflux coming from the spermatic veins can be transmitted to the saphenofemoral junction. In other cases, a collector running from the medial segment of the pampiniform plexus and going through the subcutaneous fascia runs into collaterals of the anterior or great saphenous vein, bypassing the saphenous femoral junction.

The subcutaneous fascia hole is considered the male I-Point and is always detectable medially and above the sapheno-femoral junction and valve, near the pubis in the inguinal region (see Fig. 8.12).

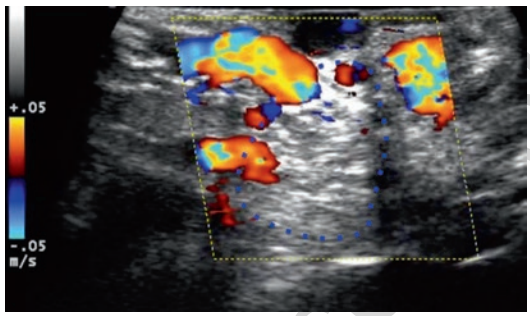

Fig. 8.11 The clitoris is the hyper-echogenic and irregular image in the centre (dashed blue line). CP reflux during the Valsalva manoeuvre

8.8.2 Male "C" Point

The scrotum is composed of different layers: the skin, the subcutaneous tissue, the dartos and a thin layer of subcutaneous tissue with vessels immediately below the dartos. The dartos of both

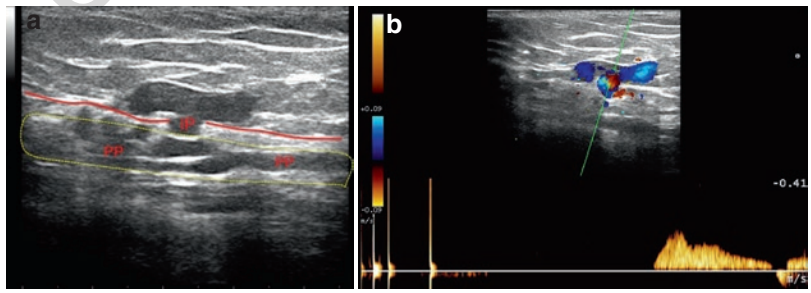

Fig. 8.12 (**a**) B-mode in cross section above the sapheno-femoral junction. The red line highlights the subcutaneous fascia. The fascia hole crossed by the venous collector (IP) and the pampiniform plexus (PP) below the subcutaneous fascia can be clearly seen. (**b**) Reflux from the pampiniform plexus through the IP to a tributary, which will feed the GSV

sides merges in the middle into the scrotal septum: the lower part of the scrotal septum joins the vaginal tunic in the scrotal ligament. Scrotal veins form a single venous path communicating with the subcutaneous veins of the lower part of the abdominal wall, the perineal region, the penis and the venous plexus draining the didymus and the epididymis. Thanks to the veins crossing through the scrotal septum, communication between the paths of the two scrotal veins is possible. The venous flow of the scrotal veins normally runs into the pudendal external vein to reach the great saphenous vein but can also drain directly into the femoral vein. The veins of the posterior part of the scrotum drain into the internal pudendal vein, and through it the flow reaches the hypogastric vein. For these anatomical reasons, a venous reflux even in males can be transmitted from one side to the other. Therefore, a reflux from the spermatic plexus of one side can create ipsilateral as well as contralateral varicose veins of the lower limbs.

In the penis, there is a superficial network and a deep venous network. The subcutaneous penile venous path drains mainly the skin and the subcutaneous tissue, and the flow normally runs into the subcutaneous dorsal veins of the penis. This vein drains into the subcutaneous plexus of the inferior part of the abdominal wall, and then the flow runs into the saphenous femoral junction. The veins of the inferior part of the superficial layer of the penis drain into the scrotal veins. The deep venous penis network drains the glans, the two corpora cavernosa and the corpus spongiosum. The flow of the deep path runs into the deep dorsal vein, normally valvulated, and through it to the pudendal vein, which represents one of the origins of the hypogastric vein. The superficial and deep paths widely communicate first through the glans and the foreskin veins and second through the veins located at the symphysis pubis level.

Furthermore, venous collectors run into the subcutaneous tissue, crossing a well-defined hole of the subcutaneous fascia, coming from the deep venous network of the penis. Through these collectors, a reflux from the deep penile venous path can be transmitted in the subcutaneous tissue of the pubic region. If there is a reflux through this fascia hole, it represents a further pelvic male leak point like the female CP: the male C-Point. It can be easily detected with a duplex scan next to the root of the penis, and minimally invasive surgical treatment is possible under local anaesthesia, thanks to a refined B-mode preoperative marking.

8.9 Obturator Leak Point

The obturator vein drains the muscles of the upper-medial segment of the thighs. Anterior and posterior muscular collectors run together into the main obturator vein trunk. The obturator vein passes through the obturator canal and runs into the hypogastric vein. The existence of anastomoses with the epigastric inferior veins and the pudendal external vein is well known [3, 6, 7, 9]. An anterior muscular circumflex collector is sometimes detectable. It runs below the muscular pectineus fascia lying on the pectineus muscle and normally drains medially into the common femoral vein at the sapheno-femoral junction level: either into the common femoral vein itself or into the junction—centrally to the terminal valve or between the terminal and preterminal valve. The confluence of this collector into the saphenous femoral junction is the so-called obturator point (see Fig. 8.13).

It represents an important anastomotic venous path between the common femoral vein and the hypogastric vein as well as the pudendal external vein. This muscular venous collector is quite distinguishable from the external pudendal vein; in fact, the latter runs superficially whilst the first is located below a muscular fascia (see Fig. 8.14).

In case of pelvic reflux and anastomosis with the obturatorian vein, this path can just drain into the common femoral vein independently of the superficial venous system, or it ends in the sapheno-femoral junction (see Fig. 8.13). This pathway is possible in male and female population.

Depending on the competence of the terminal and preterminal valve, the blood from the obturatorian vein leak could just feed the common

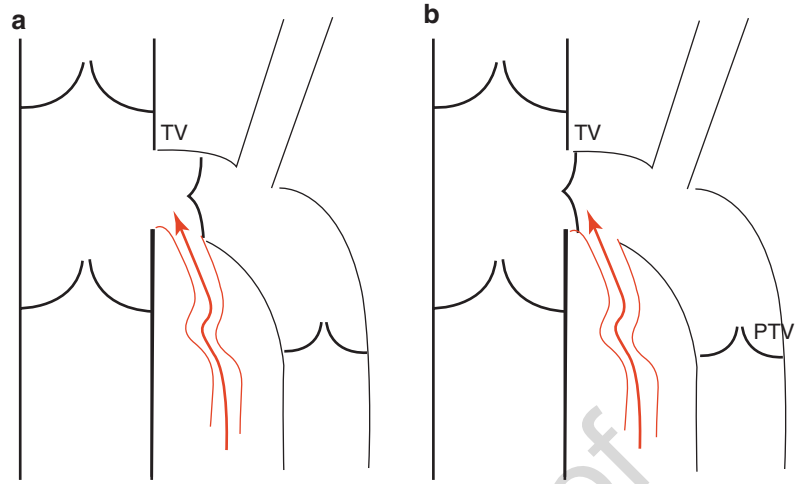

Fig. 8.13 (**a**) The circumflex muscular medial collector (red) drains into the sapheno-femoral confluence from medially, between the common femoral vein and the terminal valve (TV) of the great saphenous vein. (**b**) The circumflex muscular medial collector (red) drains into the saphenous vein arch, between the terminal (TV) and preterminal valve (PTV)

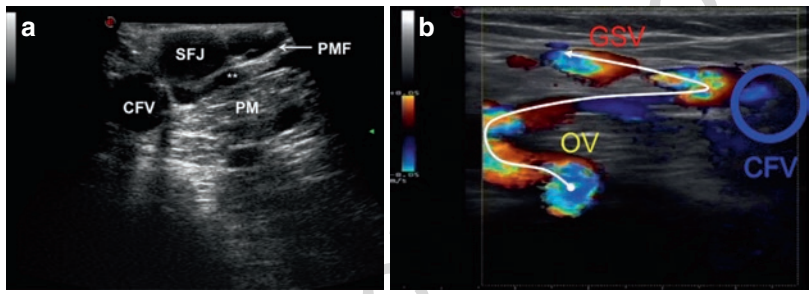

Fig. 8.14 (**a**) Cross section of the left groin region in B-mode: image of a circumflex muscular medial collector (**). It represents an anterior origin of the obturator vein. The collector runs below the pectineus muscular fascia (PMF), on the pectineus muscle (PM), and reaches the sapheno-femoral junction draining on the saphenous side of the terminal valve. (**b**) Valsalva manoeuvre. Reflux from the circumflex medial collector into the SFJ

femoral vein via the circumflex muscular medial collector or be the leakage point for a venous insufficiency in the leg.

The anterior muscular circumflex collector can be ligated if necessary opening the pectineus muscle fascia, under B-mode preoperative marking or even intraoperative control without any saphenous femoral junction dissection. In addition, different strategies are possible: OP ligation during saphenous femoral disconnection for an associated terminal valve incompetence or simple saphenous high ligation immediately below the superior collaterals of the junction. Endovenous laser treatment is a further possible therapeutic technique as encoded by the CHIVA laser strategy.

8.10 Gluteal Leak Points

Gluteal leak points are seldom found in relation to varicose veins of lower limbs.

The inferior gluteal vein (sciatic vein) is a large valvulated parietal collector that represents one of the origins of hypogastric vein. One of the main collateral branches of the inferior gluteal vein is the sciatic vein running together with the sciatic nerve, and thanks to collaterals it is connected to the superior gluteal vein and to the common femoral vein through the femoral circumflex medial vein, the terminal segment of the deep femoral vein representing an important venous bypass path in case of iliac obstruction or stenosis. Two different escape points can be detected: the

inferior gluteal point (IGP) and the superior gluteal point (SGP) (see Fig. 8.1c). Anatomically the inferior one is located below the lower margin of the piriformis muscle exactly at the ileotrochanteric line level, whilst the superior gluteal point (SGP) is located at the superior margin of the piriformis muscle. The sciatic vein can be found immediately below the margin of the piriformis muscle with the colour-coded duplex ultrasound, checking low-speed flow about 12 cm/s. The sciatic vein is also detectable posteriorly at the thigh by focussing the hyper-echogenic image of the sciatic nerve and checking the flow during the Valsalva manoeuvre in veins surrounding the nerve. From here the vein might be followed cranially to find the origin in the superior or inferior leak point and distally to find the drainage path.

The author has never treated a gluteal escape point with surgery. To access the leak point, a big surgical procedure would be necessary. So, peripheral disconnections could be one option to treat them, or ultrasound-guided sclerotherapy could be another therapeutic option, though it requires a very experienced operator, considering that veins lie close to the sciatic nerve.

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Author Queries

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Queries	Details Required	Author's Response
AU1	Please check if "Minimal" should be changed to "Minimally."	
AU3	Please check if caption of "Fig. 8.1" is okay as edited.	
AU4	Please check if "obturatorian vein" should be changed to "obturator vein" throughout text for consistency.	
AU5	Please check if all occurrences of "pelvic leakage points" should be changed to "pelvic leak point" for consistency.	
AU6	Please check if edit to sentence starting "Longitudinal image …" is okay.	
AU7	Missing citation for "Fig. 8.4" was inserted here. Please check and confirm if appropriate.	
AU8	Please check if edit to caption of "Fig. 8.3" is okay.	
AU9	Missing citation for "Fig. 8.5" was inserted here. Please check and confirm if appropriate.	
AU10	Please check if edit to sentence starting "It can estimate…" is okay.	
AU11	Please consider changing the usage of all caps for emphasis to italicized texts.	
AU12	Please check if edit to sentence starting "The vein – …" is okay.	
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AU14	Please check if edit to sentence starting "The PP, one …" is okay.	
AU15	References have been renumbered to maintain sequential order. Please check and confirm if correct.	
AU16	Reference [20] was not cited anywhere in the text. Please provide in text citation or delete the reference from the reference list.	