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Anatomy of the presacral venous plexus: implications for rectal surgery

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Abstract The presacral venous plexus results from anastomoses between the lateral and median sacral veins, and courses into the pelvic fascia covering the anterior aspect of the body of the sacrum. The presacral venous plexus is not directly visible during rectal surgery, and injuries to this plexus may be life-threatening. Dissection of the retrorectal plane or anchoring of the rectum to the sacral promontory as in rectal prolapse surgery exposes the patient to the risk of injury to the presacral venous plexus. The aim of this study was to identify some avascular areas in the anterior aspect of the sacrum in order to lower the occurrence of such injuries during rectal surgery. The pelvis of 10 fresh cadavers was dissected after injection of a colored resin into the inferior vena cava, and the presacral venous plexus was studied. Four avascular tetragonal areas were common to all the specimens. The corners of a square with a side of 3 cm, centered on the anterior aspect of the body of sacrum, were always contained in the avascular areas. The upper side of this square was parallel to a line passing through the sacral promontory, at a 3 cm distance from it. Staples or sutures should be placed in the avascular areas to avoid injuries to the presacral venous plexus.

Keywords Presacral venous plexus · Bleeding hemostasis · Rectum · Anatomy

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Introduction

The presacral venous plexus (PSVP) is formed by the two lateral sacral veins (LSV), the middle sacral vein (MSV) and the veins connecting them (communicating veins, CV). The latter are disposed perpendicular to the LSV and MDV in a stair-like fashion. Further, the PSPV is connected to the internal vertebral venous system (IVVS) through the basivertebral veins (BVV) that pass through the sacral foramina [4].

The PSVP veins course into the pelvic fascia, covering the anterior aspect of the body of the sacrum that is constituted by the presacral fascia, the piriformis and coccygeal muscle fascia, and the sacrospinous ligament. The nervous elements, such as the hypogastric plexus and the pelvic sympathetic trunk and ganglion, run anteriorly to the pelvic fascia [2, 7, 11]. For this reason, the PSVP veins are not directly visible to the eye of the surgeon, and may be accidentally injured during rectal surgery [1, 5, 8, 9, 10]. Two classical situations expose the surgeon to the risk of injuring the PSVP veins: dissection of the retrorectal plane during mobilization of the rectum as in rectal cancer surgery, and fixation of the rectum onto the sacrum as in the case of surgery for rectal prolapse. The latter can be done by directly fixing the dissected rectum to the sacral promontory as in Orr-Loygue's operation [6] or by suspending the rectum by means of a mesh that is sutured or stapled to the anterior aspect of the sacrum as in Wells's operation [12].

The aim of this study was to report the number, size and distribution of the PSVP veins in order to identify the existence of some avascular zones where the surgeon may suture or staple the mesh in Wells's operation. In addition, exact knowledge of the distribution of the PSVP veins and their anatomical variants should help the surgeon to achieve hemostasis in case of injury to these veins.

Materials and methods

Ten fresh cadavers were studied (6 males, 4 females). The inferior vena cava and the common femoral veins were dissected through a subcostal laparotomy and two inguinal incisions respectively. The isolated iliocaval venous system was washed out with saline, and then injected with 100 ml of a colored resin of methylmethacrylate (Altuglas). The incisions were closed and cadavers refrigerated at 6 °C for 72 h. The pelvis was then exposed through both midline and transverse abdominal incisions and the pubic symphysis was sectioned and kept open. The pelvic viscera were removed en bloc, and the distal aorta, the iliac arteries and their collaterals were removed along with the fascial and nervous presacral elements, sparing the nervous sacral plexus. The PSVP was completely dissected, and the disposition, number and size of the LSV and MV, as well as the CV and BVV, were recorded. A venous map of the sacrum was outlined for each specimen reporting all the venous elements of the PSVP as straight lines, and the avascular areas as squares. The distance of the PSVP veins and avascular areas from an easily identifiable point located in the middle of the sacral promontory (point P), and two lines passing vertically (V line) and horizontally (H line) through this point, was determined. The 10 resulting maps were then superimposed to obtain a cartography of the PSVP veins, and to outline the avascular areas common to the 10 specimens.

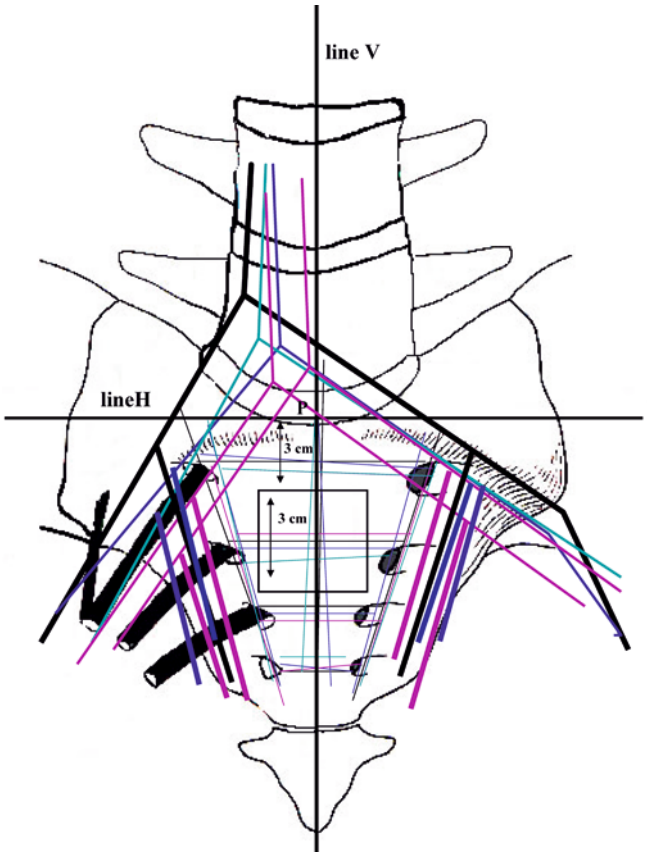

Fig. 1 Cartography of the presacral venous plexus (PSVP) in the five first specimens. The venous elements of the PSVP are shown as straight lines. Point P is located in the middle of the sacral promontory. The V line passes vertically through point P. The H line passes horizontally through point P

Results

Internal iliac vein and its confluence with the common iliac vein

The internal iliac vein was unique in 10 cases (50%), double in 6 cases (30%) and plexiform in 4 cases (20%) (20 internal iliac veins for 10 specimens). The median size was 12.6 mm (range 11–14 mm). The mean distance of the inferior border of the confluence of the internal iliac vein with the common iliac vein from point P was 4.5 cm (range 3.5–4.6 cm). This confluence was on the right of the V line in all the specimens.

Middle sacral vein

The MSV ended in the left internal iliac vein in all the specimens. It was double in 8 cases (80%) and unique in 2 (20%). The median size was 1.5 mm (range 1–2 mm). This vein passed on the right of the V line in 3 cases (3%), on the left in 3 cases (3%) (mean distance 2.3 mm, range 1.5–3 mm) and through it in 4 cases (4%).

Lateral sacral veins, basivertebral veins and connecting veins

The LSV were medial to the first sacral nerve root in all the specimens.

Two BVV were found exiting from the first sacral foramen (S1) in 16 cases (80%) and one vein in 4 cases (20%). The CV were absent in one case (10%) at this level. In the remaining 9 cases (90%) these veins had a mean diameter of 1.5 mm (range 1.1–2.3 mm) and were found parallel to the H line at a mean distance of 2 cm (range 1.5–2.3 cm) from it.

Two BVV were found exiting from the second sacral foramen (S2) in 14 cases (70%) and one vein in 6 (30%). The CV were found in all the specimens and had a mean diameter of 1.5 mm (range 1–2 mm). These veins were at a mean distance of 3 cm (range 3.5–2.8 cm) from the H line and 3 cm (range 2.9–3.5 cm) from the corresponding CV at the S1 level.

One BVV was found exiting from the third sacral foramen (S3) in 16 cases (80%), and two in 2 cases (20%). The CV were absent in 3 cases (30%). In the remaining 7 cases (70%) these veins had a mean diameter of 1 mm (range 0.8–1.2 mm). These veins were at a mean distance of 6 cm from the H line (range 5.7–6.4 mm) and 2.6 cm from the corresponding CVs at the S2 level (range 2.3–3.2 cm).

One BVV was found exiting from the fourth sacral foramen (S4) medial to the second nerve sacral root in

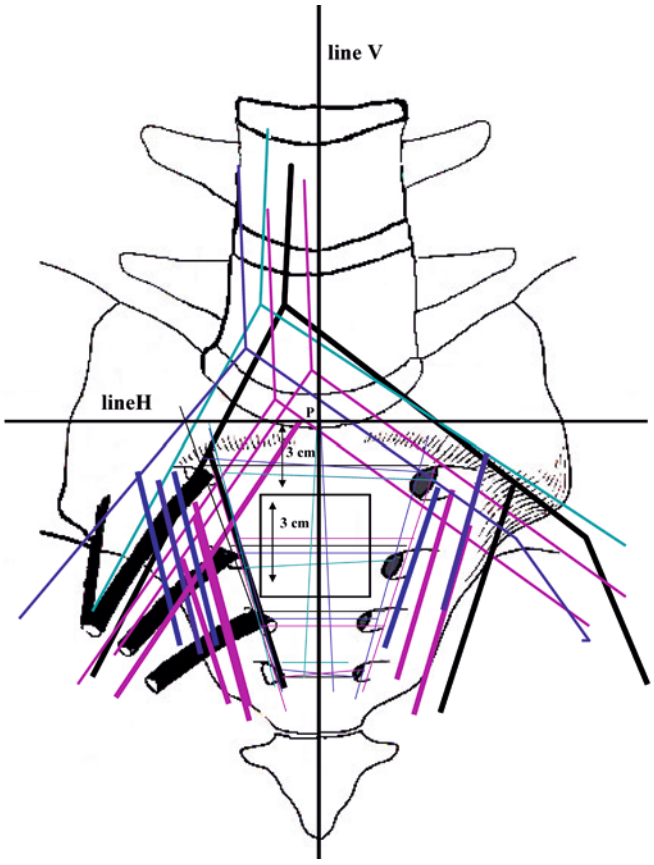

Fig. 2 Cartography of the presacral venous plexus in the five remaining specimens

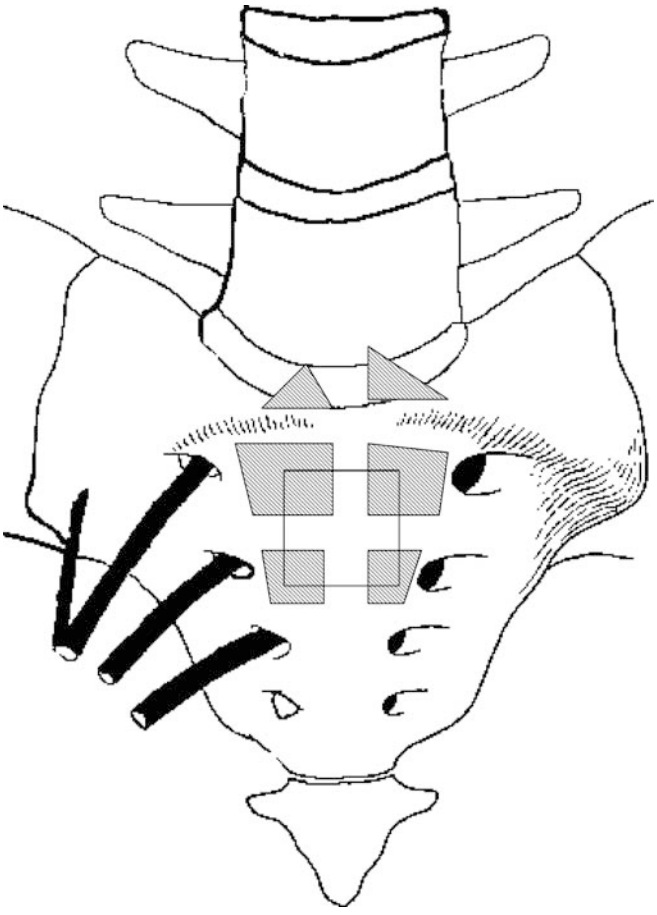

Fig. 3 Disposition of the avascular areas with the body of the sacrum. The corners of the avascular areas are contained in a square with sides of 3 cm. The upper side of the square is parallel to the H line and 3 cm distant from it

all the specimens. The CV were absent in 3 cases (30%). In the remaining 7 cases (70%) these veins had a mean diameter of less than 1 mm in all the specimens. These veins were at a mean distance of 2.5 cm (range 2.3–3 cm) from the corresponding CV at the S3 level.

The final map of the schematic superposition of the PSVP veins is shown in Fig. 1 for the first five specimens, and in Fig. 2 for the last five specimens. Four avascular tetragonal areas were common to all the specimens (Fig. 3). The corners of a square with a side of 3 cm, centered on the anterior aspect of the body of sacrum, were always contained in the avascular areas. The upper side of this square was parallel to the H line at a 3 cm distance from it. Fig. 4 shows a dissected presacral venous plexus with a plexiform internal vein on the right side, and unique internal vein on the left side, and the avascular area in between the sacral plexus.

Discussion

The internal iliac vein constitutes a complicated venous system connected to the femorocaval system. The internal iliac vein communicates with the veins coming from the inferior limb, pelvic viscera and the IVVS. The latter consists of a plexus of thin-walled veins that follows metameric somitogenesis and forms a basketwork within the sacral canal. The IVVP is connected to the PSVP through the BVV, which are tiny veins that traverse the body of the sacrum at the level of the sacral foramina. In turn, the PSVP, formed by the LSV, MSV and CV, is connected to the internal iliac veins. From an embryological standpoint [4], the three different venous systems draining into the internal iliac vein are very unstable: insufficient condensation may lead to a plexiform network of veins, while excess condensation may lead to a unique iliac vein, progressively receiving its collaterals. The CV anastomosing the lateral and median sacral veins are disposed in a stair-like fashion, and are very variable [4].

Surgical dissection of the retrorectal plane is done in the plane between the perirectal fascia anteriorly, and the pelvic fascia behind [2]. The latter covers the PSVP that, consequently, is not directly visible to the surgeon's eye. Injuries to these veins are responsible for torrential bleeding as all the pelvic venous system lacks valves [1, 4, 8, 9, 10]. In addition, the patient's lithotomy position increases the hydrostatic pressure in the PSVP up to 3 times that of the inferior vena cava. This bleeding is

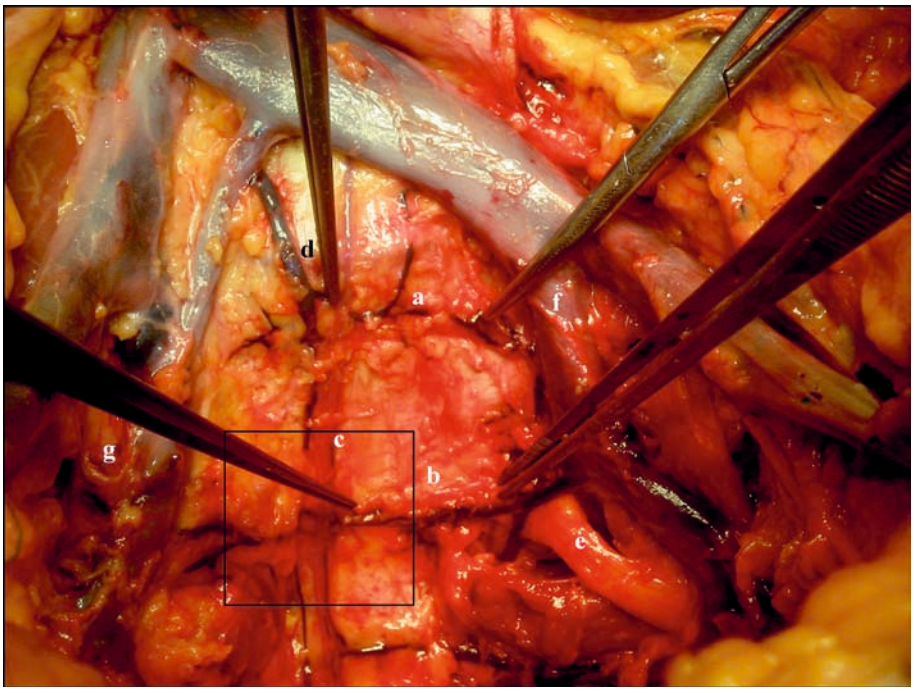

Fig. 4 Dissected presacral venous plexus with a plexiform internal vein on the right side, and unique internal vein on the left side. The avascular area is in between the sacral plexuses (square's corners). *a*, Basivertebral vein coming out the first sacral foramen; *b*, basivertebral vein coming out the second sacral foramen; *c*, middle sacral vein; *d*, point P; *e*, second sacral nerve; *f*, left unique internal iliac vein; *g*, right plexiform internal iliac vein

extremely difficult to control due to the retrofascial course of the PSVP veins and their potential plexiform disposition.

Surgery for rectal prolapse is based on the suspension of the dissected rectum onto the sacrum directly or by means of a mesh. This suspension can be achieved by means of sutures or staples [6, 12]. In both cases the risk of injuring the PSVP veins renders this maneuver potentially hazardous. With the recent development of laparoscopic technique this operation is routinely done under laparoscopy. In case of bleeding, the laparoscopic approach renders hemostasis even more challenging and, in case of conversion to open surgery, bleeding may rapidly destabilize the patient.

In the case of plexiform disposition of the iliac veins, staples or sutures on the ventral aspect of the sacrum may tear a large lateral sacral vein when placed laterally, and the median sacral vein when placed in the middle. The smaller diameter of the latter as well as an oblique stapling seems to reduce the risk of injuring this vein.

In this paper we demonstrate that four avascular areas exist in the ventral aspect of the sacrum where sutures or staples can be applied quite safely. These surgical maneuvers can be done in the corners of a square with a side of 3 cm, parallel to the H line and 3 cm distant from it.

Conclusion

Accidental injuries of the PSVP veins may bleed massively and hemostasis may be difficult to achieve. Exact knowledge of the disposition of the PSVP is essential as it is not directly visible during surgical dissection of the retrorectal plane, given its retrofascial course. Staples and sutures should be applied in the avascular areas as described in this study.

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