The TME Workshop was initiated by the Pelican Cancer Foundation and supported by Tyco Healthcare

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Anatomical Aspects of Total Mesorectal Excision

Foreword

When Professor Chummy Sinnatamby left his University Chair in Surgery in Sri Lanka, that country's loss became a major gain for generations of surgeons who have looked to England and its Royal College for their surgical training. Chummy became an anatomist with the eyes and experiences of a surgeon. For many years my own understanding of the anatomy of the pelvis in the live patient has grown as we strive to improve haemostasis and the precision of the dissection deep within its inaccessible depths. We have struggled to share these difficulties with groups of visiting surgeons, both at the College via the live link with the London hospital, and now in our Pelican Cancer Foundation at Basingstoke. Our constant helper and advisor throughout this learning process has been, and is, Chummy who continually watches and advises us via ever improving video-links as the live human pelvis yields up its secrets.

In addition to his contribution to the video based live explorations of human anatomy, Chummy's dissections have provided the basic training and groundwork for all those who have attended our courses. Indeed it is the enthusiasm of these surgeons during courses at the Pelican Cancer Foundation that has stimulated Tyco to produce this monograph. The course appraisal forms from every group bear witness to the value, in his unique hands, of skilfully presented cadaver based anatomy as a background for the improvement of surgical technique. His presentation of the detail of the autonomic nerves that subserve sexual and bladder function is a classic in its own right.

This permanent record of Chummy's wonderful lectures will provide a lasting source of understanding for all surgeons who find themselves challenged by the difficult depths of the human pelvis.

Professor R J Heald OBE MChir FRCS

A surgical procedure that comprises a monobloc resection of a cancer bearing organ and its principal field of direct lymphatic and vascular spread aims to achieve an optimal oncological outcome. Total mesorectal resection realises this objective by removing the rectum together with its integral visceral mesentery as an intact package. The technique involves deliberate dissection under direct vision along pre-existing, embryologically determined anatomical planes between visceral and parietal structures, thereby preserving the autonomic nerves in the lower abdomen and pelvis that are required for the maintenance of sexual function and normal urinary voiding.

Following adequate incisional access to the abdomen and pelvis, exploration of their contents and displacement of small intestinal loops, separation of congenital adhesions between the left leaf of the sigmoid mesentry and the parietal peritoneum (Fig. 1) allows division of the latter to gain access to the plane between the mesosigmoid and the posterior parietal structures. This allows entry of air into the retroperitoneal space created thereby and facilitates safe peritoneal division on the right side of the rectosigmoid. Detachment of the apex of the sigmoid mesocolon from the front of the bifurcation of the left common iliac artery requires identification and preservation of the left ureter, as it lies here lateral to the inferior mesenteric artery with the inferior mesenteric vein between them (Fig. 2).

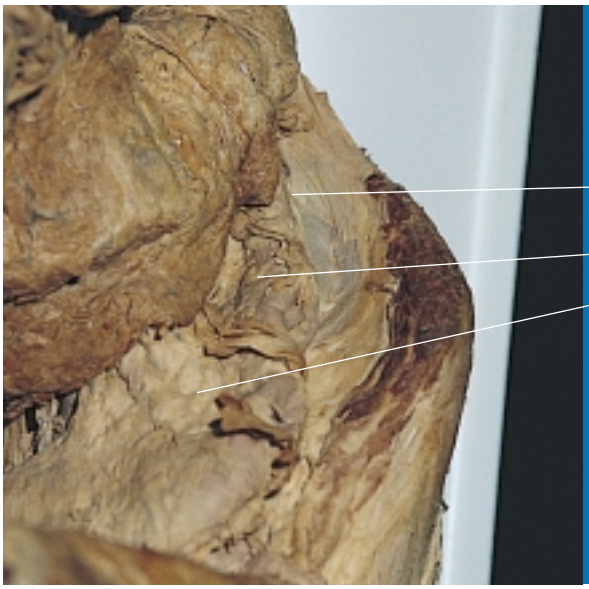


Fig. 1

Left iliac fossa

- Adhesion of mesosigmoid to parietal peritoneum
- Sigmoid colon
- Right leaf of mesosigmoid

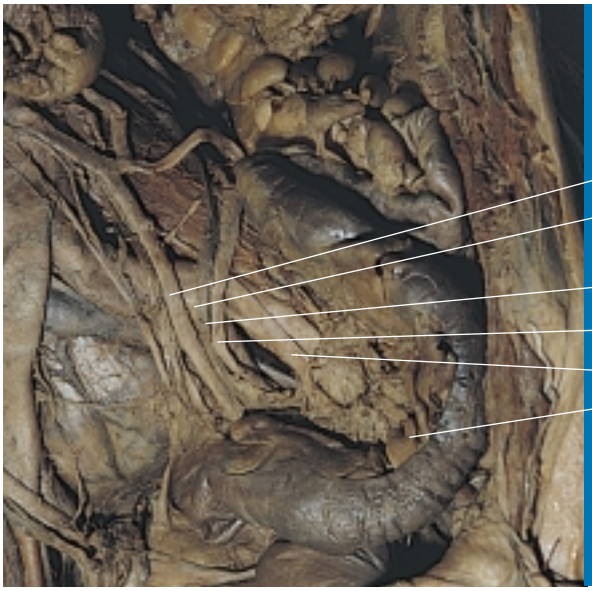


Fig. 2

Left iliac fossa

- Inferior mesenteric artery
- Bifurcation of left common iliac artery
- Inferior mesenteric vein
- Left ureter
- Left external iliac artery
- Sigmoid colon

Fig. 3

Left hypochondrium

Extension of the left paracolic parietal peritoneal incision upwards for mobilisation of the splenic flexure requires careful division of the phrenicocolic ligament which attaches the flexure to the under aspect of the diaphragm, as the lower pole of the spleen lies in contact with this peritoneal fold (Fig. 3).

A high ligation of the inferior mesenteric artery is required to obtain proximal clearance of rectal lymphatic drainage. A plexus of autonomic nerves surrounds the origin of the artery on the anterior aspect of the aorta (Fig. 4).

Fig. 4

Posterior abdominal wall

The nerve fibres are mainly sympathetic, from the lower thoracic sympathetic chain through its splanchnic branches (Fig. 5) which pierce the crura of the diaphragm to reach the abdominal aortic autonomic plexuses; other sympathetic fibres originate from the upper two lumbar sympathetic ganglia (Fig. 6).

This inferior mesenteric plexus is preserved by ligating and dividing the artery 1-2 cm from the aorta. When an involved pre-aortic lymph node overlies the origin of the artery, careful dissection of nerve fibres from off the artery could enable their preservation while ligating and dividing the artery at its origin. A high ligation of the inferior mesenteric vein at the inferior margin of the pancreas enhances mobility of the left colon for tension free anastomosis with the anorectal stump.

Fig. 5

Right side of posterior wall of lower thorax and upper abdomen

- Thoracic sympathetic chain
- Splanchnic nerves
- Segment of diaphragm

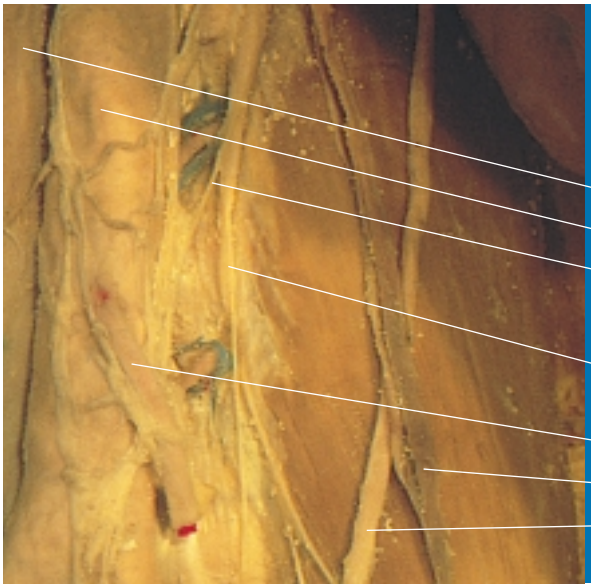


Fig. 6

Close-up view of posterior abdominal wall

- Inferior vena cava
- Aorta
- Sympathetic ramus to aortic autonomic nerve plexus
- Left lumbar sympathetic chain
- Inferior mesenteric artery
- Left gonadal vein
- Left ureter

Fig. 7

Posterior wall of lower abdomen and superior aspect of pelvis

Fig. 8

Posterior wall of lower abdomen and superior aspect of pelvis

Sympathetic nerves from the plexus around the origin of the inferior mesenteric artery and from the lower two lumbar ganglia descend to the superior hypogastric plexus, which lies in extraperitoneal connective tissue in front of the aortic bifurcation and the left common iliac vein (Fig. 7), at the level of the fifth lumbar vertebra and the sacral promontory. This plexus varies in the breadth and condensation of its constituent fibres and is often situated slightly to the left of the midline (Fig. 8),

behind the apex of the sigmoid mesocolon, in close proximity to the inferior mesenteric vessels and the left ureter (Fig. 9). A delicate filamentous latticework of areolar tissue provides an avascular plane between the superior hypogastric plexus posteriorly and the mesorectum anteriorly (Fig. 10), facilitating safe separation of the latter from an intact plexus.

Fig. 9

Posterior wall of pelvic brim

Inferior mesenteric artery

Inferior mesenteric vein

Left ureter

Superior hypogastric plexus and parietal layer of pelvic fascia

Mesorectum

Cut edge of mesosigmoid peritoneum

Fig. 10

Posterior wall of pelvic brim

Superior hypogastric plexus and parietal layer of pelvic fascia

Areolar tissue

Mesorectum

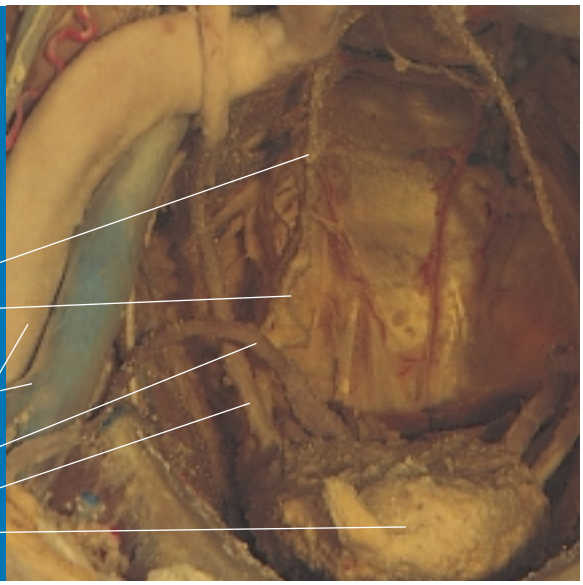
Forceps exerting anterior traction on mesorectum

Fig. 11

Posterior wall of pelvic brim

Fig. 12

Superior aspect of male pelvis



This avascular plane lies between the parietal and visceral layers of pelvic fascia and mobilisation of the rectum with an intact mesorectum is achieved by surgical separation of these fascial layers along this plane (Fig. 11).

The superior hypogastric plexus divides in the manner of an inverted Y into a pair of hypogastric nerves (Fig. 7, 8), each of which may be a single nerve or an elongated network of anastomosing fibres, which run in a sagittal plane outside the parietal layer of pelvic fascia to the side walls of the pelvis (Fig. 12). Here they merge with parasympathetic fibres (the nervi erigentes/ pelvic splanchnics) from the second, third and fourth sacral nerve roots and with a few fibres from sacral sympathetic ganglia to form the inferior hypogastric plexus on each side.

The parasympathetic contribution from the third sacral nerve is usually the largest (Fig. 13). Small branches from the inferior hypogastric plexus run medially to enter the mesorectum (Fig.14), constituting the parasympathetic nerve supply to the rectum.

A small, variable middle rectal artery likewise runs medially to the mesorectum from a more anterior location. These neurovascular structures approach each other as they near the rectum and surgical definition of surrounding connective tissue comprises the iatrogenic lateral ligament of the rectum. A middle rectal artery requiring specific electrocoagulation is encountered in only about a fifth of all cases and is then usually a branch of the internal pudendal artery or inferior vesical artery rather than the internal iliac artery itself. The inferior hypogastric plexus lies in a sagittal plane tangential to the mesorectum. As the avascular areolar tissue interface between parietal and visceral fascial layers is developed surgically on either side, undue medial retraction of the mesorectum must be avoided, or else this may tent the plexus into the path of surgical separation.

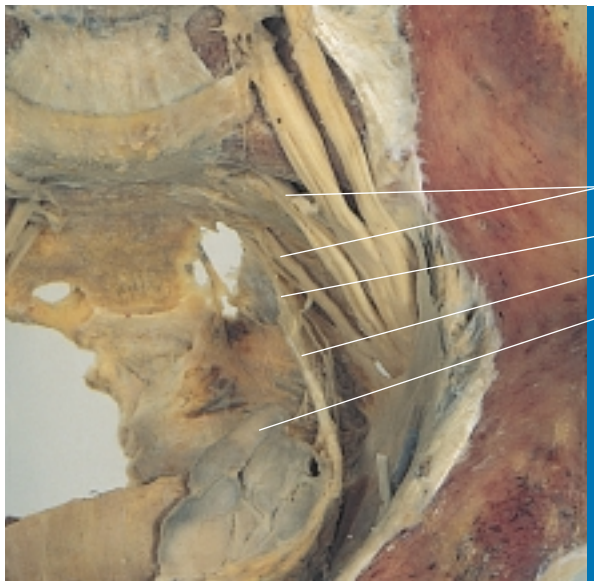


Fig. 13

Superior aspect of male pelvis

- Sacral nerves
- Nervi erigentes
- Inferior hypogastric plexus
- Seminal vesicle

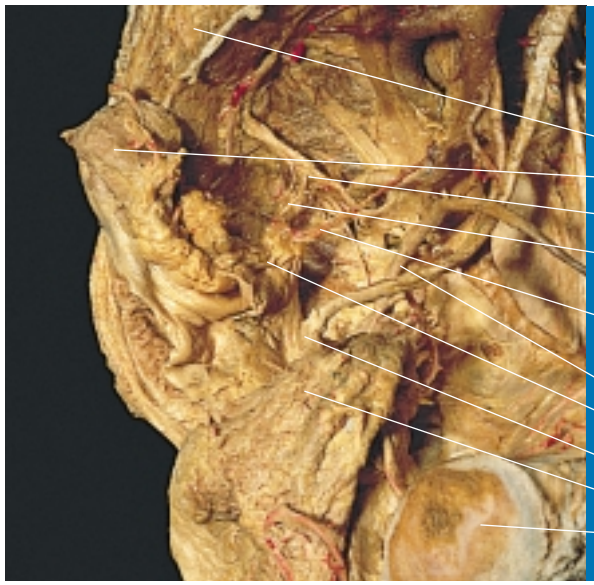


Fig. 14

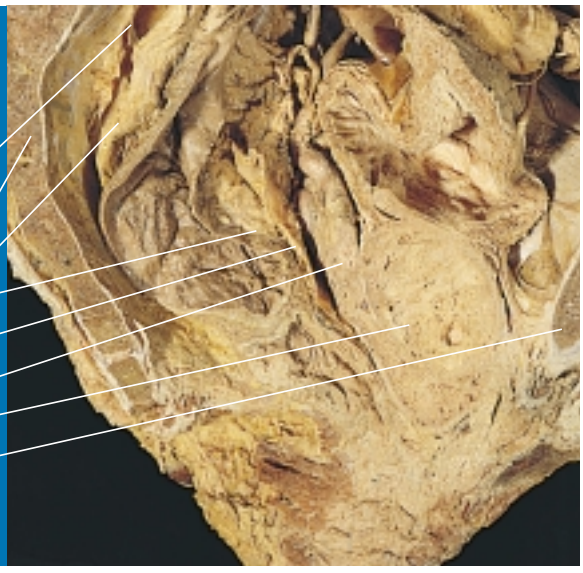
Left male hemipelvis

- Sacrum
- Rectum
- Inferior hypogastric plexus
- Parasympathetic nerves to rectum
- Rectal branch of internal pudendal artery
- Ductus (vas) deferens
- Mesorectum
- Ureter
- Bladder
- Pubic symphysis

Fig. 15
Left male hemipelvis

The parietal layer of pelvic fascia anterior to the sacrum covers the pyriformis muscles and the sacral nerve roots as they emerge from the anterior sacral foraminae. It is adherent to the sacral periosteum in the midline.
Total mesorectal excision stays entirely in front of this posterior parietal pelvic fascia; inadvertent transgression of this fascia is likely to lead to troublesome bleeding from presacral vessels (fig. 15). At the level of the fourth sacral segment a fascial layer of variable thickness runs forwards to blend with the visceral fascia on the mesorectal surface 3-5 cm proximal to the anorectal junction (Fig. 16). Division of this rectosacral fascia enables mobilisation of the mesorectal package down to the pelvic floor.

Fig. 16
Left male hemipelvis



Here the visceral and parietal fascial layers meet in the fascia on the superior surface of the anococcygeal raphe / ligament (fig. 17).

The inferior hypogastric plexus takes the form of a fenestrated rectangular plaque lying lateral to the rectum, prostate, seminal vesicles and posterior part of the bladder in the male, and lateral to the rectum, cervix, vaginal fornix and posterior part of the bladder in the female (Fig. 18).

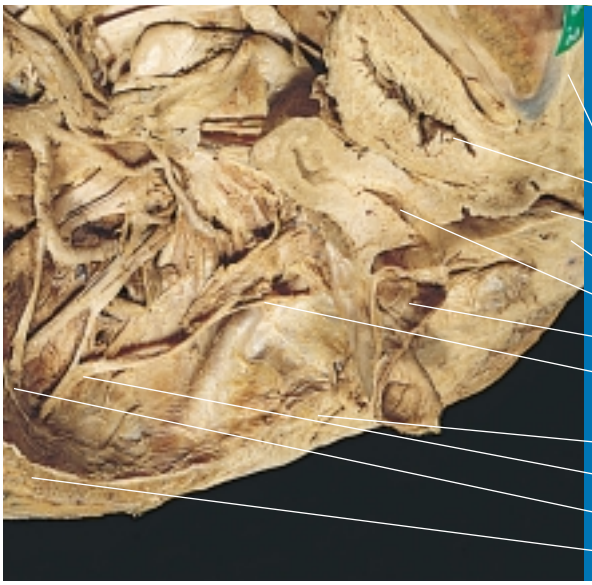


Fig. 17

Left female hemipelvis

- Pubis symphysis
- Bladder
- Vagina
- Perineal body
- Uterus
- Rectum
- Parasympathetic nerve to rectum
- Anococcygeal raphe
- Third sacral nerve
- Sacral sympathetic chain
- Sacrum

Fig. 18

Lateral aspect of right inferior hypogastric plexus in a female pelvis

- Obliterated umbilical artery
- Bladder
- Ureter
- Inferior hypogastric plexus
- Vagina
- Rectum
- Segment of levator ani

Fig. 19

Lateral aspect of left inferior hypogastric plexus in a male pelvis

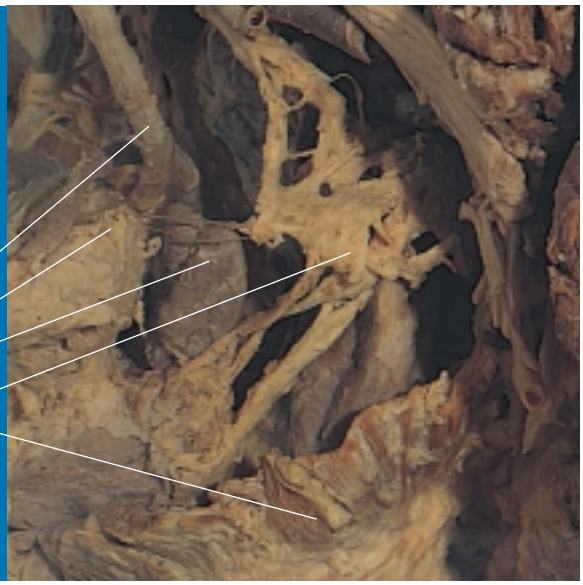


Fig. 20

Left female hemipelvis

In the male the inferior hypogastric plexus is posterolateral to the seminal vesicle, with the middle of the plexus lying at the level of the top of the vesicle (Fig. 19). Branches from the plexus run forwards and medially to the urogenital structures accompanied by branches and tributaries of the internal iliac artery and vein. These neurovascular bundles cross the lateral reaches of the rectovesical fascia (of Denonvillier's) and must be avoided as the fascia is resected with the rectum.

Following division of the peritoneum as it is reflected forwards from the front of the mid-rectum, the anterior plane of dissection in total mesorectal excision continues downwards in front of Denonvillier's fascia which covers the anterior face of the mesorectum, giving it a whitish appearance as compared to the yellowish colour of the fat visible through the visceral fascia enveloping the posterior and lateral surfaces of the mesorectum. Denonvillier's fascia is closer to the rectum than to the seminal vesicles and prostate (Fig. 16). Inferiorly, however, this rectovesical fascia is attached to the apex of the prostate and consequently has to be divided above this level to complete the anterior deliverance of the mesorectal package. A thinner rectovaginal fascia, intervening between the rectum and the posterior vaginal wall and attached inferiorly to the perineal body (Fig. 20), has a corresponding anatomical relevance to total mesorectal excision in the female.

In the male branches of the inferior hypogastric plexus pass to the bladder, seminal vesicles, prostate, urethra, corpus spongiosum and corpora cavernosa (Fig. 21). These latter cavernous nerves pass below the pubic arch to the penis (fig. 22); corresponding nerves in the female supply the vagina and the erectile tissue of the vestibular bulbs and clitoris. The parasympathetic fibres in these nerves produce vasodilatation, and the sympathetic fibres vasoconstriction, in the genital organs. In the male the sympathetic fibres cause contraction of the smooth muscle at the bladder neck and in the seminal vesicles and prostate; consequently they play an important role in ejaculation.

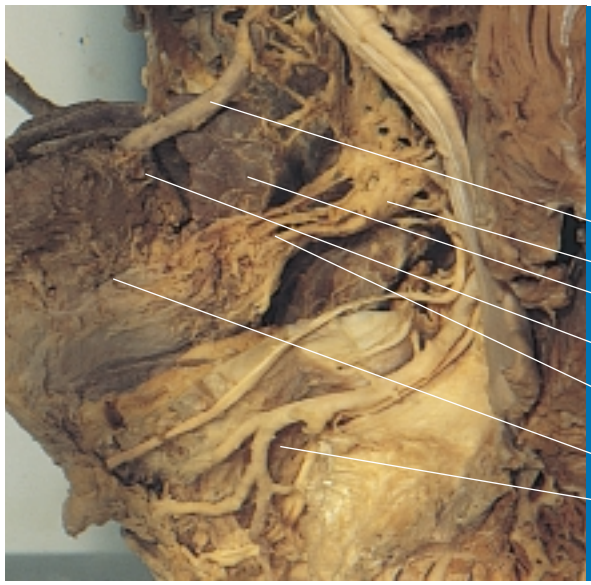


Fig. 21

Anterolateral aspect of left inferior hypogastric plexus in a male pelvis

- Ureter
- Inferior hypogastric plexus
- Seminal vesicle
- Bladder
- Autonomic nerves to urogenital structures
- Prostate
- Ischioanal fossa

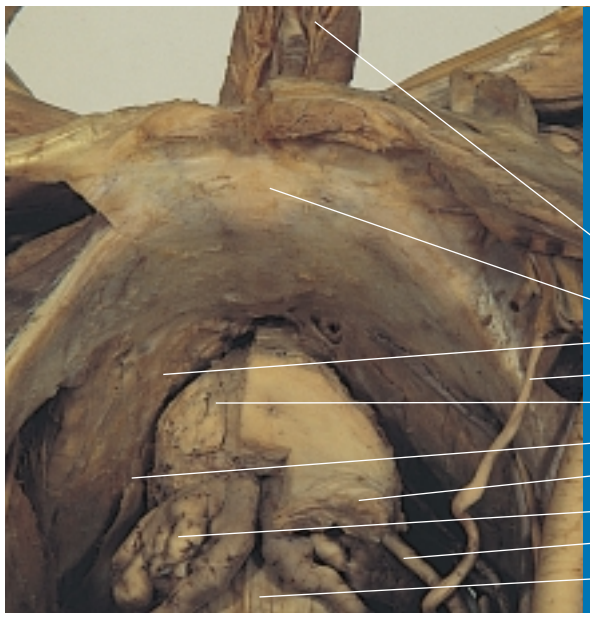


Fig. 22

Superior aspect of male pelvis

The urinary bladder has been removed apart from the right half of the trigone.

- Dorsal nerves and veins of penis
- Pubic symphysis
- Levator ani
- Right ductus (vas) deferens
- Prostate
- Cavernous nerve
- Right half of trigone of bladder
- Left seminal veside
- Right ureter
- Rectum

The illustrations depict prosections worked on by Professor Sinnatamby and Anatomy Museum exhibits at the Royal College of Surgeons of England.

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