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SURGICAL ENDOSCOPY
and Other Interventional Techniques

A prospective endoscopic study of retropubic vascular anatomy in 121 patients undergoing endoscopic extraperitoneal inguinal hernioplasty

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Abstract
Background: A sound knowledge of retropubic pelvic vascular anatomy is pivotal to the successful performance of endoscopic total extraperitoneal (TEP) inguinal hernioplasty. The objective of the current study was to evaluate the incidence and anatomy of iliopubic and aberrant obturator vessels.
Methods: Between July 2001 and March 2002, a prospective endoscopic evaluation of retropubic vascular anatomy was performed on patients who underwent TEP. Endoscopic photographs of the vasculature overlying the superior pubic ramus in the recruited patients were captured on a computer.
Results: The retropubic vascular anatomy of 121 patients, who underwent either unilateral ($n = 100$) or bilateral ($n = 21$) TEP was examined. The iliopubic artery and vein were invariably present in every patient, and traversed along the iliopubic tract toward the pubic symphysis. The aberrant obturator artery was present in 31 pelvic halves, giving an overall incidence of 22%. The aberrant obturator vein existed between the external iliac and obturator venous system in 27% ($n = 38$) of the 141 pelvic halves examined. The overall incidence of corona mortis, in the form of either an aberrant obturator vein or artery, was 40% ($n = 56$).
Conclusions: Iliopubic vein and artery are universal findings in every patient. Both aberrant obturator artery and vein cross the superior pubic rami, and are therefore susceptible to injuries during dissection of the Bogros space and stapling of the mesh onto Cooper's ligament. Awareness of these aberrant vessels will help to reduce bleeding and subsequent morbidity. Tracing along the aberrant vessel can easily identify the obturator foramen, which is an anatomic landmark that indicates an adequate inferior dissection of the preperitoneal space.

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Performance of total extraperitoneal (TEP) inguinal hernioplasty requires a sound understanding of the inguinal anatomy from a pelvic perspective. Few studies have evaluated the retropubic vascular anatomy [3, 5, 6]. Vascular connections between the external iliac and obturator system have been described as the "Corona mortis" (crown of death) [24]. Potentially fatal bleeding from these injured vessels may occur after a pelvic fracture or surgery.

The aberrant obturator artery has been the most widely studied retropubic vessel because of its liability to injury during the repair of femoral hernias [20]. Little attention has been paid to the anatomy of the aberrant obturator vein and iliopubic vessels. The TEP procedure involves dissection of the preperitoneal space and stapling of the mesh onto the Cooper's ligament in selected patients. Vasculatures, which overlie the pubic bone, are therefore at risk of injury during TEP. Awareness and early recognition of these vessels will reduce bleeding and allow expeditious completion of the procedure. The current study was undertaken to evaluate the incidence and anatomic variations of the iliopubic and aberrant obturator vessels.

Materials and methods

Between July 2001 and March 2002, a prospective evaluation of the retropubic vascular anatomy was performed on patients who underwent TEP in our institution. After creation of the preperitoneal space, the vascular anatomy overlying the superior pubic ramus was carefully examined. Intraoperative photographs of these areas in all recruited patients were taken and stored on a computer. The incidence and anatomic course of the iliopubic artery and vein as well as the aberrant obturator artery and vein were studied. The aberrant obturator artery can be distinguished from the aberrant obturator vein by its appearance, the presence of visible arterial pulsation, and its origin. The

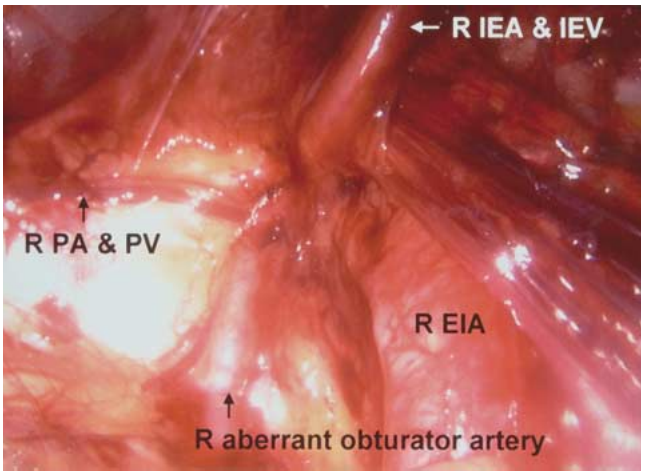

Fig. 1. R Aberrant obturator artery crosses the pubic ramus in a relatively vertical direction. IEA, inferior epigastric artery; IEV, inferior epigastric vein; PA, iliopubic artery; PV, iliopubic vein; EIA, external iliac artery.

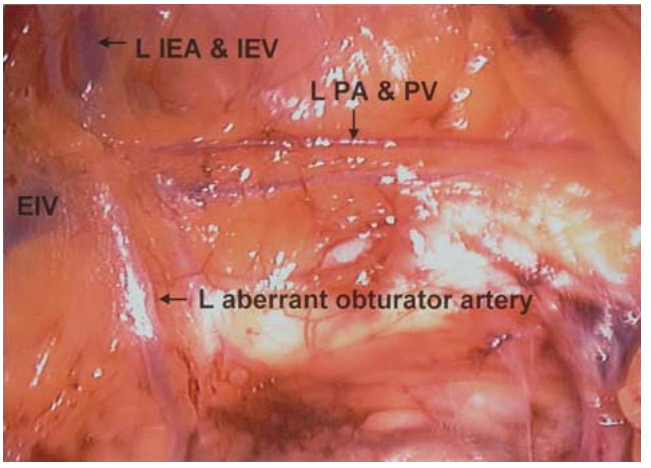

Fig. 2. Endoscopic view of the left aberrant obturator artery. IEA, inferior epigastric artery; IEV, inferior epigastric vein; PA, iliopubic artery; PV, iliopubic vein; EIV, external iliac vein.

aberrant obturator vein was identified by its bluish collapsed appearance, the absence of visible pulsation, and its origin from the external iliac or inferior epigastric vein. The aberrant obturator artery or vein was considered to be present only when there was a continuous conduit, without ramifications, joining the obturator foramen and the inferior epigastric or external iliac vessel. The results are expressed as mean ± standard deviation.

Surgical technique

Patients underwent surgery in a supine Trendelenburg position under general anesthesia. Urinary catheterization was not used. A transverse subumbilical incision was made to expose the anterior rectus sheath on the side of the inguinal hernia. Division of the anterior rectus sheath exposed the rectus muscle, which was retracted laterally. A 10-mm blunt-end trocar then was inserted into the preperitoneal space and insufflated with carbon dioxide to a pressure of 10 mmHg. Another 5- or 13-mm reusable trocar port was placed in the midline, approximately 8 cm from the pubis. The extraperitoneal space was dissected and created by endoscissors using diathermy. Balloon dissection was not used. A 5-mm reusable trocar was inserted at the anterior axillary line 3 to 4 cm proximally to the anterior superior iliac spine. The

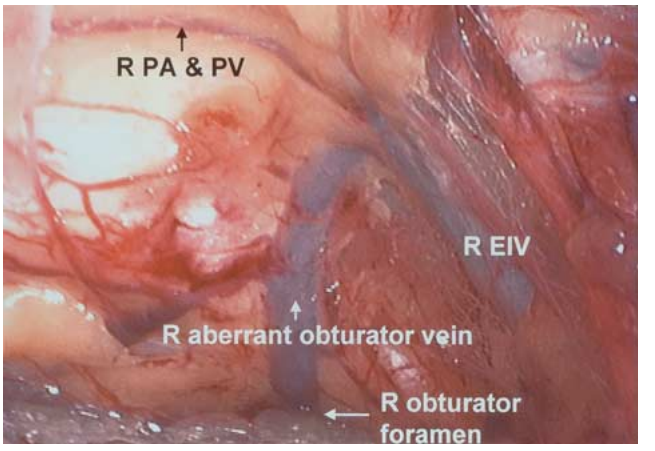

Fig. 3. The right aberrant obturator vein, originating from external iliac vein (EIV), crosses the pubic ramus toward the obturator foramen.

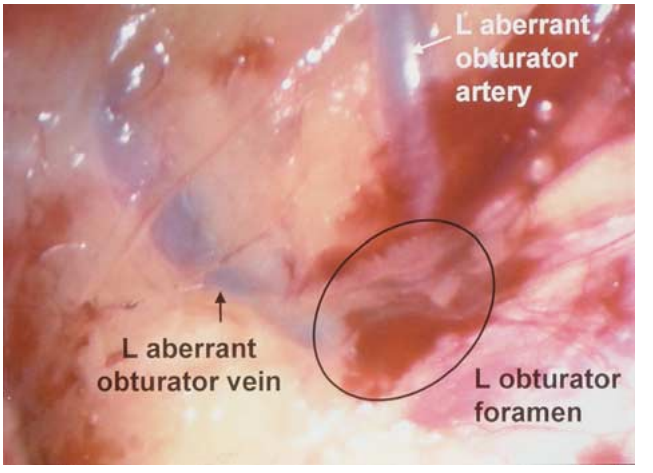

Fig. 4. Endoscopic view of the left aberrant obturator vein and artery running towards the left obturator foramen separately.

hernial sac then was dissected and reduced. The anatomy of the hernia was classified intraoperatively according to the Nyhus classification [19]. This was followed by parietalization of the spermatic cord for a distance of about 4 cm. Vasculatures overlying the pubic bone and obturator foramen were examined. Photographs were taken and stored on a computer for documentation. A prolene mesh of 10 × 14 cm^2 (Prolene Mesh; Ethicon, Somerville, NJ, USA) was introduced and anchored in place with an endostapler (Multifire Endo Hernia 0°; U.S. Surgical Corporation, Norwalk, CT, USA) in selected patients. Carbon dioxide then was released from the extraperitoneal space by opening all the trocar valves while applying gentle pressure over the corresponding iliac region.

Results

Patient characteristics

From July 2001 to March 2002, the retropubic vascular anatomy of 121 patients (117 men and 4 women) who underwent unilateral (n = 100) and bilateral (n = 21) TEP was examined. The mean age of the study population was 64 ± 15.0 years. In one patient who underwent bilateral TEP, only the vascular anatomy on the

Table 1. Comparison of aberrant obturator artery incidence among different centers

Author	Year	Pelvic halves examined (*n*)	Incidence of aberrant obturator artery (%)
Current study	2002	141 (patients)	22.2
Berberoglu et al. [6]	2001	14 (cadavers)	14.2
		26 (patients)	8.3
Gilroy et al. [9]	1997	105 (cadavers)	35.2
Tornetta et al. [24]	1996	50 (cadavers)	34
Missankov et al. [17]	1996	49 (cadavers)	69
Pick et al. [20]	1942	640 (cadavers)	29

right side was examined. A total of 141 pelvic halves (71 right and 70 left) were examined. The hernia anatomy types were II ($n = 50$), IIIA ($n = 54$), IIIB ($n = 24$), IVA ($n = 3$), IVB ($n = 7$), and IVD ($n = 3$).

Iliopubic artery and vein

The iliopubic artery and iliopubic vein were universally present in every patient. These vessels traversed together from the deep inguinal ring toward the pubic symphysis. Its course closely followed that of the iliopubic tract unless it was otherwise displaced by the presence of a direct inguinal hernia.

Aberrant obturator artery

Of the 141 pelvic halves examined, 31 aberrant obturator arteries were identified, giving an overall incidence of 22%. Of these 31 aberrant obturator arteries, 13 occurred on the right (Fig. 1) and 18 on the left (Fig. 2). The aberrant obturator artery ran a relatively straight course, in close proximity to the femoral canal, from the deep inguinal ring toward the obturator foramen. Five patients who underwent bilateral TEP, were found to have an aberrant obturator artery. Of these ($n = 5$), 4 patients (80%) had bilateral aberrant obturator arteries, and only 1 patient had a unilateral aberrant obturator artery.

Aberrant obturator vein

An aberrant obturator vein was identified in 38 pelvic halves: 20 on the right (Fig. 3) and 18 on the left (Fig. 4). The overall aberrant obturator vein incidence was therefore 27%. Three patients, who underwent bilateral TEP, were found to have an aberrant obturator vein, but only one patient (33.3%) had bilateral aberrant obturator veins.

Corona mortis

The concomitant presence of both aberrant obturator artery and vein was observed in 13 patients. Corona mortis, defined as the presence of either an aberrant obturator artery or vein, was present in 56 patients, giving an overall incidence of 40%.

Discussion

Our results demonstrate that the iliopubic artery and vein are universally present in every patient. The iliopubic artery usually arises from the inferior epigastric artery and traverses along the iliopubic tract toward the pubic symphysis [5, 10], but may sometimes be displaced by a direct inguinal hernia. It has been a misconception that the iliopubic artery may enlarge to constitute the aberrant obturator artery [7, 11, 18]. Both the iliopubic artery and vein always exist despite the presence of an aberrant obturator vessel.

The reported incidence of an aberrant obturator artery ranged from 8.3% to 69% (Table 1). The aberrant obturator artery usually originates from the inferior epigastric artery (20–34%), but occasionally may arise from the external iliac artery (1–2%) [4, 9, 20]. Last [12] stated that the aberrant obturator artery lies laterally or medially to the neck of a femoral hernia in the proportion of 10 to 1. When the artery lies near the free edge of the lacunar ligament, it is liable to injury during the repair of a femoral hernia [16, 22, 23]. The aberrant obturator artery then descends across Cooper's ligament to the obturator foramen.

The aberrant obturator vein has rarely been studied. The reported incidence of aberrant obturator vein ranged from 46% to 94.4% (Table 1) [6]. The presence of an aberrant obturator artery does not necessarily imply the existence of an aberrant vein or vice versa [23]. Furthermore, the aberrant vein does not always accompany the aberrant obturator artery. It may sometimes run a curved course toward the obturator foramen.

Pubic vascular anastomoses between the pubic branches of iliopubic and obturator systems were commonly found behind the pubis [1, 10, 17, 18, 21]. This anastomosis has been described in most anatomy texts [15, 25]. Tornetta et al. [24] reported the presence of either arterial or venous anastomoses between the obturator and external iliac systems in 84% of 50 cadaveric pelvic halves. Normal pubic vascular anastomosis consists of tiny capillaries, and poses no threat of a fatal hemorrhage. The term "corona mortis" should therefore be restricted to the presence of an abnormally enlarged pubic vascular anastomosis or the existence of an aberrant obturator vessel.

Bendavid [5] pointed out that the operating room was a better setting than the anatomy laboratory for examination of the vasculature that lies within the space of Bogros. The current study examined the retropubic vascular anatomy *in vivo* of Chinese patients undergoing inguinal hernioplasty. The discrepancy in the reported incidences of aberrant obturator vessels among the various centers may be related to the differences in the demographic and ethnic features of the study populations. Most anatomic studies were performed on cadavers, without specification of the population demographics. These findings may not be applicable to live surgical patients. It has been shown that the incidence of aberrant obturator vessels varies with the ages of the studied groups [20]. Occlusion of the obturator artery or vein secondary to any etiologies, such as atherosclerosis or deep vein thrombosis, can lead to the

development of collateral circulation and the subsequent formation of aberrant obturator vessels. Skandalakis et al. [23] described a woman with an atretic left external iliac vein who developed a huge aberrant obturator vein that was continuous with the internal iliac vein.

Aberrant obturator vessels cross the superior ramus in a relatively vertical direction and are therefore susceptible to injury during the dissection of the preperitoneal space using endoscissors or stapling of the mesh. Complete division of these vessels, which may occur during pelvic surgery, could lead to a hazardous hemorrhage and difficult hemostasis, particularly if the divided vessel retracts through the obturator foramen. During endoscopic procedures, the consequence of injuring the vein could be more serious than that of artery injury [3]. Bleeding from an aberrant obturator artery can be easily recognized and controlled during TEP. In contrast, bleeding from a damaged vein may be inconspicuous because the pressure of insufflated carbon dioxide within the preperitoneal space might temporarily seal it off. Postoperative oozing from the injured vein could then lead to hematoma formation.

The recurrence of hernias after endoscopic repair has been attributed to an inadequate overlap of the hernial defect by the mesh [8, 13, 14]. Sufficient preperitoneal space needs to be created to accommodate a mesh with adequate coverage of the defect. However, there has been no consensus on the extent of inferior dissection of the preperitoneal space. The authors recommend identification of the obturator foramen as the anatomic landmark for gauging the adequacy of inferior dissection during TEP. Recognizing and tracing along the course of aberrant obturator vessels, if present, will lead to the obturator foramen. After reduction of a small fat pad from the obturator canal, the foramen can be visualized clearly. This not only ensures the reduction of an obturator hernia, if present, but also provides sufficient preperitoneal space for the placement of a mesh. A sound knowledge of the anatomy of obturator vessels is therefore conducive to the performance of TEP [2].

In conclusion, the iliopubic artery and iliopubic vein are invariably present in every patient. Corona mortis, in the form of an aberrant obturator artery or vein, is a frequent finding (40%) during TEP. Awareness of the normal retropubic vasculature and its variations can help to identify the obturator foramen and reduce bleeding during TEP.

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