

Human Cadaveric Specimen Study of the Prostatic Arterial Anatomy: Implications for Arterial Embolization

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ABSTRACT

Purpose: To describe and illustrate the prostatic arterial anatomy from human cadaveric specimens, highlighting implications for prostatic arterial embolization.

Materials and Methods: Dissection of 18 male pelvis from white adults 35–68 years old was performed in the anatomy laboratory. Arterial branches were identified according to standard dissection technique using a 20-diopter magnifying lens for the prostatic sector. The branches were colored with red acrylic paint to enhance contrast and improve visualization.

Results: Two main arterial pedicles to the prostate from each hemipelvis were identified in all cadaveric specimens: the superior and inferior prostatic pedicles. The superior prostatic pedicle provides the main arterial supply of the gland and provides branches to both the inferior bladder and the ejaculatory system. The inferior prostatic pedicle distributes as a plexus in the prostatic apex and anastomoses with the superior pedicle. This pattern of prostatic arterial distribution was constant in all cadaveric specimens. In contrast, the origin of the superior prostatic pedicle was variable from different sources of the internal iliac artery.

Conclusions: The description and illustration of the prostatic arterial anatomy, as demonstrated by this cadaveric study, may provide useful information and guidance for prostatic arterial embolization.

ABBREVIATIONS

BPH = benign prostatic hyperplasia, IPA = internal pudendal artery, PAE = prostatic arterial embolization

The proposal of prostatic arterial embolization (PAE) as an alternative treatment for benign prostatic hyperplasia (BPH) has renewed interest in the prostatic arterial supply (1,2). Knowledge of the arterial anatomy is essential for interventional radiologists to provide proper treatment. Because prostatic angiography and embolization are uncommon in clinical practice, many

interventional radiologists are unfamiliar with prostatic arterial anatomy.

Cadaveric anatomic descriptions of the prostatic arteries were first published 60 years ago (3–5). Recent reports on prostatic arterial anatomy are scarce and mainly oriented to in vivo vascular anatomy as observed on angiography or multidetector computed tomography (CT) (6–8). Because of the lack of consistency among published studies, we decided to perform a specific anatomic dissection of the prostatic arterial supply. The aim of this study is to describe the prostatic arterial anatomy from human cadaveric specimens, highlighting the issues that may be of interest to interventional radiologists.

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MATERIALS AND METHODS

This study was performed under the ethical rules and regulations of the School of Medicine that allow dissection

of human cadaveric specimens for scientific investigations. Dissection of 18 male pelves (36 hemipelves) from white adults 35–68 years old was performed in the anatomy laboratory. Anatomic dissections were performed by senior dissectors with > 10 years of experience. Each specimen required 30–45 working hours for vessel dissection and 10 additional hours for vessel painting.

The pelves included L4 as the upper limit and the upper third of the lower limb as the lower limit. The pelves were fixed with standard formaldehyde solution (embalmed corpses). Resection was performed in all cadavers at the level of the ischiopubic and iliopubic rami, preserving the pubis and disarticulating the hip.

Dissection began with the complete removal of the parietal pelvic fascia, and once the internal iliac artery trunk was identified, all the arterial branches toward the prostate and bladder were dissected. Arterial branches were identified according to standard dissection technique using a 20-diopter magnifying lens for the prostatic sector. When dissection was completed, the arterial vessels were colored with red acrylic paint to enhance contrast and improve visualization.

For didactic purposes, the arterial anatomic description was divided into two sections: (a) distal termination (ie, the vessels surrounding and supplying the gland) and (b) proximal origin (ie, the origin of the prostatic arteries at the hypogastric level). The names of the arteries and anatomic structures illustrated in **Figures 1–10** are listed in **Table 1**.

RESULTS

Distal Termination

Two main arterial pedicles to the prostate from each hemipelvis were identified in all studied specimens: the superior and inferior prostatic pedicles. Their direction and distribution were constant in all pelves dissected (**Fig 1**).

The superior pedicle, called the prostatic artery, entered the gland in the posterior-superior sector of its lateral border in all studied cases. Before reaching the prostate, it branched to the trigone and the seminal vesicles. The superior prostatic pedicle terminated into a medial branch and a lateral branch in all cases (**Fig 2a, b**). The medial branch distributed to and supplied the upper portion of the middle lobe and the urethra proximal to the urethral crest. The lateral branch descended caudally to the apex of the gland at the external side of the lateral lobe. It had perforating branches to the lateral lobe and supplied the distal urethra, anastomosing with prostatic branches from the inferior pedicle.

In 28 (77.8%) anatomic specimens, the medial and lateral prostatic branches emerged from a single superior prostatic pedicle. In the remaining eight specimens (22.2%), these branches did not emerge from a single pedicle but from separate vessels (**Fig 3**).

The inferior prostatic pedicle entered the prostate in the posterior-inferior sector of its lateral border in all studied cases (**Figs 2a, b, 4**). This inferior pedicle formed a plexus in the prostatic apex, at the union of the prostatic and membranous urethra, and anastomosed to the lateral branch of the superior prostatic pedicle. All prostatic branches from the superior and inferior pedicles ran under the prostatic capsule in all studied specimens.

Proximal Origin

The superior prostatic pedicle was identified as the main prostatic arterial supply of the gland in all studied cases and was found to arise from different arteries at the hypogastric level (**Fig 5**). In 28 (77.8%) hemipelves, a single dominant superior prostatic artery was found. In the remaining eight hemipelves (22.2%), there were multiple superior arterial feeders. A double prostatic supply was identified in 6 (16.7%) specimens, and a triple prostatic supply (**Fig 6**) was identified in 2 specimens (5.6%), for a total of 46 arteries in the 36 dissected hemipelves. The frequency and different arterial origins of the superior prostatic arteries are listed in **Tables 2** and **3**.

The most common origin was the anterior trunk of the internal iliac artery, as a prostatic-vesical or genito-vesical

Table 1. Glossary of Arteries and Anatomic Structures Shown in **Figures 1–10**

Arteries	Anatomic Structures
1 Superior prostatic pedicle	B Bladder
2 Medial prostatic branch	P Prostate
3 Lateral prostatic branch	PB Pubis
4 Inferior vesical	R Rectum
5 Prostatic-vesical	SV Seminal vesicles
6 Vesicle deferential	DD Deferent ducts
7 Genito-vesical	IOM Internal obturator muscle
8 Gluteo-pudendal trunk	IB Iliac bone
9 Obturator	ISC Ischium
10 Superior gluteal	U Ureter
11 Inferior gluteal	S Sacrum
12 Internal pudendal	
13 Middle rectal	
14 Inferior prostatic pedicle	
15 Superior rectal	
16 Inferior mesenteric	
17 Hypogastric	
18 Superior vesical	
19 Inferior rectal	

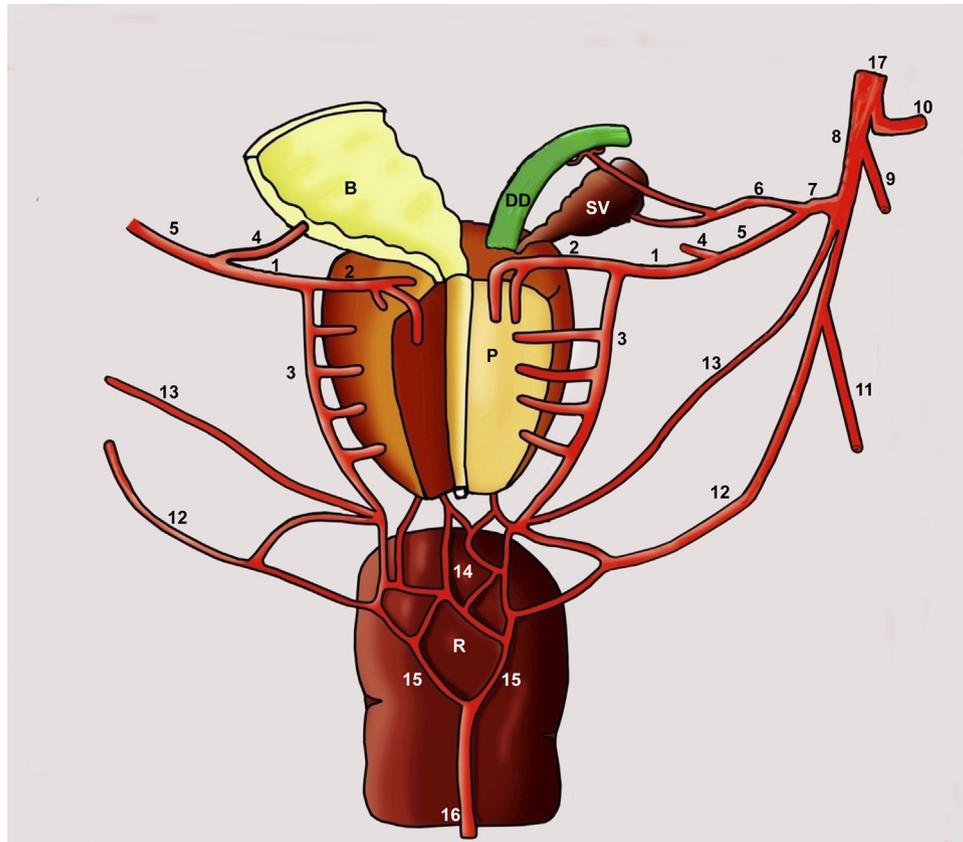


Figure 1. Schematic drawing of the prostatic arterial anatomy. References are listed in [Table 1](#).

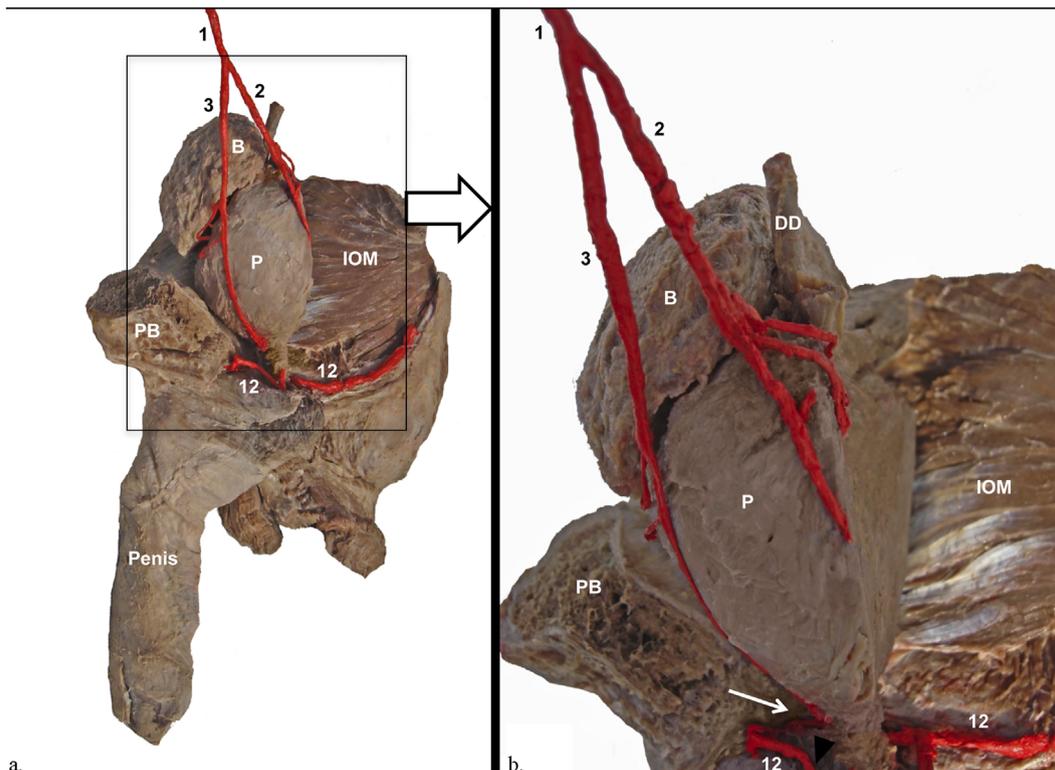


Figure 2. Anatomic specimen. Anterolateral view (a); specimen magnification after partial prostatic dissection (b). References are listed in [Table 1](#). The superior prostatic pedicle (1) divides into a medial (2) and a lateral branch (3). Notice (b) several arterial branches enter into the medial lobe and the anastomosis of the lateral branch with an inferior prostatic artery (arrow) branching from the IPA (12).

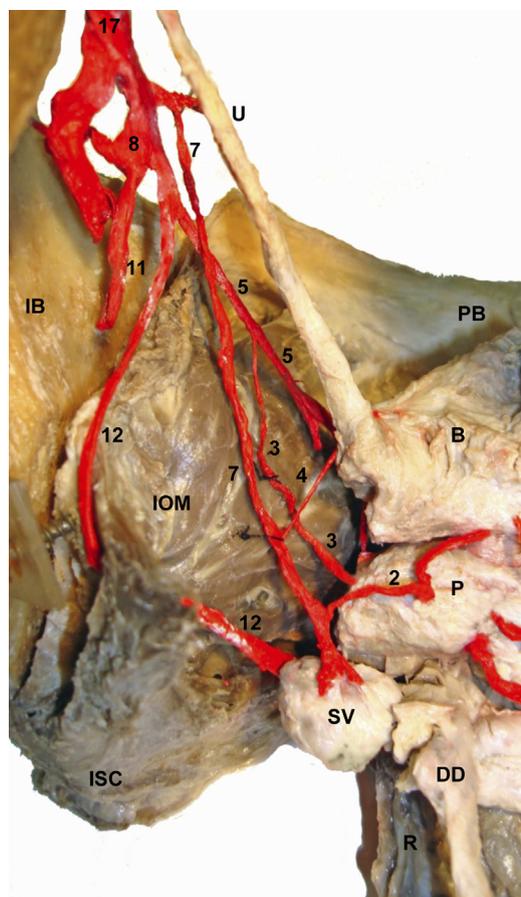


Figure 3. Anatomic specimen with enlarged prostate. Posterior view. References are listed in [Table 1](#). The medial and lateral prostatic branches emerge from two separate superior prostatic pedicles. Notice the enlarged medial branch (2) from the genitovesical artery (7) and the lateral branch (3) from the prostatic-vesical artery (5).

artery. This arterial pattern was found in 26 (56.5%) cases. In eight (17.4%) cases, the superior prostatic supply originated in the middle rectal artery. In the other eight cases (17.4%), it originated from the internal pudendal artery (IPA), in two (4.3%) from the obturator artery and in two (4.3%) from the accessory IPA.

The inferior prostatic pedicle at the apex was not regarded as a single artery in any case but as a plexus that formed an anastomosis with the lateral branch of the superior prostatic pedicle. The arterial afferents to the plexus were from the right and left IPA in all studied specimens. In 12 (25%) cases, there were additional arterial afferents: in 6 (12.5%) cases from the superior rectal artery, in 4 (8.3%) cases from the inferior rectal artery, and in 2 (4.2%) cases from the middle rectal artery, for a total of 48 arteries supplying the inferior plexus in the 36 dissected hemipelves ([Fig 7](#)).

DISCUSSION

The present study describes the prostatic arterial anatomy as observed in human cadaveric specimens with an

emphasis on relevant findings in the context of PAE. This anatomic study revealed the main arterial supply of the prostate by the superior prostatic arterial pedicle.

Before accessing the prostate, the superior prostatic arterial pedicle provides branches to both the inferior bladder and the seminal vesicles and divides into a medial and a lateral branch. The medial branch supplies the cranial portion of the gland, including the medial lobe and the urethra proximal to the urethral crest. The lateral branch descends laterally to the apex of the gland, provides perforating branches to the lateral lobe, and supplies the urethra distal to the urethral crest. The lateral branch of the superior prostatic pedicle anastomoses with the inferior prostatic pedicle, forming an arterial plexus at the prostatic apex. The afferent vessels to the inferior prostatic plexus originate in the IPA and rectal arteries.

In some previous anatomic reports, the main artery supplying the prostate was named the prostatic-vesical artery because it supplied not only the prostate but also the inferior bladder (4,5). Other authors named this same vessel the inferior vesical artery, assuming that the main pedicle supplied the inferior bladder and prostatic arteries branched off from this artery (3). Because the arterial trunk supplied not only the inferior bladder and the prostate but also the ejaculatory system (vesicle deferential artery), some authors designated it the genitovesical artery (9).

From a practical point of view, most parts of the prostate, and especially its medial lobe, are supplied by the superior pedicle. This superior pedicle is regarded as the prostatic artery that must be catheterized to perform PAE in patients with BPH ([Fig 8a, b](#)).

The origin of the prostatic artery is highly variable as is usually the case with other arteries arising from the internal iliac artery (10). In our cadaveric study, the most frequent origin of the superior prostatic pedicle was directly from the anterior division of the internal iliac artery as a prostatic-vesical artery (56.5%) ([Fig 9](#)). Less commonly, the prostatic artery originated in the middle rectal artery (17.4%) ([Fig 10](#)), IPA (17.4%), or obturator artery (4.3%). Clegg (4), in a cadaveric study of 17 hemipelves, similarly reported the origin of the main prostatic arterial supply to be more common from the anterior internal iliac artery as a prostatic-vesical artery, with few cases originating in the IPA or the obturator artery. Conversely, Bilhim et al (7), in a study of 25 patients performed with multidetector CT, reported the IPA as the most common origin of the prostatic artery (56% of cases), followed by the anterior division of the internal iliac artery (28% of cases). In another subsequent publication of 75 patients, the same authors again reported the IPA as the most common origin of the prostatic artery based on multidetector CT (8).

The prostatic vascular pattern found in this cadaveric study may be of interest for the interventional radiologist because of its potential clinical implications. In 77.8%

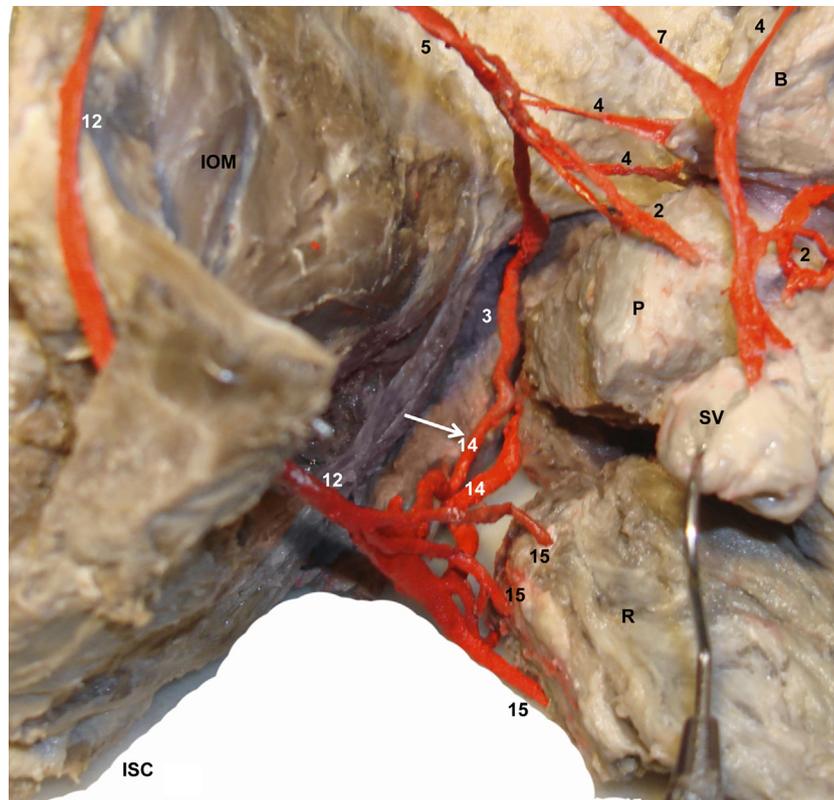


Figure 4. Anatomic specimen with enlarged prostate. Posterior lateral view. References are listed in [Table 1](#). The rectum and the left seminal vesicle are retracted in the posterior-inferior direction. The inferior prostatic arteries (14) enter the prostate in its lateral border. Notice the anastomoses with the lateral branch of the superior prostatic pedicle (arrow) and the plexual configuration of the inferior prostatic pedicle.

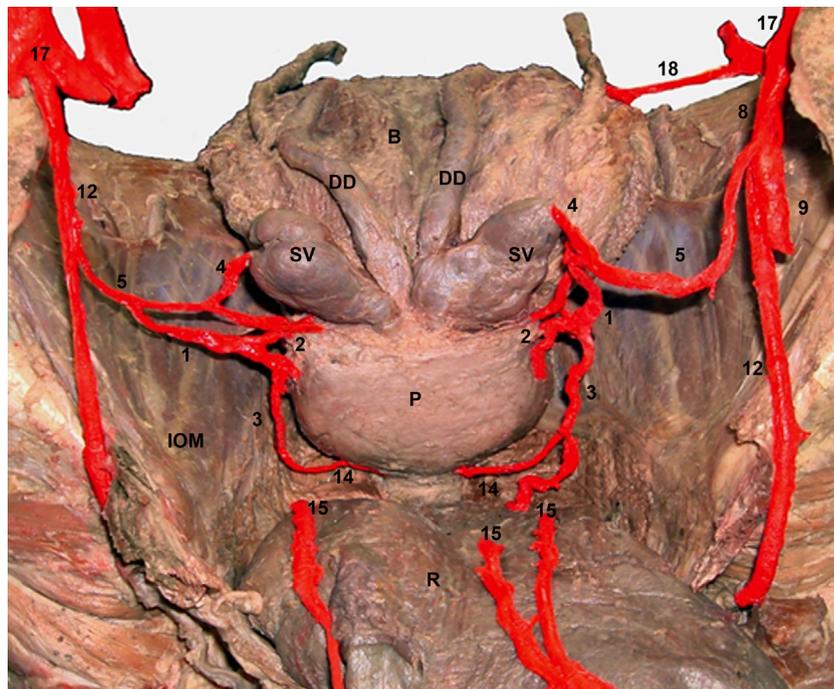


Figure 5. Anatomic specimen with enlarged prostate. References are listed in [Table 1](#). Posterior view. The rectum is retracted in the posterior-inferior direction. The left superior prostatic pedicle (1) branches from a prostatic-vesical artery (5) originating in the IPA (12). On the right, the superior prostatic pedicle originates directly from the anterior trunk of the internal iliac artery (8) as a prostatic-vesical artery (5).

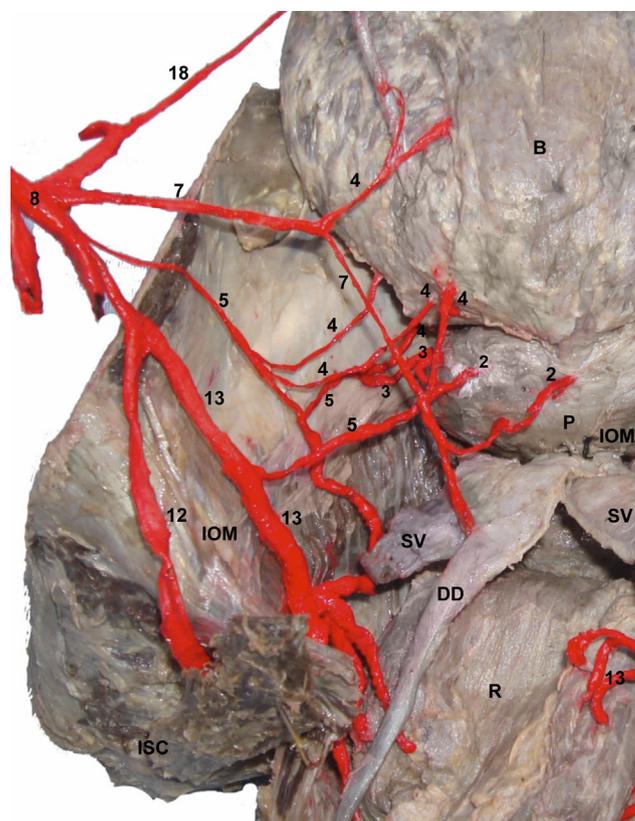


Figure 6. Anatomic specimen. Left hemipelvis, posterior view. References are listed in [Table 1](#). The rectum and the seminal vesicles are retracted in the posterior-inferior direction. There are three separate superior arterial feeders to the prostate: two separate medial branches arising from the genito-vesical artery (7) and middle rectal artery (13), respectively, and a lateral branch (3) arising from the prostatic-vesical artery (5).

Table 2. Arterial Origin of Superior Prostatic Pedicle

Origin	Frequency
HA trunk: PVA	26 (56.5%)
MRA	8 (17.4%)
IPA	8 (17.4%)
OA	2 (4.3%)
aIPA	2 (4.3%)
Total	46 (100%)

Note. There were 46 arteries constituting the superior prostatic pedicle in 36 hemipelvises.

aIPA = accessory internal pudendal artery, HA = hypogastric trunk, IPA = internal pudendal artery, MRA = middle rectal artery, OA = obturator artery, PVA = prostatic-vesical artery.

of the dissected hemipelvises, a single superior prostatic pedicle was identified. This finding may imply that catheterization of a single artery from each side may be sufficient to approach the vascular supply of the medial lobe of the prostate in most cases. Some authors have reported very good clinical and technical results after PAE of single unilateral or bilateral superior prostatic pedicles (11).

Table 3. Multiple Superior Arterial Prostatic Afferents Identified in Eight Hemipelvises

Afferents	Hemipelvis
Double supply	6 (16.7%)
PVA + MRA	
PVA + IPA	
PVA + OA	
Triple supply	2 (5.6%)
PVA + GVA + MRA	

GVA = genito-vesical artery, IPA = internal pudendal artery, MRA = middle rectal artery, OA = obturator artery, PVA = prostatic-vesical artery.

In 22.2%, a double or triple vascular supply from different superior prostatic vessels was identified. The clinical and technical implications of this anatomic finding are difficult to determine and may be a matter of speculation. When the medial and lateral prostatic branches arise from separate arteries, it may be speculated that it is most likely unnecessary to approach both of them for PAE in cases of BPH because adenomas are supplied only by the medial branch (5). In cases in which more than one vessel supplies the medial lobe, as was the case in one specimen with triple prostatic feeders, it is difficult to discern the technical or clinical significance. In a clinical study of PAE to treat BPH, Carnevale et al (12) recommended the catheterization of all potential prostatic arterial feeders to optimize results.

Knowledge of the prostatic arterial anatomy may provide a better understanding of some concerns associated with PAE, such as the risk of bladder wall ischemia or necrosis, or both (11,12). Pisco et al (11) reported a case of bladder ischemia after PAE that required surgical repair. Carnevale et al (12) reported one case of hematuria associated with bladder hypoperfusion observed using magnetic resonance imaging that resolved spontaneously. The intimacy of prostatic and inferior bladder arterial supply of the prostatic-vesical artery distribution may explain the nontarget embolization that caused the aforementioned complications.

Another potential concern associated with PAE is the possibility of genital or rectal vascular injuries owing to prostatic arterial communications with the rectal and seminal vesicle arteries. Some mild and self-limited symptoms, such as hematospermia, diarrhea, and rectal bleeding, reported after PAE may also be explained by nontarget embolization (11,12). Bagla et al (13), in a recent publication about cone-beam CT before PAE, reported contrast enhancement of nontarget organs in half of the acquisitions after injection of prostatic arteries with contrast medium. The organs involved were mainly the rectum, bladder, penis, and seminal vesicles, which led the operator to implement distal catheter repositioning to avoid ischemic complications.

The anastomoses between the inferior and superior prostatic pedicle may imply that the former pedicle

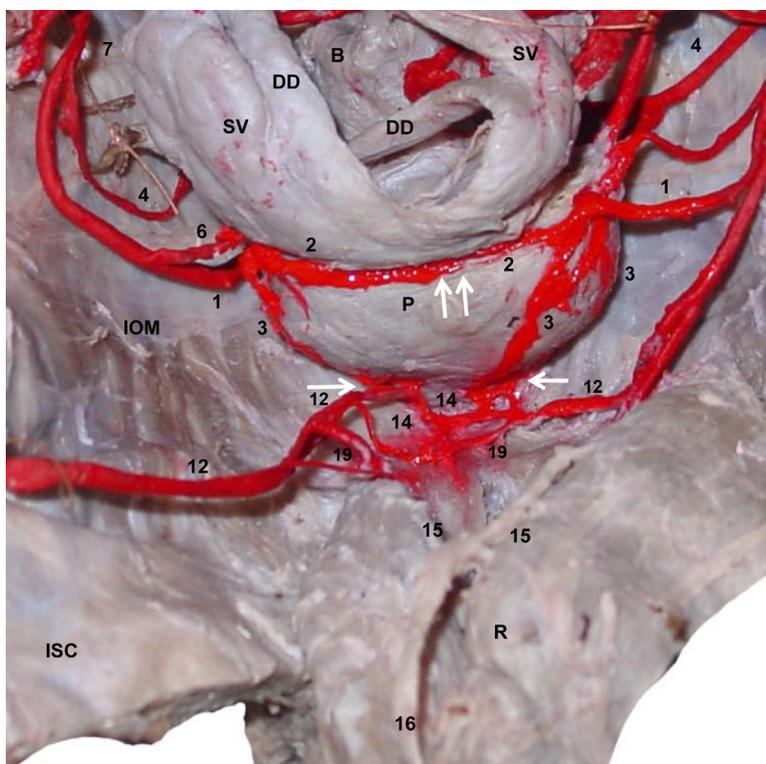


Figure 7. Anatomic specimen. Posterior view. References are listed in [Table 1](#). The inferior prostatic pedicle forms a plexus (14) at the prostatic apex. Its afferents are vessels originating from the IPA (12), the inferior rectal artery (19), and the superior rectal artery (not colored) (19). Notice the longitudinal anastomoses of the superior and inferior prostatic pedicles (arrows) and a transverse anastomosis between the right and left medial branches (double arrows).

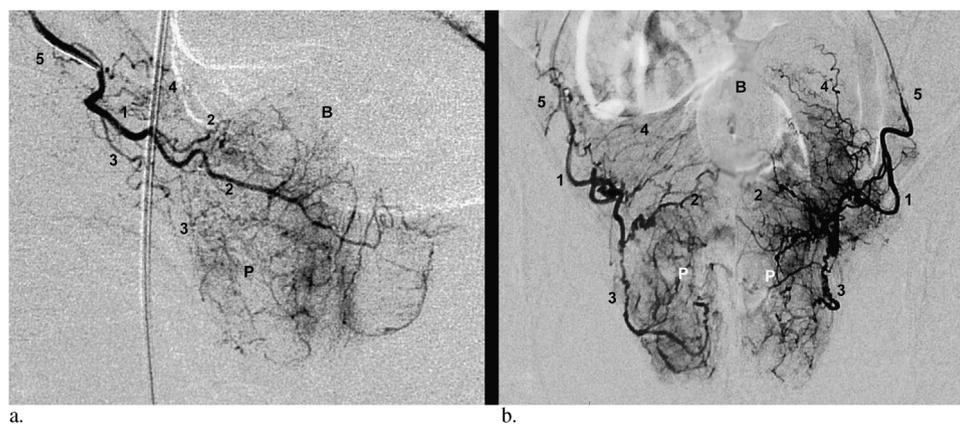


Figure 8. Angiogram in a patient with BPH. References are listed in [Table 1](#). (a) Angiogram after selective catheterization of the right prostatic-vesical artery. Oblique view. (b) Angiogram after bilateral selective catheterization of the prostatic-vesical arteries. Anteroposterior view (right and left image fusion).

could serve as a potential access for PAE in cases of proximal occlusion of the superior pedicle. Clegg (4) mentioned a prominent vascular supply to the prostate from the superior rectal artery in one third of the cadavers studied by latex injection into the inferior mesenteric artery.

The present cadaveric study has some limitations. The small number of cadaveric specimens may underestimate the anatomic findings and variants of a larger

population. Because most cadaveric specimens had normal-sized prostates, it is not possible to extrapolate completely the anatomic findings in patients with BPH who may need PAE. Hemodynamics patterns and vessel size may differ in normal-sized prostates compared with enlarged prostates.

In conclusion, the present study provides a representation of vascular anatomy to the prostate that may provide useful information and guidance for PAE.

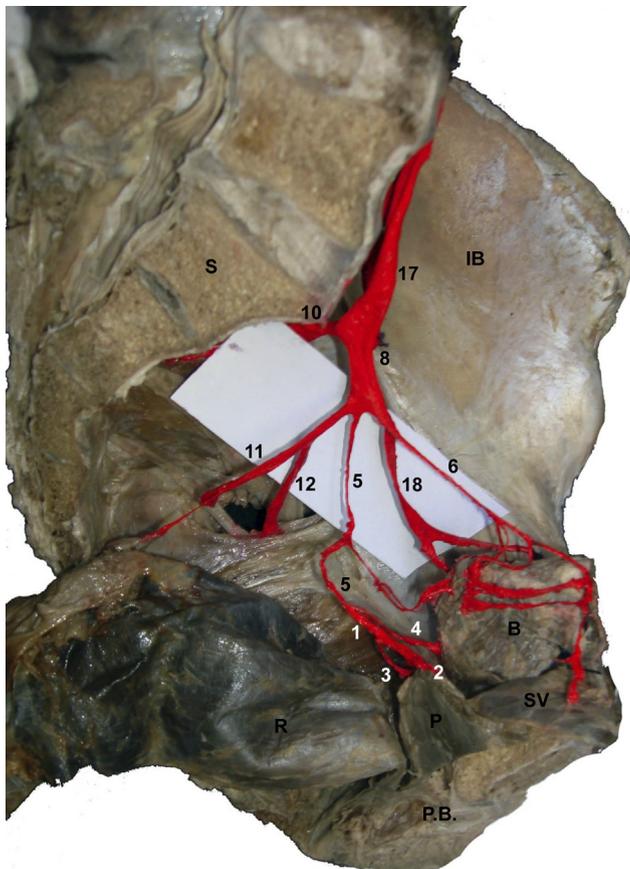


Figure 9. Anatomic specimen. Lateral view. References are listed in [Table 1](#). The superior prostatic pedicle (1) originates directly in the anterior division of the hypogastric artery as a prostatic-vesical artery (5).

Detailed knowledge of prostatic arterial anatomy is essential to allow identification and catheterization of prostatic vessels. Comprehension of the functional arterial anatomy is crucial for effective and safe embolization, allowing better results and avoiding predictable complications.

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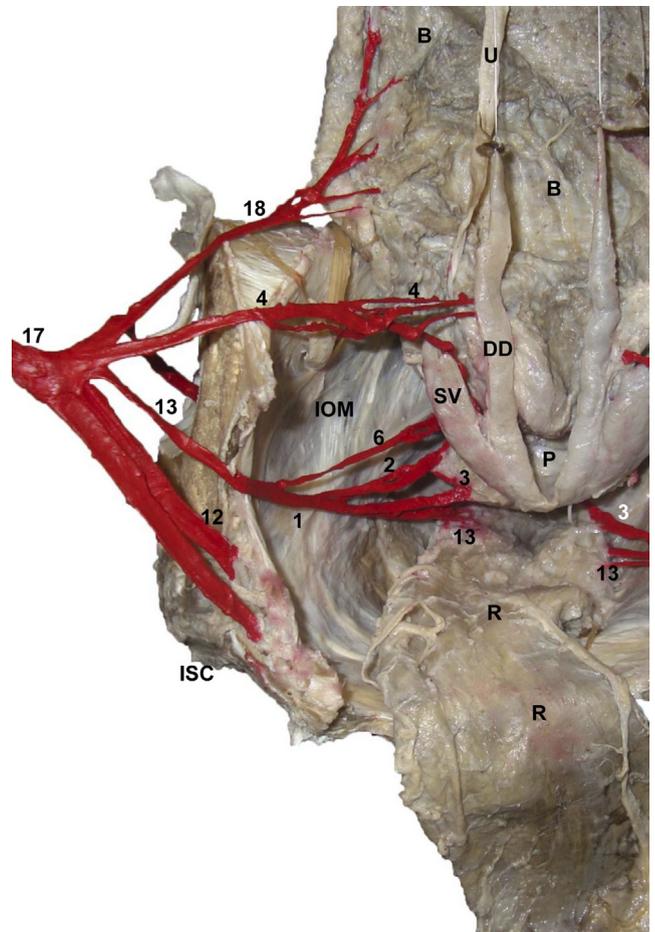


Figure 10. Anatomic specimen of the left hemipelvis. Posterior superior view. References are listed in [Table 1](#). The rectum is retracted in the posterior-inferior direction. The superior prostatic pedicle (1) originates in the middle rectal artery (13).