Variant arterial anatomy related to Prostate Artery Embolisation (PAE)

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Learning Objectives

1. To provide a comprehensive review of variant arterial anatomy related to PAE, within the framework of an established angiographic classification system.

2. To compare the reported incidence of arterial variants with findings from a case series of PAE at a single Australian institution with illustrative examples.

3. To describe the impact of variant arterial anatomy on PAE technique and outcomes.
**Background**

**OVERVIEW**

- PAE is emerging as an effective treatment option for benign prostatic hyperplasia (BPH).
- Accurate identification of the prostate arteries, variant anatomy and intra/extra-prostatic anastomoses is crucial for improving technical success and preventing non-target embolisation.

**INTERNAL ILIAC ARTERY (IIA) ANATOMY**

The IIA branching pattern is highly variable; however, it usually bifurcates into an anterior division and a posterior division.

Yamaki et al (1998) classified the IIA anatomy into 4 groups according to the pattern of branching of the:

- superior gluteal artery (S)
- inferior gluteal artery (I)
- internal pudendal artery (P)

<table>
<thead>
<tr>
<th>Group</th>
<th>Posterior division IIA:</th>
<th>Anterior division IIA:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>formed by the superior gluteal artery</td>
<td>formed by the gluteopudendal trunk, which gives rise to the inferior gluteal and internal pudendal arteries</td>
</tr>
<tr>
<td>Group B</td>
<td>formed by the gluteal trunk, which gives rise to the superior and inferior gluteal arteries</td>
<td>formed by the internal pudendal artery</td>
</tr>
<tr>
<td>Group C</td>
<td>Trifurcation of the IIA gives rise to the superior gluteal, inferior gluteal and internal pudendal arteries</td>
<td></td>
</tr>
<tr>
<td>Group D</td>
<td>formed by the common trunk for superior gluteal and internal pudendal arteries</td>
<td>formed by the inferior gluteal artery</td>
</tr>
</tbody>
</table>
The origin of the prostate artery is highly variable and there is a lack of uniformity in the reported nomenclature.

Typically, the prostate gland is supplied by two branches:
- Central (anterolateral) branch
  - Supplies the central zone and median lobe
- Capsular (posterolateral) branch
  - Supplies the peripheral zone

These branches usually arise from a single common trunk. Occasionally, they may have independent origins (dual arterial supply).

Intraprostatic anastomoses (ipsilateral or contralateral) are common. Extra-prostatic anastomoses with arteries supplying the bladder, rectum or penis are variably present.

The classification system proposed by de Assis et al (2015), provides a standardised framework for categorising prostate artery origin into 5 types:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
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<tbody>
<tr>
<td>Type I</td>
<td>Origin from anterior division of IIA in a common trunk with the superior vesical artery (SVA)</td>
</tr>
<tr>
<td>Type II</td>
<td>Origin from anterior division of IIA, inferiorly to SVA</td>
</tr>
<tr>
<td>Type III</td>
<td>Origin from obturator artery</td>
</tr>
<tr>
<td>Type IV</td>
<td>Origin from internal pudendal artery</td>
</tr>
<tr>
<td>Type V</td>
<td>Less common origins</td>
</tr>
</tbody>
</table>

(de Assis et al, 2015; Carnavale et al, 2017)
Digital Subtraction Angiographic anatomy was retrospectively reviewed in 101 PAE procedures performed at a single Australian institution (Liverpool Hospital, Sydney) between 2015 and 2018.

PAE was performed in patients with BPH and lower urinary tract symptoms (LUTS) following clinical assessment in a multi-disciplinary team with Urology and Interventional Radiology, and pre-procedure CTA and MRI. Intra-procedural Cone-beam CT was used in every case. Each patient was followed up in the Liverpool Hospital Interventional Radiology clinic.

A total of 202 pelvic sides were reviewed. For each pelvic side:

- The IIA branching pattern was classified into 4 groups according to the classification system described by Yamaki et al (1998)
- The prostate artery origin was classified into 5 types according to the classification system described by de Assis et al (2015)
- Dual prostate artery supply was defined as independent origins of the peripheral and central branches from a single side. In these cases, the prostate artery origin was classified according to the origin of the main central branch.

The incidence of each anatomic type (IIA branching pattern; prostate artery origin) and the incidence of dual supply was calculated as a percentage and compared with available literature.
# Clinical findings

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<tbody>
<tr>
<td></td>
<td></td>
<td>(review of 645 cadaveric pelvic sides)</td>
<td>(review of 42 pelvic side angiograms)</td>
</tr>
<tr>
<td>Group A</td>
<td>178/202</td>
<td>88.1%</td>
<td>79.5%</td>
</tr>
<tr>
<td>Group B</td>
<td>21/202</td>
<td>10.4%</td>
<td>15%</td>
</tr>
<tr>
<td>Group C</td>
<td>3/202</td>
<td>1.5%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Group D</td>
<td>0/202</td>
<td>0%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Type I</td>
<td>42/202</td>
<td>20.8%</td>
<td>28.7%</td>
</tr>
<tr>
<td>Type II</td>
<td>47/202</td>
<td>23.8%</td>
<td>14.7%</td>
</tr>
<tr>
<td>Type III</td>
<td>36/202</td>
<td>17.8%</td>
<td>18.9%</td>
</tr>
<tr>
<td>Type IV</td>
<td>66/202</td>
<td>32.7%</td>
<td>31.1%</td>
</tr>
<tr>
<td>Type V</td>
<td>7/202</td>
<td>3.5%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

Dual supply from a single pelvic side:
- 25 out of 202 pelvic sides (12.4%)

Not visualised on DSA (due to atherosclerotic disease):
- 4 out of 202 pelvic sides (2.0%)
The posterior division of the IIA is formed by the superior gluteal artery (SGA).

The anterior division of the IIA is formed by the gluteopudendal trunk (GPT).

In this case, the gluteopudendal trunk trifurcates into the inferior gluteal (IGA), internal pudendal (IPA) and obturator (Obt) arteries.

PA = Prostate artery

GROUP A (88%)

GROUP B (10%)

GROUP C (2%)

The IIA trifurcates into the superior gluteal, inferior gluteal and internal pudendal arteries.

In this case, there is a quadrification of the IIA, as the obturator artery arises from the same origin. Note, the obturator origin is not included in the Yamaki et al classification system.
The prostate artery arises from the obturator artery.

**TYPE I** (21%)

The prostate artery arises from the anterior division of the IIA in a common vesicoprostatic trunk with the superior vesical artery (SVA).

**TYPE II** (24%)

The prostate artery arises from the anterior division of the IIA inferior and separate to the origin of the SVA.

**TYPE III** (18%)

The prostate artery arises from the internal pudendal artery. Most common type of origin.

**TYPE IV** (33%)

The prostate artery arises from the internal pudendal artery. Most common type of origin.
Prostate artery supplied by the inferior mesenteric artery (IMA)

Type V (less common origins)

Prostate artery arising from the superior gluteal artery (posterior division IIA)

Common origin (trifurcation) of the internal pudendal, obturator and prostatic arteries

Prostate artery origin from an aberrant obturator artery, which arises from the external iliac artery (EIA).
Intra/extra-prostatic anastomoses

- Left prostate arteriogram demonstrates filling of the dorsal penile artery, due to the presence of an extra-prostatic anastomosis.
- The penile anastomosis was protected with coil occlusion. Subsequent left prostate lobe arteriogram demonstrates improved enhancement of the intraprostatic branches.

Subsequent left prostate lobe arteriogram demonstrates improved enhancement of the intraprostatic branches.

- Coil occlusion of the extraprostatic anastomoses was performed prior to PAE.

Prostate artery branches

- DSA and intraprocedural cone beam CT after selective left prostate artery catheterisation demonstrates the central and capsular branches of the prostate artery.
- The central branch typically demonstrates a more horizontal course, whilst the capsular branch usually runs more vertically.
- Multiple ipsilateral intraprostatic anastomoses are commonly present between the central and capsular branches.

Intraprostatic anastomosis

- Left prostate arteriogram demonstrates opacification of the right prostate gland and the right capsular and central branches, illustrating the presence of intra-prostatic anastomoses.

Extraprostatic anastomosis

- Right prostate lobe arteriogram through the microcatheter demonstrates an intraprostatic shunt and contralateral filling of the left prostate artery (solid arrow).
- There is also an extra-prostatic anastomosis with filling of the dorsal penile artery (dashed arrow).

Intra and extraprostatic anastomosis

- There is also an extra-prostatic anastomosis with filling of the dorsal penile artery (dashed arrow).
Accurate identification of the prostate artery is critical for successful PAE.

The observed incidence of IIA branching patterns and prostate artery origins was found to be similar to the reported incidence in previous studies.

An awareness of less common (Type V) prostate artery origins and an understanding of intra-extra-prostatic anastomosis improves technical success, reduces the chance of revascularisation and minimises non-target embolisation.
References


