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Pelvic magnetic resonance imaging angioanatomy of the arterial blood supply to the penis in suspected prostate cancer patients

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ABSTRACT

Purpose: To describe the internal pudendal artery (IPA) and accessory pudendal artery (APA) detected by magnetic resonance (MR) angiography to help surgeons to find and preserve them during radical prostatectomy (RP).
Materials and methods: Constrast-enhanced MR 3.0 T angiography of the pelvis were performed in 111 male patients suspected diagnosis of prostate cancer (PCa), and describe the penile arterial blood supply.
Results: There are three patterns of the arterial blood supply to the penis (IPA and/or APA) accounting for 51.4%, 46.8% and 1.8% of cases, respectively. About the accessory pudendal artery (APA): 54/111 (48.6%) patients had APA with five different branching patterns, they were type I (APA bilateral symmetry): 17 (31.5%); type II (APA bilateral asymmetry): 1 (1.9%); type III (APA unilateral lateral): 13 (24%); type IV (APA unilateral apical): 21 (38.9%); type V (APA unilateral mix): 2 (3.7%). APA origin were from inferior epigastric artery (IEA): 7 (9.5%); from inferior vesical artery (IVA): 32 (43.2%); from obturator artery (OA): 35 (47.3%).
Conclusion: A precise angioanatomic evalutation of arteries destined to the penis by MR angiography pre-operation for male pelvic organs will help surgeons to preserve them and contributes to reduce the erectile dysfunction after these procedures.

1. Introduction

Many factors may affect the sexual function after radical prostatectomy and after prostate radiation therapy: age, clinical and pathological stage, and surgical technique (preservation or excision of the neurovascular bundle, etc. Lot of studies showed that injuries to blood supply system of penis during operation and prostate radiation therapy affect the erectile function of the penis [1–5]. The arterial blood supply is delivered to penis via the accessory pudendal artery (APA) and/or internal pudendal artery (IPA), one of the terminal branches of the internal iliac artery. The IPA, after giving off its perineal branch, continues as the penile artery, it is not uncommon for a single cavernosal artery to supply both corporal bodies or to be absent altogether. Alternatively, APA may supplement or completely replace branches of the common penile artery, APA are highly variable in their branching, courses and anastomoses [6].

A precise description pre-treatment (radical prostatectomy and prostate radiation therapy) of angioanatomy of the arterial blood supply to the penis may help surgeon and radiotherapists avoid them injury and maintain the sexual function [7,8].

The aim of this study was to describe the angioanatomy of the arterial blood supply to the penis in patients suspected of prostate cancer evaluated by magnetic resonance imaging angiography.

2. Materials and methods

This retrospective study included 111 consecutive patients suspected of prostate cancer, who were evaluated by

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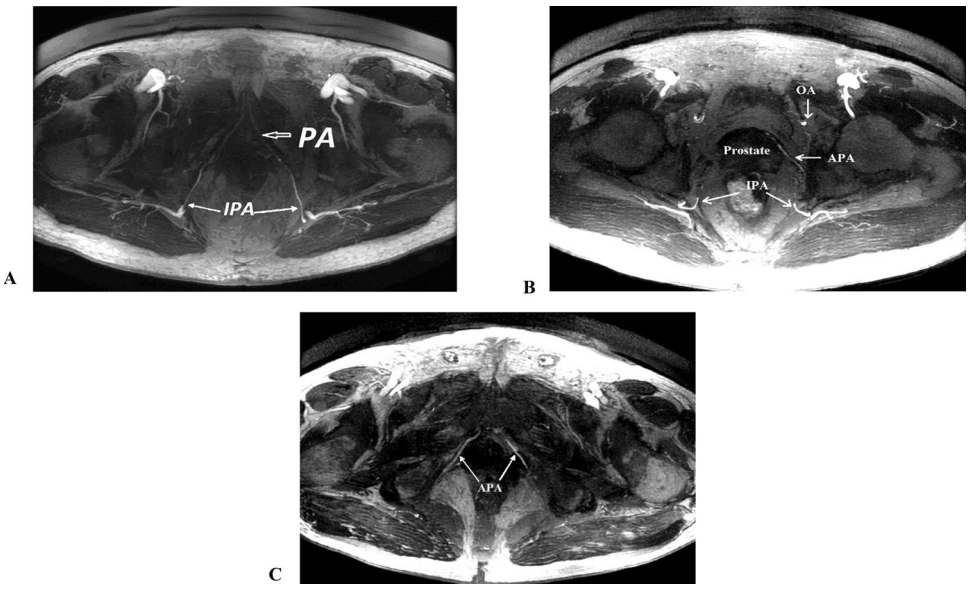

Fig. 1. Patterns of penile arterial blood supply, by MRI high-resolution 3DT1, MIP (Maximum Intensity Projection): (A) type I arising exclusively from IPA; (B) type II arising from both APA and IPA; (C) type III arising exclusively from APA. IPA, internal pudendal artery; APA, accessory pudendal artery; OA, obturator artery; PA, penile artery.

contrast-enhanced MR angiography of the pelvis at radiology department between February 2010 and April 2012.

All MR images were obtained with a 3.0 T unit (Signa HDxt; General Electric, Milwaukee, USA) using a cardiac phased-array coil. Routine prostate MR imaging consisted of a transverse, coronal, and sagittal T1-weighted fast spin-echo sequence, and a transverse echo-planar diffusion weighted imaging pulse sequence. Contrast-enhanced MR angiography was performed with an axial multiphase three-dimensional fast gradient-echo sequence, contrast agent: 19 ml of DOTAREM was administered through an 18–20-gauge cannula. The slab of 70–90 mm thickness was positioned to include the prostate, the internal pudendal arteries, and the accessory pudendal arteries. The acquisition parameters were as follows: section thickness, 2.8/1.4 mm; field of view, 360 mm × 320 mm; vowel size, 0.9 mm × 0.9 mm × 1.4 mm; T2-weighted MR imaging (T2WI) scan parameters were: repetition time/echo time (TR/TE): 3566-3631/100 ms; interslice gap: 1 mm; slice thickness: 3 mm; matrix: 512 × 352; field of view: 20 cm. Diffusion-weighted MR images were acquired in the transverse plane using the single-shot echo planar imaging technique with spectral attenuation inversion recovery. Scan parameters were: TR/TE: 4830-4840/75-76; interslice gap: 1 mm; slice thickness: 3 mm; matrix: 112 × 110; field of view: 20 cm.

All MR data were transferred to a computer workstation for 3D (three-dimensional) post processing and multiparametric analysis.

The pattern of penile arterial blood supply was grouped into three types according to the classification of Stéphane Droupy (1997): Type I: arising exclusively from IPA; type II: arising from both APA and IPA; type III: arising exclusively from APA [9].

About the APA we proposed to classify into five types: Type I: APA bilateral symmetry (two apical or two laterals); type II: APA bilateral asymmetry (apical and lateral symmetry); type III: APA unilateral lateral (only one lateral); type IV: APA unilateral apical (only one apical); type V: APA unilateral mix (apical and lateral in one side).

Statistical analysis for quantitative variables is expressed as mean standard deviation (SD). Chi-square analysis was used to determine statistically significant of qualitative variables as percentages. *p*-Value <0.05 was considered statistically significant.

Table 1
Origin of APA.

Origin	*n* (%)
Inferior epigastric artery	7 (9.5%)
Inferior vesical artery	32 (43.2%)
Obturator artery[a]	35 (47.3%)
Total	74 (100%)

[a] The most common origin of APA was obturator artery (47,3%).

3. Results

Of 111 male patients with who underwent contrast-enhanced MR 3.0 T angiography of the pelvis, the mean age was 63.56 ± 6.94 years (mean ± SD), we observed: three patterns of penile arterial supply (according to Droupy's classification) were type I in 57/111 patients (51.4%); type II in 52/111 patients (46.8%) and type III in 2/111 patients (1.8%), the common type were type I and type II ($p < 0.0001$) (Fig. 1).

The presence of APA was observed in 54/111 of patients (48.6%) with 74 APA, in which right APA 36/74, left APA 38/74, lateral APA 34/74, apical APA 40/74, lateral APA course along the lateral aspect of the prostate in intimate contact with the anterolateral prostate surface or with the endopelvic fascia (Fig. 2d), whereas apical APA emerge near the apical region of the prostate, inferior and lateral to the puboprostatic ligament (Fig. 2e). There is no difference of incidence between the right and left APA ($p = 0.98$).

We classified the APA into five types, and the results were: type I (bilateral symmetry) in 31.5%, type II (bilateral asymmetry) in 1.9%, type III (unilateral lateral) in 24%, type IV (unilateral apical) in 38.9%, and type V (unilateral mix) in 3.7%, type IV is the most encountered according to our classification, There is no difference between the type of APA and age group ($p = 0.509$) (Fig. 2).

The most common origin of APA was obturator artery in 47.3%, followed by the inferior vesical artery in 43.2%, and then the inferior epigastric artery in 9.5% ($p < 0.0001$) (Figs. 3 and 4 Table 1).

In 81 who have the suspicious cancer zone of 111 patients we observed 43 patients with APA (38.7%), in which: left in 8 patients (18.6%), right in 11 patients (25.6%) and bilateral in 24 patients (55.8%).