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Microvascularization of the Pelvic Urethra in the Newborn and the Child: Urologic Surgical Research

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ABSTRACT
The pelvic urethra is the most complex apportion of the human urethra, which passes through the prostate and the urogenital diaphragm. The aim of the present study is to examine the origin and distribution of tributary arteries of this portion of the male urethra. This was an observational, prospective and chirurgical research. The vascular system of the various 8 subjects was injected with Chinese ink agar either by catheterization of the abdominal aorta after upper ligation of this one or from a buttoned needle introduced into the common iliac artery. The thick sections are dehydrated in increasingly concentrated alcohol solutions and then transparified according to the Spalteholtz method. On the thin slices, stained with Hemalum eosin or Masson's Trichrome, and vascular structures were analyzed. Our reading of the microvasculature of the posterior urethra was related to the histological structure of the wall. The pelvic urethra includes a smooth muscle tunic and a thick mucosa. It is tributary of the pelvic vessels and those coming from the muscularis and the bladder mucosa. The verumontanum received its vascularization from vessels of the mucous and smooth muscle layers of the bladder. The vascular network comes from the arteries of the area of the urethra. These are transverse, parallel to the muscular fibers. They are reduced-sized arteries that descend either directly into the smooth muscularis (penetrating artery) or through its inter-fascicular or fascicular branches. The glandular portion of the urethra was traversed by fine arterial vessels whose caliber decreases in depth of the prostatic tissue. They were oriented obliquely downwards and forwards, either directly towards the urethral sub-mucosa, or after 3-4 anastomoses with homologous arteries. The study of the microvasculature of the pelvic urethra which is the initial aim of this work, led us to examine the origin and distribution of tributary arteries of this portion of the urethra. To the vascular networks, a particular vascular device very anastomotic consisting of transverse, recurrent, fascicular and inter-fascicular spiral arteries. Surgically, the first ligation of the vesicoprostatic artery into the vesicoprostatic groove is necessary in ademomectomy.

Keywords: human newborns and children - pelvic urethra - microvasculature.

INTRODUCTION

There are many studies on the vascularization of the pelvic urethra, but the same is not true for its microvasculature.

Only the now old descriptions made by some authors among whom[1,2,3,4] on the vascularization of the penis, involve the integuments and cavernous bodies.

However, the finesse of these vessels does not allow a very high precision of their description. In addition, the venous side of the vascularization of the pelvic urethra is still rudimentary.

Because of the popularization of microsurgery techniques, it has therefore appeared useful to consider a global and synthetic study of angioarchitectony of the pelvic urethra as regards both its arterial reports and its capillary network and its venous drainage.

Structurally, the wall of the pelvic urethra consists of an outer tunic made of muscle fibers transversely oriented compared to the axis of the urethra and the longitudinal internal smooth fibers.
The muscular tunics of the pelvic urethra can be identified by their histological and microcirculatory appearance[5,6,7,8].

The posterior urethra is represented by a layer of tissue extending upwards the adventitia of the bladder and continuing downwards with the fascias of the urogenital diaphragm. Laterally, the connective tissue joins the pubo-vesico-genito-recto-sacral blades. This tissue is present all around the circumference of the pelvic urethra. That study is performed on a human cadaver donated to our laboratory for research.

MATERIALS AND METHODS

Microvasculature of the pelvic urethra was studied in 8 subjects: 4 newborns and 4 children of age ranging between 1 and 3 years. All human anatomical materials were obtained from human cadavers transferred to the

anatomy laboratory.

The vascular system of the various subjects was injected with Chinese ink agar either by catheterization of the abdominal aorta after upper ligation of this one or from a buttoned needle introduced into the common iliac artery.

At first, the vascular bed was rinsed with physiological warm water at 40 ° C and then in a second time the material was injected with a mixture heated to a temperature of 40 ° C, comprising a part of China ink and a part of gelatinous water. The concentration of gelatin established according to the total volume of this second solution, ranges from 10 to 20% depending on the type of injection desired.
The thick sections are dehydrated in increasingly concentrated alcohol solutions and then transparified according to the Spalteholtz method (Appendix).
On the thin slices, stained with Hemalum eosin or Masson's Trichrome, the histological structures were analyzed with a stereoscopic magnifyin glass and photographed using the Zeiss photomicroscope. Comparison of thick and thin adjoining slices made it possible to superimpose the microvacularization image on the histological one.

RESULTS

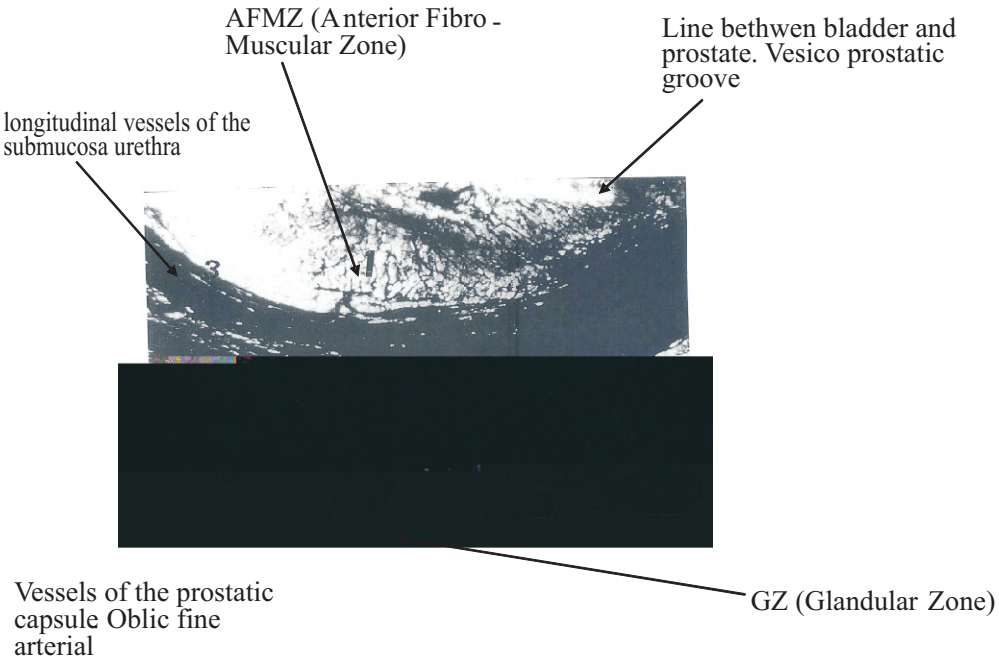

Figure 1: Sagittal section of the pelvic urethra Child aged 2 years and 6 months. (x4) Injection-Transparification.

1. AFMZ (Anterior Fibro-Muscular Zone) -2 GZ (Glandular Zone) -3 longitudinal vessels of the submucosa urethra -4 Vessels of the prostatic capsule anastomosed to the vessels of the smooth urethral muscularis continuing those of the bladder – 5 line bethwen bladder and prostate.

At the gross artery: The adventitia conveys the pelvic vascular pedicles and their arterial and venous anastomotic systems.

Its vascular system depended on the pedicles placed on its periphery, the muscular vessels situated at its contact and directly vessels of the mucosa placed at a distance.
The posterior urethra included a smooth muscle tunic and a thick mucosa. It was tributary of the prostatic vessels and those coming from the muscularis and the bladder mucosa. They were longitudinal, about twice the size of the membranous urethra. They were largely anastomosed on the anterior and lateral surfaces and very little on the posterior surface.

The membranous portion of the posterior urethra received its vascularization from the urethral, capsular and prostatic arteries, branches of the inferior vesical artery and perineal arteries, branches of the internal pudental artery and the terminal branches of the inferior rectal artery. These so-called muscular arteries anastomosed between them, and with the arteries of the prostatic urethra at the top and bulbourethral branch of the internal pudental artery at the bottom. The vesicoprostatic groove was tributary of the vesicoprostatic artery, a branch of the inferior vesical artery, while the prostate receives a capsular and glandular branch of the prostatic artery.

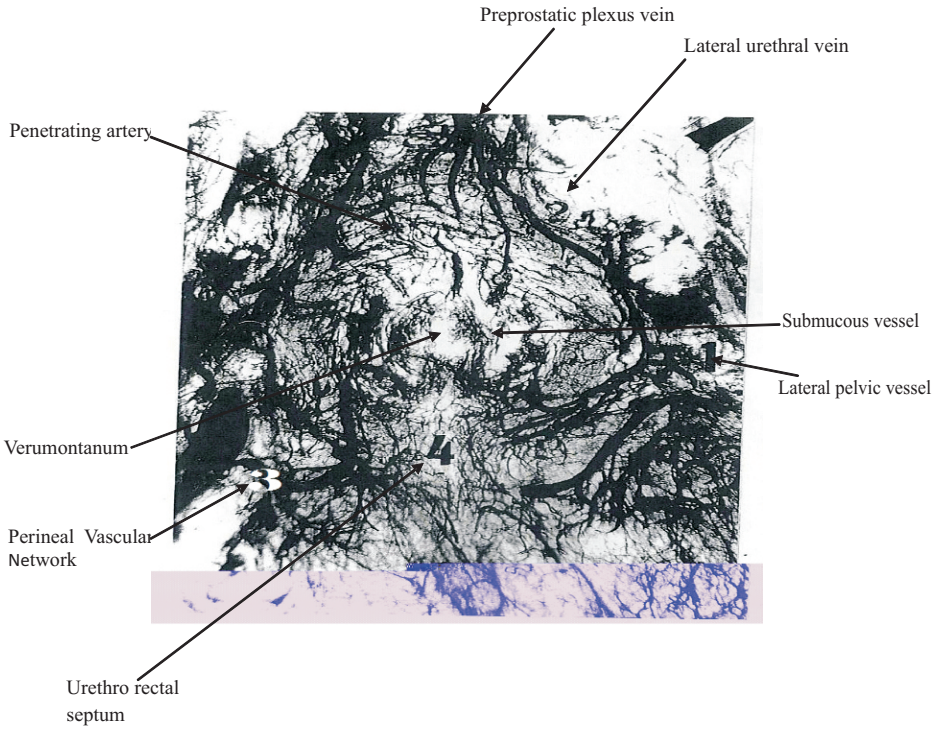

Figure 2: sagittal section of the prostatic urethra. Child aged 2 years and 6 months (x4) Injection-transparification.
1. lateral pelvic vessel -2 Lateral urethral vein -3 Perineal Vascular Network – 4 Urethro rectal septum – 5 Submucous vessel – 6 Verumontanum

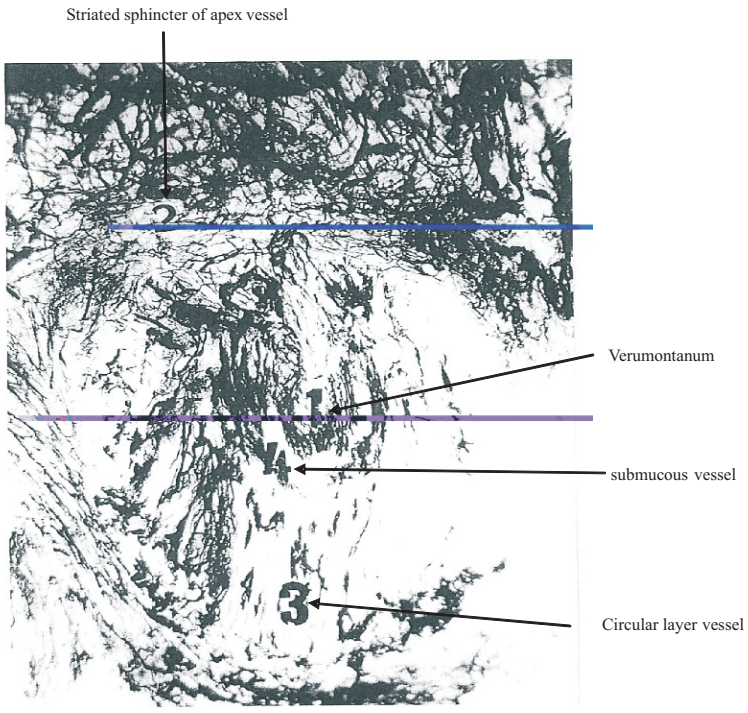

Figure 3: Cross section of the prostatic urethra. 3-year-old child, verumontanum (x4) Injection-Transparification.
1. Verumontanum -2 striated sphincter of apex vessel -3 circular layer vessel. -4 submucous vessel.

At the microcirculatory level: The glandular portion of the prostate was traversed by fine arterial vessels whose caliber decreased in depth of the prostatic tissue. They were oriented obliquely downwards and forwards, either directly towards the urethral sub-mucosa, or after 3-4 anastomoses with homologous arteries [figures: 1, 2]. The posterior surface of the prostate urethra showed the peripheral longitudinal anastomotic network. The transverse anastomses of often oblique path connected at variable heights of the posterior urethra, longitudinal anastomotic axes.

The vascular network comed from the arteries of the area of the urethra. These are transverse, parallel to the muscular fibers. They were reduced-sized arteries that descended either directly into the smooth muscularis (penetrating artery) or through its inter-fascicular or fascicular branches.

The arteries of the outer smooth layer are composed of arteries coming from the outer striated and smooth layers of the bladder neck, capsular, prostatic and perineal arteries. They are transverse and follow the orientation of the muscle fibers. They anastomose between them and with the muscular arteries of the membranous urethra. They extend in depth but in a smaller gauge, the arteries of the striated layer. They followed the orientation of the outer smooth muscle fibers and anastomose between them and with the arteries of the striated layer.
Some recurrent arteries join the striated muscle layer. The vessels of the outer smooth muscular layer vascularized the outer smooth layer and the sub-mucosa.

The arteries of the inner smooth muscle layer continue the path of the arteries of the outer plexiform and circular layer of the bladder. They are longitudinal, parallel to the muscular fibers and depend on the arteries of the outer smooth layer, but especially on the middle longitudinal, circular and plexiform outer layers of the bladder. The large or even dilated veins joinded the first, second and third generation veins that runed into the venous pre-prostatic plexus [figure 2].
The sub-mucosa was richly vascularized by numerous longitudinal arterial branches independent of each other.
Regular-sized veins drained the chorion and the urethral muscularis either directly to the pre-urethral veins or laterally to the veins of the sagittal veins from which the latero-urethral veins that run into the pre-urethral veins [figure 3].

The verumontanum received its vascularization from vessels of the mucous and smooth muscle layers of the bladder. It had a thick mucosa much vascularized, real vascular sponge serving as a valve at the time of urination and ejaculation.

The anterior wall of the prostatic urethra was made of smooth external and internal muscle layers [figures 2, 3].

The prostatorectal septum was poor in vessels and these were oriented according to the fibers of the prostatic capsule. Some recurrent arteries ascended to vascularize the adventitial layer of the prostatic urethra. The vessels of the inner smooth layer were fewer and parallel to each other. The drainage was done from the veins of the pelvic fascia They becomed parallel in the sub-mucosa. During their course, they anastomosed between them and with the vessels of the muscularis and the sub-mucosa of the vesical neck. Below, the anastomosis was done with the muscular vessels and those of the outer smooth sphincter. The sub-mucosa was thin, traversed by a few fine vessels whose number increased towards the prostatic apex.

The cervicorectal septum was tributary of the upper and middle arteries and the collateral branches of the vesicoprostatic arteries [figures 2,3].

DISCUSSIONS

Our present study interested the pelvic portion of the urethra. At this level, the first portion was occupied by the prostate and the last was at the level of the perineal muscles. The cavernous bodies were absent.
The injection of the urethra was made from the abdominal aorta to be certain of the massing of the bladder and the prostate as well as the prostatic rectal fascia.

This technique gave us a better angioarchitectural reading of the couples unlike the other injections reserved for the global reading of the vascularization of the pelvic organs [1,6,2,7,9,10].
Urethral architecture has been the subject of several studies among which [11,2,12,13,14].
In the analysis of our observations, the vessels followed the orientation of the muscular fibers and the vascularization of the urethral wall clearly reflected the different layers of the wall. Only, we managed to distinguish the artery from the vein by its finer caliber.

The prostate and posterior urethras are tributary of the vesicoprostatic artery, the branches of the genitovesical trunk of the internal iliac artery, the inferior rectal artery and the perineal artery. According to Gosling[13], Clegg[15], and Becade[16], these arteries are richly anastomosed at the periphery and in the striated layer of the urethra. For the anterior portion of the urethra and cavernous bodies receive vascularization of the urethral, cavernous and dorsal arteries of the penis. This finding has been proved in our study.

The posterior and anterior urethra were vascularized by the arteries of the plexiform layer of the bladder, the arteries of the vascular sagittal blades and the clean arteries of the periphery of the urethra. The arterial ramificationswere anastomosed then gived rise to a network of dense and regular meshes, extended over the whole height of the urethra and in all the layers of its

wall.

The pelvic urethra was a well vascularized organ and the vessels that participate in the constitution of its arterial network were in fact a remarkable functional unit, without any break in continuity. The increased in the venous density of the chorion of the verumontanum could probably explain the urinary continence.
Some surgical procedures (previous pelvic exenteration, replacement bladder cystectomy, pelvic irradiation) were a source of postoperative incontinence or dysuria, which could be explained by the lesion of sagittal blades, inferior vesical arteries[4,17,18].

CONCLUSION

The study of the microvasculature of the prostatic urethra which is the initial aim of this work, led us to examine the origin and distribution of tributary arteries of this portion of the urethra.
The pelvic urethra depends almost entirely on branches from the lower vesical arteries, the inner prostatic and pudental arteries.

To the vascular networks specific to each of the pelvic organs, are added at the level of other tunics, a particular vascular device very anastomotic consisting of transverse, recurrent, fascicular and inter-fascicular spiral arteries.

The plexus and spiral capillary networks, functional networks of the posterior urethra show some variations, but the general vascular pattern remains identical at the level of the chorion and the mucosa of the posterior urethra.
The veins show drainage in the image of the homologous arteries, a relatively uniform morphology.
Urethral drainage is done either in the cranial direction in the long saphenous vein or in the pre-urethral plexus and in the retzius, or in the lateral direction towards the inner iliac veins.
Functionally, this study highlights modes of vascular replacement for each organ.
Surgically, the first ligation of the vesicoprostatic artery into the vesicoprostatic groove is necessary in ademomectomy.

Appendix
The spalteholz method uses:
- Dilute hydrochloric acid,
- Ethanol (11for 4 liters of distilled water)
- Methyl benzoate (3 baths)
- Methyl salicylate (300 ml), 3 volumes
- Benzyl benzoate (200 ml), 2 volumes

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

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