Intersystemic Arterial Anastomoses in Testicles

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Anastomoses between three main vessels of the testes (testicular, cremasteric, and efferent duct arteries) at the level of the inguinal and scrotal parts of the spermatic cord are extremely rare. The role of these anastomoses in the maintenance of collateral circulation is negligible. A complex anatomical formation located near epididymis-efferent duct connection, where the three vessels are anastomosed (intersystemic junction of testicular arteries), is highly prevalent. This formation is presented by two morphological variants: closed and open vascular rings (semiring).

Key Words: *intersystemic junction of testicular arteries; anastomosis; testicle; epididymis; efferent duct*

The arterial system of the testicle and spermatic cord is well studied. The anatomy of arteries of the scrotal organs and their anastomoses was described in details [1,3,5,7,10]. Many reports describe anastomoses between the main arteries of the scrotal organs and their branches [2,4,6,8]. However these reports usually analyze the arterial system of the testicle from the morphological viewpoint with the emphasis on its age-related changes, and the data are ambiguous. For example, I. S. Gil'bo [2] described 15 variants of connections between the three main vessels of the testicle.

White spots in our knowledge of the morphology of the testicular arterial system at the microanatomical level, the absence of the integral picture of arterial anastomoses in the testes and their structure, and the requirements of clinical andrology and reconstructive genital microsurgery prompted us to undertake this study.

MATERIALS AND METHODS

Experimental morphological study was carried out on 62 anatomical complexes including the testicle, epididymis, and all elements of the spermatic cord with tunicas up to the internal orifice of the inguinal canal.

The following methods were used: monochromatic and polychromatic injection of the Gerot mass into the arterial bed, microanatomical preparation, glass printing of anatomical structures, angiography, and morphometry of blood vessels.

Contrasting was carried out after perfusion with warm normal saline containing spasmolytics. Radiocontrast agents (cobalt blue, zinc white) were injected in small doses into the testicular artery until the appearance of dense vascular network on testicular and spermatic cord tunicas. Micropreparations were made under a magnifying glass or microscope and fixed by glass printing. In some cases X-ray films and photographs (macrophotographs) were analyzed. Morphometry was carried out with an eyepiece micrometer. Each region of the preparation (the inguinal and scrotal parts of the spermatic cord, the testicular and epididymal areas) was thoroughly examined.

The anatomy of the main artery, its syntopy, diameter of the lumen, number of branches and their anastomoses were studied.

RESULTS

In some cases branching of the testicular artery (branches to the gonad and epididymis) was seen in the inguinal part of the spermatic cord in some cases (Table 1). Branching of the testicular artery in the scrotal part of the spermatic cord was observed in all 62 cases.

Anastomoses between first-order branches of the main arteries were detected in the scrotal part of the spermatic cord (Table 2).

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TABLE 1. Morphological Characteristics of Arteries of Scrotal Organs

Type of main artery; diameter, mm	Place of ramification			Number of branches	Diameter of branches, mm	Number of cases
	inguinal compartment	scrotal compartment	testicular area			
Testicular; 1.5-2.0						
I order branches						
to testis	+	+	—	1	1.50-1.95	26
to epididymal head	+	+	—	1	0.30-0.45	8
to epididymis corpus and tail	+	+	—	1	0.80-0.95	48
to duct wall	—	+	—	1-2	0.2-0.5	4
to tunica vaginalis	—	+	—	2-6	—	62
into cord fatty tissue	—	+	+	numerous	—	62
II order branches						
to epididymal head	—	—	+	1	0.3-0.4	54
to epididymal tail	—	—	+	1	0.2-0.25	4
Efferent duct; 0.6-1.4						
I order branches						
to duct wall	+	+	+	numerous	—	62
to tunica vaginalis	+	+	+	numerous	—	62
Cremasteric: 0.5-0.8						
I order branches						
to duct wall	—	+	+	1-2	0.1-0.5	62
to tunica vaginalis	+	+	+	numerous	—	62
to cord fascia	+	+	+	numerous	—	62

Note. Location of anastomoses near the testis and epididymis: *proximal part of the duct, +caudal part of the epididymis and proximal part of the duct.

Anastomoses between the testicular artery and the efferent duct artery were observed in 4 cases. The diameters of communicative vessels varied from 0.2 to 0.5 mm. Anastomoses between the testicular and cremasteric arteries were detected in 4 cases, the diameter of communicative vessels varied from 0.1 to 0.3 mm. Anastomoses between the efferent duct artery and the cremasteric artery were detected in 6 cases, the diameter of communicative branches was 0.2-0.6 mm.

The most intricate and interesting was angioarchitectonics of the third compartment, the testicle and epididymis. In addition to the terminal portions of the testicular artery, cremasteric artery, and efferent duct artery, there were large first-order branches of the testicular artery towards the epididymis and its head: epididymal artery and epididymal head artery. The testicular artery, represented by one or two stems, perforated the tunica albuginea at the level of the middle of the posterior edge of the testis and branches in the organ parenchyma. The largest branches of the testicular artery (0.85-0.95 mm epididymal artery and 0.30-0.45 mm epididymal head artery) passed in front of the main vessel on the epididymis head or corpus, perforating the capsule of the epididymis and leading to its caudal part along the posterior edge of the organ. In 2 cases an additional arterial stem branched from the epididymal artery at the level of the epididymal head transfer into the body of the epididymis (epididymal tail artery, diameter 0.3 mm). The artery led under the epididymal capsule towards its tail.

The terminal portions of the epididymal head artery, epididymal artery, and epididymal tail artery at the site of epididymal tail connection to the efferent duct were connected to the terminal portion of the efferent duct artery, forming a sort of anastomosis which presented as an arterial arch of the testis. The testicular arterial arch was observed in all cases, its diameter was 0.3-1.2 mm. It gave rise to branches to the tail of the epididymis and the proximal part of the efferent duct.

In most cases (52) the testicular arterial arch was formed by the terminal part of the efferent duct artery and epididymal artery. In 8 cases the anastomosis was formed by the efferent duct artery and epididymal head artery, and in 2 cases by the efferent duct artery and epididymal tail artery.

TABLE 2. Anastomoses of Three Arterial Systems along the Spermatic Cord, near the Testicle and Epididymis

Anastomosing vessels; type of anastomosis	Inguinal compartment	Scrotal compartment	Testicular and epididymal area
Testicular and efferent duct arteries			
branches originating from the main vessel	—	4	—
terminal branches (vascular arch of the testis)	—	—	62+
Testicular and cremasteric arteries			
branches originating from the main vessel	—	4	—
terminal branches	—	—	62*
Efferent duct and cremasteric arteries			
branches originating from the main vessel	—	6	—
terminal branches	—	—	62*
Testicular, cremasteric, and efferent duct arteries			
intersystemic anastomoses of testicular arteries (vascular arch and vascular ring)	—	—	28*
intersystemic anastomoses of testicular arteries (vascular arch and vascular semiring)	—	—	34*

The cremasteric artery led to the zone of the epididymal tail transfer into the twisted part of the efferent duct and joined the arterial vascular arch in all cases. Hence, all three main arteries of the scrotal organs united at the beginning of the efferent duct, forming an anastomosis of different arterial systems.

Specific architectonics of this area differed from the adjacent areas primarily by dense vascular network. This pattern was formed by two groups of vessels. The first group was presented by small arteries originating from the arterial arch and lying across the organ. The second group was presented by vessels encircling the proximal part of the efferent duct. In 34 cases this anatomical formation was seen as an open arterial ring (semiring; Fig. 1, *a*) and in 28 cases as a closed arterial ring (Fig. 1, *b*). The stem of the arterial ring (semiring) anastomosed directly to the arterial arch. Numerous small branches forming an additional arterial network originated from the vascular semiring (ring).

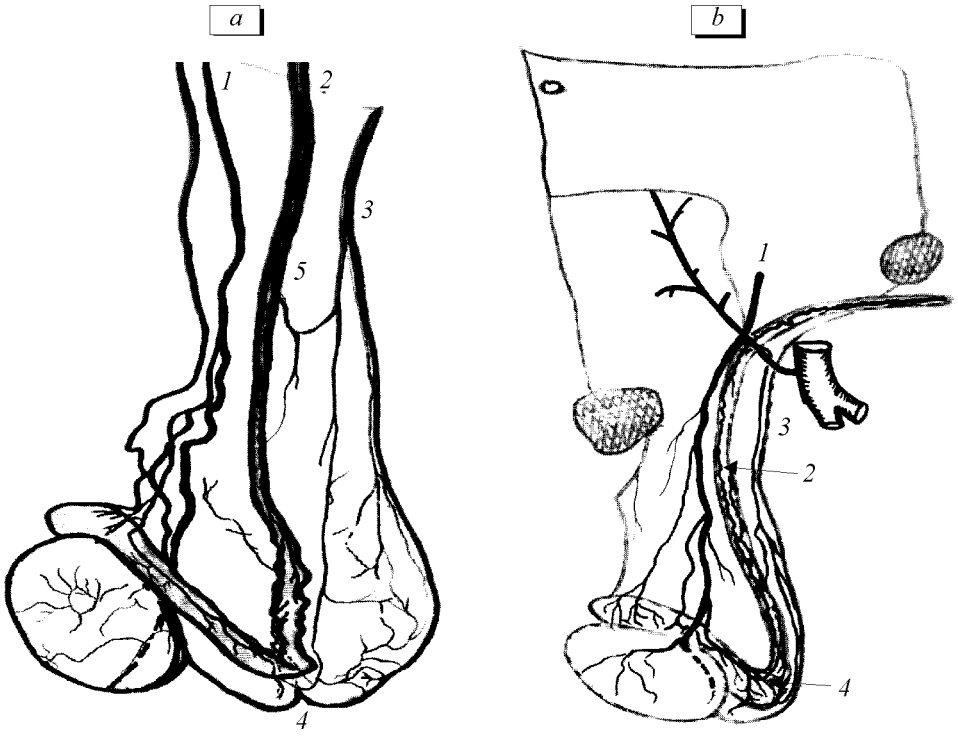

Fig. 1. Glass prints of anatomical preparations of the scrotal arterial system. *a*) semiring; *b*) closed arterial ring. Here and in Fig. 2: *1*) testicular artery; *2*) efferent duct artery; *3*) cremasteric artery; *4*) intersystemic junction of testicular arteries; *5*) arterial anastomosis.

Hence, the studied arterial formation is present in all cases, is characterized by compact structure and constant location, and is presented by two morphological variants (closed ring or semiring).

These characteristics give grounds to distinguish this formation as a morphological entity; we call it as intersystemic junction of testicular arteries (*confluens arteriae testis*).

Intersystemic junction of testicular arteries is a complex formation with the following morphological components (Fig. 2):

- testicular arterial arch: anastomosis of the terminal parts of efferent duct artery and first-order branch of testicular artery (epididymal artery, artery of the epididymal head or tail);
- terminal portion of the cremasteric artery;
- arterial ring or semiring, the central component directly ensuring the anatomic and functional connection of the testicular arterial arch to the cremasteric artery.

Hence, the only anastomosis of all three testicular arteries and the spermatic cord is anastomosis of a complex morphological structure, located at the site of epididymal tail transfer into the twisted part of the efferent duct: intersystemic junction of testicular arteries. Other anastomoses are formed by two main arteries, are rare, and their role in the collateral circulation is negligible.

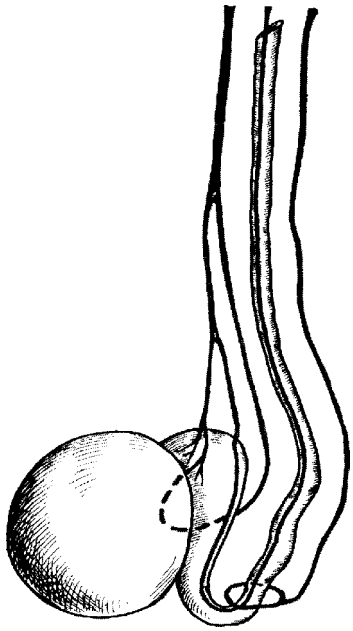

Fig. 2. Scheme of intersystemic junction of testicular arteries.

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