Anatomy and Microanatomy of the Venous System of Scrotal Organs and Spermatic Cord

A. A. Artyukhin

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Three structural and hemodynamic variants of venous angioarchitectonics of the epididymis were detected: direct testicular outflow (direct outflow into veins of the plexus pampiniformis), indirect testicular outflow (outflow into veins of the plexus pampiniformis with involvement of the communicant veins), and mixed outflow (combination of indirect testicular outflow with the outflow into vas deference veins). Anastomosis of caudal veins of the epididymis and the initial compartment of veins of the vas deference forming the "testicular venous arch" plays an important role in collateral venous bloodflow system; the arch anastomosing with the source of cremasteric vein forms a three-system anastomosis, the "testicular venous plexus" at the site of the epididymis tail transition into the vas deference.

Key Words: *plexus pampiniformis; venous arch; venous node; testicle; cremasteric vein*

Operations aimed at cessation of the bloodflow in varicose vessels are widely used in clinical andrology for the treatment of varicocele [1,2,4].

The venous system of the scrotal organs and spermatic cord is well studied; however, the structure and location of venous anastomoses between the three main collectors testicular vein, cremasteric vein (CV), and vas deference (VD) vein (VDV) deserve further studies.

We studied the venous system of the scrotal and spermatic cord organs at the microanatomical level.

MATERIALS AND METHODS

The study was carried out on 60 isolated anatomical complexes including the testicle, epididymis, and all elements of the spermatic cord along its entire length, including the membranes and the inner orifice of the inguinal canal.

Central Inter-Clinical Department of Andrology, I. M. Setchenov Moscow Medical Academy

After washing the veins with warm saline with spasmolytics, Gerot's injection mass with X-ray contrast stains (Cobalt Blue, Zinc White) was injected into the testicular vein by small portions until the emergence of dense vascular network on the testicular membranes and spermatic cord.

Microanatomical preparation was carried out under a magnifying glass or operation microscope, the results were fixed by glass printing. X-Ray contrast study was carried out in some cases.

Morphometry was carried out using an ocular micrometer.

The course of the main venous trunk (trunks), the level of its formation from the venous plexus, syntopy of the vessels, size of the lumen, number of branches, type of venous plexuses and their anastomoses were studied.

RESULTS

The testicular and epididymal area includes the extraorgan compartments of three venous systems: testicular vein, VD veins, and CV (Fig. 1).

Anatomical and microanatomical preparation with subsequent glass printing was the most informative; it showed all variants of anatomical structure of the venous system (Fig. 2). X-Ray contrast venography (Fig. 3) does not show the type of anatomical connections between the main venous collectors and evaluate the blood outflow from the epididymis.

Extraorgan compartments of the venous system of gonads originate at the interface between the upper and middle thirds of the posterior edge of the testicle and in 51 cases were represented by two independent plexus pedicles, located vertically (Table 1). In 33 of these cases the upper and lower pedicles of the testicular venous plexus were united into the plexus pampiniformis at the upper end of the testicle, while in 18 cases remained independent until the scrotal compartment of the spermatic cord. In 9 cases the plexus pampiniformis was formed by a common venous pedicle.

The VD veins in the testicular and epididymal area are presented by a well developed venous plexus, located on the anterior semicircumference of the organ in 39 cases. Two plexus bundles, lying on the anterior and posterior semicircumference of the duct and connected between each other by numerous small venous trunks, were detected in 21 cases.

The cremasteric veins are formed from the network of capillaries of the tunic and seminal fascia and are located at their posterior semicircumference. One or two large trunks 0.4-2.5 mm in diameter were most often (42 cases) detected at the upper pole of the testicle. In two cases CV were represented by 4-5 trunks 0.2-1.8 mm in diameter, and in 4 cases 8-10 small trunks of ≤0.4 mm in diameter were detected at the upper pole of the testicle.

The venous systems of the testicle and epididymis are connected to each other. A most important component in the anastomosis system are epididymal veins, forming from dense venous network located under the capsule of the organ. The initial compartments of epididymal extraorgan veins are presented by pedicles of venous plexuses, in some cases by solitary venous trunks. The entire variety of venous angioarchitectonics can be classified as 3 variants (Table 2).

The most incident is angioarchitectonic variant 1 (n=48) with direct testicular outflow. In this variant an epididymal venous plexus forms from the venous network located under the epididymal capsule; in the majority of cases it originates from the epididymal head, lies in front of the plexus pampiniformis veins, and at the level of the testicle apex

TABLE 1. Anatomic Characteristics of the Main Venous Collectors of the Scrotal Organs (n=60)

Vessel and area	Anatomic form of vascular formation	Number of branches (pedicles)	Diameter of branches, mm
Testicular vein			
testicle and epididymis	Plexus pedicles	1-2	—
scrotal portion of spermatic cord rarely	Common venous plexus, separate trunks	1-3	1.4-2.8
inguinal portion of spermatic cord	Venous trunk(s)	1-3	1.6-3.4
VDV			
testicle and epididymis	Venous plexus	1-2	—
scrotal portion of spermatic cord	Plexus on anterior circumference, rarely trunks on posterior circumference	1	0.4-0.7
inguinal portion of spermatic cord	Usually venous plexus, rarely main trunks	1-2	0.4-1.0
	CV		
testicle and epididymis	Network of small vessels, trunks formed at the upper pole of testicle	1-10	0.4-2.5
	(at upper pole of testicle)		
scrotal portion of spermatic cord	Venous trunks formed at posterior circumference of spermatic cord	1-8	0.4-2.6
inguinal portion of spermatic cord		—	—

TABLE 2. Anatomic and Hemodynamic Characteristics of Epididymal Veins

Angioarchitectonics variant	*n*	Level of venous plexus formation in epididymis	*n*	Site of connection	Forming main vein
Direct testicular outflow	48	Head	36	Plexus pampiniformis	Testicular vein
		Head and body	9		
		Body	3		
Indirect testicular outflow	9	Head	9	Plexus pampiniformis	Testicular vein
		Body	9	Communicant veins	Testicular vein, CV, and VDV
Mixed variant	3	Head	3	Plexus pampiniformis	Testicular vein
		Body	3	Communicant veins	Testicular vein, CV, and VDV
Tail	3	VDV			VDV

falls into the plexus pampiniformis or, rarely, remains autonomous until the scrotal compartment of the spermatic cord. In 9 of 48 cases the venous flow from the epididymis is realized via the plexus pedicles, originating from the epididymal head and body and fusing at the upper pole of the testicle to form the epididymal plexus immediately outflowd into the venous testicular plexus. In just 3 cases the venous plexus originated from the epididymal body and lay laterally and then in front of the testicular vein plexus, retaining this position until the scrotal compartment of the spermatic cord.

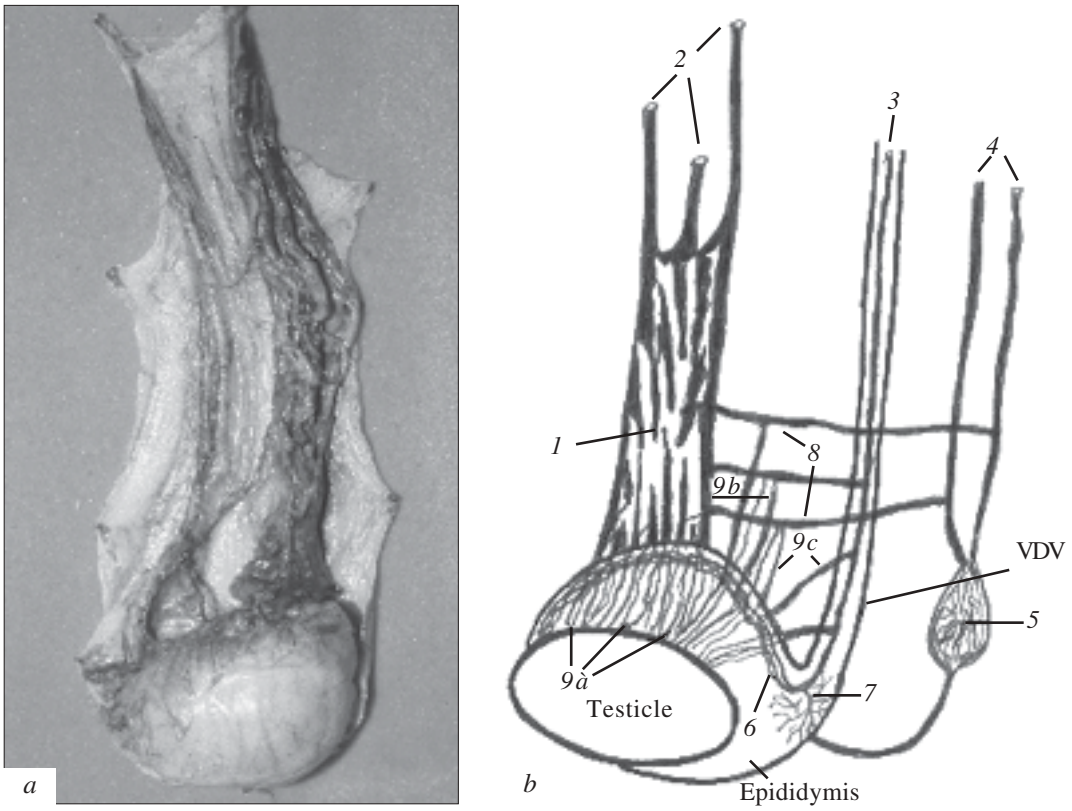

Fig. 1. Venous system of the scrotal and spermatic cord organs. *a*) 3 venous collectors and their components clearly seen in the testicular, epididymal, and two VDV compartments: plexus pampiniformis, testicular vein trunks, CV, VDV (plexus), and separate intersystem venous communicants; *b*) structure: *1*) plexus pampiniformis; *2*) formed testicular venous trunks; *3*) VDV; *4*) CV; *5*) intermediate CV plexus (rarely observed); *6*) TVA; *7*) testicular venous node; *8*) intersystem venous communicants; *9a*) direct and *9b*) indirect testicular outflow; *9c*) mixed variant.

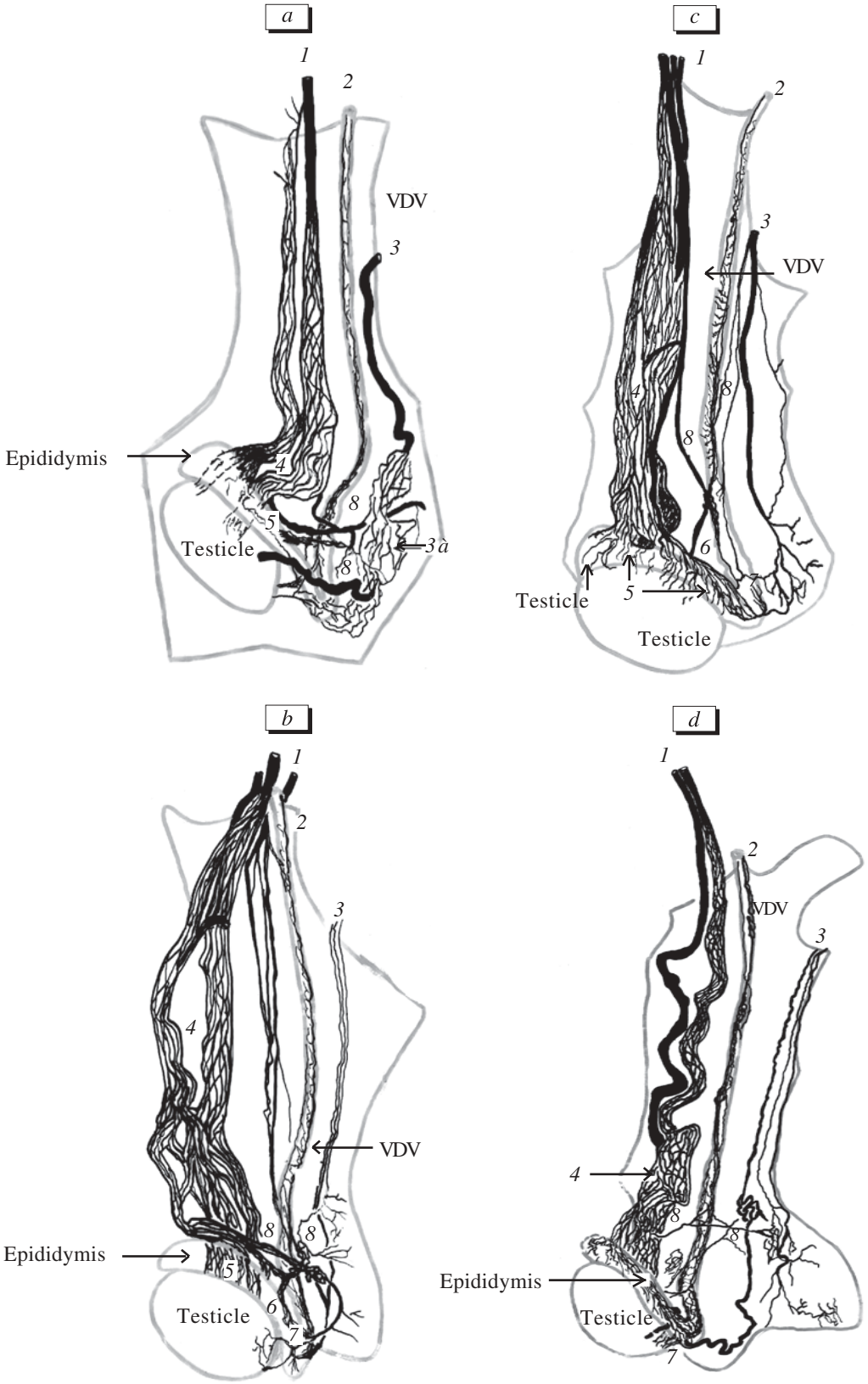

Fig. 2. Variant anatomy of venous system of the scrotal and spermatic cord organs (glass printing). *1*) testicular vein trunks; *2*) VDV; *3*) CV; *3a*) CV plexus; *4*) plexus pampiniformis; *5*) epididymal plexus; *6*) TVA; *7*) testicular venous node; *8*) intersystem venous communicants.

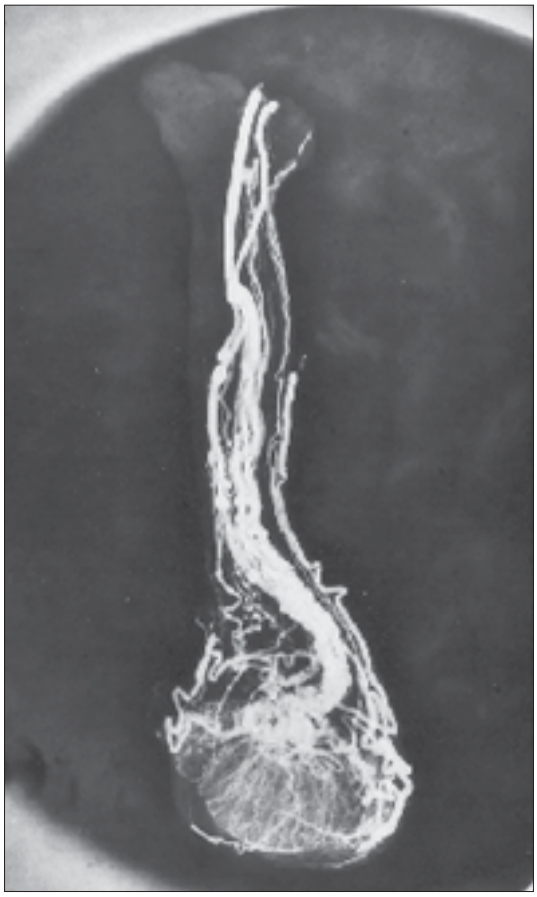

Fig. 3. X-Ray contrast angiography of venous system of the scrotal organs. Venous plexuses and main vessels of three collectors are clearly seen: testicular vein, CV, and VDV. Anastomoses between vessels and type of venous outflow are not seen because of mutual superimposing of shadows.

In cases with variant 2 (indirect testicular outflow; *n*=9) the venous plexus originated from the epididymal body and outflows into the communicant veins (in addition to the venous plexus originating from the epididymis head and falling into the plexus pampiniformis at the level of the upper pole of the testicle). The communicant veins connected the plexus to VD veins in all cases and to CV in 48 cases. They are located behind the epididymis, their structure varying from groups of small trunks of 0.2-0.4 mm in diameter to well developed venous plexus.

Mixed variant of venous outflow is characterized by the formation of three independent pedicles of venous plexuses originating from the epididymis head, body, and tail. The venous pedicle formed from the epididymal head veins fuses with the plexus pampiniformis veins at the upper pole of the testicle. Venous plexus originating from the epididymal body falls into the communicant veins, while the venous pedicle formed from veins of the epididymal tail falls into VD veins at the site of the twisted compartment.

Anastomosis between the epididymal tail veins and the initial compartment of VDV, located parallel to the testicular arterial arch, was detected in all anatomical preparations — testicular venous arch (TVA; Table 3). The venous pattern was more intense in the zone of epididymal tail transition into twisted compartment of VDV. A peculiar vascular "tree", with the trunk connected to TVA, formed from numerous small veins in this zone.

The TVA is connected to the CV system by separate trunks or a network of small veins (up to 9) located in the zone of epididymal tail transition into twisted compartment of VDV (Table 3).

Anastomosis of three venous systems (epididymal veins participating in the formation of plexus pampiniformis, testicular veins, VDV and initial CV venous plexus) — the testicular venous node — forms in the initial compartment of VDV.

Testicular and epididymal veins were represented in the scrotal compartment of the spermatic cord by a common venous plexus in 45 cases, but separate large venous trunks of 1.4-2.8 mm in diameter were detected in 9 cases. The VD veins formed one main trunk of 0.4-0.7 mm in diameter in 12 cases; in 9 cases this trunk was located at the posterior and in 3 at the anterior circumference of VDV. In 48 cases the VD veins retained the plexus structure and were located on the anterior VDV semicircumference. Two pedicles of the plexus were detected in 21 cases, with VD veins located on the anterior and posterior VDV circumferences. Cremasteric veins in the scrotal compartment were detected on the posterior semicircumference of the

TABLE 3. Characteristics of Anatomic Components of Testicular Venous Node

Anatomic components of testicular venous node	Number of branches	Vessel diameter, mm	*n*
TVA (*n*=60)	1	0.2-2.3	33
	2	0/3-1/3	6
	Venous plexus	—	21
TVA connected to CV (*n*=60)	1	0.6-2.6	24
	2	0.1-1.8	18
	8-9	<0.3	18
TVA connected to intraorgan testicular veins (*n*=21)	1	0.9-1.1	6
	Many	—	15

spermatic cord. In 45 cases CV were represented by 1-2 trunks 0.4-2.6 mm in diameter, in 9 cases by 4 trunks of 0.2-1.9 mm, and in 6 cases by 8 trunks ≤0.5 mm in diameter.

No anastomoses between the three venous systems were detected in the scrotal compartment, an anastomosis between the plexus pampiniformis and VD veins with anastomoses of 0.2-0.4 mm was detected in only 3 cases.

One to three venous trunks of 1.6-3.4 mm in diameter formed from the testicular plexus in the inguinal compartment of the spermatic cord. The VD veins were represented by plexus in 39 cases, with the main vessels of the venous plexus ≤0.4-0.5 mm in diameter. In 21 cases the VD veins were rather large main vessels (0.4-1.0 mm). No CV were detected in the inguinal compartment.

Hence, solitary anastomoses between two main veins of the scrotal organs, detected in the scrotal compartment of the spermatic cord, are of no functional and clinical significance.

Two levels of intersystem venous communicants of the scrotal organs can be distinguished. The lower level (first-level intersystem venous communicant) is the testicular venous node. The upper level (second-level intersystem venous communicants) are venous segments including extraorgan veins of the epididymis and intersystem communicant veins connecting all main venous collectors of the scrotal organs to epididymal veins and providing not only blood outflow from the epididymis by the three hemodynamic variants, but serving as the main component in the system of venous collateral bloodflow between the testicle, epididymis, VDV, fascias, gonad, and spermatic cord membranes.

The data on the structure of extraorgan venous system of the scrotal and spermatic cord organs prompt a critical approach to currently used methods for the treatment of andrological diseases and development of new surgical guidelines.

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