

# Vascularization of the penis of a man

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## Abstract

**Purpose:** The study of the features of the blood supply of a penis of the man.

**Material and methods:** Macromicropreparation, angiography, corrosion method, morphometry, statistical method.

**Results:** The penis has three venous collector-executing outflow of blood. First of them is submitted surface dorsal vein, which is shaped from small-sized venous vessels of skin, subcutaneous fat and surface fascia of penis. The beginning deep dorsal vein, which will derivate second venous collector, gives veniplex of head of the penis. The spongy veins outstanding as third venous collector, reach the bulb of penis, where they receive small-sized bulbar vein. The arterial blood supply of penis happens at the expense of external and internal pudendal arteries. The external pudendal artery starts from an internal wall of femoral artery on 2.5-2.7 cm below inguinal ligament. In some cases (8%) the artery starts by two trunks – forward and back. The internal pudendal artery is main source of blood supply of penis of the man. It removes from forward trunk of internal iliac artery independently in 50% of cases. In remaining cases it or removes from this artery by one trunk with lower gluteal (36%), common trunk with the upper and lower gluteal arteries (4%), or with upper gluteal (8%), or with obturator artery (2%). Besides in the arterial blood supply of penis take part bulbar, urethral, dorsal and deep arteries of penis.

**Conclusions:** The penis receives blood from external and internal pudendal arteries, which are very variable. The venous blood of the penis flows off in three types of veins.

**Key words:** penis, veins of penis, arteries of penis, erectile dysfunction.

## Introduction

The development of the medical technology has deepened the knowledge of organic violations of gears of erection. It was straightened out, that more than 50% from them cause vascular disorders [1-4]. It has given a particular push to more detailed learning extra- and intraorgans vessels of the penis. At the same time, the problems of vascularization and relationships of blood vessels of the penis have been investigated not enough, and in number of cases the results of the researches are contradictory [5-8].

The purpose of the research is to study of the arteries and veins of the penis of a man.

## Material and methods

As the materials for the research penises from 160 corpses of men aged from 17 to 74 that had died unexpectedly were used. Methods of the research are:

### 1. Cavernozometry

According to Wespes E [9], infusion cavernozometry, which use in clinic, maybe exploit on the corpse not later than 24 hours from the moment of death. It is accepted to consider 150-200 ml/min as conditional norm of infusion cavernozometry in this case, more than 200 ml/min and absence of artificial erection as pathology of venous outflow. Therefore, with the purpose of building the artificial erection each corpse was

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exposed cavernozometry for definition of functioning of venous outflow from the penis. The nature of the method consists in the following. One of cavernous bodies in range of prepuce is punctured by a needle with the diameter of foramen of 0.8 mm, which with the help of polychlorvynil tube paired to the device of artificial circulation and pot with solution. Perfusion within 3-5 minutes was carried out by warm (37°C) normal saline solution in the following parameters: 1) 150 ml/min; 2) 200 ml/min; 3) more than 200 ml/min. The first and second parameters were accepted for conditional norm, and more than 200 ml/min or absence of artificial erection spoke about infringement of venous hemodynamics of penis.

## 2. Macromicropreparation

With the purpose of specification of some topographical features and simplification of the subsequent preparing of the fine branches the filling of the veins of the penis (after preliminary erasion from the organ of the residual blood with the help of the lavage by the normal saline solution) with the solution of leaden bleached on monomer "Etakril" in the ratio 1:5 with addition 2 parts of polymer was carried out. Injection mass was introduced backward through the deep dorsal vein of the penis by access from the perineum under pressure of 50 mmHg. Then penis was exposed to level-by-level preparing under binocular supraforehead magnifier.

The received data were recorded in the protocols, where the some variants of the arteries and veins of the penis were described; their sketches and photographing were carried out.

## 3. Roentgen angiography

For reception of roentgenograms of vessels of the penis was used roentgen contrast mass of the following structure: a) leaden suric 30%, zinc bleached 15%, rest turpentine; b) leaden bleached 40%, rest turpentine. The injection of veins of the penis was carried out as follows. In a position of the corpse on a back with bent in patellar and hip joints and divorced femurs, access to deep dorsal vein of the penis carries out by the semicircular cut with the establishment at ischial tuber and apex at root of the scrotum. The deep dorsal vein of the penis excretes in the triangle formed by superficial transversal muscle of the perineum, the bulbo-spongy and ischial-cavernous muscles. This vein, having removed by Farabef's hook the spongiform body of the penis, take on the forceps and the forward wall dissect transversally by scissors. Then through the cut introduce the subclavian catheter of the diameter of the foramen 0.3 sm and advance it against the stop with venous valve, which, as a rule, settles down at the level of the basis of the organ. Through the catheter the metal explorer of the diameter 0.2 cm advance and blast the valve. Then remove explorer and the special device attach to the catheter, allowing to supervise pressure of the introduced contrast agent, which freely fills in all veins of the penis, due to presence of anastomoses between superficial both deep dorsal, and spongiform veins. Thus complete architectonic of the veins of the penis turns out without contrasting of the cavernous bodies, dui to the perforate veins are submitted as the turned funnel, that interferes to hit of contrast in the cavernous bodies.

## 4. Morphometry

After anatomical preparation and the performances of roentgenography with the help of MBS-2 measured the diameter of dorsal veins (at the basis of the organ), circumflex ones (at the place of run them in deep dorsal vein), spongiform veins (at the level of the bulbus of the penis), veins of the retroglandular plexus (at the level of their coalescence). The detailed study of topographo-anatomical features of the internal pudendal artery and its branches was carried out: their position both mutual relation with veins and nerves, length and diameter on different departments, depth of the lying, definition of the projection of the internal pudendal artery in relation to anatomical orienteer of the perineum. In each age-grade the vessels were exposed to the morphometry: length and diameter, as the basic parameters capacitor and bandwidth of veins; depth of the wall and shells, amounting it.

## 5. Histological method

For study of inner structures of the vascular canals of the penis the tissue specimens on the standard procedure were produced. For this purpose at the level of the head, cervix, middle third of body and the basis of the organ were cut out slices by depth of 10 mm. The received fields of the penis were fixed in 10% solution of neutral Formalin. After flush in water and the deaquations in alcohol of growing concentration were filled in paraffin. Sections by depth of 5 micron from paraffin trochleas prepared on the microtome. The microstructure of the wall of vessels studied with use of histological procedures: coloring of paraffin sections by hematoxylin – eosin, by van Gizon.

## 6. Statistical method

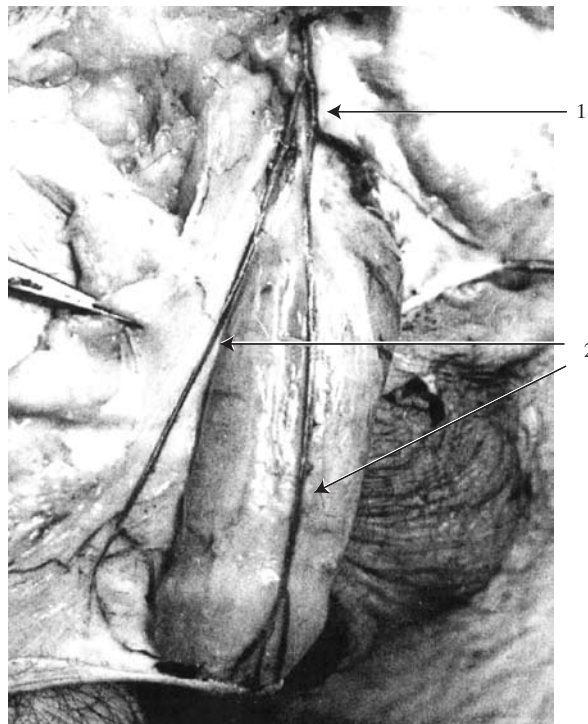
All data are subjected to statistical processing. Thus average arithmetic size, average square deflection, mean error average arithmetic, and coefficient of variation were calculated. The specified statistical parameters are received on the computer with the help of the program "Statistica 5.5". Reliability of difference between separate bunches determined with the help of criterion T. Under the Student's tables the probability (P) of reliability of differences of compared sizes estimated. For the minimal probability of differences was accepted  $p < 0.05$ .

All anatomical terms are given under the International nomenclature.

## Results

The analysis of the received results gives the basis to state the number of situations, not enough illustrated and explained in the literature. A penis has three venous collector-executing outflow of blood. The first of them is submitted by superficial dorsal vein, which is formed from small-sized venous vessels of skin, subcutaneous fat and superficial fascia of penis. One (36.5%) or two (63.5%) trunks can submit it. If the superficial dorsal vein is submitted by one trunk, it is located on the dorsum penis, if it consists of two trunks, then they lie on upper-lateral area of the organ. Placing between superficial and deep fascias of the organ, the superficial dorsal vein irrespective of the quantity of trunks, reaches for the basis of the penis, then turns

Figure 1. Veins of the penis of man: 1 – subcutaneous veins of anterior abdominal wall; 2 – superficial dorsal veins



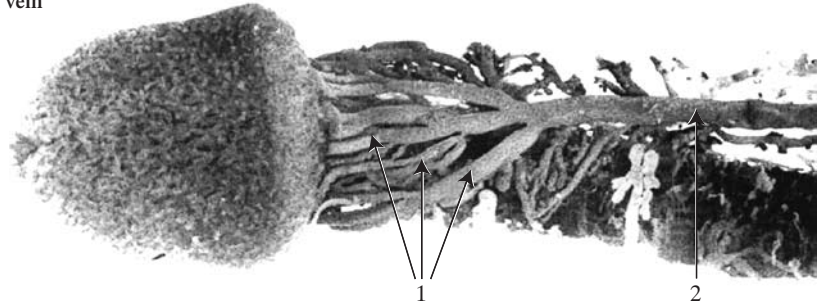
externally, and in the field of hypodermic slot of the femur runs accordingly into the left or dextral large hypodermic vein of the femur. At presence of one trunk, the superficial dorsal vein is a more often (82.9%) run into the left large hypodermic vein of the femur. In 16.9% of cases the superficial dorsal vein is poured in hypodermic veins of the abdominal wall (Fig. 1).

The beginning deep dorsal vein, which is the derivate of the second venous collector, gives the head of penis veniplex. Divided by connective tissues trabecules, veins of the head of the penis, which on shears imitate cells of cavernous tissue, sequentially merge from small-sized in larger and leave from under crown on the back of the organ. These trunks also shape the head of penis veniplex, which lies between deep fascia of the penis and white of cavernous bodies. The quantity of the venous trunks can vary from two up to seven. The average diameter of the veins of this veniplex is  $1.87 \pm 0.01$  mm. These venous trunks merge among themselves and form the deep dorsal vein (Fig. 2). It represents rather large vessel with the diameter of 4-5 mm with thick walls, which are densely fixed to white of cavernous bodies. Not far from the basis the deep dorsal vein has the valve opening proximally, and for the basis of the doors of the valve the thickening of the walls of the vein is scored at the expense of the growth of the muscular coat. The deep dorsal vein in some cases (28.2%) can be divided into two trunks with the average diameter of  $2.69 \pm 0.14$  mm, from them at a level of mean third of penis (81.05%) or for the basis (18.95%). According to our data, in the deep dorsal vein, in it distal and middle third, the

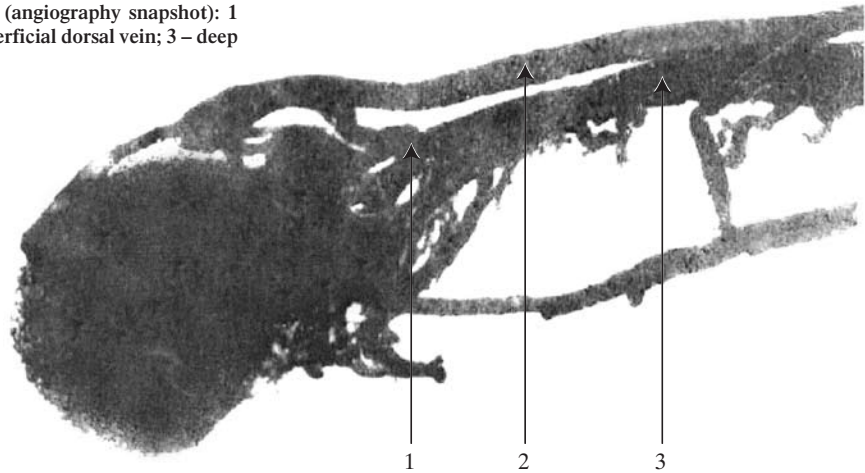
circumflex veins, which carry blood from cavernous bodies, run. There is an anastomosis between the superficial dorsal and the deep dorsal veins in the area of the prepuce in 87.6% of cases. (Fig. 3). It was shown, that the circumflex veins with the average diameter of  $1.65 \pm 0.06$  mm in the majority cases (96.2%) are shaped of junction of two trunks: the perforation vein of the cavernous body and the vein leaving the spongy body in area of the urethral sulcus. In 3.8% of cases the circumflex veins are direct prolongation by one only perforation vein passing through a dense white. As the result of the carried out research, we detect in 19.86% of cases the circumflex vein with the average diameter of  $1.75 \pm 0.01$  mm, which was shaped in the field of mean third of cavernous body, placing on lateral area of penis, and run in deep dorsal vein at the basis of the organ, i.e. behind of venous valve. On our material in the majority cases (80,14%) the circumflex veins run into the deep dorsal vein in its distal and middle third in numbers from four up to eight pairs. Besides it is necessary to note, that at the left circumflex veins runs a little bit more, than on the right ( $p > 0.01$ ). Having accepted in itself circumflex veins the deep dorsal vein reaches a place of divergence of cavernous bodies on two pinches and further passes in interval between arcuate ligament of pubis and transversal ligament of perineum in the cavity of small basin, where runs into prostate veniplex. At presence of two trunks, they run into prostate veniplex independently.

We, having carried out the research of the venous channel of the penis of 160 corpses [10], in one of them we have not found

**Figure 2. Veins of the penis of man (corrosion preparation):**  
1 – retroglandular veniplex; 2 – deep dorsal vein



**Figure 3. Veins of the penis of man (angiography snapshot):**  
1 – anastomosis between veins; 2 – superficial dorsal vein; 3 – deep dorsal vein



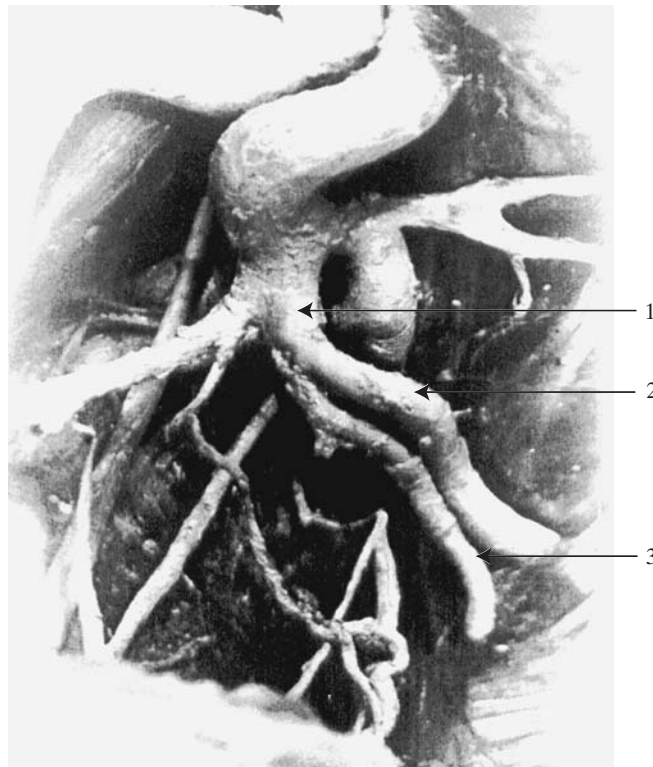
deep veins of the organ. According to it we consider that the deep veins of the penis as real anatomical object in the norm are absent. The rather low efficiency of the method of surgical correction of vascular impotency of venous genesis offered the Brazilian scientists bears also to it [11]. They assert, that the deep veins of the organ act from a proximal part of cavernous bodies at once after place of their bifurcation, and the nature of their operation consists that the cavernous bodies in their proximal part, i.e. pinch of penis dressed completely.

The spongy veins execute the venous outflow from a like body. As a rule, it is a pair veins (93.7%) with the average diameter of  $0.87 \pm 0.01$  mm located on the lateral area of the spongy body under the deep fascia of the penis. They are formed from small-sized venous vessels leaving in the area of urethral sulcus. The spongy veins outstanding as third venous collector, reach the bulb of the penis, where they receive small-sized bulbar veins. Then pass the interval between the arcuate ligament of the pubis and the transversal ligament of the perineum and run into the prostate veniplex (88%). In some cases, (12%) they run into the deep dorsal vein in the field of the perineum.

The arterial blood supply of the penis takes place at the expense of external and internal pudendal arteries [12]. The external pudendal artery starts from the internal wall of the femoral artery 2.5-2.7 cm below the inguinal ligament. In some cases (8%) the artery starts by two trunks – forward and back. The diameter of the initial department of the external pudendal artery or its forward trunk varies from 1.0 up to 2.1 mm. The

external pudendal artery, and in the case of it the forward branch division, goes ahead to the femoral vein below the places of locking in last of large hypodermic vein of the femur. In the region of the hypodermic slot of the femur, the artery perforate the loosened site of the broad fascia of femur also passes in hypodermic fat, being routed in tracking of the similar vein to the upper edge of the body of the pubic bone. At level of the pudendal artery returns last a branch with average diameter of  $0.4 \pm 0.01$  mm to a skin of the scrotum. The external pudendal artery with average diameter of  $0.95 \pm 0.02$  mm goes to the basis of penis, where it turns under a corner in the party of the head of the penis and is located above the deep fascia of the organ. It is necessary to note, that the indicated branch of the external pudendal artery goes parallel dorsal artery of the penis also passes from it to the left apart  $0.25 \pm 0.01$  mm, and on the right –  $0.2 \pm 0.01$  mm. Thus, the branch of the dextral external artery intersects the dextral dorsal artery at the level of mean third of body and is located internal from it. At the same time, as a branch of the left external pudendal artery, which reaches for the left dorsal artery, in our material never intersected her and is situated external that matters at operations on arteries of penis. The diameter of final department of the external pudendal artery on the average makes  $0.68 \pm 0.02$  mm. The back of the trunk of the external pudendal artery, whose average diameter makes  $0.8 \pm 0.01$  mm, as against the upper trunk places behind the femoral vein and at once breaks up to small-sized veins in a skin of scrotum. It is necessary to note the fact, that the

Figure 4. Arteries of the pelvis of man: 1 – common trunk for inferior gluteal and internal pudendal arteries; 2 – inferior gluteal artery; 3 – internal pudendal artery



dextral external pudendal artery in its proximal 2/3 always has the main type of the constitution, in too time as the left external pudendal artery in 12,5% of cases has loose the type, when after waste from femoral artery it is divided into small-sized branches going to penis, to scrotum, to skin of the femur and the forward abdominal wall.

The internal pudendal artery is the main source of the blood supply of the penis of a man [12,13]. It moves from the forward trunk of the internal iliac artery independently in 50% of cases. In other cases it either moves from this artery by one trunk (Fig. 4) with lower gluteal (36%), common trunk with the upper and lower gluteal arteries (4%), or with upper gluteal (8%), or with obturator artery (2%). The internal pudendal artery with average diameter of  $3.6 \pm 0.02$  mm leaves the cavity of a small basin through the infrapiriform opening. Then bends the ischial spine and through the small sciatic foramen catches in the cavity of ischiorectal fossa. According our data, the internal pudendal vessels and the accompanying nerve are situated on the lateral wall of the ischiorectal fossa. In this place, they are concluded in special fascial shell formative pudendal channel. The fascial shell accretes with the bottom of the obturator fascia. Being spread upwards, it accretes with the lower fascia of the pelvic diaphragm and, being spread downwards, passes on the falcate process of ischio-tuberal ligament. In 100% of cases, the internal pudendal artery has a turnpike – a free type of constitution. The overall length makes it from infrapiriform opening before branching  $94.3 \pm 0.03$  mm. Back or ischiorectal

department of the internal pudendal artery with the average diameter of  $3.3 \pm 0.03$  mm deposits on depth from the top of the tuber of the ischium  $66.4 \pm 0.02$  mm. The forward or the genitourinary department of the internal pudendal artery on caliber is a little bit less 2.8 (0.01 mm) places on depth  $63.2 \pm 0.04$  mm from the top of the tuber of the ischium. The lower rectal artery with the average diameter of  $1.58 \pm 0.02$  mm and the length of  $37.8 \pm 0.03$  mm starts from the internal pudendal artery at a level of ischial tuber. The artery of the perineum with the average diameter of  $1.2 \pm 0.01$  mm and the length of  $1.7 \pm 0.02$  mm removes a little bit below. After deriving the artery of the perineum the internal pudendal artery has a title of artery of penis; it is posed in horizontal plane between pelvic and back department of the genitourinary diaphragm, then at a level of the bulb of the penis, perforate the genitourinary diaphragm is returned by two branches: bulbar and urethral arteries. The bulbar arteries with the average diameter of  $1.6 \pm 0.02$  mm enter the bulb of the penis. Here they return reflexive branches, blood supply the given department of the penis, and, gradually made by thin, follow forward in spongy body and in mean third they are bound with branches of urethral arteries. Urethral artery with the average diameter of  $1.73 \pm 0.03$  mm removes from artery of the penis 0.5cm distal from bulb. They in pour into spongy body at the place of connection it with the cavernous bodies and pass through the spongy body in longitudinal direction, returning on the stretch short branches in its material, and it's bound with branches dorsal arteries of the penis.



The arteries of the penis with the average diameter of  $2.3 \pm 0.03$  mm after about passage of it bulbar and urethral arteries under pubic symphysis are divided into the final branches: deep and dorsal arteries of the penis. The dorsal artery with the average diameter of  $1.9 \pm 0.02$  mm takes the lateral position on the inferior surface of the deep transversal muscle of the perineum. The initial department of the dorsal artery of the penis is covered with the lower fascia of the genitourinary diaphragm. For forward boundary of the genitourinary triangle artery is covered with a tendon of ischiocavernosus muscle, which in place of transition of the artery on the dorsum penis is fixed strongly by vessel to the inferior surface of the pubic bone and to the ligament, executing the pubic corner. Dextral and left dorsal arteries are located under deep fascia of the penis on the dorsum of penis. At the initial department of the organ the arteries run parallel to the dorsal vein and lateral from them place dorsal nerves. In forward third of body of penis dorsal arteries displace on inferiolateral surface of cavernous bodies, i.e. dorsal nerves will lie here from the medial party. In a place of decussating, the dorsal artery places superficially from dorsal nerve. From dorsal arteries 5-6 pairs of the circumflex arteries with the average diameter of  $1.1 \pm 0.03$  mm starts. They sequentially go out cavernous bodies of the penis and on lower – lateral area they perforate dense white. In more thickly cavernous tissue they are bound with branches of the deep arteries of the organ. Besides it is necessary to note, that up to perforation of white dorsal arteries anastomose also with urethral arteries. Both dorsal arteries, having entered in the head of the penis, decrease in diameter and, incorporating among themselves and final bifurcations of the deep and urethral arteries, will derivate extensive anastomosis, from which in various directions miss are numerous divided branches. Incorporating among themselves for the type of arcade, they will derivate a peculiar arterial framework. The deep arteries with the average diameter of  $1.83 \pm 0.02$  mm enter penis in the field of the medial surfaces of its pinches. In cavernous body the deep artery goes in longitudinal direction, taking position is closer to the dividing wall. On all stretch from it the numerous cochlear arteries move, which quantity gradually decreases in the direction of the head. In distal and mean third of the organ, the deep arteries well to are bound among themselves. In same area arteriolo-venular shunts between branches of the deep artery and dorsal vein of the penis exist. The main trunk of the deep artery, as a rule, in a mean third has sphincters, which represent the thickening of muscular coat of wall of the artery.

In findings of investigation is established, that the venous outflow from the penis is realizes on three veins: the superficial dorsal, the deep dorsal and the spongy vein. The arterial blood supply of the penis take place at the expense of external pudendal arteries, bulbar, urethral, dorsal and deep arteries of the penis. The head of the penis represents the system of the anastomosis between urethral, dorsal and deep arteries of the organ. The constitution of the circulatory channel of the penis has a number of features, which must be taken into account to realize the surgical correction of the erectile vascular impotency.

## Discussion

The given research is dedicated to analysis of variant anatomy of the vascular channel of the penis.

Our research demonstrates, that though the intraorgan arterial channel of the penis is partitioned on different departments having its own morphological features, functionally it is the unified system, as all intraorgan arteries are wide anastomoses among themselves. Apart from numerous anastomoses, between same name arteries of both sides the following constant intersystem anastomoses connecting different arteries are present:

- 1) Arterial arch of the head of the penis, where dorsal, deep and urethral arteries of both sides anastomose;
- 2) Arterial plexus of the urethral sulcus, in formation which the branches of the dorsal, deep and urethral arteries participate;
- 3) Anastomosis between dorsal and deep arteries in the tissues of the cavernous bodies itself.

Therefore confirmations of some researchers that “urethral arteries vascularise only bulbus of the penis [14], or that the dorsal arteries vascularise head of the organ [11], or that the main source of influx of the arterial blood in cavernous bodies are the deep arteries” [10] are not absolutely precise. According our data, all three arteries (dorsal, deep and urethral) almost equally participate in the blood supply of the penis. The dorsal arteries as well as deep execute of influx of the blood in cavernous bodies through the spiral arteries, which are vessels of the muscle-elastic type, i.e. with high functional activity. The presence of a longitudinal layer of muscle cells situated between the endothelium and an internal elastic membrane, is that apparatus, with the help of which the lumen of the spiral arteries change. The spiral course of longitudinal muscle cells results that in torsion, to elongate of all system, changes diameter of the lumen and regulates the blood stream. Thus, for valuable influx of the blood in cavernous bodies two pair of arteries should operate.

During research of the venous system of the penis series of features have found which either are not described in the literature, or it is required refinements. The division of the deep dorsal vein on two trunks has direct practical value. As a rule, the surgeon dresses or resects the trunk of the deep dorsal vein, which places in an intercavernous sulcus between dorsal arteries and nerves. If there are two trunks, one of them lies between dorsal arteries, and another places externally from these vessels and during operation is not affected by the surgeon that, apparently, has an effect of correction of the venous outflow.

Divergences with literary data are available also in the attitude of sources, number and basic dislocation of the circumflex veins. The some authors [15] consider that in norm there are two-three pairs of the circumflex veins locating only in distal one third of the penis, and consider as the sign of infringement of the venous hemodynamics their greater number and their other localization. On data of our investigation, it was seen more often four or five pairs of the circumflex veins drain in deep dorsal vein (but not in superficial dorsal vein, as affirm some authors [16]), and on the right them is localized a little bit more, than at the left.

We have found the circumflex vein, which drained the blood from the distal parts of cavernous bodies, and ran into deep dorsal vein behind its valve. Description of this vein in the accessible literature we have not met. The ignorance by the surgeon of this fact can have an effect on results of surgical treatment of the erectile dysfunction of the venous genesis at the ligation or resection of the deep dorsal vein.

As it was mentioned above, we affirm, that the deep vein of the penis misses: venous outflow from a most part of organ is carried out by the deep dorsal vein, and the proximal parts of cavernous bodies are drained at the expense of veins of the crura of the penis. But Hodos AB (1963) described the deep vein as the unpaired vessel, which passes from the head up to the root on the dorsal surface of the spongiform body in the urethral sulcus. On a transit the vein forms sine dilatations, from which circumflex veins originate. Series of other authors [16,17] guess, that the blood from the central part of cavernous bodies flows off in the deep vein through short postcavernous veins collecting blood from cavernous spaces and from venules, posed inside of cavernous tissue. The direct outflow of the blood was postulated on the basis of "locked valves" in deep veins in mammals, having osteal basis in the penis and found in experiment. But in cavernous bodies of the penis of the man there is no such structure. Exponential is that documentary any author does not confirm presence of the deep vein of the penis. Therefore should be logical, radiating from function of the penis, that the reinforced inflow is important first of all, at the expense of which penis acquires an erection, and the retarded outflow from cavernous bodies. For this reason, deep dorsal vein is accompanied with two dorsal arteries, but not opposite.

The venous channel of the penis cannot be surveyed as separately taken veins, as it represents a uniform extensive complex of anastomoses. For example, assertion that the spongiform veins realize outflow from the same (spongiform) bodies is a little bit untrue, as due to their anastomosis with circumflex veins, they can be main structures in the drainage of the blood from cavernous bodies. The similar situation is with superficial dorsal veins, which are in most cases connected by means of intervenous anastomosis with deep dorsal vein.

## Conclusions

In conclusion, during of investigation it was fixed, that the venous outflow from the penis is carried out on three veins:

superficial dorsal, deep dorsal and spongiform veins. The external pudendal, bulbar, urethral, dorsal and deep arteries of the penis take part in arterial blood supply of this organ. The head of the penis represents system of anastomoses between urethral, dorsal and deep arteries. The structure of the circulatory channel of the penis has series of features, which are necessary for taking into account at performing of surgical correction at an erectile vascular dysfunction.

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