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Anatomy of the visceral branches of the iliac arteries in newborns

Abstract

The arising of the branches of the internal iliac artery is very variable and exceeds in this feature the arterial system of any other area of the human body. In the literature, there is enough information about the anatomy of the branches of the iliac arteries in adults, but only a few research studies on children's material. The material of our investigation was 23 cadavers of newborns without pathology of vascular system. Significant variability of iliac arteries of newborns was established; the presence of asymmetry in their structure was shown. The dependence of the anatomy of the iliac arteries of newborns on the sex was revealed. Compared with adults, the iliac arteries of newborns and children have different structure, which should be taken into account during surgical operations.

Keywords: variant anatomy, arteries of the pelvis, sex differences, correlation, newborn

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Introduction

Diseases of the cardiovascular system are one of the leading problems of modern medicine. Prevention and treatment of diseases of blood vessels is the focus of many research institutes.[1] The increase in the number of diseases of blood vessels necessitates the use of direct surgery. Interventions on the arteries are widely carried out for diagnostic and therapeutic purposes, when radiopaque or drugs are injected into the vascular bed.[2]

It is known, the arterial bed of the pelvis of newborns undergoes changes due to its restructuring after birth and the transition from placental to the pulmonary blood circulation. Studying of the anatomy of newborns is very difficult due to lack of material. Therefore, the investigation the age anatomy of human body is relevant.[3]

The arising of the branches of the internal iliac artery is very variable and exceeds in this feature the arterial system of any other area of the human body.[4] All branches of the internal iliac artery are divided into three types: 1) parietal; 2) visceral; 3) mixed. Parietal branches are iliolumbar, lateral sacral, superior gluteal, inferior gluteal, and obturator arteries. To visceral branches belongs the middle rectal, superior vesical, inferior vesical, uterine – in females, artery of deferent duct in males.[5]

The internal pudendal artery is a branch of a mixed type, since it supplies approximately equally both the walls and the internal organs of the pelvis. It was found that with the growth of the body there is a change in the level and position of the branches of the internal iliac artery.[4,6]

Internal iliac artery is the main source for blood supply to the pelvic organs, gluteal muscles, and perineum. There is an important and increased potential of anatomic variations for the internal iliac artery, especially for the end branches, so the pelvic surgeon should be careful during the dissection of this area. In the literature, there is enough information about the anatomy of the branches of the iliac arteries in adults, but only a few research studies on children's material. The aim of the study is to study the variability of the visceral branches of the iliac arteries in newborns.

Materials and methods

The material of investigation was 23 cadavers of newborns without pathology of vascular system, which were in anatomical educational morgue. Two halves of each cadaver's pelvis was involved in research, so 46 specimens were used in total: 18 halves were taken from boy's cadavers (9 left and 9 right) and 27 ones from the girls cadavers (14 left and 13 right). After routine anatomical dissection, the length of the iliac artery branches was measured. With the help of binocular magnifier using the ruler eyepiece with a calibration of 0.1mm the diameter of the vessels was measured (in place of their arising).

"Statistica 10.0" (StatSoft Inc., USA) was used for statistical processing of the obtained data. The Spearman test was used to study the correlation between the morphometric parameters of the iliac arteries.

Results and discussion

Variant anatomy of the bifurcation of the abdominal aorta

In literature, the level of bifurcation of the aorta varies within two vertebrae – from the middle of the body of L3 to the middle of the body of L5.[7] The abdominal aorta is most often (50-78%) divides into two common iliac arteries at the level of the L4.[7,8] However, there are some data[8] indicating the most frequent (43.8%) location of aortic bifurcation at the level of the L3. In newborns and fetuses, the level of aortic bifurcation is located more often in the region of the 3rd lumbar vertebra.

Our study shows[9] a significant variability of the aortic bifurcation level also. Thus, the aorta was most often divided at the level of the middle of the body of L4 (in 33.3 %), a little less (24.4 %) – at the level of the lower edge of the body L4. In addition, the dependence of the level of aortic division on sex was found (Table 1).

As the Table 1 shows, in girls, the abdominal aorta more often is divided at the level of the lower edge of L4, while in boys at the level of the middle of the same vertebra. It was found that in newborn girls usually the angle of aorta bifurcation is in range of 60-80° (61%) while in boys in 50% the angle was in the range of 5° to 30°.

Variant anatomy of bifurcation of the common iliac artery

The common iliac artery in most of cases (68.0%) is bifurcated in to internal and external iliac arteries at the level of promontorium (Figure 1A). Variants of artery bifurcation at the level of the lower

edge of L5 (8%), the upper edge (8%) and the middle of S1 (8%), as well as at the level of the middle (2%) and upper edge of L5 (2%) were noted less often. The angle of bifurcation of the common iliac artery varies greatly – from 10° to 90°. In most of cases, this angle varies within 30°–60° (49.2%), in 31% it was in the range from 10° to 30°; in 19.8% the angle ranges from 60° to 90°.

Table 1 The dependence of the level of bifurcation of the abdominal aorta on the sex in %

Level of bifurcation	Boys	Girls	Total
Upper edge of L4	22,2	7,4	13,3
Middle of L4	38,9	22,6	33,3
Lower edge of L4	11,1	33,3	24,4
Upper edge of L5	16,6	7,4	11,1
Middle of L5	11,1	14,8	13,3
Lower edge of L5	–	7,4	4,4

Branches of the internal iliac artery

The internal iliac artery, being a direct continuation of the common iliac artery, goes down along the lateral wall of the lesser pelvis and at the level of the upper edge of the greater sciatic opening is divided into 2 branches, or trunks: anterior and posterior.[7] Some authors (Corning G. K., Tonkov V. N., 1949) divide branches of the iliac artery on the visceral and parietal. According to Anikina TI & Zernova DN[5] the iliac artery is divided into the superior gluteal artery, which gives the iliolumbar and lateral sacral arteries, and the anterior trunk, giving all other branches of the internal iliac artery. The majority of authors artificially allocate the proximal part of the upper gluteal artery as the posterior trunk of internal iliac artery, while the trunk, without changing its caliber, passes to the suprapiriform foramen. Almost all researchers say that the posterior trunk gives off only the parietal arteries, while the anterior one both parietal and visceral.[10] However, our study shows that the posterior trunk may give the visceral branches also.

The umbilical artery (a. umbilicalis) artery in newborns and foetuses is one of the largest arteries (diameter is 0.29±0.18cm) due to its important functional value, and it is a direct continuation of the internal iliac artery. It functions only in the foetus, and after birth is gradually obliterated and in adults it is a fibrous band that turns into a lateral umbilical ligament.

The length of a. umbilicalis varies from 0.35 to 4.05cm depending on the level of obliteration and the level of arising of the vesical arteries from it. The results of our research identified three variants of the origin of the umbilical artery. In 95%, it is a continuation of the internal iliac artery (Figure 1B), forming a blunt angle with it, in another 5% a. umbilicalis originates from the anterior and posterior trunks of the internal iliac artery.

Despite the great constancy of the umbilical artery, there are some sexual differences in its structure. Thus, in boys, the umbilical artery has always been a continuation of the internal iliac. In girls, 100% of this variant was observed only on the right side, while on the left only in 85.7%.

The superior vesical artery (a. vesicalis superior) as well as the umbilical artery, is not variable. Some authors[6] argue that in fetuses and newborns, the upper vesical arteries always depart only from the umbilical artery, which is a direct continuation of the internal iliac artery.

According to our study[11] the upper vesicular artery departs from the proximal part of the umbilical artery, and then, tightly adjacent to the lower edge of the obliterated umbilical artery, goes to the top of the bladder. Initially, several (5-6) arteries are laid in fetus. As a rule, parallel to the obliteration of umbilical artery after birth, 3-4 vesical arteries also obliterate, as a result of that in adult one or two superior cystic arteries remain.[4,6]

Except departing from the umbilical artery, a. vesicalis superior with a diameter of 0.10±0.02cm ($p<0.05$) and a length of 1.10±0.1cm in 2.2% of cases can start from the internal iliac artery and in 2.2% by common trunk with the uterine and with the lower vesical arteries (Figure 1C).

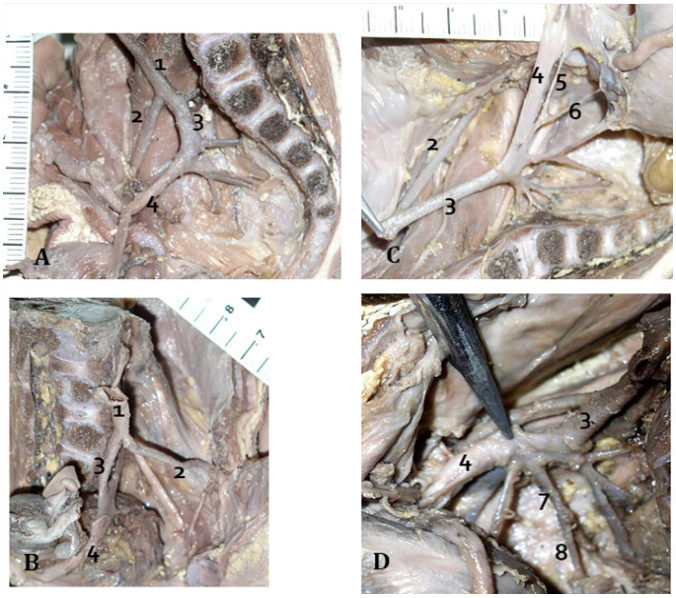

Figure 1 Arteries of the pelvis of the newborn.

1, Common iliac artery; 2, external iliac artery; 3, internal iliac artery; 4, umbilical artery; 5, superior vesical artery; 6, inferior vesical artery; 7, internal pudendal artery; 8, middle rectal artery

There is a clear positive relationship between the lengths of the upper and lower vesical arteries ($R=0.61$, $p<0.00001$). In addition, diameter a. vesicalis superior has a negative correlation with the diameter of the posterior trunk of the internal iliac artery ($R= -0.75$, $p<0.01$).

The inferior vesical artery (a. vesicalis inferior) together with the upper vesical artery are the main arterial trunks that supply the bladder. However, a. vesicalis inferior is more variable.[12] The majority of authors indicate that the inferior vesical artery in most of cases departs from the internal iliac artery and sometimes from the middle rectal, inferior gluteal or uterine artery.[4,6]

Our results differ from that. Thus, it was found that the lower vesical artery more often (64.4%) originates from the umbilical artery. Less often a. vesicalis inferior departs from the internal pudendal (28.9%). In some cases the lower vesical artery starts from the obturator artery (in 2.2%), from the inferior gluteal (in 2.2%) and by common trunk with the superior vesical artery (in 2.2%) (Figure 1C). A. vesicalis inferior with the diameter of 0.09±0.05cm, depending on the place of

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origin had a length of 0.35 to 2.28cm. The significant asymmetry and some sex differences in the inferior vesical artery were noted (Table 2).

So, the inferior vesical artery starts from the obturator and lower gluteal arteries only in boys on the left and departs by the common trunk with the uterine and superior vesical arteries only in girls on the left. In addition, the inferior vesical artery begins from the umbilical artery in boys more often on the right side, but in girls – on the left one.

Table 2 Asymmetry and sex differences of the inferior vesical artery variants in %

Origination	Boys			Girls			Left	Right
	Left	Right	Both	Left	Right	Both		
Umbilical artery	44,4	77,8	61,1	78,6	53,8	66,7	65,2	63,6
Obturator artery	11,1	–	5,5	–	–	–	4,3	–
Inferior gluteal artery	11,1	–	5,5	–	–	–	4,3	–
Internal pudendal artery	33,3	22,2	27,8	14,3	46,1	29,6	21,7	36,4
By the common trunk with uterine and superior vesical artery	–	–	–	7,1	–	3,7	4,3	–

The middle rectal artery (a. rectalis media) is very variable.[13] Blood supply to the intestinal tube has the great practical importance, since the conditions of its vascularization determine the outcome of surgical interventions on this organ.[14] Understandable hence interest to this issue is reflected in a number of studies.[13] However, it is not well investigated especially blood supply to the rectum of newborn.[4,13] It started from an internal pudendal artery in 42.2%, from the internal iliac artery in 17.8%, from the common trunk for internal pudental and inferior gluteal arteries in 17.8 %, from inferior gluteal artery in 11.1%. In our study, the middle rectal artery was absent in 27.5 %, and according to the literature this vessel is absent from 1%[13] to 88%.[6]

The sex differences of a. rectalis media were established. The a. rectalis media departs from the internal iliac artery in 5 times more often in girls (25.5%) than in boys (5.5%), but it starts from the internal pudendal genital artery in 2 times less in girls (37.1%) (Figure 1D).

In addition, only in girls the middle rectal artery began from the uterine artery and by the common trunk with the lower gluteal and internal pudendal arteries. The beginning of the artery by a common trunk with the lower and upper gluteal, obturator and internal pudendal arteries, as well as from the angle between the internal iliac and umbilical arteries was found only in boys.

The described artery resembled one of the lateral branches of the upper rectal artery in its diameter in 25 %. This is especially characteristic for the newborns and children of the first years of life.[1,13]

The middle rectal artery with a diameter of 0.08±0.03cm ($p<0.02$), depending on the place of originating, has a length of 0.35 to 2.28cm. The left middle rectal artery is longer in boys, but in girls, the right one is longer. The internal pudendal artery (a. pudenda interna) is in an intermediate position between the parietal and visceral branches of the internal iliac artery.

Number of authors (Hodos A. B., 1963) consider the internal iliac is the most frequent variant of the beginning of internal pudendal artery (70.6 %). According to other data,[4] it in most cases (43-62%) originates by the common trunk with the lower gluteal artery.

According to our study, a. pudenda interna with a length of 1.08±0.35cm and a diameter 0.11 0.06cm ($p<0.02$), in most of cases (55.6%) begins by the common trunk with the inferior gluteal artery (Figure 2A).

The internal genital artery begins from the internal iliac artery in three times less. In single cases a. pudenda interna originates from the anterior trunk of a. iliaca interna, from the umbilical artery, by the common trunk with the inferior gluteal and middle rectal artery; by the common trunk with the obturator, lower and upper gluteal arteries; by the common trunk with the uterine artery; by the common trunk with the middle rectal, obturator, upper and lower gluteal arteries; by the common trunk with the upper and lower gluteal arteries, as well as from the angle between the umbilical and internal iliac arteries (Figure 2B).

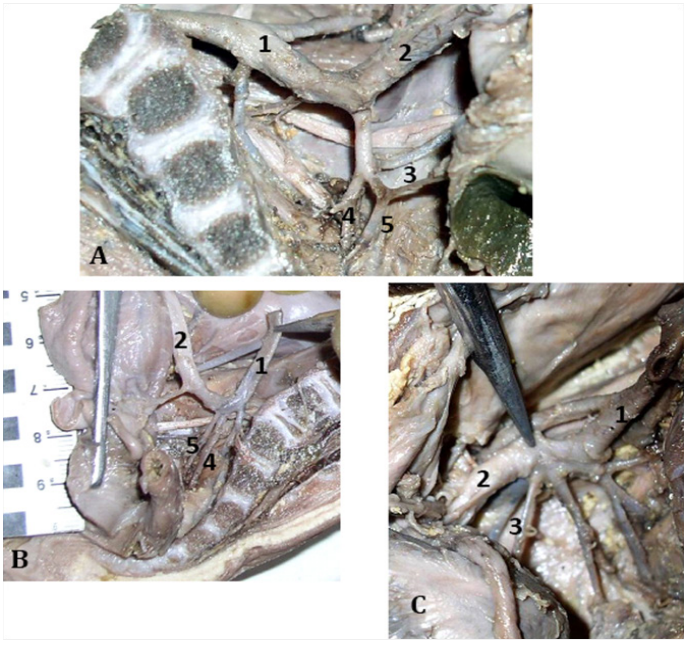

Figure 2 Arteries of the pelvis of the newborn.

1, internal iliac artery; 2, umbilical artery; 3, uterine artery; 4, inferior gluteal artery; 5, internal pudendal artery

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Internal pudendal artery is characterized by significant asymmetry. It departed from the umbilical artery, by the common trunk with the uterine artery, by the common trunk with the lower and upper gluteal arteries only on the left. Only on the right, the internal pudendal artery begins with the common trunk with the lower gluteal and middle rectal arteries. A. pudenda interna departs from the internal iliac artery more often on the right side (27.3%) than on the left one (8.7%).

We have established sexual differences in the variants of the internal pudendal artery. This artery departed by the common trunk with the lower gluteal artery more often (66.7%) in boys, than in girls (48.1%). At the same time, the beginning of the internal pudendal artery from the anterior trunk of the internal iliac artery, by the common trunk with the lower gluteal and middle rectal arteries, as well as from the angle between the internal iliac and umbilical arteries was found only in girls.

A characteristic feature of the uterine artery (a. uterina) is that in the intrauterine period it originates from the umbilical artery, whereas after birth (due to the termination of embryonic blood circulation) its place of origin moves from the umbilical artery to the internal iliac artery.[4] Thus, a number of authors[15] note that in all fetuses the uterine artery departed from the umbilical artery. According to other researchers[16] the beginning of the uterine artery gradually shifts from the umbilical to the internal iliac artery.

We found that the uterine artery with a diameter of 0.10±0.03cm and a length of 0.50 to 2.30cm, most often (42.8%) begins from the internal iliac artery. Twice rarely (25.0%) it departs from the angle between the umbilical and internal iliac arteries (Figure 2C). Uterine artery starts from the internal pudendal artery (in 11%) (Figure 2A), from the anterior trunk of the internal iliac (11%) and from the common trunk for the internal pudendal and inferior gluteal arteries.

Uterine artery in newborns is also characterized by significant asymmetry (Table 3). Description of the artery of the ductus deferens (a. ductus deferentis) in the literature is very diverse. So, Dolgo-Saburov B.A. (1946) described this artery as a branch of the internal iliac artery. I. E. Fraser (1937) noted that the artery of the ductus deferens can depart from any branch of the iliac artery. According to some researches, the artery in 68 % begins from the anterior trunk of the internal iliac artery, in 5% – from the upper vesical artery.[17]

Table 3 The asymmetry of variants of origin of uterine artery newborns in %

Origination	Side	
	Left	Right
Anterior trunk of internal iliac	7,1	14,3
Internal iliac	35,7	50,0
Internal pudendal	14,3	7,1
Common trunk for internal pudendal and inferior gluteal	7,1	14,3
Angle between umbilical and internal iliac	35,7	14,3

Our study shows the only two variants of the arising of the artery of ductus deferens were revealed: in 95 % a. ductus deferentis with a diameter of 0.09±0.04cm and a length of 0.98±0.20cm was takes origin from the umbilical artery and in 5% from the inferior vesical artery. Moreover, on the left the artery in 100 % departed from the umbilical artery, while on the right only in 89%.

Conclusion

In the early stages of postnatal ontogenesis due to the cessation of placental blood circulation there is a restructuring of the arterial bed of the human pelvis. In newborns, the pelvic arteries begin in the area of the angle formed by the internal iliac and umbilical arteries. In adults, trunks (anterior and/or posterior, sometimes middle) are formed. They give rise to the pelvic arteries (this variant can be seen in 88%). In other 12% the infantile type of the structure of the branches of the internal iliac artery is preserved.

It is necessary to note the significant variability of the visceral branches of iliac arteries. The inferior gluteal artery is the most variable, while the artery of ductus deferens and the umbilical artery are less variable.

The largest branch of internal iliac artery in newborns is umbilical artery because of its physiological importance.

The study revealed a significant asymmetry of the arteries of the pelvis of newborns, which is extremely important for pediatrics, because in the literature this aspect is practically not described. The uterine, middle rectal and inferior vesical arteries are the most asymmetric. The branches of the left iliac artery are more variable than the right one. Sexual differences in the structure of the branches of the iliac arteries of newborns were established. In girls, the pelvic arteries are more variable than in boys.

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None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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