

PERINATAL ANATOMY OF THE SIGMOIDORECTAL SEGMENT

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ПЕРИНАТАЛЬНА АНАТОМІЯ СИГМОРЕКТАЛЬНОГО СЕГМЕНТА

Резюме. За допомогою анатомічного дослідження 79 препаратів плодів і новонароджених людини та ультразвукового дослідження 32 дітей визначені типові макромікроскопічні ознаки сигмокретального сегмента, варіантна анатомія сигмоподібної ободової кишки, хронологічна послідовність становлення топографоанатомічних взаємовідношень сигмокретального сегмента із суміжними органами і структурами живота в перинатальному періоді, його ультрасонографічні параметри у новонароджених та грудних дітей.

Ключові слова: сигмокретальний сегмент, перинатальний період, анатомія, ультрасонографія.

One of causes of the causes of perinatal and early neonatal mortality is congenital malformations, whose incidence makes up 20.3 per 1000 of newborns. Congenital malformations, requiring surgical correction, are detected in 3% of the newborns. The death rate from congenital malformations of the internal organs occupies the 3d place in the overall pattern of children's mortality during the first year of life. For the purpose of detecting congenital pathology in the perinatal period screening examinations are performed widely whose results influence the process of planning the termination of pregnancy. An adequate performance of sonographic studies, the performance of surgical operations on the fetal organs in the mother's womb, an interpretation of the results of modern diagnostic maneuvers and embryotomies are based on objective anatomical findings [1, 2].

A study of the topographoanatomical characteristics and organometric parameters of the sigmoidorectal segments in the perinatal period has a ponderable significance for an anatomical substantiation of new diagnostic-medical measures. The objective data about individual anatomic variability of the components of the sigmoidorectal segments will be conducive to identifying the mechanisms of the origin of congenital defects of the terminal portion of the gastrointestinal tract. However, its structure and interrelations with the adjacent organs and structures in the dynamics of the

perinatal period are dealt with fragmentarily and unsystematically.

The object of the research: to determine the macroscopic characteristics of the structure and the chronological order of the forming of topographo-anatomical interrelations of the sigmoidorectal segments in the perinatal period of human ontogenesis.

Material and methods. The research was carried out on 79 specimens of human fetuses and newborns without the external signs of anatomical deviations of anomalies within the framework of elective dissections and complying with the ethical and legislative norms [3]. The division of the material into age-specific groups was carried out in compliance with the "Instructions of determining the criteria of the perinatal period, live birth and natimortality" (the order of Ukraine's MHP of 29.03.06 № 179). The age of the subject of inquiry was determined on the basis of measurements of the parietocalcaneal length according to the tables of Б.М.Пэттен [4], Б.П.Хватов, Ю.Н.Шановалов [5].

We determined the form and location of the sigmoid colon, the macroscopic signs of the sigmoid colon and rectum [6, 7]. The diameter of the abdominal portion of the rectum was measured 1.0 cm more distally of the sigmoidorectal junction, the diameter of the sigmoidorectal junction – at the level of the narrowest portion between the sigmoid colon and the rectum, the diameter of the distal

portion of the sigmoid colon – by 1.0 cm more proximally from the sigmoidorectal junction. The length of the sigmoid colon was measured along the mesocolic band. Fragments of the alimentary tract with the adjacent structure were excised 1.0-1.5 cm more proximally and distally of the sigmoidorectal junction. Specimen desiccation was accomplished via their passage through a battery of spirits. Histological sections, 10 mm in length were prepared from paraffin blocks by means of a sledge microtome. Upon staining and fixing the specimens in the Canada balsam they were examined with a microscope.

An injection of the vessels was performed with the help of a radio-opaque mixture on the base of read lead. Skeletopy was studied by means of roentgenography. In order to detect desmin in the wall of the sigmoidorectal segment the immunohistochemical reaction (En Vision + System Peroxidase (DAB) with monoclonal antibodies to Desmin (of the "DAKO" company, Germany) was used.

We have carried out a screening-ultrasound examination of the sigmoidorectal segment in 16 full-term newborns and 16 infants of both sexes (equally) without pathology of the digestive organs within the framework of a routine examination. The study was carried out together with Associate Professor Л.В.Шуруп on the "Toshiba SSA-SSOA" by means of the PSM50AT3MH transducer on the base of Chernivtsi Regional Clinical Hospital № 1.

A statistical analysis of the morphometric and sonographic findings was performed by means of the MS Office-Excel software, using parametric and nonparametric methods.

The results of the investigation and their analysis. During the second trimester of the intra-uterine development the form of the colon is distinguished by the highest individual variability. We have detected C-, U-, Ω-like colons, in the form of an inverted letter V, a hook-like, spiral-like and zigzag-like forms. The C- and U-shaped form of the sigmoid colon is inherent to the majority of fetuses (26,6%). Fetuses with the dolichomorphic type of the constitution are characterized by a short sigmoid colon of the C-shaped form, whereas the brachymorphic type – a long sigmoid colon of the spiral-shaped form.

In the dynamics of the 3^d trimester the form of the sigmoid colon changes. Specimens with the spiral-like (38,8%) and zigzag-like (25,8%) forms of the sigmoid colon are more common, however, no Ω-shaped form and that of an inverted letter V

have been revealed. The variability of the anatomical forms of the sigmoid colon is due to an uneven development of the portions of the colon and the type of the stature [8]. The dolichomorphic type is characterized by a short sigmoid colon of the C- and U-shaped forms, whereas the brachymorphic one – by a long sigmoid colon of the spiral-like and zigzag-like form.

The sigmoid colon more often has a spiral-like form (77,8 %), less seldom (22,2 %) – a zigzag-like form in newborns. Neonates with the brachymorphic type of the stature are characterized by a long sigmoid colon of the spiral-shaped and zigzag-like forms, while a short one is typical of the dolichomorphic type.

A skeletopic projection of the sigmoidorectal junction in the 2nd trimester shifts from the middle of the body of the IVth lumbar vertebra to the middle of the body of the sacral vertebra. In the majority of fetuses (53 %) the projection of the sigmoidorectal junction was identified at the level of the body of the Vth lumbar vertebra. In 50 % of the cases the sigmoidorectal junction is identified to the right from the median plane. Skeletopically the projection of the sigmoidorectal junction was identified between the inferior margin of the body of the Vth lumbar vertebra and the promontorium ossis sacri in the majority (74,2 %) of the fetuses of the 3^d trimester. The skeletopic projection of the sigmoidorectal junction becomes formed more often (66,7 %) in newborns between the inferior margin of the body of the 1st sacral vertebra and the superior margin of the IInd sacral vertebra.

The organometric indices of the components of the sigmoidorectal segment in the 2nd trimester are indicative of an insignificant prevalence of the diameter of the abdominal portion over the distal one of the sigmoid colon (Table 1). The diameter of the sigmoidorectal junction strongly ($r=0,69$; $p<0,001$) correlates with the diameter of the distal portion of the sigmoid colon in fetuses of both sexes. The length of the sigmoid colon, the diameter of its distal portion and the diameter of the abdominal part of the rectum increase with the development of fetuses.

In the 3^d trimester the organometric data of the sigmoidorectal segment are indicative of the prevalence of the diameters of the abdominal portion of the rectum and the distal portion of the sigmoid colon over the diameter of the sigmoidorectal junction (Table 2). The diameter of the sigmoidorectal

junction strongly ($r=0,9$; $p<0,001$) correlates with the diameter of the abdominal portion of the rectum.

The diameter of the sigmoidorectal junction is lesser than the diameter of the adjacent portions of the colon in newborns (Table 3). A strong dependence between the diameter of the sigmoidorectal junction and the age of the subjects of the research, the length of the sigmoid colon, the diameter of the distal portion of the sigmoid colon and the diameter of the abdominal portion of the rectum has been detected. It should be noted that the most significant correlation ($r=0,8$; $p<0,001$) is observed between the diameter of the sigmoidorectal junction and the length of the sigmoid colon. It is demonstrative that an accelerated growth of the sigmoid colon in length and an increase of the diameters of the components of the sigmoidorectal segment occur in the 3^d trimester of the intrauterine development.

The specific characteristics of the blood supply of the sigmoidorectal segment during the perinatal period are worth taking into account in colorectal surgery in terms of miniinvasive surgical technologies [9]. In the process of resecting the sigmoid colon the preservation of anastomosis bet-

ween the last sigmoid and the superior rectal arteries may become a determinant of a favourable course of the postoperative period. In case of the absence of an adequate blood supply postoperative ischemic colitis ischemic structures may develop [10]. It has been established by us that the sigmoidorectal segment in fetuses is supplied by the last sigmoid and the superior rectal arteries. A marked anastomotic branch between them is clearly defined in the neonatal period.

A narrowing of the intestinal tube at the point of the transition of the sigmoid colon into the rectum; the absence of haustra and epiploic appendages within the limits of the sigmoidorectal segment; a continuation of the teniae of the sigmoid colon into a continuous longitudinal muscular layer of the rectum; the presence of the semilunar fold of the mucous tunic located transversely to the axis of the colon, are worth considering to be the basic macroscopic and microscopic signs of the sigmoidorectal segment during the perinatal period [6, 7]. The specific characteristic of the myo- and angioarchitectonics of the distal portions of the large intestine are worth considering to be the absolute signs of the anatomic border between the sigmoid colon and

Table 1

Organometric indices of the sigmoidorectal segment in fetuses of the second trimester (n=30)

The length of the sigmoid colon (mm)	The diameter of the distal portion of the sigmoid colon (mm)	The diameter of the sigmoidorectal junction (mm)	The diameter of the abdominal part of the rectum (mm)
28,32±1,50 ($p\leq 0,05$)	4,47±0,22 ($p\leq 0,05$)	3,68±0,15 ($p\leq 0,05$)	4,63±0,19 ($p\leq 0,05$)

Table 2

Organometric indices of the sigmoidorectal segment in fetuses of the third trimester (n=31)

The length of the sigmoid colon (mm)	The diameter of the distal portion of the sigmoid colon (mm)	The diameter of the sigmoidorectal junction (mm)	The diameter of the abdominal part of the rectum (mm)
56,95±2,32 ($p\leq 0,05$)	6,05±0,22 ($p\leq 0,05$)	5,65±0,33 ($p\leq 0,05$)	7,75±0,26 ($p\leq 0,05$)

Table 3

Organometric indices of the sigmoidorectal segment in newborns (n=18)

The length of the sigmoid colon (mm)	The diameter of the distal portion of the sigmoid colon (mm)	The diameter of the sigmoidorectal junction (mm)	The diameter of the abdominal part of the rectum (mm)
104,88±3,64 ($p\leq 0,05$)	11,52±0,4 ($p\leq 0,05$)	9,5±0,33 ($p\leq 0,05$)	13,9±0,41 ($p\leq 0,05$)

the rectum [11]. Our findings about the anatomical borders of the sigmoidorectal segment corroborate the results of the research by A.Shafic et al. [12].

A decrease of the thickness of the mucous coat of the sigmoidorectal junction and an increase of the thickness of its muscular tunic occur in the dynamics of the 2nd trimester (Fig. 1). Rich vascularization is typical of the submucous and serous membranes of the sigmoidorectal junction. The presence of a papilla-like haustrum of the colic wall into the lumen of the sigmoidorectal junction attracts attention.

Histologically, the thickness of the mucous coat is larger in 7-month old fetuses as compared with fetuses aged 8-9 months. The blood vessels form plexuses in the submucous layer of the sigmoidorectal junction. According to the findings of D.W.Fawcett et al. [13] the submucous plexus bears a relation to a regulation of the local colic secretion, absorption and muscular contraction. A partial submersion of the loose connective tissue of

the submucous layer into the muscular tunic of the initial area of the abdominal portion of the rectum is observed.

The thickness of the muscular tunic of the sigmoidorectal segment in 7-month old fetuses makes up more than a half of the colic wall, but in the 8th-9th month of the development the mucous tunic is made very thin (Fig. 2). Groups of individual muscular fibers are partially demarcated by the strata of the loose fibrous tissue, the latter being indicative of the fact that an increase of the diameter of the colon outstrips the growth of the muscular tunic.

The goblet cells prevail within the cellular composition of crypts, their number in the direction of the rectum diminishes. The relief of the mucous coat of the rectum in newborns is formed only by shallow and scarce crypts.

The submucous layer of the distal portion of the sigmoid colon in newborns contains a great number of elastic fibers and an insignificant number of blood vessels. At the same time, the submu-

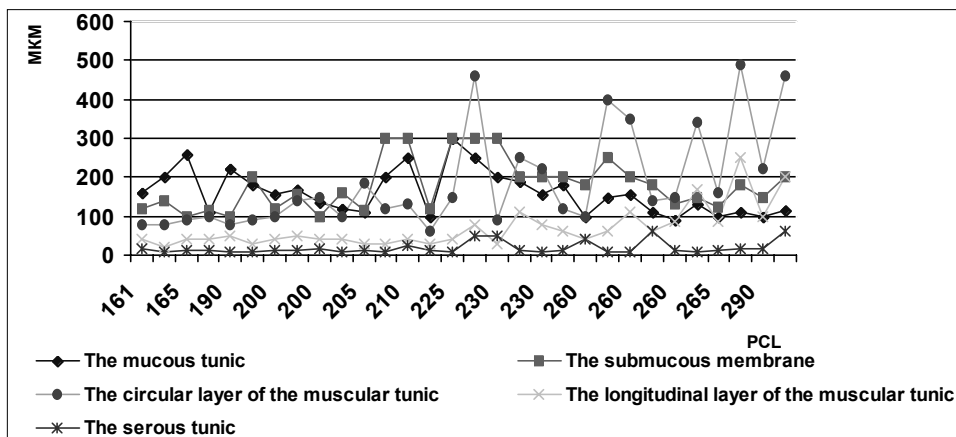


Fig. 1. The dynamics of a change of the membranes of the sigmoidorectal junction in fetuses of the second trimester.

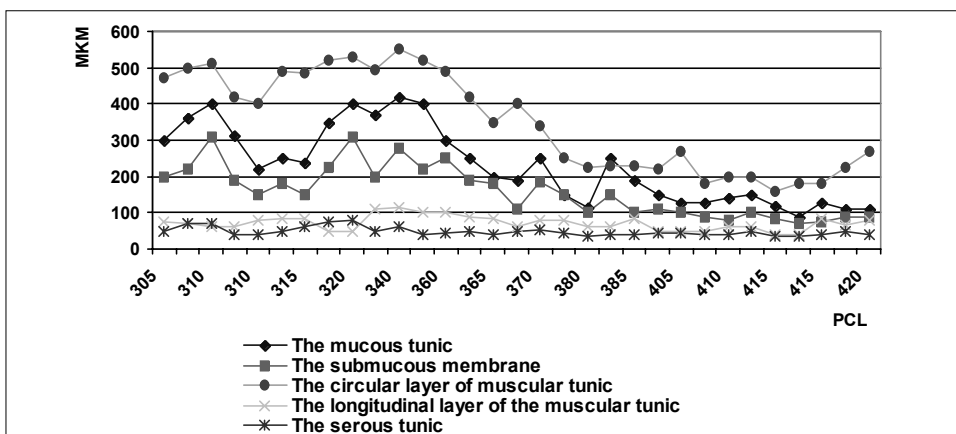


Fig. 2. The dynamics of a change of the membranes of the sigmoidorectal junction in fetuses of the third trimester.

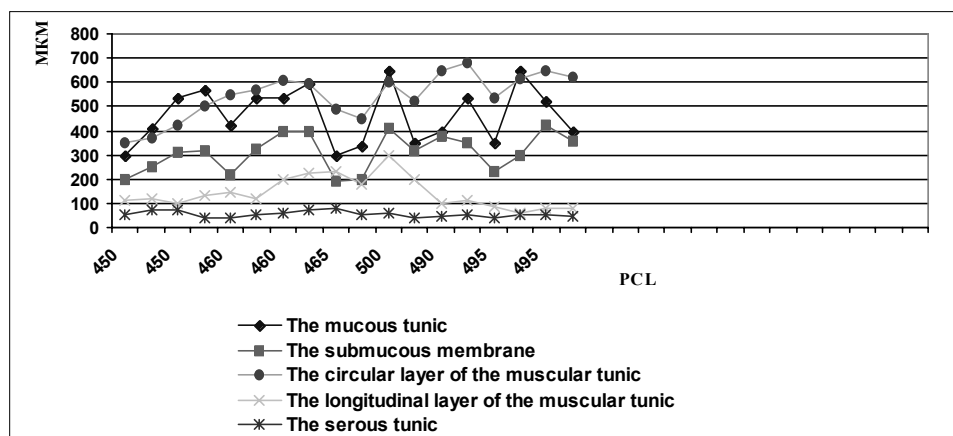


Fig. 3. The dynamics of a change of the membranes of the sigmoidorectal junction in newborns.

cous layer of the sigmoidorectal junction contains a great number of vascular plexuses. A small number of blood vessels is visualized in the submucous layer of the abdominal portion of the rectum.

A gradual magnification of the thickness of the circular muscular layer in the aboral direction is detected in case of a photooptical examination of the muscular tunic of the sigmoid colon. The muscular tunic of the sigmoidorectal junction in newborns acquires a sphincter-like structure. On the basis of the results of our own studies we share the opinion of A. Shafic et al. [12] about the presence of the anatomical sphincter within the limits of the sigmoidorectal junction since the moment of birth. It is formed by two layers of the smooth muscular tissue among which the strata of the loose connective tissue are visualized. The thickness of the circular layer of the muscular tunic considerably predominates over the thickness of the longitudinal one. The thickness of the circular layer of the muscular tunic gradually increases in the aboral direction, its considerable thickening is observed in the distal region of the sigmoidorectal segment where the muscular tunic along with the loose connective tissue of the mucous and submucous membranes invaginate into the colic lumen. The thickness of the muscular tunic of the sigmoidorectal segment in newborns exceeds the thickness of the mucous membrane (Fig. 3).

Thus, the microscopic structure of the wall of the sigmoidorectal segment is indicative of the formation of the sigmoidorectal sphincter: the mucous and submucous tunics of the sigmoidorectal junction invaginate into the colic lumen, the blood vessels form vascular plexuses in the tela submucosa of the sigmoidorectal junction. The thickness of

the circular layer of the mucous tunic of the sigmoidorectal segment gradually grows in the aboral direction and predominates over the thickness of the longitudinal one.

While performing the immunohistochemical reaction with antibodies to desmin, the reaction turned out to be negative, indicating that desmin is absent in the muscular tunic of the colic wall of the distal portion of the sigmoid colon of the rectum. The findings submitted refute the statement of Y. Watanabe et al. [14], N. Guaring et al. [15], to the effect that desmin is actively detected in the process of myogenesis.

The results of our studies point to the presence of O'Beirne-Pyrohov-Moutier's sphincter in the sigmoidorectal junction. Meanwhile, one can agree with Л.Л. Колесников [16] conclusion to the effect that sphincters are a broad transitional region, providing a dosed and regulated contraction, represented by the presphincter portion with an accumulating function, namely, the sphincter system proper and the postsphincter portion with the evacuating function. In the sigmoidorectal segment the presphincter part is the distal portion of the sigmoid colon, the sphincter system is represented by the sigmoidorectal junction, whereas the postsphincter part is the abdominal portion of the rectum.

As is generally known [17], an elaboration of specific echosymptoms of pathological conditions of hollow organs is based on the findings of normal ultrasound anatomy, whereas the basic trend of present day anatomical studies should be regarded a study of the age-related anatomical parameters [12]. The results of an ultrasonographic examination obtained by us in children of early age corroborate the presence of O'Beirne-Pyrohov-Moutier's

sphincter in the region of the sigmoidorectal junction. The latter is visualized with a vertical position of the probe, it has a form of a tubular hyperechogenic structure on a longitudinal section that is composed of the distal part of the sigmoid colon, the sigmoidorectal junction and the abdominal portion of the rectum. A colic haustrum is present in the lumen of the sigmoidorectal junction which is visualized at the level of the IInd-III^d sacral vertebrae. The sigmoidorectal junction during the phase of evacuation is narrower than the distal part of the sigmoid colon and the abdominal part of the rectum. The sphincter part of the sigmoidorectal segments is visualized in the form of a slightly echonegative semicircular structure. The parameters of the diameters of the distal portion of the sigmoid colon, the sigmoidorectal junction and the abdominal portion of the abdominal part of the rectum in girls are higher than in boys. We regard that the results obtained by us in normal ultrasound anatomy of the transitional region between the sigmoid colon and rectum are worth taking into account, when elaborating the typical echographic signs of congenital and acquired pathology of the distal portion of the large intestine in neonates and infants.

Conclusions. 1. The sigmoidorectal segment in the perinatal period of ontogenesis is characterized by such macromicroscopic signs: a narrowing the colic tube and the absence of the epiploic appendages in the transitional region between the sigmoid colon and the rectum, the formation of a solid muscular layer of the colic wall out of three muscular teniae, the presence of the rectosigmoid angle, the muscular constrictor of O'Beirne-Pyrohov-Moutier and the transverse semicircular fold of the mucons coat. 2. The form of the sigmoid colon is distinguished by a marked individual anatomic variability; in the dynamics of the perina-

tal period the frequency of the spiral-like form of the sigmoid colon increases from 6,6% in the 2nd trimester to 77,8% in newborns, the frequency of the C – shaped form decreases from 26,6% in the 2nd trimester to 6,5% in the 3rd trimester. 3. In the 2nd trimester the diameters of the sigmoidorectal junction strongly correlates ($r=0,69$) with the diameter of the distal portion of the sigmoid colon; the most significant correlation ($r=0,9$, $p<0,001$) is between the diameter of the sigmoidorectal junction and the diameter of the abdominal part of the rectum is observed in fetuses of the 3^d trimester, between the diameter of the sigmoidorectal junction and the length of the sigmoid colon ($r=0,8$, $p<0,001$) – in newborns; the diameter of the sigmoidorectal junction increases 2.6 times and makes up 9.5 ± 0.33 mm ($p<0.05$) in newborns. 4. The submucous vascular interlacement, the greatest thickness of the circular layer of the muscular tunic (348 ± 24.89 mm, $p<0.05$ – in fetuses, 546.5 ± 24.9 mm, $p<0.05$ – in newborns) and the greatest number of blood vessels in the serous tunic is identified in the colonic wall at the of the rectosigmoidal angle. 5. The sceletopic projection of the sigmoidorectal junction in the dynamics of the perinatal period shifts caudally – from the middle of the body at the Vth lumbar vertebra in fetuses of the second trimester (63.3%) to the middle of the body of the IInd sacral vertebra in newborns (66.7%). 6. According to the findings of an ultrasonographic examination the transitional region between the sigmoid colon and rectum has the form of a hyperechogenic tubular structure on longitudinal sections; the diameter of the sigmoidorectal junction in newborns makes up 1.38 ± 0.03 cm ($p<0.05$), it is larger in girls (1.4 ± 0.04 cm, $p<0.05$) than in boys (1.3 ± 0.04 cm, $p<0.05$); the diameter of the sigmoidorectal junction makes up 1.6 ± 0.03 cm ($p<0.05$) in infants of both sexes.

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ПЕРИНАТАЛЬНАЯ АНАТОМИЯ СИГМОРЕКТАЛЬНОГО СЕГМЕНТА

Резюме. С помощью анатомического исследования 79 плодов и новорожденных человека и ультразвукового исследования 32 детей определены типичные макромикроскопические признаки сигмо ректального сегмента, вариантная анатомия сигмовидной кишки, хронология становления топографоанатомических взаимоотношений сигмо ректального сегмента со смежными органами и структурами живота в перинатальном периоде, его ультрасонографические параметры у новорожденных и грудных детей.
Ключевые слова: сигмо ректальный сегмент, перинатальный период, анатомия, ультрасонография.

PERINATAL ANATOMY OF THE SIGMOIDORECTAL SEGMENT

Abstract. By means of an anatomical investigation of 79 specimens of human fetuses and newborns and an ultrasound examination of 32 infants the typical macromicroscopic signs of the sigmoidorectal segment, the variant anatomy of the sigmoid colon, the chronological order of the forming of topographical relationships of the sigmoidorectal segment with the adjacent organs and structures of the abdomen during the perinatal period, its ultrasonographic parameters in newborns and infants have been determined.
Key words: sigmoidorectal segment, perinatal period, anatomy, ultrasonography.

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