

MORPHOLOGIC CHARACTERISTICS OF THE VERMIFORM APPENDIX DURING THE PRENATAL PERIOD IN MAN

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In the literature, there are different data about the morphologic characteristics and variations of the appendix during the postnatal period in man, but the information about its characteristics in the prenatal period is scarce. In our study, the characteristics of the appendix in prenatal period of development were studied on the fetal material. We used the fetuses from the collection of the Institute of Anatomy, Faculty of Medicine in Niš, 100 of them in total, formalin-fixed, of both genders, in their second and third trimester of intrauterine development. Regarding anatomical variations, we found a missing appendix in one case and a double appendix in another. The appendical opening into the cecum was located on the inner, posterior, outer, and anterior walls of the cecum, always below the ileal opening. The origin from the inferior, lowest part of the cecum was also observed. The appendix ran in preileal, retroileal, prececal, retrocecal, and retrocolic directions. The appendix had tubular shape, with one or two bends, being rarely straight. The length of the appendix varied from very short to very long, descending from the inferior edge of the liver to the right iliac fossa. The morphologic characteristics of the appendix in fetus, observed in our study, in the literature have been described to exist in the postnatal human life as well. *Acta Medica Medianae* 2012;51(4):26-31.

Key words: appendix, prenatal period, morphologic characteristics

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Introduction

The vermiform appendix is a tortuous structure belonging to the cecum, a portion of the large bowel, i.e. a portion of the human digestive tract. Most commonly, it originates as an opening in the posterior-inferior part of the cecum, around 2 cm below the ileal opening, where the terminal ileum joins the cecum. The appendical opening is sometimes closed with a mucous fold, forming a valve. The length of the appendix varies from 2 cm to 20 cm, 9 cm on the average, though it has been emphasized that it is longer in children and that after middle age it demonstrates atrophy and reduced length. It has a short mesoappendix, attached to the ileal portion of the mesentery, thus being movable. It is supplied with blood by one or two appendicular arteries, the branches of the ileocolic artery. In more advanced age, its lumen often obliterates (1-3).

Regarding embryonal development, the appendix shares the same destiny as cecum, i.e. the right portion of the large bowel. The cecum differentiates from the primitive colon, and in the

beginning of embryonal development cecum is present in its upper end, being very short and situated high below the liver. In the lower end of the cecum, a small bud arises, from which the appendix is later formed. With the digestive tube differentiation and stomach rotation, the primitive colon with cecum and appendix also rotates counterclockwise (from left to right), moving along the lower edge of the liver towards its right side. Simultaneously with the left-right rotation of the primordial colon, the ascendent colon is formed, and cecum descends to the right iliac fossa (4). The descent of the cecum refers also to the appendix, which also occupies its place in the right iliac fossa (5-8).

Out of all anatomical variations of the appendix, the most commonly studied were those related to the variations of position of its opening and its direction in relation to adjacent structures (9-11), shape – bifid ones have been reported (6,7,12) as well as double appendices and double cecum (13), its complete absence or superfluity, as well as variations in length. As for the role of the appendix, there are conflicting opinions even nowadays, from complete denial of any function, to the ones attributing appendix a very important role in immunity. It is the fact that in the appendix, even as early as prenatal life (17th week), there firstly occurs an intense lymphocytic infiltration from which lymph follicles are later formed, persisting during adult life (4,14-17). The knowledge of the anatomical variations of the vermiform appendix has a huge clinical importance because of

possible common inflammations (acute and chronic), cysts, mucoceles, and carcinoid tumors (18-20) during the adult life of an individual. Inflammation, the most common pathologic change in the appendix, is most frequently seen in children and adolescents, but it is not rare either in the middle or old age (21). Knowledge of the above facts is important for the purpose of making a correct diagnosis and selection and performance of surgical treatment.

Review of literature has revealed little information about the vermiform appendix in the human prenatal period, and we believe it is important to study its morphologic characteristics, such as the origin, position, direction, shape, and length, as well as possible anatomical variations.

Material and methods

The material used in this study consisted of fetuses of both genders from the collection of the Institute of Anatomy, Faculty of Medicine in Niš. We analyzed 100 preparations in total, fixed and kept in 10% formaldehyde solution. The preparations originated from the Clinic of Gynecology, the teaching basis of the Faculty of Medicine, and were obtained after spontaneous or deliberate abortions. The crown-rump length of the specimens used in the study was 10-30cm, corresponding to the intrauterine age from the end of III to VIII month of intrauterine growth by Patten (20), or the second and third trimester of intrauterine life.

The methods used in the study were macrodissection and microdissection under the loupe (magnification 5x). The abdomen was open using the longitudinal and transversal incision of the anterior abdominal wall, small bowel loops were moved aside, and caecum, terminal ileum, and appendix were observed. We defined the place of origin of the

appendix on the caecum, ileal opening, direction related to the terminal ileum, caecum, and ascending colon, its length and shape, as well as possible absence, duplication, superfluity. Each of the characteristic cases was photographed using a digital camera.

Results

In our study, only one case of a missing appendix was observed, and we examined the caecum and right half of the transversal colon. One double appendix was observed as well (Figure 1B), which originated with a common basis from the anterior caecum. No superfluous appendices were identified at the level of caecum and right half of the transversal colon. These two described cases belonged to the domain of anatomical variations.

Opening of the appendix into the caecum was most commonly located medially and below the ileocecal opening, then low in the lower portion, in the posterior and external side of the caecum (Figure 2a, 2b). As for the position and direction, it was observed that it was placed in front of the caecum and ileum, preileal (Figure 2aC and 2bA1, A2), behind the ileum – retroileal position (Figure 2aA). In one case, the appendix originated from the lower portion of the caecum, running behind, across the anterior surface of the right kidney, with the tip reaching the lower edge of the liver (Figure 2bB), fixated by peritoneum and stationary.

During prenatal life, the appendix is cylindrical, with two or three coils (Figure 3A,B,C), being rarely straight (Figure 3D), and sometimes extended (dilated). As for the length in prenatal life, it was observed to be from several millimeters to 7 cm (Figure 3 A-C), extending from a point below the liver, and the tip of which reached the right iliac fossa (Figure 3D).

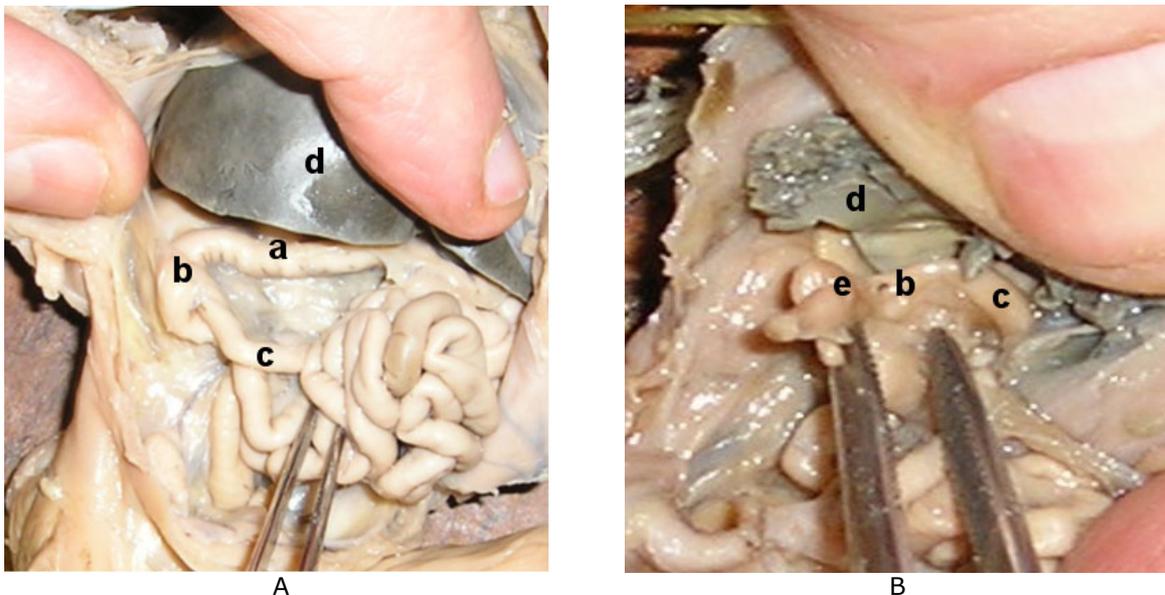


Figure 1. Variations of the appendix:

A - missing appendix on the caecum and portion of the transversal colon, B - double appendix, a.colon transversus, b. caecum, c. ileum, d. hepar, e. appendix duplex

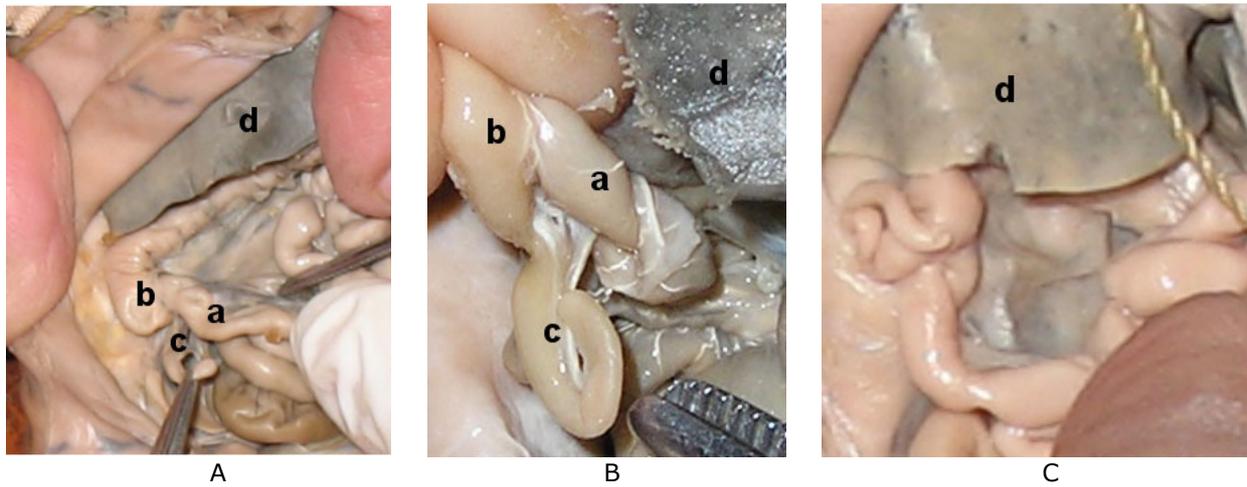
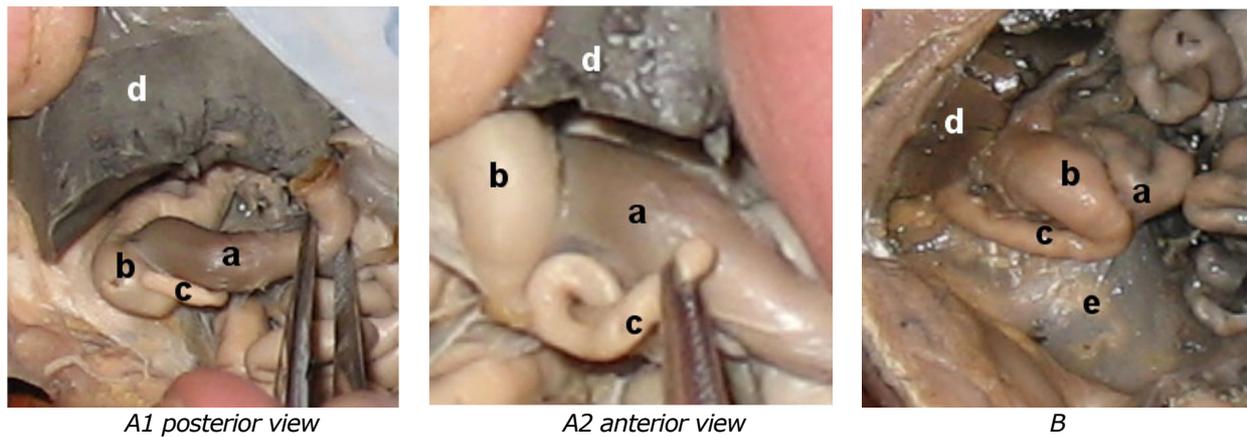


Figure 2.a Place of branching of the appendix and its direction

A- branching from the ceum medially and below the ileal opening, running in retroileal direction, B- branching from the lower portion of the ceum, running towards the right iliac fossa, C- branching from the ceum laterally, running in pre-ileal direction

a. ileum, b. caecum, c. appendix vermiformis, d. hepar



A1 posterior view

A2 anterior view

B

Figure 2b. Branching of the appendix and its direction, A1 and A2 – appendix arising on the posterior side of the ceum, running in pre-ileal direction, B – appendix arising on the inferior side of the ceum, running in retrocecal direction, with the tip reaching liver

a. ileum, b. caecum, c. appendix vermiformis, d. hepar, e. ren dexter

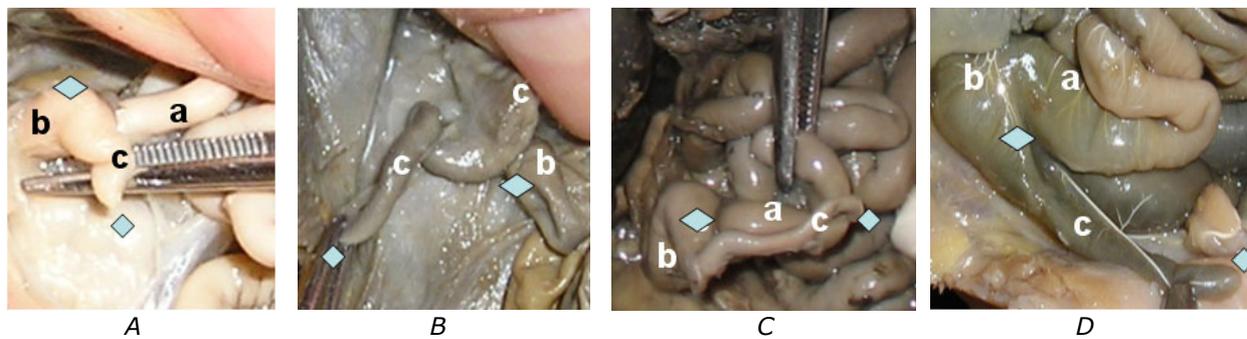


Figure 3. Shape and size of the appendix, A- short and extended appendix, B- very elongated and tortuous appendix, with tip pointing downwards, C- long and tortuous, running in pre-ileal direction, tip on the left, D- long, straight, in inferior direction, reaching the iliac fossa

a. ileum, b. caecum, c. appendix vermiformis, squares marking the start and end of the appendix

Discussion

The results of our study involved morphologic properties of the appendix in the second and third trimester of human intrauterine life, and the study involved, as said above, fetal material (100 fetuses) from the collection of the Institute of Anatomy, Faculty of Medicine in Niš (the collection is about 50 years old).

The literature data about the appendix have involved mostly children and adults, and have been obtained from autopsy material (22) or after operations and laparotomies (23). In these publications, the following positions of the appendix have been described: retrocecal and retrocolic position (behind the cecum and below ascending colon), pelvic or low position (below the border of the upper small pelvis opening), subcecal position (below the cecum), preileal position (in contact with the anterior-lateral abdominal wall), and postileal position (running behind the terminal end of ileum) (1,9,10,24,25). In our study as well, on fetal material, morphological shapes of the appendix were evidenced as in postnatal life of man. In the literature, some different positions have been described, such as a high position below the liver, with missing ascending colon (i.e. when it fails to develop and cecum does not descend into the pelvis). In the fetal period, in the first trimester, as found in our studies, the position of cecum and appendix is below the liver; at first, at the level of the umbilical vein and falciform ligament, then with fetal development it moves towards the right corner of lower liver edge, and in the end being immediately adjacent to the right end of the liver edge. From that moment on, the ascending colon develops and cecum with appendix descends towards the right iliac fossa. In various fetal age groups different heights of the cecum with appendix have been found, so that later on it occupies the position in the right iliac fossa in the fourth trimester – which is the position most commonly encountered at birth and later in life (19,12).

In our studies, we have found a case of missing appendix (26) and a double, bifid appendix, as has been described in the literature (12,13,27-29). Double appendices have been classified by Wallbridge (5, 29) into three groups: group A – one cecum with various degrees of duplication of its appendix; B1 type – one cecum with two individual appendices; B2 type – one normally positioned appendix and one rudimentary appendix along one of the tenias; and type C – two cecums, each having an appendix. In our studies, we encountered types A and B1; we were unable to identify other types in our material.

As for the length of appendix in prenatal period, it varied from several millimeters to a very long one, descending from the lower edge of the liver as far as

the right iliac fossa, coming into contact with the anterior-lateral abdominal wall. A case was identified with the appendix in the retroperitoneal space, in front of the anterior side of the right kidney, covered with peritoneum and stationary.

It is well known that that the position, shape, length, and number of appendices have a huge clinical significance in view of common inflammations, both acute and chronic (21,30), cysts, mucocoeles, and carcinoid tumors (18,19,20), as well as diverticuli (31), and the knowledge of the above facts is essential for correct diagnosis, and selection and administration of surgical treatment.

Various authors have shown different percentual values of positional incidence of appendix on a huge number of autopsy specimens (from 1.232 to 4.680), which indicates possible demographic differences, since these were different populations of examinees (4,11,32). As seen in our studies, all the positions of the appendix described in the literature were observed in them, too, except for the high position with missing ascending colon and cecum situated high below the liver. Our fetal material was from the second and third trimester of intrauterine development and we could not make inferences whether the cecum would descend into the right iliac fossa or not. We believed that the described positions of the appendix from our study would persist onwards as well, since during the general counterclockwise rotation there could be only vertical descent of the cecum and appendix, and not the rotation around its own axis, which would alter the position of both cecum and appendix.

In further studies, we intend to assess the percentual incidence of particular morphologic shapes and variations in the second and third trimester, and compare the results with the literature data about adult, postnatal human life.

Conclusion

In a one case we observed a missing appendix, and in another a double appendix.

The opening of the appendix was localized on the internal, posterior, anterior, external wall or the bottom of the cecum, always below the ileal opening.

We observed anterior, preileal, retroileal, retrocecal and low positions of the appendix. In one case, it was fixated by the peritoneum to the posterior side of the left kidney and stationary.

The appendix is a tubular structure with one or two coils, being rarely straight. In several cases, it was extended and dilated.

The measured length of the appendix ranged from 3mm to 7cm, when it extended from the right edge of the liver to the lowest point in the iliac fossa.

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MORFOLOŠKE KARAKTERISTIKE APENDIKS VERMIFORMISA U PRENATALNOM PERIODU KOD ČOVEKA

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U literaturi se ističu različiti podaci o morfološkim karakteristikama i varijacijama apendiksa u postnatalnom periodu života čoveka, ali je malo podataka o njegovim karakteristikama u prenatalnom periodu života. U našim istraživanjima ispitivane su karakteristike apendiksa u prenatalnom periodu života, odnosno na fetusnom materijalu. Korišćeni su fetusi iz zbirke Instituta za anatomiju Medicinskog fakulteta u Nišu, ukupno 100, oba pola, iz drugog i trećeg trimestra intrauterinog razvoja, koji su bili fiksirani u formalinu. Od anatomskih varijacija konstantovana je odsutnost apendiksa u jednom slučaju i takođe u jednom dupli apendiks. Otvor apendiksa u cekum nalazi se na unutrašnjem, zadnjem, spoljašnjem i prednjem zidu cekuma i uvek ispod ilealnog otvora. Evidentan je i polazak sa donjeg, najnižeg dela cekuma. Apendiks se pruža preilealno, retroilealno, precekalno, retrocekalno i retrokolično. Apendiks ima tubularni oblik sa jednom do dve vijuge, a retko je prav. Dužina apendiksa varira od jako kratkog do jako dugog, koji se od nivoa donje ivice jetre spušta u desnu bedrenu jamu. Morfološke karakteristike apendiksa kod fetusa, koje su evidentirane u našim istraživanjima, u literaturi su opisane i u postnatalnom životu čovaka. *Acta Medica Medianae 2012;51(4):26-31.*

Ključne reči: *apendiks, prenatalni period, morfološke karakteristike*