

Running course of the colon during the embryonic period

To the Editor, *Clinical Anatomy*:

Cho et al. recently described the topographical anatomy of the intestine during the embryonic stage using sagittal histological sections (*Clinical Anatomy* 31:583–592 (2018)). Strikingly, out of 17 samples, 11 “abnormal” samples were found with crown-ramp length (CRL) of 15 mm and 25 mm, because the descending colon (DC) was herniated in the extraembryonic coelom (hernia sac). On the contrary, no abnormal samples were detected on 10 samples with CRL of 26 and 39 mm, and 7 samples had CRL of 41 and 56 mm. They provided no 3D reconstruction but presented only sagittal histological sections. Therefore, it is extremely difficult to comprehend in detail, especially the spatial relationship. Three-dimensional information, such as exact location and structure of complicated intestinal tracts, location of the cecum, and length of the colon and intestine, will help accurate discrimination of normal and abnormal development. Furthermore, they argued a broad range of embryo specimens between CRL of 15 mm and 39 mm, which may correspond the Carnegie stage (CS18) to CS23 and even larger samples (O’Rahilly and Muller, 1987). Dynamic and complicated morphological changes were observed in that period. The intestinal tract especially elongates much faster than the CRL

(Ueda et al 2016). Therefore, discussion on whether “normal” development occurred or not should be considered.

We have previously described the morphology and morphometry of physiological umbilical hernia during the embryonic period using Kyoto Collection samples (Ueda et al, 2016). The intestinal tract from the stomach to rectum was 3D reconstructed using magnetic resonance imaging. The small intestine forms the cranial limb of the loop and some of the caudal limb, whereas the colon forms the remainder of the caudal limb. Thus, the cecum was located at the caudal limb of the IL, which showed that the length of the colon in the extraembryonic coelom is very short as compared to that of the small intestine (Ueda et al 2016, Nagata et al, 2019). The colon-forming caudal part of the IL returns in the abdominal cavity, which passes promptly to the rectum. The course of the tract was smoothly curved at the lateral view with vague inflection point, but almost straightly at the ventral view (Figure 1) (see Fig. 2C in Ueda et al, 2016). At CS18, the IL formed as simple hairpin with almost 90° rotation around the superior mesenteric artery (SMA). The cranial limb was located at the right side and caudal limb including the cecum at the left side in the hernial ring. According to development until CS23, the form of IL is elongated and complicated, whereas the intestinal tract in the abdominal cavity was relatively similar. The starting point of IL was almost on the midsagittal plane, whereas the colon tract passes just at

the left side of the median plane. In our study, the colon tract was similar in all 34 samples between CS18 and CS23 (CRL range, 12.8–23.2 mm). No looping and different location of the colon were observed. Discriminating the segments of the colon was avoided, although a vague infection point was recognized, because the proof of blood supply from the SMA or inferior mesenteric artery (IMA) for these segments was required for the discrimination.

Soffer et al. (2015) also showed the position of the intra-abdominal distal colon to the rectum with histological section, which is compatible with that of our study. Moreover, the border between the colon segment supported by the SMA and IMA (Colic bend) was shown (Asterisk in Figure 10 Soffers et al 2015). The border was close to the colic bend (a point near the left colic flexure in adults), which remains as a vague infection point because DC was detached from the dorsal abdominal wall. The mesentery for IL and DC was notably continuous, although the latter is not so long to allow the DC into hernial sac. Similar observation was described in another study (Figures 170-172 in Dott 1923). Such location of the colon may be recognized on a globally famous 3D models using the “Blechschmidt collection” (Figure 103 in Blechschmidt 1961).

No abnormal samples of “DC-Jejunum outside” were detected, with larger samples having CRL26 and CRL39 mm in Cho et al.’s study. The samples may correspond to

samples at CS23 and even larger samples, which remains in herniation and transition phases (on the way to return to the abdominal cavity) (Nagata et al. 2019). We described the intestinal tract with 3D reconstruction in the corresponding periods. The running course from the colon to the rectum in herniated phase (CRL32 mm) was almost similar to that in CS23 samples, whereas segments of sigmoid colon, DC, and transverse colon may be discernable in the transition phase (CRL37, CRL41, and CRL43 mm) by forming a recognizable left colic flexure (see Figure 173 in Dott 1923, Supplementary Video 1-4 in Nagata et al 2019). However, the border between transverse colon and ascending colon may be discernable in the phase after a complete return (Fitzgerald et al, 1971).

The colon segment in the herniation phase should be carefully determined because the colon during the embryonic period was short, and no obvious flexure was mostly detected. Cho et al. claimed that caudal limbs of IL are the DC in many samples, although the basis seems insufficient. I am wondering that they might not be able to identify the colic branch of the IMA, which is required for the discrimination of segments, because they described that the branch was “poorly developed.” The location of the cecum was not described in that study, which can well demonstrate the position and length of the colon in the extraembryonic coelom.

Briefly, the samples defined as an abnormal location of the colon “DC-Jejunum

outside” in that study may be identical to that of previous studies (Dott 1923; Blechschmidt 1961; Soffers et al 2015; Ueda et al, 2016; Nagata et al. 2019). The colon segment in the herniation phase should be carefully determined. The 3D reconstruction and application of adequate categorization of the developmental stage, such as the Carnegie stage, is required for the discrimination of normal and abnormal development.

Figure 1 An image of 3D reconstruction of the intestinal tract and abdominal organs at Carnegie stage 21.

Abstract

Cho et al. recently described the topographical anatomy of the intestine during the embryonic stage using sagittal histological sections (Clinical Anatomy 31:583–592 (2018)). Strikingly, out of 17 samples, 11 “abnormal” samples were found with crown-ramp length (CRL) of 15 mm and 25 mm, because the descending colon (DC) was herniated in the extraembryonic coelom (hernia sac). For my opinion, the

samples defined as an “abnormal” location of the colon “DC-Jejunum outside” in that study may be identical to that of previous studies (Dott 1923; Blechschmidt 1961; Soffers et al 2015; Ueda et al, 2016; Nagata et al. 2019). The colon segment in the herniation phase should be carefully determined. The 3D reconstruction and application of adequate categorization of the developmental stage, such as the Carnegie stage, is required for the discrimination of normal and abnormal development.

Key word

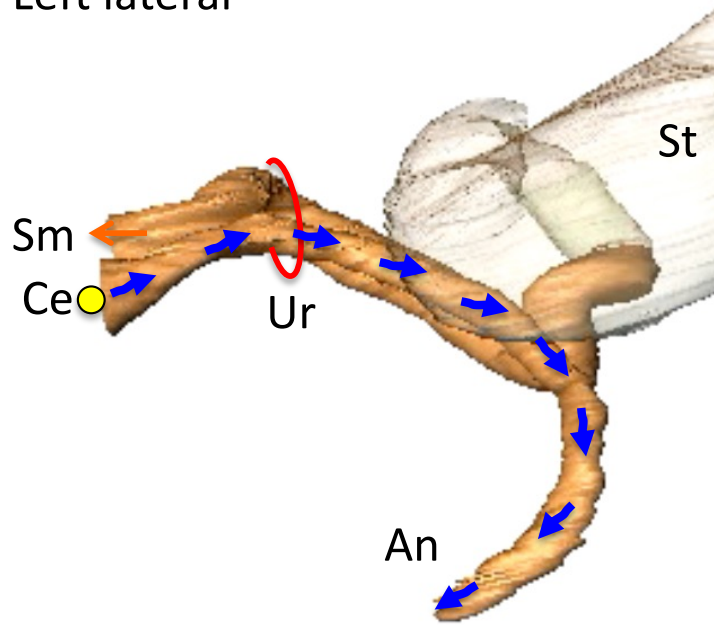
Intestinal loop

physiological umbilical hernia

superior and inferior mesenteric artery

descending colon

Left lateral



Ventral

