Case Report

Vitelline cyst in the rat ileum

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Abstract: Congenital vitelline duct anomalies other than Meckel’s diverticulum are rare in animals. A cyst of approximately 8 mm in diameter was observed on the antimesenteric surface of the ileal serosa in a 10-week-old female Crl:CD(SD) rat. Microscopically, the cyst closely resembled the ileum, but it did not communicate with the ileal lumen. We diagnosed this case as a vitelline cyst derived from the vitelline duct based on the location where it developed and its histological behavior. In rats, only Meckel’s diverticulum has been reported with a congenital anomaly of the vitelline duct, and no other spontaneous anomalies including a vitelline cyst have been reported. This case may be the first report concerning a vitelline cyst in the rat ileum. (DOI: 10.1293/tox.2015-0021; J Toxicol Pathol 2015; 28: 225–228)

Key words: vitelline cyst, rat, ileum, vitelline duct, Meckel’s diverticulum

The vitelline duct is the embryonic communication between the yolk sac and the midgut, but it normally closes and disappears during the development process. According to the literature, it closes between the fifth and seventh weeks in humans1 and by 11 days after conception in rats2. Incomplete closure and disappearance of the vitelline duct may result in a variety of abnormalities such as Meckel’s diverticulum, vitelline cyst, persistent fibrous cord, umbilical sinus and umbilicoileal fistula1, 3–5. Meckel’s diverticulum results from incomplete obliteration of the proximal portion of the vitelline duct (near the ileum), and the diverticulum opens into the ileum (Fig. 1A). A vitelline cyst develops when the midportion of the vitelline duct remains patent and each end is obliterated, and mucus then accumulates within the cyst (Fig. 1B). A persistent fibrous cord connecting the umbilicus to the ileum results from an atrophic vitelline duct that is not completely obliterated and absorbed (Fig. 1C). Umbilical sinus results from incomplete obliteration of the distal portion of the vitelline duct (near the umbilicus) and a sinus tract remaining open into the umbilicus (Fig. 1D). Umbilicoileal fistula is a completely patent vitelline duct. It may be an opening from the umbilicus to the intestine (Fig. 1E). These lesions are observed at the antimesenteric aspect of the intestine.

Meckel’s diverticulum is the most common abnormality in humans that develops due to incomplete obliteration of the vitelline duct. In mammalian animals, Meckel’s diverticulum is a rare anomaly of the gastrointestinal tract that is mainly observed in pigs and horses6 but has also been reported in rats2, 7. Other congenital anomalies of the vitelline duct are uncommon in humans and animals6, 9. In this report, we describe a cyst in the rat ileum that was considered to be a congenital anomaly of the vitelline duct.

A 10-week-old female Crl:CD(SD) rat purchased from Charles River Laboratories Japan, Inc. (Shiga, Japan), at the age of 4 weeks was used in an in-house dermal administration study. The hair on the dorsal area was clipped and then shaved, and the application area was covered with a sheet of lint cloth for about 24 hours, without treatment of any drugs. The rat was housed in a stainless steel cage filled with bedding under controlled conditions (12 h light/dark cycle, 35–75% humidity at 22–25°C). The study protocol was reviewed and approved by the Institutional Animal Care and Use Committee of LSI Medience Corporation. The animal was anesthetized by intraperitoneal injection of sodium pentobarbital (30 mg/kg), and sacrificed by exsanguination from the abdominal aorta.

Macroscopically, the cyst was about 8 mm in diameter, with a white macule (approximately 4 mm in diameter) on the cyst, and located on the antimesenteric surface of the ileal serosa (Fig. 2). It was filled with fluid.

The cyst, including a part of the intestine, was fixed in 10% neutral-buffered formalin solution. After fixation, it was cut along the vertical section of the junction with the ileum and the cyst (Fig. 2) and embedded in paraffin, and the section was then stained with hematoxylin and eosin (HE), Alcian blue (pH 2.5) (AB), and periodic acid-Schiff...
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(PAS) stains and examined by light microscopy. For immunochemical examination, the sections were subjected to the labeled polymer method with Histofine Simple Stain Rat MAX-PO (MULTI) (Nichirei Biosciences Inc., Tokyo, Japan) as the antibody against monoclonal mouse Anti-Human Smooth Muscle Actin (SMA) (DAKO, Glostrup, Denmark, dilution 1:100), and the sections were then counterstained with hematoxylin.

Microscopically, the cyst consisted of a mucosa, muscular layer and serosa. The mucosa contained short villi in which the surface was covered with a single layer of columnar epithelium, and there were numerous goblet cells among the epithelial cells. These goblet cells were stained purple by PAS and blue by AB. The lower part of the villi had crypts containing Paneth cells with eosinophilic granules in the cytoplasm. Crypts were observed in the lamina propria, which consisted of a connective tissue with blood capillaries. The muscularis mucosae were observed under them. Although a nerve plexus was not revealed between the muscles layers, these findings closely resemble those of the ileum near the cyst (Fig. 3). The cyst shared a part of the muscularis (inner circular layer) in the ileal wall, but it did not communicate with the ileal lumen.

A white area was observed on the cyst during necropsy that consisted of granulation tissue with mineralization and mucus exudate in the muscle layer and serosa (Fig. 4). In this area, thinning, necrosis and exfoliation were observed in the mucosal epithelia (Fig. 5). These changes were considered to be due to pressure of the cyst wall associated with retention of mucus in the cyst.

It is known that congenital vitelline duct anomalies arise at the antimesenteric aspect of the intestine and that they are by incomplete closure and disappearance of the vitelline duct. They are rare in animals, and only Meckel’s diverticulum has been reported in rats\textsuperscript{7,8}.
Meckel's diverticulum is a congenital anomaly in which only the umbilical side of the vitelline duct disappears, and it is the most common presentation of persistent vitelline duct. Morphologically, it is observed as a pouch on the antimesenteric surface of the ileum, exhibiting histological similarities to the intestinal mucosa, and it communicates with the adjacent ileal lumen. On the other hand, the vitelline cyst is a congenital anomaly in which both sides of the vitelline duct remain intact, leading to the formation of a cystic structure adjacent to the ileum. Histopathologically, the diverticulum shows similarities to the ileal mucosa, while the cyst is lined with columnar epithelium and contains mucous glands.

**Fig. 3.** Histopathological appearance. The left side is the ileum, and the right side is the vitelline cyst (A–F). SMA stain revealed the lamina muscularis mucosae (arrows) in the mucosa of the ileum and the vitelline cyst (B). Goblet cells in the mucosa of the ileum and the vitelline cyst show similar stainability for PAS (C) and AB (D) stains. The crypts contain Paneth cells (arrows) that have eosinophilic granules in the cytoplasm (E). The vitelline cyst does not communicate with the ileal lumen (F). Bar = 1 mm (A), 50 μm (B), 100 μm (C, D), 20 μm (E), 200 μm (F).
vitelline duct disappear. Morphologically, it exhibits histological similarities to the Meckel’s diverticulum, but it does not communicate with the adjacent ileum lumen. In dogs, formation of granulation tissue due to pressure of the cyst wall associated with retention of mucus in the cyst has been reported. In this case, the lesion developed on the antimesenteric surface of the proximal ileum and shared a part of the muscularis in the ileal wall, but it did not communicate with the ileal lumen. Similar to the report in dogs, formation of granulation tissue associated with the retention of mucus was also observed.

Small intestinal duplication, which is similar to the vitelline cyst, is a known abnormality. A small intestinal duplication has been defined in that it communicated with the lumen of the intestine, it has a smooth muscle wall and intestinal mucosa, and it arose on the mesenteric surface of the intestine. This case was observed on the antimesenteric surface of the ileum, and it was considered to be different from a small intestinal duplication.

According to the above results, we considered that the gross and histologic findings were consistent with a congenital remnant of a portion of the embryonic vitelline duct. To our knowledge, only Meckel’s diverticulum has been reported in rats, and no other spontaneous anomalies including a vitelline cyst have been reported. Therefore, this may be the first report concerning a vitelline cyst in the rat ileum.

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