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REVIEW

Meckel's diverticulum in the adult

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Summary Meckel's diverticulum (MD) is the most common gastro-intestinal congenital malformation (approximately 2% in the overall population). The lifetime risk of related complications is estimated at 4%. These include gastro-intestinal bleeding, obstruction or diverticular inflammation. Diagnosis is difficult and rarely made, and imaging, especially in the case of complicated disease, is often not helpful; however exploratory laparoscopy is an important diagnostic tool. The probability of onset of complication decreases with age, and the diagnosis of MD in the adult is therefore often incidental. Resection is indicated in case of complications but remains debatable when MD is found incidentally. According to an analysis of large series in the literature, surgery is not indicated in the absence of risk factors for complications: these include male gender, age younger than 40, diverticulum longer than two centimetres and the presence of macroscopically mucosal alteration noted at surgery. Resection followed by anastomosis seems preferable to wedge resection or tangential mechanical stapling because of the risk of leaving behind abnormal heterotopic mucosa.

Introduction

Meckel's diverticulum (MD) is better known by paediatric surgeons than those who care for adults. It is the most common congenital malformation of the gastro-intestinal tract [1]. Found in 0.14 to 4.5% of autopsy series, MD is rarely symptomatic in adults [2]. It is therefore most often discovered fortuitously, and there is no consensus as to management in this setting. The goal of this paper is to describe the various circumstances under which MD is diagnosed, to recall the indications and the modalities of surgical treatment.

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Patients and methods

Pubmed and Medline databases were explored for relevant articles with the following search key words: ''Meckel's diverticulum'' AND ''complications'' AND ''surgery'' AND ''adult''; articles published in English or French between 1976 and March 2016 were included. Case reports and series with fewer than 15 patients were not included. Thirty-four articles were selected and analysed in detail. A complementary manual search was conducted to analyse certain references found in the main articles when they appeared to be of interest.

Embryogenesis and pathophysiology

Johan Friedrich Meckel was the first to qualify the diverticulum as an embryonic vestigial remnant in 1809 [3].

In the embryo, the omphalo-mesenteric canal (or vitelline duct) communicates between the yolk sac and midgut lumen of the developing foetus. This canal usually obliterates between the 6th and the 10th week of gestation and becomes a fibrous band, called the omphalo-mesenteric ligament, which later normally resorbs completely. Meckel's diverticulum corresponds to the faulty involution of this primitive vitelline loop. It presents as a unique and blind recess on the anti-mesenteric border of the ileum, opposite the terminal branches of the superior mesenteric artery. It is located at an average distance of 60 cm from the ileo-cecal junction (range between 15 to 120 cm), with the distance varying somewhat according to the age of the patient [4].

From an anatomic viewpoint, MD is a true diverticulum, composed all layers of the gastro-intestinal wall. The average length is 3 cm, but several anatomic forms have been described ranging from minimal outpouchings to giant diverticula that can measure up to one meter long [4—6].

In 15% of cases, the omphalo-mesenteric ligament, connecting the diverticulm to the umbilicus, persists as well.

Epidemiology

Meckel's diverticulum has been found in 0.14 to 4.5% of cadaver dissections [5,7—9], with a male/female ratio of 1.9. No ethnic factor has been described but a retrospective review reported an association between MD and Crohn's disease in 5 to 8% of cases [10].

Histology

The histology of the Meckel's diverticulum is the same as the ileum. However, ectopic mucosal tissues can develop within the intestinal layers (most commonly gastric [12 to 26% [8,11—16]], but also pancreatic, duodenal, colonic, endometrial, Brunner gland, and even hepato-biliary [1]); carcinoid metaplasia is very rare (Table 1).

A relationship between heterotopic gastric mucosa and gastro-intestinal bleeding has been clearly identified. In a meta-analysis of 8389 cases, Carlioz highlighted the existence of heterotopic gastric mucosa in 98% of MD resected because of gastrointestinal bleeding [6]. Acid secretion from the ectopic gastric mucosa is responsible for ulcerations that bleed. The role of *Helicobacter pylori* seems to be minimal if not nil [15,17,18].

Diagnosis

Meckel's diverticulum is most often asymptomatic, discovered fortuitously during an operation or an imaging investigation, but the diagnosis of MD is revealed by a complication in 4 to 7% of cases [1].

Sometimes called ''the great simulator'', MD can be responsible for a non-specific array of symptoms. Periumbilical abdominal pain should lead to search for an unusual umbilical history in childhood (weeping from the umbilicus, protracted umbilical fleshy tissue) that might suggest the diagnosis [6].

Most often, complementary studies are of little or no worth, especially when the diverticulum is uncomplicated. Sonography is of little value in the adult. The diverticulum appears as a blind tubular structure originating from an ileal loop. Sonography is still used in paediatrics because it avoids radiation exposure; it has a higher sensitivity in case of complications [19]. Contrast-enhanced CT scan can easily overlook a MD, which may be mistaken for a small intestinal loop, in the absence of a complication [20]. CT enteroclysis facilitates visualization of the diverticulum and improves the sensitivity for diagnosis [21]. In case of complications, CT is the best study [22]. Magnetic resonance does not have a well-established role in the diagnosis of MD, whether complicated or not [23].

When suspected, capsule endoscopy can show the orifice of the MD but capsule sequestration in the diverticulum has been described [6].

For infants who present with gastrointestinal bleeding, Technetium-99 pertechnetate imaging is recommended. This radionuclide scan can detect gastric mucosa, and leads to the correct diagnosis with a sensitivity and specificity of 85 and 95%, respectively [1]. There are few large series of MD in adult patients in the literature. One study of radionuclide scanning reported a sensitivity and positive predictive value of 60% with a negative predictive value of 75% [24]. In fact, exploratory laparoscopy is the investigation that most often leads to the correct diagnosis [1,25].

Complications

The lifetime probability of onset of complications is evaluated at 4%, maximal before two years of age, approximately 1% near 40 years old, and progressively decreasing to nearly nil after 70 [8,26,27]. Mean age at the onset of complications is 2.8 years [6]. MD is more often symptomatic in men than in women (sex ratio = 2.8) [5,6,8,13,15,16].

Complications can be hemorrhagic, mechanical, infectious or tumoral (Table 2).

Bleeding

Gastro-intestinal bleeding and obstruction are the most common complications in infancy [14]. Meckel's diverticulitis is the leading cause of gastro-intestinal bleeding before the age of two years [6]. Bleeding is related to ulceration of the ileal mucosa adjacent to acid-secreting ectopic gastric mucosa in nearly all cases. In the adult, bleeding is the inaugural symptom in 8 to 63% of symptomatic MD [13,14]. For occult or intermittent bleeding, arteriography can detect the diverticular origin of bleeding. The embryonic remnant omphalomesenteric artery can be visualized, located at the terminal portion of the superior mesenteric