Review: Sonographic findings of complicated and uncomplicated Meckel diverticulum in children

Poster No.: C-1809
Congress: ECR 2018
Type: Educational Exhibit
Authors: N. Pérez Peláez¹, C. Gallego², D. Coca Robinot², G. del Pozo García², M. Rasero Ponferrada², E. Aguirre Pascual²; ¹Madrid, Madrid/ES, ²Madrid/ES
Keywords: Diverticula, Congenital, Acute, Education, Diagnostic procedure, Ultrasound, Nuclear medicine conventional, Pediatric, Emergency, Abdomen
DOI: 10.1594/ecr2018/C-1809

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

- Review the different clinical manifestations of Meckel diverticulum in children.
- Describe ultrasound findings of Meckel diverticulum when complicated and not.
Background

Meckel's diverticulum is the most common malformation of the gastrointestinal tract. It is a remnant of the omphalomesenteric duct, the embryological communication between the yolk sac and the developing midgut, which obliterates by the 10\textsuperscript{th}-12\textsuperscript{th} week of gestation. Incomplete obliteration of the omphalomesenteric duct may lead to a Meckel's diverticulum, omphalomesenteric sinus or cyst or fibrous cord. Meckel's diverticulum is by far the most common malformation of the omphalomesenteric duct remnants (nearly 98% of all omphalomesenteric anomalies). It is a true diverticulum, length up to 5 cm, located at the antimesenteric side of the distal ileum, classically within 60 -90 cm from the ileocecal valve in children. Heterotopic mucosa frequently lines its lumen, being gastric mucosa the most common tissue.

With a prevalence of 2-3% in general population, Meckel's diverticulum is generally asymptomatic. Clinical manifestation is more frequent in children than in adults, because of a lower prevalence of heterotopic gastric mucosa in adults. The most common clinical presentation in children less than 5 years is painless rectal bleeding, secondary to the presence of ectopic gastric mucosa, which leads to ulcer formation in the diverticulum or adjacent ileum. Bowel obstruction or pain and infectious symptoms are less common clinical manifestations.

Complication rate is about 5%, including haemorrhage; diverticulitis; small bowel obstruction due to intussusception diverticulum herniation, torsion and inversion; perforation; enterolith formation and neoplastic transformation.
Findings and procedure details

We reviewed the clinical history and imaging tests of patients with ultrasound findings suggesting complicated Meckel's diverticulum in our tertiary pediatric hospital from 2012 to 2017. Only those cases with surgical and pathological specimen confirmation were included in our revision. Our pictorial review illustrates the spectrum of Meckel's diverticulum complications and the imaging findings, with emphasis on ultrasound.

NORMAL MECKEL DIVERTICULUM

Meckel diverticulum is a blind-ending structure that arises at the antimesenteric border of the distal ileum. Its length and diameter are variable, usually about 2 cm up to 5 cm. It contains all layers of intestinal wall (gut signature): an outermost thin echogenic serosa, an outer hypoechoic ring corresponding to the muscular layer, an inner echogenic submucosa and an innermost hipoechogenic thin mucosa, usually not clearly depicted. Some authors have described the mucosa submucosa complex as more irregular in Meckel's diverticulum than in enteric duplication cyst. Although potentially visible in US when uncomplicated, it is normally mistaken for bowel loops: demonstration of a blind ending peristaltic structure with "gut signature" connected with an ileal loop is the clue for diagnosis. Diagnosis though is challenging even when a dedicated technique of graded compression is applied. The multiplanar capability of CT has increased the diagnosis of non-complicated Meckel's diverticulum.

HAEMORRHAGE

Haemorrhage due to peptic disease does not depict any characteristic features at ultrasound and diagnosis relies on clinical features and NM studies. The presence of heterotopic gastric mucosa tends to decline with age, making bleeding most probable in children. When a bleeding Meckel's diverticulum is depicted at ultrasound, findings are related to accompanying inflammation or perforation (Fig 1-2), and the US imaging characteristics of those complications will be described below.

MECKEL'S DIVERTICULITIS

US findings in Meckel's diverticulitis rely on the presence on an aperistatic blind ending structure located periumbilical or at the right iliac fossa (Fig 3) in continuity with an ileal loop with local inflammatory changes. Characteristic US features of diverticulitis include loss of peristalsis, lack of compressibility, thickened walls and increased luminal content in a blind ending structure. Although variable in length, in our experience it usually measures less than 25 mm in most cases. Signs of inflammation of adjacent fat such as increased echogenicity and stranding, and local hyperemia are also common features
and may be "the tip of the iceberg" when facing a Meckel's diverticulitis. Endoluminal contents may be fluid, air/ fluid levels, enteroliths or fecal-like solid material.

**PERFORATED MECKEL'S DIVERTICULIM**

Perforation of a Meckel's diverticulum can occur in the setting of diverticulitis, gangrene or peptic ulceration due to ectopic gastric mucosa. Ulceration can occur in the diverticulum itself or in the adjacent ileum. US features of Meckel's diverticulum perforation include signs of diverticulitis with the presence of adjacent fluid collections, extraluminal or transmural gas bubbles and foci of pneumoperitoneum.(Fig 4).

**INTUSSUSCEPTION**

One of the most frequent causes of intestinal obstruction in the setting of complicated Meckel's diverticulum is intussusception. It can act as a leading point in intussusception: the diverticulum usually inverts or invaginates into the small bowel and advances to the ileocecal valve and then into the colon. US findings of a complex intussusception are demonstrated: the intussusceptum not only contains lymph nodes or the appendix but also a complex layered structure or mass located in the center of the intussusceptum. (Fig 5, 6 & 7). Since the diverticulum is inverted, the echogenic inner layer corresponds to the mesenteric fat and serosa of the diverticulum (pseudolipoma sign) and the rest of the layers, which are thickened and hypoechoic are less easily identifiable. This ultrasound finding is called the "pseudolipoma" sign.

**TORSION OR VOLVULUS**

Torsed Meckel's diverticulum can be a cause of bowel obstruction, in which the diverticulum is twisted around a omphalomesenteric fibrous band remnant (mesodiverticular band) that attaches it to the umbilicus (Fig. 8). In those cases, it appears as a blind ending, non-compressible, aperistaltic cystic-like structure. Internal content may be present secondary to hemorrhage or inspissated material. In our experience, a diameter of more than 25mm should rise the suspicion of a volvulated Meckel's diverticulum since inflamed appendix is usually less than 20mm.

The fibrous band may also predispose to volvulus or rarely forms a true knot between distal ileus and sigma, or can impinge a small bowel loop with a mesodiverticular band that attaches it to the umbilicus.

**OTHER COMPLICATIONS**

Meckel's diverticulum can produce intestinal obstruction due to herniation through the inguinal canal or the umbilicus (Littre hernia). In most cases Meckel's diverticulum is rarely diagnosed by imaging prospectively and it is usually found in surgery.
Enteroliths are more commonly seen in patients above 40 years although they have been described in pediatrics also. Calcification of the enterolith is peripheral with alucent center in most cases. Enterolith formation can complicate with intestinal obstruction.

**DIFFERENTIAL DIAGNOSIS**

Acute appendicitis is the main differential diagnosis of perforated, inflamed and volvulated Meckel's diverticulum in children. In order to avoid incorrect diagnosis, a dedicated US technique with graded compression at the right lower quadrant is of paramount importance. Recognition of a normal appendix in the setting of an inflamed blind ending structure nearby; a diameter of more than 25mm; location of the structure halfway between the right lower quadrant and the umbilicus and inability to follow the structure all the way to the cecum should make us think of a complicated Meckel's diverticulum.

An enteric duplication cyst is also included in the differential diagnosis of complicated Meckel's diverticulums, but enteric duplication cysts do not communicate with the bowell and its mucosa is more regular than in Meckel's diverticulum.

Omental infarction can occur anywhere in the abdomen, but when occurs at the right lower quadrant or periumbilical, it can also be included in the differential diagnosis of Meckel's diverticulitis. A more superficial location (below the abdominal wall) and the absence of an accompanying inflamed small bowel segment favor the diagnosis of omental infarction.

Other leading points of intussusception can also mimic an invaginated Meckel's diverticulum in children. Both lymphoma and polyps lack the characteristic layered disposition of the inverted Meckel's diverticulum. Duplication cysts may act also as a leading point of an intussusception, but conversely to Meckel's diverticulum, they do not invaginate into the small bowel lumen, so the center of the intussusceptum is occupied with a cyst with gut signature at ultrasound.
Fig. 1: Meckel diverticulum in a 4-year-old boy presenting with profuse rectal bleeding that required blood transfusion. A- Axial Meckel's diverticulum US scan showing diverticulum wall thickening (arrow) and hyperechogenic mesenteric fat around (*). B- Longitudinal Meckel's diverticulum US scan showing diverticulum (arrow) in continuity with an ileal loop (arrowheads). Air exceeding the margins of the intestinal wall in the adjacent ileum suggested peptic ulceration (*). NM studies were obviated.

© Hospital Universitario 12 de Octubre - Madrid/ES
**Fig. 2:** 4 year old child admitted to the emergency room with low digestive bleeding. NM studies were negative for ectopic gastric mucosa (A), with normal uptake of the radiotracer in the stomach (black asterisk). (B) Dedicated graded compression US at right lower abdomen: normal terminal ileum (open white arrow) and appendix (open black arrow). C, D and E: An aperistaltic bowel loop (black arrows) with thickened walls and marked irregularity of the submucosa-mucosa complex (white arrow) was seen at the umbilical- right lumbar region (L: liver). Minimal fluid was seen in the lumen of the diverticulum (white asterisk). The structure was in continuity with the ileum (not shown). Stranded echogenic fat (arrowhead) surrounded Meckel's diverticulum and local hyperemia was noticed.

© Hospital Universitario 12 de Octubre - Madrid/ES
Fig. 3: Meckel diverticulitis in a 15-month-old boy presenting with abdominal pain and vomiting. A- Abdominal US scan shows a blind ending intestinal structure related to an inflamed Meckel's diverticulum with thickened wall (arrow). Associated inflammatory changes in the adjacent mesenteric fat (star) and a small amount of free fluid around it (*).

© Hospital Universitario 12 de Octubre - Madrid/ES
**Fig. 4:** Perforated Meckel's diverticulum in a 2-year-old child referred to rule out intussusception. A- Right upper quadrant ultrasound scan shows a blind ending tubular structure corresponding to Meckel diverticulum (arrow) with pronounced stranding of the adjacent mesenteric fat (*) and echogenic free fluid (arrowheads) in contact with the anterior wall of the ascending colon (star). B- Right flank ultrasound scan shows a complex inflammatory changes with hyperechogenic mesenteric fat (*) with adjacent small bowel loops (arrowheads) entrapment. C- Mesogastric ultrasound scan shows retrograde dilated and hypoperistaltic small bowel loops secondary to obstructive complication. In the surgery a perforated Meckel's diverticulum with associated abscess and intestinal adhesions was found.

© Hospital Universitario 12 de Octubre - Madrid/ES

**Fig. 5:** Inverted Meckel's diverticulum as a leading point for ileocolic intussusception in a 1-year-old boy. A) Longitudinal US scan at ileocecal valve during water enema - ultrasound guided reduction shows the inverted diverticulum (arrow). B) Longitudinal US scan and C) Axial US scan of Meckel's diverticulum (arrowheads) with inner hyperechogenic mesentery and the inverted hipoecogenic gut layers around (pseudolipoma sign) at the apex of intussusception (double arrowheads). Closed reduction was not possible and persistent images of intussusception were documented after many water enema reduction attempts. D) and E) Intraoperative images showing the inverted diverticulum at the antimesenteric border of the ileum (D) and after resolving the inversion (E).

© Hospital Universitario 12 de Octubre - Madrid/ES
**Fig. 6:** Complex intussusception in a 4 year old girl with crampy abdominal pain in the past 30 hours. Due to the clinical conditions of the patient a closed reduction was not attempted. Axial US scan from cephalad (A) at the Right upper quadrant to caudal (E). Axial image at the center of the intussusceptum (F). Fig. A and B. A complex intussusception with fluid trapped in the cephalad portions of the intussusceptum (asterisk) and a small soft tissue mass (red asterisk) is seen in A and B. Intussusceptum wall edema is also depicted (white arrows). The intussuscipiens' wall is markedly thinned (red openend arrow). Fig C. Ileo-ileo colic intussusception is demonstrated, with dilated edematous small bowel loops (white arrowheads) seen proximal to the intussusception consistent with bowel obstruction. Fig D. Dilated and edematous ileal loops (black arrows) are seen within the intussuscipiens, and a complex soft tissue mass with echogenic center ("pseudolipoma sign") is seen as the leading point. Fig E and F. Longitudinal and axial images at the leading point of the invagination depict a layered soft tissue mass with inner echogenic center (black arrowheads) that corresponds to the mesenteric fat and serosa and an outer thick hypoechogenic wall related to inverted muscularis, submucosa and mucosa of the diverticulum (open white arrows).

© Hospital Universitario 12 de Octubre - Madrid/ES
Fig. 7: Surgical findings in a 4 year old girl with a Meckel's diverticulum inverted and acting as a leading point of an intussusception (same case as figure 6.) A) Aspect of the intussusception before manual reduction. Dilated small bowel loops proximal to the intussusceptum (black open arrow) are seen crowding around the ileocecal valve. A dilated cecum and ascending colon (intussuscipiens) with thinned translucent walls that permit us see the ischemic changes at intussucpectum walls. B) and C)- Once reduced, a Meckel's diverticulum (black arrow) with a soft tissue mass (asterisk) at the tip is seen at the antimesenteric side of the distal ileum. Surgical resection had to be performed in the distal ileum, 15 cm distal and 2 cm proximal to the Meckel's diverticulum due to ischemic changes (C).

© Hospital Universitario 12 de Octubre - Madrid/ES
Fig. 8: US of a volvulated Meckel’s diverticulum. Fig A. Longitudinal and B axial scans show a markedly dilated Meckel’s diverticulum (black arrows) with a layered wall (gut signature) and surrounding inflamed fat (arrowheads). L: Liver C Axial in vitro US of the specimen. Hyperechoic submucosa (black arrows), hypoechoic muscularis (white arrow) and hyperechoic serosa (double arrows) are seen D. Gross specimen showing a Meckel’s diverticulum on the antimesenteric border of the ileum (long arrow) which is twisted around the vitelline duct remnant (short arrows).

© Hospital Universitario 12 de Octubre - Madrid/ES
Conclusion

Although scintigraphy is highly accurate for the diagnosis of symptomatic Meckel's diverticulum in children, ultrasound can be helpful in patients in whom nuclear medicine studies have been negative. Knowledge of common and uncommon sonographic features of complicated Meckel's diverticulum and its differential diagnosis can aid in early and appropriate diagnosis, without the need of further radiological examinations that may imply ionizing radiation or sedation/anaesthesia.

To summarize the presence of the following US findings should make us think of a complicated Meckel's diverticulum:

- A normally appearing appendix
- Focal increased echogenicity, hyperemia and stranding of mesenteric fat at the right lower quadrant or periumbilical regions
- A blind ending structure with gut signature in continuity with distal ileum, with or without inflammatory local changes
- A blind ending structure with focal inflammatory phenomena measuring more than 25mm in diameter
- A complex intussusception with an echogenic mass with a layered appearance in the middle of intussusceptum.
References


