

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

Alexis Emir Noguera Echeverría<sup>1</sup>, María Fernanda Ibarra Guerrero<sup>2</sup>, Mauricio Gerardo Martínez Morales<sup>3</sup>, Enzo Alejandro Herrera Villaseñor<sup>4</sup>, Carlos Aaron Loeza Duran<sup>4</sup>, Alison Mariel Ruz Alcocer<sup>4</sup>, Felipe de Jesús Triay Novelo<sup>5</sup>, Guiscenthia Rose Tharlene Auguste<sup>5</sup>, Ariadna del Jesús Arcos García<sup>6</sup>, Andrea Polett Quiroz Domínguez<sup>6</sup>, Alix Fernanda Castellanos Ortega<sup>6</sup>, Minerva Jiménez Reyes<sup>7</sup>, Mathilda Giorgia Forfori Palomo<sup>8</sup>, Carlos Enrique Luna Guerrero<sup>9</sup>, Luis Armando López Rico<sup>10</sup>, Jackeline García Glaxiola<sup>11</sup>

<sup>1</sup>Surgical Resident. Clínica Hospital Mérida, ISSSTE. Facultad de Medicina de la Universidad Autónoma de Yucatán.

<sup>2</sup>Pediatrics Resident. Clínica Hospital Mérida, ISSSTE. Facultad de Medicina de la Universidad Autónoma de Yucatán.

<sup>3</sup>Surgical Resident. Hospital General de México "Dr. Eduardo Liceaga", Secretaría de Salud. Universidad Autónoma de México.

<sup>4</sup>Social Service MD Intern. Universidad Anáhuac Mayab.

<sup>5</sup>Social Service MD Intern. Universidad Marista.

<sup>6</sup>Medical Intern. Universidad Anáhuac Cancún.

<sup>7</sup>Medical Intern. Universidad Anáhuac Mayab.

<sup>8</sup>Medical Student. Universidad Anáhuac Cancún.

<sup>9</sup>General Surgeon. Universidad Autónoma de Sinaloa.

<sup>10</sup>General Surgeon. Universidad de Guadalajara.

<sup>11</sup>Social Service MD Intern. Universidad de Guadalajara.

### ABSTRACT

Meckel's diverticulum (MD) is a common congenital anomaly of the gastrointestinal tract, characterized by an outpouching in the terminal ileum. It can be symptomatic in various ways, most commonly causing ulcers and gastrointestinal bleeding. Complications such as bleeding, perforation, diverticulitis, or intestinal obstruction may develop in approximately 4% of patients. Diagnosis can be challenging, but a CT scan is often the tool of choice, particularly for identifying complications. Surgical procedures like laparoscopy or laparotomy provide a more accurate diagnosis. Treatment typically involves surgical removal of the diverticulum, with laparoscopy being a safe and effective method. Risk factors for acute complications in adults include age under 50, male sex, MD length over 2 centimeters, and intradiverticular tissue abnormalities.

### ARTICLE DETAILS

**Published On:**  
**09 April 2024**

**Available on:**  
**<https://ijmscr.org/>**

### INTRODUCTION

Meckel's diverticulum (MD) is a congenital anomaly of the gastrointestinal tract that arises from the incomplete obliteration of the vitelline duct during embryonic development. <sup>(1)</sup> Although Meckel's diverticulum was first described anatomically by Hildanus in 1598, Johann Friedrich Meckel mentioned it embryologically in 1908 by identifying its origin. <sup>(2)</sup>

MD is considered the most common congenital true diverticulum of the gastrointestinal tract, and the most common congenital anomaly of the small intestine accounting for 5% of small intestine diverticulosis. <sup>(1,3)</sup> It is characterized by an outpouching in the terminal ileum that

includes all layers of the gastrointestinal system, making it a true diverticulum. <sup>(1)</sup>

Epidemiological studies have shown that Meckel's diverticulum has a prevalence ranging between 0.3% and 2.9% in the general population. <sup>(4)</sup> Although it is more common in childhood, where it can present with symptoms such as gastrointestinal bleeding or intestinal obstruction, it can also be discovered incidentally during unrelated surgical procedures. <sup>(5)</sup> The clinical presentation of Meckel's diverticulum can be variable, making its timely diagnosis and treatment difficult. <sup>(6)</sup>

The "Rule of 2" for Meckel's Diverticulum [Table 1] is a classic conceptualization that summarizes key characteristics

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

of this congenital anomaly: MD is found in 2% of the population, typically at the age of 2 years or in the first 2 years of life, the male-female ratio is 2:1; the most common location being 2 feet (40 to 100 cm) from the ileocecal valve, approximately 2 inches long (5 cm); MD can present two types of heterotopic mucosa, often gastric (75%) or pancreatic (15%) in nature, and can predominantly cause two types of symptoms: bleeding and obstruction. (2, 3, 7, 8, 9)

**Table 1. The Rule of 2 for Meckel's diverticulum.**

The "Rule of 2" for Meckel's Diverticulum
MD is found in 2% of the population
Typically at the age of 2 years or in the first 2 years of life
Male-female ratio 2:1
The most common location being 2 feet (60 cm) from the ileocecal valve, approximately 2 inches long (5 cm)
Two types of heterotopic mucosa (gastric or pancreatic)
Two types of symptoms: bleeding and obstruction

### CLINICAL MANIFESTATIONS

Meckel's diverticulum can be symptomatic in many ways. Most commonly, acid produced by ectopic gastric mucosa causes ulcers along the mesenteric border of the ileum; of those with hemorrhage, 95% contain gastric mucosa. MD can be a cause of chronic and acute gastrointestinal bleeding in the general pediatric population, but it also occurs in adults. (3) Complications such as bleeding, perforation, diverticulitis, or intestinal obstruction may develop in approximately 4% of Meckel's diverticulum patients. (2)

The 90% of children with symptomatic MD present with features of an acute abdomen. (10) Clinical manifestations in children include hematochezia (lower gastrointestinal bleeding), peritonitis (in rare cases), and intestinal obstruction as key indicators for suspecting this condition. (11, 12, 13) In the case of an inverted diverticulum, manifestations include cyclic vomiting among other symptoms of MD may be diarrhea, constipation, and gas. (14, 15)

Chronic iron deficiency anemia has been reported as an early symptom of MD and elevated inflammatory markers may be suggestive of perforation. (16) In cases of complications like MD torsion (rare), patients may present acute abdominal pain, tenderness in the right iliac fossa, elevated white blood cell count, and imaging findings indicative of ischemia. (17)

In young people, most of the symptoms are caused by occlusion (47%) due to intussusception or a fibrous band connecting the diverticulum to the umbilicus or a mesodiverticular band; painless lower gastrointestinal bleeding (25.3%), diverticulitis (19.5%) and perforation

(10%) (18, 19). Whereas, in adults, the most common clinical presentation is occlusion or obstruction of the small intestine (35.6 to 45%), followed by diverticulitis (29.4%) and hemorrhage (27.3%). In case of complications, the clinical course can be very variable and sometimes difficult to differentiate from other causes of acute abdomen. (2, 3, 18, 20)

Some retrospective studies have identified factors that increase the likelihood that a Meckel diverticulum will be symptomatic. These factors include age less than 50 years, male gender, a diverticulum greater than 2 cm, and containing ectopic tissue or peridiverticular abnormalities. The risk of an MD presenting these symptoms is 17%, 25%, 42%, and 70% when it presents one, two, three, or four of these criteria, respectively. (18)

### DIAGNOSIS

As most MDs are asymptomatic, the diagnosis is usually incidental; in fact, only 6% of cases are diagnosed before surgery. (18)

In the first instance, simple abdominal radiography has limited usefulness and can rarely provide information that modifies therapeutic behavior, except for a complicated MD that presents with intestinal obstruction where it is possible to detect dilation of intestinal loops with air-fluid level within the diverticulum. (21)

The 99m Technetium-pertechnetate-labeled abdominal scintigraphy (Meckel scan) can be used as a diagnostic technique. This imaging modality can help visualize the diverticulum and confirm its presence, visualizing abnormal uptake of technetium in the lower right quadrant of the abdomen. (22, 23)

Meckel scan uses technetium 99m-pertechnetate, which is concentrated and then secreted by mucus-producing cells (gastric mucosa). However, it only identifies the ectopic gastric mucosa, not the hemorrhage. Activity in a Meckel's diverticulum should occur at about the same time as activity in the stomach. The sensitivity of a Meckel scan ranges between 75 and 85% and can supposedly be increased by prior treatment with pentagastrin or glucagon. (3)

Abdominal Computed Tomography (CT) Scan has been reported to be superior to other imaging techniques in the evaluation of complicated MD, however, it may be difficult to distinguish uncomplicated MD from the normal small intestine. Through this examination, it is possible to visualize a tubular structure filled with liquid or gas that arises from the antimesenteric edge of the terminal ileum, enteroliths inside the diverticulum, intestinal invagination, diverticulitis, and small intestine obstruction. (21)

Therefore, a CT scan remains the diagnostic tool of choice for identifying intestinal obstruction and intussusception related to MD. (24) In this way, CT is useful in the diagnosis and evaluation of complications of MD, particularly the formation of intra-abdominal abscesses, obstruction, perforation,

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

tumors, and sometimes allows the detection of extravasation of contrast medium injected intravenously in cases of active intestinal bleeding. <sup>(21)</sup>

On the other hand, computed tomography angiography is based on the location and irrigation of the diverticulum, which is in communication with the superior mesenteric artery and anomalous branches that nourish it. It is used in hemodynamically unstable patients with active bleeding that requires prompt localization for rapid management. It has a sensitivity of 85% and specificity of 92% to find active blood extravasation within the gastrointestinal system, being able to detect active bleeding of 0.3 ml/minute. <sup>(21)</sup>

Video capsule endoscopy has become a new tool for the diagnosis of occult gastrointestinal bleeding in a non-invasive and safe way. <sup>(21)</sup> However, its use for the identification of MD is still limited and the number of described cases of its use is still small. <sup>(25)</sup> Its effectiveness has been demonstrated in finding microbleeds and the anatomical area of the diverticulum. The combined use of a video capsule and double balloon enteroscopy for the etiological diagnosis of occult gastrointestinal bleeding in DM continues to be evaluated and could be an alternative in difficult cases; It is expected that in the future it will be used as a complementary method to the current gold standard. <sup>(21, 25)</sup>

On abdominal ultrasound, a blind incompressible tubular structure can be visualized in thin people, although it can be difficult to distinguish between diverticulitis and acute appendicitis; Furthermore, interobserver variability makes it of little use. <sup>(25)</sup>

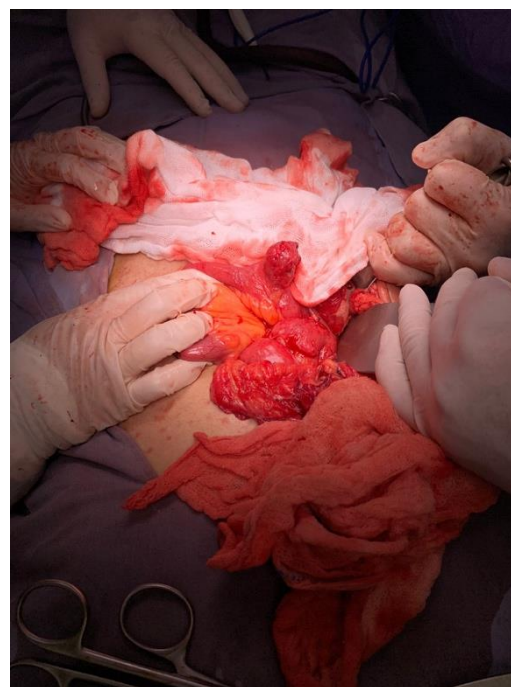
Abdominopelvic magnetic resonance imaging (MRI) is the *gold standard* in pediatric patients; it visualizes MD in most cases (90%) and its complications. The diagnosis is suspected when a cecum structure is identified (the first observed) during retrograde exploration of the small intestine after locating the cecum. <sup>(25)</sup>

The Endoscopic Ultrasound-Guided Fine-Needle Aspiration, not specific to Meckel's Diverticulum, can assist in obtaining cytological or histopathological samples for clarification before surgery. <sup>(26)</sup>

Diagnostic laparoscopy or laparotomy can be a more accurate method for diagnosing MD. <sup>(23)</sup> These surgical procedures allow direct visualization of the abdominal cavity, facilitating the identification of the diverticulum [Image 1, and Image 2]. <sup>(26)</sup> However, they are not recommended as the initial method of choice for diagnosis, only as surgical management and in cases of high clinical suspicion and without having found the cause of the digestive bleeding, both in adults and children. <sup>(21)</sup>



**Image 1. Direct visualization of a Meckel's Diverticulum during a laparotomy of a patient with acute abdominal pain, an incidental finding.**



**Image 2. Non-complicated MD finding with a length of 5 cm and a diameter of 1.5 cm.**

### TREATMENT

Treatment of a symptomatic MD is surgical. <sup>(18)</sup> It involves medical resuscitation and laparoscopic or open surgery to remove the diverticulum (diverticulectomy), fibrous bands (if present), and release any strangulated intestinal segments. <sup>(27)</sup> The resection is often part of the treatment for symptomatic Meckel's Diverticulum. <sup>(28)</sup>

The diverticulectomy with or without adjacent partial small intestinal resection (wedge resection or segmental resection),

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

by open or laparoscopic approach, is the standard treatment for symptomatic Meckel's Diverticulum. (22, 18) Both diverticulectomy and small bowel resection are appropriate approaches for managing symptomatic MD, depending on the surgeon's election. (29)

The laparoscopy or laparoscopy-assisted treatment is a safe and effective method for treating complicated MD compared to the open approach. (30, 31) Laparoscopy-assisted surgery can be performed in cases such as GI bleeding and diverticulitis without massive abdominal distension. (2) Laparoscopy reduces the length of hospitalization and the development risk of hernia in obese patients. (25)

After adequate resuscitation, intestinal obstruction caused by an MD should be treated surgically as quickly as possible, usually by wedge excision and primary closure or amputation with a surgical stapler. (3) Simple diverticulectomy should be attempted if manual reduction is easily performed in early intussusceptions. If the patient presents with late intussusception, segmental resection is a better choice because of edema in the adjacent bowel tissues. Simple diverticulectomy can be performed if there is no necrosis in non-intrusive bowel obstructions. (2)

Diverticulitis within an MD is usually indistinguishable from acute appendicitis and is treated by segmental resection and primary anastomosis. (3) Anastomosis must be performed in a patient who is not in shock, on a healthy digestive tract, without pain, and incongruity between the two digestive segments. Anastomoses can be performed manually or using a mechanical stapler, although the latter seems to present fewer complications. (25)

Hemorrhage and ulcers are also treated by segmental resection and primary anastomosis. In the operation motivated by hemorrhage, segmental resection is recommended, because the ulcer is usually at the mesenteric border of the ileum, compared to the location at the antimesenteric border of MD and occasionally distal to it; or also if the bleeding focus in the adjacent ileum is advanced or large. (2, 3) Despite improvement in diagnostic modalities, most hemorrhagic MDs are diagnosed at laparotomy. (3)

Appendectomy should be considered in any operation for a symptomatic Meckel's diverticulum to prevent any future diagnostic dilemmas. The need to look for an asymptomatic MD during appendectomy or any acute exploratory laparotomy of the abdomen has been described, and if identified, consider a diverticulectomy. (3) In young children, when MD is diagnosed by chance, it should always be removed due to the high risk of complications. (25)

There is no current consensus regarding the attitude that should be taken when Meckel's diverticulum is found incidentally during surgery performed for other causes. Proponents of resection argue that long-term complications are avoided, the rate of which is 6.4% in people over 80 years of age. Furthermore, they claim a lower number of

postoperative complications with prophylactic resection compared to those with surgery for symptomatic MD (2% versus 12%). Another favorable fact is that the incidence of cancer in MD, mainly neuroendocrine, is increasing. According to epidemiological data, it is around 5%. (18)

For adult patients, some risk factors for acute complications should lead to prophylactic resection, if it is discovered incidentally [Table 2]. (25)

**Table 2. Risk factors that should lead to MD prophylactic resection.**

Risk factors in adults to a prophylactic resection
Age < 50 years Male sex MD length greater than 2 centimeters, Intradiverticular tissue abnormalities (heterotopic mucosa, coprolith, inflammatory lesions)

However, opponents of resection insist that the probability of complications throughout life is very low and that the number of postoperative complications does not justify resection. (18) Mortality due to Meckel's diverticulum is low (< 0.001%) and is more common in the pediatric population. Most experts agree that a symptomatic or accidentally discovered Meckel's diverticulum in a young child should be resected. (3)

### CONCLUSION

Meckel's diverticulum is a congenital anomaly of the gastrointestinal tract with a prevalence in the population of 2%. However, although its prevalence could be considered low, its diagnostic suspicion should be part of the differential diagnoses in the evaluation of patients with abdominal pain syndrome, mainly in children up to 2 years of age where an accurate diagnosis has not yet been obtained. In case of a high index of suspicion, several clinical studies are useful for diagnostic reinforcement, such as abdominal CT scan and 99m Technetium-pertechnetate-labeled abdominal scintigraphy. It is important to mention that the definitive treatment of MD is surgical, mainly when a complicated MD is found. In the case of an incidental finding of MD, the decision to perform surgery and the surgical technique used will depend on multiple factors such as the patient's age, sex, hemodynamic status, and characteristics of the small intestine involved, in addition to the dimensions and morphological characteristics of the MD.

### REFERENCES

- I. Kafshgari, R., Majd, A. R., & Ledari, A. T. (2023). Meckel's diverticulum axial torsion: a rare complication case report of a 5-year-old girl. *International Journal of Surgery Case Reports*, 103, 107883. <https://doi.org/10.1016/j.ijscr.2023.107883>.

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

- II. Kocaman, O. H. and Günendi, T. (2022). Different clinical symptoms and surgical treatment of Meckel's diverticulum in children. *Dicle Tip Dergisi*, 49(1), 21-28. <https://doi.org/10.5798/dicletip.1086111>
- III. Cameron, J. L., & Cameron, A. M. (Eds.). (2020). *Terapias Quirúrgicas Actuales* (13a ed.). Elsevier.
- IV. Barbaro, A., Asokan, G., & Trochsler, M. (2021). Neuroendocrine tumor within a meckel's diverticulum. *ANZ Journal of Surgery*, 92(1-2), 285-287. <https://doi.org/10.1111/ans.17022>
- V. Chan, C. K., Pham, T., Bhagat, Y. V., Fulton, W., & Kianmajd, M. (2022). Incidental meckel's diverticulum with neuroendocrine tumor. *Cureus*. <https://doi.org/10.7759/cureus.27625>
- VI. Chang, Y., Chiu, L., Wu, M., & Wei, J. C. (2021). Epidemiology of Meckel's diverticulum: a nationwide population-based study in Taiwan. *Medicine*, 100(50), e28338. <https://doi.org/10.1097/md.00000000000028338>
- VII. Ibáñez, P. E. B. and Velasco, N. (2022). Experiencia en cirugía de urgencia de divertículo de meckel en adultos.. *Revista De Cirugía*, 74(2). <https://doi.org/10.35687/s2452-454920220021355>
- VIII. Guillén-Aguilar, J., Miranda-Ochoa, D., & Gonzales-Arreache, F. (2021). Resección de divertículo de meckel perforado. *Revista Médica (Colegio De Médicos Y Cirujanos De Guatemala)*, 160(1), 80-81. <https://doi.org/10.36109/rmg.v160i1.268>
- IX. Ayala-Garcia, D. E., Porrás-Doran, K. I., Fraga-Ramos, A., & Aguirre-Baca, D. (2023). Meckel's diverticulum presents with intestinal occlusion due to an internal hernia. *International Surgery Journal*, 10(2), 329-331. <https://doi.org/10.18203/2349-2902.isj20230014>
- X. Ghritlaharey, R. K. (2021). Management of symptomatic meckel's diverticulum in infants and children. *Annals of the National Academy of Medical Sciences (India)*, 58(01), 011-016. <https://doi.org/10.1055/s-0041-1739190>
- XI. Modna, Y. (2021). Non-operative reduction of intussusception in a 16-month-old boy with a sudden episode of hemorrhaging deterioration via reperfusion of meckel's diverticulum: a case report. *The Central European Journal of Paediatrics*, 17(1), 43-47. <https://doi.org/10.5457/p2005-114.286>
- XII. Fu, T., Xu, X., Geng, L., Huang, Y., Ding, G., & Ji, H. (2021). The clinical manifestation variety and management choice of Meckel's diverticulum with complication: a single center experience. *Gastroenterology Research and Practice*, 2021, 1-4. <https://doi.org/10.1155/2021/6640660>
- XIII. Özbey, H. and Morozov, D. (2023). Inverted Meckel diverticulum in a 13-year-old boy. *Journal of Pediatric Gastroenterology & Nutrition*, 77(2), e48-e48. <https://doi.org/10.1097/mpg.00000000000003820>
- XIV. Endo, Y., Jimbo, K., Arai, N., Ochi, T., Suzuki, M., Yamataka, A., ... & Shimizu, T. (2022). A pediatric case of inverted meckel's diverticulum presenting with cyclic vomiting-like symptoms: a case report and literature review. *Children*, 9(12), 1817. <https://doi.org/10.3390/children9121817>
- XV. Kopystecka, A., Kopeć, I., Mitek-Palusińska, J., & Woźniak, M. (2022). Intestinal intussusceptions in children population. *Journal of Education, Health, and Sport*, 12(8), 1176-1189. <https://doi.org/10.12775/jehs.2022.12.08.102>
- XVI. Alvarez, L. M., Rajderkar, D., & Beasley, G. (2023). An unusual case of a perforated meckel's diverticulum. *Case Reports in Pediatrics*, 2023, 1-4. <https://doi.org/10.1155/2023/2289520>
- XVII. Goh, A. G. W., Bee, S. W. L., & Yeong, K. Y. (2021). Axial torsion of meckel's diverticulum on imaging: a rare but important complication to consider. *ANZ Journal of Surgery*, 92(7-8), 1938-1940. <https://doi.org/10.1111/ans.17407>
- XVIII. Parrilla Paricio, P., García-Granejo Ximénez, E., Martín Pérez, E., Morales-Conde, S., Navarro Soto, S., & Targarona Soler, E. M. (2022). *Cirugía AEC: Manual de la Asociación Española de Cirujanos*. Editorial Médica Panamericana.
- XIX. Su, Y., Ko, P., Chen, Y., Shih, H., & Tsai, C. (2022). Chronic nocturnal abdominal pain as the presentation of inverted Meckel diverticulum: a case report. *Children*, 9(1), 69. <https://doi.org/10.3390/children9010069>
- XX. Joshi, P., Belbase, N. P., Mishra, R., Karki, M., & Das, L. K. (2020). Clinicodemographic profile and outcome of patients with symptomatic meckel's diverticulum: preliminary findings. *Journal of College of Medical Sciences-Nepal*, 16(1), 37-40. <https://doi.org/10.3126/jcmsn.v16i1.26769>
- XXI. Sandoval Silva, G. E., Toro-Pérez, J., Pohl Vollmer, E., Hurtado, J. P., Zambra Rojas, M., & Sanguineti Montalva, A. (2024). Divertículo de Meckel y sus complicaciones. *Revista de Cirugía*, 76(1). <https://doi.org/10.35687/s2452-454920240011786>
- XXII. Chen, Y., Liu, Y., Jiang, L., Jiang, F., & Zhu, T. (2021). Axially torsional meckel's diverticulum accompanied by small bowel volvulus: a case report. *Journal of International Medical Research*, 49(10), 030006052110535. <https://doi.org/10.1177/03000605211053554>
- XXIII. Sapalidis, K., Sevva, C., Magra, V., Manaki, V., Koulouris, C., Roulia, P., ... & Κεσίσογλου, I. (2021). Internal hernia and volvulus in an adult male caused by meckel's diverticulum: a case report. *Medicina*, 57(5), 443.

## Meckel's Diverticulum: A Literature Review of Basic Concepts, Diagnosis and Treatment Options

<https://doi.org/10.3390/medicina57050443>

- XXIV. Shirakabe, K. and Mizokami, K. (2023). A case of torsion of Meckel's diverticulum. *Cureus*.  
<https://doi.org/10.7759/cureus.33850>
- XXV. Moszkowicz, D., Massalou, D., & Voiglio, E. J. (2015). Cirugía del divertículo ileal. *EMC - Técnicas Quirúrgicas - Aparato Digestivo*, 31(4), 1–10.  
[https://doi.org/10.1016/s1282-9129\(15\)74153-x](https://doi.org/10.1016/s1282-9129(15)74153-x)
- XXVI. Li, C., Zhang, X., Zhao, C., & Liu, M. (2022). Abdominal bronchogenic cyst: a rare case report. *World Journal of Clinical Cases*, 10(34), 12671-12677. <https://doi.org/10.12998/wjcc.v10.i34.12671>
- XXVII. Dang, V. C., Tran, P. N., Tran, M. C., Pham, V. T., & Nguyen, T. T. N. (2023). Intestinal obstruction due to ligament arising from the distal end of meckel's diverticulum: a case report. *Clinical Case Reports*, 11(6). <https://doi.org/10.1002/ccr3.7608>
- XXVIII. Garza, E., Douglas, A. E., & Sun, R. C. (2022). Acute intestinal obstruction and localized peritonitis from a perforated meckel's diverticulum in a child. *The American Surgeon™*, 89(11), 4984-4986.  
<https://doi.org/10.1177/00031348221146970>
- XXIX. Brungardt, J., Cumiskey, B., & Schropp, K. (2020). Meckel's diverticulum: a national surgical quality improvement program survey in adults comparing diverticulectomy and small bowel resection. *The American Surgeon*, 87(6), 892-896.  
<https://doi.org/10.1177/0003134820954820>
- XXX. Chou, J., Chung, C., Huang, T., Tu, C., Chang, C., Chang, C., ... & Chiu, C. (2021). Meckel's diverticulum diagnosed by balloon-assisted enteroscopy: a multicenter report from the Taiwan association for the study of small intestinal diseases (tassid). *Gastroenterology Research and Practice*, 2021, 1-10. <https://doi.org/10.1155/2021/9574737>
- XXXI. Halabi, M., Abid, G., Zenilman, M., & Moussa, H. (2022). Treatment of an unusual case of meckel's diverticulum with a new robotic platform. *International Journal of Surgery Case Reports*, 99, 107613. <https://doi.org/10.1016/j.ijscr.2022.107613>