ONLINE VERSION: ISSN 1028-4818
RPNS-1853

Multimed 2024; 28:and 2790

Bibliographic review

Digestive ultrasound of inflammatory bowel disease in pediatrics

Digestive ultrasound of inflammatory bowel disease in pediatrics

Digestive ultrasound of intestinal inflammatory disease in pediatrics

Miguel Angel Amaró Garrido I* https://orcid.org/0000-0002-0532-9273

Mirian Belkis Nápoles Valdés II https://orcid.org/0000-0003-4614-8361

Tatiana Hernández González II https://orcid.org/0000-0002-6693-5840

Yurisbel Tomás Solenzal Alvarez II https://orcid.org/0000-0001-5795-7979

[Yo]Sancti Spíritus University of Medical Sciences. Juana Naranjo León University Polyclinic. Sancti Spíritus, Cuba.

[II]Camilo Cienfuegos Provincial General Hospital. Sancti Spíritus, Cuba.

[*]Corresponding author. Email:maagdo85@gmail.com

SUMMARY

Inflammatory bowel disease is a health problem that currently generates high morbidity in pediatric patients. Multiple diagnostic methods allow for its evaluation, including, and increasingly used, gastrointestinal ultrasound. The objective of this research was to provide an updated overview of the usefulness and suitability of this technique for monitoring inflammatory bowel disease in pediatric patients. The most recent and in-depth national and international literature on the topic was compiled and reviewed over a four-month period

ONLINE VERSION: ISSN 1028-4818
RPNS-1853

(February 2022 to May 2022). The search strategy adopted was the use of keywords or descriptors in Spanish and English, such as: inflammatory bowel disease, pediatrics, Crohn's disease, ulcerative colitis, ultrasound, and gastrointestinal ultrasound. A total of 50 articles were used, from different databases such as Scielo, PubMed/Medline, Ebesco, Clinical Key, and Springer. Thirty citations were selected for review, which analyzed the importance of the technique in describing intestinal ultrasound characteristics in pediatric patients, confirming its role in the early identification and intervention of inflammatory bowel disease.

Keywords: Ulcerative colitis; Crohn's disease; Inflammatory bowel disease; Pediatrics; Digestive ultrasound.

ABSTRACT

Inflammatory bowel disease is a health problem that currently causes high morbidity in pediatric patients. There are several diagnostic methods that allow its evaluation, among which gastrointestinal ultrasound is increasingly used. The aim of this research was to provide an updated review of the usefulness and suitability of this technique in the follow-up of inflammatory bowel disease in pediatric patients. A compilation and review of the national and international literature of greater novelty and depth in the treatment of the subject was made over a period of 4 months (February 2022 to May 2022). The search strategy adopted was the use of keywords or descriptors in Spanish and English such as: inflammatory bowel disease; pediatrics; Crohn's disease; ulcerative colitis; ultrasound; digestive ultrasound. A total of 50 articles were used from different databases such as: Scielo, PubMed/Medline, Ebesco, Clinical Key and Springer. Thirty citations were selected for review, analyzing the importance of the technique in the description of intestinal ultrasound characteristics in pediatric patients, confirming its role in the identification and early intervention of inflammatory bowel disease.

Keywords: Ulcerative colitis; Crohn's disease; Inflammatory bowel disease; Pediatrics; gastrointestinal ultrasound.

ONLINE VERSION: ISSN 1028-4818
RPNS-1853

SUMMARY

Inflammatory intestinal disease is a health problem that currently causes high morbidity in pediatric patients. There are several diagnostic methods that allow their evaluation, among which gastrointestinal ultrasound is increasingly used. The objective of this work was to make an updated review of the usefulness and adequacy of this technique in monitoring intestinal inflammatory disease in pediatric patients. It is a compilation and review of national and international literature of greater novelty and depth in the treatment of the topic, during a period of 4 months (February 2022 to May 2022). The search strategy adopted was the use of key words or descriptors in Spanish and English, such as: intestinal inflammatory disease; pediatrics; Crohn's disease; ulcerative colitis; ultrassom; digestive ultrassom. Foram used 50 articles from different databases, such as: Scielo, PubMed/Medline, Ebesco, Clinical Key and Springer. Foram 30 citations were selected for review, analyzing the importance of the technique in the description of intestinal ultra-sonographic characteristics in pediatric patients, confirming its role in early identification and intervention of inflammatory bowel disease.

Keywords: Ulcerative colitis; Crohn's disease; Inflammatory intestinal disease; Pediatrics; gastrointestinal ultrasonography.

Received: 07/03/2023

Approved: 01/22/2024

Introduction

Conventional abdominal ultrasound is an accessible, rapid, and effective technique regularly applied in real time for the study of hepatobiliary, pancreatic, and urogenital diseases.

However, it has also proven useful in certain digestive entities such as intestinal intussusception, hypertrophic pyloric stenosis, appendicitis, acute diverticulitis, and intestinal obstruction. Its easy availability, minimal invasiveness, and high diagnostic yield make it a capable means of detecting and characterizing intestinal lesions and extraintestinal abnormalities, as well as the ability to assess transmural damage associated with inflammatory activity. Therefore, it constitutes a first-line diagnostic approach. However, its usefulness for evaluating the digestive tract is less established for reasons such as technological development in other diagnostic techniques, poor image quality in obese patients, a reluctance by gastroenterologists to assess the validity of the results, and intestinal contents themselves, which impede the passage of sound and produce artifacts. Ultrasound examination of the intestinal wall requires experience, rigorous systematics, and careful, gradual compression to displace fecal debris and gaseous contents. Despite this, it is a useful first-line technique in the monitoring of inflammatory bowel disease. (1-5)

Inflammatory bowel disease (IBD) in children has been increasing in incidence in recent years, both in industrialized and developing countries. It causes chronic inflammation of the digestive tract and a course that alternates between periods of crisis and remission. In pediatric patients, the clinical manifestations are unique and differentiate them from those in adults, sometimes leading to a delay in diagnosis. The term inflammatory bowel disease includes two diseases of unknown etiology: ulcerative colitis (UC) and Crohn's disease (CD). These diseases are defined according to clinical, imaging, endoscopic, and histological criteria. Both present a chronic course with flares of inflammatory activity. (6-8)

IBD is classified according to the segment of damage, the degree of involvement, and, in the case of CD, the pattern of involvement (inflammatory, stenosing, or fistulizing). In children, gastroduodenal involvement is more common, and in most cases of UC, it is extensive. In CD, the predominant pattern is inflammatory. (8,9)

For the diagnosis of IBD, the traditional imaging method used is barium swallow; however, it has limitations such as poor infant cooperation, the use of ionizing radiation, and poor assessment of extraintestinal involvement. This has led it to currently occupy a secondary role in the study of this disease in pediatrics. The implementation of digestive ultrasound has made it possible to assess not only the intestinal lumen but also mural and extraintestinal involvement. (10,11)

The objective of this paper is to provide an updated overview of the usefulness and suitability of ultrasound in the diagnosis and follow-up of IBD in pediatric patients.

Development

The study of the digestive tract with ultrasound is currently experiencing a boom due to its advantages over other techniques such as endoscopy, CT, or MRI. Its ability to assess the intestinal wall and surrounding elements without the need for contrast, as well as the possibility of evaluating the elasticity and peristalsis of these structures, are generating growing interest in its application. Improved equipment resolution and the growing experience of imaging specialists allow the development of this technique in many more settings. Furthermore, ultrasound is an accessible and well-tolerated tool for pediatric patients; it requires no prior preparation and provides more detail than CT in assessing the layers of the intestinal wall and intestinal motility. Limitations include difficulty in following the entire small intestine, poorer image quality in obese patients, and the fact that image acquisition and interpretation are operator-dependent. (10-14)

Echostructure of the intestinal wall

The correlation between anatomy and the sonographic appearance of the digestive tract is considered adequate in clinical practice, although the different acoustic interfaces that produce the sonographic appearance of layers do not correspond exactly with the histological

differences. (12-15). Sonographically, up to 5 layers can be differentiated (Fig. 1) with alternating hyperechoic and hypoechoic layers, identifying a reproducible pattern or "SIGNATURE OF THE DIGESTIVE TRACT".

The "SIGNATURE OF THE DIGESTIVE TRACT" has five concentric layers that from the lumen to the outside are:

1. Mucosa: hyperechoic
2. Muscular mucosa: hypoechoic
3. Submucosa: hyperechoic
4. Muscularis propria: hypoechoic
5. Serosa or Adventitia: hyperechoic

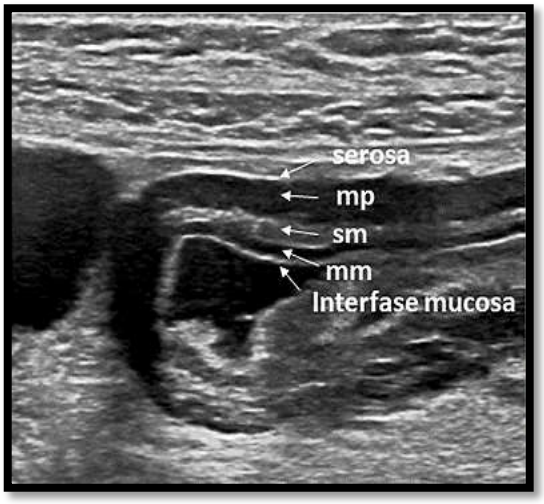

Fig. 1. Echostructure of the intestinal wall with alternating hyperechoic and hypoechoic layers. (15)

The small intestine is distinguished from the colon by its continuous peristaltic capacity, sinuous course, and the presence of connivent valves, which are more pronounced when fluid is present and in more proximal segments (jejunum). As with other imaging techniques, the loops of the jejunum and ileum cannot be differentiated. Ultrasound uses topographic criteria for identification, so that loops of the small intestine located in the infraumbilical region are generally considered ileal loops, and those located in the supraumbilical region are considered

jejunal loops. The typical sonographic appearance of the colon is haustration, and it is differentiated from the small intestine by the arrangement of gas waves and the absence of peristalsis (Fig. 2A-B).

T

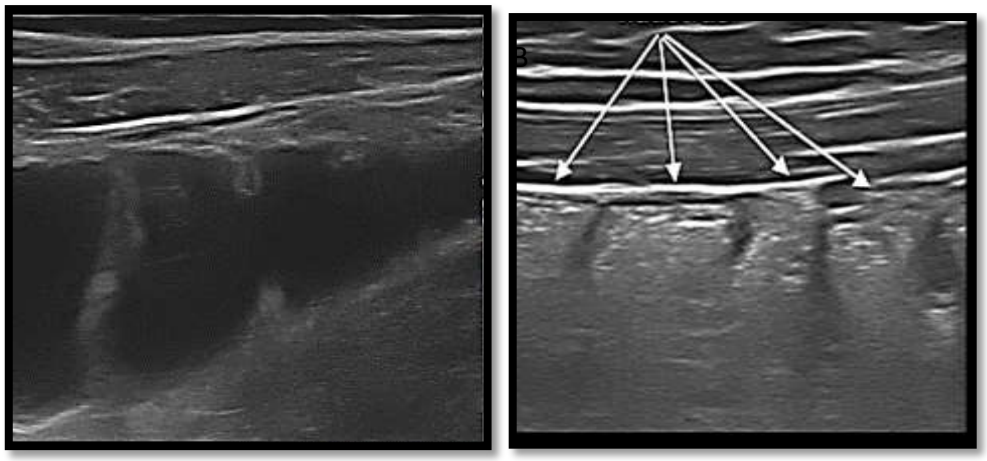

Fig. 2A-B. Echostructure of the intestinal wall of the colon in a healthy patient. (3)

Study method: It is recommended to perform the study on an empty stomach. The examination can be initiated with a 3 to 5 MHz convex transducer, through a systematic scanning of the entire abdomen. If alterations in the digestive system are evident, a targeted examination should always be performed with a high-resolution linear transducer. The graduated compression technique is used to displace gas and decrease the distance between the transducer and the area to be examined. Healthy bowel loops collapse with this maneuver, while thickened loops do not change in size. Another advantage of ultrasound examination is the ability to perform clinical palpation with the transducer and simultaneously observe the area in which the patient reports discomfort in real time. The examination of the digestive tract may be deficient in obese patients due to lack of sound wave penetration or the presence of abundant gas and fecal matter inside. High-resolution transducers can demonstrate the anterior wall of the intestine. Ultrasound allows for targeted examination by correlating the image with the patient's symptoms. (16-20)

Different ranges of intestinal wall thickness are proposed, from 1 to 5 mm. These differences are due to the equipment and frequencies used, the different examination techniques, and the degree of abdominal compression during measurement. Currently, with the use of high-frequency probes, most authors consider a normal wall thickness of approximately 3 mm, and a medium abdominal compression is employed. (14,15,18)

Parameters to take into account:

- Wall thickness: 3-5 mm is considered normal, depending on the degree of intestinal distension.
- Intestinal contents.
- Diameter.
- Compressibility.
- Motor activity or peristalsis.
- Doppler signal: in healthy intestine it is generally low.
- Changes in the mesentery and adjacent interlayers.

The colon is located on the periphery of the abdomen; the position of the ascending and descending colons, being retroperitoneal viscera, is fixed, in the dorsal-lateral portion of the abdomen. The cecum is easily identified by following the ascending colon. The hepatic flexure can be located just below the caudal portion of the right hepatic lobe, and the splenic flexure between the spleen and left kidney. Both angles can generally be identified subcostally, aided by the patient's forced inspiration, although an intercostal approach is sometimes valid. However, the position of the transverse and sigmoid colons can vary significantly depending on the length of their mesenters. To examine the transverse colon, the ultrasound scan should begin in the epigastrium from the subxiphoid region and proceed caudally to the infraumbilical region. The sigmoid can be located above the iliac vessels and the psoas muscle in the left

inguinal region. Abdominal ultrasound is not a suitable test for assessing the rectum due to its pelvic location. (20-23)

Ultrasonographic features of Crohn's disease and ulcerative colitis.

Crohn's disease: According to research by various authors, the high sensitivity and precision of digestive ultrasound in pediatric patients to detect suspected CD has been shown, these describe the accuracy of the technique in detecting wall thickening compared to other imaging techniques such as CT and MRI, with a specificity of more than 90%, concluding that it is an appropriate means to confirm or rule out its presence. (20,23) Several studies also express better results in the detection of the disease in the ileum, ascending or descending colon, which have been observed markedly affected in a discontinuous manner, with rigidity or decreased peristalsis, it is also common to observe thickening of the submucosa especially if the disease has some time of evolution, while the sensitivity is lower for lesions located in the jejunum or rectum. (20-22) In addition, with high frequency probes it is possible to observe linear hyperechoic or hypoechoic paths (depending on whether they contain gas or not) that pass through the layers in depth and which correspond to ulcerations that will cause greater or lesser destructuring of the layer pattern. (Fig. 3).

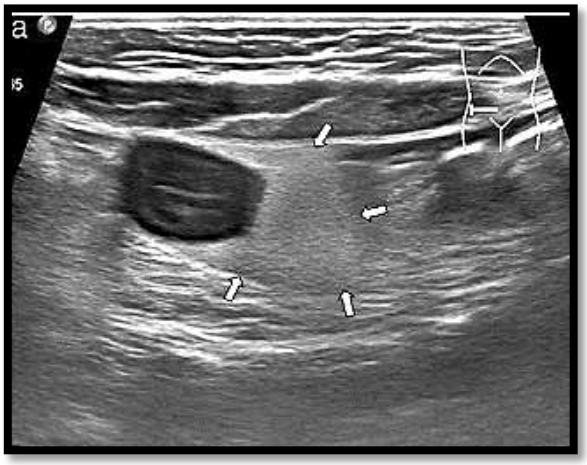

Fig. 3. Cross section of an intestinal loop showing the characteristic ultrasound data of CD involvement. (15)

Other authors point out different classic signs to differentiate CD from other processes that produce thickening of the intestinal wall, among them is the affectation of the mesenteric fat adjacent to the thickened loop, generally characterized by having a homogeneous appearance, almost isoechogenic to the submucosa, which causes edema and fibrosis in the mesentery and is described as the most striking alteration in the ultrasound of patients with perientric processes. The presence of lymphadenopathy has also been identified in the active phase of the disease, these appear as focal, rounded hypoechoic masses that surround the affected intestinal segment. (19,20,21)

Blood flow assessment is useful for monitoring inflammatory activity and response to treatment. Different studies have shown that an early histological change appears in patients with active CD with the presence of neovascularization of the intestinal wall. Color Doppler allows to see hyperemia in both the vessels of the affected intestinal segment and the main intestinal vessels, Ahmed R et al (22) showed that the measurement of blood flow in the superior mesenteric artery correlated with disease activity, which showed a significantly elevated flow, this demonstrates the capacity of digestive ultrasound with respect to other techniques by offering both a quantitative and qualitative assessment of the disease.

In UC, the clinical indices used correlate well with the inflammatory activity of the disease and are used to decide on the start of treatment and monitor response. However, this is not the case in CD, where good clinical indices are lacking, and imaging techniques play a fundamental role in demonstrating the presence or absence of inflammatory activity and complications. (19-22)

Finally, the most specific finding for diagnosing CD, apart from discontinuous involvement, is the presence of strictures, fistulas and abscesses. (20-23)

Ulcerative colitis:UC exclusively affects the colon, with damage only to the mucosal layer. It extends regularly and continuously from the rectum in a variable proximal direction, although the extent of the disease may vary without affecting the terminal ileum. Unlike CD, the layering pattern is preserved, except in severe flares of the disease or megacolon, where ulcers and wall destructuring may occur. Typically, the pericolic muscularis and fat are not usually affected. Finally, wall thickening depends on the first layer, and occasionally the submucosa may be increased due to edema or fibrosis. (23-26)

No correlation has been found between wall thickening and clinical activity. However, some authors have found a greater correlation between ultrasound and endoscopic findings in UC than in CD (18-23).

The usefulness of ultrasound in UC is important in several clinical scenarios, such as in the assessment of disease extension in cases of incomplete colonoscopy, in a severe onset of the disease where it helps in the differential diagnosis in cases of indeterminate colitis in order to rule out small bowel involvement, and finally, it is an alternative to colonoscopy in disease flares to assess disease activity or extension. However, ultrasound is not useful for evaluating the colon when toxic megacolon and its complications are suspected. (19-22)

Diagnosis of complications.

Abscesses: Abdominal abscesses present as a hypoanechoic image with diffuse borders, which may or may not contain echogenic content (gas). Using high-frequency probes, the presence of intraparietal abscesses can be identified as generally well-defined hypoechoic images. Depending on their location in the abdominal cavity, they can be classified as intraperitoneal (superficial or deep) or retroperitoneal. (21,27,28)

Fistulas: Fistulas are visualized as hypoechoic tracts or areas originating from a thickened intestinal loop that connect one intestinal loop with another loop or with other organs,

retroperitoneum or skin, which may have echogenic content inside (gas), or end blindly in the mesenteric fat (enteromesenteric fistulas). (22,26)

Stenosis: Strictures are identified as segments of thickened, aperistaltic walls with narrowing of the lumen. Prestenotic dilation is present, identified by fluid distension or echogenic content in the anterior loop.

The echostructure of the intestinal wall, as well as the vascular density of the stenotic segment, provides an approximation of the histological changes and the possibility of discriminating between fibrotic or inflammatory strictures. (25-27) Thus, both the loss of stratification and the increase in intramural vascularization are present in inflammatory strictures, whereas strictures with stratification (especially at the expense of the submucosa) with vascular poverty are more characteristic of predominantly fibrotic strictures. (26,29,30)

The authors of this research express that there are many prospective studies that compare abdominal ultrasound with other diagnostic techniques such as endoscopy, barium studies, CT, entero-MRI or capsule endoscopy, considering them better in certain qualitative aspects during the follow-up of the disease in children, however, these procedures generally cause anxiety and little cooperation from them; It is important to mention the main reason that distinguishes digestive ultrasound in pediatrics over the others, is that in addition to being an effective technique with important qualitative data, it is a non-invasive method, without radiation, it is easy to accept by the child, it is accessible and repeatable, which generates progressive interest in its use.

Conclusions

Digestive ultrasound is a seemingly complex and undervalued first-line technique for the diagnosis and follow-up of digestive diseases. Despite some limitations, it offers several advantages for the doctor-patient relationship that justify its effectiveness, such as accessibility,

the absence of ionizing radiation, dynamism, greater speed than other imaging studies, and diagnostic reliability in the evaluation of pediatric patients with IBD, both in the initial diagnosis and during follow-up.

Bibliographic references

1. Sangüesa Nebot C, Llorens Salvador R. Intestinal ultrasound in pediatrics. Radiology. 63(3): 291-304.

2. Goodsall TM, Nguyen TM, Parker CE, Ma C, Andrews JM, Jairath V, et al. Systematic Review: Gastrointestinal Ultrasound Scoring Indices for Inflammatory Bowel Disease. J Crohns Colitis. 2021;15(1):125-42.

3. Ripollés T, Muñoz F, Martínez-Pérez MJ, de Miguel E, Cordón JP, de la Heras Páez de la Cadena B. Usefulness of intestinal ultrasound in inflammatory bowel disease. Radiology (Engl Ed). 2021 Jan-Feb; 63(1):89-102.

4. Miquel M, Puig J, Montoliu S, Belmonte E, Loras C, Roson N. Positioning document of the Societat Catalana Digestologia and the Societat Catalana de Radiology: ultrasound for specialists in digestive diseases in Catalonia. Gastroenterology and Hepatology. 2022; 45(2022):77-81.

5. Vizuete del Río J, Martín Benítez G, Ripollés González T, Merino Bonilla JA, San Miguel T. Intestinal ultrasound and acute abdomen: beyond acute appendicitis. Radiology.2021; 63(2):193-205.

6. Turner D, Ruemmele FM, Orlanski Meyer E, Griffiths AM, de Carpi JM, Bronsky J, et al. Management of pediatric ulcerative colitis, part 1: Ambulatory Care-An Evidence-based Guideline From European Crohn's and Colitis Organization and European Society of Pediatric Gastroenterology, Hepatology and Nutrition J Pediatr Gastroenterol Nutr. 2018;67(2):257-91.

7. Martín-de-Carpi J, Jiménez Treviño S, Pujol Muncunill G, Martín-Masot R, Navas-López VM. Time to diagnosis in pediatric inflammatory bowel disease: Keys to diagnosis. An Pediatr (Engl Ed). 2020 Apr; 92(4):242. e1-242.e9.

8. Moriczi M, Pujol-Muncunill G, Martín-Masot R, Jiménez Treviño S, Segarra Cantón O, Ochoa Sangrador C, et al. Predictors of Response to Exclusive Enteral Nutrition in Newly Diagnosed Crohn's Disease in Children: PRESENCE Study from SEGHNP. Nutrients. 2020 Apr 7; 12(4):1012.

9. de Ridder L, Assa A, Bronsky J, Romano C, Russell RK, Afzal NA, et al. Use of biosimilars in pediatric Inflammatory Bowel Disease: An updated position statement of the pediatric IBD Porto group of ESPGHAN. J Pediatr Gastroenterol Nutr. 2019; 68(1):144–53.

10. Elliott CL, Maclachlan J, Beal I. Pediatric bowel ultrasound in inflammatory bowel disease. Eur J Radiol. 2018; 108:21-7.

11. Panizza PS, Viana PC, Horvat N, Dos Santos VR Júnior, de Araújo DA, Yamanari TR, et al. Inflammatory Bowel Disease: Current Role of Imaging in Diagnosis and Detection of Complications: Gastrointestinal Imaging. Radiographics. 2017; 37(2):701-2.

12. Molina Gutiérrez MÁ, Pérez Vigara A, Martínez Ojinaga Nodal E, Bueno Barriocanal M, López López R. Value of abdominal ultrasound in the evaluation of acute infectious ileitis in children. An Pediatr. 2021; 18: s1695–4033.

13. Furfaro F, Dal Buono A, Allocca M, D'Amico F, Zilli A, Gabbiadini R, et al. Bowel ultrasound in inflammatory bowel disease: how far in the grayscale? Life. 2021; 11(7):649.

14. Serejo Soares Branco DM, Bodlak DC, Martinez DMJ, Martinez DP, Cabezuelos DL, Malo DJ. Intestinal neoplasms: ultrasound manifestations that we should be aware of. Seram [Internet]. 2022 [cited 3 /03/2023]; 1(1). Available from:https://piper.espacio-seram.com/index.php/seram/article/view/9674

15. Martínez Pérez MJ, Blanc García E, Merino Bonilla JA. Intestinal ultrasound: examination techniques, normal and pathological patterns. Radiology. 2020;62(6):517-27.

16. Vicentín R, Wagener M, Pais AB, Contreras M, Orsi M. Prospective one-year registry of inflammatory bowel disease in an Argentine pediatric population. Arch. argent. pediatr. 2017; 115(6):533-40.

17. Andrzejewska M, Grzymisławski M. The role of intestinal ultrasound in diagnoses of bowel diseases. Prz Gastroenterol. 2018;13(1):1-5.

18. Atkinson NS, Bryant RV, Dong Y, Maaser C, Kucharzik T, Maconi G, et al. How to perform gastrointestinal ultrasound: Anatomy and normal findings. World J Gastroenterol. 2017;23(38):6931-41.

19. Ripollés González T. Presentation of the series "Ultrasound of the digestive tract. Radiology. 2020;62(6):515-6.

20. Hollerweger A, Maconi G, Ripolles T, Nylund K, Higginson A, Serra C, et al. Gastrointestinal Ultrasound (GIUS) in Intestinal Emergencies - An EFSUMB Position Paper. Ultraschall Med. 2020 Dec; 41(6):646-57.

21. Couper MR, Lewindon PJ. EP1364: Intestinal ultrasonography for pediatric inflammatory bowel disease, diagnosis, and monitoring in conjunction with serological tests and faecal calprotectin. Gastroenterology. 2022;162(7): s1112.

22. Ahmed R, Debian H, Fawzi M, Elsergany HF, Soliman MY, Mohmed Halem AA, et al. Diagnosis of Inflammatory Bowel Disease by Abdominal Ultrasound and Color Doppler Techniques. Curr Med Imaging. 2021; 17(9):1085-93.

23. Carlavilla Pérez SM, Casanovas Feliu SE, Edo Prades DM, Rocafuerte Ávila SC, Tomás Chenoll SM, Marín Lambíes SN. Basic survival guide for residents in intestinal ultrasound. Seram [Internet]. 2021[cited 26/01/2024]; 1(1). Available from:https://piper.espacio-seram.com/index.php/seram/article/view/4704/3170

24. Kunze G, Seitz K, Mauch M, Petersen F. Clinical Ultrasound in Inflammatory Bowel Disease. Ultraschall Med. 2019; 40(2):132-62.

25. Taylor K. Non-IBD findings in intestinal ultrasound. Ultrasound Med Amp Biol. 2019; 45(1): s11.

26. Zorzi F, Montesano L, Cristofaro ED, Lolli E, Biancone L, Monteleone G, et al. Mo1531: Monitoring ulcerative colitis using intestinal ultrasound. Gastroenterology. 2022; 162(7): s806.

27. Moncayo Hinojosa MP, Mañas Hernández A, Parra Salcedo N, Gill S, Gomez Peña S, Peñalver Calero P, et al. The value of ultrasound in intestinal pathology. Seram [Internet]. 2022 [cited 3/03/2023]; 1(1). Available from:https://piper.espacio-seram.com/index.php/seram/article/view/9506/7972

28. Miranda Bautista J, De Miguel Campos E, Lanzarote Vargas L, Llorente Peris J, Otermin Barrera P, Buongermini RE. Crohn's disease: correlation between intestinal ultrasound and enteric MRI. Our experience. Seram [Internet]. 2021 [cited 7/03/2023]; 1(1). Available from:https://piper.espacio-seram.com/index.php/seram/article/view/3411/1877

29. Fernández Hernández CM, Sarabia Tirado F, Martinez Paredes Y, Domenech Abellán E, Serrano García C, Gilabert Úbeda A. Enteral MRI in the study of Crohn's disease in children: our experience. Seram [Internet]. 2018 [cited 7/03/2023]. Available at:https://piper.espacio-seram.com/index.php/seram/article/view/47/46

30. Poza Cordón J, Ripollés González T. Usefulness of abdominal ultrasound in the diagnosis and monitoring of inflammatory bowel disease. Rev. esp. enferm. dig. 2014; 106(6): 395-408.

Conflict of interest

The authors declare no conflicts of interest.

Authorship contribution:

Conceptualization: Miguel Angel Amaró Garrido.

Data curation: Miguel Angel Amaró Garrido.

Formal analysis: Miguel Angel Amaró Garrido,Mirian Belkis Nápoles Valdés.

Funding Acquisition: This research did not rely on the acquisition of funds.

Research: Miguel Angel Amaró Garrido,Mirian Belkis Nápoles Valdés, Tatiana Hernandez Gonzalez, Ana Lucia Martinez Hernandez.

Methodology: Miguel Angel Amaró Garrido,Mirian Belkis Nápoles Valdés, Tatiana Hernandez Gonzalez, Ana Lucia Martinez Hernandez.

Project management: Miguel Angel Amaró Garrido.

Resources: Tatiana Hernandez Gonzalez, Yurisbel Tomas Solenzal Alvarez.

Software: Tatiana Hernandez Gonzalez, Yurisbel Tomas Solenzal Alvarez.

Supervision: Miguel Angel Amaró Garrido.

Validation: Tatiana Hernández González,Mirian Belkis Nápoles Valdés.

Visualization: Miguel Angel Amaró Garrido.

Original draft written by: Miguel Angel Amaró Garrido,Mirian Belkis Nápoles Valdés.

Editing, review and editing: Miguel Angel Amaró Garrido,Mirian Belkis Nápoles Valdés, Tatiana Hernández González, Yurisbel Tomás Solenzal Álvarez.