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DIAGNOSTIC ACCURACY OF ULTRASOUND FOR SMALL BOWEL OBSTRUCTION: A SYSTEMATIC REVIEW

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Abstract

An obstruction of the small bowel, which can be caused by mechanical blockage of the bowel, is a prevalent medical emergency that requires surgical intervention. However, intra-abdominal adhesions are the leading cause of small intestine obstruction in industrialized countries. Obstruction of the small bowel can be caused by a wide variety of pathologic events; however, the most prevalent cause is intra-abdominal adhesions. Radiographs are routinely used as a supplementary imaging modality; however, ultrasonography is an imaging modality that is both more sensitive and more specific than radiographs. POCUS is an efficient approach for detecting dilated loops of intestine in patients whose diagnoses may be consistent with SBO. It is probable that employing POCUS may reduce the number of CT scans that are required in order to arrive at an appropriate diagnosis of SBO. This, in turn, will speed up the surgical management and care of patients in the emergency department. When evaluating these patients, however, it is important to exercise caution when interpreting negative ultrasound findings due to the fact that POCUS is less sensitive than other ultrasound techniques. According to the findings of recent studies, diagnostic ultrasound, particularly when performed using POCUS, has a high degree of accuracy. The sensitivity and negative predictive value of a US examination in determining SBO are practically both one hundred percent.

Keyword: *Accuracy; Diagnostic; Ultrasound; POCUS; Small Bowel Obstruction*

INTRODUCTION

Gastrointestinal obstruction is relatively a common problem requiring appropriate diagnostic and therapeutic interventions. This situation can occur anywhere along the gastrointestinal tract, and its clinical symptoms often vary based on the level of obstruction. Small bowel obstruction (SBO) is the sudden occurrence of a partial or total blockage of the small intestine. In developed countries, the causes of SBO include adhesions (74%), Crohn's disease (7%), neoplasia (5%), hernia (2%) and radiation (1%). In contrast, in poor nations, adhesions (34%), hernia (16%), malignancy (13.5%), and tuberculous stricture (10%) are the most common causes of acute intestinal obstruction; foreign bodies rarely cause acute intestinal obstruction in adults.[1,2]

In contrast to SBO produced by matted adhesions, previous abdominal surgery is not a significant risk factor for SBO caused by solitary band adhesions; in patients with no history of abdominal surgery, the risk for bowel obstruction is often attributable to a solitary band.[3] SBO is diagnosed in around 2% of patients who appear with abdominal discomfort in the Emergency Department (ED) and 15% of patients who are finally admitted to the surgical unit from the ED.[4] Typically, the clinical suspicion of SBO is based on the patient's medical history, symptoms, and physical signs (crampy abdominal pain, abdominal distension, nausea and vomiting).[5]

Delay in the identification and care of SBO is related with an increased risk of bowel resection, consequences may include strangling and intestinal necrosis, and both can lead to perforation, sepsis, and eventually death. Over the past decades, the indications and timing of surgical intervention for SBO have shifted.[5] Widespread belief holds that the majority of these conditions may cure spontaneously provided parietal vascular injury is absent and nonsurgical treatment, mainly nasointestinal decompression, is administered (nasogastric tube insertion, bowel rest, intravenous fluids). Confronted with a probable SBO, surgeons and radiologists have the problem of confirming or ruling out the pathology. Imaging should reveal whether or not the small bowel is obstructed, the severity of the blockage, its location, its origin, and whether or not strangulation is present. It has been advocated that multimodal imaging (X-rays, ultrasonography, CT, and MRI) be used to confirm, stage, and identify the source of SBO. CT is the gold standard imaging modality for the examination of SBO, addressing all diagnostic critical points.[6,7]

It can establish the pathology, determine the etiology and severity of mechanical blockage and the stage of the SBO, and identify the presence or absence of parietal damage. In recent years, there has been an increase in the use of point-of-care ultrasonography (POCUS) for the evaluation of SBO, and ultrasound is increasingly promoted as a first-line imaging modality for SBO. Multiple "official" (radiologist-conducted) studies validated the US's usefulness. In addition, ultrasound conducted at the patient's bedside by an emergency physician has been proposed to confirm or rule out the existence of SBO in an emergency setting.[8,9]

As with other POCUS applications, the ability of POCUS to reliably identify SBO could improve patient care by minimizing time to diagnosis and accelerating consultation. Furthermore, POCUS can uncover numerous different reasons of stomach discomfort (gallstones, abdominal aortic aneurysm, appendicitis, hydronephrosis suggestive of a kidney stone or intra- abdominal free fluid).[9] In addition, ultrasonography is typically the only imaging modality that is readily available in settings with limited resources, making it particularly beneficial for assessing a patient for an SBO when CT is unavailable or prohibitively expensive.[3,10]

This study discusses the diagnostic accuracy of ultrasound for small bowel obstruction.

METHODS

Protocol

The methodology of this inquiry was carried out in accordance with the guidelines established by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020. These factors had an impact on the decision to pass the legislation.

Criteria for Eligibility

By assessing or analyzing previous research on the subject, this review of the literature aims to demonstrate the diagnostic accuracy of ultrasound for small bowel obstruction. This is a major concern raised in the current study. Researchers take part in studies that meet the following criteria: 1) To be considered for publication, articles must be written in English and highlight or focus on the diagnostic accuracy of ultrasound for small bowel obstruction. 2) This evaluation included articles published after 2015 but before the period covered by this systematic review. Editorials, submissions without a DOI, previously published review articles, or entries that are very similar to those previously published in a journal, for example, will not be considered for publication.

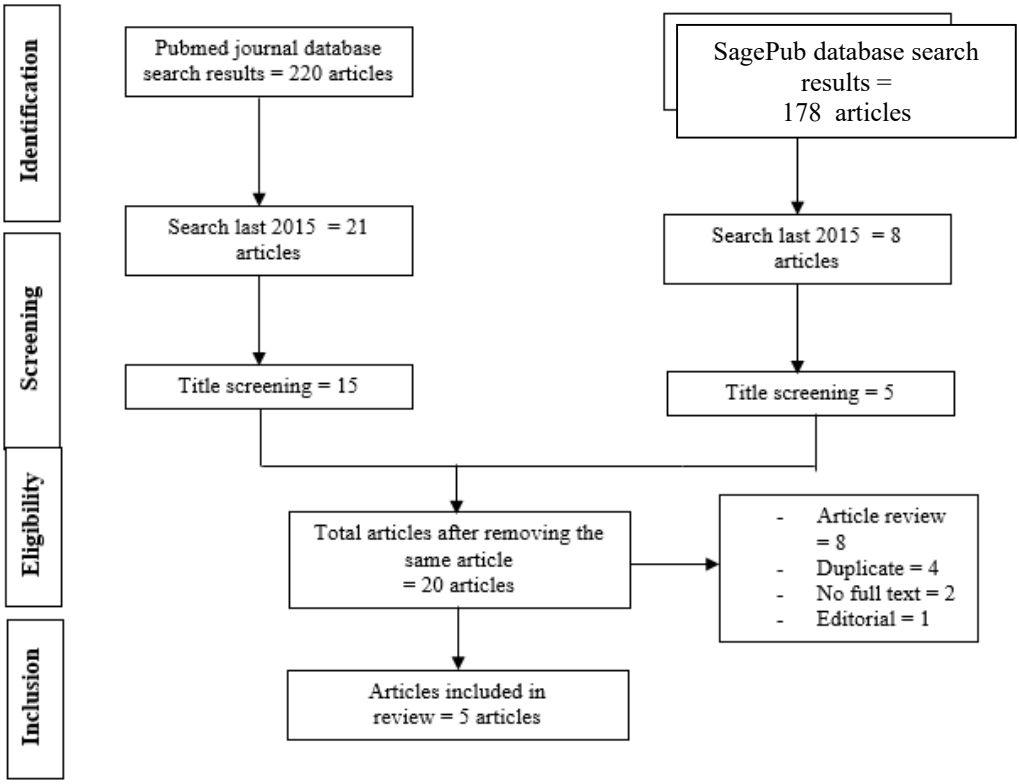

Figure 1. Article search flowchart

Search Strategy

The search for studies to be included in the systematic review was carried out from January, 22th 2023 using the PubMed and SagePub databases by inputting the words: "diagnostic accuracy", "ultrasound", and "small bowel obstruction". Where *("diagnosis"[MeSH Terms] OR "diagnosis"[All Fields] OR "diagnostic"[All Fields] OR "diagnostical"[All Fields] OR "diagnostically"[All Fields] OR "diagnostics"[All Fields]) AND ("accuracies"[All Fields] OR "accuracy"[All Fields]) AND ("diagnostic imaging"[MeSH Subheading] OR ("diagnostic"[All Fields] AND "imaging"[All Fields]) OR "diagnostic imaging"[All Fields] OR "ultrasound"[All Fields] OR "ultrasonography"[MeSH Terms] OR "ultrasonography"[All Fields] OR "ultrasonics"[MeSH Terms] OR "ultrasonics"[All Fields] OR "ultrasounds"[All Fields] OR "ultrasound s"[All Fields]) AND ("intestine, small"[MeSH Terms] OR ("intestine"[All Fields] AND "small"[All Fields]) OR "small intestine"[All Fields] OR ("small"[All Fields] AND "bowel"[All Fields]) OR "small bowel"[All Fields]) AND ("obstruct"[All Fields] OR "obstructed"[All Fields] OR "obstructing"[All Fields] OR "obstruction"[All Fields] OR "obstructions"[All Fields] OR "obstructive"[All Fields] OR "obstructs"[All Fields])* is used as search keywords.

Data retrieval

Following the completion of a literature review that entailed an examination of the titles and abstracts of previously conducted research, the author revised the inclusion and exclusion criteria. The supplementary materials of the study include an explanation of the newly developed criteria. This highlighted the various aspects of the issue that call for more research and brought to light the scope of the problem. After conducting research on a wide variety of other studies that followed a comparable format, the author arrived at this conclusion. During the process of the systematic review, only the papers that satisfied all of the inclusion criteria were taken into consideration.

This ensured that only relevant information was uncovered during the search. Research proposals that did not fulfill all of our requirements were not considered for evaluation by our team. Because of this, it was guaranteed that a thorough evaluation would be carried out. The results of this effort provided information that was relevant to the studies, such as their titles, authors, publication dates, locations, types of research investigations, and parameters. These are the different product categories that are easily accessible. These are abilities that can be improved with practice. Depending on the origin of the information, this data could be provided in any one of a number of different formats.

Quality Assessment and Data Synthesis

Before deciding which articles to investigate, each author conducted an independent investigation of a piece of research mentioned in the titles and abstracts of the papers. The full texts of publications that meet the systematic review's inclusion criteria will then be reviewed to determine which papers will be included in the review. This determines which articles will be reviewed. To facilitate the selection of articles for the review. Which studies are of sufficient quality to be included in the review?

RESULT

Tamburrini, et al (2019)[11] showed US findings were compared with CT examination results: The morphologic CT findings (split into loop, vascular, mesenteric, and peritoneal signals) permitted the classification of SBO into simple, decompensated, and complicated forms. US diagnostic accuracy rates in relation to CT results were calculated: ultrasound showed a sensitivity of 92.31% (95% CI= 74.87-99.05%) and a specificity of 94.12% (95% CI = 71.31-99.85%) in the diagnosis of SBO when compared to CT imaging.

Frasure, et al (2018)[12] compared the accuracy of ultrasound imaging performed in the emergency department (ED) by a variety of providers (physicians with varying levels of experience, physician assistants) to CT imaging in 47 patients suspected of having SBOs. When compared to abdominal CT, our data showed a sensitivity of 93.8% and a specificity of 93.3%; however, when considering a composite endpoint consisting of abdominal CT and discharge diagnosis, our data indicated a sensitivity of 94.3% and a specificity of 95.2%.

Study in Iran conducted with 133 patients. They were evaluated with US, with decrease bowel peristalsis having the highest sensitivity (100%), but dilated bowel (>25 mm) having the highest specificity (100%) for SBO diagnosis. 88% of patients with dilated bowel and 100% of patients with unstable vital signs underwent emergency surgery. Urgent surgery was performed; 80.9% of bowel peristalsis was reduced. Patients with none of the US variables and signs and symptoms of acute abdomen were discharged from the emergency department after nonsurgical treatment, and 100% of them were cured.[13]

Table 1. The litelature include in this study

Author	Origin	Method	Sample Size	Period	Result
Tamburrini, 2019[11]	Italy	Retrospective, single-center cohort study	43 patient in ED	September 2018 and June 2019	US findings were compared with the results of CT examinations: Morphologic CT findings (divided into loop, vascular, mesenteric and peritoneal signs) allowed the classification of SBO in simple, decompensated and complicated. Results: US diagnostic accuracy rates in relation to CT results were calculated: ultrasound compared to CT imaging, had a sensitivity of 92.31% (95% CI, 74.87% to 99.05%) and a specificity of 94.12% (95% CI, 71.31% to 99.85%) in the diagnosis of SBO.
Frasure, 2018[12]	United State of America	Retrospective, single-center cohort study	64 patient in ED	September 2015 and September 2016	When compared to abdominal CT, our data showed a sensitivity of 93.8% and a specificity of 93.3%; however, when considering a composite endpoint consisting of abdominal CT and discharge diagnosis, our data indicated a sensitivity of 94.3% and a specificity of 95.2%.
Bargezari, 2016[13]	Iran	Retrospective, single-center cohort study	133 patient in ED	No data	US can detect decrease bowel peristalsis and dilated bowel (>25 mm) having the highest specificity (100%) for SBO diagnosis. 88% of patients with dilated bowel and 100% of patients with unstable vital signs underwent emergency surgery. Urgent surgery was performed; 80.9% of bowel peristalsis was reduced.
Liaqat, 2022	Pakistan	Cross sectional	133 pediatrics patient in ED	Jun 2018 to Jun 2019	In 98.7% (76 of 77) of surgically verified cases of bowel obstruction, dilated bowel loops were the most consistent greyscale indicator of bowel obstruction. Ultrasound had a respective sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of 98.7%, 71.4%, 97.4%, 83.4%, and 94.4%. In 51 (67%) of 76 genuinely positive instances, the sonological cause of blockage was readily proven.
Sabzghabaei, 2022[14]	Iran	Cross sectional	24 pediatrics patient in ED	No data	Ultrasonography findings revealed the lumen diameter ≥ 2.5 cm in 21 (87.5%) cases, wall thickness ≥ 3 mm in 3 (12.5%) cases and inter-loop free fluid in 3 (12.5%) cases. Sensitivity, positive predictive value, and accuracy of ultrasound in detection of intestinal obstruction were found to be 85.00% (95%CI: 61.13 – 96.03), 80.95% (95%CI: 57.42 – 93.71), and 70.83% (95%CI: 48.91 – 87.38), respectively

Liaqat, et al (2022)[15] conducted research with 133 different participants. They found that dilated bowel loops were the most consistent greyscale predictor of bowel blockage in 98.7% (76 of 77) of medically proven cases of intestinal obstruction. The diagnostic accuracy of ultrasound was 94%, with a sensitivity of 98.7%, a specificity of 71.4%, a positive predictive value of 97.4%, and a negative predictive value of 83.4%. The sonological cause of obstruction was easily demonstrated in 51 (or 67%) of the 76 cases where the results were truly positive.

According to the findings of another study that utilized ultrasonography, the lumen diameter was less than 2.5 centimeters in 21 (87.5%) of the cases, the wall thickness was less than 3 millimeters in three (12.5%) of the cases, and there was free fluid between the loops in three (12.5%) of the cases. It was discovered that the sensitivity, positive predictive value, and accuracy of ultrasound in the detection of intestinal obstruction were, respectively, 85.00% (95%CI: 61.13 – 96.03), 80.95% (95%CI: 57.42 – 93.71), and 70.83% (95%CI: 48.91 – 87.38). These results were found using a 95% confidence interval.[14]

DISCUSSION

Obstruction of the small bowel, which can be caused by mechanical blockage of the bowel, is a common surgical emergency. The obstruction of the small bowel can be brought on by a wide variety of pathologic events; nevertheless, intra-abdominal adhesions are the most common cause in industrialized countries. Obstructions of the small bowel can be either partial or complete, and they can occur either with or without strangulation.[16,17] The obstruction of the small bowel is most frequently brought on by postsurgical adhesions. Hernias caused by being caught in clothing or other objects are the second most common cause.[18]

Malignancy, inflammatory bowel disease, stool impaction, foreign substances, and volvulus are some of the other prominent causes of this condition. Congenital atresia, pyloric stenosis, and other congenital defects, as well as intussusception, are among of the most common causes of this condition in children.[18] Physical examination by itself may be sufficient to diagnose small intestinal obstruction, but additional diagnostic testing is typically necessary before surgical evaluation and management of the condition. The diagnosis of small intestinal obstruction was previously made by the use of a physical examination; however, with the development of computed tomography (CT), the accuracy of this disease has significantly increased, as has its characterisation.[19]

Radiographs are frequently utilized as an additional imaging modality; nevertheless, ultrasonography is a more sensitive and specific imaging modality than radiographs. In addition, ultrasonography does not result in any exposure to radiation and has the advantage of being able to do quick and serial exams. The sensitivity of plain radiography is quite low, falling between between 50 and 80 percent. It is possible that it could serve as an initial screening test for obvious air-fluid levels and free intra-abdominal air, but it is not reliable enough to determine whether or not a small intestinal obstruction is present. Concerning signs of obstruction include a small bowel diameter that is greater than 6 centimeters, a large bowel diameter that is greater than 12 centimeters, and a cecum diameter that is greater than 15 millimeters.[19]

The following is the point-of-care abdominal ultrasonography for patients with small intestinal obstruction: When SBO is suspected and the patient has abdominal pain, nausea, or vomiting, abdominal distention, and constipation and no other cause of acute abdomen such as tenderness, rebound tenderness, morphi's sign, mesenteric ischemia, or perforated abdominal halo viscose in plain abdominal X-ray and no abdominal aortic aneurism, cholecystitis, ovarian cyst rupture, ovarian torsion, etc. Second, if they do not have dilated colon, look for signs of decreased intestinal peristalsis, thick gut wall, or free fluid: A - Urgent surgery consultation is required if they have decreased intestinal peristalsis, thick wall bowel, or free fluid and stable vital signs. B -If they do not exhibit decreased intestinal peristalsis, thick bowel wall, or free fluid, they should be admitted to an observation unit for nonsurgical therapy.[3,8,11]

POCUS is an effective method for locating dilated loops of bowel in patients with a possible SBO diagnosis. It is possible that using POCUS will cut down on the number of CT scans required to arrive at an accurate diagnosis of SBO, which will in turn speed up the surgical management and care of patients in the ED. When evaluating these patients, however, negative ultrasound findings should be read with caution because POCUS has a lesser sensitivity than other ultrasound techniques. A negative result might not necessarily be regarded as a negative diagnosis, depending on the circumstances.[20,21]

SBO can be thought of as a dynamic pathology. In modern medicine, the treatment for SBO is entirely predicated on the presence of bowel parietal involvement. When it comes to SBO, the diagnostic imaging modalities should be able to determine the existence or absence of SBO, as well as parietal involvement, the cause, and the level of SBO. The CT scan is still the imaging modality that is considered the gold standard. CT scans are linked to higher radiation exposure, more financial burden, and longer wait times before diagnosis.[11,12] In addition, a CT diagnosis of SBO is limited since it requires finding the transition point between dilated bowel loops and decompressed bowel loops. Tamburrini, et al (2019) showed ultrasonography has a sensitivity of 92.4% and a specificity of 96.6% for detecting SBO.[11]

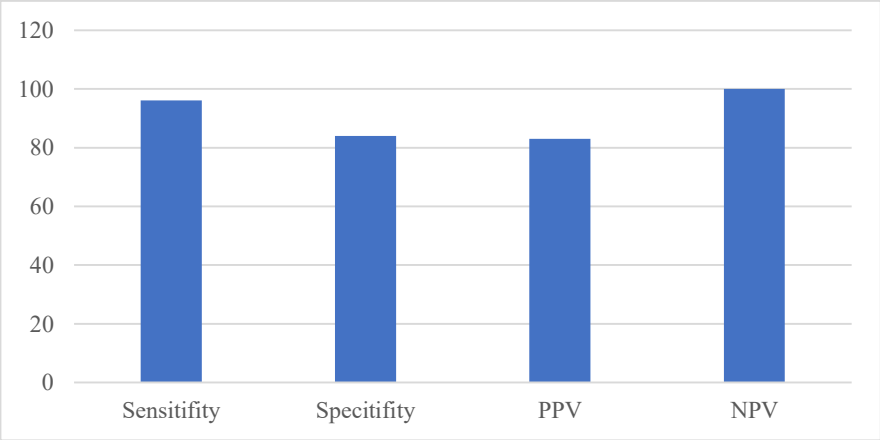

Figure 2. Diagnostic accuracy of US for SBO

High-resolution ultrasound probes (frequencies greater than 7.5 Mhz) demonstrate the stratification of the SB wall as having five distinct concentric layers: the first layer from the lumen is an echogenic interface between the lumen content and the mucosa, followed by hypoechogenic mucosa, echogenic submucosa in the middle of the wall, next hypoechogenic muscularis propria, and the fifth—outer echogenic layer represents serosa and the interface with periente These sonographic layers might be thought of as being analogous to the histology layers.[22,23]

The typical SB has a thickness that does not exceed three millimeters (with only a minor amount of probe compression), it maintains its stratification (five layers), the intramural vascularization is weak, peristalsis is normal, and the lumen is

compressible. Due to the fact that high resolution (high-frequency) probes still have the disadvantage of unsatisfactory penetration, they are unable to be used in the evaluation of deep abdominal structures, particularly in patients who are obese. In addition, in some instances of initial forms of SB diseases, false negative results are possible.[22,23]

CONCLUSION

Research shows that the diagnostic accuracy of ultrasound examination, especially when using POCUS, is high. The sensitivity and NPV of US examination in establishing SBO is almost 100%.

REFERENCE

[1]. Miller G, Boman J, Shrier I, Gordon PH. Etiology of small bowel obstruction. Am J Surg. 2000 Jul;180(1):33–6.
[2]. Skoglar A, Gunnarsson U, Falk P. Band adhesions not related to previous abdominal surgery–A retrospective cohort analysis of risk factors. Ann Med Surg. 2018;36:185–90.
[3]. Taylor MR, Lalani N. Adult small bowel obstruction. Acad Emerg Med Off J Soc Acad Emerg Med. 2013 Jun;20(6):528–44.
[4]. Hastings RS, Powers RD. Abdominal pain in the ED: a 35 year retrospective. Am J Emerg Med. 2011 Sep;29(7):711–6.
[5]. Hwang U, Aufses Jr AH, Bickell NA. Factors associated with delays to emergency care for bowel obstruction. Am J Surg. 2011;202(1):1–7.
[6]. Maung AA, Johnson DC, Piper GL, Barbosa RR, Rowell SE, Bokhari F, et al. Evaluation and management of small-bowel obstruction: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg. 2012;73(5):S362–9.
[7]. Sarani B, Paspulati RM, Hambley J, Efron D, Martinez J, Perez A, et al. A multidisciplinary approach to diagnosis and management of bowel obstruction. Curr Probl Surg. 2018;55(10):394–438.
[8]. Becker BA, Lahham S, Gonzales MA, Nomura JT, Bui MK, Truong TA, et al. A Prospective, Multicenter Evaluation of Point-of-care Ultrasound for Small-bowel Obstruction in the Emergency Department. Acad Emerg Med Off J Soc Acad Emerg Med. 2019 Aug;26(8):921–30.
[9]. Mazzei MA, Guerrini S, Cioffi Squitieri N, Cagini L, Macarini L, Coppolino F, et al. The role of US examination in the management of acute abdomen. Crit Ultrasound J. 2013;5(1):1–9.
[10]. Hefny AF, Corr P, Abu-Zidan FM. The role of ultrasound in the management of intestinal obstruction. J Emerg Trauma Shock. 2012;5(1):84–6.
[11]. Tamburrini S, Lugarà M, Iaselli F, Saturnino PP, Liguori C, Carbone R, et al. Diagnostic Accuracy of Ultrasound in the Diagnosis of Small Bowel Obstruction. Diagnostics (Basel, Switzerland). 2019 Aug;9(3).
[12]. Frasure SE, Hildreth AF, Seethala R, Kimberly HH. Accuracy of abdominal ultrasound for the diagnosis of small bowel obstruction in the emergency department. World J Emerg Med. 2018;9(4):267.
[13]. Barzegari H, Delirrooyfard A, Moatamedfar A, Sohani S, Sohani M. A New Point of Care Ultrasound in disposition of patients with small bowel obstruction in Emergency Department. Int J Pharm Res Allied Sci. 2016;5(2).
[14]. Sabzghabaei A, Shojaei M, Chavoshzadeh M. Diagnostic Accuracy of Ultrasonography by Emergency Medicine Resident in Detecting Intestinal Obstruction; a Pilot Study. Arch Acad Emerg Med. 2022;10(1).
[15]. Liaqat R, Majeed A, Liaqat B, Shafi A, Riaz R, Akhtar S. Diagnostic Accuracy of Ultrasound for Small Bowel Obstruction in Paediatric Population Undergoing Laparotomy Keeping Surgical Findings as the Gold Standard. Pakistan Armed Forces Med J [Internet]. 2022 Sep 6;72(4 SE-Original Articles). Available from: https://www.pafmj.org/index.php/PAFMJ/article/view/4460
[16]. Brunicardi FC. Schwartz's Principles of Surgery. Philadelphia: McGraw-Hill Education; 2011.
[17]. Linden AF, Raiji MT, Kohler JE, Carlisle EM, Pelayo JC, Feinstein K, et al. Evaluation of a water-soluble contrast protocol for nonoperative management of pediatric adhesive small bowel obstruction. J Pediatr Surg. 2019 Jan;54(1):184–8.
[18]. Bower KL, Lollar DI, Williams SL, Adkins FC, Luyimbazi DT, Bower CE. Small Bowel Obstruction. Surg Clin North Am. 2018 Oct;98(5):945–71.
[19]. Behman R, Nathens AB, Look Hong N, Pechlivanoglou P, Karanicolas PJ. Evolving Management Strategies in Patients with Adhesive Small Bowel Obstruction: a Population-Based Analysis. J Gastrointest Surg Off J Soc Surg Aliment Tract. 2018 Dec;22(12):2133–41.
[20]. van Wassenaer EA, de Voogd FAE, van Rijn RR, van Der Lee JH, Tabbers MM, van Etten-Jamaludin FS, et al. Diagnostic accuracy of transabdominal ultrasound in detecting intestinal inflammation in paediatric IBD patients—a systematic review. J Crohn's Colitis. 2019;13(12):1501–9.
[21]. Hata J, Imamura H. The Use of Transabdominal Ultrasound in Inflammatory Bowel Disease. Korean J Radiol. 2022;23(3):308.
[22]. Gokhale S. High resolution ultrasonography of the anterior abdominal wall. Indian J Radiol Imaging. 2007;17(04):290–8.
[23]. Bedewi MA, El-Sharkawy MS, Al Boukai AA, Al-Nakshabandi N. Prevalence of adult paraumbilical hernia. Assessment by high-resolution sonography: a hospital-based study. Hernia. 2012;16(1):59–62.