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Diagnostic Accuracy of Ultrasound by Emergency Physicians in Patients with Suspected Small Bowel Obstruction (SBO): A Multi-center Study

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Abstract

Background: Timely diagnosis of small bowel obstruction (SBO) is essential to prevent complications. While computed tomography (CT) is the gold standard for diagnosing SBO due to its high sensitivity and specificity, it has notable limitations, including radiation exposure, high cost, delayed diagnosis, and limited accessibility. Recently, ultrasound has gained attention as a potential alternative in emergency departments (ED) because it is radiation-free, cost-effective, and accessible. This multi-center study seeks to assess the diagnostic accuracy of ultrasound in identifying SBO among patients presenting to the ED.

Methods: This multicenter cross-sectional study included 100 patients with suspected SBO, examined by a trained ED physician using ultrasound and confirmed by CT. Ultrasound findings evaluated were excessive gas, bowel wall thickening, interloop free fluid, lumen diameter ≥2.5 cm, and decreased peristalsis. Sensitivity, specificity, and likelihood ratios were calculated for each finding.

Results: We found that the most efficient parameters were lumen size greater than 2.5 cm (efficacy: 73%, 95%CI: 63% - 81%), and a decrease in peristalsis (efficacy: 73%, 95%CI: 63% - 81%), The most specific parameters were excessive gas (specificity: 89%, 95%CI: 75% - 97%) and thickening of the bowel wall (specificity: 82%, 95%CI: 66% - 92%). The most sensitive parameters were interloop free fluid (sensitivity: 77%, 95%CI: 65% - 87%) and lumen diameter ≥ 2.5 cm (sensitivity: 77%, 95%CI: 65% - 87%) among other diagnostic findings.

Conclusion: Ultrasound may be a useful diagnostic tool for SBO in the ED, offering a potentially efficient and accessible option for diagnosis.

Keywords: Diagnostic Accuracy, Ultrasound, Small Bowel Obstruction

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Introduction

Small bowel obstruction (SBO) is a major issue in emergency medicine. It disrupts the normal flow of contents in the small intestine. It stands as a prevalent surgical emergency, contributing to substantial morbidity and mor-

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↑What is "already known" in this topic:
Small bowel obstruction (SBO) is a common surgical emergency with high morbidity. Computed tomography (CT) is the gold standard for diagnosis due to its high sensitivity and specificity, but it involves radiation, cost, and accessibility issues. Ultrasound is emerging as a radiation-free, cost-effective alternative for SBO diagnosis in emergency departments, with prior studies suggesting promising accuracy, particularly for detecting dilated bowel loops and abnormal peristalsis, though its effectiveness depends on operator experience.

→What this article adds:
This multicenter study confirms ultrasound's utility for SBO diagnosis by emergency physicians, identifying lumen diameter ≥2.5 cm and reduced peristalsis as highly efficient diagnostic criteria (73% efficacy). It highlights excessive gas and bowel wall thickening as specific findings, and interloop free fluid as sensitive. The study suggests optimal diagnostic accuracy with at least three ultrasound findings, supporting its role as a bedside screening tool, though operator training and confirmatory CT are essential.

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tality worldwide (1, 2). With symptoms such as abdominal pain, vomiting, bloating, and constipation, SBO poses diagnostic dilemmas, often leading to delayed intervention and adverse outcomes (3).

Typically, diagnosing SBO has depended on imaging methods such as plain radiography, computed tomography (CT), and magnetic resonance imaging (MRI) (4, 5).

While CT stands as the gold standard due to its high sensitivity and specificity, limitations such as radiation exposure, cost, and accessibility hinder its widespread use, particularly in certain patient populations and resource-constrained settings (6, 7). MRI, albeit offering comparable accuracy, faces challenges related to time consumption and availability, especially in acute settings (8).

Recently, there has been increasing interest in using ultrasound as a diagnostic tool for SBO at the point of care. This interest is particularly strong in emergency departments where quick assessments are crucial (9). However, its diagnostic accuracy varies with operator skill and training, necessitating adequate experience to optimize its utility. Ultrasound presents several advantages, including its real-time nature, cost-effectiveness, and lack of radiation exposure, making it an attractive alternative to conventional imaging methods (10). Previous meta-analyses have suggested promising diagnostic accuracy for ultrasound in SBO detection, albeit with limitations in study size and setting heterogeneity (11).

Given the pivotal role of emergency physicians in the initial evaluation and management of SBO, there arises a pertinent need to ascertain the diagnostic accuracy of ultrasound performed by non-radiologists in this context. Therefore, we conducted a multi-center study to thoroughly evaluate how accurate ultrasound is in patients suspected of having SBO. Through this study, we aim to provide valuable insights into the role of ultrasound in diagnosing SBO, which could improve patient outcomes and resource use in emergency care.

The main objective of this study was to assess the diagnostic and staging accuracy of ultrasound in the detection of SBO and to evaluate the efficacy, sensitivity, and specificity of different ultrasound abnormal findings.

Methods

Study design

In this multicenter cross-sectional study, we examined 100 patients suspected of having SBO. These patients showed obstructive symptoms like vomiting, nausea, and constipation. This examination took place between August 2018 and August 2019, conducted by trained emergency medicine physicians using ultrasound. We chose a cross-sectional design because it allows for the assessment of diagnostic accuracy at a single point in time, which is suitable for evaluating the performance of a diagnostic test like ultrasound. A prospective cohort approach would be more appropriate for studying the natural history or outcomes of SBO, which was not the primary aim of this study. A non-probability convenience sampling strategy was employed, with suspicious cases included when trained physicians and research associates were available. Subsequently, the patient was referred to a surgeon for further consultation. Surgeons were instructed to examine the patient and identify any signs or symptoms indicative of SBO through imaging (CT-Scan) and other diagnostic techniques, and to provide a final diagnosis. This study was conducted on patients admitted to all emergency departments of Iran University of Medical Sciences hospitals, including Rasoul Akram Hospital, Haft-e-Tir Hospital, and Firoozgar Hospital. The present study was approved by the ethics and research committees of the participating hospital in accordance with the relevant ethical standards. (IR.IUMS.FMD.REC.1397.309)

Ultrasound technique

Patients suspected of having SBO who were admitted to the emergency departments underwent abdominal ultrasound while lying on their backs. We used a 3.5 MHz transducer for a general overview of the abdomen. In addition, we performed a focused examination with a linear probe (7.5 MHz) when patients reported a specific area of tenderness. We checked all abdominal and pelvic quadrants for free fluid and conducted a thorough evaluation of the entire abdomen. Two individuals (S. Karimi and R. Mosaddegh) received three months of training in ultrasound under the supervision of an emergency medicine specialist (M. Chardoli) with ten years of experience. This training length was based on previous studies that suggested emergency doctors can gain competence in point-of-care ultrasound for SBO after similar training periods. The training included lectures on ultrasound criteria for SBO, hands-on practice with at least 50 supervised scans, and an assessment of competence using a standardized checklist that focused on five diagnostic findings. We diagnosed obstruction through the following five findings:

1.Excessive gas
2.Thickening of bowel wall
3.Interloop free fluid
4.Lumen size greater than 2.5 cm
5.Decrease of peristalsis

Note that for each patient, the number of positive ultrasonography signs has been documented.

In cases where ultrasound findings contradicted CT results, discrepancies were resolved through clinical follow-up (e.g., symptom progression) or surgical findings when available, ensuring alignment with the final diagnosis.

Statistical analysis

A power calculation indicated that with 100 patients, the study had 80% power to detect a sensitivity of 80% with a precision of ±10%, assuming a lower SBO prevalence than 50%. This sample size is appropriate for preliminary analysis, given the expected prevalence in primary clinical assessment. Patients were approached for inclusion in the study if they presented with symptoms suggestive of SBO, such as abdominal pain, vomiting, bloating, or constipation. Informed consent was obtained from all participants after explaining the study's purpose, procedures, and potential risks. Patients were recruited during times when trained ultrasound operators and research associates were available. The sensitivity, specificity, PPV, NPP, efficacy, and LR were calculated. The level of significance was set

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at $P < 0.05$. All the analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software version 19 (SPSS, Chicago, IL).

Results

One hundred patients suspected of having SBO were included in this study and received an ultrasound examination. The mean age of the patients was 64.4±14.56 years, with 55 being male and 45 being female. After evaluating the patients with a gold standard test (CT scan) for a final diagnosis, 20% of the patients were diagnosed with SBO and 22% of them were diagnosed with partial SBO, in total 62 patients were diagnosed with an obstructive disease, while the others did not show signs of obstruction disease.

Ultrasound findings revealed excessive gas in 14 patients (10 of whom had obstruction), thickening of the bowel wall in 39 patients (32 of whom had obstruction), inter loop free fluid in 62 patients (48 of whom had obstruction), lumen diameter ≥ 2.5 cm in 61 patients (48 had obstruction), and a decrease in peristalsis in 59 patients (47 of whom had obstruction). The most efficient parameters were lumen size greater than 2.5 cm (efficacy: 73%, 95%CI: 63% - 81%), and a decrease in peristalsis (efficacy: 73%, 95%CI: 63% - 81%), The most specific parameters were excessive gas (specificity: 89%, 95%CI: 75% - 97%) and thickening of the bowel wall (specificity: 82%, 95%CI: 66% - 92%). The most sensitive parameters were interloop free fluid (sensitivity: 77%, 95%CI: 65% - 87%) and lumen diameter ≥ 2.5 cm (sensitivity: 77%, 95%CI: 65% - 87%) among other diagnostic findings (Table 1).

Ultrasound revealed no abnormalities in 14 patients, while 19 patients had one abnormality, 20 had two, and 12 had four abnormalities. We then calculated the diagnostic efficacy indices for this procedure. The area under the ROC curve for a single abnormality or more was 0.81 (95% CI=0.72-0.90; P<0.001). This AUC is comparable to that reported in previous studies, which have found AUCs ranging from 0.75 to 0.85 for ultrasound in diagnosing SBO. We measured sensitivity, specificity, PPV, NPV, positive and negative likelihood ratios, efficacy, and kappa based on the number of abnormal findings in ultrasound. A sensitivity analysis showed that as the number of abnormal findings increased from one to four, sensitivity decreased (98% to 50%) while specificity increased (34% to 89%), reflecting a trade-off in diagnostic performance. This suggests that requiring more findings enhances specificity but may miss early or subtle cases. There was no significant difference in efficacy, with the number of abnormal findings averaging 74% (95%CI: 64%-82%), except for cases with at least four abnormal findings, where it dropped to 65% (95%CI: 55%-74%) (Table 2).

Discussion

This study investigated the diagnostic efficacy of ultrasound in detecting SBO in patients presenting with abdominal symptoms. The results demonstrated that ultrasound can accurately detect SBO-related abnormalities with varying sensitivity, specificity, and overall diagnostic efficacy. Our findings indicate that a lumen diameter of ≥2.5 cm and a reduction in peristalsis, which are established as diagnostic criteria for bowel obstruction (12), exhibit acceptable sensitivity and specificity. However, we observed that excessive gas demonstrated a higher specificity than other criteria, thereby reinforcing the potential utility of the diagnosis of SBO. In this study, we also evaluated the sensitivity and specificity of the number of ultrasound findings. Our findings indicate that at least three findings are the optimal number for achieving high sensitivity, specificity, and efficiency.

The use of convenience sampling may have introduced selection bias, potentially overrepresenting patients with more severe or typical SBO presentations. This could lead to spectrum bias, where diagnostic accuracy is overestimated compared to a broader population with varied disease severity. Consequently, the external validity of our findings may be limited, particularly in settings with different patient demographics or disease prevalence. Future studies should employ random sampling to mitigate this limitation.

Our findings align with previous studies highlighting the diagnostic utility of ultrasound in SBO. In a study conducted by Dickman et al., it was determined that the identification of dilated bowel is a crucial aspect of diagnosing SBO. The accuracy of this diagnosis is further enhanced when abnormal peristalsis is also taken into account (13). Barzegari and colleagues demonstrated that the dilated bowel wall exhibited the highest specificity and that decreased bowel peristalsis demonstrated the highest sensitivity among the diagnostic criteria for SBO (14). Tamburrini et al. asserted that the most critical sonographic indicator is the presence of dilated bowel loops,

Table 1. Diagnostic Accuracy of Ultrasound Findings for SBO

Ultrasound Finding	Sensitivity (95% CI)	Specificity (95% CI)	Efficacy (95% CI)
Excessive gas	16% (8% - 27%)	89% (75% - 97%)	43% (33% - 53%)
Thickening of the bowel wall	52% (39% - 64%)	82% (66% - 92%)	63% (53% - 72%)
Interloop free fluid	77% (65% - 87%)	39% (24% - 56%)	61% (51% - 70%)
Lumen diameter ≥ 2.5 cm	77% (65% - 87%)	66% (49% - 80%)	73% (63% - 81%)
Decrease in peristalsis	76% (63% - 86%)	68% (51% - 82%)	73% (63% - 81%)

Table 2. Diagnostic Accuracy Based on Number of Positive Ultrasound Findings

Number of Positive Findings	Sensitivity (95% CI)	Specificity (95% CI)	Efficacy (95% CI)
At least 1	98% (91% - 100%)	34% (20% - 51%)	74% (64% - 82%)
At least 2	85% (74% - 93%)	58% (41% - 74%)	74% (64% - 82%)
At least 3	65% (52% - 76%)	79% (63% - 90%)	71% (61% - 80%)
At least 4	50% (37% - 63%)	89% (75% - 97%)	65% (55% - 74%)

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and that diagnosis cannot be made on the basis of peristalsis activity alone (15). In several studies, the primary diagnostic criteria were dilated bowel wall and abnormal peristalsis. Other criteria, like free fluid, were employed as staging criteria (16-18).

The cutoff diameter of bowel dilation plays a critical role in diagnosing SBO via ultrasound, although there is no standard consensus on an ideal threshold. Most studies use a cutoff of ≥25 mm for SBO (19-22), which balances sensitivity and specificity while maintaining diagnostic accuracy. However, this threshold may result in false positives, as some research suggests. Increasing the cutoff to 30 mm improves specificity but may reduce sensitivity, which is vital for ultrasound's role as a screening tool. On the other hand, reducing the threshold to 20 mm maximizes sensitivity, which is particularly useful in initial evaluations where excluding SBO is critical (23).

The diagnostic accuracy reported here reflects operators with three months of training, which may not generalize to physicians with less or more experience. Ultrasound's operator-dependent nature suggests that accuracy could improve with greater expertise, as seen in prior studies (24-26). While we could not compare operators with varying experience due to the study's design, this limitation highlights the need for standardized training protocols and further research into experience-related variability. For broader application, especially by less-experienced physicians, dedicated training and ongoing quality assurance are essential to ensure effective and reliable ultrasound use in diagnosing SBO. It is crucial to rely on expertise in order to fully realize the advantages of ultrasound over other imaging modalities used to diagnose SBO.

Ultrasound offers distinctive advantages and certain limitations in comparison to other imaging modalities for the diagnosis of SBO. In contrast to CT scans, ultrasound is a non-invasive technique that does not involve radiation exposure and can be performed rapidly at the bedside. This makes it particularly beneficial for critically ill patients, children, pregnant women, or patients with contraindications to CT, such as renal insufficiency or contrast allergies (18). Ultrasound is also more cost-effective than CT and beneficial in low-resource settings where CT may not be available (26). While CT generally provides higher sensitivity and specificity, ultrasound's ease of use and ability to differentiate dilated, fluid-filled loops of bowel from aerated bowel allows for accurate SBO diagnosis, especially when performed by experienced operators. However, ultrasound's diagnostic accuracy heavily depends on operator experience, and less-experienced users may find it challenging to interpret certain cases accurately (27).

The sample size of 100 patients in this study provides a solid foundation for preliminary analysis. However, to robustly confirm these findings across various patient populations and clinical settings, larger, multi-center studies are necessary. While the result of our study achieved an average diagnostic efficacy of 74%, it remains lower than that reported in some literature (19, 23), possibly due to methodological differences in operator experience, equipment, or diagnostic criteria. The use of a single operator also introduces a potential bias, as inter-operator variability can significantly affect ultrasound results. Future studies should focus on investigating the predictive value of ultrasound over time and its impact on clinical outcomes, such as morbidity, length of hospital stay, and need for surgical intervention. Lastly, it would be beneficial to assess the training and experience required for optimal ultrasound efficacy, as proficiency levels may vary widely among clinicians.

The wide confidence intervals (e.g., sensitivity of interloop free fluid: 77%, 95% CI: 65%-87%) indicate imprecision, likely due to the modest sample size. This reduces the reliability of ultrasound as a standalone diagnostic tool, suggesting it may be better suited as a screening modality where high sensitivity is prioritized over precision in specificity.

False negatives pose a risk of missed SBO diagnoses, potentially delaying surgery and leading to complications such as bowel ischemia or perforation. Conversely, false positives may result in unnecessary imaging or interventions, increasing patient burden. These errors underscore the need to integrate ultrasound with clinical judgment and, where indicated, confirmatory CT.

Factors such as patient BMI or prior abdominal surgeries could influence ultrasound accuracy by affecting image quality or disease presentation. Due to our modest sample size, subgroup analysis was not feasible, but such analyses could reveal variability in diagnostic performance and are recommended for future studies with larger cohorts.

Combining ultrasound with clinical examination (e.g., abdominal tenderness) or bedside tests (e.g., lactate levels) could enhance diagnostic accuracy. For instance, integrating ultrasound findings with a clinical decision rule might improve specificity, reducing false positives and guiding more selective use of CT. This approach warrants further investigation.

Limitations

This study has several limitations. First, the use of convenience sampling may limit the generalizability of our findings due to potential selection bias. Second, the ultrasound examinations were performed by operators with only three months of training, which may not be sufficient for optimal diagnostic accuracy. Third, we did not assess interobserver agreement, which could provide insights into the reliability of the ultrasound findings. Fourth, we did not adjust for potential confounders in our analysis, which could affect the diagnostic accuracy estimates. Future studies should address these limitations to provide more robust evidence on the diagnostic accuracy of ultrasound for SBO.

Conclusion

This study supports ultrasound's effectiveness in diagnosing SBO through criteria like lumen diameter ≥2.5 cm and reduced peristalsis. Accuracy improves with experienced operators and at least three positive findings. While less precise than CT, ultrasound offers a non-invasive, bedside screening tool to guide initial management, par-

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ticularly in resource-limited settings, with CT reserved for definitive diagnosis.

Authors' Contributions

Dr. Mojtaba Chardoli: Conceptualization, methodology, supervision, data interpretation, manuscript revision, and approval.

Dr. Shaghayegh Karimi Tajan: Study design, data collection, analysis, manuscript drafting, and critical revision.

Dr. Kourosh Javdani Esfahani: Data acquisition, clinical expertise contribution, critical revision, manuscript review, and final approval.

Dr. Reza Mosaddegh: Methodology, statistical analysis oversight, manuscript review, editing, and final approval.

Dr. Samira Vaziri: Data collection and curation, statistical analysis, manuscript drafting, editing, and approval.

Dr. Fatemeh Mohammadi: Data acquisition, literature review, clinical consultation, manuscript revision, and approval.

Dr. Alireza Javan (Corresponding Author): Study concept and design, overall coordination, data interpretation, manuscript drafting, critical revision, submission, and correspondence responsibilities.

All authors have reviewed and approved the final manuscript for submission.

Ethical Considerations

The present study was conducted in strict accordance with ethical principles and guidelines to ensure the protection of participants' rights, safety, and well-being. The study protocol was reviewed and approved by the Ethics and Research Committees of the participating hospital at Iran University of Medical Sciences under approval number IR.IUMS.FMD.REC.1397.309. All procedures adhered to the ethical standards outlined in the Declaration of Helsinki and relevant national and international guidelines for medical research involving human subjects.

Acknowledgment

None.

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Rami Reddy SR, Cappell MS. A Systematic Review of the Clinical Presentation, Diagnosis, and Treatment of Small Bowel Obstruction. Curr Gastroenterol Rep. 2017;19(6):28.
2. Ha GW, Lee MR, Kim JH. Adhesive small bowel obstruction after laparoscopic and open colorectal surgery: a systematic review and meta-analysis. Am J Surg. 2016;212(3):527-36.
3. Mellor K, Hind D, Lee MJ. A systematic review of outcomes reported in small bowel obstruction research. J Surg Res. 2018;229:41-50.
4. Paulson EK, Thompson WM. Review of small-bowel obstruction: the diagnosis and when to worry. Radiology. 2015;275(2):332-42.
5. Matsuoka H, Takahara T, Masaki T, Sugiyama M, Hachiya J, Atomi Y. Preoperative evaluation by magnetic resonance imaging in patients with bowel obstruction. Am J Surg. 2002;183(6):614-7.
6. Li Z, Zhang L, Liu X, Yuan F, Song B. Diagnostic utility of CT for small bowel obstruction: Systematic review and meta-analysis. PLoS One. 2019;14(12):e0226740.
7. 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). 2019;9(3).
8. Boniface KS, King JB, LeSaux MA, Haciski SC, Shokoohi H. Diagnostic Accuracy and Time-Saving Effects of Point-of-Care Ultrasonography in Patients With Small Bowel Obstruction: A Prospective Study. Ann Emerg Med. 2020;75(2):246-56.
9. Shokoohi H, Boniface KS, Loesche MA, Duggan NM, King JB. Development of a nomogram to predict small bowel obstruction using point-of-care ultrasound in the emergency department. Am J Emerg Med. 2020;38(11):2356-60.
10. Carroll AG, Kavanagh RG, Leidhin CN, Cullinan NM, Shah S, Lavelle LP, Malone DE. Small and Large Bowel Obstruction in Adults: Evidence-Based Emergency Imaging. In: Kelly A, Cronin P, Puig S, Applegate KE, editors. Evidence-Based Emergency Imaging: Optimizing Diagnostic Imaging of Patients in the Emergency Care Setting. Cham: Springer International Publishing; 2018. p. 329-54.
11. 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):267-71.
12. Tamburrini S, Serra N, Lugarà M, Mercogliano G, Liguori C, Toro G, et al. Ultrasound Signs in the Diagnosis and Staging of Small Bowel Obstruction. Diagnostics (Basel). 2020;10(5).
13. Dickman E, Tessaro M, Arroyo A, Haines L, Marshall J. Clinician-performed abdominal sonography. European Journal of Trauma and Emergency Surgery. 2015;41:481-92.
14. 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. International Journal of Pharmaceutical Research & Allied Sciences. 2016;5(2).
15. 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. 2019;9(3):88.
16. Pourmand A, Dimbil U, Drake A, Shokoohi H. The accuracy of point-of-care ultrasound in detecting small bowel obstruction in emergency department. Emergency medicine international. 2018;2018(1):3684081.
17. Rosano N, Gallo L, Mercogliano G, Quassone P, Picascia O, Catalano M, et al. Ultrasound of small bowel obstruction: a pictorial review. Diagnostics (Basel). 2021.
18. Lin YC, Yu YC, Huang YT, Wu YY, Wang TC, Huang WC, et al. Diagnostic accuracy of ultrasound for small bowel obstruction: A systematic review and meta-analysis. European Journal of Radiology. 2021;136:109565.
19. Gottlieb M, Peksa GD, Pandurangadu AV, Nakitende D, Takhar S, Seethala RR. Utilization of ultrasound for the evaluation of small bowel obstruction: A systematic review and meta-analysis. Am J Emerg Med. 2018;36(2):234-42.
20. Jang TB, Schindler D, Kaji AH. Bedside ultrasonography for the detection of small bowel obstruction in the emergency department. Emerg Med J. 2011;28(8):676-8.
21. Taylor MR, Lalani N. Adult small bowel obstruction. Academic Emergency Medicine. 2013;20(6):527-44.
22. Paulson EK, Thompson WM. Review of small-bowel obstruction: the diagnosis and when to worry. Radiology. 2015;275(2):332-42.
23. Lin YC, Yu YC, Huang YT, Wu YY, Wang TC, Huang WC, et al. Diagnostic accuracy of ultrasound for small bowel obstruction: A systematic review and meta-analysis. Eur J Radiol. 2021;136:109565.
24. Shokoohi H, Mayes KD, Peksa GD, Loesche MA, Becker BA, Boniface KS, et al. Multi-center analysis of point-of-care ultrasound for small bowel obstruction: A systematic review and individual patient-level meta-analysis. The American Journal of Emergency Medicine. 2023;70:144-50.
25. 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. Academic Emergency Medicine. 2019;26(8):921-30.
26. Gottlieb M, Peksa GD, Pandurangadu AV, Nakitende D, Takhar S, Seethala RR. Utilization of ultrasound for the evaluation of small bowel obstruction: a systematic review and meta-analysis. The American journal of emergency medicine. 2018;36(2):234-42.
27. Ünlüer EE, Yavasi Ö, Eroglu O, Yilmaz C, Akarca FK. Ultrasonography by emergency medicine and radiology residents for the diagnosis of small bowel obstruction. European Journal of Emergency Medicine. 2010;17(5):260-4.

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