

ORIGINAL RESEARCH

Diagnostic Accuracy of Ultrasonography by Emergency Medicine Resident in Detecting Intestinal Obstruction; a Pilot Study

Anita Sabzghabaei¹, Majid Shojaei², Miromid Chavoshzadeh^{1,3*}

1. Emergency Department, Shohadaye Tajrish Hospital, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

2. Emergency Department, Imam Hossein Hospital, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

3. Men's Health and Reproductive Health Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

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Abstract: **Introduction:** There are many ambiguities regarding the application of ultrasound in detection of intestinal obstruction. This study aimed to evaluate the diagnostic accuracy of ultrasound in diagnosis of intestinal obstruction. **Methods:** This cross-sectional study was performed on patients with symptoms and signs of bowel obstruction between November 2019 and July 2020 in Shohadaye-Tajrish and Imam Hossein General Hospitals, Tehran, Iran. After a brief explanation and getting verbal consent, the patients underwent ultrasound examination in the emergency department by the emergency medicine resident. The results of ultrasound were compared with the surgical findings as the gold standard. **Results:** 24 patients with the mean age of 57.50±18.26 (range: 28 – 81) years were studied (58.3% male). 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. **Conclusion:** It seems that point-of-care ultrasound has good sensitivity and accuracy in detection of intestinal obstruction when performed in the emergency department by a trained emergency medicine resident.

Keywords: Intestinal Obstruction; Point-of-Care Testing; Ultrasonography; Emergency Service, Hospital

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1. 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 (1). Intestinal obstruction is mostly due to intra-abdominal adhesions, malignancy, or intestinal hernias and its clinical manifestations generally include nausea and vomiting, colicky abdominal pain, and inability to pass stool or gas (2). The classic findings of physical examination, abdominal distention, tympanic sounds in percussion, and high-pitched intestinal sounds, might help

to diagnose the disease in a timely manner; however, imaging modalities can confirm the diagnosis and be a useful adjunct in cases where the diagnosis is uncertain (3). In this regard, although the definitive diagnosis of bowel obstruction is made on clinical assessment followed by abdominal plain radiography or computed tomography (CT) scan, in many cases we encounter false negatives leading to failure in diagnosis as well as considerable complications (4). Additionally, applying contrast-based modalities such as CT scan are frequently time-consuming, expensive, and intolerable for some patients and lead to radiation exposure (5). Therefore, employing safe, available and cost-effective devices such as ultrasound have been recently considered for assessing intestinal obstruction. In some studies, this method has been shown to be more specific and sensitive than abdominal X-ray in confirming or ruling out intestinal obstruction in addition to determining the progression via repeated scans (6, 7). Moreover, point-of-care ultrasound can help in finding

* **Corresponding Author:** Miromid Chavoshzadeh; Men's Health and Reproductive Health Research Center, Shohadaye Tajrish Hospital, Shahr-dari Avenue, Tajrish Square, Tehran, Iran. Email: omid.chavoshzadeh@gmail.com, Tel: 00989121370587, ORCID: <http://orcid.org/????????????>.



intestinal wall abnormalities such as interloop free fluid and thickened walls (8) or even deleterious problems like aortic dissection (9), which need prompt treatment. In addition, using Doppler ultrasound can help assess the blood flow in intestinal wall and detect wall necrosis or differentiate benign or malignant lesions (10, 11).

The availability of ultrasound in the emergency department, speed and ease of use, lower cost, and lack of ionizing radiation, have made it a desirable option for diagnosing small bowel obstruction (12-15). In addition to making the diagnosis of obstruction, ultrasound has been used to detect its etiology by some practitioners (16, 17). Despite these studies, there are many ambiguities regarding the accuracy of ultrasonography in confirming or rejecting/ruling out obstruction and it is not yet used as standard practice. In this study, we aimed to evaluate the accuracy of ultrasound in diagnosis of intestinal obstruction.

2. Methods

2.1. Study design and setting

This cross-sectional pilot study was performed on patients admitted to the emergency departments of Shohadaye-Tajrish and Imam Hossein Hospitals, Tehran, Iran, with signs and symptoms of intestinal obstruction, between November 2019 and July 2020. After clarifying the possibility of intestinal obstruction, explanation of the ultrasound and the purpose of performing it, and obtaining oral consent, the patients underwent abdominal ultrasonography by the trained emergency medicine resident. Then the findings of ultrasonography regarding intestinal obstruction were compared with surgery findings as the gold standard. The study protocol was approved by Ethics Committee of Shahid Beheshti University of Medical Sciences (Ethics code IR.SBMU.MSPREC.1398.216).

2.2. Participants

Not giving consent, being referred with probable diagnosis of obstruction, bringing any imaging that suggests obstruction, hemodynamic instability, life threatening conditions, and not undergoing surgical treatment (as our gold standard of diagnosis) were considered as the exclusion criteria.

2.3. Data gathering and procedure

Demographic findings (age, gender) as well as abdominal ultrasonography and surgery findings were collected using a predesigned checklist. A second-year emergency medicine resident (MC) underwent training by an emergency medicine associate professor, for four hours containing abdominal ultrasound of five patients. Patients were evaluated with the ultrasound device Honda HS-2100 in Shohadaye-Tajrish Hospital and Sonosite Edge in Imam Hossein Hospital by the

same operator. Using a low frequency (2.5-5 MHz) curvilinear probe, patients underwent ultrasound in supine position. The sweep like scan begins from the right iliac region, moves superiorly to right hypochondriac region, then epigastric region and goes downward to hypogastric region, and finally left iliac region to left hypochondriac region with the transducer in both cephalocaudal and transverse planes to cover the whole area of abdomen. Since examining peristalsis needs a couple of minutes to be correctly done and there is limited time in the busy emergency department, it was not considered. When the diameter was more than 2.5 cm, and to ensure that a small bowel loop is scanned, we looked for plicae circularis, which is a characteristic feature of small bowel. Evidence of small bowel obstruction was considered as intestinal lumen diameter more than 2.5 cm or wall thickness more than 3 mm or inter-loop free fluid (figure 1). The patients' surgical technique was similar in all samples.

2.4. Statistical analysis

Findings were presented as mean \pm standard deviation (SD) for quantitative variables and frequency (percentage) for categorical variables. To determine the diagnostic value of ultrasound in diagnosis of intestinal obstruction compared to the gold standard (surgery), screening performance characteristics were calculated and presented with 95% confidence interval (CI).

3. Results

24 patients with the mean age of 57.50 ± 18.26 (range: 28 – 81) years were studied (58.3% male). Ultrasonography findings revealed 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. The sonographic evidence of small bowel obstruction was observed in 21 (87.5%) cases, while 17 (true positive) patients were confirmed to have obstruction in surgery (4 false positives). In three patients without ultra-sonographic evidence, obstruction was confirmed following surgery (false negative). Four cases with false positive results had perforated gangrened appendix with extensive pelvic and retroperitoneal abscess, peritonitis due to cirrhosis and ascites, emphysematous pyelonephritis, and herniated abdominal wall. Considering surgery as the gold standard for diagnosis of small bowel obstruction, 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 (table 1).

4. Discussion

In recent years, with the widespread use of ultrasound in different fields of medicine, it has been used in the diagnosis



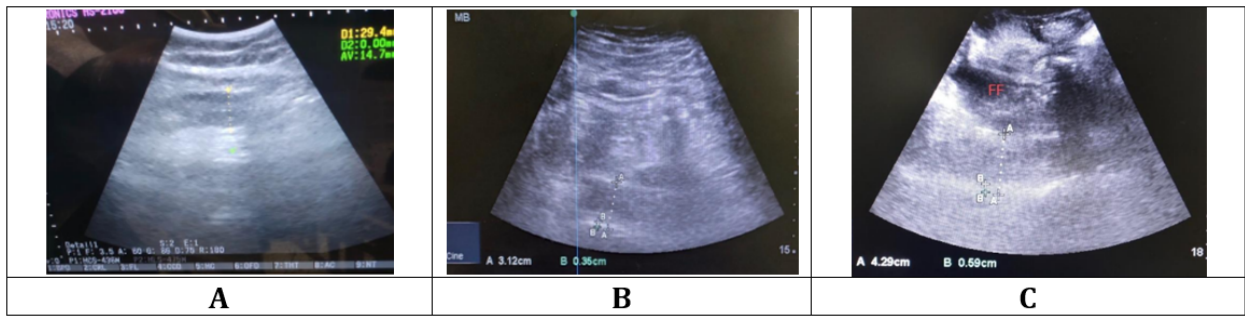


Figure 1: Increased small bowel lumen diameter more than 2.5 cm (A); increased small bowel wall thickness more than 3 mm (B); inter-loop free fluid (C).

Table 1: Screening performance characteristics of ultrasonography in detection of intestinal obstruction

Character	Value (%)	95% Confidence Interval	
		Lower Limit (%)	Upper Limit (%)
Sensitivity	85.00	61.13	96.03
Specificity	0	0	60.42
Positive predictive value	80.95	57.42	93.71
Negative predictive value	0	0	69.00
Positive likelihood ratio	4.25	1.717926	10.514134
Negative likelihood ratio	Infinity	NaN	Infinity
Accuracy	70.83	48.91	87.38

NaN: The calculation cannot be performed because the values entered include one or more instances of zero.

of patients with suspected small intestine obstruction in several studies. Because of the ease of use, low cost, high accessibility, and high accuracy reported in these studies, ultrasound has the potential to reduce many of the inherent limitations of traditional imaging. The use of ultrasound for a patient with suspected intestinal obstruction is convincing because of its potential to reduce the use of CT scans, being less expensive, limiting the use of contrast media, and reducing imaging time. The present study was performed to evaluate the diagnostic value of ultrasound in small bowel obstruction and the results showed that the sensitivity of ultrasound in diagnosis of small bowel obstruction was 85%. According to the results of this study, the positive predictive value for ultrasound was 80.95%, which means that if the test is positive in someone, they are 80.95% likely to have obstruction. The accuracy of ultrasound is also 70.8%, which means that ultrasound gives the correct answer in 70.8% of cases compared to the gold standard. In total, high diagnostic performance has been reported for ultrasound in detection of intestinal obstruction in previous studies. In a meta-analysis performed on 15 studies by Lin et al. in 2021, the pooled sensitivity and specificity of ultrasound in detection of bowel obstruction were found to be 92% (95% CI: 89%-95%) and 93% (95% CI: 85%-97%), respectively (18). Although sensitivity was similar in studies across different continents, specificity was lower in the North America, in the emergency department, and when computed tomography was used as the only reference

standard. The different findings in our study could be the result of the ultrasound operator proficiency and the ultrasonography machine. In another meta-analysis by Gottlieb et al. on 11 studies in 2018 (19), the pooled sensitivity and specificity of ultrasound was estimated to be 92.4% (95% CI 89.0% to 94.7%) and 96.6% (95% CI 88.4% to 99.1%), respectively. A meta-analysis conducted by Taylor and Lalani (20) to evaluate the method of choice for diagnosing small bowel obstruction in adults showed that ultrasound performed by an emergency physician had excellent diagnostic accuracy compared to other modalities, and was even superior to CT-scan and MRI. They also showed that ultrasound has the potential to play a greater role in diagnosis of small bowel obstruction in the emergency department. Musoke and colleagues conducted a research in Uganda in 2003, which compared the accuracy of ultrasound and abdominal radiography for diagnosing bowel obstruction (14). They reported 100% specificity, 93% sensitivity and accuracy, 100% PPV, and 73% NPV. The reason for its high accuracy could be the age of patients, which were between 3 days to two years old, and the different main cause of obstruction, which was hernia (instead of adhesions). Ultrasonography in Jang and colleagues work (15) has higher sensitivity than our study, which can be due to comparing the ultrasound with CT-scan results as well as looking for both increased lumen diameter and decreased peristalsis. Schmutz et al. found 91% accuracy when they excluded 'gassy' patients and 81% overall (17), which



might be because of the higher skills of radiologist operators. In general, different results could be related to the operators' abilities, doing the ultrasound at the crowded emergency ward with less concentration and time, and not using the modality options like various probes and Doppler, in addition to limited number of patients and their demographic characteristics. Likewise, it should be noted that the accuracy of ultrasonography in diagnosis of intestinal obstructive lesions depends on various factors, including the experience of the operator performing the ultrasound scan, anatomical status, the level of obstruction, and patient cooperation. It is worth emphasizing that ultimately, the diagnosis of obstructive pathological lesions such as the etiology of obstruction will be possible based on surgery or biopsy, and imaging techniques are mainly auxiliary and screening tools for the disease.

In addition, because of the increasing use of ultrasound in diagnostic and therapeutic procedures, especially in the emergency department, equipping these departments with advanced devices and improving users' abilities in applying and interpreting ultrasound findings is recommended.

5. Strengths and Limitations

The advantage of our study was comparing the results of ultrasound with surgery as the gold standard and performing point-of-care ultrasound by the emergency medicine resident. The major limitation of the present study was studying a limited number of patients. In fact, due to concurrence of the plan and the COVID-19 pandemic, and since the venues were referral centers for COVID-19 patients, the study could not be performed with a larger number of patients. Also, due to the special conditions of the emergency department and its crowdedness, peristalsis, which is one of the indicators of small bowel obstruction in some studies, was not evaluated.

6. Conclusion

It seems that point-of-care ultrasound has good sensitivity and accuracy in detection of intestinal obstruction when performed in the emergency department by a trained emergency medicine resident.

7. Declarations

7.1. Acknowledgments

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7.2. Authors' contributions

All authors meet the standard criteria of authorship contribution based on the recommendations of the International Committee of Medical Journal Editors.

7.3. Funding and supports

No funding was received for this study.

7.4. Conflict of interest

There is no conflict of interest in this study.

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