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Original Contribution

Utilization of ultrasound for the evaluation of small bowel obstruction: A systematic review and meta-analysis

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ABSTRACT

Introduction: Small bowel obstruction (SBO) is a common presentation to the Emergency Department (ED). While computed tomography (CT) is frequently utilized to confirm the diagnosis, this modality is expensive, exposes patients to radiation, may lead to time delays, and is not universally available. This study aimed to determine the test characteristics of ultrasound for the diagnosis of SBO.

Methods: PubMed, CINAHL, Scopus, the Cochrane Database of Systematic Reviews, and the Cochrane Central Register of Controlled Trials were assessed for prospective trials evaluating the accuracy of ultrasound for the detection of SBO. Data were double extracted into a predefined worksheet and quality analysis was performed using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool.

Results: This systematic review identified 11 studies comprising 1178 total patients. Overall, ultrasound was found to be 92.4% sensitive (95% CI 89.0% to 94.7%) and 96.6% specific (95% CI 88.4% to 99.1%) with a positive likelihood ratio of 27.5 (95% CI 7.7 to 98.4) and a negative likelihood ratio of 0.08 (95% CI 0.06 to 0.11).

Discussion: The existing literature suggests that ultrasound is a valuable tool in the diagnosis of SBO with a sensitivity and specificity comparable to that of CT. Ultrasound may save time and radiation exposure, while also allowing for serial examinations of patients to assess for resolution of the SBO. It may be particularly valuable in settings with limited or no access to CT. Future studies should include more studies in the Emergency Department setting, comparison of probe choices, and inclusion of more pediatric patients.

1. Introduction

Small bowel obstruction (SBO) is a common Emergency Department (ED) diagnosis, which has been estimated to comprise 2% of all patients presenting with abdominal pain and result in 300,000 hospitalizations per year [1,2]. Small bowel obstruction occurs due to an impedance in the normal flow of intestinal contents, most commonly due to a mechanical obstruction or functional bowel etiology. The failure to diagnose a small bowel obstruction in a timely manner can result in significant complications. These include, but are not limited to, bowel ischemia, necrosis, and perforation [3]. Due to the ease of accessibility, plain film radiography (x-ray) is usually the initial imaging choice by practitioners for the evaluation of SBO. However, this imaging modality is often non-diagnostic and has poor sensitivity and specificity [4]. Consequently, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound have been utilized as alternative diagnostic modalities for confirming the diagnosis of SBO [5,6].

While many practitioners utilize CT as the primary diagnostic tool for identifying SBO, CT is expensive, time-consuming, and exposes patients to high doses of radiation. Additionally, many locations may not have access to CT imaging. Therefore, researchers have increasingly investigated the utility of ultrasound for the diagnosis of SBO. This may have value in both the initial diagnosis, as well as serial assessments for resolution of the SBO, while saving time and reducing total radiation exposure to the patient.

We conducted a systematic review and meta-analysis to determine the diagnostic accuracy of ultrasound to detect small bowel obstruction. We hypothesized that ultrasound would be highly accurate in the detection of small bowel obstruction when compared with the gold standard as defined by the study. We also performed secondary analyses by study location (e.g. Emergency Department versus non-Emergency

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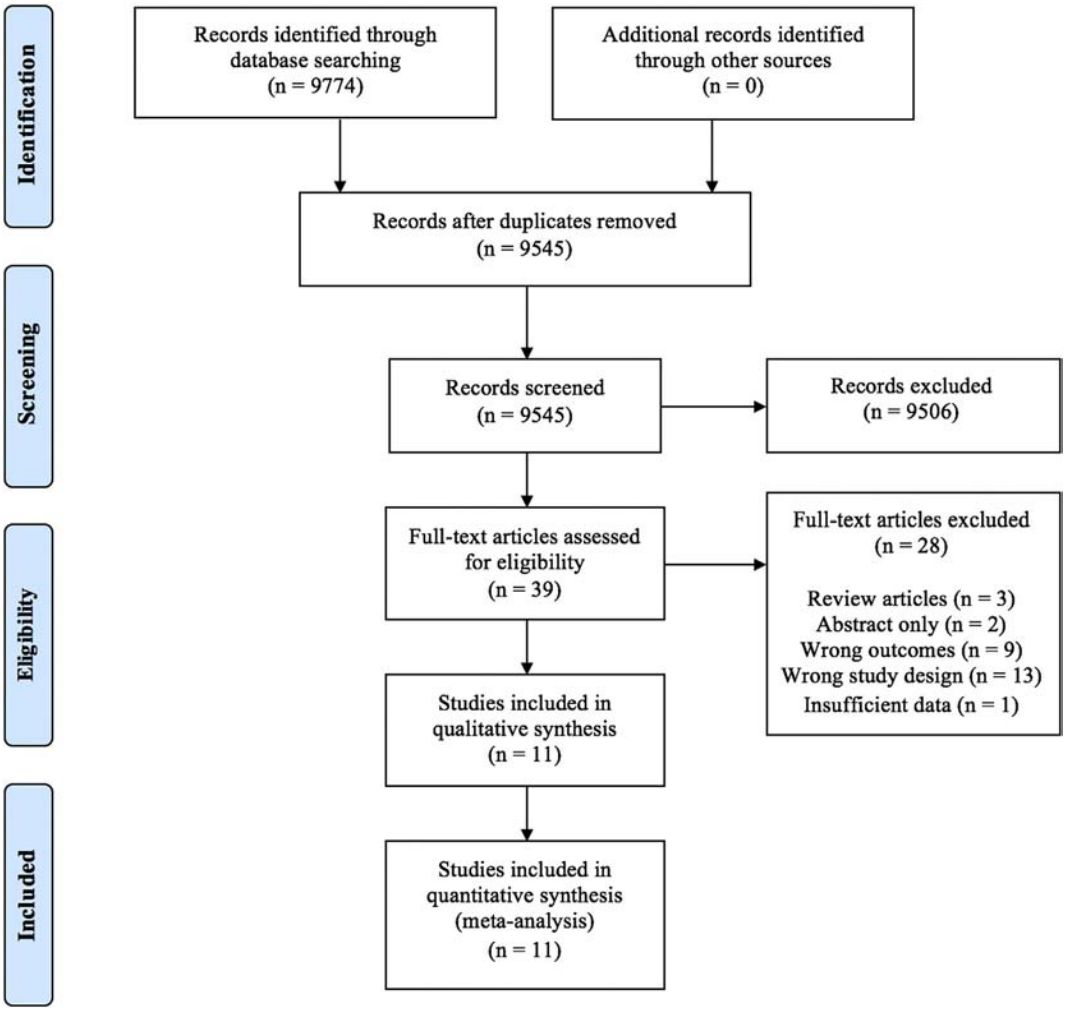

Fig. 1. PRISMA flow diagram.

Department) and sonographer type (e.g. Emergency Physician versus non-Emergency Physician).

2. Materials and methods

This protocol (#56555) was registered with and is available for review at the PROSPERO website (https://www.crd.york.ac.uk/PROSPERO/). Our study conforms to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews and was performed in accordance with best practice guidelines [7,8]. In conjunction with a medical librarian, we conducted a search of PubMed, CINAHL, Scopus, the Cochrane Database of Systematic Reviews, and the Cochrane Central Register of Controlled Trials to include citations from inception to March 17, 2017. Details of the search strategy are included in Appendix A. We reviewed the bibliographies of identified studies and review articles for potential missed articles. We also consulted with topic experts to help identify any further relevant studies.

Inclusion criteria consisted of all prospective, observational and randomized, controlled trials assessing the accuracy of ultrasound for detecting small bowel obstruction with sufficient data to develop a two-by-two table for sensitivity and specificity calculations. The gold standard was determined by the study definition, which included computed tomography (CT), enteroclysis, surgical diagnosis, discharge diagnosis, or clinical follow up. Exclusion criteria included retrospective studies, case series, and studies published in abstract format only. Only articles written in languages spoken fluently by study authors (i.e., English or Spanish) were included. Prenatal assessments were also excluded. Two physician-investigators independently assessed studies for eligibility based upon the above criteria. All abstracts meeting initial criteria were reviewed as full manuscripts. Studies determined to meet the eligibility criteria on full text review by both extractors were included in the final data analysis. Any discrepancies were resolved by consensus with a third investigator.

2.1. Data collection and processing

Two physician-investigators independently extracted data from the included studies. The investigators underwent initial training and extracted data into a pre-designed data collection form. The following information was abstracted: last name of the first author, study title, publication year, total study population size, study country, study location, mean patient age, gender distribution, ultrasound machine, ultrasound probe type, ultrasound training protocol, ultrasound criteria for the diagnosis of small bowel obstruction, gold standard for diagnosis, generation of CT scanner (if applicable), study design, true positives, true negatives, false positives, false negatives, and number of indeterminate ultrasound scans. Studies were independently assessed for quality by two separate physician-investigators utilizing the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool. Any discrepancies were resolved by consensus with a third investigator.

Table 1
Summary of existing studies on the accuracy of ultrasound for small bowel obstruction.

Study	Country	Study location	Study population size (%male)	Ultrasound probe and machine	Ultrasound training protocol	Ultrasound criteria for SBO	Gold standard
Sillero (1984)	Spain	NR	50 (NR)	NR	NR	Intestinal loops dilated by liquid contents with tubular structures and liquid	Surgery
Ogata (1996)	United States	Emergency Department or Surgical Services	50 (46%)	3.5-MHz transducer; Biomedica Model AU530 Esaote	NR	1) The presence of fluid-filled dilated small bowel (diameter ≥ 25 mm) proximal to collapsed small bowel or ascending colon and 2) the presence of peristaltic activity in the entire dilated proximal small bowel	Surgery or clinical diagnosis (if non-operative)
Czechowski (1996)	Sweden	Emergency Department or Surgical Services	96 (47%)	5- or 7.5-MHz linear transducer; Acuson 128 and Aloka 650	NR	1) Distention of bowel loops above a hindrance with increased or normal peristalsis and 2) absence or decrease of peristalsis below the hindrance	Surgery
Schmutz (1997)	France	NR	123 (58%)	3.5-, 4.0-, 5.0- or 7.5-MHz sectorial or linear probes; ATL Ultramark 4, Kretz COmbison 320, and Acuson P4	> 2 years of prior experience	Diameter of the fluid-filled loops >25 mm in the jejunum or >15 mm in the ileum over a length of >3 loops	Surgery, pathology examination, advanced imaging, or clinical follow up
Suri (1999)	India	NR	32 (66%)	3.5-MHz sector or 5-MHz linear transducers; General Electric R 3600	NR	Dilated bowel loops with or without peristaltic activity and a zone of transition beyond which dilatation was not appreciated	Surgery, contrast imaging, or clinical follow up
Kohn (1999)	Italy	Department of Gastroenterology	44 (75%)	3.5-MHz convex or 5-MHz linear transducer	NR	Presence of bowel dilatation >3 cm and fluid-filled loops proximal to an intestinal segment with prominent wall thickening (>5 mm) and impaired motility	Enteroclysis
Grunshaw (2000)	United Kingdom	NR	60 (50%)	Transducer NR; Siemens Sonoline SL400 or General Electric RT 2800	NR	Dilated fluid-filled bowel loops >2.0–2.5 cm in the upper to mid-small bowel or > 1.5–2.0 cm in the distal small bowel	Surgery, contrast enema, colonoscopy, CT, pathology, or clinical follow up
Musoke (2003)	Uganda	Department of Radiology	70 (60%)	3.5-, 5.0-, or 7.5-MHz curved or linear array transducer; Sonoline Prima or Sonoline SL-1	Senior house officer under the supervision of a senior radiologist	Lumen diameter > 25 mm for the jejunum or >15 mm for the ileum over a length of >100 mm or >3 bowel loops	Surgery, pathology, or clinical follow up
Lin (2006)	Taiwan	Emergency Department	229 (NR)	3–6 MHz curvilinear transducer; Toshiba SSA-340A	NR	Presence of dilated, fluid-filled bowel loops >25 mm in diameter with prominence of valvulae conniventes and collapsed distal bowel loop	Surgery, contrast-enhanced CT, enterolcysis, or endoscopy
Unlüer (2010)	Turkey	Emergency Department	174 (61%)	3.5-MHz curvilinear transducer; Sonosite Titan[a] 5-MHz curvilinear transducer; Shimasonic SDU-450[b]	3 h of didactic and 3 h of hands-on training by a radiologist[a] NR[b]	1) Small bowel loops >25 mm in the jejunum or >15 mm in the ileum over a length of more than three loops, 2) increased peristalsis, and 3) a collapsed colonic lumen (2 of 3 criteria)	Surgery, CT, or clinical follow up
Jang (2011)	United States	Emergency Department	76 (NR)	Phased-array transducer; Ultrasonix CEP	10-minute hands-on lecture and performance of 5 prior ultrasound SBO exams	1) Presence of fluid-filled, dilated bowel (>25 mm) proximal to normal or collapsed bowel or 2) decreased or absent bowel peristalsis	CT

NR, not reported; SBO, small bowel obstruction; CT, computed tomography.
[a] Emergency Medicine residents.
[b] Radiology residents.

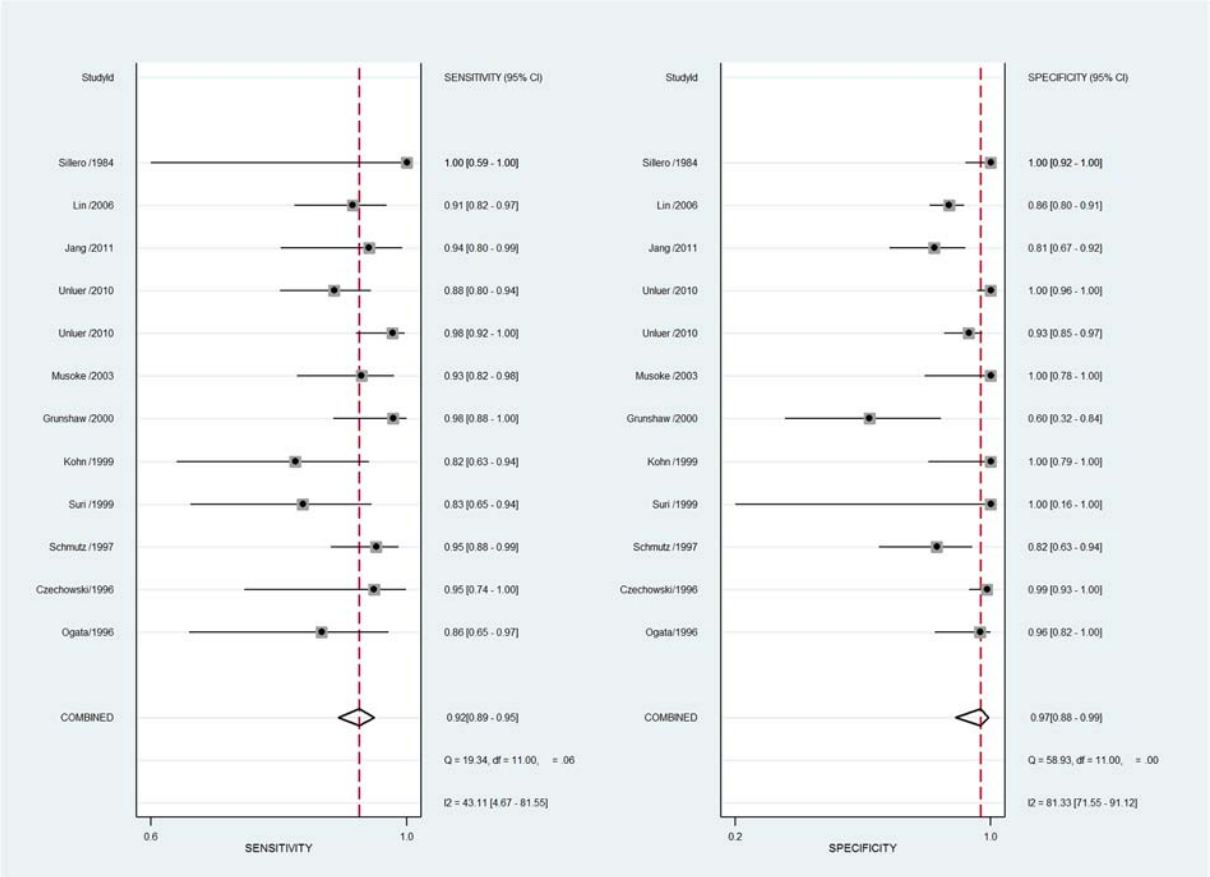

Fig. 2. Forrest diagram of the overall accuracy of ultrasound for the diagnosis of small bowel obstruction.

2.2. Primary data analysis

The sensitivity, specificity, positive likelihood ratio (+LR), and negative likelihood ratio (−LR) with 95% confidence intervals (95% CI) were calculated using a mixed-effects binary regression model. The I^2 statistic was calculated to assess the heterogeneity between the included studies. Forest plots were constructed for the sensitivity and specificity. Additionally, a summary receiver-operating characteristic (SROC) graph with 95% confidence intervals around the pooled estimates was constructed. Publication bias was examined by constructing a funnel plot using the Egger regression model. Funnel plot asymmetry was tested by drawing a regression line, with p-value < 0.1 for the coefficient of the slope considered to be significant for asymmetry.

A subgroup analysis was conducted based upon the location of the ultrasound examination. The study location was dichotomized as occurring in the ED or occurring outside the ED (e.g., radiology ultrasound suite, gastrointestinal department). There were 16 ultrasound examinations that were inconclusive and not included in the primary analysis. A sensitivity analysis was performed categorizing all 16 of those inconclusive ultrasound exams as false negatives, as this was thought to be the most clinically significant. All analyses were performed using Stata 14.0 (StataCorp, College Station, TX).

3. Results

A total of 9774 studies were identified. PubMed yielded 6603 studies, Scopus identified 2909 studies, CINAHL found 212 studies, the Cochrane Database of Systematic Reviews yielded one study, and the Cochrane Central Register of Controlled Trials identified 49 studies. After removing duplicates, 9545 abstracts were reviewed with 39 selected for full text review (Fig. 1). No additional papers were identified through bibliographic review.

Eleven prospective, observational studies, comprising 1178 total patients, were selected for the final analysis (Table 1). Of note, the study by Unlüer et al. included data on the use of ultrasound independently by

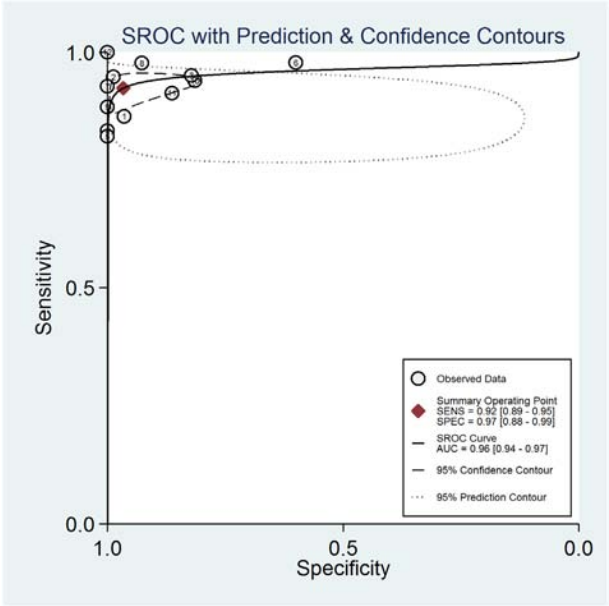

Fig. 3. SROC graph of the overall accuracy of ultrasound for the diagnosis of small bowel obstruction.

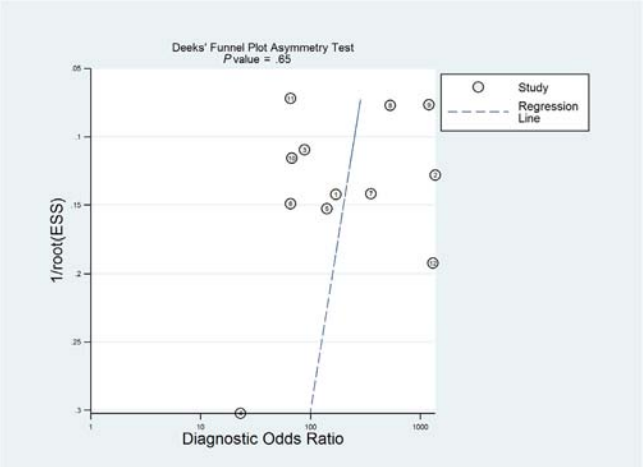

Fig. 4. Funnel plot of the overall accuracy of ultrasound for the diagnosis of small bowel obstruction.

both Emergency Medicine residents and radiology residents, so both data sets were included [9]. The studies were conducted between 1984 and 2011 with population sizes ranging from 32 to 229. Six studies were performed in Europe, [9-14] two studies were performed in North America, [4,15] two studies were performed in Asia, [5,16] and one was performed in Africa [17]. Five studies were conducted in the Emergency Department (ED), [4,9,11,15,16] while the remainder occurred in a non-ED location. Only three studies were performed by ED providers [4,9,16]. Mean age was 50 years with a range from 3 days to 98 years and 73.5% of patients were male.

Overall, ultrasound was found to be 92.4% sensitive (95% CI 89.0% to 94.7%) and 96.6% specific (95% CI 88.4% to 99.1%) (Figs. 2 and 3). This resulted in a + LR of 27.5 (95% CI 7.7 to 98.4) and a -LR of 0.08 (95% CI 0.06 to 0.11). The studies had mild degree of heterogeneity for sensitivity (I^2 = 43.1) and moderate degree of heterogeneity for specificity (I^2 = 81.3). Funnel plot analysis demonstrated no evidence of publication bias (Fig. 4).

Subgroup analysis by location revealed similar test characteristics. Studies performed in the ED had a sensitivity of 93% (95% CI 89% to 95%) and a specificity of 96% (95% CI 86% to 99%) with a +LR of 21.1 (95% CI 6.5 to 68.9) and a −LR of 0.08 (95% CI 0.05 to 0.12) (Figs. 5 and 6). Studies performed in the non-ED setting had a sensitivity of 92% (95% CI 85% to 96%) and a specificity of 99% (95% CI 60% to 100%) with a +LR of 70.8 (95% CI 1.5 to 3279.7) and a −LR of 0.08 (95% CI 0.05 to 0.15) (Figs. 7 and 8). Subgroup analysis by type of provider could not be performed due to an insufficient number of studies.

There were 16 ultrasound examinations that were determined to be inconclusive and not included in the original data sets. A sensitivity analysis was performed assuming that all 16 cases were false negatives, resulting in a sensitivity of 90.9% (95% CI 86.0% to 94.2%) and specificity of 96.3% (95% CI 87.8% to 99.0%) with a +LR of 24.6 (95% CI 7.2 to 84.3) and −LR of 0.09 (95% CI 0.06 to 0.15).

Studies were overall at low to moderate risk of bias (Table 2). Five studies were at unclear risk of bias with respect to patient selection due to either the use of a convenience sample [4,9,15] or unclear recruitment strategy [10,11]. Two studies were at unclear risk of bias for the reference standard due to lack of clarity with respect to blinding of the outcome assessor [12] and confirmation of non-obstructive cases [11]. Most studies were at unclear risk of bias for flow and timing due to differences in the reference standard [5,9,12-17]. Czechowski was considered at high risk due to verification bias [11]. With regard to

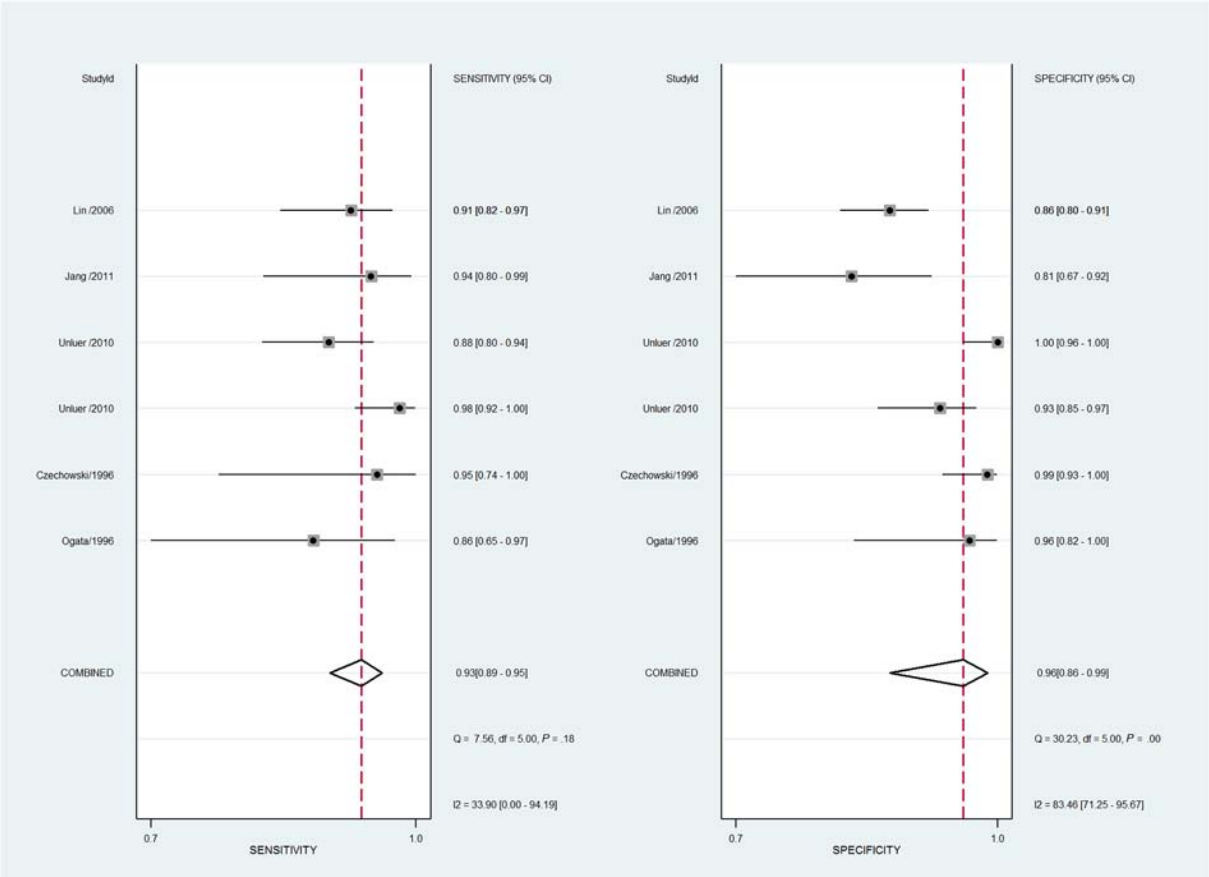

Fig. 5. Forrest diagram of the accuracy of studies performed in the Emergency Department.

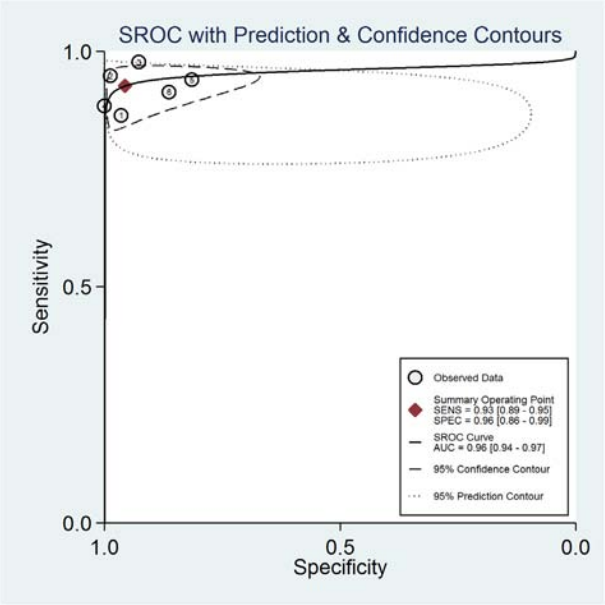

Fig. 6. SROC graph of the accuracy of studies performed in the Emergency Department.

applicability, four studies were at unclear risk due to the specific patient populations involved [10-13]. All studies were at unclear applicability risk for the index test due to the differences in ultrasound probe choices and machine quality over time. Czechowski was at high applicability risk for the reference standard because it was unclear how non-obstructed cases were confirmed [11].

4. Limitations

This systematic review and meta-analysis has several limitations that should be considered. All of the included studies were prospective, observational studies. There were no randomized, controlled trials identified in this review. Therefore, it is possible that there are unidentified confounders within the studies. However, we could not identify any significant confounders upon our review and the consistency in the results across studies suggests that this is less likely. There was moderate heterogeneity in the studies with respect to the patient population and outcome assessments. Additionally, the differences in sonographer experience and diagnostic criteria further limit the data. Only three studies were performed by ED providers [4,9,16], limiting the ability to perform meta-analysis by this subset. While the accuracy was similar in these studies when compared with the overall data, it is possible that ED providers may have subtle differences in accuracy and more studies are needed among ED providers. In two studies, it was not possible to differentiate the cases diagnosed as small bowel obstruction from those diagnosed as large bowel obstruction [5,14]. Attempts were made to contact the authors, but we were unsuccessful. However, this data comprised a small portion of the total data set (n = 92 total patients) with an even smaller subset of those patients having diagnosed large bowel obstructions. There was very limited data with respect to the pediatric population, limiting applicability to this subgroup. Finally, 16 cases were non-diagnostic. Assuming that all of these cases were

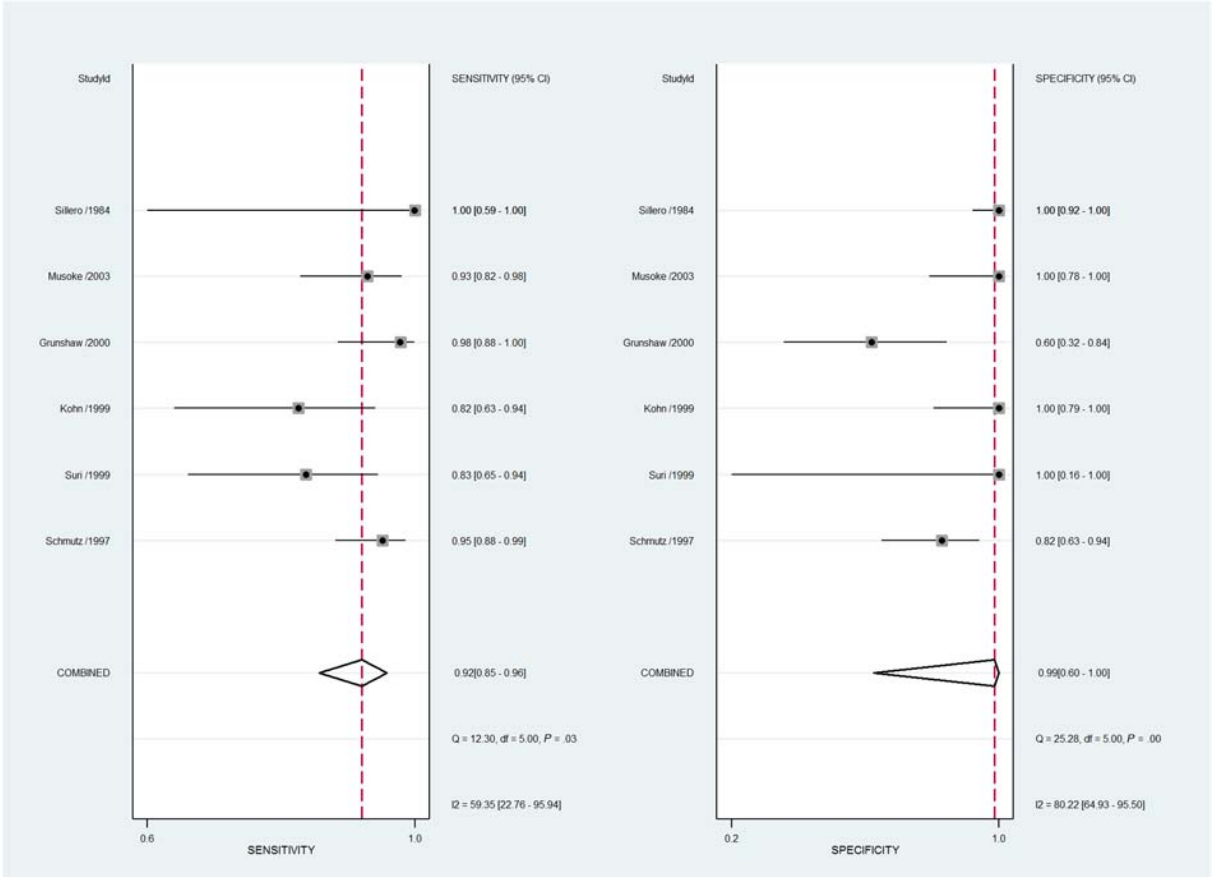

Fig. 7. Forrest diagram of the accuracy of studies performed in a non-Emergency Department setting.

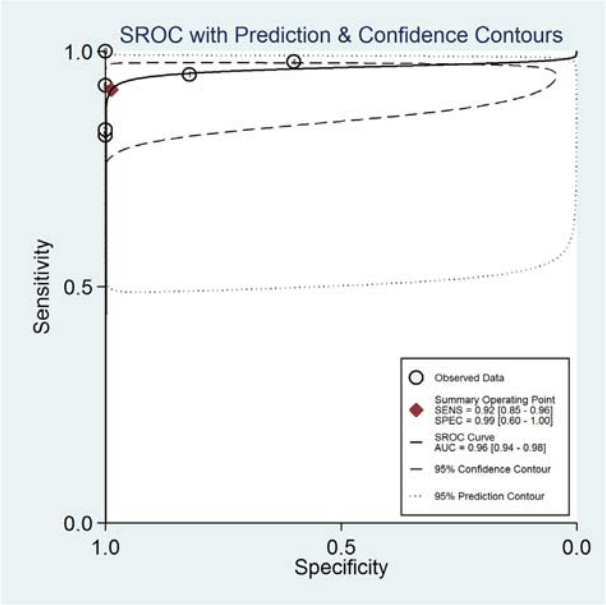

Fig. 8. SROC graph of the accuracy of studies performed in a non-Emergency Department setting.

incorrectly diagnosed as false negatives, our sensitivity analysis demonstrated minimal effect upon the test characteristics.

5. Discussion

Our systematic review and meta-analysis demonstrated that ultrasound is both sensitive and specific for the diagnosis of small bowel obstruction. When compared with other imaging modalities, ultrasound has similar test characteristics to newer generation CT scanners and appears better than magnetic resonance imaging (MRI) and radiography [18].

To our knowledge, this is the first systematic review and meta-analysis focused on the use of ultrasound for the detection of small bowel obstruction. Taylor and Lalani performed a scoping systematic review of historical features, physical examination findings, and all advanced imaging for the diagnosis of small bowel obstruction which included ultrasound as a subgroup [18]. However, their review was performed in 2011, six years prior to our current study. Furthermore, the authors utilized a limited search strategy with respect to the use of ultrasound for small bowel obstruction. Our updated systematic review and meta-analysis utilized a more extensive and targeted search of the use of ultrasound for the detection of small bowel obstruction, including the addition of expanded search terms and additional search databases, which led to the identification of five additional studies not previously identified by Taylor and Lalani which were included in this review [10,11,13,14,16]. The addition of these five studies led to an additional 479 patients being included and resulted in a higher specificity than noted by Taylor and Lalani [18].

A prior systematic review and meta-analysis assessing the diagnostic accuracy of CT for identifying SBO found a summary sensitivity of 87% and specificity of 81% [18]. A subgroup analysis of only the newest CT scanners (64-slice or greater multidetector CT with thin slices) found that sensitivity ranged from 93 to 96% and specificity ranged from 93 to 100% [18]. This is similar to the test characteristics noted in our meta-analysis of ultrasound for SBO.

Ultrasound is advantageous when compared with CT as it can be performed easily at the bedside, allowing for more rapid diagnosis, consultation, and intervention. This may lead to decreased time to admission and shorter ED length of stay. Ultrasound does not carry the inherent radiation risks associated with CT, which may lower total radiation dosing in select patients. This may also be valuable if performed serially to assess for resolution of the obstruction. Additionally, ultrasound is much less expensive than CT and has the potential to decrease overall healthcare costs. Finally, as CT is not universally available, ultrasound may be particularly valuable in low resource settings, where it appears more accurate than x-ray.

We performed subgroup analyses by study location (e.g. Emergency Department versus non-Emergency Department) and sonographer type (e.g. Emergency Physician versus non-Emergency Physician). When comparing studies performed in the Emergency Department with those performed in an alternate setting, the sensitivity and specificity were not significantly different based upon the study location. However, there were insufficient studies to evaluate differences by provider type and further studies are needed to assess this subgroup.

It is important to consider the potential for operator variability with respect to the use of ultrasound. Unlüer et al. demonstrated that Emergency Medicine residents could identify small bowel obstruction with excellent accuracy after a 6-hour training session [9]. Jang et al. identified very good accuracy after a 10-minute training session followed by 5 practice ultrasound scans [4]. This suggests that providers may acquire this skill after a relatively short training and practice period. Further studies are needed to determine the optimal training time and method for this modality.

Future studies should assess the use of ultrasound in larger patient groups and with a focus in the Emergency Department setting. Additionally, studies should compare the accuracy between different probes to determine the ideal ultrasound probe choice. Finally, more studies are needed in the pediatric population, which was an exclusion criteria for most of the above studies.

Table 2
QUADAS-2 assessment.

Study	Risk of bias				Applicability concerns		
	Patient selection	Index test	Reference standard	Flow and timing	Patient selection	Index test	Reference standard
Sillero (1984)	**U**	L	L	L	**U**	**U**	L
Ogata (1996)	**U**	L	L	**U**	L	**U**	L
Czechowski (1996)	**U**	L	**U**	**H**	**U**	**U**	**H**
Schmutz (1997)	L	L	**U**	**U**	**U**	**U**	L
Suri (1999)	L	L	L	**U**	L	**U**	L
Kohn (1999)	L	L	L	**U**	**U**	**U**	L
Grunshaw (2000)	L	L	L	**U**	L	**U**	L
Musoke (2003)	L	L	L	**U**	L	**U**	L
Lin (2006)	L	L	L	**U**	L	**U**	L
Unlüer (2010)	**U**	L	L	**U**	L	**U**	L
Jang (2011)	**U**	L	L	L	L	**U**	L

L, low risk of bias; U, unclear risk of bias; H, high risk of bias.

6. Conclusion

The existing literature suggests that ultrasound is a valuable tool in the diagnosis of SBO with a sensitivity and specificity comparable to that of CT. Ultrasound may save time and radiation exposure, while also allowing for serial examinations of patients to assess for resolution of the SBO. It may be particularly valuable in settings with limited or no access to CT. Future studies should include more studies in the Emergency Department setting, comparison of probe choices, and inclusion of more pediatric patients.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. We have no disclosures to declare.

Appendix A

Database: PubMed.

Concept	Ultrasound	Small bowel obstruction
Subject headings	"Ultrasonography" [MeSH terms] "Ultrasonography, Doppler" [Mesh] "Ultrasonography, Doppler, duplex" [Mesh] "Ultrasonography, Doppler, color" [Mesh] "Ultrasonography, interventional" [Mesh] "Diagnostic imaging" [Mesh:NoExp] "Ultrasonography, Doppler, pulsed" [Mesh] "Elasticity imaging techniques" [Mesh] "Endosonography" [Mesh] "Microscopy, acoustic" [Mesh] "Ultrasonography, prenatal" [Mesh] "Ultrasonics"[Mesh] OR "ultrasonic therapy" [Mesh]	"Intestine, small" [Mesh] "Intestinal obstruction" [Mesh]
Keywords	Ultrasonography Ultrasound imaging ultraso* sonograp* Ultrasounds Ultrasound "Diagnostic images" diagnos* Ultrasonic diagnosis Ultrasonic diagnoses imag*	Small bowel obstruction Small bowel obstructions "Small bowel" AND "blocked" "Small bowel impactions" "Small bowel impaction" "SBO" "Small intestine" Afferent Loop Syndrome Duodenal obstruction Fecal impaction Ileus Intestinal pseudo-obstruction Intestinal volvulus block* AND "small bowel" "Small bowel" OR "small intestine" AND obstruct* OR impact* OR loop*

Notes: Automatic mapping. To avoid automatic mapping, use quotation marks and/or [tw] field tag. May not truncate within quotation marks.

Database: CINAHL.

Concept	Ultrasound	Small bowel obstruction
Subject headings	(MH "diagnostic imaging") OR (MH "ultrasonography") OR (MH "ultrasonography, Doppler") OR (MH "ultrasonography, Doppler, duplex") OR (MH "ultrasonography, Doppler, color") OR (MH "ultrasonography, Doppler, pulsed") OR (MH "ultrasonography, prenatal+") OR (MH "ultrasonics+")	(MH "intestine, small+") AND (MH "intestinal obstruction+"

Okay to truncate within quotation marks. * at the end of the word or word stem finds all endings of that word. # is used in places where an alternate spelling may contain an extra character (e.g., isch#emic).

Database: Cochrane Database of Systematic Reviews.

Concept	Ultrasound	Small bowel obstruction
Subject headings	(((((ZU "ultrasound") or (ZU "imaging techniques") OR (ZU "ultrasound guided compression") or (ZU "ultrasound guided evacuation")) or ((ZU "ultrasonography") or (ZU "ultrasonography, Doppler") or (ZU "ultrasonography, Doppler, color") or (ZU "ultrasonography, interventional") or (ZU "ultrasonography, interventional methods"))) or ((ZU "ultrasonic therapy") or (ZU "ultrasonic therapy economics") or (ZU "ultrasonic therapy instrumentation") or (ZU "ultrasonic therapy methods") or (ZU "ultrasonics"))) or ((ZU "diagnostic imaging and testing") or (ZU "diagnostic imaging methods"))) or ((ZU "diagnostic imaging standards"))	((((ZU "small bowel")) or ((ZU "bowel obstruction"))) or ((ZU "intestine, small") or (ZU "intestine, small diagnostic imaging"))) or ((ZU "intestinal obstruction diagnostic imaging"))

Okay to truncate within quotation marks. * at the end of the word or word stem finds all endings of that word. # is used in places where an alternate spelling may contain an extra character (e.g., isch#emic).

Database: Cochrane Central Register of Controlled Trials.

Concept	Ultrasound	Small bowel obstruction
Subject headings	(((((ZU "ultrasonography") or (ZU "ultrasonography adverse effects") or (ZU "ultrasonography classification") or (ZU "ultrasonography economics") or (ZU "ultrasonography instrumentation") or (ZU "ultrasonography methods") or (ZU "ultrasonography standards") or (ZU "ultrasonography statistics & numerical data") or (ZU "ultrasonography utilization") or (ZU "ultrasonography, Doppler") or (ZU "ultrasonography, Doppler drug effects") or (ZU "ultrasonography, Doppler economics") or (ZU "ultrasonography, Doppler instrumentation") or (ZU "ultrasonography, Doppler methods") or (ZU "ultrasonography, Doppler nursing") or (ZU "ultrasonography, Doppler standards") or (ZU "ultrasonography, Doppler statistics & numerical data") or (ZU "ultrasonography, Doppler, color") or (ZU "ultrasonography, Doppler, color adverse effects") or (ZU "ultrasonography, Doppler, color drug effects")) or ((ZU "ultrasonography, Doppler, color drug effects") or (ZU "ultrasonography, Doppler, color instrumentation") or (ZU "ultrasonography, Doppler, color methods") or (ZU "ultrasonography, Doppler, color standards") or (ZU "ultrasonography, Doppler, color statistics & numerical data") or (ZU "ultrasonography, Doppler, duplex") or (ZU "ultrasonography, Doppler, duplex adverse effects") or (ZU "ultrasonography, Doppler, duplex drug effects") or (ZU "ultrasonography, Doppler, duplex economics") or (ZU "ultrasonography, Doppler, duplex instrumentation") or (ZU "ultrasonography, Doppler, duplex methods") or (ZU "ultrasonography, Doppler, duplex standards") or (ZU "ultrasonography, Doppler, duplex statistics & numerical data") or (ZU "ultrasonography, Doppler, pulsed") or (ZU "ultrasonography, Doppler, pulsed instrumentation") or (ZU "ultrasonography, Doppler, pulsed methods"))) or ((ZU "ultrasonography, interventional") or (ZU "ultrasonography, interventional adverse effects") or (ZU "ultrasonography, interventional economics") or (ZU "ultrasonography, interventional instrumentation") or (ZU "ultrasonography, interventional methods") or (ZU "ultrasonography, interventional mortality") or (ZU "ultrasonography, interventional nursing") or (ZU "ultrasonography, interventional standards") or (ZU "ultrasonography, interventional statistics & numerical data") or (ZU "ultrasonography, interventional trends") or (ZU "ultrasonography, interventional utilization")))) or ((ZU "ultrasonic therapy"))	((((((((ZU "intestine, small")) or ((ZU "intestine, small ultrasonography"))) or ((ZU "intestines ultrasonography"))) or ((ZU "fecal impaction") or (ZU "fecal impaction diagnosis") or (ZU "fecal incontinence") or (ZU "fecal incontinence diagnosis"))) or ((ZU "fecal incontinence ultrasonography"))) or ((ZU "afferent loop syndrome etiology"))) or ((ZU "ileus") or (ZU "ileus blood") or (ZU "ileus complications") or (ZU "ileus diagnosis") or (ZU "ileus etiology")))) or ((ZU "colonic pseudo-obstruction etiology"))

Okay to truncate within quotation marks. * at the end of the word or word stem finds all endings of that word. # is used in places where an alternate spelling may contain an extra character (e.g., isch#emic).

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