Internal and Emergency Medicine
https://doi.org/10.1007/s11739-025-04150-8

EM - ORIGINAL

Point-of-care ultrasound diagnostic accuracy for fecal impaction in the emergency department: a prospective study

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Received: 3 July 2025 / Accepted: 10 October 2025

Abstract

Point-of-care ultrasound (PoCUS) is increasingly used in many medical specialties. Fecal impaction (FI) is common among elderly individuals living in nursing homes. Since it is a major source of morbidity, with a multifactorial etiology, improving its diagnosis is crucial. Combining physical examination and PoCUS could enhance the diagnostic approach to FI. In this prospective interventional multicenter study, we assessed the value of PoCUS in diagnosing FI compared with abdominal X-ray in the emergency department (ED). The secondary objectives were to evaluate the impact of body mass index, final diagnosis, bladder repletion, difficulty performing PoCUS, and FI consistency on FI diagnosis by PoCUS. A total of 172 patients were enrolled in the study and data from 163 patients were analyzed. The specificity and sensitivity of PoCUS in diagnosing FI were 0.94 and 0.84, respectively. The positive and negative likelihood ratios were excellent (14.8) and good (0.16), respectively. Regarding subgroup analyses, PoCUS sensitivity and specificity did not significantly differ according to BMI category, bladder repletion, or difficulty performing PoCUS. Specificity was good enough to diagnose FI without performing complementary examinations, thus avoiding the need for invasive procedures such as digital rectal examination. Although sensitivity was acceptable, it was not good enough not to consider abdominal X-ray when the clinical presumption is high. Given the good likelihood ratios, we showed that FI diagnosis can be made or excluded during clinical management based on the PoCUS result. Overall, this study supports the use of PoCUS for diagnosing FI in elderly patients in emergency departments. NCT06333106 in ClinicalTrials.gov (registered on March 27, 2024).
Trial registration.

Keywords Fecal impaction · Diagnosis · PoCUS · Elderly patient · Diagnostic accuracy

Introduction

Point-of-care ultrasound (PoCUS) is being used more and more in various medical specialties [1–3] and is an important part of the clinical evaluation process, along with inspection, palpation, percussion, and auscultation [4, 5]. This component of clinical examination has become essential in daily clinical practice as it improves differential diagnosis [6–8]. According to guidelines published by the American Academy of Emergency Medicine and the European Federation of Societies for Ultrasound in Medicine and Biology in 2015 and 2016, including PoCUS in the medical curricula is recommended to improve learning of core concept and enhance students' understanding of physical examinations [4, 5]. The diagnostic accuracy of PoCUS has been demonstrated in various medical conditions and populations [9–11]. Several studies have shown a decrease in time to diagnosis, Emergency Department (ED) processing time, ED length of stay, and abdominal X-ray rates thanks to PoCUS [12–14].

Constipation is defined according to the Rome IV criteria as infrequent bowel movements (fewer than three per

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Published online: 03 November 2025

week), hard stool consistency, straining, sensation of incomplete evacuation, or anorectal blockage during defecation. Its causes are varied and its main risk factors are advanced age, low fiber diet, low socioeconomic status, abdominal or pelvic surgery, immobility, and polypharmacy [15]. Fecal impaction (FI) is defined as the accumulation of hard stool in the rectum and colon due to prolonged constipation, without spontaneous evacuation. FI's annual prevalence is 47.3% in nursing homes, affecting around 70% of nursing home patients [16], with a prevalence rate two to three times higher in women than in men [17]. Moreover, 42% of patients admitted to geriatric services suffer from FI [18]. In the United States, 21.9% of patients admitted to the ED with FI died in the hospital. Severe morbidity was identified in 40.6% of patients, and over 90% of patients with FI who were admitted to the ED subsequently required hospitalization [19]. In 2011, 42,000 ED visits were reported in the United States for FI as the principal diagnosis, with patients aged over 65 being the most affected [20]. Although FI incidence increases with age and impairs the quality of life of patients over 65 [17], this condition is often underdiagnosed and thus left untreated. Frequent symptoms include false diarrhea, fecal incontinence, behavioral disorders, appetite loss, nausea, vomiting, abdominal pain, and electrolyte disorders. The impaction site is rectal in most cases (66.4%) [21]. FI's fast identification and treatment minimize the risk of complications, which include intestinal wall damage (ischemia), such as colitis, ulcers, and colorectal perforation, damage to the bowel lumen with large bowel obstruction, and damage to the adjacent structures in the urinary system [22].

Among the conditions where PoCUS could play a role, FI in elderly patients represents a common yet often underdiagnosed issue. FI is currently diagnosed using plain abdominal X-ray or abdominal computed tomography (CT) and careful digital rectal examination, if required as part of the ED investigations [23, 24]. More recently, Tanaka et al. have studied the ultrasound features compatible with fecal retention in elderly patients and showed the added value of PoCUS for monitoring constipation in this population. Thus, PoCUS could be a valuable tool for investigating suspected FI as it has the potential to help the investigator to make a rapid diagnosis, thus leading to its prompt management [25]. To assess FI presence using PoCUS, the patient should be supine and comfortable [26]. In cases of fecal retention in the rectal lumen, ultrasound waves are reflected from the surface of the contents at a depth greater than that of the bladder (anechoic area), and a hyperechoic area with a half-moon (or "crescent") shape is depicted in the transverse ultrasound image (Fig. 1) [26]. In addition, when there is hard stool accumulation, an acoustic shadow appears in the transverse ultrasound image of the crescent-shaped hyperechoic area. By contrast, when there is no fecal retention or gas in the rectal lumen, no obvious hyperechoic area is depicted. In the transverse ultrasound image, a circumferential hypoechoic area may appear in an empty intestine [26].

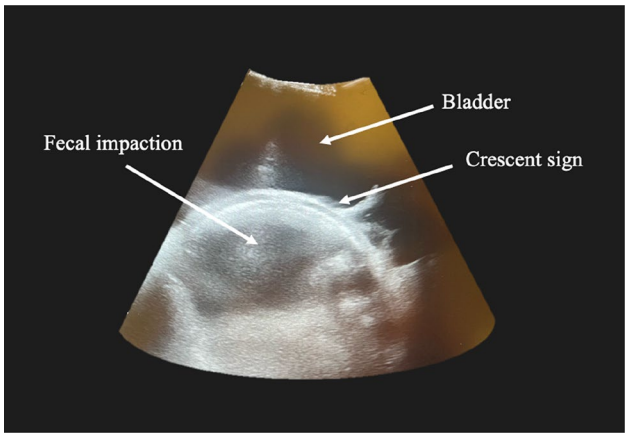

Fig. 1 Suprapubic transverse PoCUS images of fecal impaction

Thus, in this study, we sought to evaluate the overall contribution of PoCUS to the clinical examination of elderly patients presenting to the ED with suspected FI compared with the reference examination (abdominal X-ray), as well as according to body mass index (BMI), echogenicity, diagnosis at discharge, bladder repletion, difficulty performing PoCUS, and FI consistency.

Methods

This study was an interventional multicenter prospective pilot study conducted from April to October 2024 in seven centers: two tertiary-level Belgian university centers (Saint-Luc University Hospital and Liège University Hospital) and five secondary-level hospitals in Belgium (Saint-Jean Hospital, Jolimont Hospital, Charleroi Great Hospital, and Saint-Pierre Ottignies Hospital). The study obtained ethical approval (B4032023000156) from the Hospitalo-Facultaire Ethics Committee, was conducted according to the Helsinki Declaration and its subsequent amendments, and was registered on the ClinicalTrial.gov platform under the number NCT06333106.

Study population

Patients over the age of 75 with an indication for an abdominal X-ray to assess FI presence and who (or whose legal representative) provided informed consent were included in the study. Patients with a contraindication to suprapubic ultrasound or who did not understand either French, Dutch, or English were not included. Patients younger than 75 years or those who had undergone an imaging examination just

before visiting the ED in the same clinical context were excluded from the study. The number of patients to include was not calculated before starting the enrollment. This was due to the pilot nature of the study and the lack of sensitivity and specificity data in the literature in the context of FI diagnosis by PoCUS, which would have been required to calculate the number of patients needed.

Study objectives and endpoints

The primary objective of the study was to evaluate the diagnostic accuracy of PoCUS in patients aged ≥ 75 years who presented to the ED with suspected FI, with plain abdominal X-ray being the reference examination for the FI diagnosis (or abdominal CT scan if required for the ED investigations). Abdominal X-ray was selected as the reference standard, as it remains the most commonly used imaging modality in the ED for suspected FI. The primary endpoint was the calculation of specificity and sensitivity of PoCUS vs. the reference method. Secondary objectives were to assess the influence of several patient characteristics on the diagnostic accuracy of PoCUS in patients with suspected FI: BMI, echogenicity, diagnosis at discharge, bladder repletion, difficulty performing PoCUS, and FI consistency. Assessment of secondary endpoints was performed by calculating the sensitivities and specificities of PoCUS vs. abdominal X-ray, according to patient characteristic subgroups. Moreover, sensitivities and specificities were compared among the subgroups of BMI, bladder repletion, and difficulty performing PoCUS.

Study design

All investigators were emergency physicians familiar with PoCUS prior to the study because they used it on a daily basis in their clinical practice. All investigators attended a standardized 4-h training course on PoCUS for FI, developed and delivered by a senior emergency physician with expertise in abdominal ultrasound. The course included a theoretical component (review of sonographic signs of FI, including crescent sign and acoustic shadowing). This training was designed to complement investigators' routine experience with PoCUS. When an eligible patient with suspected FI was identified, the emergency physician in charge advised one of the investigators before scheduling a plain abdominal X-ray. Patients ≥ 75 years were selected because in this age group, abdominal X-ray is systematically performed in case of suspected FI, reflecting local ED practice and minimizing the relative impact of radiation. Suspected FI was defined as clinical presentation suggestive of FI, including abdominal pain, distension, constipation or overflow diarrhea, fecal incontinence, or unexplained delirium. The investigator assessed the patient's eligibility, thoroughly explained the study, and obtained signed informed consent. Inclusion and exclusion criteria were then checked. Abdominal PoCUS was performed to search for FI (suprapubic probe and longitudinal and transverse sections), and images were stored according to the procedures and capacities of each study center. Investigators and PoCUS examinations were independent of the patient medical management at the ED, and PoCUS was performed before the diagnostic procedure using the reference method. A case report form was then completed in the REDCap database, attesting to the presence or absence of FI. Then, the FI diagnosis was made based on a plain abdominal X-ray (or abdominal CT scan if required as part of the ED investigations). The emergency physician in charge of the patient management was blind to the PoCUS result. The emergency physician did not report the findings to the study investigators. If the X-ray result was positive, the emergency physician performed a digital rectal examination to determine FI consistency (hard or soft) and initiate the appropriate treatment. A referring radiologist blinded to the initial readings and patients' identities read the abdominal X-rays a second time. If there was disagreement, a third referring radiologist read the abdominal X-ray to adjudicate the result. Abdominal X-ray was the primary reference standard. When abdominal CT was clinically indicated, it was used as the reference method. When a CT scan was performed, no additional blinded review was carried out, as CT is considered a standard reference for abdominal pathologies. The result was reported in the REDCap database. Incidental findings during PoCUS were reported and information was forwarded to patients under medical confidentiality.

Statistical analysis

Descriptive statistics were calculated and results were expressed as the mean ± standard deviation or the median and range (minimum and maximum) for continuous variables, depending on the distribution. Frequencies and percentages were computed for categorical variables. Crosstables showing patient proportions according to the mode of FI diagnosis, i.e., PoCUS or abdominal X-ray, were presented, as well as tables showing estimators of sensitivity and specificity and their 95% confidence intervals (CIs). Likelihood ratios (LRs) were also computed. Sensitivity and specificity analyses were then repeated for patient subgroups as defined by the secondary objective. Moreover, comparisons regarding sensitivity and specificity were performed using the exact Fisher test according to BMI categories (< 20 kg/m^2, 20 to 25 kg/m^2, and > 25 kg/m^2), bladder repletion (full or empty), and PoCUS difficulty (easy or difficult). A p-value < 0.05 was considered statistically significant and 95% CIs were calculated using the Wald statistics. Analyses were performed using SAS 9.4 on Windows on anonymized data.

Results

Patient characteristics

A total of 172 patients were enrolled. Of those, eight were excluded: three did not provide informed consent, three were duplicates, one was under 75 years old, and one did not undergo abdominal X-ray. Reference method diagnosis was not available for one patient. The analyzed population therefore included 163 patients. Of these patients, 109/163 (66.9%) were from Saint-Luc University Hospital, 27/163 (16.6%) were from Charleroi Great Hospital, 22/163 (13.5%) were from Liege University Hospital, and 5/163 (3.1%) were from Saint-Pierre Ottignies Hospital. Descriptive statistics of the analyzed population are provided in Table 1. Patients were on average 85.4 ± 6.29 years old and approximately two-thirds were women.

Diagnosis at discharge

At discharge, the final diagnoses were colitis in 4/163 (2.5%), urinary retention in 6/163 (3.7%), functional decline of elderly patient in 8/163 (4.9%), fall in 17/163 (10.4%), delirium in 26/163 (16%), infection in 28/163 (17.2%), constipation/FI/occlusion in 62/163 (38%), and other diagnosis in 12/163 (7.4%) of cases.

Characteristics and results of PoCUS, X-ray, and CT examinations

When PoCUS was performed, echogenicity was deemed good in 76.7% (125/163) patients, satisfactory in 16.6% (27/163), and poor in 6.7% (11/163). Regarding bladder repletion, the bladder was empty in 59/163 patients (36.2%), full in 103/163 (63.2%), and not visualized in one patient (0.6%). FI was reported after PoCUS in 55/163 (33.7%) patients. The "crescent sign" was reported in 41 (74.5%) of these 55 patients. PoCUS was considered easy to perform in 121/163 (74.2%) cases and difficult in 42/163 (25.8%) cases. Of note, an incidental imaging finding was reported in 10/163 (6.1%) patients.

Abdominal X-ray was performed in 130/163 (79.8%) patients and FI was detected in 41 of these 130 (31.5%) patients. Abdominal CT scan was performed in 43/163 (26.4%) patients and FI was reported in 16 of these 43 (37.2%) patients. Regarding digital rectal examination, which was performed after a positive abdominal X-ray or CT result as part of the ED investigations according to the study protocol, data were available for a subset of patients (n = 55). This examination was performed in 31/55 patients (56.4%) and FI was reported in 22 of these 31 cases (71%). FI consistency was soft in 12/22 (54.5%) cases and hard in 10/22 (45.5%) cases.

After reading abdominal X-rays a second time (100% of abdominal X-rays), the diagnosis after abdominal X-ray correlated with the diagnosis at discharge from the ED in 93.3% (152/163) of cases, Cohen's kappa coefficient 0.86. Among the 11 patients (6.7%) whose abdominal X-ray result did not correlate with the diagnosis at discharge, FI was present in five patients (5/11, 45.5%) according to adjudication.

Table 1 Patient characteristics ($n = 163$)

Patient characteristics	Total ($n = 163$)
Age, years	
Mean (SD)	85.4 (6.29)
Gender, n (%)	
Man	56 (34.4%)
Weight, kg	
Median	68.0 (38.0, 130.0)
Height, cm	
Mean (SD)	167.1 (8.62)
BMI (kg/m^2)	
Mean (SD)	24.1 (4.64)
BMI category, n (%)	
< 20 kg/m^2	26 (16.0%)
20 to 25 kg/m^2	76 (46.6%)
> 25 kg/m^2	61 (37.4%)

BMI, body mass index; SD, standard deviation

Diagnostic accuracy of PoCUS vs. reference method

Patient proportions

A cross-table showing the proportions of patients with FI according to PoCUS vs. abdominal X-ray (reference method) is presented in Table 2.

Sensitivity, specificity, and likelihood ratio analyses

The overall specificity and sensitivity of PoCUS in diagnosing FI were 0.94 (95% CI [0.90, 0.99]) and 0.84 (95% CI [0.75, 0.94]), respectively. The positive LR was 14.8 (95% CI [6.7, 32.5]), and the negative LR was 0.16 (95% CI [0.09, 0.30]). The sensitivity and specificity values for BMI, echogenicity, bladder repletion, diagnosis at discharge, and PoCUS difficulty subgroups are summarized in Tables 3 and 4. Of note, values for the following subgroups were unavailable due to insufficient subgroup sample sizes: diagnosis of colitis at discharge, non-visualized bladder repletion, soft FI consistency, and hard FI consistency. The specificity from subgroup analyses ranged from 0.8 (diagnosis at discharge of fall and urinary retention) to 1 (satisfactory patient echogenicity, diagnosis at discharge

Table 2 Cross-table of the overall fecal impaction diagnosis accuracy between PoCUS and abdominal X-ray (reference method), as well as according to the following subgroups: BMI category, patient echogenicity, diagnosis at discharge, bladder repletion, difficulty performing PoCUS, and fecal impaction consistency

		Fecal impaction according to the reference method	
Fecal impaction detected during PoCUS		No	Yes
Overall	No	99/105 (94.3%)	9/58 (15.5%)
	Yes	6/105 (5.7%)	49/58 (84.5%)
BMI category		No	Yes
<20 kg/m^2	No	12/14 (85.7%)	1/12 (8.3%)
	Yes	2/14 (14.3%)	11/12 (91.7%)
20 to 25 kg/m^2	No	41/44 (93.2%)	4/32 (12.5%)
	Yes	3/44 (6.8%)	28/32 (87.5%)
>25 kg/m^2	No	46/47 (97.9%)	4/14 (28.6%)
	Yes	1/47 (2.1%)	10/14 (71.4%)
Patient echogenicity		No	Yes
Good	No	73/78 (93.6%)	5/47 (10.6%)
	Yes	5/78 (6.4%)	42/47 (89.4%)
Satisfying	No	19/19 (100%)	4/8 (50%)
	Yes	0/19 (0%)	4/8 (50%)
Poor	No	7/8 (87.5%)	0/3 (0%)
	Yes	1/8 (12.5%)	3/3 (100%)
Diagnosis at discharge		No	Yes
Functional decline of elderly patient	No	7/7 (100%)	0/1 (0%)
	Yes	0/7 (0%)	1/1 (100%)
Infection	No	22/24 (91.7%)	2/4 (50%)
	Yes	2/24 (8.3%)	2/4 (50%)
Delirium	No	23/24 (95.8%)	1/2 (50%)
	Yes	1/24 (4.2%)	1/2 (50%)
Constipation/fecal impaction/occlusion	No	23/23 (100%)	2/39 (5.1%)
	Yes	0/23 (0%)	37/39 (94.9%)
Fall	No	8/10 (80%)	1/7 (14.3%)
	Yes	2/10 (20%)	6/7 (85.7%)
Colitis	No	3/3 (100%)	1/1 (100%)
	Yes	0/3 (0%)	0/1 (0%)
Urinary retention	No	4/5 (80%)	0/1 (0%)
	Yes	1/5 (20%)	1/1 (100%)
Other	No	9/9 (100%)	2/3 (66.7%)
	Yes	0/9 (0%)	1/3 (33.3%)
Bladder repletion		No	Yes
Empty bladder	No	37/39 (94.9%)	3/20 (15%)
	Yes	2/39 (5.1%)	17/20 (85%)
Full bladder	No	61/65 (93.8%)	6/38 (15.8%)
	Yes	4/65 (6.2%)	32/38 (84.2%)
Non-visualized	No	1/1 (100%)	0/0 (0%)
	Yes	0/1 (0%)	0/0 (0%)
Difficulty performing PoCUS		No	Yes
Easy	No	73/78 (93.6%)	5/43 (11.6%)
	Yes	5/78 (6.4%)	38/43 (88.4%)
Difficult	No	26/27 (96.3%)	4/15 (26.7%)
	Yes	1/27 (3.7%)	11/15 (73.3%)
Fecal impaction consistency		No	Yes
Missing	No	99/105 (94.3%)	8/36 (22.2%)
	Yes	6/105 (5.7%)	28/36 (77.8%)

Table 2 (continued)

Fecal impaction detected during PoCUS		Fecal impaction according to the reference method	
		No	Yes
Soft	No	0/0 (0%)	1/10 (10%)
	Yes	0/0 (0%)	9/10 (90%)
Hard	No	0/0 (0%)	0/12 (0%)
	Yes	0/0 (0%)	12/12 (100%)

BMI, body mass index; PoCUS, point-of-care ultrasound

Table 3 Sensitivity and specificity of PoCUS vs. abdominal X-ray (reference method) for the diagnosis of fecal impaction according to subgroups (BMI category, patient echogenicity, bladder repletion, and PoCUS difficulty)

	Statistic	Estimate	95% confidence interval	
BMI category			Lower	Upper
<20 kg/m^2	Specificity	0.8571	0.6738	1.0000
	Sensitivity	0.9167	0.7603	1.0000
20 to 25 kg/m^2	Specificity	0.9318	0.8573	1.0000
	Sensitivity	0.8750	0.7604	0.9896
>25 kg/m^2	Specificity	0.9787	0.9375	1.0000
	Sensitivity	0.7143	0.4776	0.9509
Patient echogenicity				
Good	Specificity	0.9359	0.8815	0.9903
	Sensitivity	0.8936	0.8055	0.9818
Satisfactory	Specificity	1	1	1
	Sensitivity	0.5	0.1535	0.8465
Poor	Specificity	0.875	0.6458	1
	Sensitivity	1	1	1
Bladder repletion				
Empty bladder	Specificity	0.9487	0.8795	1
	Sensitivity	0.85	0.6935	1
Full bladder	Specificity	0.9385	0.88	0.9969
	Sensitivity	0.8421	0.7262	0.958
Difficulty performing PoCUS				
Easy	Specificity	0.9359	0.8815	0.9903
	Sensitivity	0.8837	0.7879	0.9795
Difficult	Specificity	0.963	0.8917	0.963
	Sensitivity	0.7333	0.5095	0.7333

NPV, negative predictive value; PoCUS, point-of-care ultrasound; PPV, positive predictive value

of functional decline of the elderly patient, of constipation/FI/occlusion, and other diagnosis). The overall sensitivity from the subgroup analyses ranged from 0.5 (patients with satisfying echogenicity and infection or delirium diagnosis at discharge) to 1 (patients with poor echogenicity, functional decline diagnosis, and urinary retention diagnosis).

Sensitivity and specificity comparisons among subgroups

Subgroup comparisons were not statistically significant for specificity and sensitivity regarding BMI categories, bladder repletion, and difficulty performing PoCUS.

Discussion

This multicenter prospective pilot study is, to our knowledge, the first evaluation of the diagnostic accuracy of PoCUS for FI in elderly patients within the ED setting. Indeed, studies on the diagnosis of constipation via ultrasound are very scarce [25, 27, 28]. In our study, the overall specificity of PoCUS for diagnosing FI was 0.94 (95% CI [0.90, 0.99]), and its sensitivity was 0.84 (95% CI [0.75, 0.94]). Specificity and sensitivity values did not differ according to BMI category, bladder repletion, or difficulty performing PoCUS. The high specificity of PoCUS supports its use in confirming a diagnosis of FI without the need for complementary examinations such as digital rectal examination or abdominal X-ray. Considering the positive and negative likelihood ratios, which were excellent and good, respectively: 14.8 (95% CI [6.7, 32.5]) for LR + and 0.16 (95% CI [0.09, 0.30]) for LR–, PoCUS results can reliably guide clinical decision-making, allowing clinicians to confirm or exclude FI during ED management depending on pre-test probability and overall clinical context. Indeed, even though the overall sensitivity exceeded 0.80, the lower bound of its confidence interval (0.75) indicates that PoCUS cannot be considered a standalone tool to rule out FI, probably especially in patients with a moderate or high pre-test probability of disease.

The lower sensitivity observed in some subgroups, particularly in patients for whom PoCUS was considered difficult by the operator, calls for caution in interpretation. In these situations, PoCUS should not be relied upon as a rule-out test, and complementary diagnostic approaches remain necessary to safely exclude FI. Subgroup analyses also revealed that diagnostic accuracy was influenced by image quality: sensitivity was only 0.5 in patients with "satisfactory" echogenicity, compared with nearly 0.9 in those with "good" echogenicity, highlighting the importance of

Table 4 Sensitivity and specificity of PoCUS vs. abdominal X-ray (reference method) for the diagnosis of fecal impaction according to diagnosis at discharge

	Statistic	Estimate	95% confidence interval	
			Lower	Upper
Functional decline of elderly patient	Specificity	1	1	1
	Sensitivity	1	1	1
Infection	Specificity	0.9167	0.8061	1
	Sensitivity	0.5	0.01	0.99
Delirium	Specificity	0.9583	0.8784	1
	Sensitivity	0.5	0	1
Constipation/fecal impaction/occlusion	Specificity	1	1	1
	Sensitivity	0.9487	0.8795	1
Fall	Specificity	0.8	0.5521	1
	Sensitivity	0.8571	0.5979	1
Urinary retention	Specificity	0.8	0.4494	1
	Sensitivity	1	1	1
Other	Specificity	1	1	1
	Sensitivity	0.3333	0	0.8668

PoCUS, point-of-care ultrasound

technical factors in image acquisition and interpretation. Similarly, patients with a BMI > 25 showed lower sensitivity (0.71) than other BMI categories, suggesting that overweight or obese patients may represent a more challenging subgroup for FI assessment with PoCUS. In contrast, diagnostic performance was robust regardless of bladder repletion status, which indicates that PoCUS may be reliable across varying bladder conditions, a reassuring finding for routine ED practice. Finally, sensitivity was lower in certain discharge diagnosis subgroups such as infection or delirium, which may reflect the clinical difficulty of detecting FI when presentations are dominated by other acute conditions common in elderly patients.

In our study, FI consistency was available for 22 patients, with 12 cases of 'soft' and 10 cases of 'hard' impaction. While PoCUS appeared to perform well in both groups, the small numbers substantially limit interpretability. These subgroup findings should therefore be considered exploratory, highlighting the need for larger studies to confirm whether PoCUS performance varies according to stool consistency. Moreover, assessing whether 'soft' or 'hard' consistency influences PoCUS image characteristics would be of particular interest for future research. Incidental findings were reported in 10 of 163 patients (6.1%). These findings were systematically communicated to the treating physicians, but their clinical relevance and outcomes were not analyzed within the scope of this study, and future research could further explore their potential impact on patient management.

Our findings are consistent with previous studies evaluating the use of ultrasound for constipation-related conditions, although direct comparisons are limited due to variations in reference standards and clinical settings. Notably, the study by Yamamoto et al. reported sensitivity and specificity values for the diagnosis of fecal retention that are comparable to ours. However, their methodology differed significantly, as they employed CT and digital rectal examination as reference standards rather than abdominal X-ray. In their study, handheld ultrasound devices demonstrated a sensitivity of 93% and specificity of 97% when compared to CT, and a sensitivity of 88% and specificity of 94% against digital rectal examination [28]. It is important to note that this study was published in 2024, after the initiation of our trial and therefore could not inform our sample size calculation. In addition, it was conducted in a palliative care setting, which represents a markedly different clinical context from the ED environment in which our study was performed.

Implementing PoCUS for FI in the ED could have many advantages, such as reducing the number of needed complementary examinations, with a decrease in costs for both patients and the society through lower health insurance costs and reduced time spent in the hospital for patients [29]. While the financial impact of PoCUS has not been studied in the context of FI, its positive effects on cost reduction and hospital length of stay have been reported in other medical conditions [30–33]. Moreover, PoCUS does not involve radiation exposure, unlike X-ray, is non-invasive, and can be performed in a timely manner. Another advantage of PoCUS is that it can be performed at the patient's bedside by not only physicians, but also nurses [25]. Since the population mainly affected by FI is the elderly, who sometimes live in rural areas far from medical facilities, the portable nature of PoCUS is also a considerable advantage [34–36]. Although PoCUS is increasingly used due to its diagnostic accuracy, lack of irradiation, and practical advantages,

a recent consensus statement from the Society of Point-of-Care Ultrasound emphasized the importance of performing PoCUS according to well-defined criteria. This involves an adequate definition of the examination procedure, clear distinction from conventional ultrasound performed by a radiologist, as well as accurate patient education on this technique and physician training [37]. To help standardize PoCUS practices, Al Ali et al. have also described a specific protocol (the ACUTE-ABDOMEN protocol) to help physicians evaluate acute abdominal pain, which can have a wide range of causes [38]. In light of the sensitivity and specificity shown in our study, PoCUS for the diagnosis of FI could be considered for integration into established PoCUS protocols, particularly those addressing acute abdominal conditions.

Moreover, one of the factors hindering uniform implementation of PoCUS is the lack of training among primary care physicians and emergency care providers [39]. As PoCUS is increasingly used in various medical conditions, contexts (e.g., hospital department or at the patient's bedside), and populations, several articles have previously highlighted the need for dedicated training to perform the examination and interpret its result accurately [40, 41]. Our team has also published a state-of-the-art study on PoCUS training in the medical curriculum of European countries and highlighted the need for standardized structure and content prior to the wider implementation of PoCUS training [42]. Of note, data regarding PoCUS training specifically in the context of suspected FI are lacking. To our knowledge, the only study dealing with fecal retention assessed the feasibility of a constipation PoCUS educational program in Japanese visiting nurses and showed satisfactory results [43].

Our study has limitations. First, using abdominal X-ray as the reference method instead of CT scan may be a limitation as CT scan probably has a higher specificity and sensitivity. Indeed, when using a reference method for sensitivity and specificity analyses, the reference should represent the "true" diagnosis of the patient (approaching 100% accuracy as much as possible). However, using CT scan would have been less representative of the ED clinical practice. Indeed, although CT is generally regarded as the gold standard for abdominal imaging, its use in this context would have been both inappropriate due to the unnecessary radiation exposure for a suspicion of FI and unrepresentative of ED practice. Consequently, X-ray was chosen as the comparator, which may introduce some bias but maintains clinical relevance and pragmatism. However, in patients for whom abdominal CT was indicated, an abdominal X-ray was not always performed. As a result, subgroup analyses may have been influenced by the uneven distribution of reference standards, potentially introducing bias. Second, because the study focused exclusively on patients ≥ 75 years, generalizability of the results to younger populations is limited. Although investigators were well trained in PoCUS, they were relatively new to its specific application for FI, which may have influenced image acquisition and interpretation. This, however, reflects a real-world scenario where clinicians receive focused training on a new PoCUS indication and apply it in practice. Although recruitment was prospective and multicenter, selection bias cannot be fully excluded due to the convenience sample. Moreover, several subgroup analyses were limited by small sample sizes, warranting larger studies to confirm our findings. Notably, diagnostic performance appeared lower in patients with only satisfactory echogenicity, in those with BMI > 25, and in subgroups with discharge diagnoses such as infection or delirium, suggesting that image quality, body habitus, and competing presentations may influence accuracy. Similarly, FI consistency was available for only 22 patients (12 soft, 10 hard), making these results exploratory and leaving open whether stool consistency influences PoCUS imaging. Incidental findings were observed in 10 patients (6.1%) and were reported to treating physicians, but their clinical relevance and outcomes were not assessed. Finally, beyond the Japanese study by Yamamoto et al., other reports on ultrasound for constipation and FI remain scarce, which limits direct comparison but underscores the originality of our work.

This multicentre prospective study supports the integration of PoCUS into the clinical assessment of patients aged 75 years or older presenting to the ED with suspected FI. The high specificity observed suggests that PoCUS can reliably confirm the diagnosis of FI, potentially reducing the need for complementary examinations such as digital rectal examination or abdominal X-ray in cases of strong sonographic evidence. This aligns with a broader trend in emergency medicine toward reducing unnecessary imaging and interventions, particularly in vulnerable older populations. Although the sensitivity is acceptable, it is possibly insufficient to safely exclude FI when clinical suspicion is moderate or high, underscoring the continued relevance of abdominal imaging in such scenarios. The excellent and good values of the positive and negative likelihood ratios, respectively, indicate that PoCUS results can meaningfully inform clinical decision-making, especially when interpreted in light of the pre-test probability. These findings reinforce the value of PoCUS as a non-invasive, bedside tool in the diagnostic pathway for FI in elderly patients in the emergency setting. Future research should aim to validate these findings in larger and more diverse patient populations, assess the impact of PoCUS on clinical outcomes and resource utilization, and explore its integration into standardized diagnostic algorithms for acute abdominal conditions.

Acknowledgements Thanks to Lara Absil, Antoine Fasseaux, Félix Gendebien[1], Axel Shiku, Raphaelle Lopez, Tommy Sinatra, and Charles Gregoire.

Author contributions All the authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Florence Dupriez, Julie Tollet, Hortense Nely and Alix Collard. The first draft of the manuscript was written by Florence Dupriez, and all the authors commented on previous versions of the manuscript. All the authors read and approved the final manuscript.

Funding No funding was received for this study.

Data availability Data are available upon request to the corresponding author.

Declarations

Conflict of interests The authors declare no competing interests.

Ethical approval and consent to participate All included patients provided informed consent.

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