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Case Report

Early identification of bladder diverticula in pre-hospital settings using screening sonography: A case report

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Abstract

Objective: Bladder diverticula, while not exceptionally rare in clinical practice, presents a significant diagnostic challenge, particularly in remote pre-hospital emergencies where technological limitations and the absence of specialized medical expertise prevail. This report aims to emphasize the role of screening ultrasound in the pre-hospital setting,

Case Presentation: A patient experiencing severe lower abdominal pain presented at a basic emergency service (BES) for the third time presenting the same symptoms. Renal and pelvic ultrasound screening was performed, revealing suspected bladder distention and adjacent fluid-filled cavities, consistent with multiple bladder diverticula. Subsequently, the patient was referred to a referral central hospital for management by medical experts. Comprehensive evaluation confirmed the findings of the BES.

Conclusion: The results of the screening ultrasound enabled the BES team to initiate clinical interventions to mitigate the patient's discomfort. Screening ultrasound was crucial in identifying imaging markers that provided the physician with clinical data for correct and prompt patient orientation.

Keywords: Diverticulum, Emergency, Screening, Ultrasound, Urinary retention

Introduction

Urologic point-of-care ultrasonography (POCUS) is a quick and reliable tool for collecting valuable clinical information (1) operating as a multifaceted instrument for emergency screening, in the assessment of the kidneys, ureters, and bladder. In the context of non-specialist orthodox evaluation of the bladder, simple emergency ultrasound protocols are utilized to gather critical data crucial for the patient's clinical assessment (2). This type of renal POCUS also contributes to the reduction of the patient's length of stay and medical cost, compared with the usual clinical practice (3). The screening evaluation algorithm in renal POCUS includes bladder volume estimation, identification of urinary retention, detection of bladder masses, assessment for bladder outlet obstruction (vesical globe), evaluation of possible causes of hematuria, identification of hydronephrosis, determination of anuria, and the ultrasound clinical exploration of flank or pelvic pain. Additionally, it is instrumental for the guidance of some more invasive interventional procedures, such as the proper placement of a Foley catheter. There is also a growing interest in ultrasound by nephrologists, using POCUS as a diagnostic tool. It enhances the sensitivity of conventional physical examination in nephrology, provides diagnostic information, and enables accurate assessment of hemodynamics and volume status in patients, explaining its increasing adoption in nephrology for a more personalized approach to patient care, especially in acute care settings. In this study, we aim to specifically emphasize the contribution of renal POCUS during emergencies within remote, underserved areas. Given the diverse spectrum of health professionals conducting screening ultrasounds (4) in emergency scenarios, it is imperative to underscore that the definitive diagnosis rests within the scope of specialized imaging professionals. A comprehensive and meticulous examination is essential, as a profound understanding of the nuanced interpretations of urological pathology through ultrasound necessitates extensive training and rigorous study to avoid pitfalls (5). Nevertheless, when executed with precision, POCUS has emerged as an invaluable asset in emergency settings. Consequently, it has been naturally integrated into the

strategic flowcharts guiding emergency actions.

Case Presentation

A 75-year-old man was transported by ambulance to a basic emergency service (BES) from his nursing home, marking his third visit in the past month. He had been experiencing continuous abdominal pain for the last four days. Caregivers at the nursing home, suspecting constipation, documented their observations accordingly. Upon evaluation using the Manchester triage system, he was classified as urgent, as denoted by a yellow bracelet, and received an abdominal pain intensity rating of 7 out of 10.

The patient exhibited normal vital signs, including being afebrile, with regular blood pressure, and an oxygen saturation level of 97% in ambient air. He did not demonstrate any signs of respiratory distress. Upon clinical examination by the physician, the patient was alert and oriented to person but disoriented in time and place.

On inspection, the skin and mucous membranes appeared slightly discolored and dehydrated, although no signs of cyanosis or jaundice were noted. The abdomen displayed mild distension, and upon palpation, a hardened and painful bladder globe was perceptible throughout the hypogastrium. Additionally, there was also an observed increase in hydro-aerial sounds.

The basic urine test, which could only be conducted post-foley catheterization with ultrasound-guided support, revealed malodorous urine exhibiting triple positive markers for leukocytes, proteins, and hematuria. In parallel, routine blood analyses conducted in the BES disclosed leukocytosis ($13 \times 10^3/mm^3$) with a notable neutrophilia of 84.9%, while the rest of the parameters remained within normal ranges.

After conducting a thorough anamnesis and physical examination, the emergency physician ordered an abdominal radiography. The radiograph allowed for the exclusion of air-fluid levels or dilation of the intestinal loops. A soft tissue bulge was observed in the hypogastric region of the radiography, consistent with a potentially enlarged bladder globe. Additionally, a renal and pelvic screening ultrasound was performed immediately after the abdominal X-ray, which is partially depicted in Figures 1 and 2. Both exams were performed by a radiographer/sonographer. It is worth mentioning that the ultrasound examination induced significant pain in the patient's hypogastric zone, which conditioned the quality of the sonographic images obtained.

The screening ultrasound unveiled a bladder image indicating total repletion (1521.9 cm^3), surpassing the volumes considered normal in existing literature (between 300 and 400 mL). Notably, the bladder contents exhibited impurities, marked by sedimentation, and suspended echoes. Adjacently, the ultrasound identified at least three cavities with liquid content, suggestive of possible bladder diverticula (6), further confirmed by their communication with the bladder, as depicted in a color Doppler image.

In response to the patient's distressing pain, immediate

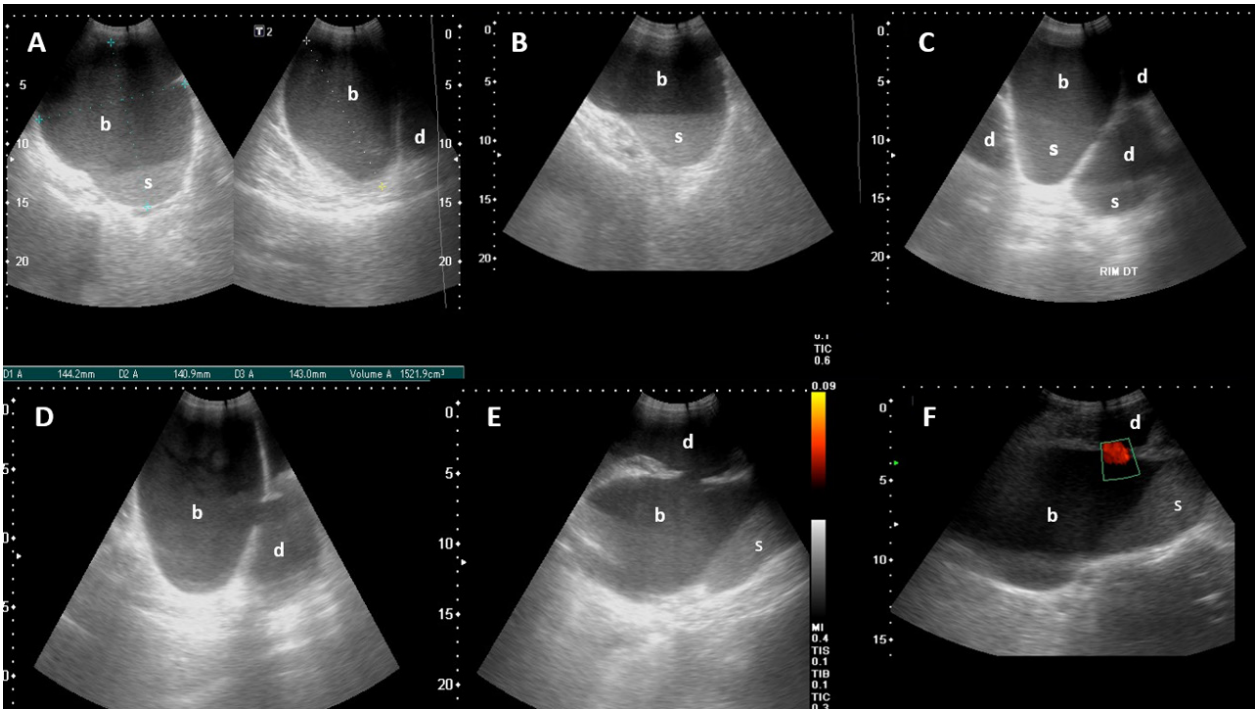

Figure 1. (Images from BES before catheter insertion). **A** and **B**: Sagittal and transversal images of the bladder (b), with an approximate measurement of urinary volume of 1521.9 cm^3. Bladder content is heterogeneous, with sediment(s) in the gravitational aspect. **C**: Recurrent image of the bladder (b) in a slightly superior plane where three cavities (d) are visible on the lateral side of the bladder compatible with diverticula in which one of the cavities has echogenic material in the form of air-fluid level(s). **D**, **E**, and **F**: Bladder in subsequent sonographic slices where the presence of communication between the bladder and the diverticula was evidenced. In **F,** the Doppler technique was used to confirm the flow from the bladder to the diverticulum (red color means flow towards the probe)

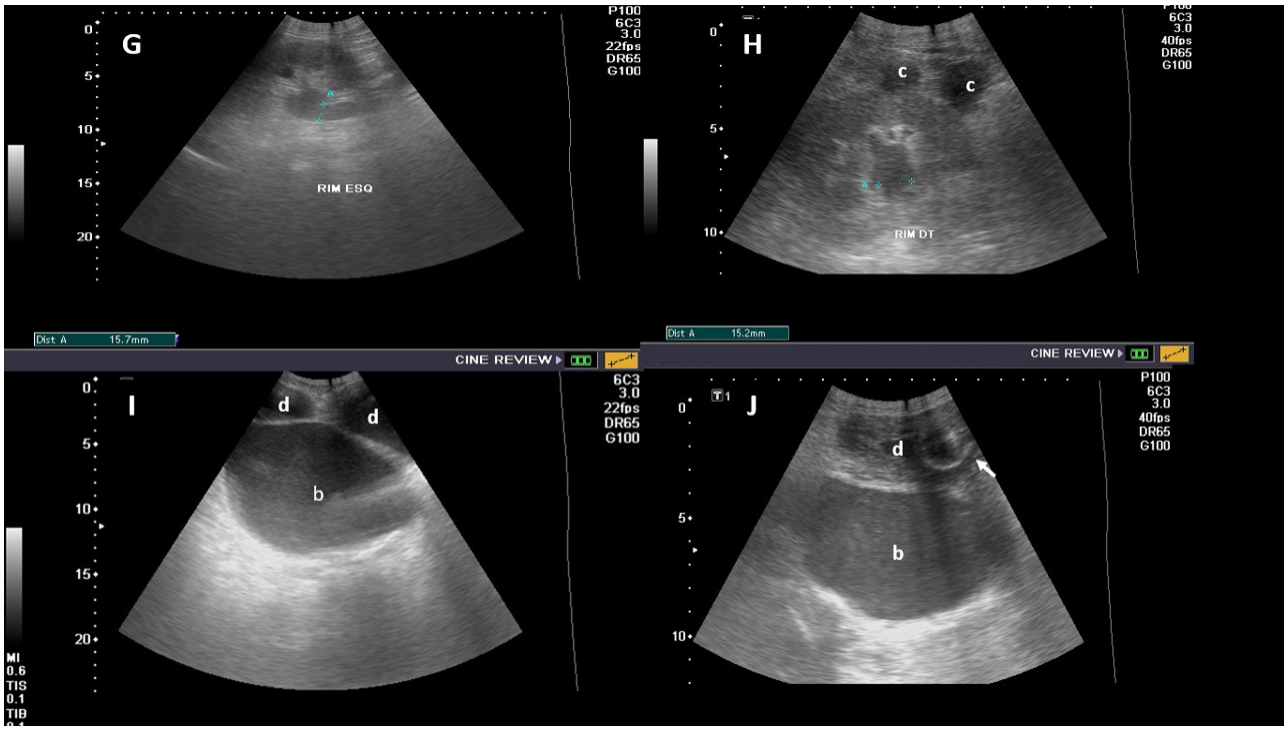

Figure 2. G: Left kidney in longitudinal plane showing subtle pyelocaliceal distention. **H**: Right kidney in axial plane showing discreet pyelocaliceal distention and two small exophytic cysts (c). **I**: Axial view of the bladder where the bladder and two of the diverticula are visible. **J**: Bladder (b) and diverticulum (d) with an insufflated balloon of the Foley catheter (white arrow) with a catheter inside

catheterization was deemed necessary to alleviate urinary retention. However, although the catheterization was echo-guided, it proved challenging and inadvertently placed the catheter within one of the diverticula, an understandable error given the morphological alterations of anatomy (7).

Nevertheless, due to the prompt drainage of urine, the priority shifted to bladder emptying rather than attempting catheter repositioning, considering the procedural challenges. Mild bilateral hydronephrosis was also evident, due to an obstruction that subsequently caused the substantial bladder distension. Following the drainage of nearly 2000 mL of urine, the diverticulum and bladder retained liquid content, sustaining bilateral pyelocaliceal dilation. The patient was transferred to the referral hospital for additional imaging exams and a detailed renal function study. While still in the BES, the patient received non-steroidal anti-inflammatory medication, opioid analgesic, antiemetic, and analgesic/antipyretic medications.

In the reference hospital (RH), the patient underwent a comprehensive set of clinical evaluations, including blood tests and abdominal, renal, and pelvic ultrasound at the Imaging Department. The blood tests revealed abnormalities in white blood cell count (WBC), registering at 15.3×10^9/L (normal range: 4.0–10.0), with a neutrophil count of 2.4×10^9/L (normal range: 2.0–7.0). The ionogram displayed a slight elevation in sodium at 149 mmol/L (normal range: 132.0–144.0) and chlorine at 113 mmol/L (normal range: 94.0–110.0). Additionally, there were deviations in blood urea nitrogen (BUN) at 42 mg/dL (normal range: 8.4–25.7) and C-reactive protein (CRP) at 107 mg/L (normal range: < 5).

The partially transcribed ultrasound report, as depicted in Figure 3, concluded:

"A subtle prominence of the pyelocaliceal caliber is discernible on the left kidney, accompanied by a measurement of the renal pelvis at 0.6 cm in the anteroposterior axis. This is concomitant with urothelial thickening, indicative of likely inflammatory origins. Notably, there is an absence of ureteral dilation on the ipsilateral side and no discernible evidence of an obstructive etiology. Non-obstructive renal lithiasis is noted. Furthermore, multiple renal cysts are evident. The bladder exhibits significant dysmorphia, featuring extensive diverticula and pronounced parietal thickening, particularly notable in the largest diverticulum, housing the bladder catheter balloon."

The patient was treated with non-steroidal and opioid analgesics, began antibiotic therapy, and remained hospitalized for one day for observation and management of cystitis. Upon discharge from the hospital, he was given specific ambulatory instructions for follow-up care.

Discussion

The initial suspicion by the BES of multiple diverticula near the bladder was confirmed by the RH. The Foley catheter, inserted during the bladder emptying study at the BES to facilitate continuous drainage of the bladder and its associated diverticula was kept in place. This intervention remained until a conventional ultrasound

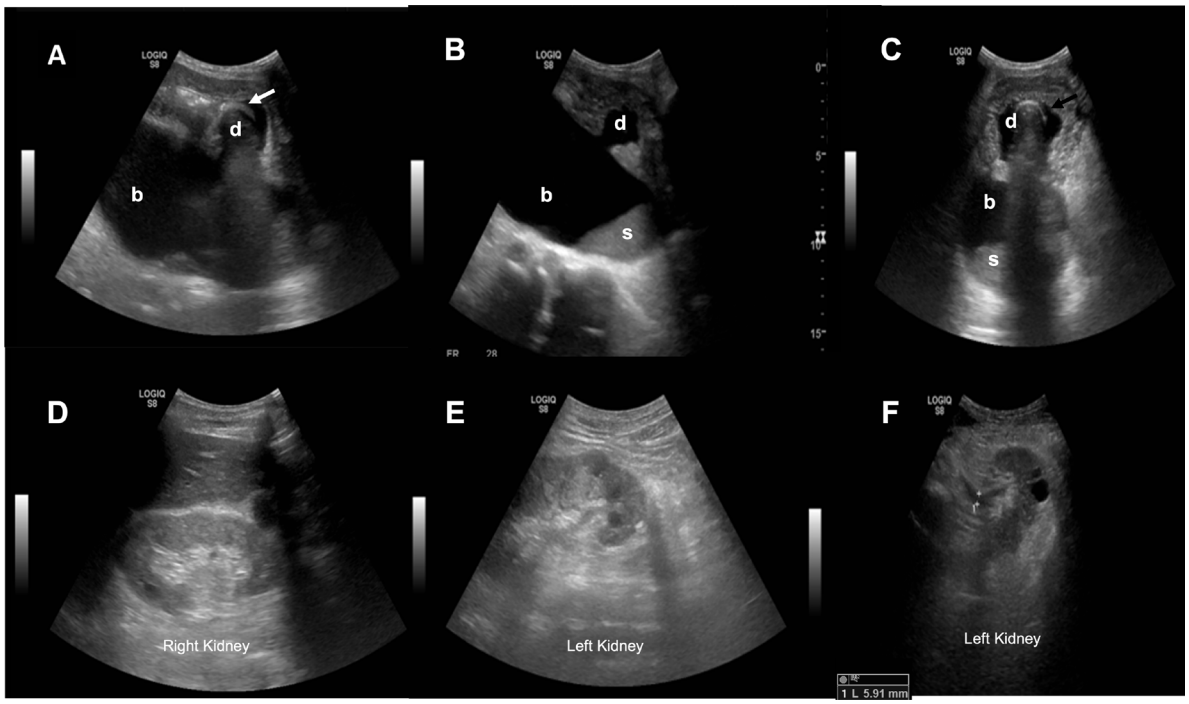

Figure 3. (Based on the report transcription from the radiologist from the RH). **A**: Represents an axial image of the bladder (b) where (d) depicts one of the diverticula and its communication to the bladder, and the white arrow represents the Foley catheter in the diverticulum. **B**: Sagittal view of the bladder(b) with stratification of echogenic sediment in the gravitational aspect(s) and over this the diverticulum as (d). **C**: A lower axial image of the bladder(b) with sediment(s). Anterior to the bladder we find one of the diverticula(d) with a Foley catheter positioned inside, the thick and irregular appearance of the walls of the diverticulum is visible in relation to infection. **D**: Represents a longitudinal section of the right kidney without apparent abnormalities. **E**: Represents a longitudinal image of the left kidney where it is possible to see a discreet pyelocaliceal distention. **F**: Represents an axial image of the left kidney where it is possible to confirm the slight pyelocaliceal enlargement and thickening of the urothelium, the white arrow represents the Foley catheter in the diverticulum which produces posterior acoustic shadowing

at the RH demonstrated a significant reduction in the bilateral pyelocaliceal dilation.

Furthermore, the ultrasound examination conducted by the radiologist confirmed the concomitant bladder inflammatory process and urothelium thickness of the renal pelvis in the left kidney. Bladder diverticulum is an uncommon finding, characterized by an invagination of the bladder mucosa, stemming from congenital or acquired factors. This condition results in the formation of one or more reservoirs for urine adjacent to the bladder. In some cases, the sac-like protrusion can surpass the bladder's volume constituting a herniation of the bladder mucosa through the muscular layers of the bladder wall. Chronic urinary retention linked to this condition may lead to recurrent urinary tract infections (8), presenting clinical challenges in their management. Additionally, although uncommon, bladder diverticula are at risk of rupturing. In the present case, although the immediate cause of the patient's pain was controlled with the urgent emptying of the bladder, there was no prior reference to anatomical changes in the patient's clinical file consulted by the physician. Despite partial emptying of the bladder, persistent bilateral pyelocaliceal dilation and evident signs of a urinary infection were observed. Due to these findings, and the inability of the BES to conduct comprehensive blood analyses and renal function tests, the attending physician referred the patient to a RH for specialized evaluation.

POCUS plays a crucial role in detecting outlet urinary obstructions (9), and diverticula are well represented in this case report. Despite this, ultrasound is often underused for evaluating bladder status (10). The literature emphasizes the importance of ultrasound monitoring in challenging bladder catheterizations and assessing bladder volume. This becomes particularly significant when monitoring geriatric patients, who, due to sequelae or incapacitating pathologies, may be unable to verbalize their condition, as seen in this case.

It is important to note that this patient had been presented multiple times to the emergency department with the same complaint, but the underlying cause remained undetected until a decision was made to perform a screening ultrasound by both the physician and sonographer. Given the constraints of peripheral emergency departments, where specialists from multiple fields are not available, and the increasing shortage of medical specialities even in central hospitals, it is essential that sonographers with advanced academic training possess a comprehensive understanding of the varied applications of ultrasound. These professionals must take on a critical role in these settings, doing so responsibly and with awareness of the limitations of ultrasound, the most notable of which is its operator-dependent nature.

Conclusion

The decision to refer the patient to the referral hospital was greatly influenced by the insights gained from the screening ultrasound. The inclusion of a radiographer/sonographer, skilled in ultrasound techniques, within the multidisciplinary clinical team significantly enhanced patient care and the overall efficacy of the healthcare system. The combined expertise of sonographers and physicians is vital for precise diagnostics, informed decision-making, and deepening our comprehension of diverse medical conditions. In essence, skilled ultrasound sonographers are a crucial asset for improving patient outcomes and the broader healthcare landscape.

This case underscores a significant challenge for healthcare professionals. Incorporating ultrasound screenings more systematically in emergency settings could enhance patient triage, optimize care efficiency, and improve diagnostic accuracy. As a future suggestion, the development of flowcharts guiding emergency physicians toward more routine use of ultrasound, either as a screening tool or as support for difficult catheterizations, could be highly beneficial. This approach would be particularly useful in cases of abdominal pain of unclear etiology, such as suspected constipation or uncertainty regarding urinary pathology. While bladder diverticula are relatively common, they are not typically the first diagnostic hypothesis considered. Structured guidance for ultrasound application in these scenarios could greatly enhance both diagnostic precision and patient management. Further comparative studies are warranted to assess whether teams utilizing screening ultrasound within the same institution can effectively yield superior patient outcomes.

Authors' Contribution

Conceptualization: Sérgio Miravent.
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Methodology: Sérgio Miravent, Carla Gomes, Manuel Duarte Lobo, Rui de Almeida.
Validation: Carla Gomes, Manuel Duarte Lobo, Rui de Almeida, Andrea Basescu, Ana Martins.
Writing–original draft: Sérgio Miravent, Manuel Duarte Lobo, Rui de Almeida.
Writing–review & editing: Sérgio Miravent, Andrea Basescu, Ana Martins.

Competing Interests

None.

Ethical Approval

Each examination in this study was ordered by the attending physician in the BES and should be viewed in the context of an emergency medical setting. No patient or institutional data were collected to adhere to general data protection regulations. The patient was duly informed about the study's objectives and provided explicit consent to participate by signing informed consent. The principal objective was to showcase the utility and efficiency of the screening ultrasound technique in remote environments. This research followed ethical standards for scientific investigations, including adherence to the Helsinki Declaration and the prevailing national data protection laws.

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