Managing Urolithiasis

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Editor's Note: *The Expert Clinical Management series consists of shorter, practical review articles focused on the optimal approach to a specific sign, symptom, disease, procedure, technology, or other emergency department challenge. These articles—typically solicited from recognized experts in the subject area—will summarize the best available evidence relating to the topic while including practical recommendations where the evidence is incomplete or conflicting.*

INTRODUCTION

Urolithiasis is a common disease, estimated to affect 11% of men and 7% of women in their lifetime.[1] Ureteral stones can cause acute unilateral flank pain radiating to the groin, often accompanied by nausea, vomiting, and urinary symptoms.[2] More than 1 million patients with suspected urolithiasis present to an emergency department (ED) each year in the United States.[3] This review will describe ED evaluation, therapies, and the identification of patients who require urgent urologic intervention, with recommendations based on clinical trials; on guidelines from the American College of Emergency Physicians (ACEP), American College of Radiology, and American Urologic Association; and on anecdotal experience.

Goals of the Evaluation

When ureteral stone is suspected, our foremost goal is to identify those patients who require urgent, and in some cases, emergency treatment, either for important alternative diagnoses (eg, appendicitis, cholecystitis, ovarian torsion)[4] or "stone-related emergencies" (Figure 1).[2,5] Approximately 10% of ED patients with suspected urolithiasis are admitted,[6-8] with prospective research identifying a 3.7% and 5.3% prevalence of important alternative diagnoses.[8,9]

Our secondary goal of confirming the presence of urolithiasis is of lesser importance because patients with an uncomplicated stone are almost always managed expectantly.

Risk Assessment for Clinically Important Diagnoses

Ureterolithiasis causes severe unilateral colicky flank pain, and patients usually present soon (within hours) of onset. The pain may radiate from the flank anteromedially toward the groin into the genitals and may be accompanied by nausea, vomiting, and hematuria.[2,8] Lower urinary tract symptoms such as dysuria and urgency suggest distal ureteral stones. The classic appearance is that of a patient in distress, unable to find a position of comfort. Vital signs are often normal. Atypical clinical features such as hypotension or abnormalities on abdominal, testicular, or pelvic examination suggest alternative diagnoses. Complicated urolithiasis should be suspected if there is persistent pain, vomiting, fever, pyuria, elevated creatinine level, anuria, or a history of a solitary or transplanted kidney. A history of urolithiasis decreases the risk of important alternative diagnosis.[10]

Although hematuria is common in urolithiasis, it does not by itself exclude or reliably identify the diagnosis, with reported sensitivities ranging from 71% to 95% and specificities ranging from 18% to 49% for urolithiasis.[11-13] A positive pregnancy test result should lead to consideration of ectopic pregnancy as a cause of pain and also limits the choice of imaging to ultrasonography. With urolithiasis, the absence of pyuria cannot exclude a complicating urinary tract infection, with a reported sensitivity and specificity of 86% and 79%, respectively.[14] Accordingly, stone patients at higher risk (female patients and those with pyuria or urinary tract infection symptoms) should receive a urine culture.[14]

Selection of Appropriate Imaging

The need for and type of imaging vary with underlying risk of important alternative diagnosis, ureteral stone, or a stone-related emergency (Figure 2). Emergency physicians should use clinical judgment to make this assessment. The

Stone-related emergencies: obstructing ureteral stone with 1 or more of the following[1]:

Proximal urinary tract infection as evidenced by sepsis/fever, ill appearance, or markedly elevated WBC count

Deterioration in renal function

Intractable pain, vomiting, or worsening symptoms despite treatment

Solitary or transplanted kidney, particularly if anuric

Clinically important alternative (nonurolithiasis) diagnoses*

Aortic aneurysm with leak or rupture, aortic dissection

Malignancy/mass concerning for malignancy (ie, renal cell carcinoma or ovarian malignancy)

Diverticulitis

Appendicitis

Cholecystitis/choledocholithiasis

Bowel obstruction or ileus

Colitis/ileitis, inflammatory bowel disease

Ovarian/testicular torsion

Ectopic pregnancy

Traumatic injury (ie, hematoma)

Vascular thrombosis/infarct (ie, renal artery thrombosis)

Pulmonary embolism/DVT

Pneumonia/pleural effusion

*This list of clinically important alternative diagnoses is adapted from previous publications, as well as experience from a recent randomized trial.[2-4]

Figure 1. Clinically important causes of acute flank pain that require urgent treatment. *DVT,* Deep venous thrombosis.

STONE score is a clinical decision rule that sorts patients with suspected ureterolithiasis into low-, moderate-, and high-risk groups, with those with a high score in the original study having an 89% probability of a stone and a 1.6% probability of alternative diagnosis.[8] In an external validation, the sensitivity and specificity of a high score were 53% and 87%, with a 1.2% probability of important alternative diagnosis (upper 95% confidence interval of 3.6%).[9] Thus, the STONE score alone cannot rule in or rule out stones or exclude clinically important diagnoses. Its role for imaging decisions remains undefined but has the potential to be used as part of an algorithm for suspected urolithiasis.

Moderate to High Risk of a Clinically Important Diagnosis

Patients at moderate or high risk of a stone emergency or a clinically important alternative diagnosis should receive an unenhanced computed tomography (CT) scan. The accuracy of CT scan for ureteral stones is excellent, and CT scan can identify hydronephrosis, characterize stone size and location, and detect important alternative diagnoses.[15-18] The American College of Radiology gives their highest appropriateness rating for CT in patients with first-time acute flank pain,[19] and 70% of patients who received a diagnosis of urolithiasis received a CT scan in 2007.[3] Despite this, routine CT does not appear to improve outcomes. A national survey found no change in the diagnosis of kidney stone, alternative diagnoses, or hospitalization despite a 10-fold increase in CT use between 1995 and 2007.[20] The ability of CT to characterize stone size and location at the initial ED visit is not routinely necessary, and this imaging increases costs, incidental findings, length of stay, and the risk of subsequent cancer.[21-23] Thus, CT should be reserved for patients who would most benefit by increasing diagnostic certainty for clinically important diagnoses or experience less harm from radiation exposure. ACEP recommends avoiding CT scan in patients younger than 50 years and with a history of kidney stones presenting with recurrent symptoms. There is promise for reduced-dose CT scan protocols.[24,25]

Low Risk of a Clinically Important Diagnosis

Patients at low risk of a stone emergency or a clinically important alternative diagnosis should receive ultrasonography, performed by either an emergency physician or the radiology department. Ultrasonography is less sensitive (24% to 57%) than CT for the identification of ureteral stone, especially small stones, and missed occasional occurrences of hydronephrosis in older studies, perhaps in dehydrated patients.[26-28] In a more recent prospective study, it was shown to accurately identify hydronephrosis (Figure 3).[28,29] Ultrasonography is first line for a number of important alternative diagnoses, such as cholecystitis and ovarian torsion, and is an acceptable initial test in appendicitis and aortic aneurysm.

ACEP has identified urinary tract point-of-care ultrasonography as a core application since 2001.[30] Its main limitation is operator skill; fellowship-trained emergency

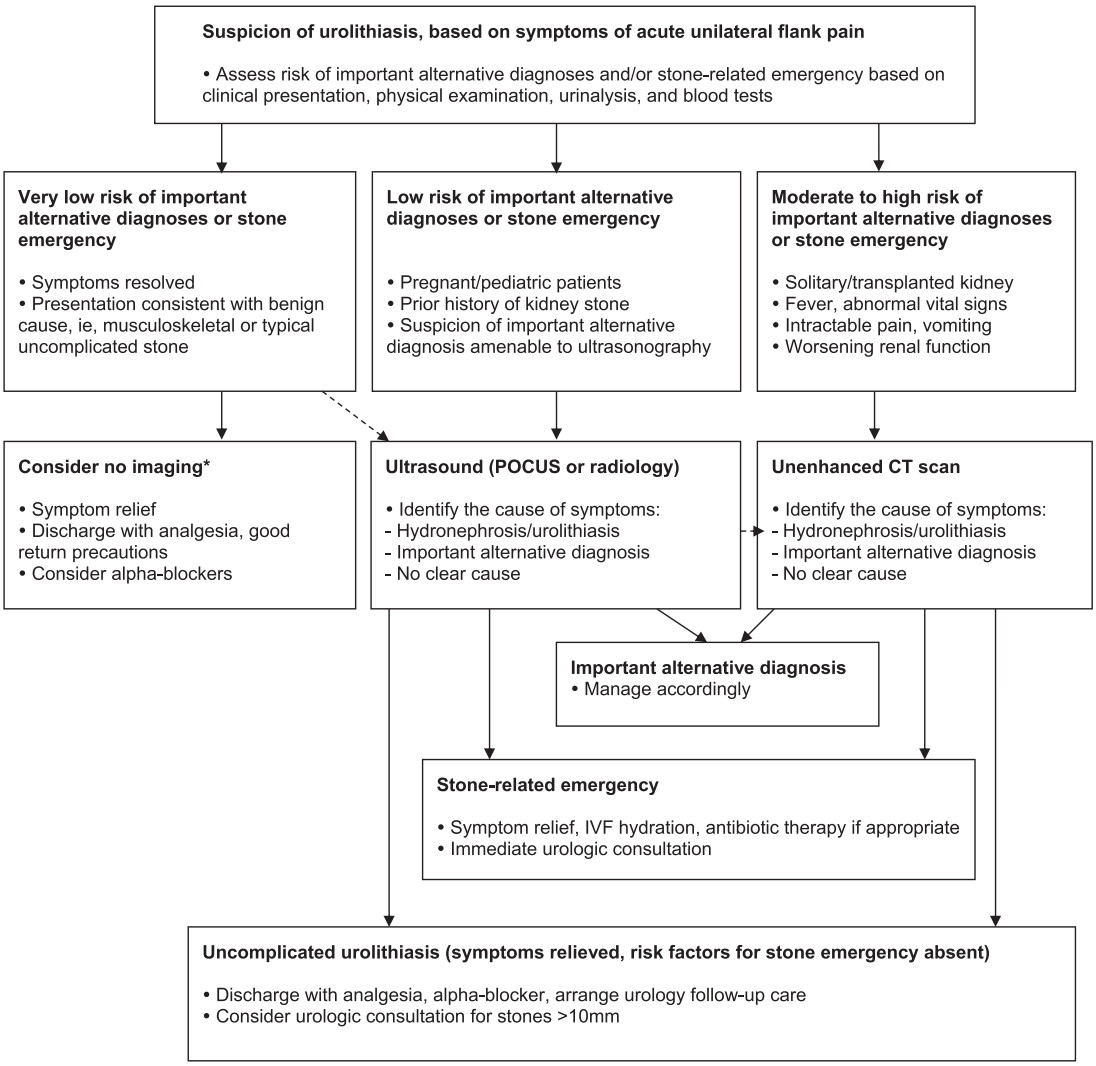

Figure 2. Algorithm for management of acute unilateral flank pain and suspected ureteral stone. Dashed lines indicate options for the clinician to obtain additional imaging if concerned about clinically important diagnosis. *A strategy with no initial imaging is not based on randomized trial evidence but in my opinion represents reasonable care. *POCUS*, Point-of-care ultrasound; *CT*, computed tomography; *IVF*, intravenous.

physicians have excellent sensitivity and good specificity for hydronephrosis, whereas those without fellowship training have modest accuracy.[31] In a multicenter randomized trial of point-of-care ultrasonography versus radiology ultrasonography versus CT scan, there was no significant difference in missed serious diagnosis or adverse events.[7] A CT scan may be obtained if the clinician is still uncertain about the presence of a clinically important diagnosis after ultrasonography; in the randomized trial, 25% of patients in the radiology ultrasonography arm and 40% of those in the point-of-care ultrasonography arm ultimately received a CT scan.[7] Ultrasonography is preferred in patients at highest risk for complications from ionizing radiation (pregnant or pediatric patients) or who are less likely to benefit from CT (history of kidney stones).[19]

Very Low Risk of a Clinically Important Diagnosis

In my opinion, well-appearing, afebrile patients with mild or transient symptoms could receive ultrasonography or instead be discharged without imaging, with a plan to return for persistent or worsening symptoms. In a national survey of ED imaging in 2005 to 2007, approximately half of patients with suspected urolithiasis did not receive either ultrasonography or CT.[20] These may have been patients who had an alternative diagnosis that did not require imaging (such as pyelonephritis or low back pain) or had transient or straightforward renal colic.

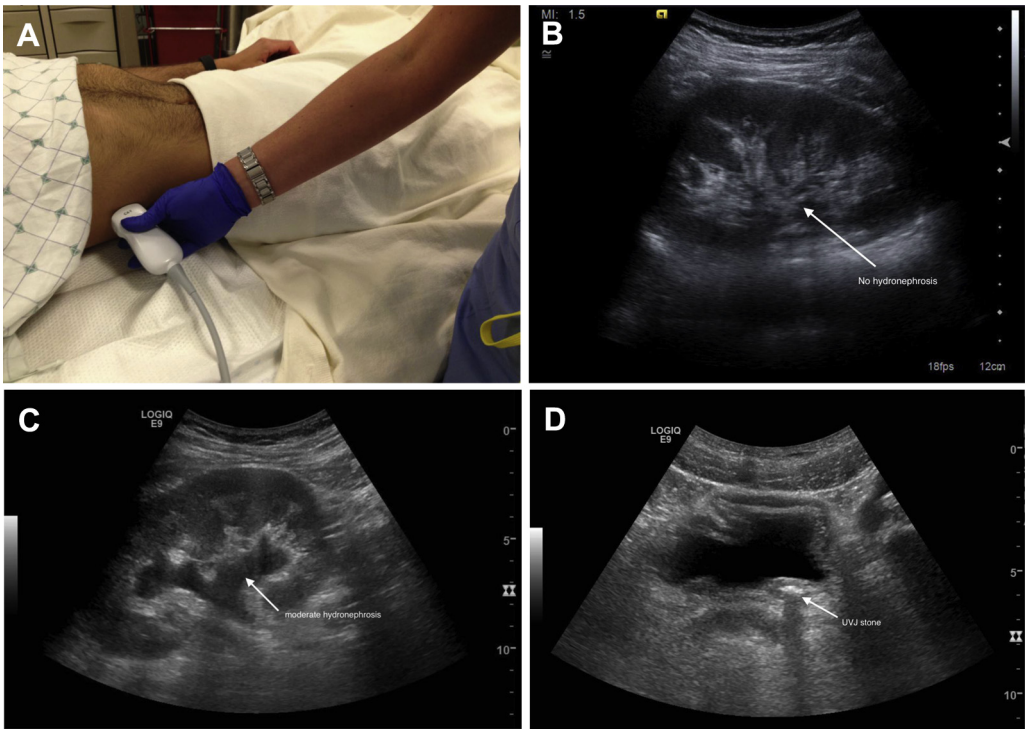

Figure 3. *A*, A curved ultrasonographic probe is placed in the flank in the coronal plane to produce an image of the long axis of the kidney. Inspect the renal pelvis for hydronephrosis. *B*, Longitudinal axis view of the kidney, with a clear view of the renal pelvis, marked with a white arrow. There is no appearance of hydronephrosis to indicate an obstructing stone. *C*, Longitudinal axis view of the kidney with mild to moderate hydronephrosis, marked with a white arrow. *D*, Transverse view of the bladder, with an ureterovesicular junction stone visible. Shadowing is present.

Treatment of Ureteral Stone

Pain relief. Provide analgesia, antiemetics, and intravenous hydration as needed at the evaluation. Nonsteroidal anti-inflammatories (eg, ketorolac 15 to 30 mg intravenously) can provide effective analgesia,[32] with opioids administered either concurrently for rapid relief or if the nonsteroidal anti-inflammatory effect is insufficient. Use oral nonsteroidal anti-inflammatories with or without opioids for patients who are less symptomatic or for analgesia after discharge.

Intravenous hydration will benefit patients who are dehydrated or have been unable to drink as a result of vomiting; however, this use of such fluids to "flush out" a stone has not been shown to improve clinical outcomes.[33]

Patient Disposition

Patients at risk for a stone-related emergency should be admitted and receive urology consultation (Figure 1). When an obstructing stone is accompanied by sepsis, the urinary collecting system should be decompressed as quickly as possible.[5] Given the limitations of pyuria for the diagnosis,[14] patients with a suspected urinary tract infection in the absence of hydronephrosis, fever, or ill appearance could be discharged with oral antibiotic treatment, a urine culture, and close follow-up.[5] Among patients receiving a diagnosis of urolithiasis, 20% are admitted.[7,20,34]

Expectant Management for Stone Passage

Patients with urolithiasis and no indications for urgent intervention can be discharged home with a plan of observation for spontaneous stone passage. Large and proximally located stones are less likely to pass spontaneously; stones less than 5 mm and 5 to 10 mm have been noted to pass in 68% and 47% of cases, respectively.[35,36] Urologists typically offer ureteroscopy or shock wave lithotripsy to patients with retained stones and persistent symptoms.[5]

The American Urologic Association recommends urology consultation for stones greater than 10 mm and medical expulsive therapy (most commonly tamsulosin) for smaller stones.[5] Tamsulosin was reported as effective in enhancing stone passage in a recent Cochrane review of 28 randomized controlled trials (risk ratio 1.5; 95% confidence interval 1.3 to 1.6).[37] Two subsequent multicenter randomized trials have yielded conflicting results; one found no benefit, and one restricted to distal

stones noted benefit in patients with larger stones (>5 mm).[38,39] Given that larger stones are less likely to spontaneously pass, it seems logical that these patients may actually benefit more from tamsulosin.[35,39] The principal adverse effect of these α-blockers is orthostatic hypotension (number needed to harm 19), although in most studies this did not require cessation of therapy.[37] Dosing just before bedtime can mitigate the risk. Despite conflicting results between the Cochrane review and the trial with negative results, I believe currently the preponderance of the evidence suggests a benefit, and I would provide tamsulosin to patients who received a diagnosis of a ureteral stone.

Finally, patients who receive a diagnosis of a ureteral stone should be instructed to follow up with a urologist and given appropriate instructions to return for worsening symptoms.

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Dr. Callaham has recused himself from the decisionmaking for this article.

REFERENCES

1. Scales CD, Smith AC, Hanley JM, et al; Project Urologic Diseases of America Project. Prevalence of kidney stones in the United States. *Eur Urol*. 2012;62:160-165.
2. Teichman JMH. Clinical practice. Acute renal colic from ureteral calculus. *N Engl J Med*. 2004;350:684-693.
3. Fwu C-W, Eggers PW, Kimmel PL, et al. Emergency department visits, use of imaging, and drugs for urolithiasis have increased in the United States. *Kidney Int*. 2013;83:479-486.
4. Moore CL, Daniels B, Singh D, et al. Prevalence and clinical importance of alternative causes of symptoms using a renal colic computed tomography protocol in patients with flank or back pain and absence of pyuria. *Acad Emerg Med*. 2013;20:470-478.
5. Preminger GM, Tiselius H-G, Assimos DG, et al. 2007 Guideline for the management of ureteral calculi. *J Urol*. 2007;178:2418-2434.
6. Westphalen ACHR, Maselli J, Wang RC, et al. Radiological imaging of patients with suspected urinary tract stones: national trends, diagnoses, and predictors. *Acad Emerg Med*. 2011;18:699-707.
7. Smith-Bindman R, Aubin C, Bailitz J, et al. Ultrasonography versus computed tomography for suspected nephrolithiasis. *N Engl J Med*. 2014;371:1100-1110.
8. Moore CL, Bomann S, Daniels B, et al. Derivation and validation of a clinical prediction rule for uncomplicated ureteral stone—the STONE score: retrospective and prospective observational cohort studies. *BMJ*. 2014;348:g2191.
9. Wang RC, Rodriguez RM, Moghadassi M, et al. External validation of the STONE score, a clinical prediction rule for ureteral stone: an observational multi-institutional study. *Ann Emerg Med*. 2016;67:423-432.
10. Goldstone A, Bushnell A. Does diagnosis change as a result of repeat renal colic computed tomography scan in patients with a history of kidney stones? *Am J Emerg Med*. 2010;28:291-295.
11. Kobayashi T, Nishizawa K, Watanabe J, et al. Clinical characteristics of ureteral calculi detected by nonenhanced computerized tomography after unclear results of plain radiography and ultrasonography. *J Urol*. 2003;170:799-802.
12. Bove P, Kaplan D, Dalrymple N, et al. Reexamining the value of hematuria testing in patients with acute flank pain. *J Urol*. 1999;162(3 pt 1):685-687.
13. Luchs JS, Katz DS, Lane MJ, et al. Utility of hematuria testing in patients with suspected renal colic: correlation with unenhanced helical CT results. *Urology*. 2002;59:839-842.
14. Abrahamian FM, Krishnadasan A, Mower WR, et al. Association of pyuria and clinical characteristics with the presence of urinary tract infection among patients with acute nephrolithiasis. *Ann Emerg Med*. 2013;62:526-533.
15. Smith RC, Verga M, McCarthy S, et al. Diagnosis of acute flank pain: value of unenhanced helical CT. *AJR Am J Roentgenol*. 1996;166:97-101.
16. Dalrymple NC, Verga M, Anderson KR, et al. The value of unenhanced helical computerized tomography in the management of acute flank pain. *J Urol*. 1998;159:735-740.
17. Smith RC, Verga M, Dalrymple N, et al. Acute ureteral obstruction: value of secondary signs of helical unenhanced CT. *AJR Am J Roentgenol*. 2012;167:1109-1113.
18. Hoppe H, Studer R, Kessler TM, et al. Alternate or additional findings to stone disease on unenhanced computerized tomography for acute flank pain can impact management. *J Urol*. 2006;175:1725-1730.
19. Fritzsche P, Amis ES Jr, Bigongiari LR, et al. Acute onset flank pain, suspicion of stone disease. American College of Radiology. ACR Appropriateness Criteria. *Radiology*. 2000;215:683.
20. Westphalen AC, Hsia RY, Maselli JH, et al. Radiological imaging of patients with suspected urinary tract stones: national trends, diagnoses, and predictors. *Acad Emerg Med*. 2011;18:699-707.
21. Smith-Bindman R, Lipson J, Marcus R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. *Arch Intern Med*. 2009;169:2078.
22. Smith-Bindman R, Miglioretti DL, Johnson E, et al. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996-2010. *JAMA*. 2012;307:2400-2409.
23. Smith-Bindman R, Miglioretti DL, Larson EB. Rising use of diagnostic medical imaging in a large integrated health system. *Health Aff (Millwood)*. 2008;27:1491-1502.
24. Moore CL, Daniels B, Ghita M, et al. Accuracy of reduced-dose computed tomography for ureteral stones in emergency department patients. *Ann Emerg Med*. 2015;65:189-198.e182.
25. Smith-Bindman R, Moghadassi M. Computed tomography radiation dose in patients with suspected urolithiasis. *JAMA Intern Med*. 2015;175:1413-1416.
26. Fowler KAB, Locken JA, Duchesne JH, et al. US for detecting renal calculi with nonenhanced CT as a reference standard. *Radiology*. 2002;222:109-113.
27. Catalano O, Nunziata A, Altei F, et al. Suspected ureteral colic: primary helical CT versus selective helical CT after unenhanced radiography and sonography. *AJR Am J Roentgenol*. 2002;178:379-387.

28. Coursey CA, Casalino DD, Remer EM. ACR Appropriateness Criteria® acute onset flank pain—suspicion of stone disease. *Ultrasound*. 2012;28:227-233.
29. Ripollés T, Agramunt M, Errando J, et al. Suspected ureteral colic: plain film and sonography vs unenhanced helical CT. A prospective study in 66 patients. *Eur Radiol*. 2004;14:129-136.
30. American College of Emergency Physicians. Emergency ultrasound guidelines. *Ann Emerg Med*. 2009;53:550-570.
31. Herbst MK, Rosenberg G, Daniels B, et al. Effect of provider experience on clinician-performed ultrasonography for hydronephrosis in patients with suspected renal colic. *Ann Emerg Med*. 2014;64:269-276.
32. Holdgate A, Pollock T. Systematic review of the relative efficacy of non-steroidal anti-inflammatory drugs and opioids in the treatment of acute renal colic. *BMJ*. 2004;328:1401.
33. Worster AS, Bhanich Supapol W. Fluids and diuretics for acute ureteric colic. *Cochrane Database Syst Rev*. 2012;(2): CD004926.
34. Foster G, Stocks C, Borofsky MS. Statistical brief #139. Agency of Healthcare Research and Quality Report. 2012:1-10.
35. Coll DM, Varanelli MJ, Smith RC. Relationship of spontaneous passage of ureteral calculi to stone size and location as revealed by unenhanced helical CT. *AJR Am J Roentgenol*. 2002;178: 101-103.
36. Papa L, Stiell IG, Wells GA, et al. Predicting intervention in renal colic patients after emergency department evaluation. *CJEM*. 2005;7:78-86.
37. Campschroer T, Zhu Y, Duijvesz D. Alpha-blockers as medical expulsive therapy for ureteral stones. *Cochrane Database Syst Rev*. 2014;(4):CD008509.
38. Pickard R, Starr K, MacLennan G, et al. Medical expulsive therapy in adults with ureteric colic: a multicentre, randomised, placebo-controlled trial. *Lancet*. 2015;386:341-349.
39. Furyk JS, Chu K, Banks C, et al. Distal ureteric stones and tamsulosin: a double-blind, placebo-controlled, randomized, multicenter trial. *Ann Emerg Med*. 2016;67:86-95.

IMAGES IN EMERGENCY MEDICINE

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DIAGNOSIS:

Incarcerated umbilical hernia. The patient underwent manual hernia reduction, with relief of his pain (Figure 3). Repeated bedside ultrasonography confirmed reduction of hernia loop (Figure 4). He was observed overnight, given his elevated serum lactate level and prolonged duration of pain, which raised concerns about bowel viability. He had no recurrence of pain and no signs of peritonitis and was later discharged from the hospital.

Umbilical hernias affect 20% of cirrhotic patients as intra-abdominal pressure increases from ascites, muscle breakdown develops from poor nutrition, and the umbilical vein dilates, enlarging the umbilical opening.[1,2] The diagnosis can be made by ultrasonographic visualization of a round sac protruding from the rectus abdominus, with peristalsis of echogenic sac contents. Prompt recognition of a strangulated hernia is essential to avoid bowel ischemia. Ultrasonographic signs of strangulation include absence of peristalsis and bowel edema.[3] In a recent meta-analysis, ultrasonography had 96.6% sensitivity and 84.8% specificity in diagnosing inguinal hernias.[4] Chen et al[5] showed a reduction in emergency surgery rate from 9.8% to 2.0% when ultrasonography was used in reduction of inguinal hernias. Ultrasonographically guided hernia reduction can help the emergency physician with rapid bedside diagnosis and evaluation for potential complications.

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REFERENCES

1. Belghiti J, Durand F. Abdominal wall hernias in the setting of cirrhosis. *Semin Liver Dis*. 1997;17:219-226.
2. Shlomovitz E, Quan D, Etemad-rezai R, et al. Association of recanalization of the left umbilical vein with umbilical hernia in patients with liver disease. *Liver Transpl*. 2005;11:1298-1299.
3. Siadecki S, Frasure S, Saul T, et al. Diagnosis and reduction of a hernia by bedside ultrasound: a case report. *J Emerg Med*. 2014;47:169-171.
4. Robinson A, Light D, Nice C. Meta-analysis of sonography in the diagnosis of inguinal hernias. *J Ultrasound Med*. 2013;32:339-346.
5. Chen SC, Lee CC, Liu YP, et al. Ultrasound may decrease the emergency surgery rate of incarcerated inguinal hernia. *Scand J Gastroenterol*. 2005;40:721-724.