International Journal of Surgery 36 (2016) 638–646

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Review

Radiology of renal stone disease

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HIGHLIGHTS

- Recent advances in Computed Tomography (CT) have improved the radiological evaluation of renal stones disease.
- With DECT, it is possible to determine the in vivo composition of renal stones, assisting with diagnosis and treatment.
- There are ongoing efforts to decrease radiation dose related to CT examinations, including those for renal stone disease.

ARTICLE INFO

Article history:
Received 24 October 2016
Accepted 30 October 2016
Available online 2 November 2016

Keywords:
Nephrolithiasis
Radiology
Computed Tomography
Low dose
Ultrasound

ABSTRACT

Nephrolithiasis is a common cause of abdominal pain and will affect approximately 1 in 10 people in their lifetime. In the past two decades, there have been several technological advances that have changed the imaging approach to stone diagnosis and follow-up. We present a review of the current imaging evaluation for renal stone disease, and outline how new technology has helped with diagnosis and management.

1. Introduction

Kidney stones remain a very common problem, affecting approximately 1 in 10 people at some point in their life [1]. The incidence of kidney stones appears to have increased over the last few decades, and although this may be partly explained by improved detection, at least some is due to changes in diet and rising levels of obesity [1].

Imaging plays an important role in the management of patients with renal stone disease including initial diagnosis, treatment planning and follow-up after medical therapy or urologic interventions. In this paper, we discuss the various imaging techniques available for renal stone detection, together with the recent advances that have improved our ability to not only detect stones, but also to use these novel techniques such as material decomposition, to characterize stone composition. The article will also discuss the impact of these technological advances on medical and urological management of nephrolithiasis.

2. Imaging

Unenhanced Computed Tomography (CT) of the abdomen and pelvis has become the first-line test for evaluation of renal calculi in patients with acute flank pain and suspicion of urolithiasis [2]. CT has sensitivity and specificity of over 95% for the diagnosis of nephrolithiasis [3]. Even in those patients who turn out not to have nephrolithiasis, CT allow diagnosis of alternative causes for the patient's pain, such as appendicitis, diverticulitis or gynecological emergencies (Fig. 1). In fact, an alternative diagnosis may be identified in up to 14% of patients undergoing CT for evaluation of suspected urolithiasis [3].

3. Ultrasound

The use of ultrasound for the evaluation of renal pathology is

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http://dx.doi.org/10.1016/j.ijsu.2016.10.045
1743-9191/

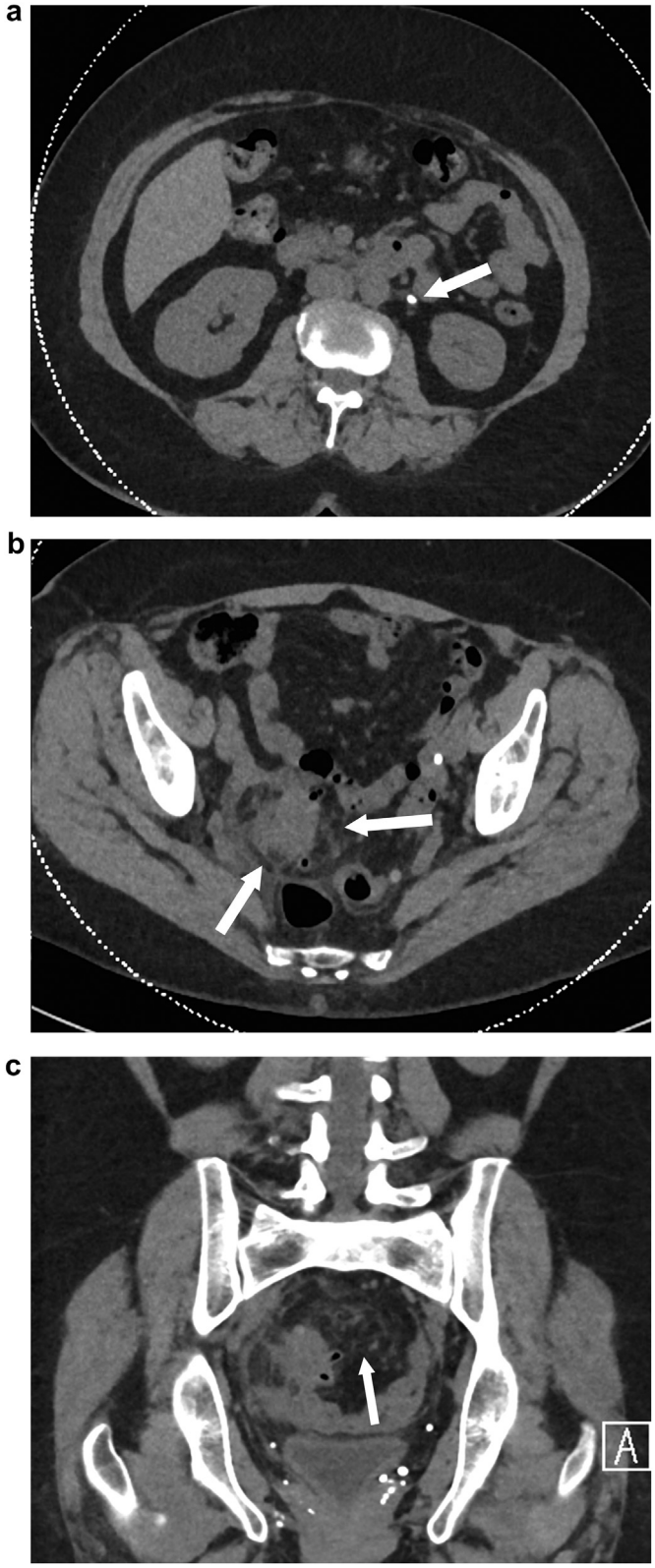

Fig. 1. 66 year old female presenting with hypogastric pain with bilateral costovertebral angle tenderness. Axial NCCT image (a) shows a calculus in left upper ureter. Axial image (b) at the level of pelvis and coronal (c) show colonic diverticulosis with diffuse bowel wall thickening, extensive pericolonic fat stranding and fluid in distal sigmoid colon, suggesting acute diverticulitis.

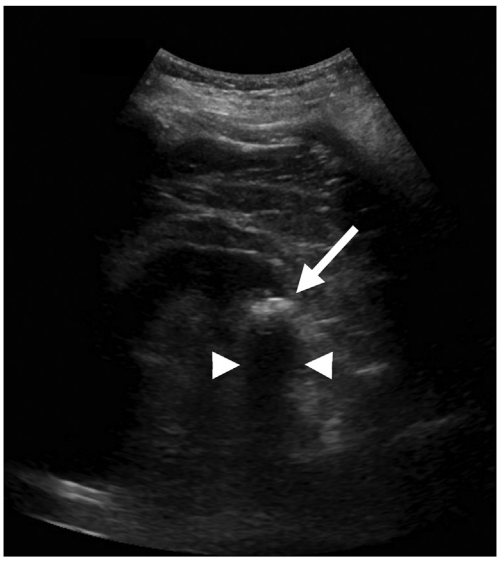

Fig. 2. 79-year-old man with history of nephrolithiasis, undergoing follow-up ultrasound. Sagittal image of the left kidney reveals a large stone in the lower pole (arrow), with posterior acoustic shadowing (arrowheads).

well established. In particular, and with regard to nephrolithiasis, ultrasound is very effective in the detection of hydronephrosis, which may be related to an obstructing renal or ureteric stone. Indeed, ultrasound can reliably detect larger renal stones exhibiting posterior acoustic shadowing (Fig. 2) with relative ease. However, smaller stones, and in particularly those less than 5 mm in size, may be difficult to detect on ultrasound [4–6]. Others have countered that argument, and stated that although such small stones may be missed on combination of ultrasound and plain radiograph of the abdomen, such stones were not likely to become clinically important, and may pass spontaneously [7].

In a recent randomized control trial, over 2700 patients with suspected nephrolithiasis were randomized to undergo point of care ultrasound (by an Emergency physician), diagnostic ultrasound in the radiology department, or CT scan. Although the use of ultrasound is attractive given the relative easy of access, low cost and absence of ionizing radiation, the authors found that in those patients who had undergone point of care ultrasound and diagnostic ultrasound required additional workup in the form of CT scan in 40.7% and 27% of cases, respectively. On the other hand, this meant that more than half of the patients enrolled in an ultrasound arm of the study did *not* require a subsequent CT scan [8].

Ultrasound at the point of care may also allow for the detection of hydronephrosis. The STONE PLUS prediction tool, for example, has recently addressed the significance of detecting hydronephrosis [9]. By combining Sex, Timing, Origin, Nausea, Erythrocytes (STONE) with point-of-care limited ultrasonography (PLUS), the authors noted that moderate or severe hydronephrosis improved risk stratification of patients with nephrolithiasis, specifically identifying those who may be more likely to require intervention. As a result, ultrasound remains an important tool in the armamentarium of the urologist, not only for follow-up of patients with known nephrolithiasis, but also in those patients for whom exposure to ionizing radiation is to be avoided, including pregnant and pediatric patients.

4. Conventional radiography and intravenous pyelogram (IVP)

The advent of MDCT and its advantages in the evaluation of