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*Original article*

# Use of CT Scout Radiographs in the Management of Urolithiasis

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**ABSTRACT**

Unenhanced CT is the gold standard imaging for patients with suspected urolithiasis. The aim of this study was to determine the sensitivity of CT scout radiographs in detecting urinary stones in patients with confirmed urolithiasis on unenhanced CT. A retrospective study was carried out with data collected consecutively from January to November 2021. The included cases were those with confirmed urinary stones on unenhanced CT. CT scout radiographs were read and cross-referenced with unenhanced CT. Stones were classified as visible and non-visible on scout radiographs. The location and size of stones on axial CT were recorded. Means of the size of visible and non-visible stones and frequency of detection by scout radiographs between proximal stones and distal stones were tested for significance. 117 stones were analyzed. The sensitivity of CT scout radiographs was 56%. There was a direct correlation between stone size and stone visibility on CT scout radiographs. There was a statistically significant difference between the means of the sizes of visible and non-visible stones on scout radiographs ($P < 0.001$). 54% (41/76) of proximal stones and 59% (24/41) of distal stones were visible on CT scout radiographs. There was no statistically significant difference between visibility and stone location ($P = 0.6$). Conclusion: CT scout radiography could detect stones in 56% of patients with urolithiasis diagnosed on unenhanced CT. Therefore, it could serve as a baseline investigation to detect stone radio-opacity and should be reported in conjunction with the findings of unenhanced CT for guiding treatment/follow-up decision options.

## Introduction

Urolithiasis, or stone formation in the urinary tract, is an extremely common clinical diagnosis globally [1]. Adverse health effects from urolithiasis include severe colicky pain, infection, obstructive uropathy, hypertension, and renal failure [2]. Patients with acute ureterolithiasis are now almost exclusively diagnosed with unenhanced helical CT [3]. Unenhanced CT is far more sensitive than plain radiography in detecting urolithiasis [4]. It has the advent of identification of any type of stone, including uric acid stones, which are commonly radiolucent on radiography [3]. Unenhanced helical CT can also reveal small stones that are usually non-visible on plain abdominal radiography in addition to abnormalities outside the urinary tract that may cause flank pain [4,5]. Therefore, unenhanced helical CT for the kidney, ureter, and bladder (CT KUB) has become the imaging modality of choice in patients with acute flank pain [6].

Unenhanced CT provides not only confirmation of the presence of urinary stones but also the precise size and location of the stone [5]. However, because of the higher radiation dose of CT, most clinicians still use plain abdominal radiographs in their protocol for treatment planning as baseline and follow-up investigations to monitor the passage of stones if they were found to be radiographically visible [5,6]. The CT scout view is a low-radiation digital radiograph taken before each CT examination to determine patient position and plan CT slice locations [7,8,9]. It is frequently overlooked by the reporting radiologist and considered to be of poor diagnostic validity. However, it has been suggested that a thorough review of the CT scout radiograph could reveal urolithiasis and eliminate the requirement for a baseline plain abdominal radiograph, and the decision of whether or not the patient could be followed with plain abdominal radiographs can be made at the time of presentation [6]. The topic of visibility of urinary stones on scout radiographs has been addressed in previously published research. However, the number of studies done is small, and the most recent one by Yab et al. [6] was done over a decade ago; they reported a sensitivity of CT scout radiography that ranged between 42% and 52%. The purpose of this study was to assess the sensitivity of CT scout radiographs for detecting urinary stones in patients with confirmed urolithiasis on CT KUB to determine if CT scout radiography can be used in place of plain radiography in treatment planning and to compare it with previous published studies. In addition to investigating factors that may affect the visibility of stones on scout views, such as stone size and location.


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## Methods

From January 2021 to November 2021, consecutive patients who presented to the radiology department of Omer Almukhtar Hospital in the Green Mountain, Libya, for CT KUB imaging were retrospectively examined. Their scans were electronically stored in the department's Packed Archive Information System (PACS). Only those who had confirmed urolithiasis on CT and an available CT scout radiograph were included. Fifty-three patients (36 males, 17 females; mean age 53.5 years ± 16.7 (standard deviation); age range 22-85 years) comprised the study population.
The non-contrast helical CT examinations were performed with a 32-slice CT scanner (Aquilion, Toshiba Medical Systems, Japan) at standard scan parameters of 120 kV, automatic current modulation, section thickness of 1x16 (detectors), 5 mm collimation, helical pitch of 1.5, rotation time of 0.75 sec., reconstruction interval of 0.8 mm for axial images. Coverage was from the top of the diaphragm to the symphysis pubis. Before obtaining the axial CT images, a separate anteroposterior scout radiograph was acquired at 50 mAs and 120 kVp from the level of the xiphoid process to the level of the lesser trochanter.
For the purpose of this study, the ureter was divided into the proximal ureter (ureter segment lying above the sacroiliac joints), mid ureter (ureter segment overlying the sacroiliac joints), and distal ureter (ureter segment lying below the sacroiliac joints).
Studies were interpreted by a consultant radiologist using DICOM Viewer. The various system tools were used to optimize the viewing, and optimal window settings were applied when viewing the scout image for each patient. The CT scout radiographs and the CT images were reviewed during the same reading session, starting with the scout radiograph first. The CT KUB was used as the standard reference. The scout radiograph was evaluated for stone detection, with stone location cross-referenced to the CT images. The stones were classified as visible or non-visible. The stone location was determined on axial CT images and coronal reformatted images. The stone location was classified into the kidney, pelviureteral junction (PUJ), proximal ureter, mid ureter, distal ureter, ureterovesical junction (UVJ), and urinary bladder (UB). Stone location in the kidney, PUJ, or proximal ureter was scored as being proximal, while stone location in the mid ureter, distal ureter, UVJ, or UB was scored as being distal. Stone size was measured on the axial CT images (the maximum transverse diameter) to the nearest millimeter. Stone sizes were divided into less than 4 mm, 4-8 mm, and more than 8 mm diameter stones. This classification of the size of stone was based on the fact that stones smaller than 4 mm are likely to pass without intervention, while stones larger than 8 mm are less likely to pass spontaneously and usually require intervention [6]. In cases of multiple stones, each stone was described separately.
Statistical analysis was done using MedCalc Software Version 20.027. A p-value of less than 0.05 was considered significant. Descriptive data were represented as means, ± standard deviations (SD), and ranges. The sensitivity of the scout radiographs was calculated. A two-sample t-test was used to compare the mean size of visible stones with the mean size of the non-visible stones. The frequency of stone detection was calculated for different stone sizes. Frequencies of visible stones were calculated for each stone location and were compared using a chi-squared test.

## Results

Altogether 117 stones were detected by unenhanced CT. Mean stone size was 8 mm ± 6.9 (SD), range: 1-40 mm. 34 (29%) stones were smaller than 4 mm, 45 stones (39%) were between 4 and 8 mm in size, and 38 stones (33%) were larger than 8 mm. The overall sensitivity of CT scout radiograph for detecting urolithiasis was 56% (65 of all 117 stones were visible on CT scout radiographs). Table 1 details the CT scout radiograph sensitivity per stone size. There was a direct correlation between stone size and stone visibility on the CT scout radiograph. The sensitivity of CT scout radiograph detection was poor (34%) for stones smaller than 4 mm, while for stones larger than 8 mm, the sensitivity of scout radiograph markedly improved to 89%.

***Table 1. Sensitivity of CT scout radiography versus stone size***

| Size of stones | Number | Number of visible stones on CT scout |
|---|---|---|
| < 4 mm | 34 | 8 (24%) |
| 4-8 mm | 45 | 23 (51%) |
| > 8 mm | 38 | 34 (89%) |
| Total | 117 | 65 (56%) |

The mean size of all stones detected on CT KUB was 8 ± 6.9 mm. Those visible on the CT scout radiograph were 11 ± 7.8 mm, and those not visible were 4.4 ± 2.5 mm. There was a significant difference between the two means of visible and non-visible stones on scout radiography ($P < 0.001$).


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There were 76/117 (65%) proximal stones (in the kidney, PUJ, and proximal ureter), whereas 41/117 (35%) were distal stones (in the mid ureter, distal ureter, UVJ, and UB). In all, 54% (41/76) of proximal stones and 59% (24/41) of distal stones were visible on the CT scout radiograph. There was no significant difference between stone location and visibility (P = 0.6). Table 2 details the sensitivity of the CT scout radiograph based on stone location.

***Table 2. Stone visibility on scout radiograph versus stone location***

| Location of the stone | Number | Number of visible stones on CT scout radiograph |
|---|---|---|
| Kidney | 60 | 33 (55%) |
| PUJ | 3 | 1 (33%) |
| Proximal ureter | 13 | 7 (54%) |
| Mid ureter | 7 | 3 (43%) |
| Distal ureter | 13 | 8 (67%) |
| UVJ | 12 | 5 (42%) |
| UB | 9 | 8 (89%) |
| Total | 117 | 65 (56%) |


***Figure 1. A 35-year-old woman with a right ureteral stone. A, Axial CT scan shows a ureteral stone at right UVJ (arrow) measuring 6 mm. B, CT scout radiograph shows a right ureteral stone.***


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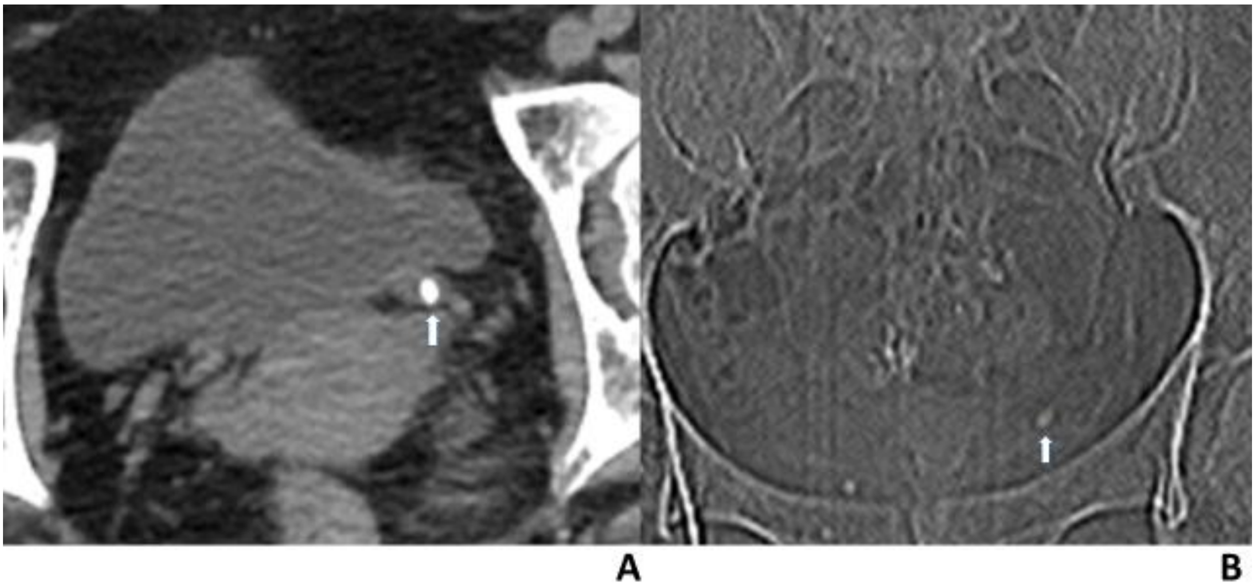


***Figure 2. 60-year-old woman with left ureteral stone. A, Axial CT scan shows a distal left ureteral stone (arrow) measuring 6 mm. B, CT scout radiograph shows left ureteral stone (arrow) distinct from the uterine calcifications.***

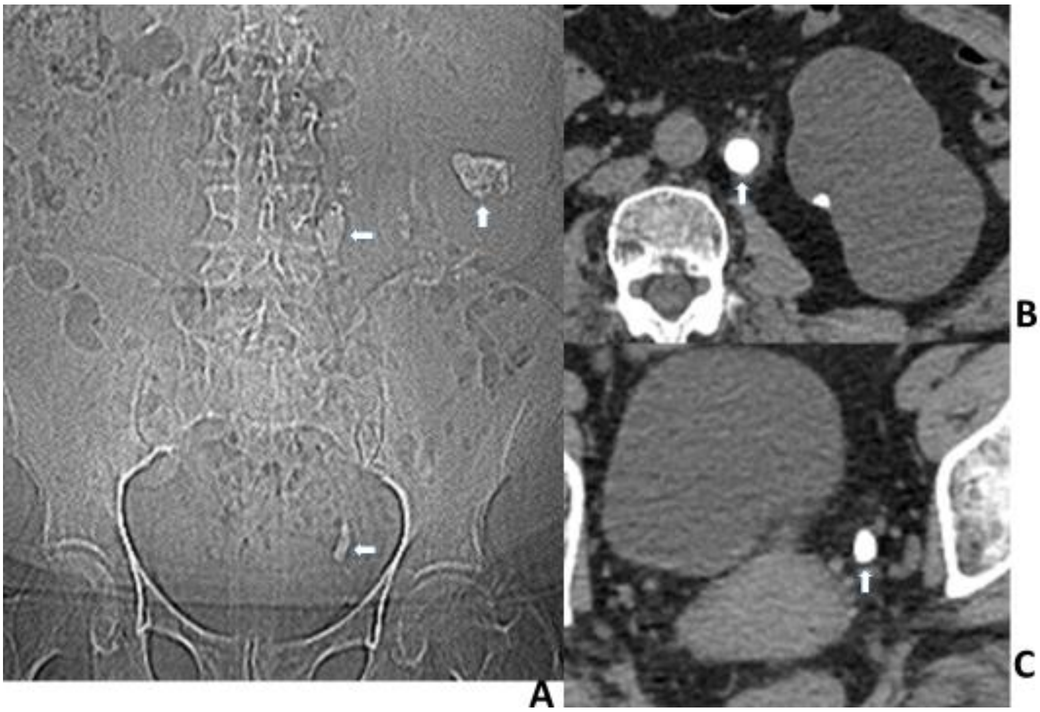


***Figure 3. 80-year-old woman with left renal and ureteral stones. A CT scout radiograph shows multiple left renal stones (vertical arrow), two left ureteral stones (horizontal arrows). B, Axial CT scan shows proximal left ureteral stone (arrow) measuring 12 mm. C, axial CT scan shows distal left ureteral stone (arrow) measuring 11 mm.***


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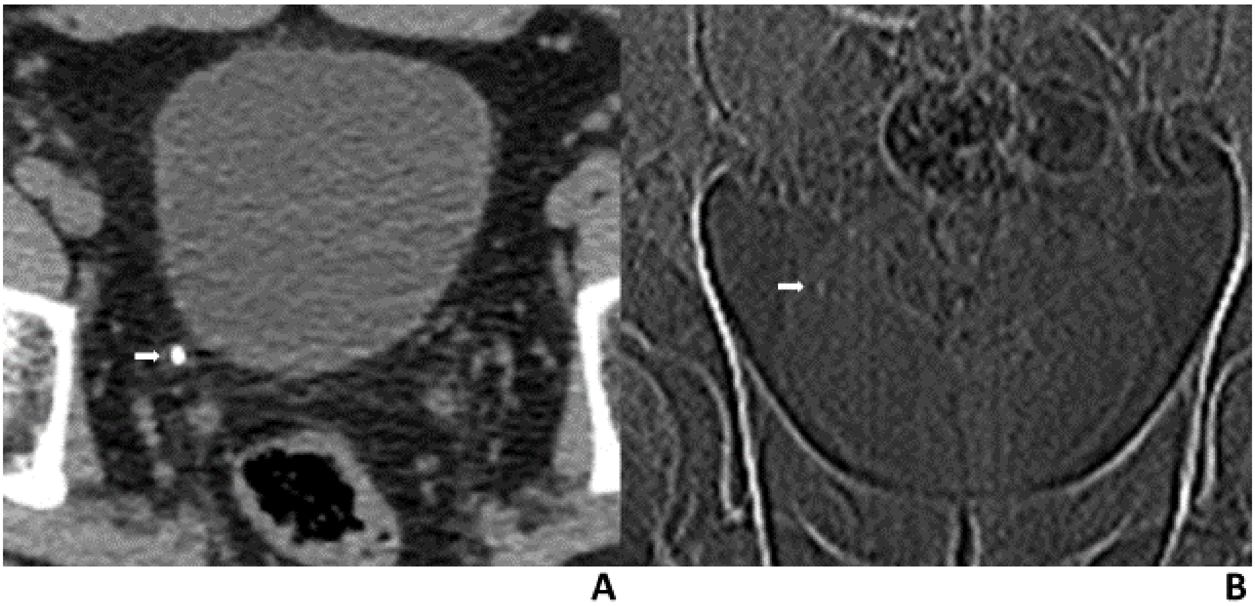


***Figure 4. 68-year-old man with right ureteral stone. A, axial CT scan shows a distal right ureteral stone (arrow) measuring 5 mm. B, CT scout radiograph shows right ureteral stone (arrow).***

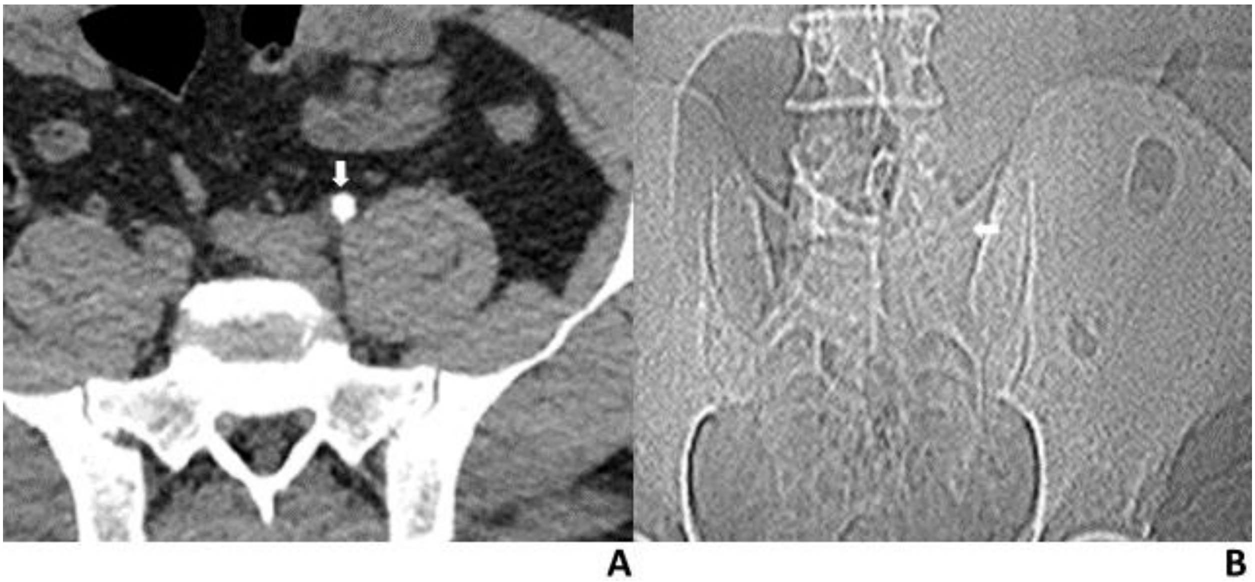


***Figure 5. A 39-year-old man with a left ureteral stone. A, axial CT scan shows a left mid-ureteral stone (arrow) measuring 8 mm. B, CT scout radiograph does not reveal a stone. The arrow points to the location of the stone, cross-referenced to axial CT.***

## Discussion

Imaging is important in the management of patients with urinary tract stone disease, whether relating to the initial diagnosis, treatment planning, or follow-up post-drug therapy or urologic procedures. The first-line examination for assessing suspected urolithiasis in patients with acute flank pain is unenhanced CT of the abdomen and pelvis. It has the benefits of accuracy, safety, and speed. The reported sensitivity and specificity of CT KUB for detecting urolithiasis exceed 95%. CT KUB can be used to diagnose alternative reasons for acute flank pain, such as diverticulitis, appendicitis, or gynecological problems, among patients who turn out not to suffer from urolithiasis. In fact, up to 14% of patients obtaining CT scans to evaluate suspected urolithiasis may have a different diagnosis [10]. The management of patients who have been diagnosed with urinary stones is then based on the CT results [9]. The most important factors for predicting that the stones are likely to pass spontaneously are stone size and stone location. Findings of small size and distal location at CT KUB at time of presentation indicate increased likelihood for spontaneous passage of the stone [3,9]. Follow-up imaging of stone progress is necessary for the conservatively treated stones to confirm stone passage. It is important in the follow-up routine after the diagnosis has already been made to


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choose the most effective imaging tool with the least cost and harm to the patient [4]. Scout radiographs are regularly acquired as part of the unenhanced helical CT scan. This has raised the possibility that CT scout radiograph can be included in the management routine of urolithiasis.

A standard abdominal radiograph delivers significantly less radiation than an unenhanced helical CT scan. A CT KUB exposes the patient to approximately 10-20 times more than a plain abdominal radiograph [11]. Therefore, despite the limitations of plain abdominal radiography in the evaluation of urolithiasis, plain radiography is still used in the daily monitoring of patients with urinary stone disease, especially in the follow-up of patients having urologic intervention to observe changes in stone burden [10].

Several previous studies have examined the sensitivity of scout radiography for the detection of urinary stones. Chu et al. [12] studied a cohort of 215 patients with a single ureteral stone and discovered that 49% of the stones were identified on the CT scout radiograph. Assi et al. [13] examined 60 patients with ureteral stones who had plain abdominal radiography and unenhanced helical CT; the sensitivity of CT scout radiography was 47% compared to 60% for plain abdominal radiography. Ege et al. [9], who also compared the sensitivity of plain radiographs with CT scout radiographs in a series of 111 ureteral stones, reported 52% for plain radiographs and 40% for CT scout radiographs. Johnston et al. [4] revealed the sensitivity of a CT scout radiograph to be 47% and that of a plain radiograph to be 63% in a series of 108 stones. Yab et al. [6] conducted a study involving a series of 203 stones, which showed that the sensitivity of scout radiography in detecting stones, when assessed with CT images, ranged between 42% and 52%.

The sensitivity of CT scout radiographs for detecting urinary stones in this series was comparable to previous published research. The sensitivity of CT scout radiography in detecting urolithiasis was found to be 56%. This aligns with the findings of the most recent study by Yab et al. [6], which reported a sensitivity of 52%. The sensitivity in this study was slightly higher than the older studies conducted by Chu et al. [12], Assi et al. [13], Ege et al. [9], and Johnston et al. [4], where the sensitivity of CT scout radiography was reported as 49%, 47%, 40%, and 47%, respectively. The increased sensitivity of CT scout radiography in the current study can be attributed to the reader's practice of cross-referencing findings from the CT KUB with the CT scout radiograph after reviewing the CT KUB. This approach was not employed in the older studies.

When stone size and detection on scout radiography were analyzed for correlation, there was a statistically significant difference between the means of sizes of the visible and non-visible stones, indicating that stone size has an important influence on stone detection by scout radiographs. Yab et al. [6] had reported similar results; they found the size and Hounsfield unit of the stone as two determining factors for CT scout radiograph sensitivity. Assi et al. [13] and Ege et al. [9] also reported stone size as a significant variable for the visibility of the stones. Assi et al. [13] compared the sensitivity of CT scout radiography for detecting stones measuring 3 mm or smaller to those larger than 3 mm; in their study, the sensitivity increased from 47% for small stones to 81% for larger stones. Ege et al. [9] found that the sensitivity of CT scout radiographs improved from 22% for small stones (< 5 mm) to 66% for big stones (≥ 5 mm). Similarly, in the current study, CT scout sensitivity improved from 24% to 51% to 89% for revealing stones measuring < 4 mm, 4-8 mm, and > 8 mm, respectively.

The majority of previous studies have reported no significant association between stone location and its visibility on CT scout radiography [4,6,13]. These findings are consistent with the results of the present study, which similarly demonstrated no statistically significant difference in CT scout detection rates between proximal and distal urinary tract stones. In contrast, Chua et al. [5] reported that stone location did influence detection on CT scout radiography. In their investigation of the Hounsfield Unit values for radiographic visibility on CT scout and non-contrast CT, they observed a higher sensitivity of CT scout radiographs for detecting stones located in the proximal collecting system (58%) compared to those in the lower collecting tract (20%). The authors attributed this disparity to anatomical factors, noting that stones in the lower collecting system are more likely to be obscured by overlying osseous structures and varying soft tissue densities.

Conservative management is the preferred approach for ureteral stones to allow spontaneous stone passage if there are no associated signs of infection or risk to renal function. A ninety-five percent rate of spontaneous passage is reported in the literature for stones measuring 2 to 4 mm in size, which decreases to 50% for stones exceeding 5 mm in size [14]. In the present study, the sensitivity of CT scout radiography for detecting urinary stones smaller than 4 mm was found to be 24%. This finding of poor sensitivity indicates that CT scout radiography cannot be used as a baseline investigation for stones of this size. However, this limited sensitivity may be of little clinical impact, as stones < 4 mm typically do not require follow-up imaging or intervention, and symptomatic management of patients is more effective. Conversely, for stones measuring 4 to 8 mm, the sensitivity of CT scout radiography increased to 51%. Since these stones have a 50% probability of needing intervention and require follow-up imaging, this finding is of clinical relevance as it means that a CT scout radiograph can be used as a baseline investigation to determine the radiographic visibility of the stones, which has significant implications for guiding patient follow-up and decisions regarding definitive treatment.


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In all the previous studies that compared the sensitivity of CT scout and plain radiographs, all stones seen on the CT scout radiograph were also visible on plain abdominal radiography [4,6,13]. In the present study, the sensitivity of location-based detection of CT scout radiography was 54% when stones were found in the proximal tract (kidney, PUJ, and proximal ureter combined) and 59% when stones were found in the distal tract (mid ureter, distal ureter, UVJ, and UB combined). According to guidelines, stones located proximally need follow-up imaging if larger than 5 mm to ensure progress of the stone and decide management, as it may fail to pass and cause obstruction [14]. Our findings suggest that if stones were visible on the CT scout radiograph of the baseline CT KUB, a plain radiograph may be used for follow-up imaging.

Like previous studies, which frequently used settings between 120 and 140 kV to obtain CT scout radiographs, a standard scan parameter of 120 kV was applied in this study. According to Chu et al. [12], using lower kilovoltage settings for CT scout radiography may improve the sensitivity for stone detection because it results in a higher percentage of photoelectric interactions in calcium-containing stones. The fact that stone detection was reliant on kilovoltage settings may have contributed to CT scout radiography's lower sensitivity. Based on experience from the present study, the overlying bowel contents decrease the visualization of stones on CT scout radiography, whereas the tools of the DICOM viewer, like magnification of the area of interest and windowing of the CT scout radiograph, improve the detection of the stones.

Regardless of location, any stone visible on a CT scout radiograph is probably radiopaque. In the present study, 56% of patients with urolithiasis confirmed on CT KUB had stones that were visible on CT scout radiographs, indicating radiopacity. This finding suggests that in more than half of these cases, a baseline plain abdominal radiograph is unnecessary at the time of diagnosis. For those patients whose stones are visible on CT scout radiography, follow-up imaging with a plain radiograph can be confidently used to track stone progression or before intervention procedures to check on stone location. This eliminates the need for a baseline plain radiograph at presentation. However, for the remaining 44% of patients whose stones are not visible on CT scout radiograph, a baseline plain abdominal radiograph may still be useful, especially when follow-up imaging is needed, such as in cases of stones >5 mm or those located in the proximal urinary tract. If these stones remain undetected on the plain radiograph, alternative imaging methods like ultrasound or unenhanced CT would be more appropriate for follow-up. The analysis of the current study suggests that reporting the CT scout radiograph with CT KUB at the time of presentation would cut close to 60% of baseline plain abdominal radiographs. This would lead to better use and distribution of health funds by lowering the quantity of unnecessary plain radiographs performed during presentation, as well as lowering the radiation dosage for people whose urolithiasis diagnosis has already been made on CT KUB and their stones were visible on CT scout radiographs.

### *Limitations*

This study has several limitations. First, it was retrospective in nature, which may introduce selection bias. Second, the visibility of stones on scout radiographs was determined by a single consultant radiologist, which, while ensuring consistency, did not allow for assessment of interobserver variability. Third, the radiologist had access to the CT KUB images during evaluation, which may have introduced confirmation bias when assessing stone visibility on the scout radiographs. Lastly, no direct comparison was made between scout radiographs and conventional plain abdominal radiographs, which are commonly used for follow-up in clinical practice.

## Conclusion

Although the sensitivity of CT scout radiography is lower than plain abdominal radiography, the findings of this study encourage the use of CT scout radiography as baseline imaging, particularly for large stones. Scout radiographs should be used as an adjuvant in the management of urolithiasis and reported in conjunction with CT KUB findings for guiding treatment/follow-up decision options.

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### *Conflicts of Interest*

The author declares no conflicts of interest.

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