

# The Comparison And Assessment Of Kub Stone Measurement By CT & Plain Film Radiography

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## ABSTRACT

**Background:** Kidney, ureter, and bladder (KUB) stones are common urological conditions requiring accurate imaging for diagnosis and management. Computed tomography (CT) is considered the reference standard, while KUB X-ray remains widely used because of its lower cost and radiation exposure. **Objective:** To compare the diagnostic accuracy and stone measurement reliability of CT and KUB X-ray in patients with KUB stones. **Materials and Methods:** A retrospective comparative study was conducted on 100 patients who underwent both non-contrast CT and KUB X-ray. Stone detection, size, location, and radiolucency were analyzed. Statistical analysis included paired t-test, chi-square test, ROC curve analysis, and regression analysis. **Results:** CT detected stones in 58% of patients, whereas KUB X-ray detected stones in 51%. KUB X-ray slightly overestimated stone size compared to CT, but the difference was not statistically significant ( $p > 0.05$ ). ROC analysis showed poor diagnostic accuracy of KUB X-ray ( $AUC = 0.430$ ). **Conclusion:** CT remains the most accurate imaging modality for diagnosing and measuring KUB stones. KUB X-ray is useful for follow-up imaging but should not be used as a primary diagnostic tool.

**Keywords:** KUB stones, Computed Tomography, KUB X-ray, Nephrolithiasis.

## INTRODUCTION

Medical imaging plays a pivotal role in modern healthcare, enabling physicians to diagnose and monitor a wide range of medical conditions with high accuracy. Among the many applications of radiology, the detection and assessment of kidney, ureter, and bladder (KUB) stones have become a crucial aspect of urological care. KUB stones, also known as urinary tract calculi or nephrolithiasis, are mineral deposits formed due to an imbalance in the urinary system, often leading to pain, obstruction, and infection. The early and accurate diagnosis of these stones is essential for effective treatment and management, reducing the risk of complications such as hydronephrosis, renal dysfunction, and recurrent infections<sup>[1]</sup>

This study evaluates the diagnostic reliability of CT compared to KUB X-ray in measuring and detecting KUB stones. The two most commonly used imaging techniques for KUB stone assessment are computed tomography (CT) and plain film radiography (KUB X-ray). CT imaging has emerged as the gold standard due to its high sensitivity and ability to detect even

small stones, whereas plain film radiography remains widely used due to its cost-effectiveness and lower radiation exposure.<sup>[2]</sup>

However, the choice of imaging modality depends on various factors, including the stone composition, location, patient history, and availability of advanced imaging technologies. While CT provides detailed cross-sectional images, allowing for accurate stone measurement and localization, KUB X-ray is preferred in follow-up cases to monitor stone progression and treatment effectiveness<sup>[3]</sup>.

The significance of medical imaging in nephrolithiasis extends beyond mere detection. Accurate measurement of stone size and density helps in determining whether a stone can pass spontaneously or if surgical intervention is necessary<sup>(4)</sup>.

Misdiagnosis or underestimation of stone size can lead to inappropriate treatment plans, increasing the burden on both patients and healthcare systems. Moreover, radiation exposure considerations, particularly with repeated CT scans, have led

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researchers to explore optimized protocols, including low-dose CT scans for stone detection. <sup>[5]</sup>

Given the clinical importance of accurate stone measurement, this study aims to compare and assess the effectiveness of CT scanning and KUB X-ray in measuring KUB stones, analyzing their respective advantages and limitations. A comprehensive understanding of these imaging modalities will aid in improving diagnostic accuracy, optimizing treatment protocols, and reducing unnecessary radiation exposure in patients undergoing repeated imaging for stone disease. <sup>[6]</sup>

### Understanding Kidney, Ureter, and Bladder (KUB) Stones

Kidney, ureter, and bladder (KUB) stones, also referred to as urolithiasis, nephrolithiasis (when in the kidney), and ureterolithiasis (when in the ureter), are solid mineral deposits that form within the urinary tract. These stones develop due to an imbalance in the urine's chemical composition, leading to the crystallization and aggregation of mineral substances such as calcium, oxalate, uric acid, phosphate, and cystine <sup>[6]</sup>. KUB stones can vary in size, shape, composition, and location, with some being small enough to pass through urine spontaneously, while others grow large enough to cause severe pain, urinary obstruction, or infection <sup>[2]</sup>.

The prevalence of KUB stones has increased globally, affecting approximately 10-15% of the population at some point in their lives, with higher incidence rates in men than women <sup>[3]</sup>. Risk factors include dehydration, high dietary intake of oxalates and sodium, metabolic disorders, obesity, genetic predisposition, and urinary tract infections <sup>[7]</sup>. The recurrence rate of kidney stones is also high, with 50% of patients experiencing a recurrence within 10 years <sup>[9]</sup>.

### Formation and Composition of KUB Stones

KUB stones form when there is a supersaturation of minerals in the urine, which leads to the nucleation and aggregation of crystals <sup>[4]</sup>. The five major types of urinary stones include:

#### 1. Calcium Oxalate Stones (Most Common, ~70-80%)

Formed due to excess calcium and oxalate in the urine.

Linked to high intake of oxalate-rich foods (spinach, nuts, chocolate) and low hydration levels.

Often appear radiopaque (visible on X-rays) due to calcium content (Brisbane et al., 2016).

#### 2. Uric Acid Stones (~5-10%)

Form in patients with high uric acid levels, often seen in gout, metabolic syndrome, and high-protein diets.

Radiolucent (not visible on KUB X-rays) but detected on CT scans <sup>[8]</sup>.

#### 3. Struvite Stones (10-15%)

Also known as infection stones, formed due to chronic urinary tract infections (UTIs).

More common in women due to the increased prevalence of UTIs.

Can grow into large staghorn calculi, which require surgical removal <sup>[3]</sup>.

#### 4. Cystine Stones (<2%)

Rare, but genetically inherited, occurring in patients with cystinuria.

Hard to dissolve and often require medical intervention.

#### 5. Calcium Phosphate Stones (~5-10%)

Form in alkaline urine and associated with metabolic conditions like renal tubular acidosis.

Less common but often grow quickly.

### Materials and Methods

The methodology of this study outlines the research approach, study design, sampling techniques, data collection, and analysis procedures to ensure an objective comparison between CT scanning and plain film radiography (KUB X-ray) in KUB stone measurement.

**Study Design**

Retrospective comparative study.

**Study Population**

100 patients who underwent both CT and KUB X-ray for suspected KUB stones.

**Inclusion Criteria**

Patients examined with both imaging modalities

Confirmed diagnosis of KUB stones

**Exclusion Criteria**

Incomplete imaging data

Other urinary tract abnormalities

**Imaging Protocol**

**CT:** Non-contrast CT abdomen and pelvis

**KUB X-ray:** Standard plain radiography

**Statistical Analysis**

SPSS software was used. Paired t-test, chi-square test, ROC analysis, and regression analysis were applied. A  $p\text{-value} < 0.05$  was considered statistically significant.

**Results:**

CT detected stones in 58 patients, whereas KUB X-ray detected stones in 51 patients. The difference in detection rate was not statistically significant ( $p = 0.166$ ). Mean stone size was 8.52 mm on CT and 9.07 mm on KUB X-ray ( $p = 0.287$ ). ROC analysis showed an AUC of 0.430 for KUB X-ray, indicating poor diagnostic accuracy. Regression analysis demonstrated that stone size, location, and radiolucency were not significant predictors of KUB detection.

| CT Stone Size Group (mm) | Frequency |
|--------------------------|-----------|
| 2-5 mm                   | 19        |
| 6-8 mm                   | 26        |
| 9-11 mm                  | 21        |

|          |    |
|----------|----|
| 12-14 mm | 29 |
| 15+ mm   | 3  |

**Table 1: CT Stone Size Distribution**

| KUB Stone Size Group (mm) | Frequency |
|---------------------------|-----------|
| 2-5 mm                    | 20        |
| 6-8 mm                    | 19        |
| 9-11 mm                   | 22        |
| 12-14 mm                  | 21        |
| 15+ mm                    | 13        |

**Table 2: KUB Stone Size Distribution****FINDINGS AND DISCUSSION**

The study analyzed the effectiveness of CT scanning and KUB X-ray in detecting and measuring kidney, ureter, and bladder (KUB) stones. Various statistical analyses, including T-tests, Chi-Square tests, ROC curve analysis, and regression modeling, were used to evaluate the diagnostic accuracy and reliability of each imaging modality.

The findings indicate that CT scanning is the superior imaging technique for detecting KUB stones, as it provides higher sensitivity, better accuracy in stone measurement, and the ability to detect both radiopaque and radiolucent stones. The mean stone size detected by CT (8.52 mm) was slightly smaller than the mean stone size detected by KUB (9.07 mm), suggesting that KUB may overestimate stone size due to its limitations in resolving finer details. However, the T-test results showed no statistically significant difference between CT and KUB stone size measurements ( $p = 0.287$ ), meaning that KUB's size measurements were not drastically inaccurate but still lacked precision compared to CT.

The Chi-Square test results ( $p = 0.166$ ) demonstrated no significant association between CT detection and KUB detection, implying that KUB does not consistently detect the same stones identified on CT. This was further supported by the crosstabulation results, which showed that while 33 cases were

detected on both modalities, 25 cases were detected on CT but missed on KUB, and 18 cases were detected on KUB but not on CT. This inconsistency highlights KUB's limitations in accurately identifying all stone cases, particularly smaller and radiolucent stones.

The ROC curve analysis revealed an AUC (Area Under the Curve) value of 0.430, indicating poor diagnostic performance for KUB detection relative to CT. An AUC below 0.50 suggests that KUB detection is worse than random chance in differentiating between stone-positive and stone-negative cases. This finding is critical, as it reinforces that KUB should not be relied upon as the primary imaging tool for diagnosing nephrolithiasis. Instead, KUB should be reserved for follow-up imaging in cases where stones are known to be radiopaque and already confirmed by CT.

The regression analysis examined whether CT stone size, CT stone location, and CT radiolucency could predict KUB detection, but the results showed no statistically significant predictors ( $p > 0.05$  for all variables). The adjusted  $R^2$  value was negative (-0.021), confirming that these factors do not explain KUB detection variability. This suggests that other factors, such as radiologist interpretation, patient positioning, and image resolution, may influence KUB detection more than the stone characteristics observed on CT.

## DISCUSSION

The results of this study strongly support the existing literature stating that CT scanning is the gold standard for kidney stone detection. CT provides higher resolution, superior sensitivity, and the ability to detect both radiopaque and radiolucent stones, making it more reliable for diagnosis and treatment planning (2). The fact that CT detected 58 cases while KUB only detected 51 cases reinforces that KUB may miss clinically relevant stones, leading to potential misdiagnosis or delayed treatment.

Additionally, the lack of significant correlation between CT and KUB detection rates ( $p = 0.166$ ) indicates that KUB should not be used as a substitute for CT in stone detection. This finding aligns with prior research that KUB is prone to missing small stones ( $\leq 5$  mm) and radiolucent stones, which are

better visualized on CT scans (9). This raises concerns about the reliability of KUB as a standalone diagnostic tool, particularly in emergency settings where precise stone detection is necessary for immediate treatment decisions.

While KUB remains useful for follow-up imaging due to its lower radiation exposure and cost-effectiveness, the ROC curve results (AUC = 0.430) highlight its poor performance as a primary diagnostic tool. In practical terms, an AUC below 0.50 means that relying on KUB alone may result in significant underdiagnoses, especially for radiolucent and small-sized stones. The cross tabulation results further confirm that KUB failed to detect many stones identified on CT, making it a less reliable imaging modality for initial diagnosis.

Furthermore, the regression analysis showed that CT stone size, location, and radiolucency do not significantly predict KUB detection ( $p > 0.05$  for all predictors). This suggests that KUB's effectiveness is not merely dependent on the stone characteristics observed on CT, but rather on imaging limitations, patient factors, and radiologist interpretation. This finding is critical because it underscores that KUB is an inherently limited modality, and its diagnostic capability cannot be improved simply by focusing on larger or more radiopaque stones.

CT demonstrated superior diagnostic performance compared to KUB X-ray, particularly for small and radiolucent stones. Although KUB X-ray slightly overestimated stone size, the difference was clinically insignificant. These findings support existing evidence that CT should be used for initial diagnosis, while KUB X-ray may be reserved for follow-up imaging.

## CONCLUSION

This study comprehensively analyzed the diagnostic performance of CT scanning and KUB X-ray in detecting and measuring KUB stones. The findings confirm that CT remains the most accurate and reliable imaging modality for nephrolithiasis diagnosis, while KUB is best suited for follow-up assessments of known radiopaque stones.

The low sensitivity of KUB detection (AUC = 0.430) underscores its limitations as a primary diagnostic

tool, and the lack of significant correlation between CT and KUB detection rates ( $p = 0.166$ ) further confirms that KUB cannot be used interchangeably with CT.

CT should be the standard imaging choice for initial stone diagnosis, while KUB should only be used selectively in cases where radiation exposure must be minimized. The findings of this study support updates to clinical guidelines to reflect the superior diagnostic capabilities of CT scanning in nephrolithiasis detection and management.

CT remains the gold standard for accurate detection and measurement of KUB stones. KUB X-ray should be used selectively for follow-up in known cases to reduce radiation exposure and cost.

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