

Evaluation of the Frequency and Results of Tomography Use in Patients Diagnosed with Renal Colic in The Emergency Department

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Abstract

Objective: An increasing trend in the utilization of computed tomography (CT) imaging has been observed worldwide for patients presenting to emergency departments with acute flank pain and suspected urolithiasis, resulting in significant exposure to ionizing radiation. This study aims to investigate the frequency and indications of CT imaging, as well as the findings and factors influencing these outcomes.

Materials and Methods: This is a retrospective, single-center study. Patients who presented to the emergency department with acute-onset flank pain were diagnosed with renal colic and underwent non-contrast CT were included in the study. Symptoms other than flank pain, demographic data, comorbid conditions, vital signs, laboratory results and CT findings. The frequency and indications for CT imaging were analyzed along with the CT results and factors influencing findings.

Results: A total of 232 patients were included in this study. Despite the presence of urolithiasis, CT imaging was performed in 15.9% of the patients, CT was performed due to accompanying abdominal pain with flank pain. In 15% of the cases, no indication for CT imaging could be identified. Across the entire patient group, the rate of detecting abdominal pathologies that could contribute to morbidity aside from urolithiasis was found to be 4.7%, with acute cholecystitis and appendicitis being the most commonly observed pathologies.

Conclusion: Severe flank pain was observed as the most common reason for obtaining CT imaging. A significant portion of patients, however, had no identifiable indication for CT. Avoiding CT imaging may be advisable in young male patients with a known history of stones and hematuria. More up-to-date guidelines are especially needed to reduce unnecessary CT imaging.

Keywords: CT imaging, emergency department, renal colic

Introduction

Urolithiasis refers to the formation of calculi within the urinary tract, encompassing the kidneys, bladder, and urethra. The estimated lifetime prevalence of urinary stones is approximately 12%, with the condition most frequently observed in individuals aged 30 to 60 years. Moreover, it is reported to be three times more prevalent in men than in women [1]. Acute flank pain associated with urolithiasis constitutes a significant reason for emergency department visits, contributing to over one million consultations annually in the United States [2]. Ureteral hyperperistalsis during stone formation frequently manifests as

acute flank pain, a symptom that, while common in urolithiasis, is non-specific and may be associated with various other conditions [3]. Additionally, irritation and trauma to the ureter can lead to hematuria. A significant complication of urolithiasis is ureteral obstruction, which can result in hydronephrosis. Imaging modalities are essential for diagnosing urinary calculi, as these stones often exhibit non-specific characteristics. Furthermore, imaging plays a crucial role in evaluating differential diagnoses, identifying complications, and assessing the suitability of potential treatment options [3]. Non-contrast computed tomography (CT) has emerged as the predominant



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initial imaging modality for suspected urolithiasis, owing to its high sensitivity, which ranges from 91% to 100% for urinary stone disease [2]. CT is particularly effective in assessing the degree of obstruction caused by ureteral calculi, as it not only confirms the presence and precise location of the stone but also facilitates the identification of other abdominal pathologies. In contrast, renal ultrasonography is generally not a reliable technique for visualizing ureteral stones, often failing to detect stones smaller than 3 mm [4]. This limitation can result in mismanagement in approximately 20% of patients, as ultrasonography provides insufficient information regarding the size and location of the stones [5]. However, unlike other imaging modalities such as ultrasonography, CT subjects patients to significant levels of ionizing radiation, which may increase the long-term risk of cancer [6]. Estimates suggest that some unnecessary abdominal and pelvic CT scans could contribute to cancer development in the United States [2]. Consequently, there is widespread recognition of the need to minimize unnecessary CT imaging for renal colic symptoms. Specifically, the American College of Emergency Physicians recommends limiting CT examinations of the abdomen and pelvis in young, otherwise healthy emergency department patients (aged <50 years) with a known history of urolithiasis who present with symptoms indicative of uncomplicated renal colic [2]. The objective of this study is to evaluate the frequency and indications for CT scanning, the results of these scans, and the factors influencing the findings in patients diagnosed with renal colic, in the emergency department.

Materials and Methods

Study Design

This retrospective study was conducted in the emergency department of a tertiary hospital located in a provincial center that experiences approximately 380,000 patient visits annually. Approval for the study was granted by the local Ankara Atatürk Sanatorium Training and Research Hospital Scientific Studies Ethics Committee under (decision number: 50, date: 24.04.2024). Our research was designed in accordance with the Standards for Reporting of Diagnostic Accuracy Studies statement [7].

Data Collection

Information was extracted from electronic medical records and patient charts. A retrospective chart review was conducted by two emergency medicine specialists, each possessing a minimum of three years of experience. This review included an analysis of clinical and demographic patient characteristics, as well as the results of CT scans.

Study Population

Between January 1, 2021, and December 31, 2023, patients aged 18 years and older who presented to the Emergency Medicine Clinic with flank pain were diagnosed with renal colic,

and underwent non-contrast abdominal CT were included in the study. The inclusion criteria were based on ICD-10 codes (International Statistical Classification of Diseases: N23 and its subcodes, R51) retrieved from the hospital's data system. Patients with a history of trauma, known renal malignancy, or incomplete information were excluded from the study.

Patients' symptoms beyond flank pain such as dysuria, abdominal pain, nausea, vomiting, hematuria, and fever were documented, along with demographic data, comorbid conditions, vital signs, and laboratory results [such as glucose, blood urea nitrogen (BUN), creatinine, white blood cell counts, and an assessment of erythrocytes, leukocytes, and density in a complete urinalysis]. A body temperature of 37.5 °C or higher was classified as a high fever. The indications for CT imaging were categorized as follows: clinical evidence of an associated urinary tract infection, absence of recent kidney stone history, recurrent or persistent severe flank pain in patients over 50 years of age, CT requested by the relevant specialty, presence of oliguria or anuria, and cases suspected to involve complicated renal colic. Complicated renal colic was defined as the presence of fever at presentation, persistent vomiting requiring repeated antiemetic doses, ongoing pain necessitating multiple doses of narcotic analgesics, and a history of underlying urologic or nephrologic disease [2]. It was noted that patients underwent CT scans based on one or more of the defined indications.

CT images were assessed for the presence of stones, hydronephrosis associated with stones, simple cysts, and masses. Patients were divided into two groups based on their non-contrast urinary CT findings: those with urolithiasis (stone positive group) and those without (stone negative group). Concurrently, other abdominal pathologies that could potentially lead to morbidity in the patient were also evaluated on the CT scans. The analysis encompassed CT indications, findings, final diagnoses, and the discharge or hospitalization status of the patients.

Statistical Analysis

Analysis of study data was performed using the IBM SPSS statistical software. The Kolmogorov Smirnov test was used to investigate whether the distribution of discrete and continuous numerical data follows the normal distribution. Continuous numerical variables were shown as median [interquartile range (IQR)], and categorical variables were shown as the number of cases and percentage. Categorical variables were evaluated with chi-square and Fisher's exact test, and continuous variables were evaluated with Mann-Whitney U test. Results for $p < 0.05$ were considered statistically significant.

Results

During the study period, 1,770 patients were diagnosed with renal colic in the emergency department, and urinary CT

was performed in 276 patients (15.6%). Forty-two patients were excluded due to missing data, leaving 232 patients for inclusion in the study. Of these, 69.8% were male, and the median age was 33.2 years [interquartile range (IQR) 22.5]. A total of 88% of the patients had no comorbidities, while 15.9% had a prior history of urolithiasis. Urology consultations were requested for 24.1% of the patients, and 8.6% of those patients were subsequently hospitalized. The demographic data of the patients are presented in Table 1, and the indications for CT and the results are provided in Table 2. The most common indication for CT was severe flank pain. CT was performed for one or more of the predefined indications. Despite a known history of urolithiasis, 15.9% of patients underwent CT. In 7.8% of patients, CT was conducted due to abdominal pain accompanying flank pain. Additionally, 15% of patients underwent CT without a clear indication. The incidence of abdominal pathologies unrelated to urolithiasis that could cause morbidity was 4.7%, with the most common conditions being acute cholecystitis and appendicitis.

A comparison between patient groups with and without stones on CT revealed that the majority of patients with urolithiasis were male. These patients more frequently experienced recurrent or persistent severe flank pain, hematuria, and a positive history of kidney stones ($p=0.009$, $p=0.006$, $p=0.034$, respectively). Upon analysis of laboratory results in patients with urolithiasis detected on CT, higher levels of glucose, BUN, and creatinine were observed, along with an increased presence of erythrocytes in the urinalysis (Table 3), ($p=0.01$, $p=0.009$, $p<0.001$, $p<0.001$ respectively).

Discussion

In this study, which examined the frequency, indications, and outcomes of CT in patients presenting with renal colic in the emergency department, we found that 15.6% of patients with a preliminary diagnosis of renal colic underwent CT. The most common indication for CT was severe flank pain. However, despite the relatively low rate of CT utilization, approximately 15% of patients underwent CT without a clear indication. Additionally, some patients underwent CT despite having a known history of urolithiasis.

In the evaluation of patients presenting to emergency departments with suspected renal colic, CT plays a crucial role due to its high sensitivity for diagnosing urolithiasis, providing detailed information on stone size and location. Additionally, CT is effective in identifying other serious conditions that may mimic renal colic symptoms, such as appendicitis and diverticulitis [8]. However, the widespread use of CT may lead to unnecessary radiation exposure, especially in young patients with recurrent renal colic, potentially increasing long-term health risks. Despite the rising trend in CT utilization, studies have shown no significant changes in hospital admission rates

or surgical interventions, suggesting that CT may not influence clinical management in some cases [2,9]. In a retrospective cross-sectional analysis conducted by Westphalen et al. [10] across 50 states in the USA, 3-year intervals (1996-1998, 1999-2001, 2002-2004, 2005-2007), 3,818 patients were identified, and it was reported that the rate of CT utilization steadily increased over time (4%, 18.3%, 30.8%, 42.5%) [10]. In our study, the CT utilization rate over a 2-year period was 15.6%. The relatively low rate of CT usage in our study was attributed to the careful adherence to symptoms and findings detailed in the methodology section for ordering CT, the setting of the study in a teaching hospital, and the high consultation rate between specialty trainees and expert physicians during

Table 1. Demographic data of patients (n=232)

Age , years, median (IQR)	44 (22.5)
Sex , n (%)	
Male	162 (69.8%)
Co-morbidity , n (%)	
No comorbidity	204 (87.9%)
Hypertension	13 (5.6%)
Diabetes mellitus	8 (3.4%)
Cardiac disease	6 (2.6%)
Urological disease	14 (6%)
Urolithiasis	37 (15.9%)
Others	6 (2.6%)
Symptoms , n (%)	
Unilateral flank pain	206 (88.8%)
Dysuria	96 (41.4%)
Abdominal pain	66 (28.4%)
Nausea/vomiting	55 (23.7%)
Hematuria	42 (18.1%)
Fever	14 (6%)
Others	32 (13.7%)
Vital signs , median (IQR)	
Pulse	88 (15)
Systolic	134 (12)
Diastolic	84 (11)
Temperature	36.2 (0.1)
Laboratory , median (IQR)	
Glucose	107 (29)
BUN mg/dL	33 (13)
Creatinine mg/dL	1.03 (0.43)
WBC	11 (4.1)
Urine analysis	
Erythrocyte	2 (4)
Leukocyte	3 (51)
Density	1014 (16)
Urology consultation	56 (24.1%)
Hospitalization , n (%)	20 (8.6%)
Hospital stay duration , (days) median (IQR)	2 (3)

IQR: Interquartile range, BUN: Blood urea nitrogen, WBC: White blood cell

imaging requests. However, the occurrence of CT scans without clear indications was thought to be because ultrasounds were only available between 08:00 and 16:00 in our hospital.

Many studies in the literature have identified a significant difference in the prevalence of urolithiasis based on gender. According to the European Association of Urology, calcium-containing stones are more common in men, with a male-to-female ratio of 2.7:1 [11]. It is well-established that testosterone plays a key role in stone formation, which likely explains the higher prevalence of urolithiasis observed in male patients in our study.

Urinary system stones have a recurrence rate of 50% within 10 years [12]. In our study, patients with a history of prior stones were significantly associated with having urolithiasis detected on CT. The presence of hematuria was also statistically significant in patients with urolithiasis. However, it is well-documented that 9-33% of patients with stones may not present with hematuria on urinalysis [13,14]. When a patient's history is consistent with renal colic, the presence of hematuria strongly supports urolithiasis as the most likely diagnosis. Repeated CT scans in patients with a known history of stones may have been prompted by complications such as concomitant infection or by requests from consulting clinics for further evaluation. In the literature, a retrospective study evaluating patients with a

known history of urolithiasis, who presented to the emergency department with recurrent symptoms and underwent CT imaging, reported that 82% of the patients were diagnosed with renal colic, with no significant difference compared to their CT findings. Additionally, an alternative non-urgent diagnosis was made in 11.6% of the cases, while 6.5% of the patients were found to have a diagnosis requiring urgent intervention [15].

The literature indicates that CT findings can aid in the identification of abdominal pathologies beyond urolithiasis [12,13]. In a study where a diagnosis other than urolithiasis was established in 9% of all CT scans, only 6.1% of these cases were deemed acutely significant. In our study, non-renal abdominal pathologies that could cause morbidity were detected in 11 patients (4.7%). Previous research has shown that incidental pathologies are more frequently identified in women and geriatric patients [16]. However, in our study, the results may differ due to the predominance of male and younger patients, who constituted approximately 70% of our cohort. The most common pathologies detected were acute appendicitis and acute cholecystitis. It is important to note that non-renal abdominal pathologies can present with symptoms and urinary features that mimic those of renal pathologies. A study by Özen Olcay et al. [17] evaluating the urinalysis of patients with acute appendicitis found a considerable incidence of hematuria.

Inadequate water consumption, dehydration, and hyperglycemia are associated with the formation of urinary stones. Chronic hyperglycemia increases urinary calcium excretion and promotes calcium stone formation. Type 2 diabetes is a strong predictor of uric acid stone formation due to lower urine pH and insulin resistance mechanisms [18]. While low fluid intake is a recognized risk factor for stone disease, increasing fluid consumption may contribute to a reduction in the recurrence of stones. Additionally, renal function tests may be adversely affected in dehydrated patients [19, 20]. In our study, elevated levels of glucose, BUN, and creatinine were significantly associated with pathological findings on CT. This relationship may be attributed to dehydration, which can lead to urolithiasis, resulting in the onset of flank pain in patients.

Study Limitations

Finally, the generalizability of our study is limited because of its design as a single-center audit with a relatively small sample size. Additionally, a limitation arises from the possibility that emergency department physicians may have considered the diagnosis of urolithiasis, however, an alternative discharge ICD diagnosis may have been recorded in the hospital's automated system.

Conclusion

Despite current guidelines, CT is frequently utilized as the initial diagnostic modality for suspected recurrent renal colic.

Table 2. Computed tomography imaging findings

*CT imaging results, n (%)	
No evidence of calculi	75 (32.3%)
Presence of stone	70 (30.2%)
Stone + presence of hydronephrosis	87 (37.5%)
Simple renal cyst	23 (9.9%)
Pathological conditions associated with potential morbidity	
Acute appendicitis	3
Acute cholecystitis	3
Ovarian cyst	2
Acute pancreatitis	2
Renal infarct	1
**Clinical indication for computed tomography	
Severe pain/recurrent analgesic needs	66 (28.4%)
Suspicion of urinary tract infection more than two vomiting	48 (20.7%)
Hematuria	30 (12.9%)
Oliguria	42 (18.1%)
Presence of urolithiasis history	12 (5.2%)
Abdominal pain with flank pain	37 (15.9%)
After consultation	18 (7.8%)
No indication available	30 (12.9%)
	35 (15.1%)
*A patient may have multiple computed tomography findings	
**The patient was referred for computed tomography based on several clinical indications	

Table 3. Analysis of patient groups with and without stones based on computed tomography findings

Characteristic	Urolithiasis positive (n=157)	Urolithiasis negative (n=75)	p
Sex, n (%)			
Male	123 (78.3)	39 (52)	<0.001
Age, years, median (IQR¹)	45 (21)	41 (20)	0.139
Co-morbidity, n (%)			
No comorbidity	20 (12.7)	8 (10.7)	0.650
Hypertension	11 (7)	2 (2.7)	0.232
Diabetes mellitus	6 (3.8)	2 (2.7)	1.000
Cardiac disease	5 (3.2)	1 (1.3)	0.667
Urologic disease	9 (5.7)	5 (6.7)	0.774
Indication for computed tomography, n (%)			
Severe pain/recurrent analgesic suspicion of UTI	53 (33.8)	13 (17.3)	0.009
More than two vomiting	64 (40.8)	32 (42.7)	0.783
Hematuria	22 (14)	8 (10.7)	0.537
Oliguria	36 (22.9)	6 (14.3)	0.006
Presence of urolithiasis history	10 (6.4)	2 (2.7)	0.346
Abdominal pain with flank pain	31 (19.7)	6 (8)	0.034
	15 (9.6)	3 (4)	0.191
Vital signs, median (IQR)			
Pulse	101 (6)	100 (8)	0.433
Systolic	132 (10)	135 (14)	0.215
Diastolic	85 (10)	83 (13.5)	0.802
Temperature	36.6 (0.5)	36.4 (0.3)	0.851
Laboratory, median (IQR)			
Glucose	109 (29)	105.5 (30.3)	0.010
BUN mg/dL	33 (14)	30 (13.5)	0.009
Creatinine mg/dL	1.12 (0.42)	0.92 (0.34)	<0.001
WBC	11.1 (5.13)	10.5 (4.53)	0.220
Urine analysis			
Erythrocyte	7 (80)	1 (5)	<0.001
Leukocyte	2 (4.5)	2 (4)	0.371
Density	1015 (17)	1010 (16)	0.114
Hospitalization, n (%)	16 (10.2)	4 (5.3)	0.317
Hospital stay duration, (days) median (IQR)	2.5 (3.7)	2 (1.5)	0.962

IQR: Interquartile range. UTI: Urinary tract infection, WBC: White blood cell, BUN: White blood cell

Severe flank pain was identified as the most common indication for CT. Notably, a substantial proportion of patients underwent CT scans without a clear indication. It may be advisable to avoid CT imaging in young male patients with a known history of urolithiasis and hematuria. There is a pressing need for updated guidelines to minimize unnecessary CT imaging, particularly in this patient population.

Ethics

Ethics Committee Approval: Approval for the study was granted by the University of Health Sciences Türkiye, Ankara Atatürk Sanatorium Training and Research Hospital Scientific Studies Ethics Committee under (decision number: 50, date: 24.04.2024).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Y.Y.A., E.E., Z.H.T., Y.Ç., Concept: Y.Y.A., E.E., H.Ö.O., Z.H.T., Y.Ç., Design: Y.Y.A., E.E., H.Ö.O., Z.H.T., Y.Ç., Data Collection or Processing: Y.Y.A., E.E., Z.H.T., Analysis or Interpretation: Y.Y.A., E.E., H.Ö.O., Y.Ç., Literature Search: Y.Y.A., E.E., H.Ö.O., Z.H.T., Writing: Y.Y.A., E.E., Y.Ç.

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