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External Validation of CHOKAI and STONE Scores for Detecting Ureter Stones in the Eastern Turkish Population

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What's known on the subject? and What does the study add?

It is known from previous studies that STONE and CHOKAI scores are effective in predicting ureteral stones in patients with renal colic. In our study, we showed that the CHOKAI score is more sensitive and specific than the STONE score in predicting ureteral stones.

Abstract

Objective: To investigate the effectiveness of CHOKAI and STONE scoring systems in predicting ureter stones in patients admitted to emergency and urology departments.

Materials and Methods: This was a single-center prospective observational study. Patients over the age of 18 years with back, flank, or lower abdominal pain and suspected of ureteral stones and performed non-contrast abdominal computed tomography for diagnostic imaging were included. Each patient's CHOKAI and STONE score was calculated on their medical interviews and physical and laboratory findings. Receiver operating characteristic analysis was used for the sensitivity and specificity of the scoring systems at optimal cut-off values.

Results: Of the 348 patients in the study, 228 were detected with ureteral stones. For the CHOKAI score, the area under the curve (AUC) at an optimal cut-off point of 8 was 0.923 [95% confidence interval (CI), 0.894-0.952], with a sensitivity of 0.842, and specificity of 0.975, a positive likelihood ratio (LR+) of 33.68, and a negative likelihood ratio (LR-) 0.162. For the STONE score, the AUC at an optimal cut-off point of 9 was 0.847 (95% CI, 0.807-0.887), with a sensitivity of 0.697 and specificity of 0.900, an LR+ of 6.97, and an LR- 0.336.

Conclusion: The CHOKAI score is more sensitive and specific than the STONE score in predicting ureteral stones. Using the CHOKAI score in routine practice will reduce radiation exposure and cost and prevent time loss for serious differential diagnosis.

Keywords: Renal colic, ureter stone, scoring system

Introduction

Flank pain due to ureteral stones is essential for admission to the emergency department (ED) and urology clinics. Its lifetime prevalence is approximately 10-15% (1). In this population, the need for urological intervention in the early period is around 10% (2). The non-contrast helical computed tomography (NCCT) is the most sensitive radiological tool for detecting urinary system stone disease (3). Whereas, repeated computed tomography (CT) scans cause increased radiation exposure, as recurrence rates of ureterolithiasis are high.

Moore et al. (4), for predicting ureter stones created the STONE score to reduce CT-related radiation toxicity. It includes the following five parameters between 0-13 points: Gender, timing, ethnicity, nausea/vomit, and microscopic hematuria (Table 1). This score divides patients into low (0-5), moderate (6-9), and high (10-13)-risk categories for the probablity of ureteral stones. After that, a low-dose CT protocol was developed to reduce radiation exposure of intermediate and high-risk groups on the STONE score (5). It also showed the need for alternative diagnoses for low-risk group. The addition of hydronephrosis detected by ultrasound (US) to the STONE score, STONE-

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plus was developed and further strengthened for detecting ureteral stones (6). Ethnic variation (black and non-black) was a restricting issue in STONE scoring, and it was stated that hydronephrosis concurrently encouraged the diagnosis. Due to these limitations, a new scoring named CHOKAI was produced. The CHOKAI scoring consists of age, sex, pain duration, nausea/vomit, microscopic hematuria, hydronephrosis and history of urolithiasis (Table 1). The sensitivity and specificity of the CHOKAI scoring for determining urolithiasis were 93%, and 90%, respectively (7).

Because of the large number of patients presenting to ED and urology clinics with flank pain, these scoring systems are valuable in facilitating differential diagnosis and reducing increased radiation exposure. Therefore, our aim was to investigate the efficacy of these scoring systems in predicting ureterolithiasis in our patient population.

Materials and Methods

This prospective study was conducted in our clinic between November 2020 and January 2022. The Local Institutional Ethics Committee approved the study (approval number: 2020/01.01). Patients who applied to the emergency and urology departments with lower abdominal, back or flank pain and underwent NCCT were included in the study. Patients under 18 years of age, with unstable vital signs, urinary stone surgery history (within one year), trauma, under urological treatment, referred from other hospitals for urolithiasis treatment, insufficient examination, active malignancy, and declining to participate in the study were excluded.

Table 1. CHOKAI and STONE score categories

Category	Characteristic	Points	
		CHOKAI score	STONE score
Age	≥60 years	0	-
	<60 years	1	-
Gender	Female	0	0
	Male	1	2
Race	Black	-	0
	Non-black	-	3
Duration of pain to presentation	>24 h	0	0
	6-24 h	0	1
	<6 h	2	3
Nausea and vomiting	No	0	0
	Only nause	1	1
	Vomiting	1	2
Urinary stone history	No	0	-
	Yes	1	-
Microscopic hematuria	No	0	0
	Yes	3	3
Hydronephrosis on US	No	0	-
	Yes	4	-
Total points		0-13	0-13

US: Ultrasound

After the study protocol was established, a questionnaire was created asking questions about the pain duration, nausea/vomiting, previous history of urinary stone, and informed consent of patients or their caregivers. Urinalysis was then performed to investigate microscopic hematuria. US examination was performed using Mindray DC-7 (Shenzhen Mindray Bio-Medical Electronics Co., Ltd, Shenzhen, China) to detect hydronephrosis. After the initial US was performed, the physician recorded findings, and NCCT imaging was applied to approve the determination of urolithiasis. NCCT reported by the radiologist was approved as the definitive diagnosis. NCCTs were reported by the responsible radiologist on the day of the procedure. NCCT scans were reviewed by the relevant researchers concurrently with the report. Radiologists were unaware of initial US findings; NCCT reports routinely reported with prediagnosis of urolithiasis. After making a definitive diagnosis, CHOKAI and STONE scores were calculated and entered into the forms.

Statistical Analysis

All statistical analyzes were performed using SPSS Statistics software version 26.0 (IBM, Armonk, NY, USA). Categorical variables were expressed as numbers and percentages. Continuous variables are indicated as appropriate means and standard deviation, or median and interquartile range. Receiver operator characteristics (ROC) curve defined optimal thresholds via area under the curve (AUC). The Youden index was used to define the optimum cut-off values of the CHOKAI and STONE scores for predicting of ureterolithiasis, at maximum sensitivity and specificity. Positive likelihood ratio (LR+), and negative likelihood ratio (LR-) also were calculated at the optimal cut-off scores. P-value <0.05 was defined as statistical significance.

Results

Of the 388 eligible patients, 40 were excluded; thus, final analyses were performed with 348 patients (Figure 1). Ureteral stones were present in 228 (65.5%) patients in NCCT, and no stones were detected in 120 (34.5%) patients. The demographic and clinical characteristics of patients are demonstrated in Table 2. All the participants were of non-black ethnicity. The mean age was 36.7±13.4 years. The number of male patients was 225 (64.7%), and the number of female patients was 123 (35.3%).

The ROC curve analysis was used for the diagnostic accuracy of the CHOKAI and STONE scores (Figure 2). The optimum cut-off

value for the CHOKAI score was assigned to be 8, with an AUC of 0.923 [95% confidence interval (CI) 0.894-0.952]. The highest sensitivity was 0.842, specificity was 0.975, LR+ was 33.68, and LR- was 0.162. The optimum cut-off value for the STONE score was assigned to be 9, with an AUC of 0.847 (95% CI, 0.807-0.887). The highest sensitivity was 0.697, specificity was 0.900, LR+ was 6.97, and LR- was 0.336 (Table 3).

Of 120 patients without ureteral stones, 117 were estimated correctly in the CHOKAI scoring system and 108 in the STONE scoring system. One hundred ninety-two patients with the CHOKAI scoring and 159 patients with the STONE scoring were classified correctly in patients with ureteral stones. According to the STONE score risk categories, ureteral stone diagnosis rates were 37.5% in the low-risk group, 52.5% in the moderate risk group and 97.7% in the high-risk group, respectively (Table 4).

Discussion

The present study found that both CHOKAI and STONE scores have good performance for detecting ureteral stones in our flank pain patient population. However, the CHOKAI score has better results due to its higher sensitivity and specificity.

The presence of hydronephrosis in the US has a significant 4-point effect on the 13-point CHOKAI scoring. In the STONE plus study, Daniels et al. (6) added US to the STONE scoring system. They reported that the US increased the rate of diagnosing ureteral stones, especially in low and moderate-risk groups (6). However, Sternberg et al. (8), reported that the detection of hydronephrosis on US was not specific for ureteric stones and they focused on the need for NCCT because stone size and location give significant data for ureter stone management. However, the cumulative radiation exposure and cost burden from repetitive CT must be considered. Sternberg et al. (8) believed that the STONE scoring system could be helpful in determining the imaging modality. For increased radiation exposure when diagnosing ureterolithiasis, the European Association of Urology and the American Association of Urology encourage the use of low-dose CT, which has similar sensitivity and specificity as NCCT (9,10). By using the STONE score Moore et al. (5), produced beneficial criteria for using low-dose CT.

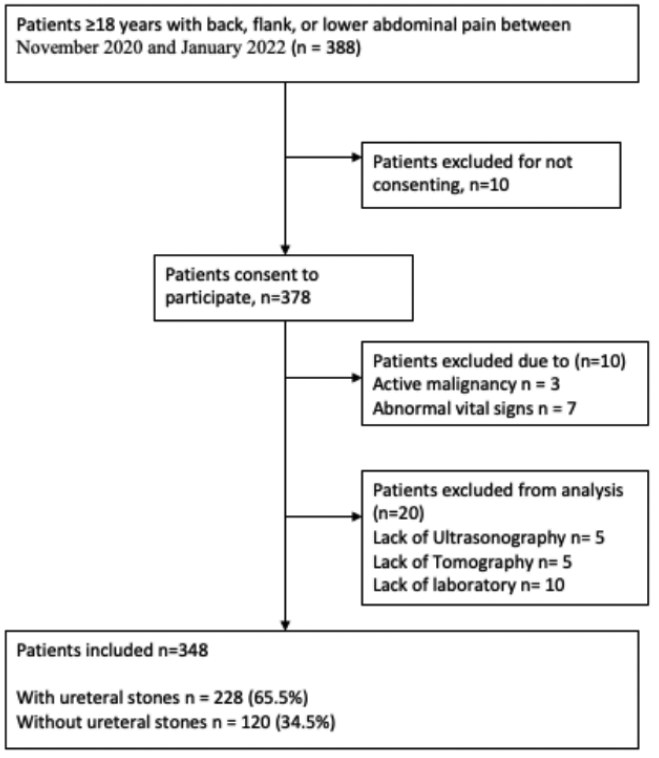

Figure 1. The flowchart of patient inclusion and exclusion criteria

In a retrospective study conducted with 157 Turkish patients, the effectiveness of STONE, modified STONE, and CHOKAI scores were analyzed. The specificity and sensitivity values of STONE, modified STONE, and CHOKAI scores for the diagnosis of ureteral stones were 64.71, 71.70; 70.59, 87.74; and 66.67, 90.57, respectively, and the CHOKAI showed the best performance (11). In addition, the effectiveness of STONE and CHOKAI scores was evaluated in a recent prospective study conducted on a Turkish population of 105 patients. They reported that the AUC for the CHOKAI score was 0.788 (95% CI: 0.697-0.862, p<0.001) and 0.615 (95% CI: 0.515-0.709, p=0.087) for the STONE score and the CHOKAI score has a better diagnostic accuracy than the STONE score (12). Similarly, in our study in the eastern Turkish patient population, the sensitivity and specificity of the CHOKAI and STONE scores for predicting ureteral stones were 0.842, 0.975, and 0.697, 0.900, respectively. The absence of black patients can explain the low effectiveness of the STONE score in our and other Turkish societies.

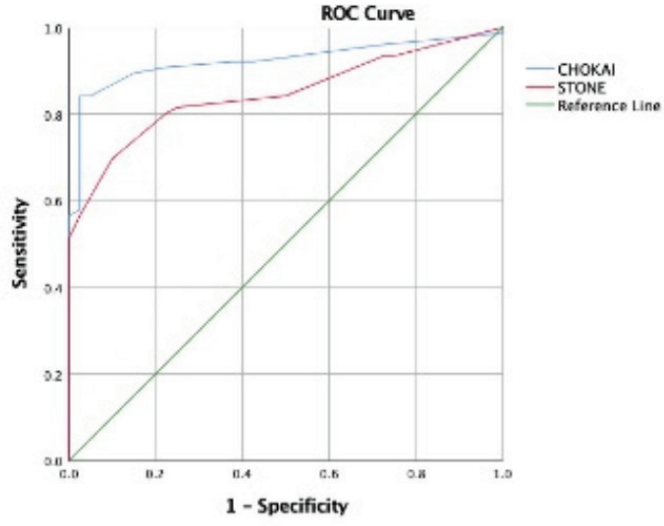

Figure 2. The area under the curve with receiver operating characteristic curves of the CHOKAI and STONE scores at the optimal cut-off point

For an ideal diagnostic test, LR+ is >10 and/or LR- <0.1 (13). Fukuhara et al. (7), in their multicenter prospective study, reported LR+ of 9.3 (95% CI, 3.7-23) and LR- of 0.079 (95% CI, 0.036-0.17) in the CHOKAI score for an optimum cut-off value of 6 and stated that "it is a good prediction test for ureterolithiasis". But the reported LR+ value was below 10. However, in our study, the optimal cut-off value for the CHOKAI score was 8, with LR+ 33.68 and LR- 0.162. Therefore, we can advocate stronger that the CHOKAI score is an ideal diagnostic test with these data. The larger sample size in our study than in other studies may have contributed to this difference. However, the other studies were generally managed only in ED, and in our research, all US and patient evaluations were performed by specialist urologists in the urology clinic. Therefore, it might be another factor affecting the results.

Table 2. Demographic and clinical characteristics of the patients

	Stone group (n=228)	No stone group (n=120)	Total (n=348)
Age (years), mean ± SD	37.7±13.7	34.8±12.5	36.7±13.4
Gender, n (%)			
Male	165 (72.4)	60 (50)	225 (64.7)
Female	63 (27.6)	60 (50)	123 (35.3)
Race, n (%)			
Black	0		
Non-black	228 (100)	120 (100)	348 (100)
Duration of pain to presentation, n (%)			
>24 h	66 (28.9)	72 (60)	138 (39.7)
6-24 h	30 (13.2)	12 (10)	42 (12.1)
<6 h	132 (57.9)	36 (30)	168 (48.3)
Nausea and vomiting, n (%)			
No	129 (56.6)	96 (80)	225 (64.7)
Only nause	27 (11.8)	12 (10)	39 (11.2)
Vomiting	72 (31.6)	12 (10)	84 (24.1)
Urinary stone history, n (%)			
No	114 (50)	96 (80)	210 (60.3)
Yes	114 (50)	24 (20)	138 (39.7)
Microscopic hematuria, n (%)			
No	36 (15.8)	105 (87.5)	141 (40.5)
Yes	192 (84.2)	15 (12.5)	207 (59.5)
Hydronephrosis on US, n (%)			
No	18 (7.9)	114 (95.0)	132 (37.9)
Yes	210 (92.1)	6 (5.0)	216 (62.1)
CHOKAI score, median (IQR)	11 (3)	2 (3)	9 (9.75)
STONE score, median (IQR)	11 (4)	5.5 (3.5)	8 (6)
Disposition, n (%)			
Hospitalization	16 (7.0)	26 (21.7)	42 (12.1)
Discharge	212 (93.0)	94 (78.3)	306 (87.9)

SD: Standard deviation, IQR: Interquartile range

Table 3. Diagnostic accuracy of the CHOKAI and STONE scores at the optimal cut-off score

Score (optimal cut-off value)	AUC (95% CI)	Sensitivity	Specificity	LR+	LR-	p
CHOKAI (8)	0.923 (0.894-0.952)	0.842	0.975	33.68	0.162	<0.001
STONE (9)	0.847 (0.807-0.887)	0.697	0.900	6.97	0.336	<0.001

LR+: Positive likelihood ratio, LR-: Negative likelihood ratio, CI: Confidence interval, AUC: Area under the curve

Table 4. External validation of STONE score distribution and risk category diagnosed with ureteral stone		
STONE score risk category	**STONE score distribution n (%)**	**Ureteral stone validating with STONE score n (%)**
Low risk (0 to 5 points)	96 (27.6)	36 (37.5)
Moderate-risk (6 to 9 points)	120 (34.5)	63 (52.5)
High-risk (10 to 13 points)	132 (37.9)	129 (97.7)

Study Limitations

Our study has some limitations:

1. It was conducted single-center, and only eastern Turkish patients were included. Thus, the features of the CHOKAI may vary in different populations.

2. This study was carried out during the daytime working hours when the researchers were actively working. Therefore, it does not reflect the entire patient population in the emergency or urology departments.

3. The US is an operator-dependent modality, so that it may have affected the study results.

Conclusion

Both CHOKAI and STONE scores effectively diagnose when ureteral stones are suspected. However, the CHOKAI score is more sensitive and specific than the STONE score predicting ureteral stones. Therefore, using the CHOKAI score in routine practice will reduce radiation exposure and cost and prevent time loss for serious differential diagnosis.

Ethics

Ethics Committee Approval: This prospective study was conducted in our clinic between November 2020 and January 2022. The Local Institutional Ethics Committee approved the study (approval number: 2020/01.01).

Informed Consent: Prospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.O., E.D., Concept: F.O., Design: F.O., Data Collection or Processing: E.D., Analysis or Interpretation: F.O., Literature Search: F.O., E.D., Writing: F.O.

Conflict of Interest: No conflict of interest was declared by the authors.

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