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Evaluation of the Shetty test to exclude fractures in patients with ankle injury in the emergency department

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ABSTRACT

Aims: Ankle sprains are a leading cause of emergency department (ED) admissions. This study aimed to compare the diagnostic performances of the Shetty test (ST) and Ottawa Ankle Rules (OAR) in excluding fractures among patients with traumatic ankle injuries.

Methods: This prospective study included 216 patients who presented to the ED. The sensitivity, specificity, predictive values, and accuracy of both ST and OAR were calculated and compared with radiographic findings.

Results: Fractures were detected in 55 (25%) patients in the study. For the ST, the sensitivity, specificity, and accuracy were 96.4 %, 61.5%, and 70.37 %, respectively. For the OAR, the sensitivity, specificity, and accuracy were 85.5%, 16.1%, and 33.80%, respectively. ROC analysis showed a significantly higher area under the curve (AUC) for ST (0.794) than for OAR (0.638) ($p<0.001$).

Conclusion: ST demonstrated superior sensitivity and specificity compared to OAR, suggesting that it is a valid and efficient method for determining the necessity of radiography in ankle injuries.

Keywords: Shetty test, ankle injury, Ottawa Ankle Rules, emergency medicine

INTRODUCTION

Ankle sprains are the most common cause of admission to the emergency department (ED).[1] The severity of ankle injuries may range from minor ligamentous sprains to severe fractures.[2] Following a physical examination, up to 80% of patients undergo radiography. However, clinically significant bone pathology is identified in only 15-20% of these patients.[3] In other words, if radiographic examinations were performed on all patients, 80% of patients would have undergone unnecessary radiographs. A number of decision-making tools have been formulated to reduce unnecessary radiation exposure of patients, as well as the length of waiting times in the ED and the unnecessary use of ED resources.[4]

The Ottawa Ankle Rules (OAR) is the most prevalent clinical decision-making instrument utilized globally for ankle damages.[4,5] A substantial body of investigation has been performed on OAR in a range of geographical contexts, with a substantial decline in the reliance on imaging.[6-8] Although OAR remains the current gold standard for imaging decision-making, it is assumed that the necessity for imaging in ankle trauma can be further reduced with the ST.[9] Given that the ST is more straightforward to implement than other tests, it is postulated that it may be more suitable for primary healthcare institutions and ED.[4] The Shetty test (ST) was first described by Shetty et al.[9] It is performed by having the patient seated with the plantar aspect of the injured foot on the physician's palm. If the patient is unable to perform the test or experiences increased pain, the result is considered to be positive. A positive test result indicated the possibility of an ankle fracture. If the patient is able to step, the test result is negative, indicating that radiography is not indicated.

Only a few studies have investigated the effectiveness of ST in the relevant literature.[9,10] Furthermore, only two studies in the literature have compared it with OAR.[4,11] This study aimed to compare the usefulness of OAR and ST in predicting fractures in patients with ankle injury.

METHODS

This study was conducted on patients who had sustained ankle injuries and presented at the authors' institution between 14/03/2019 and 26/08/2021. This study was approved by the Ethics Committee for Clinical Researches at Antalya Training and Research Hospital (Date: 25.07.2019, Decision No: 17/11). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The authors followed the applicable EQUATOR Network (https://www.equator-network.org/) guidelines during the conduct of this research project.

Patients who received pain medication, pregnant patients, patients who were uncooperative or unconscious, patients with isolated toe injuries and open fractures, patients who were admitted for a period exceeding 24 h, and patients who were unable to consent were excluded from the study.

The chart in **Figure 1** was used during patient evaluation. During the strategy, the patient's age, gender, OAR and ST results, X-ray results, and treatment outcomes were documented on the patient follow-up form. Prior to the commencement of the study, emergency physicians (EPs) underwent training in ST and OAR. Subsequently, they were tasked with recruiting patients for the study. The EP performed the OAR at the time of admission. Subsequently, the same EP administered the ST after the patient was placed on a stretcher. A radiologist subsequently analyzed the X-ray images. The patients were evaluated according to their sex, mechanism of injury, OAR Test results, ST results, and radiographic imaging results. Patients with fractures were evaluated by orthopedic surgeons and informed about their subsequent treatment plans.

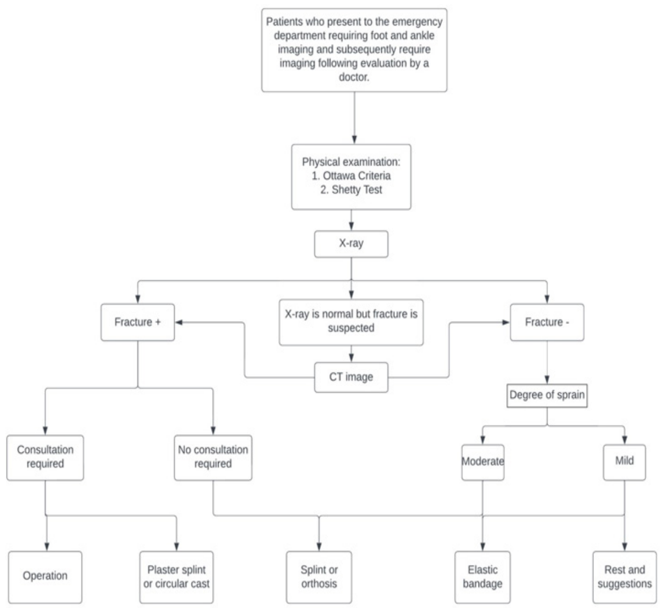

Figure 1. The patient evaluation methodology in study flowchart

According to the OAR, ankle radiographs are performed in the presence of pain on the distal 6 cm of the posterior edge of either malleolus and/or incapability to bear weight immediately after the injury or to take four steps in the ED. Foot images were obtained if there was bone tenderness at the base of the fifth metatarsal bone or over the navicular bone.[5] The ST was applied when the patients were seated with their feet unsupported and their knees flexed. The provider's hand helped the plantar aspect of the injured foot, and the patient was instructed to "push his feet down" to achieve plantar flexion at the ankle, affecting weight bearing (**Figure 2**). Should the pain level escalate or should the test not be conducted, the result will be deemed positive. Conversely, the test was considered negative if the pain level remained unchanged. Subsequently, the patient was invited to undergo an ankle radiograph to exclude the possibility of a fracture. Subsequently, the results were compared with the radiographic results.

Figure 2. Shetty test technique demonstration: The physician supports the entire foot while instructing the patient to push the foot downwards simulating "weight-bearing"

Sample Size

A power analysis was conducted to determine the required sample size. A total of 150 patients were required to achieve 80% power, a p-value of less than 0.05, and a moderate effect size. The study included 312 patients, which was 30% more than the sample size. Ninety-six patients who met the exclusion criteria were excluded, resulting in 216 patients being included in the study.

Statistical Analysis

The data collected for analysis were analyzed using SPSS (version 21). After determining the types of data, descriptive statistics for categorical data were conducted, and percentage and frequency information was presented. The Chi-square test was used to analyze categorical data. For data exhibiting a normal distribution as determined by distribution, the mean and standard deviation were used for description. The Chi-square test was employed to compare categorical data, while the t-test was used to analyze numerical data. Following the Chi-square and Fisher's exact tests, the observed comparison ratios were identified, and the McNemar test was used to analyze the strength of the tests. A p-value of less than 0.005 was considered significant for the data.

RESULTS

The study included 216 patients who met the previously described inclusion criteria. The analysis population consisted of 96 (44.4%) female and 120 (55.6%) male participants, with a mean age of 34.17±15.46 years (range: 7-72 years). Direct trauma was the most prevalent mechanism of injury, affecting 102 individuals (47.2%), followed by inversion (38%), eversion (6.02%), plantar flexion (5.09%), and other mechanisms (3.7%). A total of 115 patients (53.2%) exhibited ST (+), 101 patients (46.8%) exhibited ST (–), 182 patients (84.3%) exhibited OAR (+), and 34 patients (15.7%) exhibited OAR (–).

In the radiographic evaluation, a fracture was identified in 55 (25%) patients, whereas no fracture was observed in 161 (75%) patients. Of the patients, 40 (72.7%) exhibited fractures in the foot zone, including the 5th metatarsal, calcaneus, navicular, cuneiform, and cuboid bones. In the ankle area, lateral malleolus fractures were identified in 11 patients (20%), medial malleolus fractures in 3 patients (5.4%), and distal tibia fractures in 1 patient (1.8%). Regarding disposition, of the 210 patients discharged from the ED, 117 received medical treatment and 93 were splinted. Six patients were admitted to the hospital and underwent a surgical intervention. Table 1 presents the patient characteristics and clinical data.

Table 1. Demographic and clinical data of the patients

Variables		n	%
Number of patients		216	100
Age (years)		34±15.46	
Sex	Female	96	44.44
	Male	120	55.56
Mechanism of injury	Direct trauma	102	47.2
	Inversion	82	38
	Eversion	13	6.02
	Plantar flexion	11	5.09
	Other	8	3.7
OAR	Negative	34	15.7
	Positive	182	84.3
ST	Negative	101	46.8
	Positive	115	53.2
Fracture on X-ray	Negative	161	75
	Positive	55	25
Fracture type*	Tibia distal	1	1.8
	Lateral malleol	11	20
	Medial malleol	3	5.4
	Cuneiform	3	5.4
	5th metatarsal	28	50.9
	Navicular	4	7.3
	Calcaneus	3	5.4
	Cuboid	2	3.6
Treatment	Medical	117	54.2
	Splint	93	43
	Hospitalization and surgery	6	2.8

OAR: Ottawa Ankle Rules, ST: Shetty test. * Percentages in this section were calculated for 55 patients with fractures

The patients were categorized into two groups: those with and without fractures. After performing the ST and OAR, the outcomes were compared between the two groups. The ST was positive in 96.4% of patients with fractures and 38.5% of patients without fractures. Conversely, the ST was negative in 61.5% of patients without fractures and in 3.6% of patients with fractures. The differences in the ST results between the groups were statistically significant (p<0.001). Negative OAR results were found in 16.1% of patients without fractures and 14.5% of patients with fractures. The OAR positivity rate was 83.9% in the non-fracture group and 85.5% in the fracture group, with no statistically significant differences between the groups (p=0.778). Pearson Chi-square analysis indicated a statistically significant difference in patients undergoing the Shetty and Ottawa tests based on the presence or absence of radiological fractures (p<0.001) (Table 2).

Table 2. Distribution and comparison of patients with and without fractures

Test		Fracture (n=55)	Non-fracture (n=161)	p value
ST	Positive	53 (96.4)	62 (38.5)	<.001*
	Negative	2 (3.6)	99 (61.5)	
OAR	Positive	47 (85.5)	135 (83.9)	0.778*
	Negative	8 (14.5)	26 (16.1)	

OAR: Ottawa Ankle Rules, ST: Shetty test. *Pearson's Chi-squared test

After our analysis, the sensitivity and specificity of the two tests, along with PPV, NPV, and LR values, were determined. The ST showed a sensitivity of 96.4%, specificity of 61.5%, PPV of 46.1%, NPV of 98%, positive LR of 2.504, negative LR of 0.059, and an accuracy of 70.37% (Figure 3). For OAR, the sensitivity, specificity, PPV, NPV, positive LR, negative LR, and accuracy were 85.5 %, 16.1%, 25.8%, 76.5%, 1.02, 0.90, and 33.80 %, respectively (Figure 4).

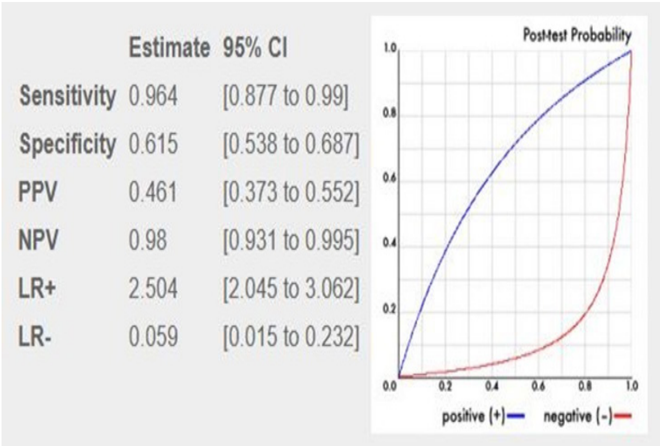

Figure 3. Sensitivity, specificity, PPV, and NPV values indicating the success of the ST in predicting the need for radiography
CI: Confidence interval, ST: Shetty test, PPV: Positive predictive value, NPV: Negative predictive value, LR+: Likelihood ratio for a positive test result, LR-: Likelihood ratio for a negative test result

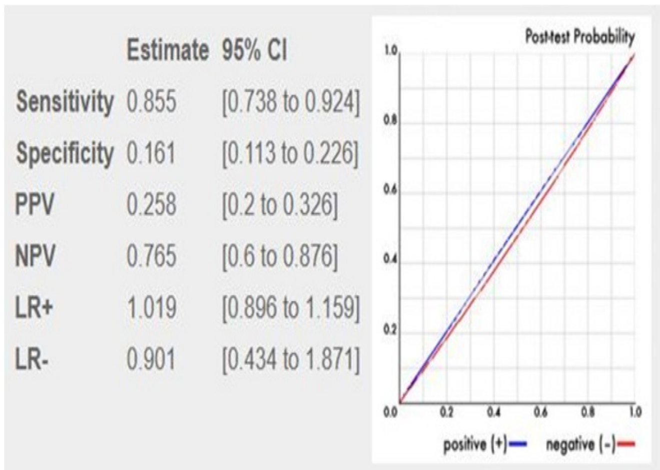

Figure 4. Sensitivity, specificity, PPV, and NPV values indicating the success of the OAR in predicting the need for radiography
CI: Confidence interval, OAR: Ottawa Ankle Rules, PPV: Positive predictive value, NPV: Negative predictive value, LR+: Likelihood ratio for a positive test result, LR-: Likelihood ratio for a negative test result

To evaluate the efficacy of the two tests, receiver operating characteristic (ROC) analysis was conducted (Table 3). The area under the curve (AUC) for the ST was 0.794±0.022 (95% CI, 0.750-0.838), while the AUC for the OAR test was 0.638±0.026 (95% CI, 0.586-0.690) ($p<0.001$).

Table 3. The ROC analysis of the tests in prediction of fracture

	AUC	SE	%95 CI	p value
Shetty	0.7946	0.02244	0.7506 to 0.8386	<0.001
OAR	0.6382	0.02666	0.5860 to 0.6905	<0.001

ROC: Receiver operating characteristics, AUC: Area under the curve, SE: Standard error, CI: Confidence interval, OAR: Ottawa Ankle Rules

DISCUSSION

Ankle sprains are common among the general population, and their treatment is a standard procedure in the ED.[12] To manage ankle sprains, clinicians utilize a combination of physical examinations and radiographic evaluations. Comprehensive palpation of the injured ankle is essential for evaluating the surrounding anatomical structures. In certain circumstances, patients are promptly transferred to the radiology department.[9] In certain instances, the presence of significant swelling may render the examination of the ankle more challenging.[13] Therefore, it is crucial to identify techniques that can be used to evaluate the necessity of radiographs.

To exclude fractures, patients have traditionally undergone plain radiography. However, clinically important fractures are observed in only 15% of cases.[14] Therefore, the primary concern at this juncture is the potential for unnecessary radiation exposure.[15] Stiell et al.[5] formed the OAR to predict the necessity of radiographs in acute ankle damage and to avoid unnecessary imaging. The OAR defines a time- and resource-saving approach that effectively prevents unnecessary radiation exposure in patients. In the ED, it is evaluated that applying these guidelines for patients with acute ankle injuries will reduce unneeded radiographs by 30-40%.[2] Nevertheless, despite their efficacy, the widespread implementation of OAR has not been successful due to the complexity of certain components of the test.[16-22]

In 2013, Vijay Shetty developed a clinical trial, designated the ST, which is straightforward to achieve, cost-effective, and minimizes the potential radiation danger.[9] Although OAR is currently the gold standard for screening before imaging, it is postulated that the ST, a simple physical examination technique, will safely reduce the need for imaging in ankle trauma.[10] Ojeda et al.[21] demonstrated that the ST is a straightforward, quick, and reproducible clinical screening tool for determining whether radiography is indicated in foot and ankle damage. In this study, the sensitivity, specificity, PPV, and NPV of ST were 100%, 95%, 71%, and 100%, respectively. In a separate study involving 50 patients with ankle injuries, the sensitivity of ST in detecting fractures was 100%, specificity was 91.4%, PPV was 42.8%, NPV was 100%, and the diagnostic accuracy of the test was 92%.[9] In our study, the sensitivity of ST in detecting fractures was 96.4%, which is similar to the findings in the literature. However, its specificity was 61.5%, which differs from that reported in the literature.

A review of the publications reveals a paucity of studies that have reached the performance of OAR and ST in patients with ankle trauma who were admitted to the ED.[4,11] In a study instructed by Ak et al.[11] demonstrated that the performance of the OAR and ST in patients with ankle trauma admitted to the ED was reached. In their study, the sensitivity of the OAR was 97.22%, specificity was 48.89%, PPV was 50.36%, NPV was 97.06%, positive LR (LR+) was 1.9, and negative LR (LR+) was 0.06. The sensitivity and specificity of ST were 51.39% and 85.93%, respectively. PPV was 66.07%, NPV was 76.82%, and the positive (LR+) and negative (LR-) likelihood ratios were 3.65 and 0.57, respectively. Therefore, owing to its high sensitivity (97.2%), the OAR can be used as a screening tool for ankle trauma. However, ST was inadequate for ruling out ankle fractures. In a study conducted by Avınca et al.[4] reported the OAR sensitivity was 85.71%, specificity was 82.61%, PPV was 60%, NPV was 95%, positive (LR-) of 4.93, negative (LR-) of 0.17, and overall accuracy was 83.33%. The sensitivity and specificity of ST were 82.86% and 77.39%, respectively. The PPV was 52.73%, NPV was 93.68%, and the positive (LR+) and negative (LR-) likelihood ratios were 3.66 and 0.22, respectively. The overall accuracy was 78.67%. Although the sensitivity of the ST and OAR resulted in similar percentages (82.86 vs. 85.71%), the specificity of the OAR was higher. The authors further suggested that a combined test method could be employed based on the findings of recent studies.

In our study, the sensitivity and specificity of ST were superior to those of OAR (96.4 vs. 85.5% and 61.5 vs. 16.1%, respectively). In our study, fractures were detected in only two of 101 patients with a negative ST, whereas fractures were detected in eight of 34 patients with a negative OAR assessment. This indicates that the NPV of ST is superior to that of OAR in ruling out fractures. A comparison between the ST and OAR informed that the ST was more useful than the OAR in detecting fractures ($p<0.0001$).

Limitations

It is important to consider the limitations of this study, which include the following: First, the patient population was limited to those presenting to the ED of a single hospital, which may limit the generalizability of our findings. Furthermore, all ST and OAR assessments were conducted by EPs in a single setting, which could potentially introduce bias related to the specific practices and protocols of that institution. The observation period did not include any children or toddlers. Another limitation of this study is its reliance on radiographic imaging as the definitive method for diagnosing fractures. This approach may not capture all the clinically significant injuries.

CONCLUSION

This study shows that ST exhibits higher sensitivity and specificity than OAR in predicting the necessity of radiographic imaging for patients with ankle injuries. The simplicity and ease of use of ST make it a viable option for primary healthcare settings and ED, potentially reducing unnecessary radiation exposure and optimizing resource utilization. While the ST shows promise as an effective clinical decision-making tool, further multicenter studies with larger and more diverse patient populations are necessary to confirm its generalizability and robustness of the results. Incorporating both ST and OAR into clinical practice could enhance the accuracy of ankle fracture diagnosis, thereby improving patient outcomes and streamlining emergency care protocols.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study was approved by the Ethics Committee for Clinical Researches at Antalya Training and Research Hospital (Date: 25.07.2019, Decision No: 17/11).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights—including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: CD, FY, ÖK; Design: CD, FY, ÖK, ÖZ; Control: CD, FY, CK; Resources: CD, FY, YFY, TAD; Materials: CD, FY, EDA; Data Collection and/or Processing: CD, FY, EDA; Analysis and/or Interpretation: FY, CK, IB; Literature Review: FY, CK, YFY; Writing the Article: CD, FY, TAD; Critical Review: FY, CK, IB, FYF.

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