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The Shetty Test's Performance in Predicting Fractures in Radiography for Pediatric Patients

Seval Komut,[1] Burcu Doğan,[2] Ali Kemal Erenler[1]

[1]Department of Emergency Medicine, Hitit University Faculty of Medicine, Çorum, Türkiye
[2]Department of Emergency Medicine, Erol Olçok Training and Research Hospital, Çorum, Türkiye

ABSTRACT

Objective: The objective of this study was to determine the diagnostic performance of the Shetty test (ST) in predicting fractures in pediatric ankle trauma and to prevent unnecessary radiation exposure in these cases.

Materials and Methods: The ST was administered to all the patients included in the study, and the cases were categorized as ST-positive and ST-negative. The sensitivity and specificity of the test were determined based on radiographic findings.

Results: The distribution of trauma mechanisms of pediatric patients was as follows: sprain (65%, n=78), fall from height (20%, n=24), direct trauma (10%, n=12), and accidental hit (10%, n=12). Radiographically, 3 (2.5%) cases showed displaced fractures, 12 (10%) showed non-displaced fractures, 1 (0.8%) showed incomplete fractures, and 104 (86.7%) showed no fractures. The sensitivity of the Shetty Test was 75%, specificity was 59.6%, positive predictive value (PPV) was 22.2%, and negative predictive value (NPV) was 93.9% in predicting the need for radiography.

Conclusion: The sensitivity and specificity of the ST in predicting fractures in pediatric patients with ankle trauma within the limits of radiographic indication were found to be lower than those for adults. However, due to limited information in the literature, further studies with larger cohorts are needed.

Keywords: Ankle, foot, fracture, shetty, trauma.

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Address for correspondence:
Seval Komut.
Department of Emergency Medicine, Hitit University Faculty of Medicine, Çorum, Türkiye
Phone: +90 364 222 11 00
E-mail: drsevalkomut@hotmail.com

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INTRODUCTION

Foot and ankle traumas are the most common extremity injuries, representing a significant portion of Emergency Department (ED) presentations.[1,2] In the majority of these cases, the trauma affects the ligaments, ankle joint capsule, or results in soft tissue contusion.[3] Despite this, diagnostic radiographs are often requested for these patients, regardless of clinical indications. It has been reported that only 13–30% of this patient group actually have fractures, yet radiographic imaging of ankle trauma in EDs is performed at rates of 80%–100%.[1,2 4] This practice unnecessarily prolongs the time spent in the ED and exposes the majority of patients to unnecessary radiation.[5]

In an effort to reduce unnecessary radiography evaluations, screening tests have been proposed in the literature.[6–8] One such test is the Shetty test (ST), which has been suggested as an alternative to the widely used Ottowa Ankle Rules (OAR) die to its ease of application.[1,7–10] There is no studies in the literature that has examined the diagnostic performance and effectiveness of the ST in determining the need for radiographic imaging in pediatric cases.

Fractures associated with ankle trauma constitute 7% of physeal fractures and 5–14% of all fractures in pediatric cases. In younger age groups, the increased cartilage component provides resistance to fractures.[11–13] However, it is also known that children are 10–15 times more sensitive to radiation than adults.[14] In other words, ankle fractures are less common in children, but screening tests are more important in pediatric cases due to the high sensitivity to ionizing radiation.

The aim of this study was to determine the diagnostic performance of the Shetty test in predicting ankle fractures in pediatric cases and thereby prevent unnecessary radiation exposure.

MATERIALS AND METHODS

After obtaining ethical approval from Hitit University Non-Interventional Research Ethics Committee (decision no: 2022-23, date 04/11/2022), we conducted an observational, cross-sectional study involving 120 consecutive pediatric patients with ankle injuries admitted to the ED. All procedures were conducted in accordance with the ethical guidelines and the principles of the Declaration of Helsinki.

The study included 120 consecutive pediatric patients who presented at the ED with an ankle injury. The inclusion criteria were patients aged <18 years, who presented within 24 hours of the trauma with an isolated, non-penetrating ankle trauma, and whose parents provided informed consent for participation. The study exclusion criteria were defined as follows: multiple trauma, presence of crepitation in physical examination, findings indicating luxation or severe and definitive fractures such as open fractures, neuropathic or paraplegic patients, or a history of foot or ankle surgery. Additionally, patients were excluded if they had mental development retardation that would hinder sufficient cooperation, motor function retardation affecting walking abilities, or if they had not yet achieved full independent walking. The medical history of the patients was obtained from their parents.

For each patient, a record was made of their age, gender, mechanism of trauma, physical examination findings, and pain localization as the basic variables. The ST was then administered to the patients in the trauma unit of the ED by resident physicians with at least six months of experience in the ED trauma unit. These physicians had received training in the application of the ST on at least 20 patients from the same ED faculty member. The patients were then classified as ST-positive or ST-negative, and two-directinal radiographs were obtained in the anteroposterior and lateral positions in the ED imaging unit. The radiographs were evaluated for fractures in the hospital's digital imaging archive system by a second emergency medicine faculty member. This evaluator was blinded to the patient's medical history and physical examination findings.

Figure 1. Shetty test technique demonstration: The physician supports the entire foot while instructing the patient to push the foot downwards simulating "weight-bearing"

Shetty Test: The patient was seated on the examination table with the legs side by side and hanging freely. The patient was instructed to place the affected foot in the palm of the examining physician's hand. While the physician supported the entire foot, the patient was instructed to push the foot downwards, simulating "weight-bearing" as described in the literature (Fig.1).[15] If the patient was unable to perform the downward pushing movement due to pain, they were classified as ST-positive. If the patient could perform the movement, they were classified as ST-negative. A positive test result indicates a potential fracture, while a negative result suggests the absence of a potential fracture.[3]

Statistical Analysis

The data were analyzed using SPSS software (Version 22, SPSS Inc., Chicago, IL, USA, Licence: Hitit University). Descriptive statistics were used to present categorical data as numbers (n) and percentages (%). For numerical data with a normal distri-

Table 1. Comparison of sociodemographic and clinical characteristics among the research groups formed based on the ST results

	Positive (n=54)		Negative (n=66)		p
	n	%	n	%	
Age	11.07±3.32		11.38±3.83		
Gender					0.604[b]
Female	22	42.3	30	57.7	
Male	32	47.1	36	52.9	
Pain site					0.528[b]
Foot	21	48.8	22	51.2	
Ankle	33	42.9	44	57.1	
Mechanism of trauma					0.459[c]
Fall	8	33.3	16	66.7	
Sprain	37	47.4	41	52.6	
Blow	4	66.7	2	33.3	
Bump	5	41.7	7	58.3	
Physical examination					**<0.001**[b]
No	2	8.3	22	91.7	
Yes	52	54.2	44	45.8	
Radiographic finding					**0.010**[b]
No	42	40.4	62	59.6	
Yes	12	75	4	25	

a: Student's t-test; b: Chi-square test; c: Fisher's exact test.

bution, descriptive statistics were presented as mean±standard deviation (SD). The conformity of numerical data to a normal distribution was assessed using the Kolmogorov-Smirnov test. Student's t-test was employed for comparing means between two independent groups when the assumptions of parametric tests were met. Chi-square test or Fisher's exact test, depending on sample sizes in the cross-tabulation cells, was used for ratio comparisons and correlation investigations involving categorical data. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated to assess the prediction success of the Shetty test in determining the need for radiography. A $p<0.05$ was considered statistically significant.

RESULTS

A total of 120 children were included in this study for statistical analysis. Among the patients, 43.3% (n=52) were female and 56.7% (n=68) were male. The mean age of the patients was 11.24±3.6 (min–max: 4–17). Foor pain was reported by 35.8% (n=43) of the patients, while 64.2% (n=77) reported ankle pain. The distribution of trauma mechanisms was as follows: fall from height (20%, n=24), sprain (65%, n=78), direct trauma (10%, n=12), and accidental hit (10%, n=12). Physical examination findings were as follows: tenderness in 61 (50.8%) patients, swelling in 7 (5.8%) patients, and no findings in 20% of the patients. Radiographs revealed fractures in 16 (15.3%) patients, while 104 (86.7%) patients had no fractures.

When the ST was performed, it was positive (+) in 54 patients (45%) and negative (-) in 66 patients (55%). The sociodemographic and clinical characteristics of the groups formed based on the ST results are presented in Table 1. The groups were statistically similar in terms of age, gender, pain location, and trauma mechanism (p=0.646, p=0.604, p=0.528, p=0.459, respectively, Table 1). However, there was a significant difference between the groups in terms of physical examination findings ($p<0.001$, Table 1). Additionally, a significant difference was found between the groups in terms of radiography findings (p=0.010, Table 1). Among the patients with radiographic findings, the ST was positive (+) in 12 patients (75%), while among the patients without radiographic findings, the ST was negative (-) in 42 patients (40.4%).

Table 2. Distribution of ST results according to physical examination findings and statistical results

	Shetty test				Total	p*
	Positive		Negative			
	n	%	n	%		
Physical examination						<**0.001**
Tenderness	30	49.2	31	50.8	61	
Swelling	2	28.6	5	71.4	7	
Ecchymosis	1	50	1	50	2	
Temperature change	0	0	0	0	0	
Tenderness and swelling	12	75	4	25	16	
Tenderness and ecchymosis	2	50	2	50	4	
Swelling and ecchymosis	1	100	0	0	1	
Tenderness, swelling and ecchymosis	4	80	1	20	5	
No	2	8.3	22	91.7	24	
Radiography						**0.024**
Displaced fracture	3	100	0	0	3	
Nondisplaced fracture	8	66.7	4	33.3	12	
Incompetent fracture	1	100	0	0	1	
No fracture	42	40.4	62	59.6	104	
Total	54		66		120	

*: Fisher's exact test.

Table 3. Sensitivity, specificity, PPV, and NPV values indicating the success of the ST in predicting the need for radiography

	Radiography		Total	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
	No	Yes					
Shetty test				75% (47.4–91.7)	59.6% (49.5–68.9)	22.2% (12.5–35.9)	93.9% (84.4–98.0)
Negative	62	4	66				
Positive	42	12	54				
Total	104	16	120				

PPV: Positive predictive value; NPV: Negative predictive value; ST: Shetty test; CI: Confidence interval.

Table 2 presents the comparison of ST results with physical examination findings and radiography findings. There was a statistically significant difference between the ST groups in terms of physical examination findings (p<0.001, Table 2). Similarly, the distribution of radiography findings differed significantly between the groups (p=0.024, Tablo 2). The ST was positive (+) in all patients with a radiographic finding of displaced fracture or incomplete fracture. Among the patients with non-displaced fracture on radiography, 8 (66.7%) had a positive (+) ST, while 42 (40.4%) of the patients without a fracture had a positive (+) ST (Table 2).

In Table 3, a cross-designed table, the relationship between the ST and radiography indication is presented. Additionally, the sensitivity, specifity, PPV and NPV values of the ST for predicting radiography indication are provided. The ST demonstrated a sensitivity of 75%, specificity of 59.6%, PPV of 22.2%, and NPV of 93.9% for successfully predicting radiography indication.

DISCUSSION

In the general approach to ankle trauma in EDs, radiological examinations are typically performed following physical examination.[7] The reasons for requesting radiologic tests have been reported to include medicolegal factors, functional requirements such as defensive medicine applications due to legal responsibilities, patient requests, and extended waiting times in crowded EDs.[16] However, careful consideration should be given to determine appropriate radiographic indications due to escalating healthcare costs, prolonged ED stays, and, most importantly, the risk of unnecessary exposure to ionizing radiation, which has been reported to be 0.6 mSv per diagnostic radiograph in the ED.[17]

Pediatric patients are known to exhibit 10–15 times more sensitivity to radiation than adults and have an approximately 5% per Sv risk of developing fatal cancer. Therefore, it is crucial to minimize unnecessary radiological examinations in this vulnerable population.[14] This highlights the importance of clinical screening tests in the pediatric population, as they are even more crucial than in adults. In order for reliable and easily applicable tests to be widely adopted, their diagnostic contributions need to be objectively demonstrated.

Previous studies on pediatric trauma epidemiology have consistently reported a male gender predominance ranging from 65% to 68%.[18–20] In our study, 56.7% of the cases were male, which, although lower than the reported rates, aligns with the understanding that male children are more vulnerable to trauma. The most common cause of ankle trauma in our study was determined to be sprain (65%), which is consistent with findings from similar studies that also identified sprains as the leading cause of injury.[2,21]

It has been reported that in many healthcare institutions, ankle trauma patients are often sent directly to the radiography unit before undergoing a physical examination.[3,16,21,22] The aim of this study was to evaluate the diagnostic success of the ST in predicting fractures in pediatric cases. However, the significant difference in the distribution of physical examination findings between the groups formed based on the ST results suggests the importance of physical examination alone in limiting the need for radiography. The impact of different physical examination findings on the ST results could be a topic for future studies. Furthermore, previous studies related to the ST have primarily focused on the presence of fractures.[1–3,7] Therefore, the significant difference in the distribution of radiography findings observed in the current study could encourage the development of new scoring systems that incorporate both physical examination findings and the ST to determine fracture subtypes.

To date, no previous study has examined the success of the ST in predicting fractures with the aim of reducing radiography indications specifically for pediatric cases of ankle trauma. While the majority of studies have focused on adult patients, there are also studies that have included patients from the lower age limit of the pediatric population.[2,3,21] In a study evaluating 50 patients with isolated ankle trauma, where the ST was introduced for the first time, the reported sensitivity, specificity, PPV, and NPV were 100%, 91%, 43%, and 100%, respectively.[7] Another study reported values of sensitivity 95.5%, specificity 100%, PPV 71.40%, and NPV 100% for the ST, and highlighted that the ST reduced radiography indications at similar rates to the OAR, which were evaluated in the same population.[21] In a study of 150 patients, the ST and OAR were compared in terms of predicting fractures in ankle trauma, and the sensitivity, specificity, PPV, and NPV were reported as 82.6%, 77.39%, 52.73%, and 93.68%, respectively.[1] In the current study, which evaluated the success of the ST in predicting the need for radiography, the sensitivity was 75%, specificity was 59.6%, PPV was 22.2%, and NPV was 93.9%. These values were lower than the high sensitivity and specificity rates reported in most of the limited available literature on the ST. However, another study comparing the ST and OAR in 207 patients reported lower sensitivity and specificity values than those observed in the current study and in the literature (sensitivity 51.39%, specificity 85.93%, PPV 66.07%, NPV 76.82%).[3]

Weight is, of course, a subjective symptom that exhibits significant variability among patients.[3] The ST is designed to assess the presence of pain during weight-bearing simulation. Therefore, the ST is fundamentally a patient-centered subjective test. However, it is known that clinical evaluation of pediatric patients is not always reliable and may not always provide sufficient information.[23] The factor likely contributed to the lower sensitivity and specificity values obtained in this study compared to studies conducted with adult patient groups. Additionally, it is challenging to thoroughly discuss these results since there are no other studies that have investigates the success of the ST specifically in pediatric patients.

There were limitations to this study, primarily related to the subjective nature of the ST. Due to the difficulty in obtaining reliable clinical findings in pediatric patients, there might have been insufficient objective evaluation. In other words, pediatric patients express their response to pain in diverse ways and at different levels, and the practitioner's judgment may influence the decision regarding the ST result. This aspect could be more robustly analyzed through studies that examine different age groups separately. A second limitation was that the ST in this study was performed by different physicians. However, since previous studies have been limited to adult patients and there is no existing research on pediatric patients, it was not possible to compare the differences between physicians. Future studies will undoubtedly include subsections that quantitatively demonstrate the practitioners' decision-making process regarding the ST results.

CONCLUSION

In conclusion, the findings of this study revealed that the sensitivity and specificity of the ST in predicting fractures and reducing the need for radiography were lower in pediatric ankle trauma patients compared to adults. Nevertheless, the ST provides pediatric patients with potential protection against the adverse effects of ionizing radiation. Therefore, further studies with larger cohorts that compare multiple variables are warranted to gain a deeper understanding of its effectiveness.

Peer-review: Externally peer-reviewed.

Ethics Committee Approval: The Hitit University Non-Interventional Research Ethics Committee granted approval for this study (date: 04.11.2022, number: 2022-23).

Informed Consent: Written informed consent was obtained from patient's family in this study.

Author Contributions: Concept – BD, SK; Design – SK, AKE; Supervision – SK, AKE; Resource – SK; Materials – SK, BD; Data Collection and/or Processing – SK, BD; Analysis and/or Interpretation – SK, BD, AKE; Literature Search – SK; Writing – SK, AKE; Critical Reviews – BD, AKE.

Conflict of Interest: The authors have no conflict of interest to declare.

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