

Accuracy of Ottawa ankle rules for midfoot and ankle injuries

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Abstract. *Background:* The management of ankle sprains is common practice in emergency departments. Traditionally, physicians would order radiographs for all ankle injuries although the overall incidence of fractures are less than 15%. The Ottawa Ankle Rules (OAR) have been developed to predict the necessity of radiographs in acute ankle injuries. *Material and Method:* This is a prospective study of consecutive patients aged 16 years or older with acute non-penetrating ankle or foot injuries and who had a radiography of ankle or foot or both. *Results:* 499 cases were included in the study. 56.90 % of the patients were male and the median age of the patients was 30 (IQR 22,44). 22.85 % (114/499) of patients with ankle or midfoot injuries had fractures. The sensitivity, specificity, PPV and NPV of OAR for ankle and midfoot injuries were 100, 45.26, 26.00, 100 and 100, 43.71, 19.92 and 100 respectively. In this study 792 x rays were ordered from 499 patients. According to OAR 509 (%64.27) of them were indicated whereas 283 (% 35.73) were not. When the weight bearing test is sole criteria 303 (38.26%) x rays were obtained to find out three fractures. *Conclusion:* OAR should be safely used in emergency departments. Implantation of this rule prevents patients from unnecessary radiation exposure. It is a reasonable approach to reassess the patient if symptoms not resolve several days later for avoiding unnecessary x ray exposure when the weight bearing test exist as the only positive criteria. (www.actabiomedica.it)

Key words: Ottawa Ankle Rules, Ankle and Midfoot Injuries, X ray, Emergency Department

Background

Ankle sprains are common in general population and constitute a large volume of emergency department admissions. Therefore the management of ankle sprains is common practice in emergency departments. Traditionally, physicians would order radiographs for all ankle injuries although the overall incidence of fractures are less than 15% (1,2). Stiell et al developed and then validated the Ottawa Ankle Rules (OAR) to predict the necessity of radiographs in acute ankle injuries and to avoid unnecessary imaging (3,4). According to OAR the ankle radiographs are indicated if there is pain on the posterior edge of distal 6 cm or on the tip of the either malleoli;

and / or inability to bear weight immediately after injury or to take four steps in emergency department (ED) and similarly the foot radiographs are indicated if there is bone tenderness either at the base of fifth metatarsal bone or over the navicular bone and inability to bear weight immediately after injury or take four steps in ED .

It is clear that the use of OAR is a time and resource saving approach and may prevent patients from unnecessary radiation exposure if it exhibits satisfactory results. However some studies failed to rule out the probability of ankle and midfoot fractures by using OAR (5). The aim of our study is to validate the OAR in the ED of an training and research hospital in Turkey..

Material and Method

This was a prospective study of consecutive patients aged 16 years or older with acute non-penetrating ankle or foot injuries occurred within the last 24 hours who had a radiography of ankle or foot or both. The study was conducted in emergency department (ED) of Ankara Dışkapi Yıldırım Beyazıt Hospital which is an urban training and research hospital with approximately 400.000 attendances annually, over a period of 6 months after approval of the ethic committee. Ethical approval was obtained from the local Ethics Committee (DYBEAH:30.05.2016- 30/30) and informed written consent was obtained from all patients. Data collection forms including demographic features, date and mechanism of injury, clinical criteria of OAR and a picture representing OAR were prepared. Patients were evaluated and managed by their primary physicians at admission and the investigator had no concern with in this stage. If the primary physician ordered any radiography of ankle, foot or both and if the x rays were taken; the patient was included in the study. We excluded patients who had multiple trauma, depressed consciousness, open and/or displaced fracture, trivial injuries such as isolated skin abrasions and who refused to be a participant in the study. All eligible patients were evaluated by a single senior resident (investigator) who was trained for the interpretation of OAR all criteria of OAR were checked and then recorded at the data collection form and the question that if a radiography was necessary or not for the patients was answered. The investigator was blinded to the results of x rays. All ankle and or foot radiographies were evaluated by a radiologist or an orthopedic surgeon who were blinded to the results of OAR. Finally the investigator recorded if any fracture was present or not.

Descriptive statistics were used to define patients' demographics and the accuracy of OAR were assessed by sensitivity, specificity, positive predicting value and negative predicting value.

Results

In the study period 534 eligible patients presented to the ED. 35 patients had phalanx fractures, therefore

they were excluded and 499 cases were included in the study. 56.90 % of the patients were male and the median age of the patients was 30 (IQR 22,44). 22.85 % (114/499) of patients with ankle or midfoot injuries had fractures. Demographic characteristics and types of injuries were given in table 1 and the sites of fractures were given in table 2. 403 patients were evaluated for ankle injuries and 65 of them had fractures at malleolar site whereas 389 patients were evaluated for midfoot injuries and 49 of them had fractures. Distribution of OAR criteria for foot and ankle injuries and number of the fractures corresponding to the criteria were given in table 3. The sensitivity, specificity, PPV and NPV of OAR for ankle injuries were 100.00, 45.27, 26.00, 100.00%; whereas 100.00, 45.00, 20.76 and 100.00 % for midfoot injuries respectively.

(table 4). In this study 792 x rays were obtained from 499 patients. According to OAR 509 (%64.27) of them were indicated whereas 283 (%35.73) were not (Table 5).

Discussion

In this study we have validated Ottawa Ankle Rules and have shown that rules have 100% sensitivity

Table 1. Patients Characteristics (n= 499)

Demographics		
	Median age (IQR 25,75)	30 (22, 44)
	Range	15-70
	Gender: n (%)	Male; 284 (56.90)
Type of Injury		
	Ankle n (%)	110 (22.04)
	Foot n (%)	96 (19.24)
	Ankle and Foot n (%)	293 (58.72)
Mechanism of Injury		
	Strain n (%)	440 (88.20)
	Falls n (%)	14 (2.80)
	Direct blow n (%)	32 (6.40)
	Snagging n (%)	5 (1.00)
	Road accident n (%)	8 (1.60)

Table 2. Distribution of Fractures according to Anatomic Site

Ankle Injuries			n (%)
	No fracture n (%)		338 (83.87)
	Fracture n (%)		65 (16.13)
		Medial malleol	9
		Lateral malleol	42
		Bimalleolar fracture	12
		Talus	2
Midfoot Injuries			
	No fracture n (%)		340 (87.40)
	Fracture n(%)		49 (12.60)
		Base of fourth and fifth metatars	44
		Navicular	3
		Calcaneus	2

Table 3. Distribution of OAR criteria for foot and ankle injuries

	CRITERIA	n (%)	n of fractures
Foot injuries (N=389)	Navicular pain	11 (2.83)	3
	5 th metatarsal pain	54 (13.88)	44
	Weight bearing	215 (55.27)	36
	Negative for OAR	153 (39.33)	0
Ankle injuries (n=403)	Lateral malleolar pain	103 (25.56)	55
	Medial malleolar pain	34 (8.44)	22
	Weight bearing	234 (58.06)	62
	Negative for OAR	153 (37.97)	0

for both ankle and midfoot injuries when applied by trained physician. OAR have been validated in different countries and settings. Some of them have failed to rule out the significant fractures without obtaining x rays (6-9). On the other hand some studies have shown 100 % of sensitivity and NPV for OAR (10-12). We believe that most important factor for reaching higher sensitivity values is training of the physicians who are applying the rules as noted by Broomhead and colleagues (10). In addition, we would ensure 35% reduction in the number of radiographs if the rules were implanted in clinical practice in the study period. When evaluated together OAR represent an important tool to predict fracture possibility and avoiding unnecessary radiation exposure in ankle and foot injuries.

In this study we have observed that OAR for both ankle and foot injuries have low specificity that

still indicates avoidable unnecessary radiographs and the criteria with the lowest specificity and lowest positive likelihood ratio is weight bearing immediately after injury or taking four steps in ED as given in Table IV. We have observed that when the weight bearing test was the sole criteria 131 (32.50 %) more radiographs were obtained to find only one fracture for ankle injuries and 172 (44.22 %) more radiographs were obtained to find two fractures for foot injuries in our study. Health care providers might consider the advantages and disadvantages of unnecessary tests for patients. Therefore we may consider the weight bearing test is not a must for ordering foot and ankle series when exist as a sole criteria. At this point the physician might have a decision when the weight bearing test was the sole criteria such as ordering more x rays in order to not to miss any fracture or making an agreement

Table 4. Ottawa rules for ankle and foot injuries

Criteria	Sensitivity % (95% CI)	Specificity % (95 % CI)	PPV % (95 % CI)	NPV % (95 % CI)	LR + (95 % CI)	LR – (95 % CI)	Accuracy % (95 % CI)	
Ankle n=403	LMP	84.62 (73.52 - 92.37)	85.80 (81.62 - 89.34)	53.40 (46.36 - 60.30)	96.67 (94.24-98.09)	5.96 (4.5-7.9)	0.18 (0.1-0.38)	85.61 (81.80-88.89)
	MMP	33.85 (22.57 - 46.65)	96.45 (93.88- 98.15)	64.71 (48.87- 77.86)	88.35(86.42 - 90.03)	9.53 (4.97-18.28)	0.69 (0.58-0.82)	86.35 (82.61-89.55)
	WB	95.38 (87.10 - 99.04)	49.11 (43.66-54.58)	26.50 (24.27- 28.85)	98.22 (94.80 -99.41)	1.87 (1.66 - 2.10)	0.09 (0.03-0.27)	56.58 (51.58-61.48)
Foot n=389	Ottawa ankle	100 (94.48-100)	45.27 (39.87-50.74)	26.00 (24.18-27.91)	100	1.83 (1.66-2.02)	0	54.09 (49.09-59.04)
	NP	6.12 (1.28 – 16.87)	97.65 (95.42-98.98)	27.27 (9.33-57.73)	87.83 (87.02-88.59)	2.60 (0.71- 9.47)	0.96 (0.89-1.03)	86.12 (82.28-89.40)
	5 th MP	89.80 (77.77 - 96.60)	97.06 (94.66-98.58)	81.48 (70.34-89.09)	98.51 (96.64-99.34)	30.53(16.46-56.63)	0.11 (0.05-0.25)	96.14 (93.72-97.83)
	WB	73.47 (58.92-85.05)	47.34 (41.94-52.81)	16.74 (14.18-19.66)	92.53 (88.47-95.24)	1.40 (1.15-1.70)	0.56 (0.35-0.90)	50.64 (45.56-55.72)
Ottawa foot	100 (92.75-100)	45.00 (39.63-50.46)	20.76 (19.23-22.39)	100	1.82 (1.65-2.00)	0	51.93(46.84-56.99)	

LMP: Lateral Malleolar Pain, MMP: Medial Malleolar Pain, NP: Navicular Pain, NP: Navicular Pain, NP: Metatarsal Pain WB: Weight Bearing, PPV: Positive Predictive Value, NPV: Negative Predictive Value, LR: Likelihood Ratio

Table 5. Radiographs according to OAR

	Indicated n (%)	Not Indicated n (%)	Total n
Ankle series	61 (55.45)	49 (45.55)	110
Foot series	42 (43.75)	54(56.25)	96
Ankle &Foot series	406 (69.28)	180 (30.72)	586
Total	509 (64.27)	283 (35.73)	792

with the patient to reassess him or her if symptoms not resolve several days later for minimizing unnecessary screenings as Yuen and colleagues pointed (8). Beside this, any patient with positive Ottawa Rules and initial normally evaluated radiographs should be reassessed if symptoms not resolved several days later in order to minimize unfavorable outcomes.

Conclusion

OAR should be safely used in clinical settings after training physicians on applying the rules. Implantation of this rule is a cost saving approach and prevent patients from unnecessary radiation exposure. It is a reasonable approach to reassess the patient if symptoms not resolve several days later for avoiding unnecessary x ray exposure when the weight bearing test exist as the only positive criteria. Further studies are needed in this field.

Conflict of interest: Each author declares that he or she has no commercial associations that might pose a conflict of interest in connection with the submitted article.

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