



# Overlooked extremity fractures in the emergency department

## Acil serviste gözden kaçan ekstremitte kırıkları

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### BACKGROUND

The purpose of the study was to analyze the accuracy of interpretation of extremity traumas by emergency physicians (EP) to determine the most difficult areas for interpretation in comparison to official radiology reports of direct X-ray.

### METHODS

Radiologist reports and EP reports of direct X-rays from isolated extremity trauma patients were retrospectively compared from 01.05.2011 to 31.05.2011. A total of 181 fractures in 608 cases were confirmed.

### RESULTS

The locations of the misinterpreted fractures were ankle and foot (51.4%), wrist and hand (32.4%), elbow and forearm (5.4%), shoulder and upper arm (5.4%), hip and thigh (2.7%), and knee and leg (2.7%). The diagnostic accuracy of the EPs and radiologists were not significantly different ( $\kappa=0.856$ ,  $p=0.001$ ).

### CONCLUSION

Knowledge about the types of fractures that are most commonly missed facilitates a specifically directed educational effort.

**Key Words:** Emergency department; extremities; overlooked fractures; radiography.

### AMAÇ

Bu çalışmanın amacı izole ekstremitte travmalarında, acil servis doktorlarının yorumlarının resmi radyoloji raporlarıyla karşılaştırılmasıyla en zor yorumlama alanını belirlemek ve acil doktorlarının yorumlarının doğruluğunu analiz etmektir.

### GEREÇ VE YÖNTEM

Radyolog raporları ve acil servis doktorlarının yorumları izole ekstremitte travmalı hastalarda geriye dönük olarak 01.05.2011'den 31.05.2011 tarihine kadar karşılaştırıldı. Toplam 608 olguda 181 kırık saptandı.

### BULGULAR

Yanlış yorumlanan kırıkların yerleri sırasıyla ayak bileği ve ayak (%51.4), el bileği ve el (%32.4), dirsek ve önkol (%5.4), omuz ve üst kol (%5.4), kalça ve uyluk (%2.7), diz ve bacak (%2.7) olarak belirlendi. Acil servis doktorlarının ve radyologların tanısallık doğrulukları arasında anlamlı bir fark saptanmadı ( $\kappa=0.856$ ,  $p=0.001$ ).

### SONUÇ

En sık atlanan kırık tiplerinin bilinmesi, bu konuda eğitimin yoğunlaştırılmasıyla acil servislerde kaçırılan olguların en aza indirilmesini sağlayabilir.

**Anahtar Sözcükler:** Acil servis; ekstremitte; kaçırılan kırıklar; radyografi.

Direct radiographic examinations frequently contribute important information to the medical decision-making processes in trauma units (TU) of emergency departments (ED). Radiographs are often initially interpreted by an emergency physician (EP), and decisions are made based on this initial interpretation.

Studies analyzing errors in fracture diagnoses have focused on the nature of the fractures and the interpretation of X-rays.<sup>[1-4]</sup> Misdiagnosis of a fracture is a very common occurrence in EDs and can have serious consequences because of delays in treatment and resulting long-term disability.<sup>[1]</sup> It is also one of the most

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common causes of medical legal claims in the United States.<sup>[5,6]</sup> Analysis of the circumstances in which errors in medical practice occur may suggest ways to prevent them. Several strategies are available to reduce the misdiagnosis rate: radiograph interpretation by a radiologist who provides full-time, on-site coverage of the ED; coverage of the ED with teleradiology; coverage of the ED by radiology house staff during off-hours; elimination of over-interpretation of ED radiographs by radiologists; and reduction in radiology department workload.<sup>[7]</sup> In exploring the implications of radiologists workload reduction, it is necessary to determine the potential areas of misdiagnosis by EPs in TUs and to develop a relevant educational program. Therefore, we conducted a study to analyze the accuracy interpretation of extremity traumas by EPs in comparison to interpretations in official radiology reports following X-ray analysis (gold standard).

## MATERIALS AND METHODS

We conducted a retrospective cross-sectional study from 01.05.2011 to 31.05.2011 at an academic, adult tertiary care center ED of a university hospital in Turkey. This ED serves more than 240,000 adult patients annually, and 19% of these involve isolated extremity trauma. The study protocol was approved by our local ethics committee. All ED patients who were undergoing evaluation in the TU and had an isolated extremity trauma with direct X-rays were recruited for this study. Patients were ineligible if they were medically unstable, had multiple traumas, were <18 years old, or were pregnant. In addition, cases lacking a written radiography interpretation by EPs were excluded.

We have also reviewed the radiology reports of the direct X-ray images. During the data collection phase in the ED, fractures were categorized as upper or lower extremity, long or short bone, articular or extra articular, and shaft or distal fracture by an EP who was blinded to the study protocol. The independent sample t-test was used for descriptive analyses between groups, and kappa statistics were calculated for comparing EP and GS results.

A receiver operator characteristic curve (ROC) analysis was conducted to identify the threshold that maximized the sensitivity and specificity of the EPs interpretation. The sensitivity, specificity, the positive likelihood ratio (+LR), and the negative likelihood (-LR) were calculated. In this study, the maximum type I error was 0.05 and the level of significance was accepted as  $p < 0.05$ . In this study, MedCalc Software version 11.5 and SPSS version 15 were used for statistical analyses. Confidence intervals for the sensitivity, specificity, positive, and negative likelihood ratios were calculated.

## RESULTS

During the study period, 608 patients, including 302 (49.7%) men and 306 (50.3%) women, with isolated extremity trauma were evaluated using the GS. The mean age of the patients was  $41.89 \pm 17.49$ . The characteristics of the fractures are listed in Table 1. Of these, 181 (29.8%) were corroborated by GS reports and 427 (70.2%) were negative. In 405 (94.8%) cases, the EP was negative for fractures (true negatives), whereas 22 (5.2%) were diagnosed as fracture by the EP (false positives). In 166 (91.7%) cases, the EP was positive for fractures (true positives), whereas 15 (8.3%) were diagnosed negative for fractures by X-ray (false negatives) (Table 2). In addition, 47 patients were excluded from the data analyses because no reports were found in the ED files. The results for the EP and GS are listed in Table 2 and 3. The diagnostic accuracy of the EP and the GS were not significantly different ( $\kappa = 0.856$ ,  $p = 0.001$ ).

## DISCUSSION

It is critical to regularly evaluate our methods of caring for patients admitted to ED in order to better serve the needs of patients and to reduce costs. In other national systems, the diagnostic error rate has been evaluated systematically, with revisions made accordingly. In the literature, the observed rate of disagreement between EPs and radiologists in the interpretation of radiographs ranges from 8-11%<sup>[2,8-12]</sup> and a change in treatment was required for 1-3% of these patients. These errors in interpreting radiographs

**Table 1.** The distribution of false positive and false negative cases according to anatomical location, extremity, bone size and shaft-joint rates

	False positive		False negative		Total	
	n	%	n	%	n	%
<b>Region</b>						
Shoulder-upper arm	1	4.5	1	6.7	2	5.4
Elbow-forearm	2	9.1	0	0.0	2	5.4
Wrist-hand	11	50.0	1	6.7	12	32.4
Hip-thigh	0	0.0	1	6.7	1	2.7
Knee-leg	0	0.0	1	6.7	1	2.7
Ankle-foot	8	36.4	11	73.3	19	51.4
<b>Extremity</b>						
Lower extremity	8	36.4	13	86.7	21	56.8
Upper extremity	14	63.6	2	13.3	16	43.2
<b>Large-small bone</b>						
Small bone	17	77.3	8	53.3	25	67.6
Large bone	5	22.7	7	46.7	12	32.4
<b>Shaft-joint</b>						
Joint	14	63.6	7	46.7	21	56.8
Shaft	8	36.4	8	53.3	16	43.2

**Table 2.** The distribution of the diagnoses according to emergency physician and radiologist evaluation

		Radiologist					
		Positive		Negative		Total	
		n	%	n	%	n	%
Emergency physician	Positive	166	91.7	22	5.2	188	30.9
	Negative	15	8.3	405	94.8	420	69.1
	Total	181	29.8	427	70.2	608	100.0

**Table 3.** The statistical calculations to compare the sensitivities of the emergency physician and radiologist interpretation

		95% CI
Sensitivity	91.7	86.7-95.3
Specificity	94.6	92.3-96.7
Positive predictive value (+PV)	88.3	82.8-92.5
Negative Predictive value (-PV)	96.4	94.2-98.0
Positive likelihood ratio (+LR)	17.8	16.9-18.7
Negative likelihood Ratio (-LR)	0.09	0.05-0.20
ROC area under the curve (AUC)	0.933	0.910-0.951

in the ED can also have significant clinical and legal consequences.<sup>[13]</sup> These studies covered not only isolated extremity scans but also all direct X-rays in ED. Between 1974 and 1985 the liability program of the American Collage of Emergency Physicians identified the most frequent cause of malpractice actions as the failure to diagnose fractures among these direct images. In our country, because of developing medical legal issues in practice, it not possible to obtain reliable data regarding these missed fractures and their medical-legal results. Perhaps in the future, clearer data will be available regarding this issue.

In this study, lower extremity fractures (ankle and foot) were overlooked most frequently (n=19, 51.4%). The fractures were located at the proximal region around the joint. This result was consistent with those of previous studies.<sup>[2,5,14]</sup> The wrist and hand (n=12, 32.4%) was the second most common location of missed fracture diagnoses. There were no missed mid-shaft fractures of any bone. The elbow and forearm (n=2, 5.4%) and the shoulder and upper arm (n=2, 5.4%) were the third most common site of missed fracture diagnosis. These results were correlated with those in the literature.<sup>[2,14]</sup> None of the fractures were considered to be clinically important after follow up. There are several limitations of our retrospective analysis. It was not possible to determine the impact of the level of training among individual physicians on the pattern of overlooked fractures. We did not analyze fractures at specific anatomical locations, and we were unable to determine the specific distribution of tibial

plateau fractures and tibial spine fractures because these were grouped together.

Studies have shown that there is a problem regarding the speed of X-ray reporting in EDs. Time is a major factor and 48.9% of reports are not available within 48 h. We would therefore recommend a rapid reporting system to decrease the rate of overlooked fractures.<sup>[15]</sup>

In the short-term, teaching methods should be improved and guidelines on the use of ED radiology have been published.<sup>[16]</sup> However, this cannot be expected to eliminate all errors and it is important to develop fail-safe mechanisms to detect errors when they occur. Radiology departments should give priority to reporting ED films and the best solution is to have an immediate reporting system. Marking of abnormal radiographs by radiographers can assist in reducing diagnostic errors<sup>[17]</sup> but the value of this may be limited by a high rate of false positives.<sup>[18]</sup>

Few EDs have a full-time radiologist on duty 24 hours a day. When clinicians in an ED read X-ray films that are later reviewed by radiologists, overlooked fractures will inevitably appear. The fractures that were missed most often were elbow and leg fractures. Knowledge about the types of fractures that are most commonly missed facilitates a specifically directed educational effort.

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