

## PAPER DETAILS

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# Determination of Radiography Requirement with Physical Examination in Elbow Trauma

## Dirsek Travmasında Fizik Muayene Bulguları ile Radyografi Gerekliliğinin Belirlenmesi

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### Abstract

**Objective:** The purpose of this study was to estimate the presence of fracture and to determine radiography requirements through results obtained by evaluating the physical examination findings in elbow injury.

**Material and Method:** This was a single center prospective study. All patients were evaluated in terms of trauma mechanism, inspection findings, presence of pain at palpation, pain with active movement, circulatory examination and loss of sensation. Sensitivity, specificity, positive and negative predictive value (NPV) were determined for each sign and each examination finding.

**Results:** The study was performed with 47 patients. Fracture was determined in 10 patients (21.2%). Presence of pain at the elbow extension, forearm supination (FS), medial epicondyle (ME) palpation and forearm pronation tests exhibited high sensitivity (100%, 100%, 90%, and 80%, respectively) and high NPV (100%, 95%, 96.4%, and 91%, respectively) for elbow fracture. These four tests produced significant p values (0.088, 0.012, 0.001, and 0.079, respectively) in elbow fractures. Combining the pain at FS and ME palpation tests exhibited 90% sensitivity, and 96.7% NPV.

**Conclusions:** Positivity on any one of the four tests employed increases the probability of fracture and is sufficient for elbow radiography to be recommended in patients presenting due to elbow injury. However, radiography may not be required if combined FS and ME palpation test findings are negative in this patients.

**Keywords:** Elbow fracture, physical examination, radiography requirement, emergency medicine

### Öz

**Amaç:** Bu çalışmada dirsek travmasında fizik muayene ve dirsek eklem fonksiyonlarını ölçen bazı testlerin yapılması ve bu veriler ışığında hangi hastalarda kırık olabileceğinin değerlendirilmesi amaçlanmaktadır.

**Gereç ve Yöntem:** Bu prospektif klinik çalışmada, tüm hastalar travmanın mekanizması, inspeksiyon bulguları, palpasyon ile ağrı varlığı, aktif hareket ile ağrı varlığı, dolaşım muayenesi ve duyu kaybı açısından değerlendirildi. Tüm semptom ve bulguların sensitivite, spesivite, pozitif prediktif değer ve negatif prediktif değerleri (NPD) istatistiksel olarak belirlendi.

**Bulgular:** Çalışma 47 hasta ile yürütüldü. Toplamda 10 hastada kırık saptandı (%21,2). Dirsek ekstansiyonu, ön kol supinasyonu (ÖS), medial epikondil (ME) palpasyonu ve ön kol pronasyon testleri ile ağrı varlığının dirsek kırığı için sensitivitesi yüksekti (sırasıyla, %100, %100, %90 ve %80). Dirsek kırığı için bu 4 testin p değeri anlamlı olarak tespit edildi (sırasıyla, 0,088, 0,012, 0,001, and 0,079). ÖS ve ME palpasyon testlerinin birlikte değerlendirilmesinin sensitivitesi %90 ve NPD'si %96,7 olarak tespit edildi.

**Sonuç:** Kullanılan bu dört testten herhangi birinin pozitif olması kırık olasılığını artırır ve dirsek yaralanması nedeniyle başvuran hastalarda dirsek radyografisinin önerilmesi için yeterlidir. Ancak bu hastalarda birlikte değerlendirilen ÖS ve ME palpasyon testi bulguları negatif ise radyografi gerekmez.

**Anahtar Kelimeler:** Dirsek kırığı, fizik muayene, radyografi gerekliliği, acil servis



## INTRODUCTION

Elbow traumas constitute 2-3% of emergency department presentations.<sup>[1,2]</sup> The most feared event following acute elbow trauma is complex fracture accompanied by severe neurovascular injury. Cases of missed fracture may also occur under some conditions, such as a simple and undisplaced fracture.<sup>[3]</sup> The diagnosis of an existing fracture is important since disability may be observed following elbow injuries. However, there is still no specific agreed procedure for the identification of elbow traumas.<sup>[4-9]</sup>

The ability to determine fractures on direct x-rays in some patients with normal physical examination obliges physicians to request large numbers of x-ray tests. This prolongs emergency department stays, and leads to patients being unnecessarily exposed to radiation, and to increased treatment costs. Results showing that x-ray is not necessary in every case of wrist trauma in recent studies revealed a need for procedures to be followed in elbow trauma.<sup>[5-11]</sup> Some studies intended to identify those patients for whom x-ray should be requested have reported that extension tests at physical examination may be sufficient,<sup>[9]</sup> while the most recent studies have shown that the elbow extension test and fracture point tenderness test cannot by themselves exclude elbow injury.<sup>[12]</sup>

The purpose of this study was to perform various tests measuring elbow joint functions in patients presenting to the emergency department with acute elbow trauma and to identify those patients in whom fractures may be present in the light of the data obtained. The ultimate purpose of all these evaluations was to identify a procedure in the light of clinical examination for determining the need for x-ray requests in patients presenting to hospital with wrist trauma.

## MATERIAL AND METHOD

### Study Design and Setting

This prospective, single-center study was conducted in an university hospital teaching emergency medicine assistant physicians (50.000 ED visits annually). The study was performed between December 2015 and August 2016 following receipt of ethical committee approval (No. 2013/8).

Patients aged over 18, with elbow trauma and presenting to the emergency department within the first 72 h, and consenting to participate were included in the study. Patients with multiple trauma, clouded consciousness, known neuromuscular disease, trauma in the contralateral elbow or forearm, with open fracture or with another distracting injury were excluded from the study. All patients were examined, and an examination form specially designed for this study was completed for all patients. All patients were evaluated in terms of trauma mechanism, inspection findings, presence of pain at palpation medial epicondyle (ME), lateral epicondyle (LE), olecranon, and radial head (RH), ulnar and median nerve sensation tests, radial-brachial and ulnar artery pulse examination, pain during elbow flexion (EF) and elbow extension (EE), and pain during forearm pronation (FP) and forearm supination (FS).

### Methods and Measurements

The emergency department physicians taking part in the study were instructed concerning the standard elbow examination techniques used in it. The examination results of the patients assessed using these techniques were recorded onto a form produced for the study. The physicians examined patients in terms of deformity findings in the affected region, and presence of ecchymosis and swelling, and the data obtained were recorded on the study form. Each patient was evaluated for tenderness when the medial ME, LE, olecranon, and RH were touched. The radial, ulnar, and brachial artery pulses were palpated, and circulation examination was performed. Median and ulnar nerve sensation examinations were performed, and the presence of sensory loss was noted. Patients were also evaluated for presence of pain with active movements (pain at EE and EF, and pain at FP and FS), and the results were recorded on the study form.

Once the physical examinations were complete, and irrespective of the physical examination findings, all patients were sent to the radiology unit for two-sided radiography (anteroposterior and lateral). The recordings were made with a digital x-ray device (Konica Minolta Aero Dr X70). The radiography results were reported by an experienced radiologist blinded to the study findings. Patients with suspected fracture but in whom this could not be confirmed with radiography underwent computerized joint tomography, the results of which were reported by the same radiologist. Computerized joint tomography was performed using a Siemens Sensation 16 Slice device. The presence and location of fracture were recorded for patients with fractures diagnoses using radiography and tomography.

Radiographic examination of elbow bone traumas represented the primary end point for establishing the validity of the proposed criteria in order to determine their predictive value in producing a clinical decision-making tool for the management of such patients. The predictive value of each individual criterion was first calculated separately. Combinations of findings exhibiting the highest predictive values for fracture were then evaluated together.

### Statistical Analysis

Statistical analysis was performed on SPSS (Chicago, IL) 21.0 software. Descriptive characteristics (side affected, mechanism of trauma, and dominant hand) were expressed as numbers and percentages. Sensitivity, specificity, and positive and negative predictive values (NPV) for all symptoms and examination findings were expressed as percentages. Incidences of symptoms between fracture and non-fracture groups were analyzed using the Pearson  $\chi^2$  and Fisher exact tests. P values < 0.05 were regarded as statistically significant.

## RESULTS

Eighty-seven patients presenting to our emergency departments during the study period were included. Twenty-two patients with multiple traumas, two with open fractures,

six unwilling to take part, and 10 with missing records were excluded from the study, which was finally performed with 47 patients. Men represented 78.7% (n=37) of the patients in the study and women 21.3% (n=10). Trauma mechanisms involved falling onto the elbow in 68.1% of cases (n=32), sports injuries in 10.6% (n=5), vehicular accidents in 2.1% (n=1), and other injuries in 19.1% (n=9). Right hand dominance was present in the great majority of patients (97.9%), and the right elbow was the most commonly affected region (59.6%). Fracture was determined in 10 patients (21.2%). The pathological findings of these 10 subjects with fractures are shown in **Table 1**.

The data, and predictive values, of patients with or without fracture determined at physical examination, point palpation and active movements are shown in **Table 2**. Among the clinical findings, pain occurring with EE exhibited the highest sensitivity values, with sensitivity and NPV of 100%. The second highest sensitivity values, at 90%, were pain occurring with FS and

ME palpation and NPV of 95.4% and 96.4%, respectively. Pain occurring with FP exhibited sensitivity of 80% and NPV of 91%. These four tests with significant p values (0.088, 0.012, 0.001, 0.079, respectively) in elbow fracture. We also evaluated the sensitivity in determining the presence of fracture by combining the pain test with the FS and ME palpation, these tests with the highest p value (<0.001). The combination of these two tests exhibited 90% sensitivity, 81% specificity, and NPV 96.7%.

**Table 1.** Details of patients with fractures on elbow radiographs

Radiological diagnosis	Number of patients	Percentage (%)
Radial head fracture	3	30
Medial epicondyle fracture	2	20
Lateral epicondyle fracture	2	20
Supracondylar fracture	1	10
Radial head dislocation	1	10
Proximal ulna fracture	1	10
Total	10	100

**Table 2.** Predictive values of clinical findings

Findings		Fracture (+) (n=10)	Fracture (-) (n=37)	P value $\chi^2$	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
Inspection								
Deformity	+	4	6	0.186	40	83.7	40	83.7
	-	6	31		(13.6-72.6)	(67.3-93.2)	(13.6-72.6)	(67.3-93.2)
Ecchymose	+	4	11	0.704	40	70.2	26.6	81.2
	-	6	26		(13.6-72.6)	(52.8-83.5)	(8.9-5.5)	(62.9-92.1)
Edema	+	7	16	0.168	70	56.7	30.4	87.5
	-	3	21		(35.3-92)	(39.6-72.4)	(14-53)	(66.5-96.7)
Pain with palpation								
Medial epicondyle (ME)	+	9	10	0.001	90	72.9	47.3	96.4
	-	1	27		(54.1-99.4)	(55.6-85.6)	(25.2-71)	(79.7-99.8)
Lateral epicondyle (LE)	+	7	16	0.168	70	56.7	30.4	87.5
	-	3	21		(35.3-92)	(39.6-72.4)	(14-53)	(66.5-96.7)
Olecranon	+	7	16	0.168	70	56.7	30.4	87.5
	-	3	21		(35.3-92)	(39.6-72.4)	(14-53)	(66.5-96.7)
Radial head (RH)	+	6	15	0.229	60	59.4	28.5	84.6
	-	4	22		(27.3-86.3)	(42.1-74.8)	(12.1-52.3)	(64.2-95)
Pain with active movement								
Elbow flexion (EF)	+	9	24	0.242	90	35.1	27.2	92.8
	-	1	13		(54.1-99.4)	(20.7-52.5)	(14-45.7)	(64.1-99.6)
Elbow extension (EE)	+	10	26	0.088	100	39.7	27.7	100
	-	0	11		(65.5-100)	(16.4-47.1)	(14.7-45.4)	(67.8-100)
Forearm supination (FS)	+	9	16	0.012	90	56.7	36	95.4
	-	1	21		(54.1-99.4)	(39.6-72.4)	(18.7-57.3)	(75.1-99.7)
Forearm pronation (FP)	+	8	17	0.079	80	54	32	91
	-	2	20		(44.2-96.4)	(37.1-70.1)	(15.7-53.5)	(69.3-98.4)
Circulatory examination								
Brachial artery pulse	+	10	36	1.000	100	2.7	21.7	100
	-	0	1		(65.5-100)	(0.1-15.8)	(11.4-36.7)	(5.4-100)
Radial artery pulse	+	10	36	1.000	100	2.7	21.7	100
	-	0	1		(65.5-100)	(0.1-15.8)	(11.4-36.7)	(5.4-100)
Ulnar artery pulse	+	9	36	0.384	90	2.7	20	50
	-	1	1		(54.1-99.4)	(0.1-15.8)	(10-35)	(26.6-97.3)
Loss of sensation								
Ulnar nerve	+	0	1	1.000	0	97.2	0	78.2
	-	10	36		(0-34.4)	(84.1-99.8)	(0-94.5)	(63.2-88.5)
Median nerve	+	1	0	0.213	10	100	100	80.4
	-	9	37		(0.5-45.8)	(88.2-100)	(5.4-100)	(65.6-90.1)
Combined test								
FS + ME palpation	+	9	7	<0.001	90	81	56.2	96.7
	-	1	30		(54.1-99.4)	(64.2-91.4)	(30.5-79.2)	(81.4-99.8)

PPV: positive predictive value, NPV: negative predictive value

## DISCUSSION

We determined that pain at EE was 100% sensitive for diagnosis of fracture. The occurrence of pain with the FS and palpation of the ME in patients with trauma was 90% sensitive in diagnosing fracture, while pain at FP was 80% sensitive in the presence of pain. These four tests, being capable of rapid, simple and practical application, emerged as physical examination findings with high sensitivity and significant p values in determining the presence of fracture in elbow injuries. When we evaluated FS and palpation of the ME of the humerus, the two tests with the highest p values, this combination exhibited 90% sensitivity in identifying the presence of fracture.

Due to a lack of specific rules concerning which patients should be sent for radiography in elbow trauma, one of the most common reasons for presentation to the emergency department, a number of studies have been performed on this subject.<sup>[1,2]</sup> One study of 145 patients by Hawksworth et al.<sup>[9]</sup> described the EE test as an important marker in showing the presence of injury, with sensitivity of 90.7% and specificity of 69.5%. They also reported that if the patient is able to achieve full extension, the probability of significant injury is only 9.3%. In a similar study of 114 patients, Docherty et al.<sup>[8]</sup> described full extension as a practical marker in the emergency department, with 97% sensitivity and 69% specificity, and reported that this test reduced radiography requirements in patients presenting with elbow trauma by 50%. All of the patients with determined fractures in our study were unable to achieve full EE, and the EE test exhibited 100% sensitivity and 39.5% specificity in identifying the presence of fracture. Our study confirms those previous studies, revealing a high probability of injury in patients with positive EE tests, and the need to refer these for radiography.

Appelboom et al.<sup>[4]</sup> reported a NPV for the EE test of 98.4%, with a negative likelihood ratio of 0.03. Based on these values, they concluded that EE had high specificity and NPV, that the test was practicable in the emergency department, and that radiography requirements for patients presenting with elbow trauma would be reduced by a quarter. They also concluded that the likelihood of fracture appearing at x-ray on patients unable to achieve full extension was approximately 50%. We obtained similar results in the present study, with EE exhibiting 100% sensitivity and NPV in determining the presence of fracture.

Lennon et al.<sup>[2]</sup> concluded that a patient able to perform the same range of elbow movements in both elbows, affected and unaffected by trauma, could safely be discharged, that there was no need for patients able to perform normal extension, flexion and supination to be sent for x-ray, but that there was a risk, albeit a low one, of inability to identify pathology at x-ray in adult patients even if physical examination is normal. Darracq et al.<sup>[13]</sup> expressed a different opinion, reporting that equal ranges of elbow movement in both arms, affected and unaffected by trauma, considerably reduced the probability

of determining fracture in these patients. In our study, EE, FS and FP tests and presence of pain at palpation of the ME had high sensitivity and specificity, whereas the EF test was not statistically significant in determining the presence of fracture. A combination of FS and ME palpation tests was statistically significant ( $p < 0.001$ ) and exhibited 90% sensitivity.

Arundel et al.<sup>[14]</sup> reported that a combination of the ability to perform full extension, absence of pain or tenderness with application of pressure to either the RH, the olecranon or the ME, and the absence of contusion-ecchymosis was 100% sensitive and 24% specific in determining fracture in elbow trauma. In our study, the presence of pain at palpation of the RH and olecranon was not statistically significant in determining the presence of fracture ( $p = 0.229$ ,  $0.168$ , respectively), and only pain at pressure on the medial epicondyle was significant ( $p = 0.001$ ), with sensitivity of 90% and specificity of 72.9%. The EE test in the present study was 100% specific. The statistical significance of FS and ME palpation tests was higher in our study, and due to the high sensitivity, specificity and NPV values of a combination of these two tests in identifying the presence of fracture, we think that this combination is suitable for determining the presence of fracture in the emergency department. Kim et al.<sup>[12]</sup> also reported that the use of the EE test alone or the single point tenderness test alone could not exclude elbow injuries. In our study, too, use of the EE test alone was not appropriate, while a combination of FS and ME palpation tests was more suitable.

## Limitations

The principal limitation of this study is the low patient number. The main reason for this low number is that only isolated elbow traumas were included and injuries accompanying multitrauma were excluded. A second important limitation is that range of elbow movement was not included in the physical examination findings. According to Darracq et al.'s study<sup>[13]</sup>, the addition of these parameters with high sensitivity in determining elbow traumas to physical examination findings, and to the combination of results obtained will result in more significant results in determining the presence of fracture.

## CONCLUSIONS

Positivity on any one of the four tests (EE, FS, ME palpation, and FP tests) employed increases the probability of fracture and is sufficient for elbow radiography to be recommended in patients presenting due to elbow injury. However, radiography may not be required if combined FS and ME palpation test findings are negative in these patients, and this can significantly reduce the numbers of non-essential radiographs performed.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** For this research; Karadeniz Technical University Faculty of Medicine Ethic Council approval was obtained (Date: 29/08,2013 number: 2013/35).



**Informed Consent:** All patients signed the free and informed consent form.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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