Original Article

# The Value Of Physical Examination In The Diagnosis Of Elbow Fracture In Elbow Trauma In Adult Patients With Positive Clinical Findings

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## Abstract

**Background:** The existence of a method to rule out elbow fractures in acute injuries prevents unnecessary radiography, resulting in reduction of costs. Clinical decision tools are widely available and accepted to standardize clinical assessment after limb injury, but currently there is no sensitive predictive method for elbow assessment. Therefore, this study aimed at investigating the value of physical examination in diagnosing elbow fracture in elbow trauma among patients with positive clinical findings.

**Materials and Methods:** This cross-sectional study was conducted on patients with elbow trauma who were referred to an educational center. Then the demographic information questionnaire including age, sex and injury mechanism was completed by the researcher. Elbow examinations, including observation and touching, were performed for all patients, and tenderness point tests and extension tests were performed for all patients. In addition, anteroposterior and lateral radiographs of the elbow were performed for all patients. Visual pain questionnaire was completed for all patients.

**Results:** A total of 150 patients were included in the study. The patients consisted of (74.83%) men and (25.17%) women. In terms of fractures detected in elbow radiography, 41 patients showed fractures in the elbow joint and 106 patients (72.11%) did not have fractures. The sensitivity and specificity of severe pain (19.51% and 82.08%), swelling (26.83% and 62.26%), deformity (31.71% and 100%), ecchymosis (56.1% and 87.74%), abnormal range of motion (100% and 83.02), extension test (97.56% and 94.34%), flexion test (90.24% and 58.49%), pronation test (26.83% and 80.19%), supination test (41.46% and 93.4%) and point test (100% and 66.98%) was calculated.

**Conclusion:** The extension test demonstrated the highest accuracy for the diagnosis of elbow fracture, while the local swelling has the lowest accuracy for this diagnosis. Point tenderness and abnormal range of motion had the highest sensitivity, and deformity had the highest specificity for elbow fractures.

**Keywords:** Elbow Fracture, Specificity, Sensitivity, Clinical Criteria.

## INTRODUCTION

The elbow joint is bounded by a synovial capsule, consistent of ulnotrochlear (hinge), Radiocapitellar (hinge and axis) and radioulnar (axial) joint. This complex anatomy allows for two types of movement, which include flexion and extension movements and pronation and supination movements. The physiological range of movements is from 0 to 140 degrees for flexion and extension movements and 0 to 180 degrees for pronation and supination movements (2,1). The elbow joint is highly susceptible to injury from trauma, and even minor injuries can be associated with major disability. Fractures around the elbow joint usually occur when axial force is applied to the forearm (3, 4). The severity of these injuries ranges from fractures with minimal displacement requiring less treatment, to injuries with displacement or large fractures requiring surgery (5, 6). Elbow injuries are common in primary and secondary care, accounting for 2-3% of emergency department visits (7,8). Only 1% of patients with such injuries have elbow fractures. Although the clinical decision rules for injuries of other parts of the body are well known, there are no clear guidelines for the need for radiography in patients with elbow injuries.

A method to rule out elbow fractures in acute injury prevents unnecessary radiography, leading to lower costs (9, 10). Clinical decision tools are widely available and accepted to standardize clinical assessment after limb injury, but there is currently no sensitive predictive method for elbow assessment (11). For example, clinical decision rules for the need of radiographs of other limb injuries (e.g, the Ankle Rule) are used to avoid unnecessary radiographs. There is no such rule for acute elbow injuries (12,

13). A comprehensive study has not been done in this field. The purpose of this study was to evaluate the value of elbow fracture diagnosis examination in elbow trauma patients with positive clinical findings.

## Materials and Methods

This cross-sectional study was conducted on patients with elbow trauma referred to Shahid Madani Medical Training Center in Karaj, Iran. Patients who met the inclusion and exclusion criteria were included in the study by convenience sampling. Inclusion criteria include: age over 18 years, elbow injury, consent to participate in the study, ability to answer questions and cooperate in examinations. Exclusion criteria include: lack of consent to participate in the study, presence of wounds or soft tissue damage in the elbow area, presence of simultaneous trauma to other parts of the body, presence of systemic disease, history of elbow fracture, and history of elbow trauma in the last 6 months.

### Sample Size

The sample size was estimated to be 150 people by considering 95% confidence interval, 0.05 error coefficient and 80% power, according to Acar et al.'s studies (14).

$$n = \left( \frac{Z_{1-\alpha/2} \times \delta}{d} \right)^2$$

### Procedure

At first, demographic information questionnaire including age, sex and injury mechanism was completed by the researcher. Next, elbow examinations, including observation and palpation, were performed for all patients, and tenderness point and extension tests were performed for all patients. Next, anteroposterior and lateral radiographs of the elbow were performed for all patients. Visual pain questionnaire was completed for all patients.

## Data Analysis

Average and standard deviation indices were used for descriptive data. Also, ANOVA and non-parametric t-test were used to analyze the data. Data analysis was done using SPSS statistical software ver.18.0. A significance level of 0.05 was considered.

### Ethics Declarations

Ethical approval was obtained from the Research Council of the Faculty of Medicine. The study adhered to the principles of the Declarations of Helsinki and ethics research committees of the University of Medical Sciences. The information of all patients was kept confidential with the project manager.

## Results

A total of 150 patients were included in the study. The average age of the examined patients was 1995 ± 45.43 years. The study population consisted of 110 (74.83%) men and 37 (25.17%) women. In terms of the amount of fracture detected in the radiograph, 41 patients (27.89%) had a fracture in the elbow joint, and 106 patients (72.11%) did not have a fracture.

According to the visual pain questionnaire (VAS), the average pain score of the patients is equal to 4.64, with the lowest and highest scores being 1 and 10 (SD: ±2.2), (Figure 1). A score of 7 or more was considered as severe pain, which was found in 27 patients (18.4%).

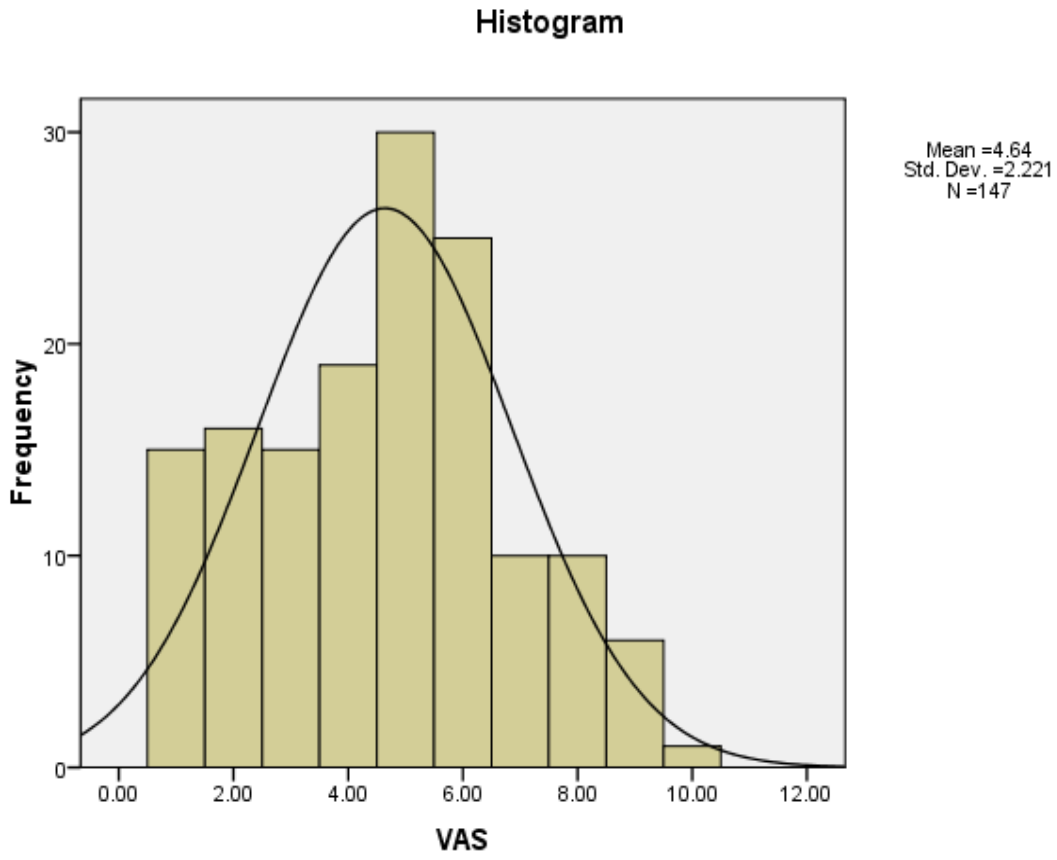


**Figure 1:** Frequency of Visual Pain Questionnaire (VAS) scores

The sensitivity and specificity of severe elbow pain for fracture was determined to be 19.51% and 82.08%, respectively. The positive and negative predictive value was found to be 29.63% and 72.5%, respectively, and the accuracy was 64.63%.

The sensitivity and specificity of severe elbow pain for fracture is 19.51% and 82.08%, respectively, and the positive and negative predictive value is 29.63% and 72.5%, respectively, and the accuracy is 64.63%.

The accuracy of local swelling for elbow fracture was investigated and the results showed that 51 patients (34.69%) had swelling in the elbow area. The sensitivity and specificity of elbow swelling for fracture were 26.83% and 62.26%, respectively. The positive and negative predictive values of elbow swelling were determined as 21.57% and 68.75%, respectively, and the accuracy was 52.83%.

Deformity was seen in 13 patients (8.84%), the sensitivity and specificity of elbow deformity for fracture were 31.71% and 100%, respectively, for which the positive and negative predictive values were also determined as 100% and 79.1%, respectively, and the accuracy was 80.95%. The presence of ecchymosis was seen in 36 patients (24.48%).

The accuracy of abnormal range of motion for elbow fracture is shown in Table 1. Range of motion (ROM) was abnormal in 69 patients (46.93%). The sensitivity and specificity of abnormal range of motion for fracture were 100% and 83.02%, respectively, and the positive and negative predictive values were found 64.49% and 100%, respectively, and the accuracy was 87.76%.

**Table 1:** Accuracy of abnormal range of motion for elbow fracture

| Statistic | Formula | Value | 95% CI |
|---|---|---|---|
| Sensitivity | $\frac{a}{a+b}$ | 100.00% | 91.40% to 100.00% |
| Specificity | $\frac{d}{c+d}$ | 83.02 % | 74.50% to 89.61% |
| Positive Likelihood Ratio | $\frac{Sensitivity}{1-Specificity}$ | 5.89 | 3.87 to 8.97 |
| Negative Likelihood Ratio | $\frac{1-Sensitivity}{Specificity}$ | 0.00 | |
| Disease prevalence | $\frac{a+b}{a+b+c+d}$ | 27.89% (*) | 20.82% to 35.88% |
| Positive Predictive Value | $\frac{a}{a+c}$ | 69.49% (*) | 59.92% to 77.63% |
| Negative Predictive Value | $\frac{d}{b+d}$ | 100.00 % (*) | |
| Accuracy | $\frac{a+d}{a+b+c+d}$ | 87.76% (*) | 81.34% to 92.58% |

Abnormal extension test was observed in 46 patients (31.22%), the sensitivity and specificity of abnormal extension test for fracture were determined as 97.56% and 94.34%, respectively, for which the positive and negative predictive values were 86.96% and 99.01 %, respectively, and the accuracy was equal to 95.24%. Abnormal flexion test was seen in 81 patients (55.1%), where the sensitivity and specificity of abnormal flexion test for fracture were also calculated to be 90.24% and 58.49%, respectively, for which the positive and negative predictive values were 45.68% and 93.94 %, respectively, and the accuracy was equal to 67.35%.

Abnormal pronation test was observed in 32 patients (21.76%), where the sensitivity and specificity of abnormal pronation test for fracture were 26.83% and 80.19%, respectively, and the positive and negative predictive values were found to be 34.38% and 73.91 %, respectively and the accuracy was determined as 65.31%.

The accuracy of supination test for elbow fracture was shown in Table 2. The test results showed abnormal supination in 24 patients (16.32%).

**Table 2:** Accuracy of supination test for elbow fracture

| Statistic | Formula | Value | 95% CI |
|---|---|---|---|
| Sensitivity | $\frac{a}{a+b}$ | 41.46% | 26.32% to 57.89% |
| Specificity | $\frac{d}{c+d}$ | 93.40 % | 86.87% to 97.30% |
| Positive Likelihood Ratio | $\frac{Sensitivity}{1-Specificity}$ | 6.28 | 2.81 to 14.02 |
| Negative Likelihood Ratio | $\frac{1-Sensitivity}{Specificity}$ | 0.63 | 0.48 to 0.81 |
| Disease prevalence | $\frac{a+b}{a+b+c+d}$ | 27.89% (*) | 20.82% to 35.88% |
| Positive Predictive Value | $\frac{a}{a+c}$ | 70.83% (*) | 52.11% to 84.43% |
| Negative Predictive Value | $\frac{d}{b+d}$ | 80.49 % (*) | 76.03% to 84.29% |
| Accuracy | $\frac{a+d}{a+b+c+d}$ | 78.91% (*) | 71.42% to 85.20% |

Point tenderness was observed in 76 patients (51.07%), the sensitivity and specificity of abnormal point tenderness for fracture were 100% and 66.98%, respectively, for which the positive and negative predictive values were 53.95% and 100%, respectively and the accuracy was found as 76.19%.

## DISCUSSION

A method to rule out elbow fractures in acute injury avoids unnecessary radiography and can reduce costs (15). Clinical decision tools are widely available and accepted to standardize clinical assessment after limb injury, but there is currently no sensitive predictive method for elbow assessment (16). For instance, clinical decision rules indicating the need for radiographic diagnosis of other organ injuries are used to avoid unnecessary radiographs. There is no such rule for acute elbow injuries (17).

The aim of this study was to evaluate the value of elbow fracture diagnosis examination in elbow trauma patients with positive clinical findings. The results of the present study showed that 41 patients (27.89%) had fractures in the elbow joint and 106 patients (71.11%) had no fractures. The elbow fracture rate varied from 22 to 70% as reported by previous studies (18).

In the present study, range of motion (ROM) was abnormal in 69 patients (46.93%). The sensitivity and specificity of abnormal range of motion for fractures were 100% and 83.02%, respectively. In Darracq et al.'s study, the sensitivity and specificity of abnormal range of motion were found to be 100% and 97%, respectively, which is in line with the results of the current study (19). On the other hand, abnormal extension test was observed in 46 patients (31.2%), the sensitivity and specificity of abnormal extension test for fracture was found to be 97.56% and 94.34%, respectively, and similar results were reported in the study of Darracq et al. (both sensitivity and specificity of 100%) (19). However, Appelboam et al. reported the sensitivity and specificity of 97% and 48%, for abnormal extension test, respectively (20).

In the current study, abnormal flexion test was seen in 81 patients (55.01%), the sensitivity and specificity of abnormal flexion test for fractures were determined as 90.24% and 58.49%, respectively. A study by Baker et al reported the sensitivity and specificity of the flexion test for elbow fracture were reported as 89% and 45%, respectively, which is in line with the results of the present study (21). On the other hand, abnormal pronation test was observed in 32 patients (21.76%), the sensitivity and specificity of abnormal pronation test for fracture were 26.83% and 80.19%, respectively. However, Lennon et al., reported a sensitivity and specificity of 51% and 80%, respectively (22).

In the current study, 24 patients (16.32%) showed abnormal supination test, the sensitivity and specificity of abnormal supination

test for fracture was found to be 41.46% and 93.4%, respectively. Darracq et al.'s study showed this rate as 55% and 97%, respectively (19). On the other hand, 76 patients (51.7%) exhibited point tenderness, where the sensitivity and specificity of abnormal point tenderness for fracture was determined as 100% and 66.98%, respectively. Darracq et al reported this rate as 100% and 67%, respectively, confirming the results of the present study (19). No study has been published about the sensitivity and specificity of severe pain, deformity, ecchymosis, and swelling, and our study is the first study in this field.

## CONCLUSION

The extension test showed the highest accuracy for the diagnosis of elbow fracture, while the local swelling has the lowest accuracy for this diagnosis. On the other hand, point tenderness and abnormal range of motion had the highest sensitivity, and deformity had the highest specificity for elbow fractures.

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