

# Clinical diagnosis of clavicle fractures: a pilot study

Jim Landine, MD; Robert McGraw, MD; William Pickett, PhD\*

## ABSTRACT

**Objective:** Clavicle fractures are commonly encountered in the emergency department (ED). Our objective was to determine whether emergency physicians can clinically predict the presence and location of a clavicle fracture prior to obtaining x-rays.

**Methods:** Over a 16-month period we prospectively studied ED patients who had injuries compatible with a clavicle fracture. Following clinical examination and prior to obtaining radiographs, ED physicians or senior emergency medicine (EM) residents were asked to predict whether the clavicle was fractured and, if fractured, the location of the fracture. Clinical predictions were later compared to the radiologist's report.

**Results:** Between April 1999 and August 2000, 184 patients with possible clavicle fracture were seen and 106 (58%) were enrolled. Of these, 94 had an acute fracture, and all 94 fractures were predicted on clinical grounds prior to x-ray. In 6 cases, physicians predicted a fracture but the radiograph was negative. In 6 additional cases, physicians were clinically unsure and the radiograph was negative. Physicians correctly predicted fracture location in 83 of 94 cases (88%; 95% confidence interval [CI], 82%–95%). In the 64 cases where physicians predicted a middle third fracture, they were 100% accurate (95% CI, 95%–100%). Errors made by physicians were conservative; that is, they occasionally predicted fractures in patients with only soft tissue injury, but they did not "miss" existing fractures.

**Conclusions:** The results of this pilot study suggest that ED physicians can clinically predict the presence and location of clavicle fractures with a high degree of accuracy. It may be that x-rays are not always necessary in patients suspected of having a clavicle fracture. Future studies should define the indications for diagnostic radiography in patients with suspected clavicle fractures.

## RÉSUMÉ

**Objectif :** On rencontre souvent des fractures de la clavicule à l'urgence. Notre objectif était de déterminer si les médecins d'urgence pouvaient prédire au moyen de l'examen clinique la présence et la localisation d'une fracture de la clavicule avant d'avoir les résultats des radiographies.

**Méthodes :** Au cours d'une période de 16 mois, nous avons effectué une étude prospective des cas de patients reçus à l'urgence pour une blessure compatible avec une fracture de la clavicule. Après l'examen clinique et avant d'obtenir les radiographies, on demanda aux médecins d'urgence ou aux résidents sénior en médecine d'urgence (MU) de prédire la présence de fracture de la clavicule et dans l'affirmative, de déterminer l'emplacement de la fracture. Les prédictions cliniques furent ensuite comparées au rapport du radiologiste.

**Résultats :** Entre avril 1999 et août 2000, cent quatre-vingt-quatre patients présentant une fracture possible de la clavicule furent examinés et 106 d'entre eux furent inclus dans l'étude (58 %). Parmi ces patients, 94 présentaient une fracture aiguë. Chacune d'entre elles fut prédite à l'examen clinique avant les radiographies. Dans six cas, les médecins prédirent une fracture alors que la radiographie était négative. Dans six autres cas, les médecins ne pouvaient déterminer avec certitude la

From the Department of Emergency Medicine, Queen's University, Kingston, Ont.

\*Dr. Pickett is a Career Scientist, funded by the Ontario Ministry of Health and Long-Term Care.

Received: Nov. 24, 2000; final submission: Feb. 12, 2001; accepted: Feb. 12, 2001

*This article has been peer reviewed.*

présence d'une fracture et la radiographie était négative. Les médecins prédirent correctement l'emplacement de la fracture dans 83 des 94 cas (88 %; intervalle de confiance [IC] à 95 %, 82 %–95 %). Parmi les 64 cas où les médecins prédirent une fracture du tiers moyen de la clavicule, leur prédiction était exacte à 100 % (IC à 95 %, 95 %–100 %). Les erreurs que les médecins firent étaient conservatrices, c'est-à-dire qu'ils prédisaient à l'occasion des fractures chez des patients qui ne souffraient en fait que d'une blessure aux tissus mous, mais ils ne «ratèrent» pas les fractures existantes.

**Conclusion :** Les résultats de cette étude pilote suggèrent que les médecins d'urgence peuvent prédire à l'examen clinique la présence et l'emplacement des fractures de la clavicule avec un taux élevé de précision. Il est possible que les radiographies ne soient pas toujours nécessaires chez des patients chez qui l'on soupçonne une fracture de la clavicule. Des études ultérieures devraient définir les indications pour les radiographies diagnostiques chez les patients chez l'on soupçonne une fracture de la clavicule.

**Key words:** clavicule, fracture, radiography, clinical diagnosis

## Introduction

The clavicle is the most commonly fractured bone in children, and clavicle fractures account for up to 40% of shoulder girdle injuries seen in the emergency department (ED).<sup>1</sup> Because the bone is subcutaneous along its entire length, it is easily accessible to both inspection and palpation. Consequently, clavicle fractures and their management have been described as far back as ancient Greece and Hippocrates.<sup>2</sup>

The Allman classification divides clavicle fractures by location.<sup>3</sup> Group I fractures involve the middle third, Group II, the lateral third and Group III, the medial third. These zones account for approximately 80%, 15% and 5% of clavicle fractures, respectively. The Neer classification further subdivides Group II fractures based on associated ligamentous disruption.<sup>4</sup> The S-shape of the clavicle and its regional porosity variations give it flexural and torsional properties that make it weakest in its middle portion. In addition, strong ligamentous and muscular attachments medially and laterally leave the relatively free middle third more susceptible to fracture when it is stressed. Therefore, most fractures occur in the middle third.

It is standard ED practice to obtain radiographs when evaluating clavicular injuries. Radiographs confirm the presence and location of fractures, but whether it is necessary to x-ray all clavicle fractures has yet to be determined. When considering the need for any diagnostic test, it is important to ask whether the same information is available clinically, and whether the test (i.e., radiograph) will lead to a change in patient management or outcome.

Clavicle fractures in general, and middle third fractures in particular, have excellent outcomes with conservative management.<sup>1</sup> Complications from clavicle fractures are rare and are generally restricted to fractures in the medial or lateral aspects of the bone. Therefore, it would seem that if

physicians can accurately identify middle third fractures clinically, then x-rays may be unnecessary. Omitting radiographs in the diagnostic work-up of these patients could shorten ED length of stay, reduce diagnostic costs and limit exposure to ionizing radiation.

The objective of this study was to determine whether ED physicians can accurately predict, on clinical examination, both the presence and location of clavicle fractures prior to obtaining radiographs. Our hope is that this pilot study could pave the way for a formal prospective analysis of the utility of clavicle radiography.

## Methods

### Design

A prospective study of ED patients who had injuries compatible with a clavicle fracture, seen during the 16-month study period.

### Setting and participants

The study was carried out at 2 urban teaching hospitals with a combined census of 85,000 ED patient visits per annum. One of the hospitals is a regional Level 1 trauma centre, and both are staffed by full-time emergency physicians. Participating physicians were either FRCP(C) or CCFP-EM qualified, or were senior emergency medicine (EM) residents.

### Intervention

Participating physicians were encouraged not to alter their clinical practice for this study, and no extra training was provided except for a 1-hour didactic session discussing the diagnosis, complications and management of clavicle fractures. After examining patients and prior to obtaining radiographs, ED physicians completed a data form that asked

them to predict the presence or absence of a fracture. In cases where a fracture was predicted, physicians were asked to specify the fracture location based on the following choices: medial third, middle third, lateral third, or "unsure." Clinical predictions were subsequently compared to radiology reports, which were considered to be the diagnostic reference standard. Patients were excluded if the data form was not completed or if the x-ray was performed prior to completion of the data form. Multiple trauma victims were also excluded, and multiple trauma was defined as a significant injury involving a second (non-musculoskeletal) organ system.

### Analysis

Descriptive statistics, including proportions and means, were determined using standard formulae. Intervals of 95% confidence were calculated to show the precision of critical values, and contingency tables were constructed to illustrate the level of agreement between clinical predictions and radiographic findings. The study received ethics approval from the Queen's University Research Ethics Board.

### Results

Between April 1999 and August 2000, 184 patients with injuries consistent with clavicle fracture were seen. Of these, 106 (58%) were enrolled and 78 excluded — 70 because of recruitment failure, 7 because of multiple trauma and one who had an x-ray done prior to data form completion. Table 1 shows that clinical characteristics were similar for patients enrolled and excluded.

Ninety-four of 106 enrolled patients (89%) had an acute clavicle fracture, and all 94 of these were predicted on clinical grounds prior to x-ray (Table 2). In 6 cases, physicians

predicted a fracture when the radiograph was negative and in 6 additional cases, physicians were clinically unsure and the radiograph was negative. In the latter group, 3 patients had nonspecific soft tissue injuries, 2 had acromioclavicular separations and 1 had a glenohumeral dislocation.

Seventy-five clavicle fractures (80%) were middle third, 15 (16%) were lateral third, 2 (2%) were medial third and 2 (2%) involved both middle and lateral thirds (Table 3). Physicians correctly predicted fracture location in 83 of 94 patients (89%; 95% confidence interval [CI], 82%–95%). In the 64 cases where physicians predicted a middle third fracture, they were 100% accurate (95% CI, 95%–100%). The 11 incorrect predictions were "conservative" errors, with the physician predicting the fracture to be lateral (8 times) or unsure (3 times) when it was actually middle third. In the 15 cases of lateral third fracture and the 2 cases of medial third fracture, the physicians' predictions were correct all 17 times. Two fractures involved both middle and lateral thirds. Physicians predicted both of these to be lateral. In this series of 172 consecutive ED patients with acute clavicle fracture, no cases of pneumothorax or neurovascular injury were identified during the ED visit.

### Discussion

Clavicle fractures are common. Most involve the middle third, the diagnosis is usually clinically obvious, and they are managed conservatively with a sling or shoulder immobilizer for support. Functional outcomes are very good and complications are rare.<sup>1</sup> The least invasive management option, simple support, has outcomes at least as good as more invasive surgical options, even if there are multiple fracture fragments.<sup>5</sup> In fact, some authors feel that commin-

**Table 1. Clinical features of enrolled (*n* = 106) vs. excluded (*n* = 78) patients**

	Enrolled (%)	Excluded (%)
Gender		
Male	81 (76)	54 (69)
Female	25 (24)	24 (31)
Age		
0–15	57 (54)	42 (54)
16–35	25 (24)	17 (22)
36–55	18 (17)	14 (18)
>55	6 (6)	5 (6)
Fracture site*		
Middle	75 (80)	59 (76)
Lateral	15 (16)	18 (23)
Medial	2 (2)	1 (1)
Middle + lateral	2 (2)	0 (0)

\* 94 fractures enrolled and 78 excluded

**Table 2. Physician diagnostic accuracy for predicting fractures (*n* = 106)**

	Radiograph interpretation	
	Fracture	No fracture
Fracture	94	6
Unsure	0	6

**Table 3. Physician diagnostic accuracy in predicting fracture location (*n* = 94)**

	Radiograph interpretation			
	Medial	Middle	Lateral	Mid + lateral
Medial	2	0	0	0
Middle	0	64	0	0
Lateral	0	8	15	2
Unsure	0	3	0	0

uted fractures unite more quickly and strongly because there is more callus to enhance bone healing.<sup>6</sup>

Morbidity associated with clavicle fractures may be related to associated injuries or delayed complications. Associated injuries include other orthopedic trauma, pneumothorax, brachial plexus disruption or major vascular injury.<sup>1</sup> Delayed complications include fracture mal-union, non-union and shoulder arthritis.<sup>1</sup> But while pneumothorax and neurovascular injuries are frequently discussed, they are, in fact, very rare. In a series of 690 clavicle fractures, Rowe<sup>7</sup> reported a 3% incidence of pneumothorax, and in our series of 172 consecutive fractures, we identified no cases. This suggests that clavicle fractures should not provoke physicians to perform chest radiography unless the history and physical exam raise a suspicion of pneumothorax or blunt chest injury.

Neurovascular injuries are even more uncommon.<sup>1</sup> Since the neurovascular bundle is protected under the thick, medial portion of the clavicle, it takes considerable trauma to injure these structures.<sup>8</sup>

Non-union and arthritis are largely associated with Group II (lateral) fractures, which account for only 15% of clavicle fractures<sup>9</sup> but are responsible for half of all non-unions. Delayed arthritis is most likely in patients who suffer lateral fractures with ligamentous (acromioclavicular and coracoclavicular) disruption. However, while delayed complications are more likely with lateral fractures, the majority of such injuries do well. Nordqvist followed 110 patients with lateral clavicle fractures, all managed with simple sling support.<sup>10</sup> At 15-year follow-up, only 5% complained of mild pain with range of motion and none had any disability.

Clavicle radiographs are performed to confirm the diagnosis and location of fractures. Because outcomes may be worse with medial third or lateral third injuries, it may be important to localize these accurately in the ED. Consequently, we attempted to determine whether emergency physicians can make the diagnosis of a fracture clinically and whether they incorrectly diagnose medial or lateral third injuries as middle third. Our data show that ED physicians can clinically predict the presence and location of clavicle fractures with a high degree of accuracy. The data also show that, in every case where the physician's clinical prediction differed from the radiographic diagnosis, the clinical impression was conservative (i.e., overestimated the potential injury severity).

### **Limitations and future research**

Approximately 40% of the patients who presented with clavicle fractures during the study period were not enrolled. So, although there are no apparent differences between enrolled and non-enrolled patients, it is possible that there is an unidentified selection bias. Further, the physicians in this study were

full time ED physicians and dedicated EM residents; therefore, these findings may not be generalizable to all physicians in all centres. In addition, our sample size was limited; we enrolled a relatively small number of patients with medial and lateral clavicular fractures. If we had enrolled a larger number of patients with these less common injuries, our physicians might have incorrectly identified some of the injuries as middle third injuries. Finally, it is conceivable that patients with subtle clavicle fractures were seen at our centre and missed because the clinical suspicion was so low as to not perform an x-ray. If this occurred, it would falsely increase the apparent sensitivity of clinical examination.

This study paves the way for future prospective studies to clarify the indications for diagnostic radiography in patients with suspected clavicle fractures.

### **Conclusions**

This pilot study suggests that ED physicians can clinically predict the presence and location of clavicle fractures with a high degree of accuracy. It may be that x-rays are not always necessary in patients suspected of having a clavicle fracture. Future studies should define the indications for diagnostic radiography in patients with suspected clavicle fractures.

**Acknowledgments:** We thank Dr. Paul Fenton, Department of Diagnostic Radiology, for his assistance with study design, and Julie Richard, Fenecia Loye and Kathy Bowes of the Department of Emergency Medicine Research Group for their assistance with patient recruitment.

### **References**

1. Rockwood CA, Green DP. Fractures in adults. 4th ed. Philadelphia: Lippincott-Raven; 1996.
2. Adams CF. The genuine works of Hippocrates. Baltimore: Williams & Wilkins; 1939.
3. Allman FC. Fractures and ligamentous injuries of the clavicle and its articulation. *J Bone Joint Surg [Am]* 1967;49:774-84.
4. Neer CS. Fracture of the distal clavicle with detachment of coracoclavicular ligaments in adults. *J Trauma* 1963;3:99-110.
5. Andersen K, Jensen PO, Lauritzen J. Treatment of clavicular fractures. Figure-of-eight bandage versus a simple sling. *Acta Orthop Scand* 1987;58(1):71-4.
6. Dandy DJ. Essential orthopedics and trauma. 2nd rev. New York: Churchill-Livingstone; 1993.
7. Rowe CR. An atlas of anatomy and treatment of mid-clavicular fractures. *Clin Orthop* 1968;58:29-42.
8. Penn I. The vascular complications of fractures of the clavicle. *J Trauma* 1964;4:819-31.
9. Neer CS. Non-union of the clavicle. *JAMA* 1960;172:1006-11.
10. Nordqvist A, Petersson C, Redlund-Johnell I. The natural course of lateral clavicle fracture. 15 (11–21) year follow-up of 110 cases. *Acta Orthop Scand* 1993;64(1):87-91.

**Correspondence to:** Dr. Jim Landine, Department of Emergency Medicine, 76 Stuart St., Kingston ON K7L 2V7; jimlandine@hotmail.com