

# Radiography of Clavicle Fractures— A Review of the Literature

## —Do Various Radiographic Views of Clavicle Fractures Affect the Management Plan?

Njalalle Baraza\*, Thomas Wood

Department of Trauma and Orthopaedics, Alexandra Hospital, Redditch, Worcestershire, UK

Email: [\\*njaleb@gmail.com](mailto:njaleb@gmail.com)

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### Abstract

**Introduction:** Fractures of the clavicle are common and make up 5% - 10% of all fractures. Treatment options in part depend on the location of the fracture along the bone and degree of displacement. These two parameters are best determined by good quality, standardized radiographs of the clavicle. We reviewed the literature to determine the optimal radiographs of clavicle fractures and their influence on the treatment plan. **Methods:** A comprehensive search of Medline™ database was undertaken with the following search terms and MeSH headings: clavicle, fractures, bone, radiography, and X-ray. We included articles in English published from 1950 to present. We ruled out fractures in children, fracture dislocations, open fractures, those with neurological and vascular injuries and fractures involving the acromioclavicular or sternoclavicular joints. **Findings:** Of the 821 citations obtained, only four studies proved eligible. In the most pertinent, four orthopaedic surgeons were shown standard views (antero-posterior and 20° cephalic tilt) of 50 clavicle fractures and then additional two views (45° cephalic and caudal tilt), and found that alternative views influenced their decision making, with more surgeons opting for surgical fixation. In a different study, it was shown that orthogonal views of the clavicle increased surgeons' understanding and improved their treatment of these fractures. The third paper was a case series on clavicle fractures that were missed on the initial antero-posterior radiograph, and the fourth paper postulated that postero-anterior views of the thorax were most accurate in determining length of the clavicle. **Conclusion:** Studies showing an optimal view for assessment of clavicle fractures with a decision to then progressing to operative fixation are few, but the evidence points towards surgical fixation when alternative views of mid-shaft clavicle fractures are present.

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\*Corresponding author.

## Keywords

### Clavicle Fractures, X-Ray, Radiographs, Clavicle Surgery

## 1. Introduction

Fractures of the clavicle are common and constitute up to 10% of all fractures [1]. The mechanism of injury is usually medium to high energy, with falling on to an outstretched arm, direct impact during sports and motor vehicle accidents being among the leading causes. Treatment of these fractures is largely divided into conservative and surgical. The decision is dependent upon a variety of factors, the most salient being whether the fracture is open or closed, the location of the fracture on the bone, associated injuries, damage to neural or vascular structures and the degree of displacement. Gauging the degree of displacement can be difficult and good quality radiographs are required to aid the clinician. The purpose of this study is to review the literature on optimal radiographic views of clavicle fractures and their effect on the patients' management plan.

## 2. Methods and Materials

A comprehensive computerised search of Medline™ database was undertaken. We identified articles that discussed various radiographic views of the clavicle in the decision making as to whether the fracture was to be treated conservatively or surgically. Articles in languages other than English, involving the skeletally immature, open fractures, fractures with neurological or vascular injuries and those focusing on acromioclavicular or sternoclavicular joint disturbances were excluded.

We searched for articles in English, published from 1950 to present and additional relevant material was obtained by reviewing the references of eligible studies. The following terms were:

- 1) "clavicle" [MeSH Terms] OR "clavicle" [All Fields] AND
- 2) "fractures, bone" [MeSH Terms] OR ("fractures" [All Fields] AND
- 3) "bone" [All Fields] OR "bone fractures" [All Fields] OR "fracture" [All Fields] AND
- 4) "radiography" [Subheading] OR "radiography" [All Fields] OR "radiography" [MeSH Terms]).

The articles were then assessed for type of study, outcomes, risk bias, statistical analysis and limitations. We identified 827 citations of which four (see **Table 1**) met the eligibility criteria [2]-[5]. One discussed the need for orthogonal views of the clavicle to better understand the true fracture pattern and gave a simple, reproducible method of obtaining these. In this paper there was an increase in the proportion of patients having surgery for clavicle fractures after introduction of orthogonal views [2]. One was a case series on two clavicle fractures that

**Table 1.** Synopsis of eligible articles.

Author	Harris <i>et al.</i>	Alao <i>et al.</i>	Smekal <i>et al.</i>	Austin <i>et al.</i>
Type of study	Retrospective observational Study	Case series	Retrospective observational Study	Comparative cohort study
Level of evidence	III	IV	III	II
Number of patients	41 pre implementation, 45 post intervention	3	30	50
Statistical analysis	None	None	Paired <i>t</i> test or Wilcoxon signed rank test	Kappa analysis for interobserver reliability, Pearson correlation coefficient for intraobserver reliability
Conclusion	Increased proportion of patients having surgery after introduction of orthogonal views (54% v 67%)	Patients would not have had their clavicle fractures missed and treatment delayed if they had alternative views of clavicle	When compared to CT, PA views of the thorax give the most accurate determination of clavicle length	Surgical treatment more likely with orthogonal views

were missed initially, and therefore a delay to treatment because of the failure to perform alternative views of the clavicle [3]. One paper promulgated the theory that the best determinant of clavicle length was a PA view of the thorax, and true shortening of the clavicle fracture can thus be accurately determined [4] and the final paper was a study on how alternative views of clavicle fractures affect the surgeon's decision making [5].

### 3. Critical Appraisal

The study by Harris *et al.* [2] retrospectively compared the treatment of clavicle fractures prior and after the introduction of orthogonal views. Initially, a single antero-posterior (AP) view of the clavicle was used to decide the treatment plan. When this was the standard practice, 22 clavicle fractures were treated surgically and 19 non-surgically. They stressed that the need for orthogonal views of the clavicle is as important as that of any other fractured long bone and they devised a simple and reproducible method of obtaining this, with 30° cephalic and 60° caudal tilt. After the introduction of these orthogonal views, 30 patients were treated surgically and 15 non surgically, a 13% increase in the proportion of patients surgically treated.

This study was done under the guidance of the lead author, an upper limb specialist, so there would be little interobserver variation in the decision making process. It also questions why views of the clavicle are usually compromised despite other long bones getting orthogonal views, a notion that holds much common sense. Ultimately it does show that orthogonal views did tilt the balance of treatment towards surgery, but there were a few weaknesses. There is no mention of the type of clavicle fractures that were being dealt with—medial, midshaft or lateral—as each of these has its own characteristics and it would have been valuable to narrow down the inclusion criteria based on this. Also it would have been meaningful to know whether the fractures pre-implementation of the orthogonal views were similar in nature to those post implementation. Another drawback was that there were more patients in the treatment group after adopting the orthogonal views (45 v 41), and with no statistical analysis it is difficult to determine whether the increase in the proportion of patients undergoing surgery was statistically significant. Also, being a retrospective study, there may have been selection and treatment bias.

Alao and Guly [3] reported a case series of three mid-shaft clavicle fractures that were missed on the initial radiographs but later on repeat X-rays found to be markedly displaced. They pointed out that most emergency departments only perform one antero-posterior (AP) view of the clavicle and acknowledged that had a 45° cephalic tilted view been performed then the fractures were unlikely to have been missed. They pressed upon the need for the diagnosis to be made in a timely manner as delay to immobilisation is implicated in non-union [6] [7].

This paper, though level IV in evidence, gives a stark reminder of the consequences of delaying or missing these fractures altogether. It is relevant clinically, simple and to the point. With the authors only having three patients in their series however, there is a suspicion that the occurrences of missed clavicle fractures are vanishingly rare and raises the cost/benefit question of implementing additional views of all clavicle radiographs without strong clinical suspicion of a fracture and a clear vision that these alternative views will alter the management plan.

Smekal *et al.* [4] measured the length of 30 healed midshaft clavicle fractures. Using a CT scan of the shoulder as a reference, the proportion of shortening of these clavicle fractures was compared to a postero-anterior (PA) view of the thorax, a 15° cephalic tilted view of the shoulder girdle and a 15° cephalic tilted view of the fractured clavicle. Four independent observers were used to evaluate the radiographs and this was supported with clinical measurements from the acromio-clavicular to the sternoclavicular joint. This was all repeated one month later to obtain intraobserver data. Mean differences were compared using the paired *t* test or Wilcoxon signed-rank test. It was found that postero-anterior radiographs of the thorax was the best determinant of clavicle length when compared to 15° cephalad tilted radiographs of the shoulder or clavicle.

This paper has a straightforward study question—how can we best determine length of the clavicle?—and is supported by a good design, multiple observers who performed the evaluation twice for accuracy, and robust statistical analysis. Another strength of the study is comparison with the uninjured clavicle so each case already had a control for comparison. The conclusion is that a PA view of the thorax most closely agrees with the measurement of clavicle length using a CT as a reference. It was also the view that had the most interobserver agreement and the highest repeatability co-efficient. This conclusion is unique in that all the other papers only dealt with cephalic and caudally tilted AP views in determining translational displacement, whereas this paper

states that these views are inadequate when trying to determine shortening, one of the most salient factors in the decision as to whether to treat a fracture conservatively or surgically. One small weakness of the study is the assumption that both clavicles are of equal length, which may have led to small inaccuracies of the data. In the discussion bit of the paper they do mention that shortening of the fracture having a detrimental impact on function but they do not give any functional outcome in the thirty patients of the study, which would have been of considerable interest to clinicians.

Austin *et al.* [5] was perhaps the most relevant paper. 4 blinded orthopaedic surgeons were shown a series of 50 clavicle fractures, firstly 2 views (AP and 20° cephalic tilt) and then 4 views (AP, 20° cephalic tilt, 45° cephalic tilt and 45° caudal tilt) one week apart, and asked to comment on how they would treat the fractures with the additional views. The whole exercise was repeated 2 months later. There was an increase in both inter and intra observer reliability with 4 views compared to 2 views as noted by an increase in both the interclass correlation coefficient (ICC—0.87 and 0.65 for the first and second review of 2 views to 0.88 and 0.88 for the first and second review of 4 views) and the Pearson correlation coefficient (0.64 for 2 views and 0.76 for 4 views). In 17 out of the 50 cases at least 1 surgeon changed their mind upon the viewing of four views, and in 13 of these cases the change was towards operative fixation from initial conservative management.

This study was well constructed, carried out multiple times to increase the accuracy of data and had sound statistical analysis that aided interpretation. The four surgeons chosen were of differing experience in dealing with clavicle fractures and there was no standardized criteria for operative intervention but this was left intentionally so by the authors as they thought that this scenario is most consistent with what happens in most units. Of the searches we performed in the literature, it is the one paper which most closely mirrors what we were looking for, and which sheds light on our initial question of whether various views of clavicle fractures affect the management plan.

#### 4. Discussion

Treatment of clavicle fractures is in part dependent on the degree of displacement and orientation of the fracture fragments. The clavicle acts as a strut connecting the axial skeleton to the upper limb, and when it fractures the weight the limb displaces the lateral fragment inferiorly, and the pull of the sternocleidomastoid, which originates in part from the medial third of the clavicle, imparts an upward acting force on the medial fragment. These opposing forces cause translation, angulation and shortening. To accurately determine these parameters of displacement, quality radiographs of the affected clavicle are required. Changes in the orientation of the X-ray beam alter the perceived displacement and it is therefore essential for clinicians to have a reference point so that these parameters of displacement are standardized. This will assist in the decision making process, and anecdotally pick up the fractures that, because of the degree of displacement, would have had a higher chance of non-union and offer early surgery to this cohort whilst simultaneously reducing the number of unnecessary operations.

Radiographs of the medial clavicle are described mainly for injuries of the sternoclavicular joint. The Rockwood (Serendipity) view [8] [9] is an AP view centred on the manubrium with 40° cephalad tilt and taken with the patient supine on the X-ray cassette. With this view there is good visualisation of both sternoclavicular joints [10] [11] and by inference the medial clavicle, although there are no studies to compare it to standard AP views in the imaging of clavicle fractures. The Heinig view [12] of the medial clavicle is a tangential view of the sternoclavicular joint, which again is quoted in sternoclavicular joint injuries but there is no mention of it in the literature with regards to medial clavicle fractures. Hobbs view [13] is taken with the patient seated leaning forward with elbows resting on X-ray table. The source of beam is from above the nape of neck on affected side with the cassette directly underneath. Although mentioned in the imaging of sternoclavicular joint dislocations, there is no paper citing its usefulness compared to other views in medial clavicle fractures. In the Kattan view [14], the prone patient is angled 35° to lessen obstruction of the sternoclavicular joint by spinal structures and a PA view taken. Again it is described for sternoclavicular joint injuries and not for fractures of the medial clavicle.

Fractures of the medial clavicle are rare, comprising 2% - 3% of all clavicle fractures [15], and are usually a result of high-energy injury [16]. They are predominantly treated conservatively so this would explain why there has not been any standard radiograph or study assessing the usefulness of the various views in gauging displacement as they are unlikely to have an impact on the management plan.

Middle third clavicle fractures are the most common, accounting for 69% - 82% of clavicle fractures [17]. In most departments, a single standard AP view of the clavicle is used to diagnose the fracture and these are easier to interpret than medial third clavicle fractures as there is less interference from thoracic structures. Occasionally though, a standard AP view is inadequate leading to misinformed treatment or even missing the fracture altogether [4]. Quesana views of the clavicle [18] are AP views of the fracture site with 40° to 45° cephalad and caudal tilt of the beam and better visualises fracture displacement [17]. Austin *et al.* employed the use of Quesana views in his study and found that it had a significant influence on the decision of orthopaedic surgeons on the management of the fracture, more commonly toward surgical fixation, than a standard AP view and 20° cephalic tilt view of the fracture.

The Zanca view [19] is described in acromioclavicular joint pathology but also gives excellent views of the lateral clavicle. It is an AP view with beam centred on the acromioclavicular joint and tilted 10° to 15° cephalad. It offers good views of lateral clavicle and acromioclavicular joint though there is no literature on its use in the diagnosis of lateral clavicle fractures. One advantage of Zanca views is that it requires a lower dose of radiation than a standard AP radiograph.

Smekal *et al.* found that a postero-anterior (PA) view of the thorax was the best determinant of clavicle length. With shortening of the clavicle of greater than 18 mm in men and 14 mm in women shown to result in an unsatisfactory outcome [20], there is a need to standardise the manner in which radiographs are taken so that clinician is best able to make decisions regarding treatment. Harris *et al.* [2] and Austin *et al.* [5] showed that alternative views of the clavicle did affect the management plan with more surgeons opting for operative fixation. When studies of the clavicle are being performed, it is often based on standard AP views so when confronted with orthogonal or Quesana views of the clavicle, the clinician is left with little guidance as often published studies do not include displacement based on these alternative views.

## 5. Conclusion

From the literature, alternative views of mid-shaft clavicle fractures do influence the decision of treatment and by extension the parameters of potential non-union may be detected earlier. It is our recommendation that they should become routine in emergency departments. Shortening of clavicle fractures is best determined by PA views of the thorax but these are rarely carried out. There is no evidence that alternative views of the clavicle affect the treatment of lateral and medial clavicle fractures, and future research should be aimed at definitively answering this question.

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