

## Short Communication

# Middle third clavicle fractures are the most common fractures in head injuries: a biomechanical and epidemiological study in 1000 patients

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## ABSTRACT

A consecutive series of 1000 cases of head injury, out of which 385 patients presented with fractures. In the 385 patients with fractures, 179 patients presented with clavicle fractures, among that, 127 are middle third fractures. Out of the 189 patients who had clavicle fractures, 90% of them had direct blow to shoulders and 10% had fallen on the outstretched hand. This variation with the mechanism of injury was further investigated by biomechanical analysis of the forces involved in clavicular fractures.

**Keywords:** Middle third clavicle fractures, Head injuries, Shoulder

## INTRODUCTION

Clavicle is a “crank shaped cantilever that carries the scapula and transmits part of the weight of the upper limb to the axial skeleton”.<sup>1</sup> It serves as the sole structure which connects the axial skeleton to the shoulder girdle.<sup>2</sup> The bone is formed by enchondral ossification.<sup>3</sup> When the clavicle is fractured the shoulder slumps downward and forward due to muscle spasm and the effect of gravity. Allman divided the fracture into three groups, proposing different mechanisms of injury for each.<sup>4,5</sup> Group 1 consisted of fractures of the middle third, and the proposed mechanism of injury was a fall on the outstretched hand or direct blow to the shoulder. Group 2 were fractures distal to the coracoclavicular ligament, resulting from a force on the point of the shoulder driving the humerus and scapular downward. Group 3 were fractures of the proximal end of the clavicle and for these the mechanism of injury was given as direct force applied at an angle from the lateral side. This paper reports a clinical study of the mechanism of fracture and also

analyses the forces involved in such an injury, which causes particular type of fracture.

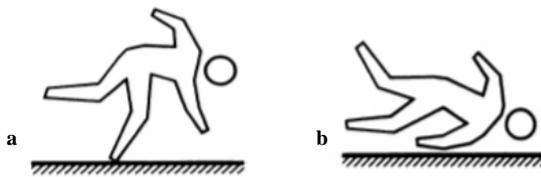
### *Biomechanical analysis of clavicle impact loading (direct blow onto shoulder)*

If a symmetrical specimen of bone is loaded uniaxially in tension then the initial deformations are elastic. Increased loads produce yielding, plastic flow and permanent shear deformation. In contrast, when strongly compressed longitudinally, bone demonstrates buckling. Shear failure, along lines which lie at an angle to the line of application of the force, occurs on the tensile side.<sup>6</sup>

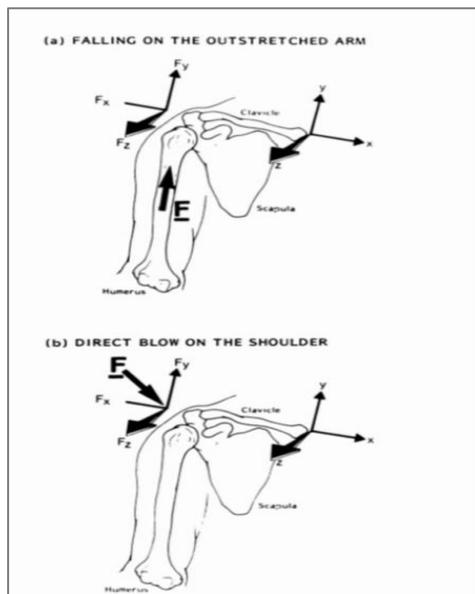
There are three basic mechanisms, apart from uniaxial tension, which can elevate local stress levels in slender bones sufficiently to initiate crack propagation and subsequent fracture (Figure 1). These are bending, torsion and compressive buckling with resultant bowing. The freedom afforded the clavicle by the sternoclavicular joint

makes pure bending an unlikely candidate for fracture during clavicular impact loading.

With impact loading, the force transmitted to the clavicle will only act over the time interval associated with the application of the force. Hence, for clavicular fracture, the critical force will depend on the speed at which the body contacts the ground or other solid object and the time taken for the collision, as well as the weight of the person. Fracture is more likely with a direct blow when the impact energy is absorbed quickly than with a glancing blow in which the impact energy is dissipated more slowly.



**Figure 1 (a, b): Direct blow and outstretched hand.**<sup>8</sup>



**Figure 2 (a, b): Forces acting during injury.**<sup>8</sup>

### **Biomechanical analysis of clavicle fracture (fall on outstretched hand)**

The direction of the applied force is also important. Figure 1 shows the transmitted force when a subject fall on the outstretched arm. It is directed through the head of the humerus to the scapula alone. There is no direct contact with the clavicle. The applied force to the clavicle is through contact with the acromion process. The only component of force which will produce clavicular compression is 'Fx', directed axially along the clavicle. The two components 'Fy' and 'Fz' will tend to move the

scapula upwards and backwards, away from the clavicle, with a predisposition to dislocation rather than clavicular fracture (Falstie-Jensen and Mikkelsen 1982) (Figure 2). Only in those cases when the outstretched arm is in the coronal plane relative to the body, is it likely that the force component 'Fz' will be sufficient to produce compressive buckling and fracture. With an upwards and backwards movement of the scapula it is unlikely this point, there is increase in tension in lateral end of the clavicle causes lateral end clavicle fracture and associated with shoulder dislocation and acromian fracture.

### **METHODS**

A consecutive series of 1000 patients with head injuries associated with clavicle fracture during the period of August 2016 to November 2018 at Sri Ramachandra Institute of Higher Education and Research (SRIHER) were included in the study. They were assessed for the mechanism of injury and the type of fracture (middle third or lateral third).

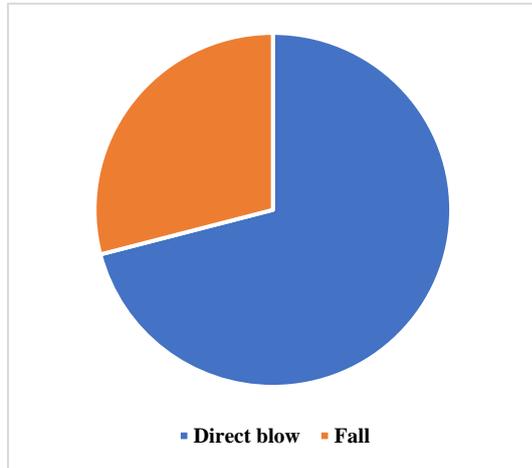
All patients in this case series had at least a cerebral contusion with skull bone fractures and the complications escalated up to massive haemorrhages. All patients were disoriented when they presented in the emergency. Initially they were admitted under neurosurgery in intensive care unit for observation (antioedema measures followed), after a week, repeat CT scan was taken. When the oedema subsided, they were taken up for clavicle fracture fixation. All patients were examined for clinical evidence, such as skin grazing, to corroborate the mechanism they had described. In this study we exclude open fractures, poly trauma (fracture more than two long bones) in which case, the mechanism of injury was different.

Then the patients who had clavicle fractures once considered fit by neurosurgery (range 4-15 days) were taken for open reduction and internal fixation with plate osteosynthesis after that patient was started on mild shoulder mobilization exercises. Postoperative X-ray taken on post-operative day 2, serial dressings were done on post-operative day 5, 8, 12, 15, sutures removed on post-operative day 15. Serial X-rays were taken on 6th week, 6th month, 12th month and 18th month.

### **RESULTS**

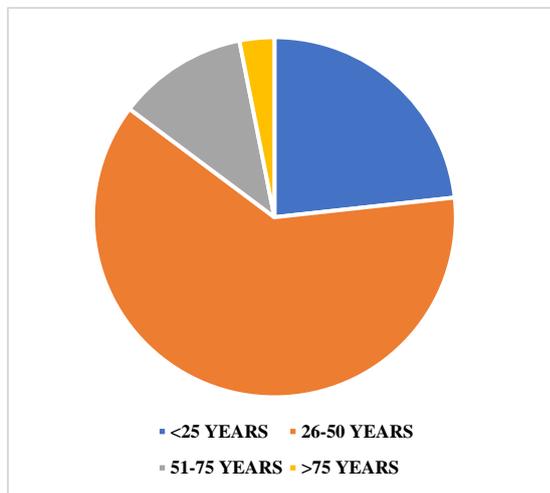
Totally 1000 head injury patients were taken into study in that, 385 patients presented with fractures among that, 179 patients are clavicle fractures, 127 are middle third clavicle fractures and we are also analysing the correlation between the site of fracture and mechanism of injury, depending on the clinical analysis the patients who had middle third fractures had a history of direct blow to shoulder with corresponding head injury, the patients who lateral third fractures had an history of fall on the outstretched hand.

In our series, out of the 179 patients with clavicle fractures, 127 fractures were middle third clavicle fractures and 52 were lateral end clavicle fractures. The mechanism of injury as described in Figure 1 and 2 applies with this fracture pattern as all the fractures in our study (middle third) was a resultant of direct blow to the shoulder.



**Figure 3: Mode of injury.**

In our series, there were 98 fractures were in male patients and 29 were fractures in female patients. Out of the patients the highest incidence was found in the 25-50 years age group (n=78) and the lowest was found in >75 years (n=4).

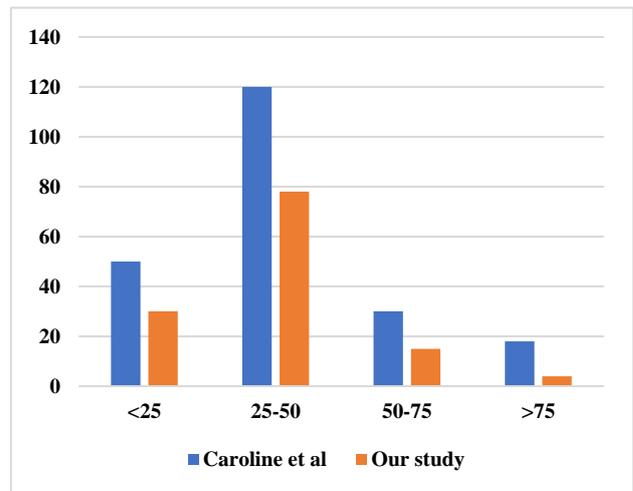


**Figure 4: Age distribution.**

This can be attributed to the mode of injury as the younger group have a higher possibility of road traffic accidents (RTA) leading to a head injury and clavicle fracture. Similarly, the incidence is lowest in the >75 years age group as the mechanism of injury is mainly fall from a stationary position in these age group which is less likely to cause a head injury and a clavicle fracture.

## DISCUSSION

The mechanism of clavicular fracture is generally assumed to be a fall on the outstretched hand. This view, however, is not supported by the clinical or biomechanical results that we have presented. In this study 84% of patients had sustained their fracture as a result of a direct injury (middle third) to the shoulder, with 10% having skin grazing over the point of the shoulder to substantiate the proposed mechanism of injury. This finding is consistent with that of Caroline et al study but unlike these authors we would suggest that a direct blow on the shoulder may also be the mechanism of injury in those who describe a fall on the outstretched hand.<sup>7</sup>



**Figure 5: Comparison of studies with respect to age distribution.**

In this situation, as the hand makes contact with the ground, the patient's body weight and falling velocity are such that his point, but the fall continues with the shoulder becoming the upper limb's next contact point with the ground. Biomechanical analysis of the forces involved indicate that with a direct injury the critical buckling load will be exceeded at a compressive force equivalent to body weight, resulting in clavicular fracture. When the force is applied along the axis of the arm, however, the forces are such that dislocation of the shoulder is the more likely outcome.

A study done by Ferre et al which studies the distribution of clavicle fractures in monotrauma and polytrauma patients shows that clavicle fractures were equally incident in both the types of trauma. This also ascertains that the pattern of fracture and the site of the fracture is solely dependent upon the mechanism of the injury and not the severity of the trauma.<sup>8</sup>

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