

# The anterior head of deltoid in relation to anterior clavicle plating: how much are we releasing?

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**Objective:** Middle to distal-third clavicular shaft fractures are commonly treated with precontoured anterior plating. Some surgeons use mini-fragment plate fixation and position these plates on the anterior clavicle. Recent studies demonstrated the advantages of anterior clavicle plating, including a possible biomechanical advantage with cantilever bending forces and less subsequent implant removal. The insertion and positioning of anteriorly based clavicle plates requires the release of a portion of the anterior deltoid origin from the lateral clavicle. The purpose of this study is to evaluate the anatomy of the deltoid in relation to the clavicle and to determine the percentage of the deltoid origin released to place modern anterior precontoured plates.

**Methods:** Six right and 4 left cadaver shoulders were dissected, each from separate cadaveric specimens (6 male and 4 female). All measurements were made with digital calipers. The length of the clavicle was measured from the acromioclavicular joint to the sternoclavicular joint. The length of deltoid origin on the lateral clavicle was measured from the acromioclavicular joint to the most medial attachment of the deltoid on the clavicle. Percentage of clavicle with deltoid origin was subsequently calculated.

**Results:** The average length of the cadaveric clavicles was 164.4 mm with a range from 134.3 to 178.1 mm. The average amount of deltoid origin on the clavicle was 58.7 mm with a range from 43.4 to 69 mm. On average 35.5% of the clavicle had deltoid origin, with a range from 30.2% to 38.8%.

**Conclusion:** On average, 35.5% of the clavicular osseous anatomy contains deltoid origin. This should be taken into consideration when performing anterior plating for clavicle fractures. With a significant portion of deltoid origin elevated, surgeons may consider altering postoperative protocols until some interval healing has occurred to this anterior head of the deltoid.

**Keywords:** anatomy, anterior inferior plating, clavicle fracture, deltoid origin

## 1. Introduction

Clavicle fractures make up 3% of fractures, and fractures of the middle-third account for approximately 81% of clavicular fractures (Figs. 1 and 2B).<sup>[1]</sup> Prior studies have focused on biomechanical advantages of various types of fixation.<sup>[2–7]</sup> Often mid-clavicular shaft fractures are treated with precontoured plates or mini-fragment anterior plate fixation due to possible

biomechanical advantage and lower implant removal rates (Fig. 2C).<sup>[3,4,6,8–10]</sup> Anterior plating of mid-clavicular fractures requires the release of a portion of the deltoid for plate placement. Prior studies have investigated the anatomy of the anterior origin of the deltoid and found that 25% of the anterior deltoid originates from the acromion.<sup>[11]</sup> The deltoid is a triangular muscle arising from the anterior and superior borders of the lateral clavicle, superior surface of the acromion, and the lower edge of the crest of the scapular spine, dividing the deltoid into anterior, lateral, and posterior groups, respectively.<sup>[12]</sup> The fibers converge distally to insert onto the deltoid tuberosity of the humerus (Fig. 1).<sup>[12]</sup> The fibers of the deltoid can work all together or can work as separate units in their respective anterior, lateral, and posterior groups. The main focus of our paper is the anterior deltoid which can assist in forward flexion and internal rotation.

To our knowledge, prior work has not quantified the amount of deltoid originating from the clavicle. The purpose of this study is to evaluate the anatomy of the deltoid in relation to the clavicle and to determine what percentage of the deltoid is released with modern anterior precontoured plates.

## 2. Methods

Ten cadaver shoulders were utilized for dissection. Each shoulder was from a separate cadaveric specimen so that a right and a left shoulder from the same cadaver were not included. This included 6 right and 4 left specimens (6 male and 4 female). All measurements were made with digital calipers. The length of the clavicle was measured from the acromioclavicular joint to the sternoclavicular joint. At room temperature the joints

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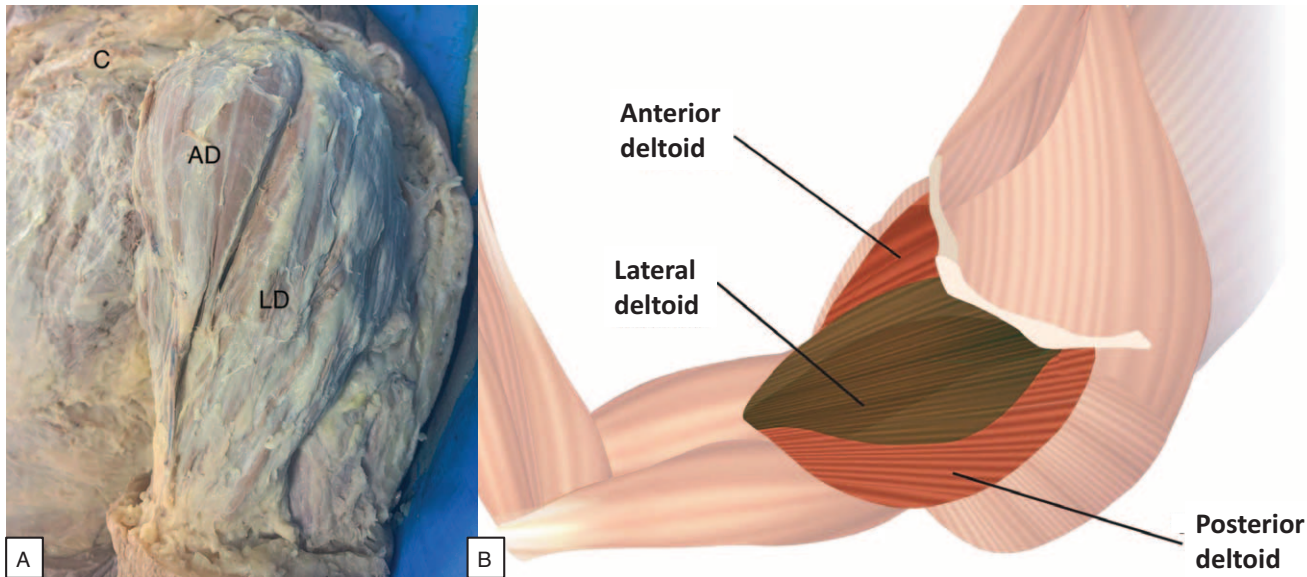
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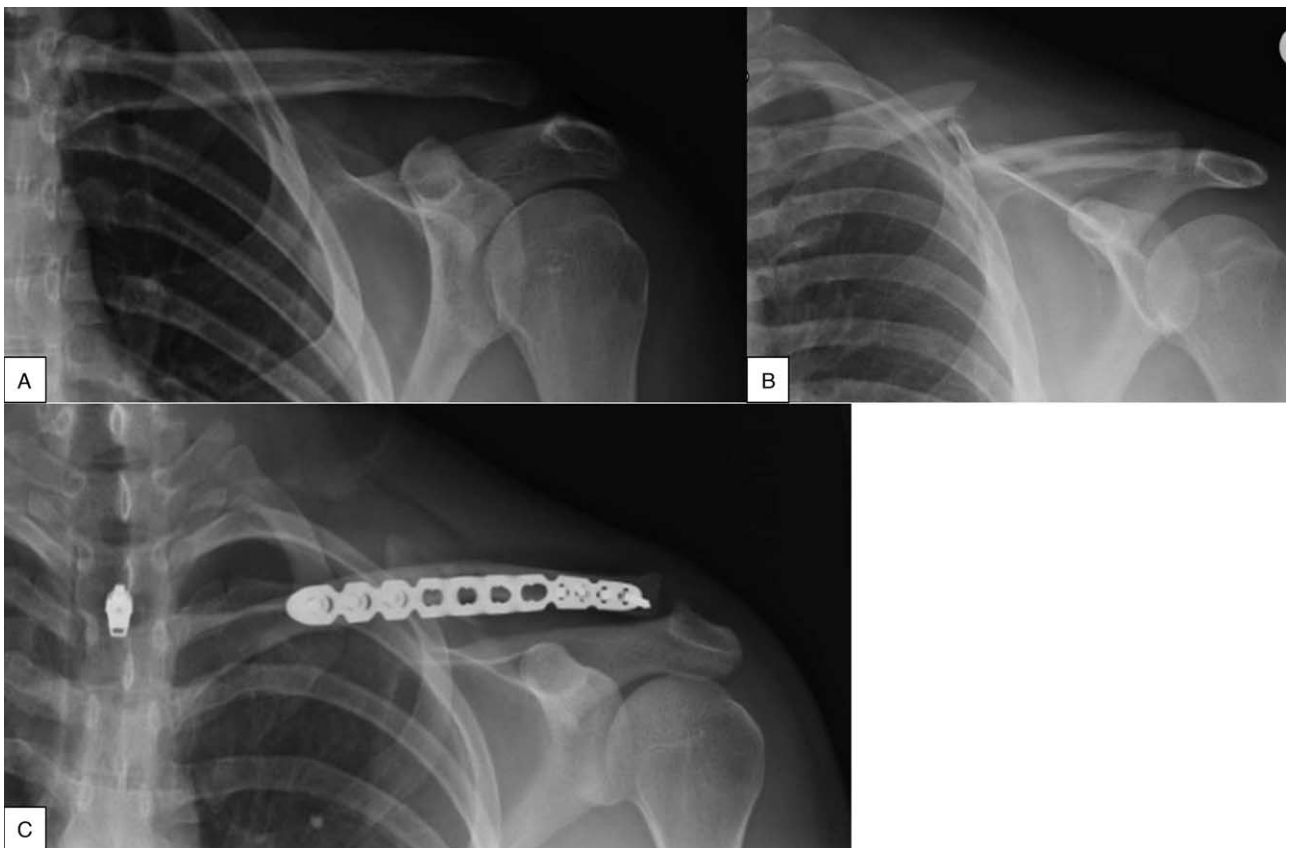
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**Figure 1.** Cadaver deltoid and illustration of a deltoid. A, Demonstrates lateral view of cadaveric deltoid demonstrating the significant contribution of the anterior head of the deltoid. AD = anterior deltoid, C = clavicle, LD = lateral deltoid. B, Demonstrates artist rendition of lateral view of deltoid, again demonstrating origin of anterior head of deltoid on the clavicle.

were dissected and marked by inserting a pin. The length of deltoid origin on the lateral clavicle was measured from the acromio-clavicular joint to the most medial attachment of the deltoid on the clavicle. The percentage of clavicle with deltoid origin was subsequently calculated (Table 1).

One cadaveric specimen was utilized to demonstrate placement of a precontoured anterior plate (Depuy Synthes) (Fig. 3C). Most midshaft clavicle fractures treated with this style contoured plate are based on many manufacturers clustering locking screws in the most lateral aspect of the plate. This study was



**Figure 2.** Radiographs of normal clavicle, clavicle fracture, and clavicle plating. A, Normal left clavicle. B, Left midshaft clavicle fracture with comminution. C, Left clavicle post open reduction internal fixation with use of anterior-inferior plate.

**Table 1**  
**Clavicle and deltoid length of each specimen measured in mm and percent of each clavicle that is covered by the deltoid**

Specimen	Clavicle length (mm)	Deltoid length (mm)	%Clavicle covered
1	160.4	61.6	38.4
2	156.1	52.8	33.8
3	172.8	66.9	38.7
4	174.8	66.5	38
5	143.3	43.4	30.2
6	178.1	69.2	38.8
7	162.3	54.2	33.3
8	159.7	50.6	31.7
9	170.2	63.5	37.3
10	166.7	58.3	34.9
Average length (mm)	164.44	58.7	35.51

exempt from institutional review as it was a cadaver study and did not involve patient data.

### 3. Results

The average length of clavicle was 164.4 mm with a range from 134.3 to 178.1 mm. The average amount of deltoid originating on the clavicle was 58.7 mm with a range from 43.4 to 69 mm. The average percentage of the clavicle with deltoid origin was 35.5 with a range from 30.2% to 38.8% (Table 1).

### 4. Discussion

Anterior plating of clavicular fractures extending from the middle to the distal third of the clavicle has gained popularity amongst orthopaedic surgeons. A single-center study of mid-clavicular fractures utilizing a precontoured anterior-inferior plate reported good outcomes with minimal and minor complications.<sup>[13]</sup> It has been shown that anterior-inferior plating compared with superior plating has a lower rate of implant related irritation and a lower rate of implant removal.<sup>[9,14]</sup>

Analysis of the cadaveric specimens in this study demonstrate that on average, 35.5% of the clavicle contains deltoid origin. With most implant companies making a plate that ranges from the middle of the clavicle to the distal third with lateral locking

screw clustering, it was found that nearly all of the deltoid had to be elevated off the clavicle for proper plate positioning. Some surgeons may advocate for using a mini-fragment anterior-inferior plate so that some of the anterior deltoid can be spared and the plate can be positioned for the particular needs of each individual fracture. Some surgeons have advocated that use of dual mini-fragment plates for fixation of clavicle fractures would allow for preservation of deltoid origin with less symptomatic hardware.<sup>[15]</sup>

The results of this study show that on average, 35.5% of the clavicular osseous anatomy contains deltoid origin. This information may be taken into consideration when performing anterior plating for clavicle fractures as surgeons should be aware of the amount of deltoid that is released. Maintaining the platysma fascia during anterior plating and repairing it after the hardware is installed is beneficial in deltoid attachment and in decreasing plate irritation.<sup>[10]</sup> At this time, postoperative protocols vary between surgeons.<sup>[10]</sup> As this was a cadaveric study, conclusions on the clinical outcome are limited. It is likely that the deltoid release will vary between patients, and each patient may have varying release based on fracture severity. Given that the anterior deltoid contributes forward flexion strength,<sup>[12]</sup> this new information may alter postoperative protocols to account for the detachment of the deltoid from the lateral clavicle to protect the anterior deltoid in the initial



**Figure 3.** Illustration of clavicle and deltoid and cadaver clavicle plating. A, Artist rendition showing relationship of clavicle and deltoid with significant deltoid origin from the clavicle. B, Cadaveric right shoulder demonstrating deltoid origin on clavicle. C, Right clavicle with anterior inferior plate attached demonstrating elevation of deltoid origin for plate application.

postoperative timeframe. Further research should focus on the clinical outcomes of protecting the anterior deltoid after anterior plate fixation of midshaft clavicle fractures as well as importance of postoperative restriction and soft tissue repair.

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