
Plunging Dangerously: A Quantitative Assessment of Drilling the Clavicle

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Hypothesis: Neurovascular complications following clavicular plating have been reported in the literature. The center of the subclavian vein lumen has been reported to lie an average of 4.8mm from the medial clavicle. The purpose of this study was to quantify the depth of plunge during drilling of the clavicle with traditional drilling technique and the IntelliSense Drill Technology® (McGinley Orthopedics, Casper, WY).

Methods: Two fellowship-trained, board-certified orthopedic surgeons performed superior-inferior drilling of the clavicles on a fresh cadaveric torso (Figure 1). Nineteen drill holes were made using the IntelliSense Drill in freehand mode, and nineteen drill holes were made with the drill in bicortical mode. In freehand mode, the drill operates as a standard orthopedic drill, but drilling depth data, which the surgeons were blinded to at the time of drilling, were recorded. In bicortical mode, the drill automatically stops when the drill bit penetrates the second cortex and depth is measured in real-time on a digital display. The IntelliSense Drill is FDA cleared and commercially available, and its depth measurement is accurate within 0.6mm. A computed tomography (CT) scan with 0.5mm cuts was performed on the cadaveric specimen, and TeraRecon software (TeraRecon, Foster City, CA) was utilized to confirm hole depth. A predetermined average error of less than or equal to 1.1mm (0.6mm drill measurement error + 0.5mm CT scan cuts/reading error) between the drill-measured depth and CT-measured depth was considered an accurate measurement. The closest distance from the clavicle to the subclavian vein, subclavian artery and brachial plexus were also recorded.

Results: The average difference between the bicortical mode drill depth measurements and CT scan depth measurements was 0.78mm. In freehand (standard) drill mode (Figure 2), the average plunge was 8.80mm. For surgeon one, the range was 5.61mm to 15.82mm with a mean of 10.93mm, and for surgeon two, the range was 3.31mm to 11.00mm with a mean of 6.43mm. The bilateral average distances to the neurovascular structures from middle third of clavicle were: 15.5mm to subclavian vein, 18.0mm to subclavian artery, and 8.0mm to brachial plexus.

Summary Points:

- The IntelliSense® Drill in bicortical mode reliably stopped with penetration of the second cortex.
- With standard drilling technique, plunge depths of both attending surgeons were greater than distances to neurovascular structures previously reported and in this specimen.
- New technology, such as the IntelliSense® drill, may decrease risk of iatrogenic surgical complications related to plunging.

References:

1. Ding M, Hu J, Ni J, Lv H, Song D, Shu C. Iatrogenic Subclavian Arteriovenous Fistula: Rare Complication of Plate Osteosynthesis of Clavicle Fracture. *Orthopedics*. 2012. doi:10.3928/01477447-20120123-21.
2. Robinson L, Persico F, Lorenz E, Seligson D. Clavicular caution: An anatomic study of neurovascular structures. *Injury*. 2014;45(12):1867-1869. doi:10.1016/j.injury.2014.08.031.
3. Lo EY, Eastman J, Tseng S, Lee MA, Yoo BJ. Neurovascular Risks of Anteroinferior Clavicular Plating. *Orthopedics*. 2010;33(1):21-24. doi:10.3928/01477447-20091124-09.

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Figure 1. Drilling left clavicle in superior to inferior trajectory.

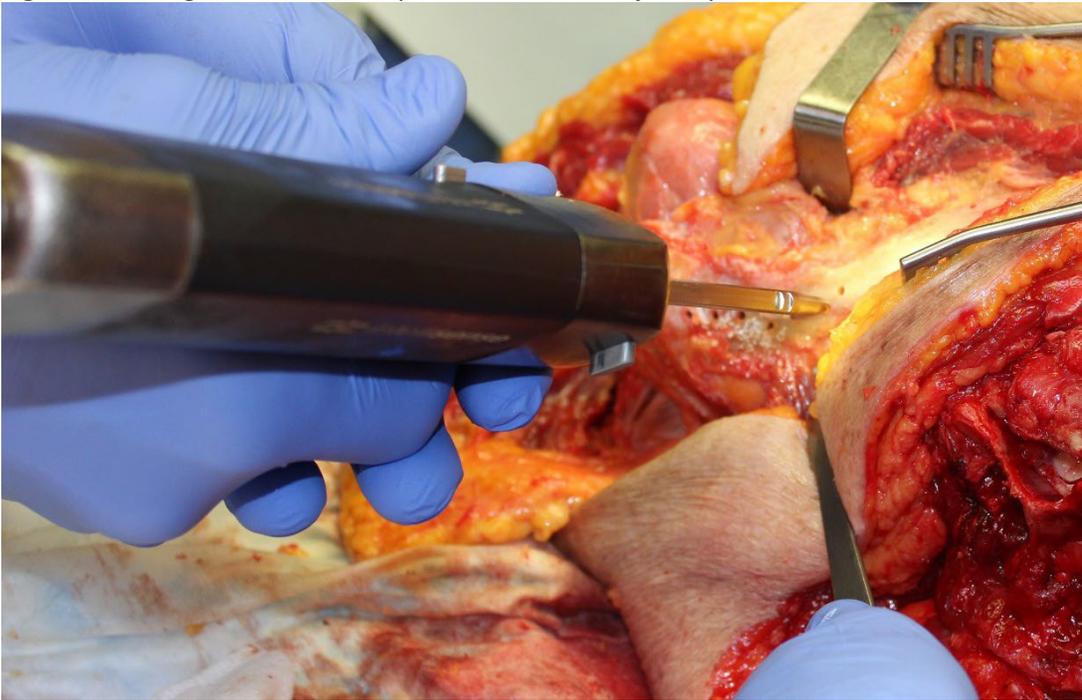


Figure 2. Graphical view of the data for the drill hole with the largest plunge. Relevant stages of drilling are labeled.

