INTRODUCTION
Studies have shown that surgically treated scapula neck and body fractures predominantly utilize a posterior surgical approach to facilitate open reduction and internal fixation. One study reported on the treatment of complex glenoid fractures using a posterior approach in 81% of 27 patients [1]. Studies have reported that intraoperative traction is a potential mechanism of suprascapular nerve injury [2, 3]. To our knowledge there have been no comprehensive studies that quantitatively describe spatial relationships of the suprascapular nerve and ascending branch of the circumflex scapular artery to the posterior surgical approach to the scapula despite these structures being vulnerable during this approach. We aimed to define the topographic distribution in which these vulnerable structures are most commonly found, thus establishing “danger-zones”.

METHODS
Twenty-four non-paired cadaveric specimens were dissected for analysis. The infraspinatus and teres minor musculature were elevated off the posterior scapula body to reveal the suprascapular artery and nerve as they emanated from the spinoglenoid notch. Additionally, the plane between the infraspinatus and teres minor was carefully dissected down to the lateral scapula border to visualize the ascending branch of the circumflex scapular artery, and its associated bony groove. A radial coordinate system to measure relevant distances of structures to critical landmarks was established by anchoring the axis of a goniometer at the medial extent of the acromial spine with a Kirshner wire. The upper arm of the goniometer was then used to measure the reference distance and angle at the terminal motor branches where the nerve enters the infraspinatus musculature, while the lower arm of the goniometer was lined up with the vertebral border. The two-dimensional coordinates were used to determine the relationship between two points based on both measured distance (r) and angle (θ) from a central point (Kirshner wire) to the point of interest (Figure 1). In order to normalize the radial coordinates for each specimen specifically with regard to laterality, a conversion was required using a Cartesian (x and y) coordinate system. Through trigonometric formulae, the radial coordinates were transformed into a Cartesian coordinate system, for purposes of frequency mapping. These data allowed for a logical matrix with true values of the nerve and artery pathways over a standardized scapula. These matrices were then overlayed, thus creating an intensity map to determine the number of times a nerve ran through a specific point. These data allowed for graphical construction of the “danger-zones”.

RESULTS
Overall, the suprascapular neurovasculature was exposed along the undersurface of the infraspinatus muscle and its trunk was always adjacent to the base of the acromion as it traversed the spinoglenoid notch. The mean distance from the spinoglenoid notch to the medial border of the suprascapular nerve where it entered the muscle was 2.5 ± 0.6 cm (range, 1.3 - 3.8 cm). The mean distance from the spinoglenoid notch to the inferior border of the suprascapular nerve “danger-zone” was 2.4 ± 0.6 cm (range, 1.2 - 3.8 cm). The mean distance from the medial extent of the scapular spine to the medial border of the suprascapular nerve “danger-zone” was 4.3 ± 0.8 cm (range, 3.0 - 6.7 cm). The entry of the ascending branch of the circumflex scapular artery was located 5.6 ± 0.7 cm (range, 4.5 - 7.0 cm) inferior to the spinoglenoid notch at the lateral border and 8.0 ± 1.2 cm (range, 5.6 - 9.5 cm) superior to the inferior angle apex of the scapula. A normalized scapula with pertinent bony landmarks was overlayed with both the suprascapular nerve and ascending branch of the circumflex scapular artery, and reflected as shaded “danger-zones” to demonstrate these distance measurements (Figure 2). The rounded maximal distances produced a 4-7-8 Triangle, which was determined by a maximum of 7 cm down the lateral border of the scapula from the spinoglenoid notch encompassing the potential location of the circumflex artery entry, and 4 cm towards the medial border from the spinoglenoid notch to outline the maximum suprascapular nerve location.

DISCUSSION
This is the first study with a detailed morphometric, anatomical assessment of the suprascapular nerve and the ascending branch of the circumflex scapular artery. The suprascapular nerve is located in a vulnerable location, where it curves around the base of the acromion through the spinoglenoid notch. The ascending circumflex scapular artery also curves around the lateral aspect of the scapula and thus is not only highly vulnerable to common fracture patterns but also to retractors placed over the lateral border [4]. Typical injury mechanisms with impact to the lateral shoulder may result in proximal fragment displacement, and fracture locations involving the spinoglenoid notch [3]. Familiarity with these anatomical landmarks and 4-7-8 Triangle can help the surgeon determine risk for suprascapular nerve injury and aid in the selection of surgical approach, and intraoperative surgical maneuvers.

REFERENCES

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