An In-Depth Review of the Muscular Subunits of the Infraspinatus and Supraspinatus

A Michael Luciani[1], Kaylan N McClary, Bethany Ricci, Christoforos Zisis, Joshua S Frantz, Gabriel Stay, Patrick J Smolinski, Mark C Miller, Christopher C Schmidt
[1]Orthopaedics

INTRODUCTION: The supraspinatus (SS) is composed of two separate subunits: SS cord and SS strap. However, there is still controversy regarding the organization of the infraspinatus muscle with some authors believing it has two subunits, while others support the idea of three subunits. Additionally, the nerve branching patterns to each subunit of the SS and IS are poorly understood. Yet, separate subunit nerve supply could imply different functions. The aim of this study was to define the structure and neurologic anatomy of the SS and IS muscles. We hoped to determine gross anatomy, tendinous connections, humeral footprint areas, muscle volume, and innervation of the SS and IS muscles. Finally, we also aimed to determine the location and amount of overlap between the footprints of the SS and IS, as we hoped to compare our findings to those reported by prior authors.

METHODS:

There were two separate cadaveric preparations and experiments performed for this study. All dissections were completed on a holding device specifically designed for this study. For the first part of the study, twenty shoulder girdle specimens (average age 53 ±16 years; 14 males, 6 females) without rotator cuff pathology were procured. The dissection of each rotator cuff muscle was carried out in a medial to lateral direction under loupe magnification beginning with elevation off the scapula. The muscles were then carefully separated and dissected along natural planes and neurolysis of the suprascapular nerve was performed. The pattern and number of suprascapular nerve branches were recorded for each specimen. Finally, individual cuff footprints were released from the capsule directly off their insertions and immediately painted a unique color. Specimens were randomized to either a SS or IS first release to further elucidate their humeral overlap. Upon release of all footprints, each footprint was then scanned using a laser micrometer (Faro-Arm) to determine footprint areas and shapes.

For the second portion of the study, five specimens (average age 70±7 years; 2 males, 3 females) were prepared to measure muscle volume. Each specimen was scanned using the laser micrometer (Faro-Arm) prior to any muscle releases. Then, each muscle was released individually in a medial to lateral direction. Immediately following each individual muscle release, the specimen was scanned with the Faro-Arm to determine individual muscle volumes. This process was then repeated sequentially until all muscles were released.

RESULTS:

In 20/20 specimens, the SS and IS muscles were composed of (anterior) cord and (posterior) strap and (superior) cord and (inferior) strap subunits, respectively. The shape of the SS and IS cords were oval and the SS and IS straps were rectangular (Figure 1). The humeral footprint areas were the following: SS cord 89±19 mm^2, SS strap 145±40 mm^2, IS cord 202±28mm^2, and IS strap 255±42mm^2**,** overlap of IS cord of SS strap 52±20 mm^2, or 26%± 4.6% of SS strap total humeral footprint area. There was a statistically significant difference between the SS and IS cord and strap footprints ($p<0.001$ and $p=0.037$, respectively). There was no significant difference in the total overlap area or percentage based on order of muscle released ($p\geq0.35$). The overlap occurred at the middle facet of the greater tuberosity in all specimens. The muscle volumes were SS cord 16,506±4068 mm^3, SS strap 9336±4302 mm^3 ($p<0.001$) IS cord 34,733±8303 mm^3, and IS strap 25,542±11,393 mm^3 ($p=0.009$). There were distinct suprascapular nerve branches into the SS cord, SS strap, IS cord, and IS strap muscle bellies in all of the specimens (Figure 2). The mean number of nerve branches into each muscle were SS cord 1.5±0.51, SS strap 1.75±0.85, IS cord 2.55±0.83, and IS strap 3.15±1.03.

DISCUSSION AND CONCLUSION: The SS and IS are both composed of cord and strap subunits. The SS and IS cord subunits have statistically smaller humeral footprint areas than their respective SS and IS strap subunits. However, the SS and IS cord mean total muscular volumes were larger than their SS and IS strap counterparts. This supports the ideas of prior authors[1] that the SS cord subunit transmits the majority of the muscle's contractile load, which should be considered when repairing tears of the supraspinatus. Given the similar anatomic findings in the IS, it is likely that the IS cord also transmits increased contractile load compared to the IS strap. Additionally, the findings of separate nerve branches to the SS and IS cord and strap subunits supports the idea that each subunit functions individually. Given this, it is possible that tears involving these different subunits may have different clinical effects. Finally, this study found overlap of the IS on the SS footprint to be present on the middle facet of the greater tuberosity, which differs from prior authors.

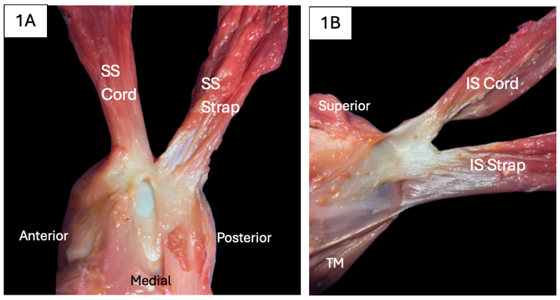

Figure 1: Depicts example of the infraspinatus cord and strap (right) and its similarity to the appearance of the cord and strap of the supraspinatus (left). *SS, supraspinatus, IS, infraspinatus, TM, teres minor.*

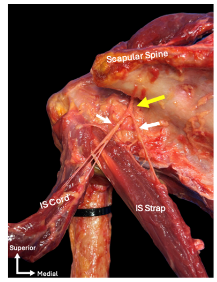

Figure 2: Displays example of the infraspinatus divided into its superior cord and inferior strap portions. The yellow arrow denotes the suprascapular nerve, while the accessory branches to the cord and strap portions are marked with white arrows. *IS, infraspinatus.*