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Research article

# Variations in the anatomy of the anterior-inferior rotator cuff: The "infraglenoid muscle"

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SUMMARY

During the dissection course, 67 shoulders from 35 cadavers were investigated for an "infraglenoid muscle" (IGM). Of the 67 shoulders, 43 cases showed an IGM. When present, the IGM originated at the so-called "marginal axillary groove" of the Scapula. Of these, 86% of the muscles inserted at the crest of the lesser tubercle, 12% at the lesser tubercle itself and 2% at both anatomical structures. During its twisted course it was observed near the capsule of the shoulder joint. All detected IGMs were separated from the subscapular muscle (SM) by a distinct fascia. Due to its anatomical position and its innervation by the axillary nerve, demonstrated in 19 of 43 shoulders, the IGM should be considered to be independent of the SM. The accessory subscapular muscle, previously described by other authors, must be distinguished from our IGM, mainly due to its origin on the surface of the SM. Considering our mere descriptive findings the biomechanical implications of the IGM concerning the rotator cuff will have to be investigated in future studies.



## 1. Introduction

Due to its poorly developed ligaments and its being proportioned between the glenoid cavity and the head of the Humerus (one part to three parts), dislocations and injuries often take place at the shoulder joint (Platzer, 2005). Taking the increasing expectancy of life and associated arthritic and degenerative changes into consideration along with high-risk sports in the younger generation, an increase in surgical interventions around the shoulder joint must be expected.

In the course of shoulder dissections we occasionally came upon a muscular belly arising from the lateral border of the Scapula and inserting on the medial side of the Humerus near the crest of the lesser tubercle. In reference to its position beneath the glenoid cavity we named this muscular belly the "infraglenoid muscle" (IGM). Its fibre course in anatomical slices suggested that the IGM antagonizes the supraspinatus muscle.

The four major muscles around the shoulder joint are the supraspinatus muscle, the teres minor muscle, the infraspinatus muscle, and the subscapular muscle (SM), summarized as the so-called rotator-cuff. The SM was the co-target of this study because the IGM could be a special variation of it.

A number of accessory muscle slips connected with the SM have been reported as variations of the SM by Gruber, Macalister, Henle, Le Double, Kameda, Breisch, and recently by Yoshinaga (Gruber, 1859; Macalister, 1867, 1875; Henle, 1871; Le Double, 1897; Kameda, 1976; Breisch, 1986; Yoshinaga et al., 2008). Therefore, the aim of this study was to define the frequency and basic anatomical parameters as there are origin and insertion of the IGM, in order to elucidate the differences among former studies and to give an overview of new findings concerning variations and anomalies.

## 2. Materials and methods

During the winter term 2009/10 dissection course in the Division of Clinical and Functional Anatomy at Innsbruck Medical University (MUI), 67 shoulders out of 35 cadavers, 23 male (12 right shoulders and 11 left shoulders) and 44 female (22 right shoulders and 22 left shoulders) were examined. Three shoulders were excluded for reasons of degenerative changes either of the SM itself or its tendon.

The bodies under investigation had been bequeathed by persons who had pre-mortally agreed to the scientific use of their bodies in the body-donation program of our division (McHanwell et al., 2008).

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**Table 1**
Distribution of the investigated shoulders.

| | Left | Right | Overall |
|---|---|---|---|
| Female | 22 | 22 | 44 |
| Male | 11 | 12 | 23 |
| Overall | 33 | 34 | 67 |

The specimens were preserved using a formaldehyde–phenol solution. The possibility that this solution could cause preserving artefacts can be ruled out (Platzer et al., 1978).

Bodies showing scars from previous surgery in the shoulder region were excluded as well as specimens with distinct degeneration or rupture of the SM tendon.

The specimens were investigated in detail after they had been removed from the body. In addition the clavicle was exarticulated and the subclavian muscle detached. The serratus anterior muscle as well as all the muscles of the back was cut through at their respective origins. The nerves and vessels were cut proximal to the clavicle. The remaining whole upper extremity was preserved for a further 48 h in our solution.

Afterwards, the Humerus was divided in the middle. All muscles except the teres minor, the deltoideus and the subscapular muscle were trimmed. All vessels and nerves, except for the axillary nerve were removed after identification.

Once an IGM appeared we tried to expose the muscle as a whole. Therefore, we had to divide the SM two centimetres crossways to its fibres in 40 of 43 cases. The nerve-fibres to the IGM were dissected as accurately as possible.

All photographs were taken using a digital camera (Canon digital IXUS 80 IS) with 8 mp at threefold Zoom.

## 3. Results

Out of the initial 35 cadavers, from which both shoulders were harvested, a final total of 67 could be investigated. Three shoulders were excluded due to degenerative or traumatic changes of the subscapular tendon.

Of those 67 shoulders, 33 were left shoulders (11 male and 22 female), and 34 were right shoulders (12 male and 22 female; Table 1).

The average age of the corpses was 82.46 years (SD: 9.1534).

Of the 67 investigated shoulders, 43 presented with an IGM (64%; Fig. 1). Of all left shoulders the muscle was found in 73% ($N = 24$) whereas it was found in 56% of all right shoulders ($N = 19$; Figs. 2 and 3).

Of 23 male shoulders, 14 showed an IGM, whereas of a total of 44 female specimens an accessory muscle was observed in 29 preparations. These numbers equate to 61% and 66%, respectively. Table 2 presents the incidences in detail.

All 43 IGMs originated on the lateral border of the Scapula, thereby always in its lateral third, the “marginal axillary groove”. None of the shoulders displayed an origin in the middle or medial third, or in the subscapular fossa.

The average distance of the origin from the infraglenoid tubercle was 7.77 mm, with a minimum distance of 0.0 mm and a maximum of 26.4 mm.

A septum as a part of the subscapular fascia, which divided the IGM from the SM, was found in all 43 investigated shoulders.

During its spirally twisted course it was determined, near the ventrocaudal part of the capsule of the shoulder joint but was never attached to it.

All IGMs inserted on the Humerus, 86% at the crest of the lesser tubercle, 12% at the lesser tubercle, and only 2% to both anatomical structures. In one case we found an additional insertion at the capsule of the shoulder joint at its ventrocaudal quadrant.

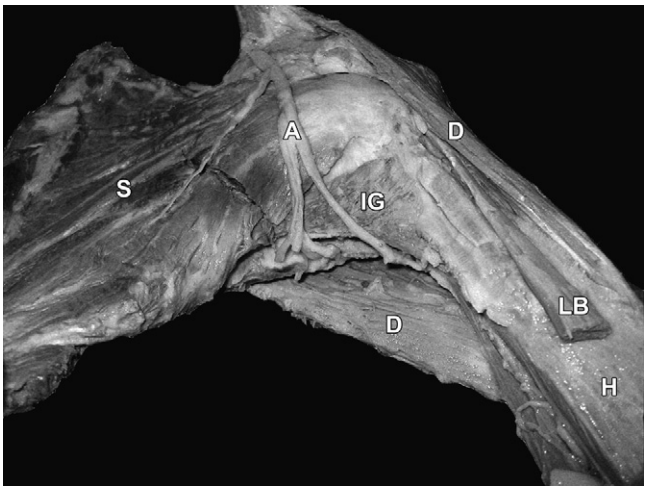


**Fig. 1.** Ventrocaudal view of a left shoulder. The origin of the infraglenoid muscle is covered by the subscapular muscle. S, subscapular muscle; D, deltoid muscle; A, axillary nerve; IG, infraglenoid muscle; LB, long tendon of the biceps muscle; H, Humerus.

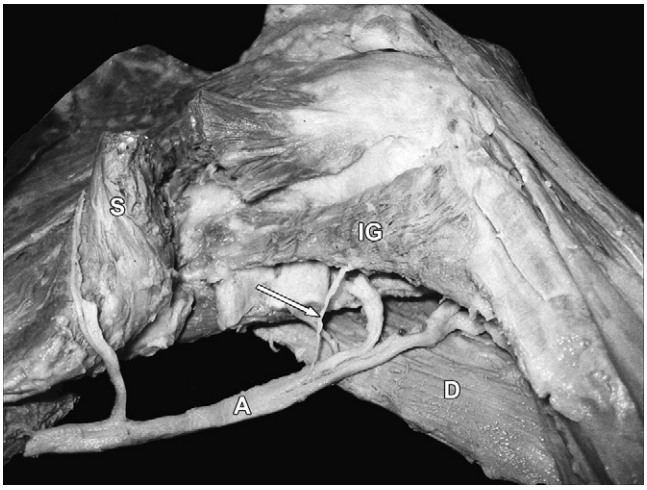


**Fig. 2.** Laterocaudal view of a left shoulder. The point of origin at the lateral third of the lateral border of the Scapula at the “marginal axillary groove” is shown. S, subscapular muscle; D, deltoid muscle; IG, infraglenoid muscle; A, axillary nerve; arrow, nerve branch to the infraglenoid muscle.

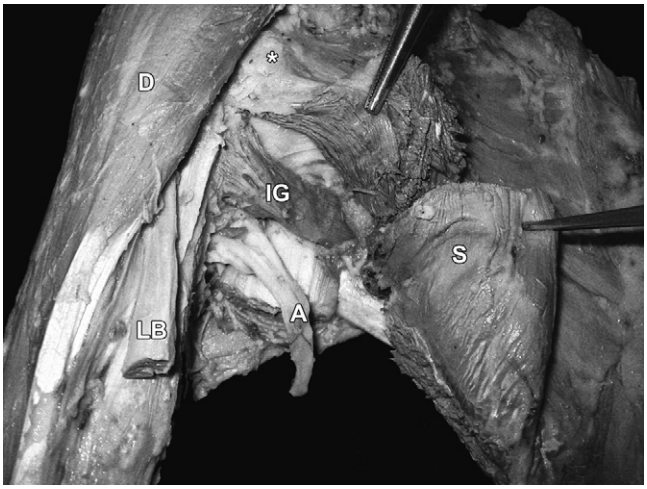


**Fig. 3.** Ventrocaudal view of a right shoulder. The whole infraglenoid muscle can be seen. S, subscapular muscle; D, deltoid muscle; IG, infraglenoid muscle; A, axillary nerve; LB, long tendon of the biceps muscle; asterisk, lesser tubercle.