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# Origin of the long head of biceps brachii from the supraglenoid tubercle and glenoid labrum

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**SUMMARY**

The long head of the biceps tendon (LHBT) provides stability to the glenohumeral joint. Although it has been observed to arise from the supraglenoid tubercle and glenoid labrum, its mode of attachment to the glenoid labrum is variable. This study therefore aimed to (i) identify the origin of the LHBT, and (ii) investigate if there are differences in attachment related to age, gender and side. A total of 140 shoulders from 30 male and 40 female cadavers were examined: the glenoid fossa with the glenoid labrum and LHBT attached were exposed. The classification of Vangsness et al. (1994) was adopted to determine the mode of attachment of the LHBT. Gender, age, side and type of attachment were double-entered into the Statistical Package for Social Sciences. Chi square tests were conducted to determine statistical significance, which was set at P<0.05. Type I was the most common attachment (47.7%) of the LHBT, then Type II (31.5%), Type III (16.2%) and Type IV (4.6%). No significant difference was observed between the type of attachment of the LHBT and sex, side or age. The LHBT consistently arose from the glenoid labrum and supraglenoid tubercle in all the specimens, with the majority of tendons having a posterior orientation. Involvement of the glenoid labrum can be associated with injury to the LHBT: this may explain the existence of a combined injury in shoulder joint instability. Further study is needed to investigate the association between variations of the LHBT attachment to the glenoid labrum and shoulder joint stability.

**Key words:** Biceps brachii – Biceps tendon origin – Glenoid labrum – Anatomy – Shoulder

**INTRODUCTION**

The long head of the biceps brachii tendon is said to originate from the supraglenoid tubercle of the scapula (Prodromos et al., 1990); however, several studies (Paul et al., 2004; Lapner et al., 2010; Bain et al., 2012) have reported that it arises from both the supraglenoid tubercle and glenoid labrum. Earlier Pfahler et al. (2003) observed that the long head of the biceps arose from the supraglenoid tubercle in 22% of specimens, from the superior glenoid labrum in 38% and from both the supraglenoid tubercle and superior glenoid labrum in the remaining 40%. Reis et al. (2009) reported that it arose from either the supraglenoid tubercle or posterior glenoid labrum, while Arai et al. (2012) stated that the tendon of the long head of biceps brachii passes posteriorly along the superior edge of the glenoid such that in the majority (92%) of shoulders the primary component of the posterior glenoid labrum is the tendon.

Pagnani et al. (1996) suggested that the role of the tendon of the long head of the biceps brachii is to stabilize the glenohumeral joint anteriorly and

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posteriorly when the arm is rotated internally and externally respectively. Applying a tensile force to the long head of the biceps tendon, with the highest tension being in passive joint extension with internal rotation, combined with extension at the elbow and pronation of the forearm, suggests that it provides stability to the glenohumeral joint (Gramstand et al., 2010). Suture anchor tenodesis has been shown to provide more joint stability and fewer complications than tenotomy in the long head of biceps lesions associated with tears in the rotator cuff, confirming the role of the tendon in providing stability to the glenohumeral joint (Koh et al., 2010).

Although the long head of the biceps tendon persistently originates from the supraglenoid tubercle, as well as the glenoid labrum, its precise mode of attachment to the glenoid labrum is not only variable (Chauhan et al., 2013; Periyasamy et al., 2012; Vangsness et al., 1994; Barthel et al., 2003; Clavert et al., 2005; Bain et al., 2012), but also of clinical importance. The aim of the current study was, therefore to (i) identify the origin of the long head of the biceps tendon, and (ii) investigate if there are differences in attachment related to gender, side and age.

## MATERIAL AND METHODS

A total of 140 shoulders from 30 male and 40 female cadavers (average age of 81.5 years, range 53-101 years), were obtained from Centre for Anatomy and Human Identification University of Dundee, in accordance with the Human Tissue Act 2006.

All muscles and blood vessels surrounding the glenohumeral joint, as well as the fibrous joint capsule, were inspected and then removed to expose the glenoid fossa with the glenoid labrum and the long head of the biceps tendon attached.

To determine the mode of attachment of the long head of the biceps brachii and the direction of its fibres, the classification of Vangsness et al. (1994) was used (Fig. 1):

Type I: the tendon attached to the posterior part of the glenoid labrum.

Type II: the tendon attached mainly to the posterior part of the glenoid labrum with a small part to the anterior labrum.

Type III: there was equal distribution between anterior and posterior parts of the glenoid labrum.

Type IV: the tendon attached mainly anteriorly with some contribution to the posterior labrum.

Gender, age, side and type of tendon attachment were double-entered into the Statistical Package for Social Sciences (Version 21; IBM, Armonk, NY, USA). Chi square tests were conducted to determine statistical significance, which was set at $P<0.05$.

## RESULTS

Of the 140 shoulders selected for the study only 130 (29 male, 36 female; mean age of 81.52 years old) were examined: in the remaining 10 shoulders there was complete degeneration of the long head of the biceps tendon.

Using the classification of Vangsness et al. (1994), the following types of tendon attachment were observed. Type I, in which all fibres attached posteriorly (Fig. 2A), was the most common and seen in 47.7% (n=62) of shoulders. Type II, in which most fibres attach posteriorly with some anteriorly (Fig. 2B), was the second most common type and seen in 31.5% (n=41) of the shoulders. Type III, in which there is equal distribution (Fig. 2C), was seen in 16.2% (n=21) of the shoulders. Type IV, in which most fibres attach anteriorly with some posterior (Fig. 2D), was only seen in 4.6% (n=6) of the shoulders. There was no significant difference between the type of the long head of the biceps tendon attachment and sex, side or age (Tables 1 and 2).

## DISCUSSION

The current study was undertaken to investigate the origin of the long head of the biceps tendon and its relation to gender, side or age. The observations are similar to previous other studies (Gray et al., 1946; Palastanga et al., 2006; Lapner et al., 2010; Bain et al., 2012) in which the long head of

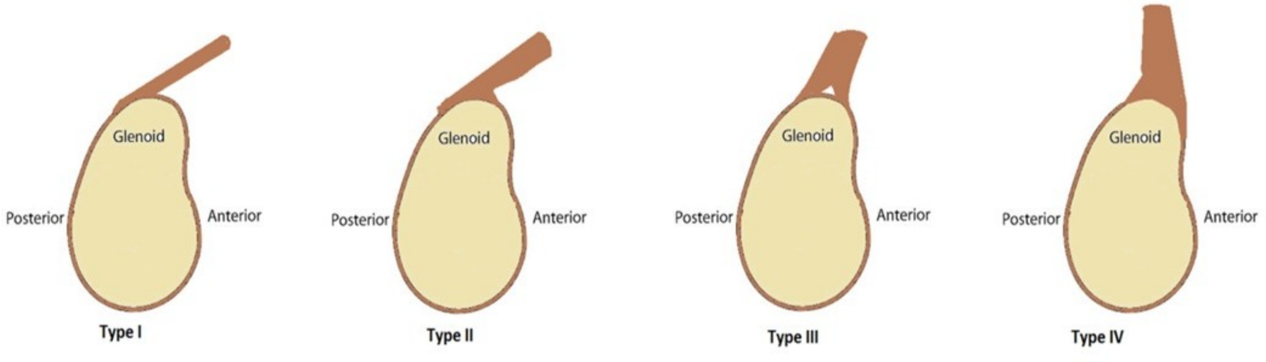


**Fig 1.** Classification of the long head of biceps attachment to the glenoid labrum adapted from Vangsness et al. (1994).

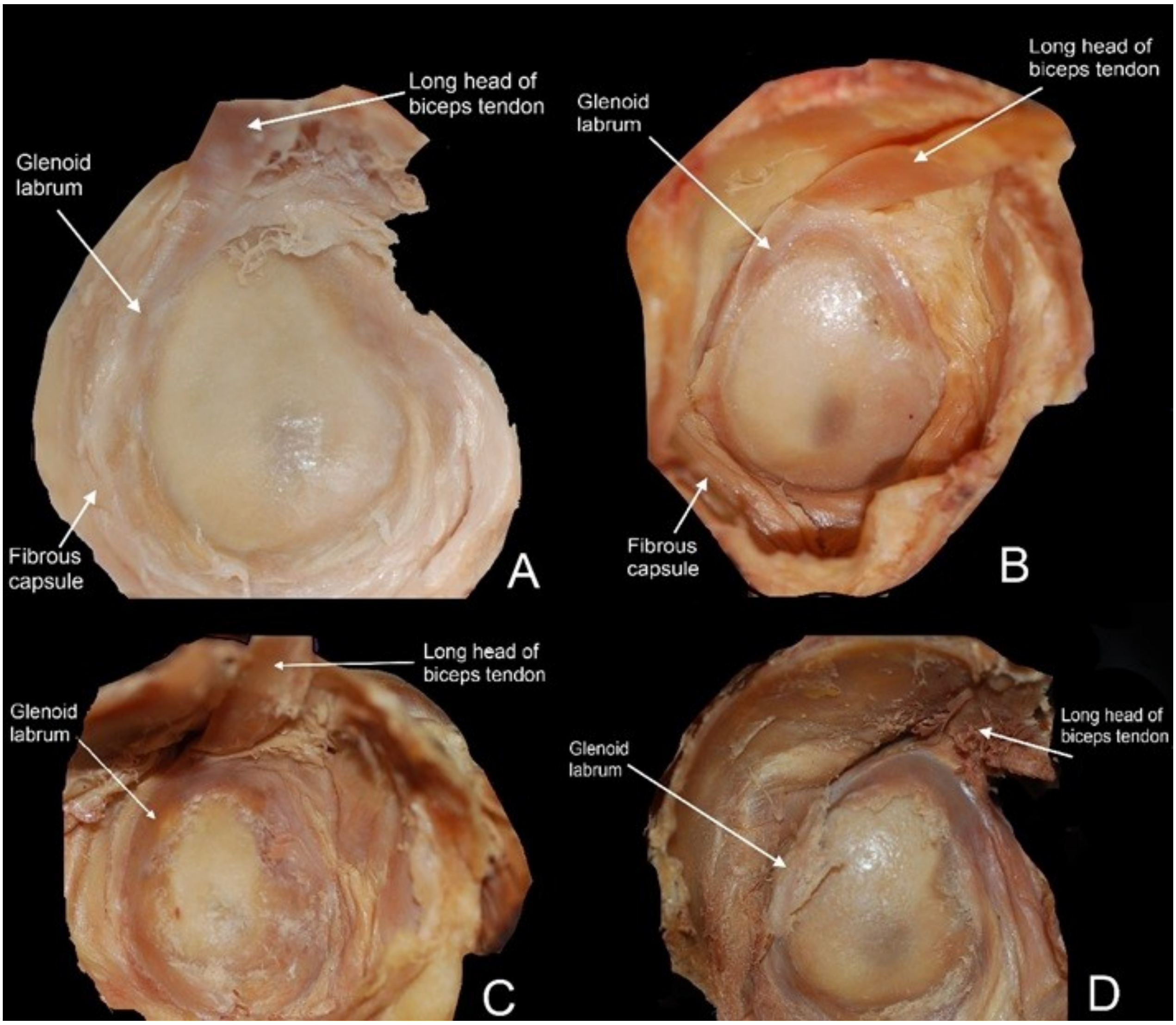


**Fig 2.** Right side shoulder joints showing the different types of attachment of the long head of the biceps tendon to the glenoid labrum: (**A**) Type I, (**B**) Type II, (**C**) Type III and (**D**) Type IV.

biceps tendon was reported to arise from the superior glenoid labrum and supraglenoid tubercle at the superior aspect of the glenoid cavity in all the specimens. In contrast Prodromos et al. (1990) state that the long head of biceps tendon originates from the supraglenoid tubercle, while Kim et al. (2009) report that it arises from the superior glenoid labrum and tendon of supraspinatus.

While the contribution of the glenoid labrum to the attachment of the long head of the biceps tendon is generally not disputed, differences in the site of attachment and its incidence have been reported. The current study found that the long head consistently originated from the supraglenoid tubercle and glenoid labrum, with the majority of tendons being attached posteriorly (79.2%, n=103). Paul et al. (2004) agree that the long head consistently originated from the supraglenoid tubercle and glenoid labrum, with the tendon attached to the posterior and anterior parts of the glenoid labrum in 67% (n=41) and 33% (n=20) of specimens respectively. According to Arai et al. (2012) the long head of the biceps tendon passes posteriorly along the superior edge of the glenoid in the majority (92%, n=45) of shoulders. Periyasamy et al. (2012) reported that the tendon arose from the supraglenoid tubercle blending with the posterior glenoid labrum in 58% (n=29), the anterior and posterior glenoid labrum in 39% (n=19) and the anterior labrum in 3% (n=2), with only a few fibres blending with the posterior glenoid labrum. In contrast, Bain et al. (2012) reported that the tendon arose from the supraglenoid tubercle with a contribution of up to one third from the superior glenoid labrum in all specimens. Earlier Pfahler et al. (2013) observed that the long head of the biceps tendon arose from the supraglenoid tubercle in 22% (n=7), from the superior glenoid labrum in 38% (n=12) and from both in 40% (n=13). In addition to the consistency of the current study in which the long head of the biceps tendon arose from the supraglenoid tubercle and

**Table 1.** Relationship of the type of the long head of biceps tendon (LHBT) attachment with sex.

| | | | Long head of biceps tendon | | | | Total | *P* >0.05 |
|---|---|---|---|---|---|---|---|---|
| | | | Type 1 | Type 2 | Type 3 | Type 4 | | |
| sex | Male | Number | 31 | 13 | 11 | 3 | 58 | |
| | | % within sex | 53.4% | 22.4% | 19.0% | 5.2% | 100.0% | |
| | | % within LHBT | 50.0% | 31.7% | 52.4% | 50.0% | 44.6% | |
| | | % of Total | 23.8% | 10.0% | 8.5% | 2.3% | 44.6% | |
| | Female | Number | 31 | 28 | 10 | 3 | 72 | |
| | | % within sex | 43.1% | 38.9% | 13.9% | 4.2% | 100.0% | |
| | | % within LHBT | 50.0% | 68.3% | 47.6% | 50.0% | 55.4% | |
| | | % of Total | 23.8% | 21.5% | 7.7% | 2.3% | 55.4% | |
| Total | | Number | 62 | 41 | 21 | 6 | 130 | |
| | | % within sex | 47.7% | 31.5% | 16.2% | 4.6% | 100.0% | |
| | | % within LHBT | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | |
| | | % of Total | 47.7% | 31.5% | 16.2% | 4.6% | 100.0% | |

**Table 2.** Relationship of the long head of biceps tendon (LHBT) attachment with side

| | | | Long head of biceps tendon | | | | Total | ***P*** >0.05 |
|---|---|---|---|---|---|---|---|---|
| | | | Type 1 | Type 2 | Type 3 | Type 4 | | |
| Side | Right | Number | 28 | 22 | 11 | 4 | 65 | |
| | | % within side | 43.1% | 33.8% | 16.9% | 6.2% | 100.0% | |
| | | % within LHBT | 45.2% | 53.7% | 52.4% | 66.7% | 50.0% | |
| | | % of Total | 21.5% | 16.9% | 8.5% | 3.1% | 50.0% | |
| | Left | Number | 34 | 19 | 10 | 2 | 65 | |
| | | % within side | 52.3% | 29.2% | 15.4% | 3.1% | 100.0% | |
| | | % within LHBT | 54.8% | 46.3% | 47.6% | 33.3% | 50.0% | |
| | | % of Total | 26.2% | 14.6% | 7.7% | 1.5% | 50.0% | |
| Total | | Number | 62 | 41 | 21 | 6 | 130 | |
| | | % within side | 47.7% | 31.5% | 16.2% | 4.6% | 100.0% | |
| | | % within LHBT | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | |
| | | % of Total | 47.7% | 31.5% | 16.2% | 4.6% | 100.0% | |

superior aspect of the glenoid labrum, in some shoulders (n=20) fibrous bands extended from the tendon which attached to the fibrous capsule near to its bony attachment.

These variations in the long head of the biceps tendon attachment have given rise to different classifications. According to Chauhan et al. (2013) the long head of biceps tendon persistently originated from the supraglenoid tubercle and glenoid labrum, however the mode of labral attachment was variable and could be classified into three types. In type I it arises from the supraglenoid tubercle and posterior margin of the labrum, which was observed in 74% (n=37) of specimens; in type II it arises from the supraglenoid tubercle and most of the posterior labrum with some contribution anteriorly, this was observed in 20% (n=10) of specimens; and in type III it arises from the supraglenoid tubercle and labrum with equal contributions from both its anterior and posterior aspects, this was observed in 6% (n=3) of specimens. Vangsness et al. (1994), in a study of 100 shoulders, extended this classified to four types: in type I the tendon arises from two sites, approximately 50% (n=50) for each part, the supraglenoid tubercle and superior glenoid labrum, with all fibres attaching posteriorly, they observed this type in 22% (n=22) of specimens; in type II fibres mostly attached posteriorly with some anteriorly, they observed this type in 33% (n=33) of specimens; in type III, there was an equal contribution anteriorly and posteriorly, which was observed in 37% (n=37) of specimens; while type IV had most fibres attaching anteriorly with a small contribution posteriorly, observed in 8% (n=8) of specimens. Barthel et al. (2003) and Bain et al. (2012) used the Vangsness et al. (1994) classification, but with fewer specimens. The advantages of the current study are the large sample size (130 cadaveric shoulders) and gross dissection: both factors decrease the risk of bias. The current study found variability in the labral attachment of the tendon, with the majority (type I + type II (79.2%, n=103)) being attached posteriorly and divided between the anterior and posterior aspects of the glenoid labrum (type III) in 16.2% (n=21). Even type IV has some contribution from the posterior aspect of the glenoid labrum. These findings support Vangsness et al. (1994), but in addition found no difference in the type of tendon attachment and sex, side or age.

Pagnani et al. (1996), Gramstand et al. (2010) and Koh et al. (2010) all state that the role of the long head of the biceps tendon is to provide stability to the glenohumeral joint. Gaskin et al. (2007) reported a case with recurrent shoulder dislocation associated with a hypoplastic long head of biceps tendon, which blended with the fibrous capsule distally and posterior glenoid labrum posteriorly: the bicipital glenoid labrum complex did not exist. Similarly, Koplas et al. (2009) and Ede et al. (2006) reported congenital absence of the tendon of the long head of the biceps brachii associated with shoulder instability. Kanatli et al. (2011) found that 7.4% (n=50) of variations of the long head of the biceps tendon were associated with a higher prevalence of labral pathology. In the current study the long head of the biceps tendon was completely degenerated in 7.14% (n=10) of shoulders and was associated with labral tears; however, due to the lack of the medical history of the cadavers the current study was not able to correlate these observations with shoulder joint instability. Further study is therefore recommended to determine whether there is an association between degenerated long head of the biceps tendon and shoulder joint instability. Nevertheless, the current study clearly showed that the long head of the biceps tendon has dual attachment to the supraglenoid tubercle and superior aspect of the glenoid labrum. Consequently, injury or trauma to the long head of the biceps tendon may also involve the glenoid labrum: this could explain why a combined injury could exist in shoulder joint instability.

A third head of biceps brachii has been reported (Fating and Salve, 2011; Shalini and Anupama, 2013; Kore et al., 2013). Other studies have reported that the long head of the biceps origin was Y-shaped with one limb originating just medial to the superior glenoid tubercle and the other from the rotator cable (ligamentum semicircular humeri) (Di Giovanni et al., 2008; Wittstein et al., 2012), which is a fibrous band that has an anterior insertion along the anterior fibers of supraspinatus and a posterior insertion along the posterior margin of infraspinatus (Clark and Harryman, 1992). Huber and Putz (1997) have reported that the long head of the biceps tendon originated from the superior and anterosuperior parts of the glenoid labrum, and the superior glenohumeral ligament. One study (Hyman and Warren, 2001) observed an extra-articular origin of the long head of the biceps tendon. In contrast, the long head of the biceps tendon was found Intracapsular form a double structure (DePalma, 1983) (cited in Benninger, 2006). Few studies (Smith et al., 2002; Glueck et al., 2003; Franco et al., 2005) (cited in Benninger, 2006) have reported a congenital absence of the long head of the biceps tendon. The current study has observed neither a third head of biceps brachii, bifurcated nor absence of the long head of the biceps tendon.

Variations of the anterior superior labrum including the sublabral foramen have been reported in 8–25% of individuals (DePalma et al. 1949; Williams et al. 1994; Tuite and Orwin 1996; Park et al. 2000) (cited in Benninger, 2006). The current study has observed the sublabral foramen in 28.6% (n=40): no significant correlation between the mode of attachment of the long head of the biceps tendon and the existence of sublabral foramen has been observed.

## CONCLUSION

The long head of the biceps tendon was observed to arise from the supraglenoid tubercle and superior glenoid labrum at the superior aspect of the glenoid cavity in all the specimens, with the majority of tendons extending posteriorly. No difference in the type of the long head of the biceps tendon's attachment and sex, side or age was found. Nevertheless, involvement of the glenoid labrum may be associated with long-head-of-biceps-tendon injury, thus explaining the occurrence of a combined injury in shoulder joint instability. Further study is recommended to determine the association between variations in the attachment of the long head of the biceps tendon to the glenoid labrum and shoulder joint stability.

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