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Original Article

Proximal attachment of long head of biceps brachii to the bicipital tubercle of scapula and its functional significance

S.D. Joshi*, S.S. Joshi

Director Professor of Anatomy, Sri Aurobindo Medical College and PG Institute, Indore, M.P. 453555, India

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ABSTRACT

Introduction: Lesions affecting the tendon of Long Head of Biceps brachii (LHB) are among the more frequent causes of pain and disability in the region of shoulder joint. Shoulder arthroscopy has shown that there is dual attachment of LHB to the Supraglenoid tubercle (SGT) and glenoid labrum, but the origin from the bony prominence on upper part of dorsal surface of neck of scapula has not been described in the literature reviewed. This bony elevation has been named as "Bicipital Tubercle (BT)". What is astonishing is the fact that such a prominent BT has been either missed or ignored by earlier workers.

Methods: During the dissection of the shoulder joint, the tendon of LHB could be separated into superficial and deeper laminae. The fibres of the superficial lamina could be traced to BT in approximately 80% cases.

Results: In 70% of specimens LHB was seen to join the posterior labrum; in 20% the anterior labrum and in the remaining to both the labrum. In 57% of right and 65% of the left scapulae the BT was very prominent

Conclusion: The efficiency of action of LHB is enhanced by its getting a firm attachment to the bicipital tubercle (BT). Thus in man the origin of the tendon of LHB has shifted from only the SGT to SGT plus labrum, and further has got an additional attachment to BT. This attachment to the BT seems to have been overlooked and demands its inclusion in all the future studies.

1. Introduction

Lesions affecting the tendon of Long Head of Biceps (LHB) are among the more frequent causes of pain and disability in the region of shoulder joint. Phylogenetic and functional considerations are important for the understanding of high degree of vulnerability of the tendon, a liability which man has had to assume in his compromise with nature by the adaptation of erect posture.[1] Origin of Long Head of Biceps Brachii (LHB) has been described in most of the text books of Anatomy,[2–7] and extensively studied by various workers[8–12] who have reported its attachment to the supra glenoid tubercle (SGT) of scapula and the glenoidal labrum in a variable manner. The origin from the bony prominence on upper part of dorsal surface of neck of scapula has not been described in the literature reviewed. This bony elevation has been named as 'Bicipital Tubercle' (BT), which is easily discernible at this site and its significance from the phylogentic, developmental and functional point of view has been discussed. What is astonishing is the fact that such a prominent BT has been missed by earlier workers.

Man has been unable to adapt himself fully to the requirements of erect posture. Changes in the shape of thorax and the functional demands of a prehensile extremity requires its use in relationship to the ventral aspect of the body, thus establishing an example of conflict between function and structure. In the orthograde animals lateral migration of shoulder girdle left the tendon behind on the ventral aspect; as a consequence the bicipital groove no longer lies in the same plane as the centre of the head, but makes an angle of 30° to it.[1] Such a relationship renders the tendon in this region highly vulnerable not only to trauma but also to the wear and tear of every day functions. Analysis of the shape of the bone provides clues to the stresses acting upon it.[13] Hence the attachment of tendon produces an elevation i.e. BT which gives a firm purchase for an efficient functioning of LHB.

2. Material and method

Seventy shoulder joints available in the department of Anatomy of this Institution over a period of three years were dissected.

* Corresponding author. Permanent address: 204, Sapna Apartment, 39, Kailash Park Colony. Indore, (M.P) -452 001, India.
E-mail addresses: Subhash.joshi@saimsonline.com (S.D. Joshi), sharda_joshi02@yahoo.co.in (S.S. Joshi).

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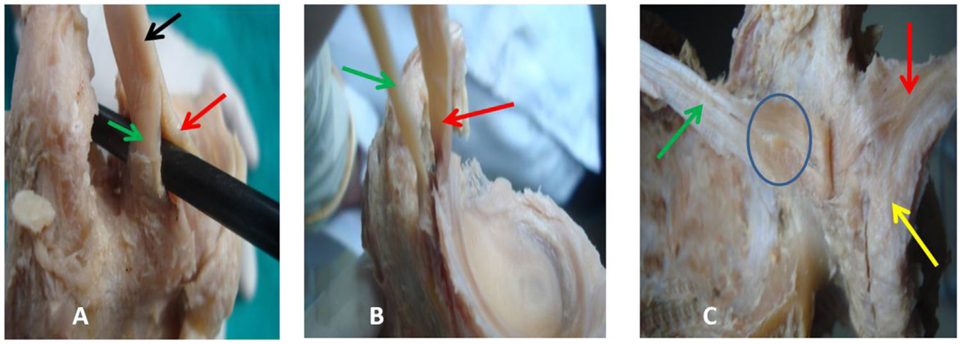

Fig. 1. A: LHB (black arrow) when traced towards the scapula is seen in the form of two laminae – i) superficial green arrow) and ii) deep lamina (red arrow). B: The two laminae have been artificially separated – superficial green arrow) and deep (red arrow). Here the deeper lamina is seen to become continuous with the labrum. C: The two laminae have been further separated to show deeper lamina (red arrow) joining the labrum (yellow arrow); fibres of the superficial lamina (green arrow) are seen to be getting attached to the BT (blue outline).

Periarticular soft tissue around the shoulder joint was removed and the long head of biceps tendon was identified below the bicipital groove of humerus. The tendon was cut transversely at the surgical neck. Later the capsule was incised near its humeral attachment and the LHB was pulled from the bicipital groove and the joint was disarticulated. With little effort the tendon of LHB could be split into a superficial and deep lamina. The scapular component of the joint was observed carefully to note: a) the continuity of LHB with the labrum and the attachment to the supra glenoid tubercle (SGT); and b) the fibres of LHB were traced further through the capsule to its attachment to the BT. All the findings were recorded and where necessary photographed.

Also 280 (140 right and 140 left) dry, macerated scapulae were utilized for the present work. The dorsal surface of the neck of scapulae was observed for the presence of an elevation (BT) which was graded as very prominent, prominent or not discernible. The beveling of the posterior margin of glenoidal rim was also noted.

3. Results

During the dissection of the shoulder joint, in most of the specimens, with little effort, the tendon of LHB could be separated into superficial and deeper laminae (Fig. 1A–C). The tendinous fibres of the deeper lamina became continuous with either the anterior or posterior labrum (Fig. 2A,B), or both and some were getting attached to the SGT. The fibres of the superficial lamina, which continued as a broad thick tendinous band, could be traced passing through the capsule in its postero-superior part to get attached to the upper part of the dorsal surface of neck of scapula to BT (Fig. 3A,B). In 70% of specimens LHB was seen to join the posterior part of labrum glenoidale; in 20% to the anterior part and in the remaining to both.

- In approximately 80% the tendon was getting attached to the BT, while only in 26% it was seen to extend to the SGT.
- In 57% of right and in 65% of the left scapulae the BT was very prominent (Fig. 4A,B; Fig.5A,B); whereas, in others it was less prominent.
- Incidence of beveling of posterior margin of glenoid cavity was distinctly more on the right side (46.14%), compared to the left (28.2%). On this beveled margin posterior part of the labrum could be moved.
- In a number of specimens there was smooth area at the SGT with a synovial pocket (Fig. 2B) intervening between the labrum and the tubercle.

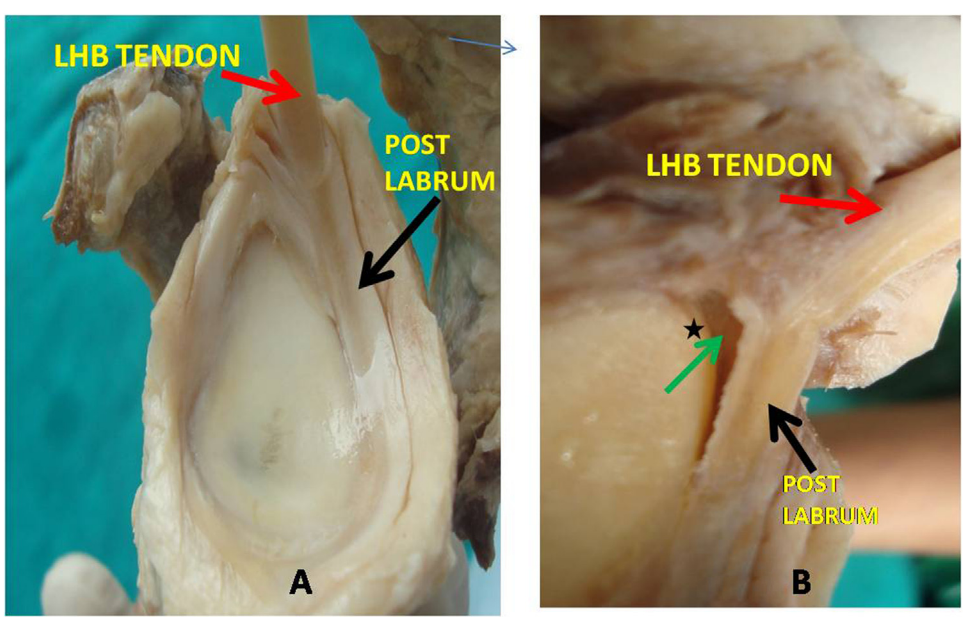

Fig. 2. A: Showing the continuity of LHB tendon (Red arrow) with the labrum, specially the posterior labrum (Black arrow). B: Green arrow shows a deep synovial recess at SGT (black star) and extending downwards deep to the posterior labrum over the beveled margin at the posterior-superior part of the glenoid rim.

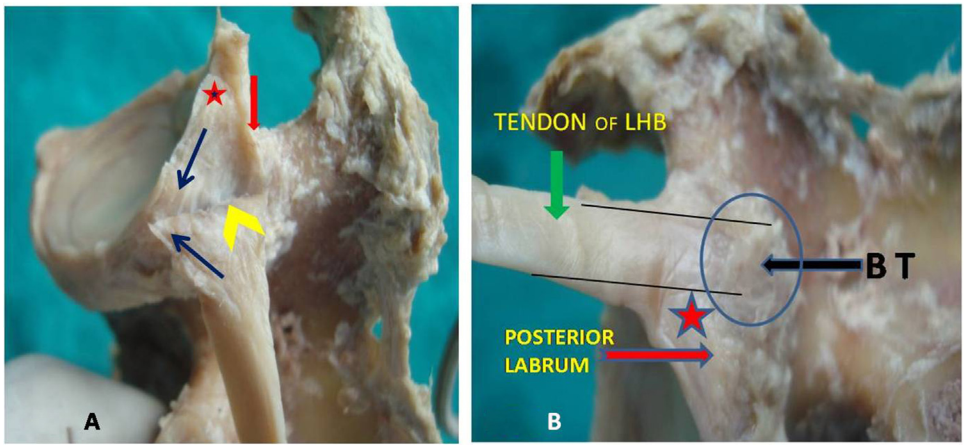

Fig. 3. A: The tendon of LHB near its origin has been separated into a deep lamina seen to be continuous with the cup shaped margin formed by the labrum; part of it divides to reach the SGT (red star). Thick superficial part of the LHB (yellow arrow head) reaches the posterosuperior part (BT) of the neck of scapula. Blue arrows show the continuity of the deep part of LHB with the labrum. Red arrow indicates the cut edge of LHB. B: The superficial surface of LHB is viewed from behind where its inferior border is seen to become continuous with the posterior labrum at the Red star. The superior border is reaching the root of coracoid process (SGT). A broad band of tendinous fibers can be traced upto BT.

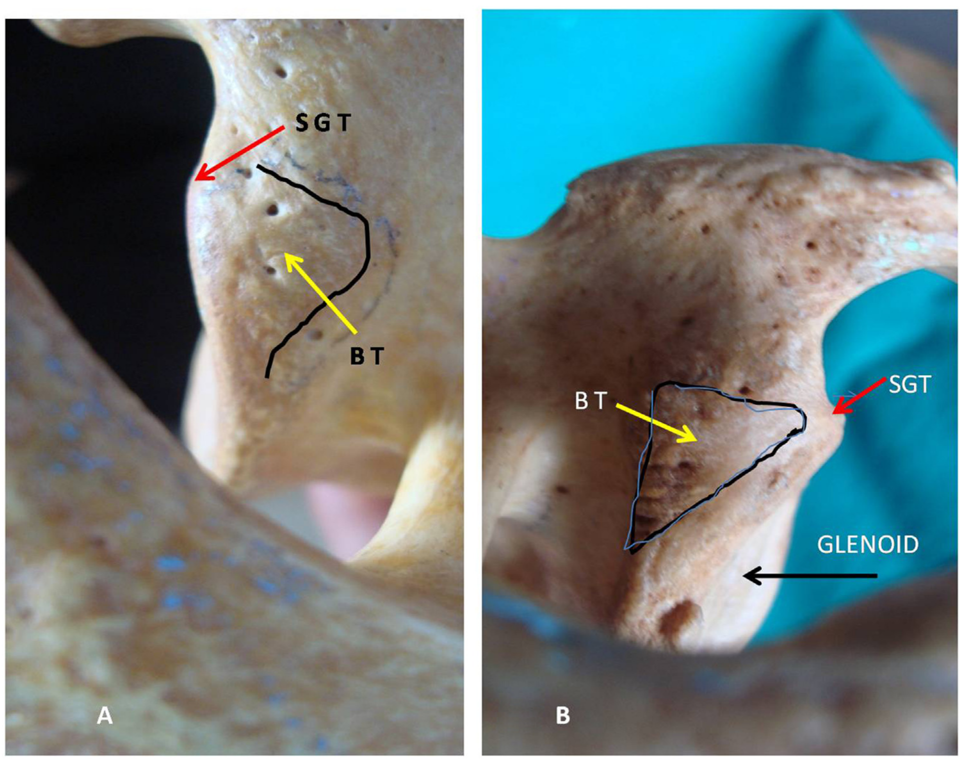

Fig. 4. A and B: Showing the dorsal surface of neck of scapula, wherein in its upper part large bony prominence of Bicipital tubercle (BT) is seen. Red arrow indicates SGT.

4. Discussion

For a proper appreciation of the attachment of long head of biceps brachii it is worthwhile to ponder over the changes that have occurred in its attachment in various animal groups.

In the primitive animals the biceps brachii has one head, whereas in the primates there are two heads.[14] It is interesting to note that in quadrupeds the head of humerus is set almost on the top of the shaft like a drum stick; the tuberosities have an unusual prominence for the stability of the forelimbs. There is no torsion of humerus and the sagittal plane bisecting the head is perpendicular to the transepicondylar line.[15] In pronograde animals the LHB tendon plays on the centre of head of humerus and the tendon is secure and it acts as a powerful elevator. Hitchcock and Bechtol have discussed the phylogenetic changes in orthograde animals stating that lateral migration of the shoulder girdle leaves the tendon of LHB behind on the ventral aspect so that it can work for forearm (Fig. 6). The Bicipital groove is no more in the centre of the head, but makes an angle of 30°.[1]

A number of Phylogenetic factors have been responsible in man for the gradual displacement of the tendon in medial direction. These factors are:

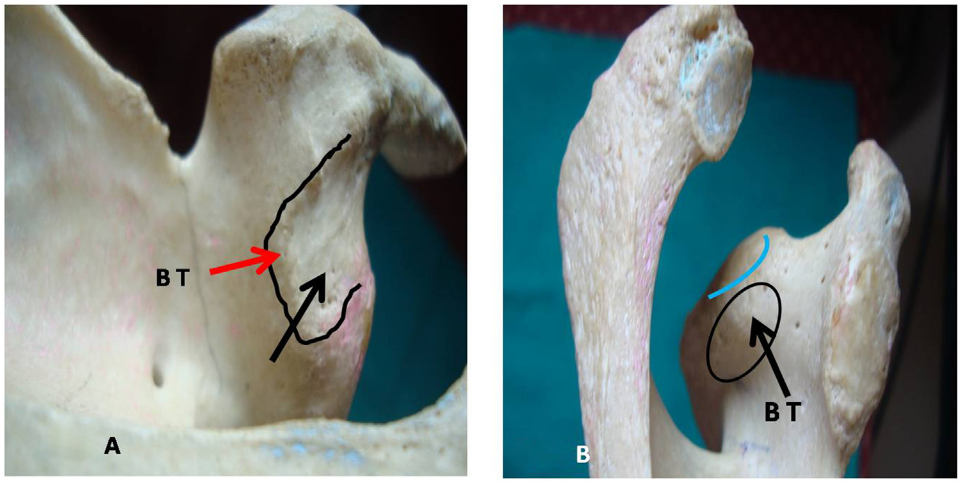

Fig. 5. A: Margins of BT are raised (black line) and wide grooved area is for the tendon of LHB (black arrow). B: Showing BT (black arrow) on the dorsal surface of neck of scapula and also beveling of the postero-superior margin of glenoid demarcated by blue curved line.

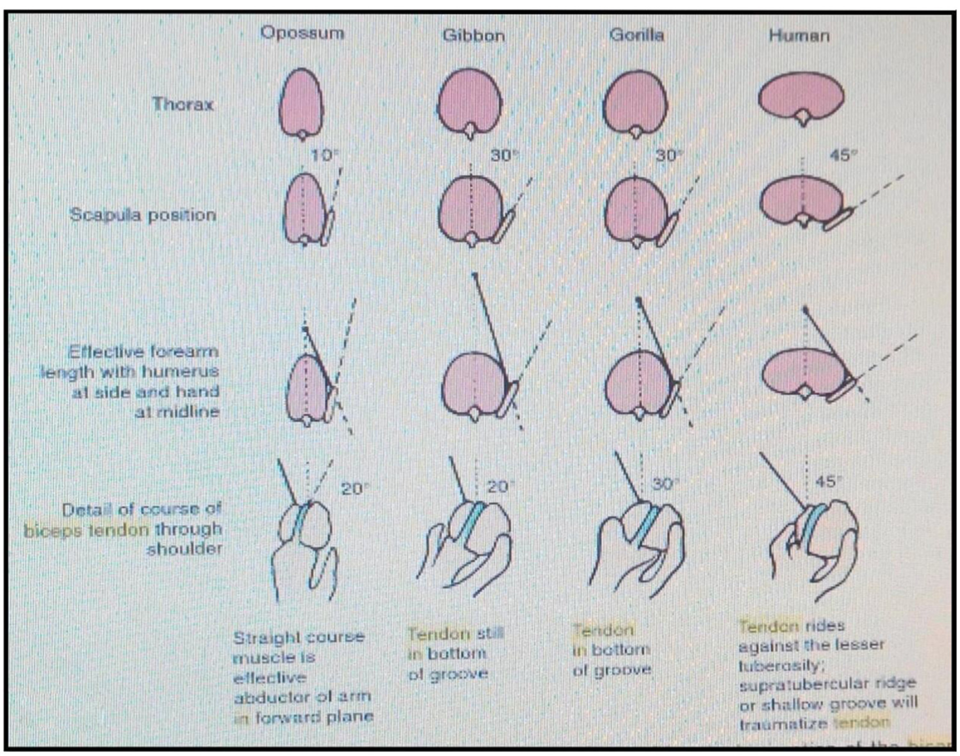

Fig. 6. Shows the phylogenetic changes in the thorax and the glenohumeral joint.

1 Anteroposterior flattening of the thorax leads to dorsal rotation of the scapula and lateral displacement of glenohumeral joint.
2 A relatively short forearm necessitates greater medial rotation of the humerus and migration of bicipital groove in order that the hand may reach the midline.
3 With the displacement of LHB, due to medial rotation of head, it encroaches upon and reduces the size of the lesser tubercle.[1]

Shoulder has been highly influenced by natural selection to promote the throwing skill. LHB has been likened as a spring (muscle), a cable (the long tendon), and a pulley (Bicipital groove). Kuhn has gone to the extent of stating that throwing was important in the evolution of the hand, the brain, bipedalism and human society.[16]

Hooton has discussed about the functional significance of biceps brachii and stated that in man the biceps muscle is ordinarily used to flex the forearm in lifting and pulling; but in climbing apes the whole body weight is often lifted by the flexing of the arm.[17]

In a very detailed and extensive study on 'Painful Shoulder' Hitchcock and Bechtol have mentioned that, contrary to what is believed, the tendon of the biceps does not slide in the groove: but, it is the humerus which moves on the fixed tendon. Motion of humerus on the tendon occurs in all movements of elevation at the shoulder. As these movements are always associated with strong flexion and supination at the elbow, the LHB is rendered exceedingly taut. We habitually use the extremity in various degrees of medial rotation during elevation. Thus, man habitually holds his humerus in abduction and internal rotation. In addition to having a poor anatomical arrangement man's arm is held and used in a position which produces greatest wear on the biceps tendon and makes dislocation more likely.[1]

Embryological considerations:

Wood Jones[2] has mentioned that LHB is attached in some animals to the external aspect of the capsular ligament. Brash JC[3] while describing the development of shoulder in the human embryos has also stated that LHB at first lies outside the developing capsule and this is the persisting relationship in some lower mammals. In human development it sinks through the capsular ligament and it is attached to its deeper surface by a mesentery like fold of synovial membrane. This condition persists in most higher mammals. Normally in man the mesentery breaks down before birth and is surrounded by a sheath of synovial membrane. This embryological progression may become arrested at any stage.[5],[18]

Obviously these descriptions and the findings of the present work do certainly warrant that unless the area is explored and investigated more in details the missing links may not be established. It is with this aim that LHB was thoroughly dissected and the findings are reported.

While examining the descriptions of origin of LHB in various Text books of Anatomy, we finds two groups: one that describes the origin only from the SGT[19–21] and another group that states that it arises from the SGT and the glenoid labrum.[2–7,22,23] Shoulder arthroscopy has confirmed that there is a dual attachment of LHB to the SGT and glenoid labrum.[10]

In the present work during the dissection of the shoulder joint, in most of the specimens, with little effort, the tendon of LHB could be separated into superficial and deeper laminae (Fig. 1A–C). The tendinous fibres of the deeper lamina became continuous with the anterior or posterior labrum or both and were also getting attached to the SGT (Fig. 2A,B). The fibres of the superficial lamina, which continued as a broad thick tendinous band could be traced passing through the capsule in its postero-superior part to get attached to an elevated area on the upper part of the dorsal surface of neck of scapula i.e.to BT (Fig. 3A,B).

Paul et al.[8] found that in about 70% of the specimen the LHB blends with the glenoidal labrum and only a small portion of it goes to the SGT. Pal et al.[9] found LHB to be attached to the SGT in 25% and in 70% it blends with the labrum. Paul S.et al.[11] found biceps tendon to be attached to SGT as well as to the labrum glenoidale. In 67% of their specimens the major part of the tendon was attached to the posterior part of the labrum, while in 33% it was seen being attached to the anterior part as well. Krupp et al.[24] stated that the LHB tendon originates in approximately 50% cases from SGT and in the remainder from the superior labrum suggesting four different variations.

Chouhan K et al.[12] reported that in all specimens it was attached to SGT which is not in agreement with majority of the workers; elaborating further they have stated that in 74% of specimens the major part of the tendon was attached to the posterior labrum, while in 26% it was seen to be attached to the anterior labrum as well. They have categorized them into three types of origin.

In the present study the tendinous fibres of the deeper lamina became continuous with either the anterior (in 20%) or posterior labrum (70%), and in the remaining to both. Thus it clearly indicates that in the majority LHB is attached to posterior labrum. In only 26% they were getting attached to the SGT. This indicates that there is dual attachment of LHB to the SGT and both the labrum and this is quite variable.

The fibres of the superficial lamina, which continued as a broad thick tendinous band, could be traced passing through the capsule in its postero-superior part to get attached to the upper part of the dorsal surface of neck of scapula (BT) in approximately 80%. Pal et al.[9] have also mentioned that there may be absence of post

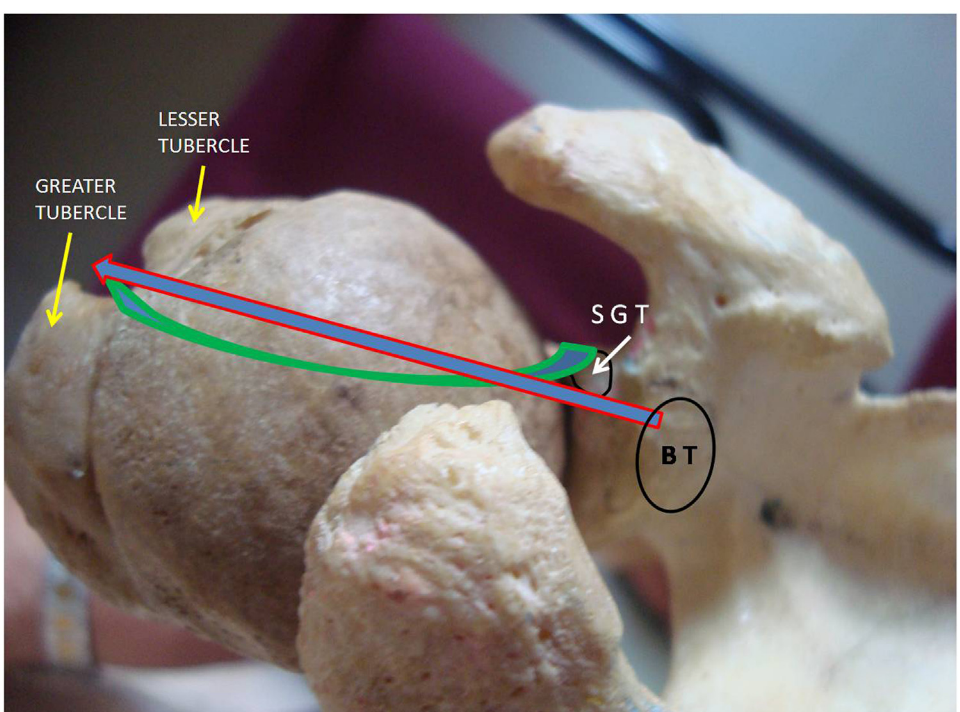

Fig. 7. Showing the left glenohumeral bony articulation viewed from above to show the curved course taken by the tendon of LHB (green) to reach the upper end of Bicipital groove from the SGT. The blue arrow shows the straight course taken by LHB from BT to the upper end of Bicipital groove.

labrum in its postero-superior part being replaced by the tendon of long head, but failed to describe its attachment to BT

In order to further confirm the attachment of superficial lamina to BT observations were made on 240 (120 Rt., 120 Lt.) dry scapulae. In 57% of right and in 65% of the left scapulae the BT was very prominent (Fig. 5A,B); whereas, in others it was less prominent.

It is interesting to note that Breethnach AS[22] and Rockwood and Matsen[25] have referred to SGT as Bicipital Tubercle giving origin to LHB, which should not be confused with the description given by the present authors.

In the present study the incidence of beveling of posterior margin of glenoid cavity (Fig. 5B) was distinctly more on the right side (46.14%) compared to the left (28.2%). On this beveled margin posterior part of the labrum could be moved. Paul et al.[8] noted the presence of a facet at the posterosuperior margin of the glenoid in a large number of dry macerated scapulae. Pal et al.[9] found that In 69% the posterosuperior margin was faceted and this they considered to be due to deficient labrum, which in turn was replaced by biceps tendon.

Krupp et al.[24] while discussing the injuries to the tendon of LHB have mentioned that during eccentric contraction, transferring large forces to the biceps anchor, causes superior labrum anterior to posterior tears (SLAP).

Finally if the origin of LHB is considered only from SGT then it follows an angular course to reach the upper end of bicipital groove, exposing it to greater wear and tear. But if it shifts a little posteriorly to the posterior labrum then this angle will decrease. Further, by getting an attachment to the BT, the course of the tendon becomes straighter (Fig.7) thereby increasing the efficiency of pull and reducing the wear and tear.

Anetzberger H and Putz R[13] in their study of scapula have discussed the underlying principles of its construction and stress and have emphasized that the shape of a bone provides clues to the stresses acting upon it. Thus it seems reasonable to believe that the traction of the broad band of tendinous fibres of superficial lamina of LHB have led to the development of an elevated area described herein as BT. The present consistent finding of an attachment of LHB to BT further confirms that to provide strength and to obviate any loss in efficiency the origin of LHB is shifting to BT.

5. Conclusion

The evolutionary trend and the dynamic role that LHB plays in the stability and protection of the shoulder joint in its various movements, specially overhead sports activities necessitates a thorough review of the attachment of LHB.

It seems that during the evolution of shoulder joint the origin of the tendon of LHB has gradually shifted from only the SGT to SGT plus the labrum. Further there is seen a gradual migration to BT to get additional strong purchase and firm anchorage so that the efficiency of action is enhanced and the direction of pull comes in a straight line rather than making an angle of 30°.This attachment to the BT seems to have been overlooked and demands its inclusion in all the future studies.

Considering all these findings it is not inappropriate to find that in the majority of the cases the long head of biceps arises from the BT, which provides it a strong bony attachment commensurate with its role in the stability of shoulder joint and also as a strong flexor at the elbow joint. In the light of these findings the LHB getting an attachment to BT gives it a biomechanical advantage for efficient functioning.

Conflict of interest

None.

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