GLENOHUMERAL ABDUCTION AND THE LONG HEAD OF THE BICEPS

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ABSTRACT

The role of the long head of the biceps in glenohumeral abduction and the accompanying external rotation is an unsettled issue. Automatic external rotation however has been previously demonstrated during passive abduction, with intact long head and the absence of factors traditionally considered to influence the rotation such as the coracoacromial arch and muscles surrounding the joint. The present study on the anatomy of the tendon of the long head in relation to passive abduction shows that not only is the tendon likely to be harmed by forced abduction without external rotation but the course of the tendon itself is such that activity in the long head during abduction is likely to influence external rotation that in turn prevents tendon impingement between greater tuberosity and glenoid labrum and allows glenohumeral abduction to be carried further towards completion.

Keywords: *Shoulder joint, glenohumeral joint, human, abduction, long head of biceps.*

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INTRODUCTION

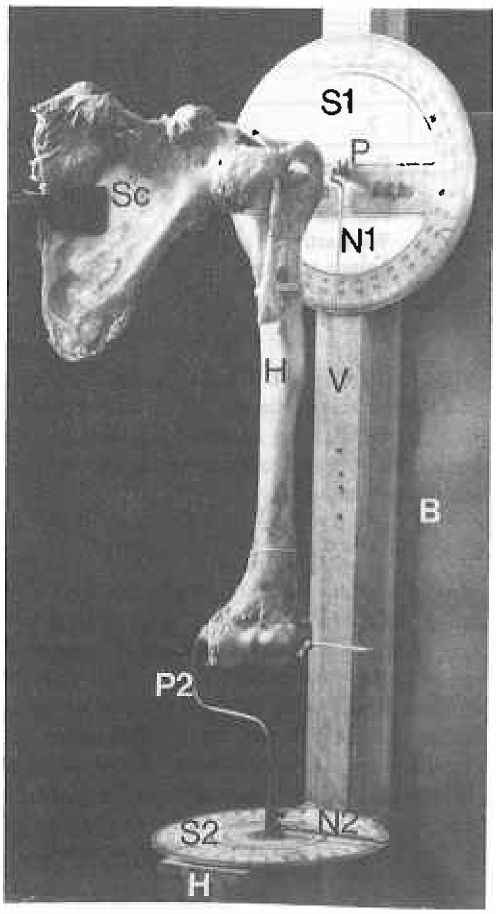
The long head of the biceps, which acts primarily as a flexor at the elbow joint and supinator at the superior radio-ulnar joint, is also generally held to stabilise the shoulder joint by discouraging upward displacement of the humeral head. Although its action as abductor at the shoulder joint is controversial, an earlier study could not exclude a possible role for it in the mechanism of automatic external rotation during abduction. The present study therefore examines the anatomy of the long head of the biceps in relation to glenohumeral abduction in order to elicit any possible relevance to this movement.

MATERIAL AND METHODS

Eleven shoulder joints were isolated intact from formalin preserved cadavers along with the complete scapula and humerus. Each specimen was cleared of all muscle except for the long head of the biceps. The coracoacromial arch was removed to exclude any possible influence on abduction[1] and a window was cut in the superior portion of the capsule to allow observation of the intra-articular portion of the long head (Fig 2). The proximal (upper) half of the long head was preserved along with the transverse humeral ligament.

A metric scale was secured vertically along the greater tuberosity. A metal staple fixed to the tendon of the long head alongside the scale (Fig 2) allowed measurement of any displacements of the tendon in response to movements. Using an implement described in an earlier study[2], each specimen was mounted so that the joint could be subjected to measured amounts of elevation in the scapular plane, or rotation. A vertical board (Fig 1) acts as a reference to the scapular plane.

Fig 1. Set-up for measuring elevation (in scapular plane) and rotation of the humerus. Vertical limb (V) of wooden L-frame is suspended from vertical board (B) at pivot P_1. Needle N_1 fixed to the pivot reads displacements of the vertical limb in the plane of the board against scale S_1. Horizontal limb (H) of L-frame has scale S_2 fixed to it. Pin P_2 passing through centre of scale S_2 is bent three times at right angles so that top horizontal portion passes through hole drilled through epicondyles. Adjustable needle N_2 fixed to P_2 is used for measuring rotary displacements of humerus transmitted through pin P_2. Sc = Scapula; H = Humerus.



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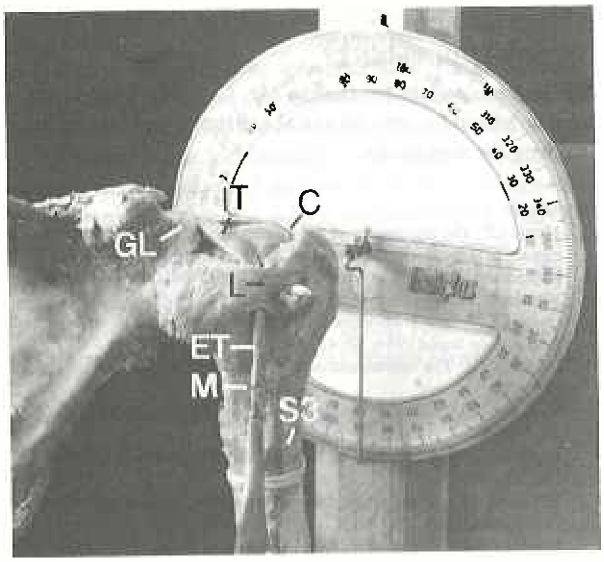

Fig 2. Intra-articular biceps tendon (IT) is exposed by removal of capsule from superior aspect of joint. Extra-articular part of tendon (ET) has metal staple (M) (also refer to Fig. 4) which is used to measure displacements against scale (S_3). GL = glenoid labrum; GT = greater tuberosity; L = Transverse humeral ligament.

A metal rod passing through the board acts as a pivot for the vertical limb of an L-shaped wooden frame. This pivot passes through a scale attached to the vertical limb, and a needle fixed to the pivot, measures the degree of elevation of the L-frame. Each specimen is supported from a retort stand by clamping the scapula so that its medial border is vertical[3] and the blade is parallel to the vertical board. The joint is aligned with the centre of the scale (Fig 1). A metal rod passing through the epicondyles of the humerus (Fig 1) is bent three times at right angles so that the lower vertical part is in line with the shaft and passes through the centre of a scale fixed to the horizontal limb of the L-frame. A pin fixed to the vertical portion of the metal rod measures rotary movements of the humerus against the scale.

Investigations were determined by the knowledge that full elevation through abduction was not possible without external rotation at the glenohumeral joint[1,4,5]. Observations were therefore made firstly on the possible role of the biceps in limiting simple abduction (ie. manual elevation without external rotation) and secondly on the possibility of it influencing external rotation so as to allow full abduction to be completed.

Each specimen was therefore subjected to the following procedures and observations. The course of the biceps tendon was noted in rest position, with humerus vertical and epicondyles approximately parallel to the plane of the scapular[6,7]. By manually elevating the L-frame, simple abduction in the scapular plane was carried out till resistance was encountered. The biceps was again examined for its possible role in limiting the movement. External rotation was then manually effected to see whether this in any way freed the obstruction and allowed any further elevation. Any added elevation was then measured. Changes in muscle length indicated by displacement of the marker on the tendon against the scale (eg. downward displacement of metal staple indicating shortening of intra-articular part of tendon and therefore the long head) in response to external rotation and, any added elevation, were also noted. Prior to any measurement the extra-articular part of the biceps tendon was stretched to take up any slack.

OBSERVATIONS

In the 'rest' position with humerus vertical and epicondyles approximately in line with the scapular plane, the intra-articular part of the biceps tendon was observed to run posteromedially from the top of the intertubercular groove to the supraglenoid tubercle (Fig 2).

After an elevation ranging between 60 and 80 degrees and averaging 67 degrees, further movement was mechanically resisted and forcing this resulted in separation between head of humerus and glenoid in the inferior aspect of the joint. Superiorly, the intracapsular part of the tendon was uniformly observed to be caught between the glenoid labrum and the greater tuberosity (Fig 3). This part of the tendon was noted to take an acute turn backwards from the part lying in the intertubercular groove. External rotation of the humerus ranging between 25 and 50 degrees and averaging 39.5 degrees was able to restore the course of the tendon to a relatively straight one and free the impingement. This also resulted in a shortening of the intra-articular part by an average of 3.7 mm. Once the course of the tendon was straightened, further elevation of the humerus was possible in all the specimens. This ranged between 10 and 30 degrees and averaged 19 degrees. With the added elevation, the intra-articular tendon underwent an average shortening of 5.8 mm. The second phase of elevation was terminated in all the specimens by contact between the greater tuberosity and the labrum glenoidiale.

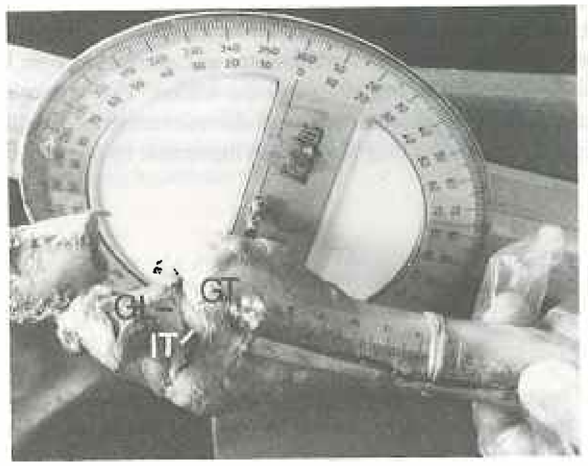

Fig 3. Simple elevation terminated by impingement of intra-articular tendon (IT) between greater tuberosity (GT) and glenoid labrum (GL). Intra-articular tendon now courses backwards from direction of extra-articular tendon.

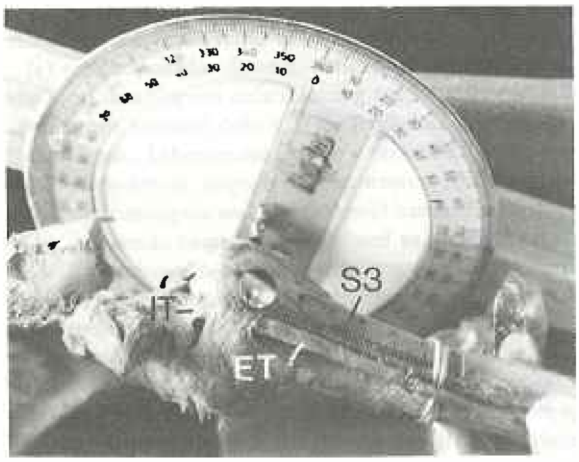

Fig 4. External rotation gives the biceps tendon (ET, IT) a more direct course towards its attachment to the supraglenoid tubercle. Accompanying shortening is measured against scale (S_3). M = Metal staple.

DISCUSSION

With a generally accepted primary action as a flexor and supinator of the forearm the biceps is also held to be a stabiliser at the shoulder joint eg. by preventing upward displacement during abduction[7]. Its disputed role during abduction at the glenohumeral joint is of interest in this present study as an earlier work on the joint was unable to exclude a possible relevance of the long head of the biceps to the mechanism of automatic external rotation during abduction.

Full elevation of the arm through abduction has long been recognised to require external rotation at the glenohumeral joint[1,4,5]. The mechanism of rotation has been attributed to the influence of various periarticular structures such as the coraco acromial arch[4], and muscle groups like teres minor and infraspinatus[8], or deltoid and infraspinatus[4]. Influence of the arch however has been disputed[4,9,10]. Automatic external rotation which is also a feature of passive elevation at the glenohumeral joint[1] has been shown in an earlier study[2] to take place in the absence of the coracoacromial arch and muscles associated with the joint with the exception of the long head of the biceps.

Findings on the anatomy of the long head of the biceps in relation to glenohumeral abduction in the present study point to a significant role for the tendon. Firstly, limitation to simple elevation is imposed at least partly by impingement of biceps tendon between glenoid labrum and greater tuberosity. External rotation was uniformly found to straighten the tendon and relieve the obstruction to elevation. As activity in a muscle with the resultant increase in tension would tend to straighten it, one may reason that activity of the long head during abduction may actively contribute towards automatic external rotation by tending to stretch and straighten the tendon. The shortening observed during external rotation is also relevant to the possible contribution of the long head to this movement by contraction. Electromyographic evidence of biceps activity during abduction however appears conflicting with some positive[11,12] and other negative[13] reports. The observation of further elevation accompanied by further shortening of the tendon lends further credibility to the role of the long head in achieving full abduction by active contraction.

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