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ORIGINAL ARTICLE

Clinico-Anatomical Elucidation of Teres Minor Muscle

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ABSTRAK

Otot rotator cuff (RCM) adalah penstabil dinamik sendi glenohumeral. Gangguan RCM adalah perkara biasa dan oleh itu otot-otot rotator cuff telah menjadi tumpuan para penyelidik. Teres minor, RCM, membantu putaran lateral pada sendi bahu. Di antara semua RCM, variasi anatomi pada otot teres minor adalah paling kurang didokumentasikan dalam literatur dan oleh itu dianggap sebagai otot yang terabai secara klinikal. Tujuan kajian ini adalah untuk meneroka varian morfologi, lokasi penyisipan dan corak penyisipan otot teres minor. Enam puluh mayat kadaver manusia dibedah untuk mempamerkan serat otot teres minor, iaitu dari tempat asal mereka pada skapula hingga ke tempat penyisipan pada humerus. Variasi morfologi bersama corak dan lokasi penyisipan otot teres minor yang tidak biasa dicatat dalam dua (3.33%) spesimen kadaver. Hasil kajian ini menyoroti perubahan filogenetik berterusan yang berlaku pada RCM. Kebiasaan mengenai variasi yang dilaporkan sangat penting bagi pakar bedah yang merancang pembedahan rotator cuff dan prosedur invasif lain di kawasan bahu. Data semasa akan menjadi penting bagi ahli radiologi yang mentafsirkan keputusan imbasan resonans magnetik untuk melaporkan hasil operasi pembedahan rotator cuff pasca operasi.

Kata kunci: filogenetik, keikatan humeral, morfologi, penyisipan, rotator cuff, tendon

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ABSTRACT

Rotator cuff muscles (RCM) are the dynamic stabilisers of glenohumeral joint. Rotator cuff disorders are common and hence RCM have been the area of interest for researchers. Teres minor, a RCM, assists in lateral rotation at shoulder joint. Among all the RCM, anatomical variations in teres minor muscle have been least documented in literature and hence considered as a neglected muscle. The aim of the present study was to explore variant morphology, insertion sites and patterns of insertion of teres minor muscle. Sixty adult embalmed human cadavers were dissected to delineate the fibers of teres minor muscle, from their site of origin on scapula up to the site of insertion on the humerus. Variant morphology along with unusual pattern and site of insertion of teres minor muscle was noted in two (3.33%) cadaveric specimens. The results of the present study highlight the continuous phylogenetic change taking place in a RCM. Familiarity about the variation reported is paramount for the surgeons planning rotator cuff surgery and other invasive procedures in shoulder region. The current data will be significant for radiologist interpreting magnetic resonance imaging scans to report post-operative outcome of rotator cuff surgeries.

Keywords: humeral attachment, insertion, morphology, phylogenetic, rotator cuff, tendon

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INTRODUCTION

The glenohumeral joint is an inherently unstable joint in the body (Standring 2008). All the movements across this joint are assisted by rotator cuff muscles. The rotator cuff muscles (RCM) act in co-ordination with the ligaments and capsule of the shoulder joint to stabilise the head of humerus in the shallow glenoid cavity. Hence, act as dynamic stabiliser of glenohumeral joint (Yanagiawa et al. 2014).

During embryonic stage muscles around shoulder joint develop from paraxial mesoderm. During 5th week the myotomes from C4-T2 somites migrate into the upper limb bud. They form two condensed masses-anterior and posterior. All the intrinsic muscles around shoulder joint including teres minor muscle (TM) develop from posterior condensed mass (Juneja & Hubbard 2020).

Anatomical variations in TM have been rarely reported. Work has been done to study the footprints of TM (Yanagisawa et al. 2009). However, to the best of our knowledge this is the first study highlighting variations in the morphology and insertion pattern of TM.

Phylogenetically, TM and deltoid originated from same muscle primordia, hence share common nerve supply. TM is absent in plesiomorphic mammals, as it is fused with the posterior fibers of deltoid. With the evolution of bipedal gait infraspinous fossa increased in dimension, few of the fibers of deltoid detached from the parent muscle and migrated to get attached near the upper end of humerus. Gradually the detached fibers fuse with the inferior border of infraspinatus (Inman et al. 1944; De Palma 2008). The phylogenetic origin of TM from deltoid was also showed by Fraser et al. (2014). They reported few fibers of TM arising from the deltoid which merged with the other fibers of TM arising from scapula.

The variant architecture of the TM reported in current study may be attributed to phylogenic change occurring in the muscle. The results of this study will assist in better understanding the biomechanics of the TM. The knowledge about the variant morphology must be considered during pre-operative planning of tendon transfer rotator cuff muscle repair (Fletcher 2013). The awareness about the variant morphology of TM will be paramount for radiologist, preventing errors during interpretation of magnetic resonance imaging (MRI) scans during pre-operative management and post-operative prognostic scans (Williams et al. 2018; Costouros et al. 2007).

MATERIALS AND METHODS

The cadaveric study was performed in the Department of Anatomy. Prosected specimens of 60 adult embalmed (eighteen years and above) human cadaveric shoulders with unknown gender were used in the study. The specimens with any signs of trauma or surgery in shoulder region were excluded from the study.

Careful dissection was performed following the steps of Cunningham's manual of practical anatomy-15th edition, to delineate the attachment sites and pattern of insertion of TM muscle. The method of study was in accordance with the Declaration of Helsinki, 1975 and its amendments, 1983.

The observations included any variation in the morphology of TM, site of scapular and humeral attachment and pattern of insertion. The morphometric analysis was done using measuring tape.

RESULTS

In two adult cadaveric specimens, variant morphology along with unusual pattern and sites of attachment of the TM were found. In the first specimen (Figure 1), fibers of TM originated from the dorsal surface of lower part

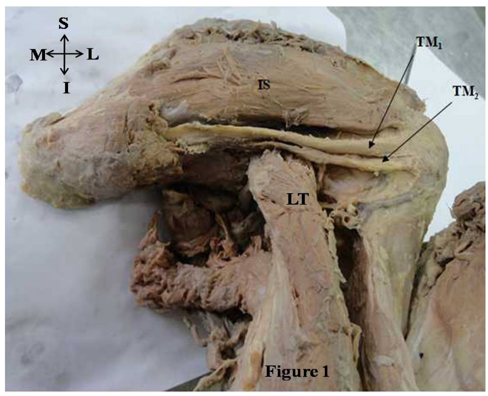

Figure 1: Depicts postero-inferior view of right scapular region showing variant teres minor muscle (IS=Infraspinatus muscle, TM1=Superior tendinous part of teres minor muscle, TM2=Inferior tendinous part of teres minor muscle, TM=Teres minor muscle, LHT= Long head of triceps brachii, TMJ: Teres major muscle)

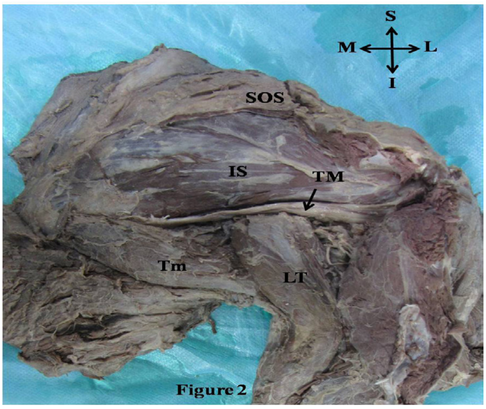

Figure 2: Depicts teres minor with long tendinous part and muscles fibers seen only near the site of insertion on humerus. (TM= Teres minor, Tm=Teres major, LT:=Long head of triceps brachi, IS=Infraspinatus, SOS=Spine of scapula S: Superior, I: Inferior, L: Lateral, M: Medial

of the lateral border of scapula just above the origin of teres major muscle. TM displayed a short muscle belly measuring 2.5 cm in length which divided into upper and lower muscular slips. The upper slip immediately became tendinous (TM1), whereas the lower slip of muscle fibers (L) continued, till the total length of 8 cm after which it became tendinous. The two tendons were labeled as TM1 and TM2. TM1 and TM2 were placed parallel to the inferior border of infraspinatus muscle. The duplicated tendons of TM coursed laterally towards the upper end of humerus, merged with capsule of shoulder joint and then attached to the greater tubercle of the humerus.

In second cadaveric specimen (Figure 2), the origin of TM was tendinous from the upper two-third of the dorsal surface of lateral border of scapula. The tendinous origin of TM continued laterally as musculotendinous slip, fibers of which merged with the shoulder joint capsule and then attached to the greater tubercle of humerus as tendinous insertion.

DISCUSSION

According to the standard textbooks of anatomy, the humeral attachment of TM extends from the lower part of greater tubercle of humerus till the upper part of surgical neck of humerus (Standring 2008). The occurrence of TM with short muscle belly and excessively long tendinous part accompanied by proximal shift of the humeral attachment reported in present study can be best elucidated by McMurrich hypothesis (1923). He suggested that the contractile part of any muscle may get converted into tendon or aponeurosis as a result of degeneration of a part or complete length of muscle. Additionally, McMinn speculated that, series of changes takes place in a degenerating muscle which includes, shortening of the muscle belly with elongation of the tendinous part accompanied by proximal shift of distal attachment of the muscle (McMinn 1990).

McMurrich (1923) postulated; the longitudinal split of muscle primordia results in the formation of two different muscles with common nerve supply. This explains the existence of single muscle belly with two tendons reported in the current study, which may be the result of partial splitting of muscle primordia destined to form TM.

Tulli et al. (2012) conducted a study on lizards and stated that, the length of tendinous part of skeleton muscles is subject of phylogeny rather habitat. Hence, the variant anatomy reported by the authors in present study might indicate towards the phylogenic degeneration of TM muscle. Our results are in accordance with Maeseneer et al. (2006) who stated that, an independent TM does not exist. Instead, TM is fused with infraspinatus and thus considered as the inferior belly of infraspinatus.

The TM muscle once considered as a neglected rotator cuff muscle is now gaining clinical significance. The muscle is now considered as prognostic indicator after rotator cuff repair surgeries. TM hypertrophy is considered as indicator of poor prognosis after rotator cuff repair (Tokish et al. 2016). Hence, radiologist must be familiar with the rare anatomic variant to prevent dilemma during MRI interpretation.

Variation in the architecture and humeral attachment of TM has been scarcely reported (Jain et al. 2012; Bergmann et al. 2006). After exploring the literature in PubMed search engine, we found that previously researchers had worked to explore cross-sectional area of rotator cuff muscles including TM. This is the first study highlighting the variant morphology depicting degenerating TM muscle. Our observations may hold paramount importance for the orthopedic surgeons and radiologist working on the cases with rotator cuff pathologies involving TM muscle.

In a similiar study done by Kang et al. (2019), the TM has been studied in detail however using only MR imaging. They aimed to report the patterns of muscle atrophy-partial or complete. Additionally, they focused to find association of muscle atrophy with the muscle trauma. However, a cadaveric study involving direct visualisation of structures could not be compared with MR study.

In present study, we highlighted the variant anatomy of TM which may be relevant for surgeons and academically for anatomists. The low prevalence reported in this study may be due to the small sample size. Also, nerve supply to variant TM could not be underscored as the work was done on prosected specimens. The comprehension about the morphological characteristic of TM is lacking in present literature hence in future researchers may work to embark the morphological details of teres minor muscle with larger sample size and may also focus upon any variation in the innervation pattern. The present study did not nail the histological features of the teres minor tendon. Further studies with the use of vital stains may be done to study microscopic details of teres minor tendon in comparison to the other tendons.

CONCLUSION

An individual RCM has its own characteristic role in movement of upper limb during locomotion. Degenerating TM muscle is extremely rare entity and probably signifies the continuing process of phylogenetic evolution. The duplicated TM tendon represents deranged embryologic development. Probability of the existence of such variant anatomy must be borne in mind by surgeons to avoid confusion during surgical access of RCM.

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