Teres Major Tendon Transfer for Massive Rotator Cuff Tears

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Introduction: Massive rotator cuff tears restrict patients in their daily activities due to the lack of glenohumeral stability. The rotator cuff muscles generate moments to move the humerus in support of the prime movers, e.g. synergy of Supraspinatus and Deltoids. Because of their small moment arms the rotator cuff muscles can also co-activate to stabilize the glenohumeral joint with minimal interference with the intended elevation moment[1]. In case of a massive rotator cuff tear the lost Supraspinatus function is taken over by the Deltoids, resulting in an increased upwards directed force on the humerus[2]. Corporately, this results in an increased proximal migration of the humerus and a painful inclination of the subacromial tissues. To prevent this, patients may alter their activation pattern in an attempt to compensate these additional destabilizing forces[3]. Adductor muscles, like the Teres major, are able to do so. However, due to its large adduction moment arm, simultaneous activation wuth the Deltoids will result in a decreased Range of Motion (RoM). In other words, there is a conflict between glenohumeral stability and arm mobility; stability is preserve at the cost of mobility. This conflict can be solved by transferring the Teres major[4]. To maintain the stabilizing downward force on the humeral head and reduce the eminent arm adduction moment arm, the Teres major tendon transfer to the insertions of the Supraspinatus on the tuberculum major might be an adequate solution. The Teres major transfer was suggested to be most successful compared to the Latissimus dorsi transfer (not addressed in this study), by biomechanical simulation[5].

Goal of this study was to evaluate the solitary Teres major tendon transfer to the greater tubercle as a treatment for irreparable massive rotator cuff tears by relating clinical outcome with data obtained from an electromyography study.

Materials and Methods: Fourteen patients (10M, 4F, age 60±9) with irreparable rotator cuff tears were tested pre-and 8±1.8 months post Teres major tendon transfer. Shoulder pain was quantified using a Visual Analog Scale (VAS), function was quantified by the Constant Score. Maximal RoM was determined using electromagnetic motion tracking. The difference between pre-and post transplant is tested to significantly differ from zero in order to control for variation in pre-operative status. Muscle function was evaluated using force direction dependent electromyography (EMG). EMG is recorded during isometric force exertion in 24 equidistant directions in a plane perpendicular to the humerus, which eventuated in one direction of maximum muscle activation (Principal Action)[6]. The Principal Action method quantifies shoulder muscles contribution. Comparison with normative values obtained from healthy subjects enables us to identify pathological muscle activation[7]. For individual analysis a Principal Action change of >100° in one or more muscles was considered a change in activation pattern. Maximal arm force was obtained from the principal action set-up in which the direction of maximum activation (principal action), as measured in healthy subjects[7].

Results: No significant correlations were found between age and/or post-operative time of clinical assessment and any of the outcome variable differences. Mean differences between pre- and post transplant clinical variables and standard deviations are presented in table 1. All functional parameters (VAS, Constant score, RoM and arm force) improved after surgery. Prior to Teres major transplant 10 patients-, and post surgery 12 patients co-contracted their Teres major during upwards force exertion (figure 1). Pre-operative this co-activation is pathological, while post-operative it is desirable!

Discussion: This study showed that a Teres major tendon transfer to the insertion of the Supraspinatus provides positive results in terms of pain relief, functional recovery, active Range of Motion and arm force. The increased external rotation force, necessary for active arm elevation[9] might explain the improved functional outcome for some part. But the observed directions of maximum teres major activation, e.g. principal action, indeed show that an alternative mechanism of co-contraction is at work[3,4].

As suggested, the complex interplay between the shoulder muscles is compromised, the balance between mobility and stability in the shoulder is upset which initiates functional limitations caused by stability compensating mechanisms. The success of the Teres major tendon transfer is attributed to Teres major co-contraction, which pre-operative constrained arm function, while this same co-activation pattern supplies glenohumeral stability post-operative, resulting in a restored arm function.

So far our experiments did not show any definite co-activation of other adductor muscles. The adductor muscle (latissimus dorsi/pectoralis major) which co-contracts most clearly might be the most suitable one to transplant. If there is a patient specific preference for any adductor muscle, the apposite approach to identify this muscle would be the principle action method. Further patient inclusion and transplantation of other muscles will clarify this.


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Materials and Methods:

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Figure 1. Principal teres major activation in patients (n=14) suffering massive rotator cuff tears pre and post teres major tendon transfer. The black lines indicate the direction of arm force exertion in which maximal teres major activation was found for every patient. Maximum teres major activation was found during upwards force exertion for 12 patients pre-operative and in 14 patients post-operative. The grey triangles indicate the 95% confidence interval for the direction of maximum activation (principal action), as measured in healthy subjects[7].