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EMG DIAGNOSTICS OF FUNCTIONAL RETRAINING OF EXTERNAL ROTATION TASKS AFTER LATISSIMUS DORSI TRANSFER.

[1]Wolfgang Seiberl, [2]Johannes Plath, [2]Stefan Buchmann, [3]Knut Beitzel, [2]Andreas Imhoff and [1]Ansgar Schwirtz
[1]Department of Biomechanics in Sports, Technische Universität München. email: wolfgang.seiberl@tum.de
[2]Department of Sport Orthopedics, Klinikum rechts der Isar, University Hospital Technische Universität München.
[3]BG Trauma Center Murnau, Department of Trauma and Orthopaedic Surgery, Murnau, Germany

SUMMARY
Latissimus dorsi (LD) tendon transfer is an established surgery for irreparable postero-superior tears of the rotator cuff. Natural muscle function thereby completely changes to external rotation and abduction at the glenohumeral joint. Patients need to relearn this new neuromechanical function. The aim of this study was to check success of relearning new LD function and to investigate possible relations to clinical postoperative results.
Using electromyography (EMG), activity of LD was measured during external rotation tasks with and without co-activation of flection muscles of the glenohumeral joint. Theoretically, enforced co-activation of arm flexion muscles (original LD function) should increase range external rotation in patients with bad postoperative outcome.
Against expectations, there was no increased external rotation in co-activation tasks, although mean LD activity was significantly increased. By dividing groups according to clinical scores, patients with less satisfying results showed a trend to higher LD activity and increased external rotation in co-activation tasks. This indicates that an inferior clinical outcome may be due to insufficient reorganization of LD muscle function. Hence, especially early rehabilitation and specific training on relearning new neuromechanical LD function could increase postoperative outcome.

INTRODUCTION
Tears of the rotator cuff can cause symptoms from discomfort and pain to total loss of shoulder function. Especially after tears of the postero-superior section (infraspinatus and posterior supraspinatus) external rotation and abduction tasks are limited or impossible.

As a salvage procedure, latissimus dorsi (LD) tendon transfer can be used for irreparable tears of the rotator cuff [1]. Here, the tendon of LD is released from the humeral insertion, mobilized and reattached to the greater tuberosity. By doing this, natural biomechanical LD muscle function (extension, adduction and internal rotation) changes to external rotation and abduction at the glenohumeral joint.

Hence, besides clinical treatment, high compliance and good motor skills are essential for a successful therapy outcome, as a new neuromechanical function is to be learned [2]. The aim of this study was to check success of relearning new LD function and its relation to clinical postoperative results. We hypothesized that if therapy results are related to reorganization of neuromechanical LD function, enforced co-activation of arm flexion muscles (original LD function) should increase range external rotation in patients with a less satisfying postoperative outcome.

METHODS
First, medical experts collected data of common scores (active and passive range of motion and American Shoulder and Elbow Surgeons (ASES); Constant-Murley; University of California, Los Angeles (UCLA) and visual analog scale (VAS) pain scores) from n=20 patients (surgery between 2005 and 2009; Ø-Follow-up after surgery: 54.5 ± 24.2 months; age (at surgery): 57.2 ± 9.1 y).

Figure 1: External rotation task with co-activation of arm adduction/flexion muscles (natural LD function).

Second, patients performed external rotation tasks with and without co-activation (CA, Figure 1) of flection muscles of the glenohumeral joint, as well as isometric strength test at operated (OP) and contra-lateral (CO) body side. During co-activation tasks, subjects had to stabilize neutral arm position against cable-machine weight (8kg) using arm adduction/flexion muscles (task ‘CA’).

Myoelectrical activity of LD and deltoideus muscle (Delta) of OP and CO body side was measured using a wireless EMG system (myon RFTD, Myon AG, CH) with a floating ground and bipolar surface electrodes (AMBU® Blue Sensor P, Germany).

Subject preparation and placement of electrodes was conducted following the guidelines of the SENIAM-group [3]. Inter-electrode distance was 2cm, and EMG signals were amplified no further than 10cm from the recording site. EMG data was collected at a sampling rate of 1000Hz and bandpass filtered (Butterworth, 10-500Hz). EMG data was further processed with root-mean-square smoothing (500ms) and was normalized to maximum voluntary activation (MVA).
Presented values of EMG and angle data are means of maximum activity and external rotation out of 3 trials each task. For statistics data of scores, EMG and degrees of external rotation were analyzed using ANOVA.

RESULTS AND DISCUSSION

N=4 patients were discarded from analysis due to sonographically proved LD tendon rupture post OP.

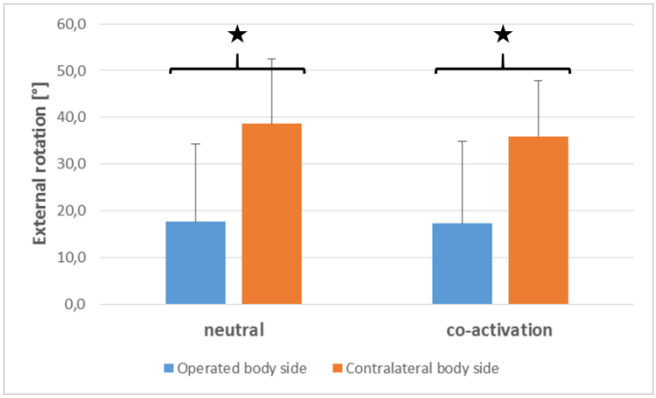

Figure 2: Active external rotation.

At OP body side, mean LD activity in neutral position task was 49.9±12.4% MVA and significantly increased in adducted position to 88.2±7.8% MVA. There was no difference in external rotation in neutral (17.6±17.2°) and CA task (17.3±18.0°) (Figure 2).

At contra-lateral body side, mean LD activity in neutral position task was 42.6±17.7% MVA and significantly increased in adducted position to 81.5±19.3% MVA. External rotation was 38.7±14.4° in neutral position and 35.9±14.3° in co-activation task (Figure 2).

From a biomechanical point of view, re-fixation of LD tendon on the greater tuberosity enables LD to generate significant external rotation torque [4]. In addition, comparable to other work [5], operated LD EMG activity is obvious during new biomechanical function. Unfortunately it is hardly possible to differentiate between patients' intensions to stabilize shoulder (LD adduction) and to actively support external rotation using new LD function. Here, the new protocol of co-activation can help to get a clearer view.

Dividing groups according to postoperative medical scores could help to support our hypothesis, as bad therapy results (n=5; ASES < 70) showed reduced LD activity in neutral position compared to good therapy results (ASES > 70), but no difference EMG at CA task. Although statistically not significant, increased external rotation in co-activation tasks further indicate that an inferiorclinical outcome may be due to insufficient reorganization of LD muscle function.

CONCLUSIONS

Overall group results of this study do not provide statistical prove of our hypothesis that enforced co-activation should increase external rotation in patients with bad postoperative outcome. Nevertheless, clinical outcome and relearning of muscle function do show a specific trend-relation for patients with inferior postoperative results. Therefore, besides successful surgery, postoperative neuromechanical rehabilitation seems to be a major factor for good therapy results.

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