Effectiveness of the Lower Trapezius Tendon Transfer with Tendon-Bone Allograft versus the Latissimus Dorsi Transfer in Reverse Total Shoulder Arthroplasty in Proximal Humeral Bone Loss

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Introduction: In Reverse Total Shoulder Arthroplasty (RSA), proximal humeral bone loss (PHBL) is associated with inferior results, as well as complications such as humeral loosening, component failure and prosthetic instability. As a result of the loss of soft tissue attachments, specifically the posterior rotator cuff, weakness of active external rotation and the inability to positionally control the upper limb in space may ensue in such situations. To address this, adjunct tendon transfers such as the latissimus dorsi transfer or the l'Episcopo procedure have been shown to be beneficial. Similarly, in native shoulders, the lower trapezius transfer (LTT) has demonstrated to lead to significant improvements of external rotation and overall function. The LTT in the setting of RSA has not yet been much examined. Recently, a variation of the LTT applicable to RSA and PHBL has been developed, using an Achilles tendon allograft including the calcanear insertion (LTT+). The purpose of this study was to biomechanically evaluate the effectiveness of the modified technique of the LTT, in comparison with the LDT.

Material & Methods: Ten fresh frozen cadaveric right upper limbs were used and prepared such that a proximal humeral bone deficiency (39.8 ± 3.1 millimetres) was created, a RSA was implanted, and the two different tendon transfers were added. The LTT+ was performed aiming for a congruent fit of the osseous part of its graft to the lateral metaphysis of the humeral stem, and the latissimus dorsi transfer was transferred to the posterolateral aspect of the humerus. The specimens were mounted on a custom-built testing apparatus and reflective markers, and an optical motion analysis system were utilized to record joint kinematics (*fig. 1a and b*). Whilst repetitively motioning the limb through a rotational and an abduction-adduction motion cycle. external rotation and adduction moment arm (ERMA and ADDMA) measurements were carried out by means of the tendon excursion method. After data processing, two-way analysis of variance (ANOVA) with a Bonferroni correction was conducted to compare the mean moment arms of LTT+ and LDT.

Results: The ERMAs of the LTT+ ranged from 11.5mm (±2.6) to 24.9 (±7.0) at 30° abduction, from 11.6mm (±1.7) to 23.0 (±6.9) at 60°, and from 11.0mm (±2.6) to 14.4mm (±4.8) at 90°. The ERMAs of the LDT ranged from 8.8mm (±3.6) to 15.6 (±5.8) at 30° abduction, from 8.3mm (±2.3) to 14.9mm (±5.3), and from 8.0mm (±2.3) to 10.1mm (±2.9). Overall, the ERMAs of the LTT+ were superior to those of the LDT, significance only being reached in end-range external rotation positions (45°-70°). The ADDMAs of LTT+ ranged from -12.6mm (±5.8) to -22.3 mm (±4.4), and the ADDMAs of LDT ranged from -33.8 mm (±6.5) to -55.4 mm (±10.5). Overall, LDT's ADDMA were significantly higher than LTT+'s ADDMA, especially in lower degrees of abduction. The pooled moment arm data including the comparative analysis are illustrated in *figure 2a and b*.

Discussion: Both LDT and LTT+ demonstrated effectiveness for shoulder external rotation of the reversed prosthetic joint in the presence of PHBL, with LTT+ biomechanically outperforming LDT. With regard to external rotation in a clinical scenario, the "in-phase" contraction of the LTT+ with the physiological external rotators may also be advantageous, as is in native shoulders. Importantly, the study's results also demonstrated that LDT compared to LTT+ produces a higher ADDMA. Considering that such forces would antagonize the deltoid's abduction moment arm, this seems disadvantageous in the setting of RSA. As has been previously discussed by other authors, the LTT+ would thus comparatively offload the deltoid muscle during arm elevation. Clinical studies including radiological, functional, and potentially neurophysiological outcome parameters are warranted.

References:

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Figures:

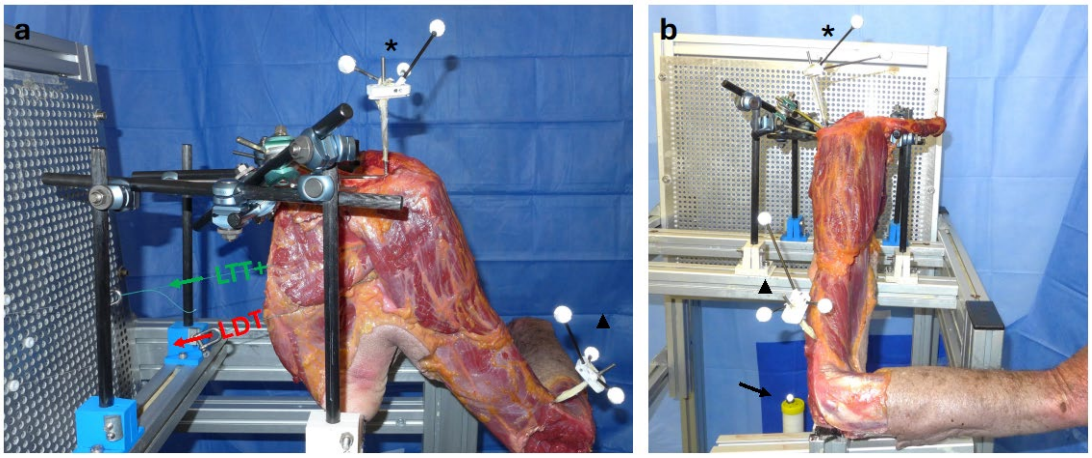

Figure 1a and b. Testing apparatus. The lines-of-pull of both LTT+ and LDT are demonstrated.
* Scapular reflective markers. ▲ Humeral reflective markers. → Tendon excursion marker.

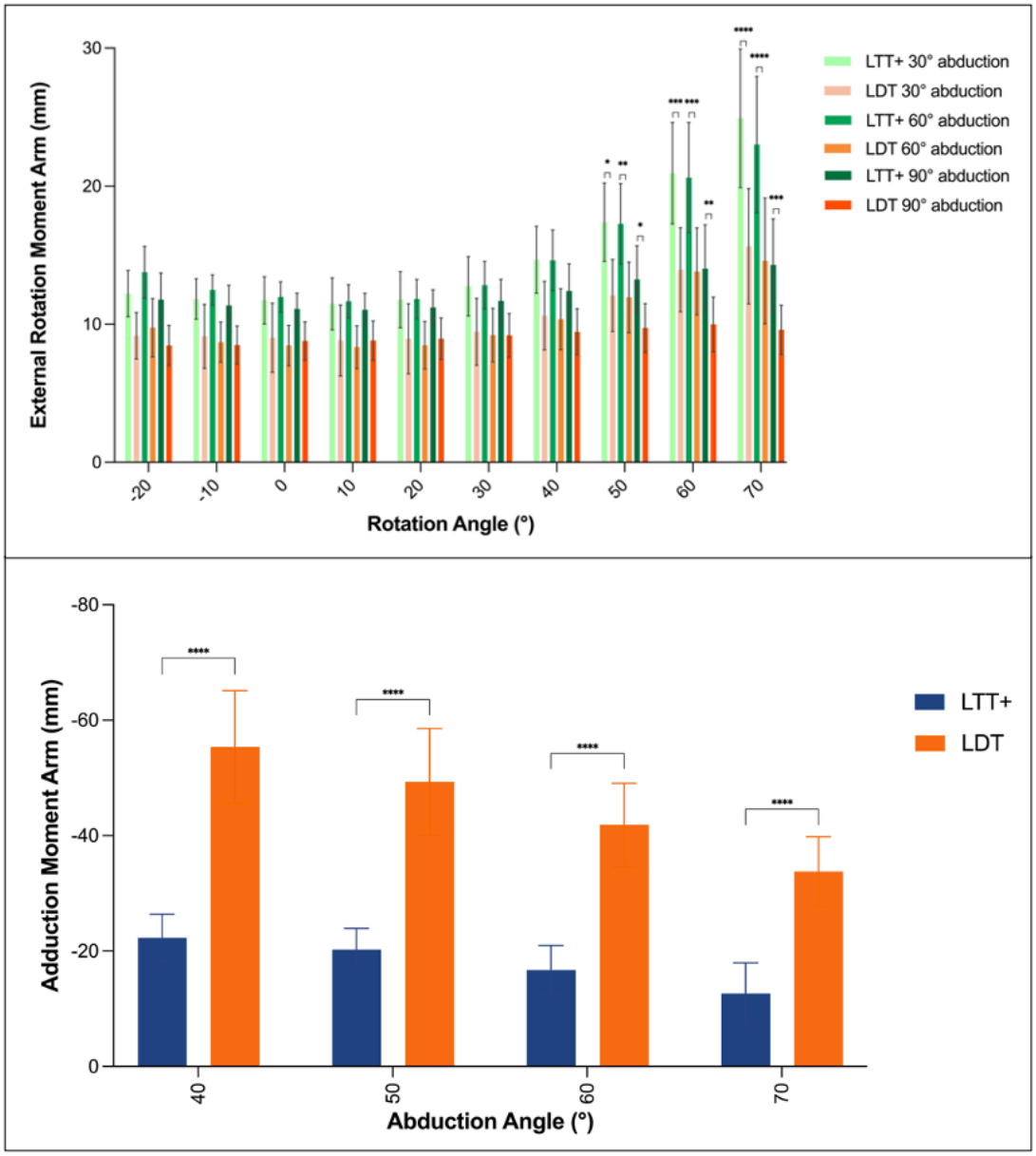

Figure 2a and b. Pooled moment arm data including the comparative analysis.
* Significance (confidence interval 95% $p < 0.05$)