Biomechanical Effects of Latissimus Dorsi Tendon Transfer in Irreparable Massive Rotator Cuff Tear

A human cadaveric study using anatomy based muscle loading testing apparatus

INTRODUCTION
The treatment of massive RCT remains a challenge as options must address each patient's desired activity level as well as the severity of the rotator cuff pathology. Latissimus dorsi tendon transfer (LDT), introduced by Gerber et al in 1988, is one of the surgical options available for irreparable massive RCT. While several authors reported favorable outcomes of this salvage procedure, clinical outcomes as a whole remain unpredictable and vary among patients. To date, there have been few biomechanical studies regarding LDT; therefore, the purpose of this study was to determine the biomechanical effects of LDT in a cadaveric model of massive irreparable posterosuperior RCT.

METHODS
Specimen Preparation: Eight fresh-frozen cadaveric shoulders were used (mean age: 56.5 years, range 45-65). All soft tissues were removed except joint capsule, insertion of rotator cuff muscles, deltoid (DEL), pectoralis major (PEC) and latissimus dorsi (LAT). Suture loops were made at the insertion of each muscle: 1 for teres minor (TM), 2 for supraspinatus (SSP) and infraspinatus (ISP), and 3 for the remaining muscles in order to load anatomically based on fiber orientation and multiple lines of action. Whole muscle of LAT was preserved for its later use of LDT procedure. A custom testing device which permits axial rotation and abduction of the shoulder was used. The scapula was fixed in the anatomical resting position with 20° of anterior tilt.

Massive Irreparable Rotator Cuff Tear (RCT) Model & Latissimus Dorsi Tendon Transfer (LDT) Procedure: Massive RCT was induced via complete resection of the entire tendon of both SSP and ISP tendons just proximal to the greater tuberosity. The massive RCT was repaired by LDT as described by Gerber et al. LAT tendon was released as close to its insertion site as possible, and it was transferred in the superior-posterior humeral head to cover the entire footprint. The lateral edge of the tendon is secured to the greater tuberosity using three transosseous sutures with #2 FiberWire (Arthrex, Naples, Florida). A total of 3 simple sutures were used to secure the medial LAT tendon edge to the remaining cuff muscles, and 2 simple sutures were used to attach the LAT tendon to the superior edge of SSC.

Muscle Loading Conditions: The amount of muscle loading was determined based on the physiological muscle cross-sectional area: SSP 10N, SSC 24N, ISP/TM 24N, DEL 48N, PEC 24N, and LAT 24N. The increased load condition for LAT (LDT 2X, 48N) was incorporated into our study to simulate increased tendon tension caused by the limitation of muscle excursion which can occur after LDT. Testing Positions: Testing was performed in the scapular plane (30° anterior to the coronal plane) with 0°, 30°, and 60° shoulder abduction with a 2:1 ratio of glenohumeral to scapular abduction.

Glenohumeral (GH) Joint Contact Characteristics: Contact area decreased in massive RCT, but restored by LDT and LDT 2X, especially in 0° and 30° abduction. LDT and LDT 2X showed increased contact pressure and peak pressure during the mid-range rotational pathway, especially in 60° abduction.

DISCUSSION
As far as the authors’ knowledge, this is the first cadaveric study regarding the biomechanical effects of the LDT in an irreparable massive RCT model. Based on our data, the LDT can be beneficial as it can reverse the abnormal biomechanics caused by massive RCT; restoring the rotational balance of humeral head, range of motion, path of HHA, and contact characteristics. However, the increased abduction angle and muscle tension due to the possibility of limiting muscle excursion by LDT can lead to an overcompensation that can further deteriorate normal kinematics of the shoulder, limit Max IR, cause abnormal displacement of the HHA, and increase GH joint pressure. Therefore, the authors believe that the clinical assessment of LAT tendon length is critical for a successful LDT.

REFERENCES

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