BRIGHAM AND WOMEN'S HOSPITAL
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Department of Rehabilitation Services
Physical Therapy

Standard of Care: Latissimus Dorsi Tendon Transfer

Case Type / Diagnosis:

Massive posterosuperior rotator cuff tears (PSRCT) involving the supraspinatus and infraspinatus are not common, as less than one third of rotator cuff tears may be classified as massive and only 5% are classified as irreparable. [7, 22] However, in general, individuals who do have a massive PSRCT often present with a painful and dysfunctional shoulder. Treatment options are limited particularly in young patients that are not suitable candidates for inverse arthroplasty.

In the case of a massive posterior superior rotator cuff tear (PSRCT), a latissimus dorsi tendon transfer (LDTT) may be done to enhance function and reduce pain. The surgical authors recommend this type of procedure to about 25% of patients with posterosuperior irreparable rotator cuff tears. This type of surgery is most commonly recommended for patients who are under the age of 60, are without significant glenohumeral arthritis and still have some rotator cuff function with at least some anti-gravity forward flexion strength. Indications for this type of surgery include a massive full thickness PSRCT, which is usually defined as a tear with a diameter of at least 5 cm. [14] Certain inclusion criteria should be met before this procedure is considered an option. Candidates must have failed to respond to conservative treatment, including the use of nonsteroidal anti-inflammatory drugs (NSAID's) and concerted efforts at physical therapy for a duration of at least six months in the presence of an external rotation lag of at least 15 degrees. [5] Finally, patients must report a subjective limitation in overhead shoulder function.

The latissimus dorsi muscle is well suited to transfer for several reasons, including its large surface area, strength, and good vascularization. [2] All of these factors are important when considering how this muscle will recover following surgery, particularly the muscle's vascularity because an adequate supply of nutrients is essential for the healing processes to occur. Further considerations are that there is adequate excursion, and that the muscle transfer is ideally in phase with the motion that is absent. Furthermore, it is generally accepted that all transferred muscles lose one grade of muscle strength as the result of the transfer, so the recovery of full strength is not possible.

The typical anatomical origin of the latissimus dorsi is on the spine of T7, the spinous processes and supraspinous ligaments of all the lower thoracic, lumbar and sacral vertebrae, the lumbar fascia, posterior third of the iliac crest, last four ribs and the inferior angle of the scapula. It inserts on the floor of the bicipital groove of the humerus and is innervated by the thoracodorsal nerve. Primary actions of the latissimus dorsi muscle are to extend, adduct and internally rotate at the glenohumeral joint. [3]

Gerber et al [6] first introduced LDTTs for the repair of PSRCT in 1988, and found it to be an alternative treatment for massive rotator cuff tears. They reported that the morbidity caused by removing the latissimus dorsi is minimal with this type of surgery. The procedure aims to regain control of external rotation by stabilizing the humeral head. Warner [22] adds that some surgeons will only perform this type of procedure if the subscapularis muscle is still intact. If this muscle is not intact, than there is a disruption of the anteroposterior force couple of the rotator cuff and this type of surgery is unable to compensate for such a loss. Furthermore, the subscapularis is important in centering the humeral head in both coronal and axial planes. Werner et al [23] explored the biomechanical role of the subscapularis in a cadaveric model, for the treatment of PSRCT with latissimus dorsi transfer. It was found that translation and rotation of the humeral head are significantly altered without the subscapularis, thus explaining why post-operative results are found to be inferior in patients without an intact subscapularis. In addition to the criteria previously described, the surgical authors recommend that candidates for LDTT surgery should also have a supple or easily pliable glenohumeral joint. A stiff shoulder is contraindicated, as it will result in additional soft tissue limitations that will affect the success of postoperative rehabilitation and overall recovery.

Other factors that may be identified preoperatively that are associated with more limited outcomes include poor tendon quality, severe fatty degeneration, previous attempt at rotator cuff repair and deltoid detachment. [21] Therefore, it is imperative that surgeons identify the integrity of these structures before operating, as they have been directly linked to both success and failure rates.

With the posterior approach a superolateral incision is used to expose the shoulder, the deltoid is detached and the rotator cuff is exposed. If the supraspinatus, infraspinatus, and teres minor are unable to be mobilized for direct repair of the supraspinatus and infraspinatus tendons, then the LDTT is performed. [5] A second posterior incision is made along the lateral border of the latissimus dorsi to the posterior border of the axilla, where it then curves more proximal in order to be perpendicular with the humeral shaft. [6] The latissimus dorsi tendon is identified and released from the humeral shaft, while protecting the axillary nerve. The latissimus dorsi is then mobilized and pulled between the infraspinatus, teres minor and the deltoid muscles around the posterior aspect of the humeral head to attach to the greater tuberosity. The remaining rotator cuff defect may then be sutured to the transferred tendon with the deltoid and fascia reattached as the incision is closed. [5] A subacromial decompression may also be performed to remove scar tissue from the subacromial space.

Postoperatively no deficiency is commonly observed with shoulder extension, adduction or internal rotation following latissimus dorsi tendon transfer, as there are six other muscles of the glenohumeral complex that share the actions of the latissimus dorsi. Therefore, after the latissimus dorsi is transferred, the teres minor muscle acts in a synergistic manner, compensating for the loss of the latissimus dorsi. Eventually, this leads to muscle hypertrophy in the teres minor and normal function should be regained. [17] Thus the shoulder, with the appropriate postoperative care, will adapt to its new configuration and the surrounding muscles will compensate for the loss of the transferred latissimus dorsi tendon.

The mechanics of the shoulder after LDTT are different than from a native shoulder. For instance, in its normal anatomical position, the latissimus dorsi muscle acts as an extensor of the humerus, but after being transferred it becomes a flexor. [14] At the same time, preoperatively the functions of the muscle are internal rotation, extension and adduction of the humerus, while postoperatively the latissimus dorsi muscle is expected to contract during abduction and external rotation. [9] This conversion to a humeral head depressor and external rotator is important because it allows the joint to function more efficiently and it compensates for the actions of the deficient supraspinatus and infraspinatus. Degreef et al [2] concludes that LDTT allows the cuff defect to be closed by the large, vascularized tendon. The biomechanics of the postoperative shoulder allow for more effective action of the deltoid, which is very important during many daily activities that incorporate elevation and abduction movements. Others have proposed that the LDTT works primarily by a tenodesis effect. By maintaining an external rotation moment on the proximal humerus, the subscapularis has a counter force and a fulcrum can be achieved.

Possible ICD.9:

Rotator Cuff Syndrome	726.10
Shoulder Pain	719.41
Rotator Cuff Tear, Full Thickness	727.61
Shoulder Region Disorder	726.2

Indications for Treatment:

Status post latissimus dorsi tendon transfer for an irreparable rotator cuff tear.

Contraindications / Precautions for Treatment:

Maximal Protection / Acute Phase (0-6 weeks postoperatively):

- Abduction sling or gunslinger orthosis should be worn all the time except for during exercise
- No passive shoulder internal rotation, adduction, and extension
- No forced forward flexion PROM
- No upper extremity weight bearing with the operative shoulder

AROM Phase (6 + weeks postoperatively):

- No forced shoulder internal rotation, adduction, or extension stretching
- No forced forward flexion PROM
- No shoulder strengthening exercises
- No lifting or carrying with the operative upper extremity

Initial Strengthening Phase (12 + weeks postoperatively):

- No forced stretching all planes
- No heavy lifting or carrying with the operative upper extremity
- No sports activity
- No strengthening with heavy weights or weight equipment

Advanced Strengthening/Return to activity Phase:

- No forced stretching all planes
- No heavy lifting or carrying with the operative upper extremity
- No strengthening with heavy weights or weight equipment

Evaluation:

Medical History: Review patient's self reported medical history questionnaire (on an ambulatory evaluation), patient's medical record (during the inpatient stay-if the patient is admitted post-op) and medical history reported in the Hospital's Computerized Medical Record. Review any diagnostic imaging, tests, work up and operative report listed under LMR

History of Present Illness: Interview patient at the time of examination to review patient's history and any relevant information that would pertain. If the patient is unable to give a full history, then interview the patient's legal guardian or custodian. Some examples of previous injury could be history of trauma, history of OA, history of shoulder joint related problems. Thoroughly review the attending Surgeon's notes to determine underlying pathology leading to the latissimus dorsi tendon transfer and irreparable rotator cuff tear.

Social History: Review patient's home, work, recreational and social situation. Areas to focus on would be any upper extremity weight-bearing activity, excessive reaching, lifting or carrying loads with upper extremities.

Medications: The surgeon typically prescribes Postoperative Pain Medication and then transitions patients to Anti-Inflammatory Medication.

Examination (Physical / Cognitive / applicable tests and measures / other):
This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.

Pain: As measured on the VAS, activities that increase symptoms, decrease symptoms, location of symptoms.

Visual Inspection: Attention to the healing of the incision, ensuring there are no signs of infection.

Palpation: Palpate entire shoulder. Focus on presence and extent of musculature atrophy and swelling.

ROM: Initial ROM assessment is contingent upon post-operative day tissue quality ROM restrictions. See attached protocols for progression.

Strength: Early post-op, only motor control will be assessed. MMT will be deferred until post-operative healing has occurred. See time frames on protocol.

Sensation: If abnormal as found via dermatomal screen or if diabetic, further assessment would be indicated.

Posture/alignment: Primary focus on sitting and standing upper quadrant and upper back posture. Patients tend to be at extremes of rounded shoulders and forward head.

Gait & Balance: Gross assessment to determine patient's safety to ensure Independence with transfers, gait, and stairs. Further in depth assessment to be conducted if impairments noted in screening.

Differential Diagnosis: None secondary to post-op condition. Unless patient has any co-morbid issues and/or post-op complications that need to be considered.

Functional Assessment:
Use of a shoulder specific functional capacity questionnaire is recommended to establish early post-op status and track progress.

Possible tools:

- Shoulder Pain and Disability Index (SPADI)
- Simple Shoulder Test (SST)
- American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES-SF)

Functional performance as reported by the subject can be measured using the Simple Shoulder Test (SST).[12] Pain, range of motion, strength, and functional performance can be standardized and measured by the American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES-SF). [10] Psychometric standards that are not specific to age, disease, or treatment group can be assessed using the MOS 36-item short form health survey (SF-36). [19, 20] The SST and SF-36 are both self-report questionnaires; the examiner can be available for assistance with these self-administered questionnaires.

The SST and the ASES-SF, which are both standardized self-assessments of shoulder function have been found to have fairly high responsiveness as well as high test-retest reliability as compared to other shoulder outcome tools. [1] They both are very simple and quick for the subject and investigator to fill out. The SST has been proven to be sensitive for various shoulder conditions as well as sensitive to detect changes in shoulder function over time. [15]
The SF-36 is a standardized self-assessment of generic health status that looks at 8 major categories including: physical function, social function, physical role function, emotional role function, mental health, vitality, comfort, and general health perception. It has been used in conjunction with the SST in assessing shoulder function in previously published studies. [18, 16] Since the SF-36 is a generic health status tool it is not as sensitive to change as joint specific outcome tools. Despite this low sensitivity, Beaton et al. states that outcome assessments that look at the overall quality of life and full impact of a condition for an individual require the use of both disease-specific and generic measures. The SPADI is another subjective questionnaire that has a pain and disability/function components. This scale uses a visual analog scale to measure pain while subjective questions are used to assess function of the shoulder. The pain and function components are weighted accordingly since there are 5 pain scales and 8 functional

questions, then the total score is computed by averaging the pain and functional score. A higher numeric value indicates greater pain and disability on the SPADI, in contrast to the other outcome measures.

In 1998 Gartsman et al. looked at the functional outcome of 50 consecutive patients that underwent an arthroscopic repair of a full-thickness rotator cuff tear (RCT). Comparison of the preoperative and postoperative responses to three (SF-36, ASES-SF, The University of California at Los Angeles (UCLA) Shoulder Score) different health questionnaires were evaluated. All three questionnaires demonstrated significant improvement in the postoperative pain and functional scores. [4]

Assessment:

Establish underlying reason for surgery and need for skilled services

Potential Initial Problem List (Identify Impairment(s) and/ or dysfunction(s))

1. Pain
2. Decreased ROM
3. Decreased Strength
4. Decreased Function as compared to baseline
5. Decreased Knowledge of Activity Modification
6. Decreased Knowledge of Rehabilitation Progression

Prognosis/Expected Outcomes: Literature Review:

Gerber et al's [5] long-term study of 67 patients who underwent a LDTT for the treatment of PSRCT between the years of 1986 to 2000 in which patients were followed for an average of 54 months reported that mean Subjective Shoulder Value scores increased from 28% preoperatively to 66% postoperatively. This assessment tool asks patients to assign a percentage of shoulder function to the affected shoulder in comparison to the noninvolved shoulder (100% being the highest possible score). [11] This study also reported mean shoulder flexion, abduction, and external rotation increased from 104° to 123°, from 101° to 119° and from 22° to 29°, respectively. Improvements were found for both function and pain, and overall strength doubled from 1.0 to 2.0 kg. [5] Patients stated that the most important change postoperatively was that they had better control of the arm in space and less fatigue during upper extremity use in abducted positions. Habermeyer et al [8] reported positive outcomes for 14 patients, with a mean age of 61, who have a LDTT performed using a single incision technique. Overall, patients demonstrated a significant improvement in active range of motion (AROM), abduction strength, pain and activities of daily living. This study also reported mean shoulder flexion, abduction, and external rotation increased from 119° to 170°, from 118° to 169° and from 19° to 33°, respectively. These findings are important to note because these gains in ROM correlate directly to functional activities.

Outcomes for patients having a LDTT following a failed traditional rotator cuff repair demonstrate less favorable results. Warner et al [21] reported on 16 patients who underwent LDTT

as a salvage procedure for a failed prior rotator cuff repair with outcomes for 6 patients who underwent a primary LDTT for an irreparable cuff defect. Functional outcomes as measured by the use of a Constant score were lower for those who had a previously failed rotator cuff repair (55%) than those who had a primary LDTT (70%). They also found that poor tendon quality, stage 4 muscle fatty degeneration, and detachment of the deltoid insertion each had a statistically significant effect on the Constant score. Postoperative rupture at a mean of 19 months of the transferred tendon occurred in 44% of patients in the previously failed rotator cuff repair group as compared to 17% in the primary LDTT group. Hence, they concluded that LDTT as a salvage procedure for previously failed rotator cuff repairs yields more limited gains in function than primary LDTT. Therapists should adjust their postoperative rehabilitation goals and treatment plan for those who have a LDTT following a failed rotator cuff repair.

Furthermore, magnetic resonance imaging (MRI) findings in a study of postoperative patients by Iannotti et al [9] showed that the transferred tendon remained attached to the greater tuberosity in 12 of 14 patients at a mean follow up of 34 weeks postoperatively. At the same time, there was no significant difference in the cross-sectional area of the muscle belly of the transferred latissimus dorsi muscle postoperatively. These results are significant because anatomical attachment of the transferred tendon is a key indicator for a successful postoperative outcome. It is important to determine if the transferred tendon is being activated during certain motions and that it is fulfilling its intended function. Habermeyer et al [8] describes the analysis of electomyographic (EMG) activity at follow-up. He reported positive findings in all patients with resisted external and internal rotation, which indicates a functional latissimus flap. These findings indicate that the transferred muscle is able to perform its new function postoperatively and functional outcomes are reliant on this fact.

Predictors of postoperative success include preoperative AROM and strength in flexion and external rotation. [21] Patients who are unable to elevate their involved arm more than 30° may not be considered candidates for a LDTT and instead may be considered for a reverse total shoulder arthroplasty (rTSA), pending age and postoperative functional expectations of the patient. It is also important to note that the subscapularis must be functioning well preoperatively. The subscapularis plays an important role in centering the humeral head in the horizontal and frontal planes during shoulder activity. [5] It has also been suggested by Iannotti et al [9] that the success of a muscle transfer with regards to strength and function may be influenced by overall body strength. If a patient is weak preoperatively then recovery after the surgery will likely be slower and outcome may be limited.

Habermeyer et al [8] reported on 14 patients who underwent a LDTT using a single incision technique for the repair of an irreparable rotator cuff and found that 13 of the 14 patients (92.9%) were satisfied with the postoperative results and reported that they would undergo surgery again. The experience of the surgical authors is that about 70% of patients are very satisfied with the outcome of their surgery and that 15% are satisfied. The remaining 15% reports no improvement, which may be secondary to complications. Overall, surgical candidates should be aware that LDTTs may take 6-12 months for complete recovery because of a prolonged tissue healing time due to the avascularity of the tendon. At the same time, there must be an understanding that despite this surgery, postoperative activity and functional expectations need to be set on a case-by-case basis.

Goals

Goals should include the following:
1. Minimal to no pain with appropriate activities of daily living
2. Functional ROM
3. Functional Strength (typically 75% of uninvolved side)
4. Enhanced Function to achieve appropriate activities of daily living
5. Improvement in preoperative functional outcome score(s) (SST, ASES-SF, SPADI)

Treatment Planning / Interventions

Established Pathway ___ Yes, see attached. _X_ No

Established Protocol _X_ Yes, see attached. ___ No

Interventions most commonly used for this case type/diagnosis.
This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.

Frequency & Duration

Inpatient Stay: Daily or as indicated by patients status and progression.

Outpatient Care: 2-3x/wk for 3-4 months as indicated by patient's status and progression.

Patient/Family Education

1. Instruction in HEP (home exercise program)
2. Instruction in pain control and ways to minimize inflammation
3. Instruction in activity level modification / joint protection

Recommendations and referrals to other providers.

None, except back to Attending Surgeon if issues arise.

Re-evaluation / assessment

Standard Time Frame- 30 days or less if appropriate

Other Possible Triggers- A significant change in signs and symptoms, significant decline in post-operative progression

Discharge Planning

Commonly expected outcomes at discharge – Please see previous literature review.

Transfer of Care (if applicable) – N/A

Patient's discharge instructions – Continue with individualized home program indefinitely to ensure maintainence of ROM, strength, and function.

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