Electrothermally-Assisted Capsulorrhaphy (ETAC): A New Surgical Method for Glenohumeral Instability and Its Rehabilitation Considerations

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Knowledge of current surgical procedures and the effect they have on healing tissue is important when developing rehabilitation guidelines. Recently, clinicians have been asked to treat patients who have undergone Electrothermally-Assisted Capsulorrhaphy (ETAC) for shoulder instability. The ultimate tensile strength of the tightened capsule is unknown during various timeframes following surgery. The use of thermal energy to shrink the shoulder joint capsule initially causes weakness of the collagen ultrastructure. Rehabilitation following ETAC includes a period of relative immobilization, followed by controlled range of motion exercises. Exercises to strengthen shoulder muscles must be done in a manner that minimizes stress on the surgically treated capsule. This article provides a brief review of capsuloligamentous repair, describes the surgical procedure, its indications, contraindications, and the effect ETAC has on the healing tissue; and provides guidelines for rehabilitation following ETAC based on the evidence available and the authors' clinical experience. J Orthop Sports Phys Ther 2000;30:390–400.

Key Words: rehabilitation, shoulder instability, thermal capsulorrhaphy

Instability of the glenohumeral joint is a complex problem, at least, in part, as it is related to capsular laxity. Numerous surgical procedures are used to address the joint laxity. Current surgical treatment for shoulder instability focuses on reinforcing the glenohumeral joint capsule through open (Neer capsular shift) and arthroscopic techniques. These techniques are aimed at achieving an "anatomic" repair, utilizing a capsuloligamentous reconstruction. Drawbacks to these stabilization procedures include postoperative loss of range of motion (ROM), pain, a potential injury to the axillary nerve, and lengthy rehabilitation. Recently, a new surgical technique using thermal energy to shrink the glenohumeral capsuloligamentous structures has been introduced to address shoulder instability. This surgical technique can be done alone for redundant capsular tissue, but often is done in combination with other arthroscopic structural repairs or partial rotator cuff debridement.
strategies, not within the context of a reliability discussion.

Dr Riddle states that we have eliminated the variability associated with therapist-patient interactions and subsequent judgments for the retest therapist. This is a good point. It remains to be seen, however, how much error is involved between certified McKenzie therapists in how they conduct the examination and, more importantly, the differences in classification that would result from variations in the examination.

To answer Dr Riddle’s last comment about making improvements in the McKenzie approach to improve the effectiveness of the system, we would like to say that if the results of our study do not generalize well to other practitioners, the more appropriate response would be to evaluate the reliability of the assessment of certified McKenzie therapists, rather than change the McKenzie approach.

Future Concerns

As we have noted in the limitation section of our study, we agree with Dr Riddle’s point that our study involved a small number of patients and examiners. Reliability studies with only 2 raters can suffer from reduced generalizability, but when according to Dr Riddle’s commentary “...no data existed to suggest that therapists with McKenzie certification demonstrated more reliability when classifying patients than therapists without certification,” it might be argued that the first order of business would be to design a study that would maximize the opportunity to demonstrate reliably, even at the cost of some generalizability.

Future reliability research is needed that uses larger numbers of subjects and physical therapists with different levels of McKenzie training. Validity research is also needed to measure outcomes by assessing categories and to evaluate the role, if any, of McKenzie assessment findings in identifying the anatomic pain-generator in the absence of diagnostic gold standards.1

Perhaps an improvement in classification is to refer to the derangement subcategories in a way that better communicates that they are merely dynamic staging of this syndrome, in an effort to avoid confusion by those unfamiliar with the McKenzie system. To eliminate the variability of the change in symptom location of the subcategories of derangement, it may be a good idea to look at the directional preferences (flex, extend, side glide, inconclusive, etc) rather than looking at D1, 2, 3, 4, 5, 6, 7.

We expect that a test-retest format evaluating the syndrome classification categories would be an important step to examine the reliability of the McKenzie classification system among examiners with varying levels of education and competency in application of the McKenzie techniques.

The test-retest format may also be successful in selecting the subcategories of derangement only if the operational definitions or guidelines for the amount of provocative testing are clear and the therapists are consistent with respect to how aggressive they should be in reproducing the distal symptoms.

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REFERENCES


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Dr Spratt was not an author on the original manuscript.
The goals of this clinical commentary are to provide clinicians who rehabilitate patients who have undergone Electrothermally-Assisted Capsulorrhaphy (ETAC) with a description of the effect ETAC has on the healing tissue, the indications and contraindications of this procedure, and the considerations for rehabilitation following ETAC.

Glenohumeral Joint Tissue

The glenohumeral capsuloligamentous structures provide a static check against excessive humeral translation at extreme positions. The ligaments of the glenohumeral joint are distinct thickenings in the capsule of the shoulder joint. Anatomical variation exists among individuals. Normal elasticity of the superior and middle glenohumeral ligaments and inferior glenohumeral structures play a crucial role in providing shoulder stability.

Ninety percent of the glenohumeral joint capsule is composed primarily of type I, II, and III collagen. Its composition is similar to that of other joint capsules found in the body. These molecules are arranged in a highly ordered, extended, triple helix to form the ultrastructure of collagen. The remaining portion of this capsuloligamentous structure consists of water, proteoglycans, fibronectin, elastin, and glycoproteins. The specific composition and arrangement of the molecules in individual ligaments provide each ligament with unique functional properties.

Bigliani et al examined the material properties of the inferior glenohumeral ligament. This structure was prone to plastic deformation before disruption of the ligament. They concluded that laxity of the inferior glenohumeral ligament might occur without actual ligamentous detachment. No similar work has been performed on other parts of the joint capsule. The result of laxity in the shoulder capsule may be subluxation and secondary impingement of the rotator cuff tendons between the acromion process and the humeral head.

Capsuloligamentous Injury and Repair

Once a ligament has undergone injury or plastic deformation, it must begin to heal. This is a morphologically complex process that takes place through a continuum of four overlapping phases. Age, tissue quality, nutritional status, degree of injury, mechanical stress, and other factors all influence the healing process. These stages have been observed in experiments with rabbits, dogs, and monkeys, and we are assuming that a similar process occurs in humans.

The initial response is the inflammation phase, and it begins with the cell's release of histamine, a potent vasodilator. At this point, endothelial buds start to proliferate into the ligament, and the presence of monocytes and macrophages are evident. Biochemical changes, including increased water content in the area, take place at the injured tissue. Active collagen synthesis (Type III > Type I) and scar production begins within 4 days.

The second phase is the proliferation phase and is characterized by rapid fibroblast activity. During this phase, immature collagen framework is laid down, elastin production begins, and the water weight is decreased. The healing ligament begins to form an unorganized collagen pattern that seems to increase the tensile strength of the matrix.

The third phase, the remodeling phase, usually begins 6 weeks following injury. During this phase, collagen turnover (synthesis-degradation) is restored to near-normal levels. As the ligament matures, the collagen fibers orient in line with the tension encountered. Electron microscopic studies revealed that collagen fibrils appear larger in diameter and more densely packed. Type I collagen fibers are more apparent than type III fibers during this phase.

The final phase, maturation, continues slowly for months and years after injury. During this period, the ligament regains its histological ligamentous appearance. Whether or not a ligament, which undergoes thermal shrinkage, responds in the same manner, has yet to be investigated.

Thermal Effect on Glenohumeral Joint Tissue

Reports of the ability to "shrink" or contract collagen have been published since the early 1950s. Investigations have shown that collagen in its hydrated state shrinks when heated. Studies have explored the effects of this nonablative laser energy on the ultrastructure of joint capsular collagen in rabbits. Hayashi et al demonstrated that the swelling and shrinkage of these collagen fibrils is secondary to the unwinding of the collagen triple helix. Although the tissue is shortened, the disruption of the capsuloligamentous cellular matrix has made the structure extensible. The authors hypothesized that the heat disrupts the hydrogen bonds which stabilize the ligaments; thus, transforming it into a denatured state.

Based on their results, we recommend caution in the immediate postoperative period with immobilization to avoid over stretching the tightened capsule.

Recently, Hayashi et al demonstrated in a cadaveric model that optimal thermal temperature for shrinkage of the glenohumeral joint capsule was at 65°C. It has been confirmed that, at this temperature, minimal ligament damage occurs while providing enough thermal energy to cause tissue shrinkage. The short-term response to thermal energy in sheep glenohumeral joint capsule tissue is an inflammatory cell infiltration and fibroblast proliferation.

Tibone et al demonstrated a significant reduction
in anterior and posterior translation after applying thermal energy to the anterior capsuloligamentous structures in cadaveric shoulders. Selecty et al. determined that the immediate postoperative (1 hour) ultimate load to failure was significantly higher in inferior glenohumeral ligament complex specimens that were lased, compared to nonlased specimens. These experimental results suggest that initial ligament shortening is possible to increase joint stability without compromising ligament strength. Despite studies evaluating the biomolecular and biomechanical changes following thermal tissue shrinkage, no study has examined the healing properties of the glenohumeral capsuloligamentous structures over time.

Nevertheless, clinical trials have begun and ETAC is being used for capsular tightening of the glenohumeral joint. Although further study is needed to determine the short- and long-term effects of thermally treated ligaments, clinicians must try to provide rehabilitation guidelines based on the scientific knowledge now available.

SURGICAL INDICATIONS

The surgical indications for ETAC are still evolving and expanding as surgeons gain more experience with this procedure and outcomes are reported. In general, this surgical technique can be done alone for capsular laxity, but often it is done in combination with other arthroscopic structural repairs or partial rotator cuff debridement.

Indications for ETAC

Patients are considered for ETAC only if they present with symptomatic shoulder instability, adversely affecting the patient's quality of life or occupation, or with duration of symptoms lasting 6 months or more. A patient should have failed at least 3 months of nonoperative treatment consisting of rest, modifications of activities, and rehabilitation. Patients with evidence of psychiatric, voluntary habitual dislocation, malingering, or chronic pain syndrome such as reflex sympathetic dystrophy, are absolute contraindications to ETAC.

The indications for ETAC are still evolving. Clinically, the plain radiographic evaluation of the patient who is an ideal candidate reveals none of the following: a bony Bankart lesion, glenohumeral dysplasia, fractures, tumors, or infection. Imaging studies should exhibit an intact and lax glenohumeral ligament. However, ETAC can be observed in conjunction with an arthroscopic Bankart repair. Physical examination should reveal a subluxating humeral head anterior, inferior, or posterior with provocative stress. The “ideal” patient should have a positive apprehension test with a positive relocation test. Instability may be unidirectional or multidirectional, but if it is greater than a grade 2, then an inferior capsular shift remains the criterion standard for surgically stabilizing a shoulder with instability.

Patients can still be considered for ETAC in the presence of radiographic evidence of a Bankart lesion or superior labral anterior to posterior (SLAP) type lesion. The surgical procedure would then include arthroscopic glenohumeral ligament or biceps tendon reattachment prior to the ETAC during the same surgical procedure. Patients with a grade III sulcus on inferior laxity testing are not good candidates for ETAC. We think that the degree of capsular redundancy in the axillary pouch is more reliably treated by an open inferior capsular shift.

SURGICAL PROCEDURE

Since this is a new surgical procedure, the patient should be given preoperative instructions regarding expectations and what will be done intraoperatively. In addition, postoperative immobilization, cryotherapy, and exercises are outlined and reviewed. Since the surgery is performed as an outpatient procedure, the patient is given, and has filled, their postoperative analgesic prescription prior to the actual surgery; thus, reinforcing the importance of postoperative analgesia. We have observed that patients experience more pain at rest following this procedure and request more pain medication refills than patients who have undergone open stabilization procedures. This may be due, in part, to the shrinkage, causing tension of neural tissue, or to the nature of the intervention because it is similar to a burn.

The patient is seen and evaluated by an anesthesiologist, who then determines the type of anesthesia. Interscalene regional anesthesia is these surgeons' (R.D.P. and S.J.N.) choice even if it is accompanied by a general anesthetic. After the patient is anesthetized, an exam under the anesthesia is performed and these findings are compared to preoperative findings of the exam on the contralateral shoulder. Differences in humeral head translation in the anteroinferior direction has been found to be most pronounced at 80° of external rotation while the patient is under anesthesia. Intravenous prophylactic antibiotic (broad spectrum cephalosporin) is administered and the entire affected, upper extremity (scapula to fingers) is prepped and draped, leaving the arm free.

Prior to any surgical incisions, the bony anatomy is marked with a surgical marker and the planned portals (posterior and anterior) are marked and infiltrated with 1% lidocaine and 1:200,000 epinephrine. The posterior portal is established and the arthroscope is inserted into the glenohumeral joint. A systematic, thorough evaluation is undertaken, whereby the rotator cuff, biceps tendon, labrum, glenohumeral ligament, and capsulolabral complex are evaluated. A “drive through” sign is present when the ar-
Even though the laser is more marketable and well-known to the patient, its disadvantages seem to outweigh its advantages, making it the least desirable thermal-delivery system. The advantage of the radiofrequency thermal-delivery systems, over the laser, is that they are less expensive and only affect the tissue they are actually touching; whereas, the laser light affects whatever tissue is in its path. There is very poor control of tissue temperature with the laser and this is partly why radiofrequency devices are preferred. In the knee, there have been case-reports of laser-induced osteonecrosis of a femoral condyle, resulting in significant morbidity and ultimate total knee arthroplasty. Laser-induced osteonecrosis on the humeral head would be a devastating complication considering the relatively young age of the population who are the best candidates for the ETAC procedure, specifically patients 16–40 years of age. Three manufacturers offer the radiofrequency thermal-energy systems: Arthrotec (Sunnyvale, Calif), Oratec (Menlo Park, Calif), and Mitek (Boston, Mass). Each company offers several delivery wand options and claims theoretical advantages over their competitors. Table 1 summarizes the unique features of each. We use the Oratec model because of the decrease, or limited depth, of penetration and the user’s ability to control the temperature.

The capsular tightening procedure begins with the inferior glenohumeral ligament and capsule treated, first by direct contact of the malleable thermal probe onto these structures. The amount of heat delivered is dependent upon the time the probe is actually in contact with the tissue. It is recommended that the surgeon time the heating by watching for bubbles and actual contraction of the tissue. The surgeon must be aware that while in the inferior pouch, the axillary nerve is at a risk of being injured. There have been anecdotal reports of axillary neuropaxia following this procedure. A brachial plexus neurologic evaluation should be part of the initial rehabilitation evaluation. Therefore, as the area at six o’clock is carefully shrunk, we are cautious not to hold the probe in one position for an extended period of time. Next, the anterior, middle, and superior glenohumeral ligaments and capsule are heated. The thermal probe is then placed in the posterior portal and the posterior capsuloligamentous structures are treated in a similar manner. The posterior inferior portal can be used to shrink the inferior pouch if it can not be reached with the standard portals. The ligaments and capsule are thermally shrunk from their insertion into the glenoid labrum to as far toward the humeral neck as possible (Figure 3). This is accomplished in a stroking pattern similar to painting a wall. Different portions of the capsule may be asymmetrically tightened, therefore, and regaining full range of motion can be difficult. It is necessary to stretch and evaluate the external rotation at abduc-

Figure 1. This is an arthroscopic view of the drive through sign prior to surgery. The glenoid fossa is on the left and the humeral head is on the right. The darkness represents the distance between the glenoid and the humeral head. This distance confirms the presence of capsular laxity.
tion positions of 0°, 45°, and 90° because different portions of the joint capsule and its ligamentous attachments are stressed at different degrees of abduction.3,4,47

The amount and extent of capsular (thermal) shrinkage has yet to be defined. Currently, it is based on the surgeon’s judgment and experience of what appears to be normal and what has worked in the past. However, there are several that measure guidelines for the surgeon. For example, when treating the anterior inferior glenohumeral liga-
moment, the infraspinatus and glenoid labrum tear are debrided first followed by thermal shrinkage.

At the conclusion of the surgery the portals are su-
tured and a sterile dressing is applied. The arm is
placed in a shoulder immobilizer.

POSTOPERATIVE MANAGEMENT

Immediate Postoperative Period

Postoperatively, the shoulder is placed in a sling,
without a swathe for 3–4 weeks. The position of the arm is in internal rotation, slightly anterior to the
frontal plane. Since the early capsular tensile
strength is presumed to be weak, the early rehabilita-
ion period is more conservative than other open
stabilization procedures.40 The main focus of the
immediate postoperative period (4 weeks, 3–6 visits) is
to maintain proximal and distal strength and mobi-
lity, provide pain relief, and prevent selective hypomobility of sections of the capsule due to iatrogenic
shortening from the surgery. During this period elbow
range of motion and gripping exercises are encou-
raged. We have found that instructing patients to
sleep with a pillow under their elbow for shoulder
support may take stress off the anterior joint capsule
and reduce discomfort. Modalities can be useful
tools in providing pain relief. The level of pain, post-
operative swelling, and degree of patholaxity that was

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<td>PROM of ER begin at abduction position of 90°</td>
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<td>Begin proprioceptive neuromuscular facilitation patterns</td>
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<td>Weeks 8–12</td>
<td>Full AROM (except ER at abduction position of 90°)</td>
<td>Modified base</td>
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<td>Normalize Scapulo-Humeral rhythm</td>
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<td>Week 16</td>
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Rehabilitation guidelines following shoulder instability, surgically treated with electrothermally-assisted capsulorrhaphy (ETAC).

The fourth through sixth weeks, usually 2 to 3 visits per week, should focus on the return of scapular stability and glenohumeral range of motion (ROM). Later in this period, rotator-cuff isotonic strengthening is initiated and the patient removes the sling, while active assistive range of motion (AAROM) exercises are initiated. These exercises may include the use of a pulley or cane to assist in forward elevation in the plane of the scapular and internal rotation in scapular plane. Initially, external-rotation stretching is done with the arm at the side, then moved to the scapular plane. In general, patients with excessive capsular laxity and generalized joint hypermobility are progressed more slowly, with passive range of motion (PROM) in all planes, to allow full healing and tightening of the capsular structures.

Stretching and mobilization of the posterior cap-
sule should be emphasized because tightness of the posterior shoulder structures has been associated with a loss of internal rotation range of motion. Tightness in posterior shoulder structures could potentially limit the patient’s progress because this limitation is thought to cause anterior superior migration of the humeral head with forward elevation of the shoulder, possibly contributing to impingement. An effective method of stretching this area is to stabilize the patient’s scapular at the inferior angle manually, while the patient provides a cross-couch adduction force in the supine position. Passive range of motion of external rotation and abduction should be limited to 45° and 70°, respectively, as to not put stress on the healing capsul. Our initial goals are to achieve full internal rotation 10° of and within passive flexion of 135° in the plane of the scapular. The goal is to maintain available mobility and prevent excessive scarring. During the early postoperative period, isotonic strengthening exercises are initiated for abduction, scaption, and internal and external rotation in the scapular plane, similar to Ellenbecker and Mattalino. Rhythmic stabilization can be preformed at this time in the available ROM. The clinician may find it useful to have their leg on the plinth during this exercise to prevent any unwanted external rotation ROM. In order to have normal scapulohumeral rhythm, dynamic scapula stability of this joint needs to be restored. Many authors have examined the EMG activity during scapular strengthening exercises, but when choosing the appropriate exercise the clinician must keep the activity painfree and protect the surgical repair. We include the “scapular clock” and rhythmic stabilization of the scapula to emphasize activation of the rhomboid and middle and lower trapezius muscles because of the role these muscles play in protecting the capsule. The scapular clock exercise is a means of aiding the patient in the visualization and awareness of contracting the upper trapezius muscle by movement of the scapula to the 12 o’clock position, the rhomboids at 9 o’clock, and the middle and lower trapezius between the 6 and 9 o’clock positions. Scapular exercises are encouraged in the early phases of rehabilitation to counteract scapulohumeral movement dissociation, and to provide a stable base of support for the AROM to be performed.

It is our opinion that the use of free-weights, with the arm in a dependent position, should be avoided during this period, minimizing the potential for detrimental humeral head translation. Using a supinated grip, and not allowing the elbows to pass the frontal plane of the body during rows, can prevent capsular winding and stress. We also recommend that the patient wait until the end of the intermediate postoperative period to initiate jogging or running for this same reason; the humeral head may be forcibly thrust anterior. It is imperative that the therapist maintains supervision of the ROM progression during this period to protect the healing tissue. Progression to the next rehabilitation period typically requires the patient to achieve flexion in the scapular plane of 135°, external rotation in the scapular plane of 45°; near full internal rotation in the scapular plane, and abduction of 70°. Symmetrical posterior shoulder flexibility and improvement to a manual muscle-testing grade of at least poor for internal and external strength in available ROM are also recommended before proceeding to the next stage of rehabilitation.

Intermediate Postoperative Period

During weeks 6–8, usually 2 to 3 treatment sessions per week, the rehabilitation continues to work towards full glenohumeral ROM and dynamic stability of the humeral head in the glenoid fossa. Gaining or maintaining full AROM within flexion of 10° in the sagittal plane, and external rotation and to be achieved later during this time frame. Once the patient has achieved the milestone of 70–80° external rotation in the plane of the scapular, we initiate therapy to acquire external rotation ROM at an abduction position of 90°. Although, in the past, we have expected the patient to have full AROM in 8 weeks following ETAC, we have found that most patients do not achieve this goal at 8 weeks following ETAC. In our experience, full external and internal rotation ROM measured in the supine position, with the glenohumeral joint abducted of 90°, typically does not occur until at least 10–12 weeks following ETAC. This is in agreement with Ellenbecker and Mattalino, who demonstrated a lack of return of active ROM on 20 patients, 12 weeks following ETAC. Specifically, forward flexion ROM was returned fully in 50% of the patients. Full abduction ROM was pres-
ent in 30%, full external rotation in 20%, and full internal rotation in 25%.7

An arm upper body ergometer (UBE), using light resistance, can be beneficial at this time to facilitate ROM and initiate active muscular control of the shoulder. The axis of rotation of the UBE should remain below the level of the shoulder joint so as not to force forward flexion above 80°. To avoid stress to the anterior joint capsule, the patient should be positioned at a distance from the axis of rotation that does not allow the elbow to move posterior to the frontal plane, when performing ergometer revolutions. We do not initiate this exercise earlier because the amount of stress placed on the capsuloligamentous structures during the use of an UBE is unknown.

Strengthening-exercises progress to resistance-training with elastic bands for internal rotation, external rotation, abduction, and extension. Maintaining the glenohumeral joint in the scapular plane (30–45° anterior to the frontal plane) will minimize the tensile stress placed on the anterior joint capsule.21 We have found that giving verbal feedback to lift the chest up and pinch the shoulders back can facilitate scapular stabilization, while training the external rotators. Hintermeister et al.17 found shoulder elastic resistance-training to have a low load on the shoulder, and, therefore, we think this treatment is safe for patients in the intermediate-postoperative period.

Proprioceptive Neuromuscular Facilitation (PNF) can be described as movements that combine rotation and diagonal components, which closely resemble the movement patterns required for sport and work activities.24 PNF presumably acts to enhance the proprioceptive input and neuromuscular responses while stressing motor relearning in the postoperative phases of rehabilitation. PNF patterns are initiated with the scapula, since scapular stability is essential for total function of the shoulder. Scapular patterns are generally performed in the side-lying position with the head and neck in neutral alignment. The coupled patterns of anterior elevation-posterior depression and anterior depression-posterior elevation are utilized, respectively. Trunk rotation should eventually be combined with scapular and extremity PNF patterns, to maximize combined, muscular movement-patterns. Techniques such as hold-relax, slow reversals, and contract-relax are employed specifically to improve motion, whereas rhythmic stabilization, repeated contractions, and combination isotonics are used to enhance concentric and eccentric muscle action. Specifically, the D2 flexion pattern combines flexion, abduction, and external rotation, whereby emphasizing the posterior rotator cuff and posterior deltoid.24 These neuromuscular control exercises are thought to properly position the scapula and stabilize the humeral head in the glenoid.24

Presently, it is unclear what affect thermal shrink-
age has on restoring the proprioception, lost by individuals with shoulder instability.9 We think that exercises directed towards facilitation of functional muscular firing patterns, in both weight bearing and nonweight-bearing positions, may provide useful input for return-to-function, following ETAC. Lear et al25 demonstrated that scapular muscle activity increases with a wall push-up progression. However, the strain on the glenohumeral joint capsule is unknown and may be too great a risk for patients following ETAC. We conclude that clinicians should refrain from using this exercise until the late postoperative period in order to protect the healing tissue.

Isotonic exercises, emphasizing light resistance and increased repetitions, are used for isolated and combined movement patterns of the shoulder. We use a progression from 3 sets of 10 to 2 sets of 15 and on to 1 set of 30 repetitions. If the patient can perform one set of 30 repetitions with good form, and no substitution, we will increase the weight 0.45–0.9 kg (1–2 lbs) and reduce the exercise to 3 sets of 10, repeating the cycle. Our rationale for this method is that the exercise reinforces tonic function of the rotator cuff muscles and the scapular stabilizers. Isolated exercises are used to enhance, or increase, the strength of a particular muscle. Combining isotonic exercises in functional movement-patterns are performed with PNF patterns using elastic resistance, or the cable column, to enhance coordinated movement. Milestones, which should be met in order to move to the next rehabilitation period, include full AROM in flexion, abduction, internal, and external in the plane of the scapula within 10°. At this time, we would like the patient to be able to perform the scaption exercise (forward flexion in the plane of the scapular) for 3 sets of 10 with 5-lb weights. Isometric internal and external strength should be at least 50% of the uninjured side.

Late Postoperative Period

After 8 weeks, the patient is in the final phase of rehabilitation. Full AROM is encouraged at this time. The only restriction on ROM is that external rotation should not be stretched beyond 90°. It may be preferable to allow the athlete to regain additional degrees of external rotation over time, rather than stress the capsule, and potentially stretching the repair. Posterior capsule stretching is appropriate if full internal rotation has not been obtained yet.

Strengthening-exercises should continue to include isotonic, concentric and eccentric loading of the rotator cuff and scapular stabilizers. An overhead pulldown machine is used for latissimus dorsi strengthening. This exercise should be performed anterior to the frontal plane to avoid stretching of the anterior joint capsule. Having the patient face away from a wall and throw a medicine ball off a wall can train