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Avoiding Shoulder Injury From Resistance Training

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ONE OF THE PRIMARY RESPONsibilities of the personal trainer or strength and conditioning specialist is educating clients in proper exercise techniques. More importantly, however, the strength and conditioning professional must be able to design exercise programs that are appropriate and safe for each client. Because there is a wide range of exercises to choose from when targeting specific muscles or muscle groups, it is sensible to avoid exercises that are more likely to lead to injury.

Injuries to the shoulder are relatively common among weight trainers and can be career-threatening to those at the competitive level (14, 26). Fortunately, most shoulder injuries from resistance training are minor musculo-tendonous strains or ligamentous-capsular sprains. However, when improper exercises or exercise techniques are utilized, resistance training may exacerbate or contribute to the development of glenohumeral joint hyperlaxity, instability (19, 21), or impingement (8, 9, 12, 16).

In this article we will identify shoulder exercises commonly performed in fitness centers that may contribute to or exacerbate glenohumeral joint injury. Alternative exercises that may be substituted will be described along with the rationale for the variations. It is beyond the scope of this article to present an exhaustive review of contraindicated exercises for all known shoulder pathologies; rather, glenohumeral joint pathologies commonly associated with resistance exercises will be discussed. Avoiding risky exercises helps prevent injury in healthy clients and further tissue damage in clients recovering from injury.

Glenohumeral Instability

The glenohumeral joint is very mobile but lacks bony congruency, rendering it vulnerable to excessive laxity (hyperlaxity) or instability. Glenohumeral joint hyperlaxity or instability may occur as the result of a congenital hypermobility, a traumatic injury, or a gradual loosening of the ligamentous-capsular restraints (19, 21). Repeated stretching of ligamentous-capsular restraints increases the likelihood of permanent elongation (acquired ligamentous laxity) and injury (10, 21). If a ligament or capsule is loosened significantly, surgery may be necessary to restore stability. Joint hyperlaxity involves excessive mobility without the presence of pain, whereas painful and uncontrollable excessive joint movement characterizes joint instability (21). When the static glenohumeral ligamentous-capsular restraints are excessively lax or unstable, the dynamic rotator cuff muscles are thought to exert greater force to stabilize the humeral head (10). This dynamic compensation often results in fatigue followed by rotator cuff tendonitis and pain. Sensibly, exercises that impart significant stresses to the glenohumeral ligamentous-capsular restraints

Figure 1. **Arm (humeral) external rotation combined with horizontal abduction.**

should be avoided, particularly if preexisting instability or hyperlaxity is present.

Anterior Glenohumeral Instability

The anterior glenohumeral joint capsule is the most common site of hyperlaxity and instability in the shoulder (4). Since shoulder (humeral) external rotation combined with abduction and horizontal abduction (Figure 1) maximally stresses the anterior capsule (6, 17–19), this movement combination should be avoided during resistance exercises in individuals with anterior hyperlaxity or instability. Examples of common exercises that put the glenohumeral joint in the "at-risk" (6) position (external rotation combined with abduction and horizontal abduction) include the latissimus pull-down performed behind the neck, the shoulder press performed behind the neck, the wide-grip bench press, and the pectoralis fly.

Exercises commonly performed behind the neck (e.g., shoulder press and latissimus pull-down) should be performed with the elbows approximately 30° anterior to the shoulder in the plane of the scapula (scaption) to decrease stress to the anterior glenohumeral joint capsule (21). The combination of shoulder external rotation, abduction, horizontal abduction, and excessive cervical spine flexion during the behind the neck latissimus pull-down was blamed for 1 reported case of temporary arm paralysis from brachial plexus injury (23). The latissimus anterior pull-down to the chest can be substituted to train the latissimus dorsi, rhomboids, and elbow flexors without compromising the anterior glenohumeral joint.

Overhead (military) shoulder presses are typically performed behind the neck, placing the shoulders in the at-risk position. Performing the shoulder press with the hands and elbows anterior to the shoulder is preferable whether using a bar (preferably with a spotting rack), dumbbells, or a machine. In our clinic, patients are instructed to face backward on the seat when using the shoulder press machine (Figure 2). This modification assures that the shoulders will avoid the at-risk position throughout the lift.

Another exercise usually performed with the weight positioned behind the neck is the back squat. During the back squat the shoulder is maintained in an externally rotated, abducted, and horizontally abducted position. Clients with glenohumeral anterior hyperlaxity or instability should be instructed to either use a modified center of mass bar (13) or perform a front squat instead. The elbows are positioned anterior to the shoulder when using a modified center of mass bar (13) or performing a front squat, substantially decreasing anterior glenohumeral ligament stress. If front squats are performed, we recommend using a self-spotting rack (e.g., Smith rack) to prevent injury if there is a loss of control of the weight.

The wide-grip flat bench press (barbells or dumbbells) or the seated machine chest press should be modified to avoid excessive horizontal abduction. Cases of bilateral anterior shoulder dislocation during bench pressing have been reported as a result of the horizontal abduction stress on the anterior glenohumeral ligaments combined with heavy resistance (1, 11). Excessive horizontal abduction during the bench press can be avoided by limiting hand spacing to 1.5 times the shoulder width (7), placing a cushion or roll on the chest, or using a range of motion (ROM) limiting stop on a machine or self-spotting rack. Likewise, limiting hand spacing and horizontal abduction on a chest press machine protects the anterior glenohumeral capsuloligamentous restraints. Clients with hyperlaxity or instability should approach the weighted bar incline press exercise with caution as the arms are maintained in the at-risk position throughout the entire movement (5). Alternatively, dumbbells may be employed during the incline press with careful avoidance of the at-risk position. Conversely, throughout the entire movement of a decline press, the arms are maintained in a safe position below 90° flexion and 45° abduction with minimal external rotation making this a reasonably safe pectoral strengthening exercise with a weighted bar or dumbbells.

Like the bench press, hand spacing during push-ups should also be limited to reduce horizontal abduction. An alternative technique for performing a push-up using a standard weight bench is demonstrated in Figure 3. This exercise can be performed from a kneeling or standard push-up position. In addition to reduced stress on the anterior glenohumeral ligaments due to the narrowed grip and decline movement, our clients have reported less wrist discomfort with this push-up technique compared with the standard push-up technique performed on the floor.

Another common strengthening exercise for the anterior shoulder and chest musculature is the pectoralis fly. Excessive horizontal abduction should be avoided when performing this exercise in order to minimize anterior capsular distention. This can be accomplished by instructing clients to initiate the movement with their elbows slightly in front of their shoulders (scapular plane) and to maintain their elbows below shoulder level throughout the movement. The elbows should be kept below shoulder level to reduce shear across the subacromial space, which may irritate the rotator cuff tendons and bursa. Clients may need to practice this technique on a pectoralis fly machine before attempting the movement with free weights.

Figure 2. Military press performed anterior to the shoulder.

Stretching the pectorals with the arm horizontally extended and externally rotated should be avoided in individuals with anterior glenohumeral joint capsular hyperlaxity or instability. Although the purpose is to stretch the pectoralis muscle, the noncontractile anterior capsule is also stretched with the arm in horizontal abduction

Figure 3. **Alternative push-up technique using standard weight bench.**

and external rotation. An alternative technique for pectoral stretching is illustrated in Figure 4. This stretch primarily affects the pectoralis minor; however, the pectoralis major will also receive a mild stretch when performed properly.

Posterior Glenohumeral Instability

Just as stretching the anterior glenohumeral joint capsule may exacerbate an anterior instability, stretching the posterior capsule may exacerbate a posterior glenohumeral instability. The posterior glenohumeral joint capsule is stressed when weight is borne through the arm with the shoulder flexed (e.g., narrow-grip bench press or push-up), or when the flexed shoulder is pulled forward (e.g., eccentric phase of rowing exercise) or across the chest (18, 21, 24). Obviously, strengthening and stretching exercises that stress a posteriorly unstable shoulder may need to be avoided entirely. The cross-chest stretch should be avoided if a posterior instability is present. In addition, rowing exercises should be modified to reduce the amount of arm distraction during the eccentric phase of the row. Clients can be instructed to begin and finish the rowing movement with their elbows slightly bent to reduce posterior capsular stretching. Deadlifts and power cleans might also need to be avoided or modified if a posterior instability is present. Both of these exercises stress the posterior capsular restraints as the arm is pulled forward when attempting to lift or lower the weight from the floor. The deadlift might need to be avoided entirely; however, the hang clean can be substituted for the power clean, eliminating the pull from the floor.

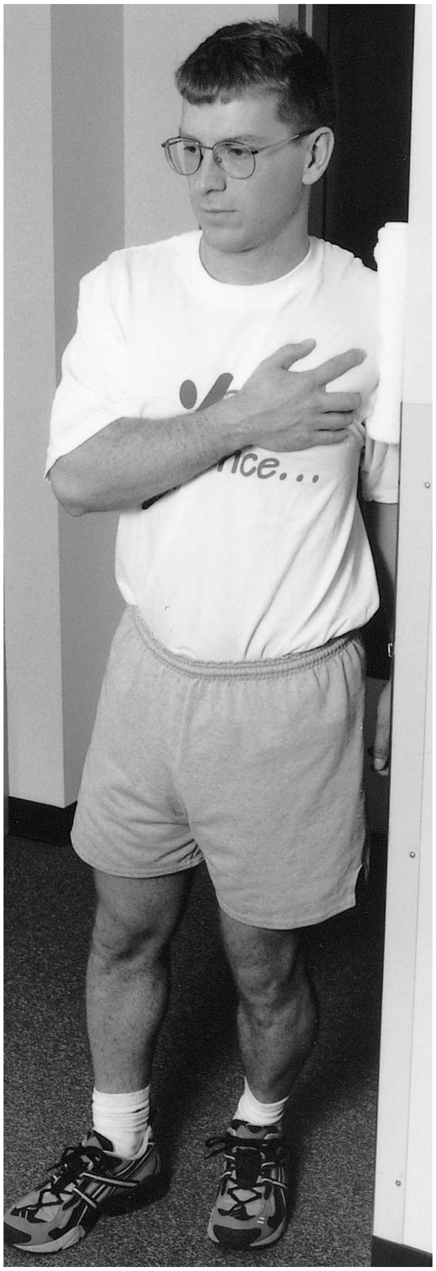


Figure 4. **Pectoralis stretching technique for clients with anterior glenohumeral hyperlaxity or instability. (a) Rest shoulder to be stretched against corner of wall using towel cushion. (b) Initiate stretch by squeezing (retract) shoulder blades (scapulae). (c) Greater stretch may be obtained by using the opposite hand to pull the pectoral muscles toward the midline of the body.**

Hand placement should be adjusted when attempting to perform the bench press or push-up in the presence of a posterior instability. In contrast to the narrow grip recommended during the bench press or push-up for shoulders with anterior instabilities, individuals with a posterior instability should use a wider grip to disperse direct force through the arm and into the glenoid fossa.

Subacromial Impingement

Primary Impingement Syndrome

Repeated compression of the rotator cuff tendons and bursa against the overlying acromion and/or coracoacromial ligament may lead to irritation and inflammation. When the cuff tendons and/or bursa are inflamed, the subacromial space is further diminished and the tendons and bursa are often impinged (pinched) in the subacromial space—a condition known as primary subacromial impingement (16). Individuals with a primary impingement often experience pain when lifting their affected arm (particularly above shoulder level) because of compression of the inflamed and sensitized cuff tendons and bursa. Several resistance exercises should be modified to prevent inducing or exacerbating a primary impingement.

The lateral raise, an excellent exercise to strengthen the middle deltoid and supraspinatus, is commonly performed with the palm facing down (internal rotation of the glenohumeral joint), which can lead to rotator cuff impingement (Figure 5). During elevation of the arm, the rotator cuff tendons normally move with minimal compression beneath the overhanging acromion. If the arm is internally rotated during elevation, however, the greater tuberosity of the humerus pinches the rotator cuff tendons and bursa against the acromion (8). Repetitive pinching can lead to inflammation and damage of the rotator cuff tendons or bursa (16). To minimize compression, elevation exercises should be performed with the arms externally rotated. Clients should be instructed to use a neutral grip done by pointing their thumbs toward the ceiling to promote arm external rotation (Figure 6). Seated lateral raise machines that require elevation with concomitant internal rotation

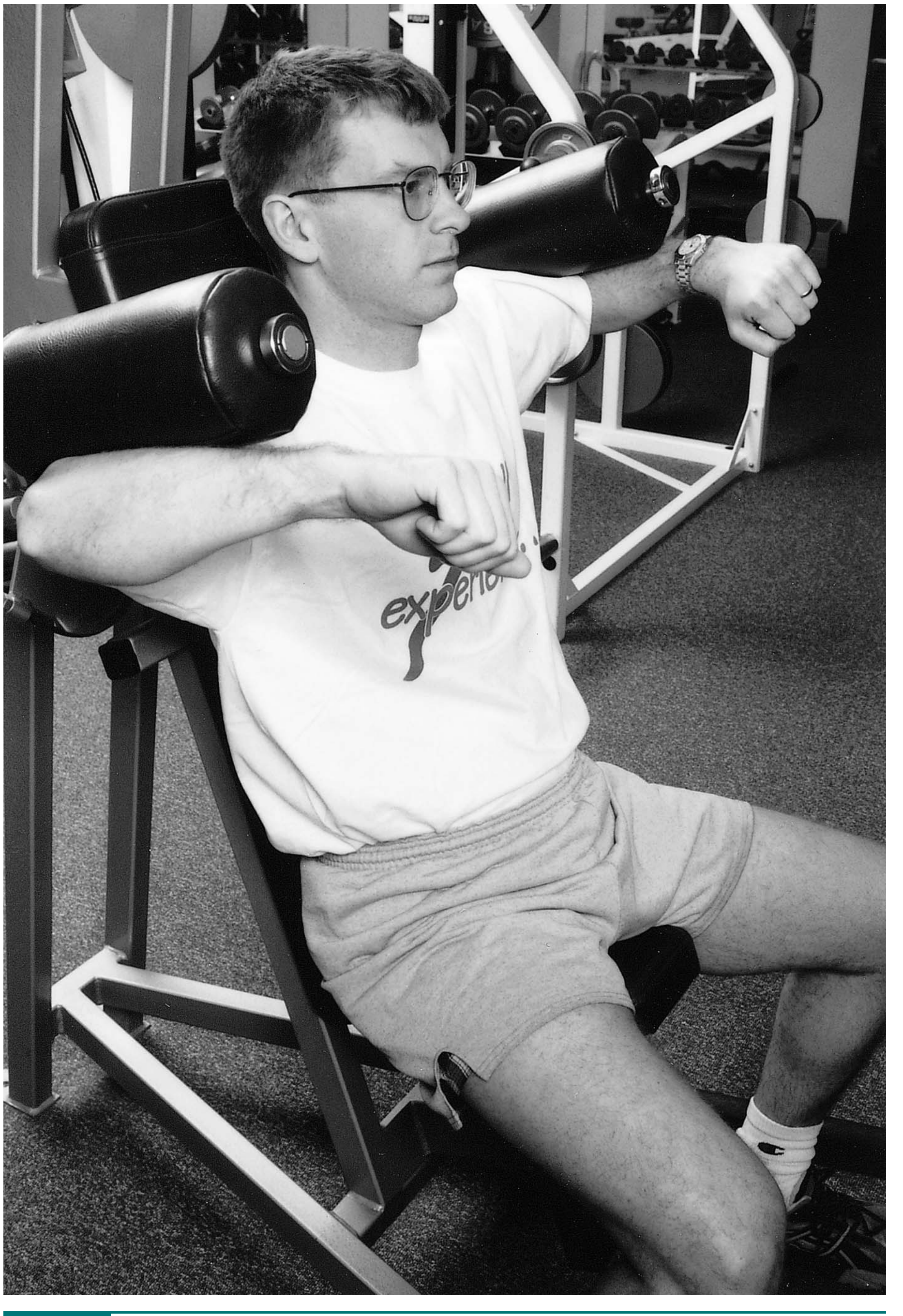


Figure 5. **Lateral raise on machine with concomitant humeral internal rotation.**

should be avoided (Figure 5). Lateral raises with the arm externally rotated using dumbbells may be substituted.

Another exercise that may lead to subacromial impingement is the upright row. During this exercise the arm is maintained in an internally rotated position throughout the full range of elevation. We recommend either avoiding this exercise entirely or limiting elevation to 80° and keeping the elbows lower than the shoulders to avoid rotator cuff impingement.

Subacromial impingement can also be exacerbated by exercises that involve excessive flexion (16). The pullover exercise performed supine with free weights (Figure 7) or on a machine forces the rotator cuff tendons and bursa against the undersurface of the acromion when the arms are hyperflexed. This exercise can be made safer by simply limiting flexion to the normal physiological limits or a comfortable ROM. Alternatively, latissimus pull-downs performed in front of the body, which challenge identical muscle groups, may be substituted.

Secondary Impingement Syndrome

Exercises that contribute to hyperlaxity of the anterior glenohumeral joint (discussed previously) can also contribute to the development of a secondary rotator cuff impingement (10, 12). If the arm does not remain centered in its shallow fossa during movement, the rotator cuff tendons and bursa can be repetitively compressed and become inflamed. In addition, the rotator cuff muscles must work harder in an attempt to restore stability and become prone to fatigue, tendonitis (microtrauma), inflammation, and subsequent impingement. This condition is referred to as a secondary impingement (10, 12) because the impingement develops secondary to hyperlaxity or instability. With secondary impingement it is sensible to avoid repeated stress to the anterior capsular restraints by limiting exercises that combine arm external rotation with horizontal abduction. Therefore, the modifications for anterior shoulder instability or hyperlaxity should be followed when prescribing exercises for an individual with a secondary impingement.

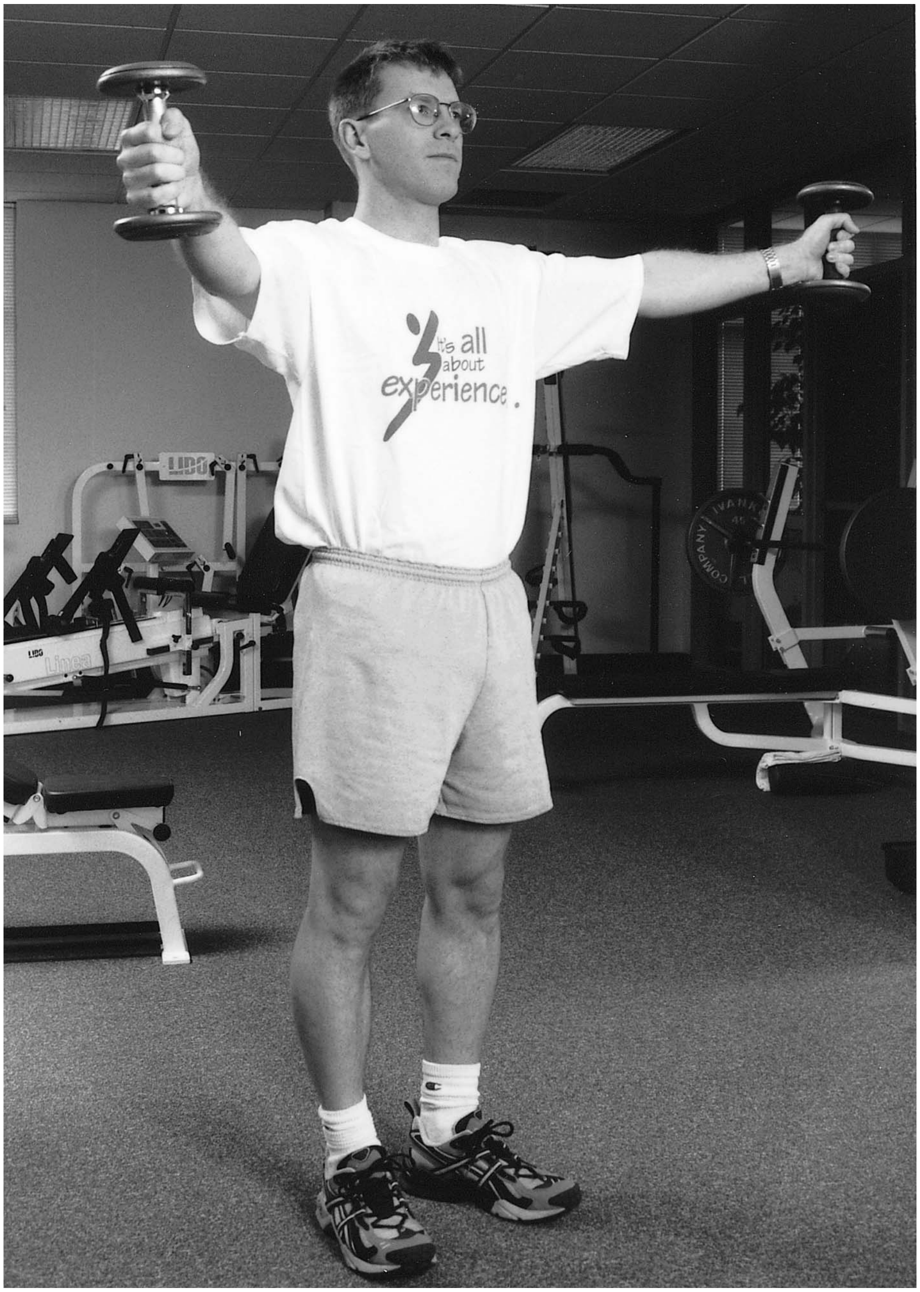


Figure 6. **Scaption–lateral raise in the scapular plane (30° anterior to the frontal plane).**

Internal Impingement Syndrome

Internal impingement of the articular side of the supraspinatus and infraspinatus tendons against the posterior glenoid labrum may occur when the shoulder is in the at-risk position (Figure 1; 3, 9). This form of impingement is most prevalent in throwing athletes because of repetitious shoulder external rotation combined with abduction and horizontal abduction, which can impinge the tendons against the labrum. Anterior glenohumeral instability may be a contributing factor to the development of internal impingement (2, 10). Sensibly, exercises that induce posterior glenohumeral joint impingement pain (not muscle soreness) and/or exacerbate an anterior instability should be avoided. Performing shoulder exercises out of the at-risk position is recommended.

Recommended Shoulder Exercises

Weight trainers frequently develop the larger shoulder muscle groups (i.e., pectorals and deltoids), yet often fail to develop the smaller rotator cuff and scapular stabilizers. This pattern of weakness and asynchronism in the smaller shoulder muscle groups was found to occur in a group of weight trainers who were unable to continue lifting because of shoulder pain (6). We recommend that exercises that develop all of the muscle groups about the shoulder, not just the larger muscles, be provided to clients. In our clinic, most patients with shoulder dysfunction perform exercises described by Moseley et al. (15), Townsend et al. (25), and Davies (3). This combination of exercises (scaption [Figure 6], rowing, push-up with a plus, press-up [Figure 8], and horizontal abduction with

Figure 7. **Pullover exercise performed supine.**

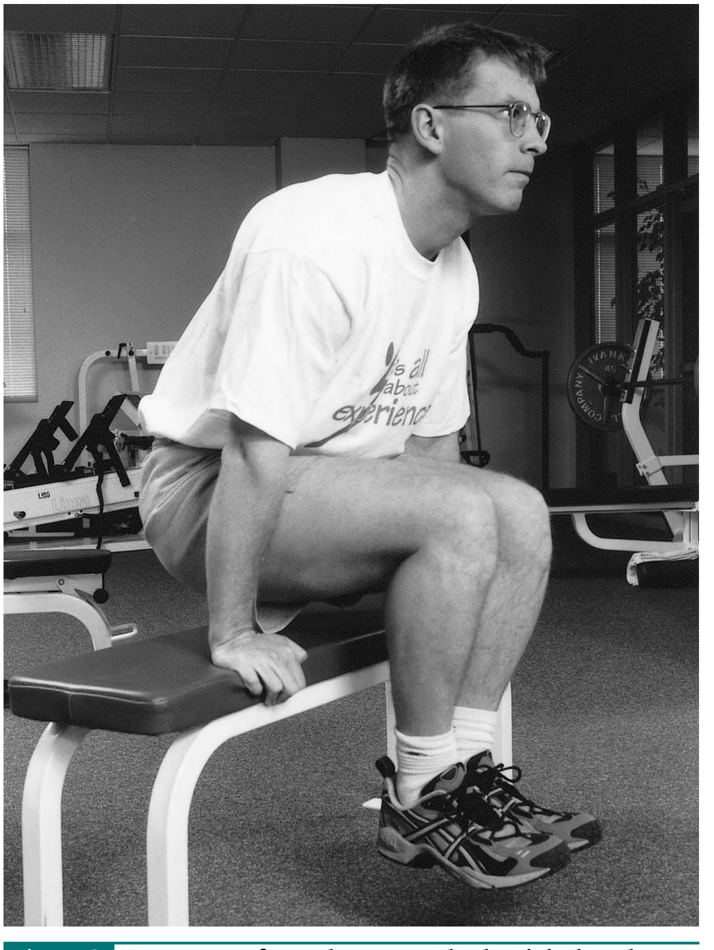


Figure 8. **Press-up performed on a standard weight bench.**

external rotation) was shown to elicit high levels of electromyogram (EMG) activity in all of the shoulder muscles. Internal and external rotation exercises in neutral or at 90° abduction (Figure 9) are also commonly prescribed for patients with shoulder dysfunction (3). Overhead athletes need to develop strength in the intrinsic rotator cuff muscles to steer the humeral head in an inferior direction while the arm is elevated. Inadequate strength can lead to excessive humeral head elevation and subsequent impingement of the soft tissues beneath the acromion (22).

As with any unfamiliar exercise techniques, we encourage you to practice the exercises described above before instructing clients. Proper exercise technique is vital to the safety of any resistance-training program. It is also imperative that the training program be comprised of exercises that are appropriate for the individual client's goals and anatomy.

The certified strength and conditioning specialist and personal trainer are increasingly being recruited to assist in the rehabilitative process. This shift in responsibility requires the strength and conditioning specialist to develop an awareness of appropriate and inappropriate exercises for a variety of pathologies. When in doubt about the safety of a particular exercise for a client recovering from injury, consult with the appropriate healthcare provider. Clients who sustain exercise-induced injuries that limit functional ability should be referred to their primary care provider. ▲

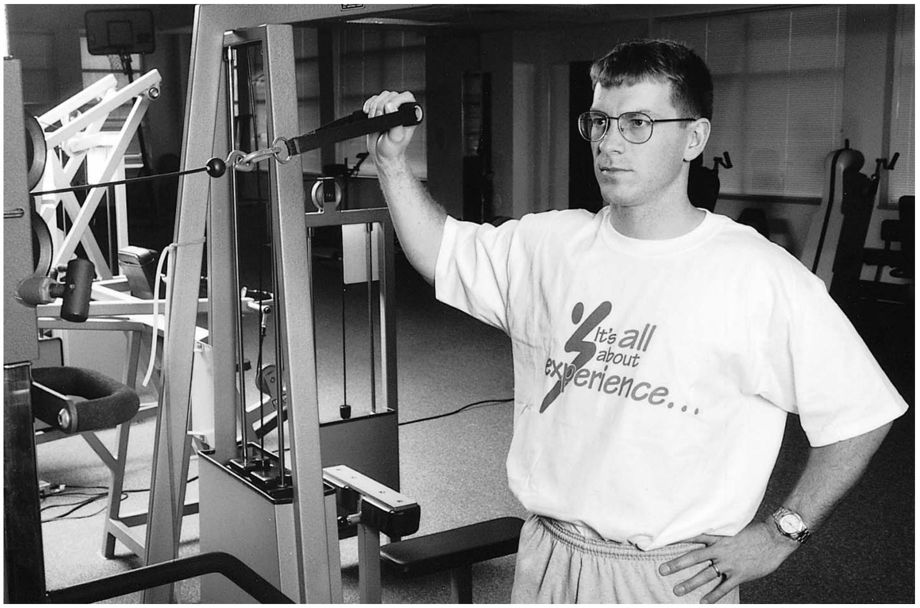
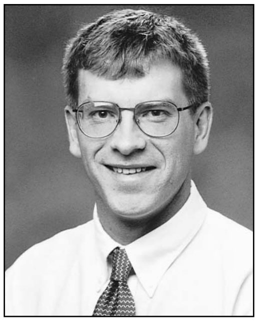


Figure 9. **Humeral external rotation at 90° abduction using a cable column.**

References

1. Cresswell, T.R., and R.B. Smith. Bilateral anterior shoulder dislocations in bench pressing: An unusual cause. *Br. J. Sports Med.* 32(1):71–72. 1998.
2. Davidson, P.A., N.S. Elattrache, C.M. Jobe, and F.W. Jobe. Rotator cuff and posterior-superior glenoid labrum injury associated with increased glenohumeral motion: A new site of impingement. *J. Shoulder Elbow Surg.* 4(5):384–390. 1995.
3. Davies, G.J., and S. Dickoff-Hoffman. Neuromuscular testing and rehabilitation of the shoulder complex. *J. Orthop. Sports Phys. Ther.* 18(2):449–458. 1993.
4. DeLee, J.C., and D. Drez. *Orthopedic Sports Medicine Principles and Practice* (Vol. 1). Philadelphia: W.B. Saunders, 1994.
5. Fees, M., T. Decker, L. Snyder-Mackler, and M.J. Axe. Upper extremity weight-training modifications for the injured athlete: A clinical perspective. *Am. J. Sports Med.* 26(5):732–742. 1998.
6. Gross, M.L., S.L. Brenner, I. Esformes, and J.J. Sonzogni. Anterior shoulder instability in weight lifters. *Am. J. Sports Med.* 21(4): 599–603. 1993.
7. Harman, E. A 3D biomechanical analysis of bench press exercise [Abstract]. *Med. Sci. Sports Exerc.* 16:159–160. 1984.
8. Hawkins, R.J., and J.C. Kennedy. Impingement syndrome in athletes. *Am. J. Sports Med.* 8(3):151–158. 1980.
9. Jobe, C.M. Posterior glenoid impingement. *Arthroscopy.* 11:530–536. 1995.
10. Jobe, F.W., and R.S. Kvitne. Shoulder pain in the overhand or throwing athlete. The relationship of anterior instability and rotator cuff impingement. *Orthop. Rev.* 18:963–975. 1983.
11. Jones, M. Bilateral anterior dislocation of the shoulders due to the bench press. *Br. J. Sports Med.* 21(3):139. 1987.
12. Kamkar, A., J.J. Irrgang, and S.L. Whitney. Nonoperative

management of secondary shoulder impingement syndrome. *J. Orthop. Sports Phys. Ther.* 17(5):212–224. 1993.
13. Lander, J.E., B.T. Bates, and P. Devita. Biomechanics of the squat exercise using a modified center of mass bar. *Med. Sci. Sports Exerc.* 18:469–478. 1986.
14. Mazur, L.J., R.J. Yetman, and W.L. Risser. Weight-training injuries: Common injuries and preventative methods. *Sports Med.* 16:57–63. 1993.
15. Moseley, J.B., F.W. Jobe, M. Pink, J. Perry, and J. Tibone. EMG analysis of the scapular muscles during a shoulder rehabilitation program. *Am. J. Sports Med.* 20(2):128–134. 1992.
16. Neer, C.S. Anterior acromioplasty for the chronic impingement syndrome in the shoulder. *J. Bone Joint Surg.* 54-A(1): 41–50. 1972.
17. O'Brien, S.J. The anatomy and histology of the inferior glenohumeral ligament complex of the shoulder. *Am. J. Sports Med.* 18:449–456. 1990.
18. O'Brien, S.J., R.S. Schwartz, R.F. Warren, and P.A. Torzilli. Capsular restraints to anterior-posterior motion of the abducted shoulder: A biomechanical study. *J. Shoulder Elbow Surg.* 4(4):298–308. 1995.
19. O'Connell, P.W., G.W. Nuber, R.A. Mileski, and E. Lautenschlager. The contribution of the glenohumeral ligaments to anterior stability of the shoulder joint. *Am. J. Sports Med.* 18(6):579–584. 1993.
21. Pagnani, M.J., and R.F. Warren. Stabilizers of the glenohumeral joint. *J. Shoulder Elbow Surg.* 3:173–190. 1994.
22. Sharkey, N.A., and R.A. Marder. The rotator cuff opposes superior translation of the humeral head. *Am. J. Sports Med.* 23(3):270–275. 1995.
23. Shea, J.M. Acute quadriplegia following the use of progressive resistance exercise machinery. *Phys. Sports Med.* 14(4):120–124. 1986.
24. Soslowsky, L.J., E.L. Flatow, L.U. Bigliani, R.J. Pawluk, G.A. Ateshian, and V.C. Mow. Quantification of in situ contact areas at the glenohumeral joint: A biomechanical study. *J. Orthop. Res.* 10(4):524–534. 1992.
25. Townsend, H., P.W. Jobe, M. Pink, and J. Perry. Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program. *Am. J. Sports Med.* 19(3):264–272. 1991.
26. U.S. Consumer Products Safety Commission. *National Electronic Injury Surveillance System: 1995 Summary on Injuries Caused by Weight Lifting and Sports.* Washington, DC: U.S. Consumer Products Safety Commission, 1997.



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