KERLAN·JOBE ORTHOPAEDIC CLINIC
Where the Science of Medicine Enhances the Art of Life

S3 EFFECTIVE FOR SHOULDER PATHOLOGIES

-Dr. Steven Smith

Introduction:

Scapular function and its role in shoulder biomechanics has gained increased notoriety in the pathogenesis of shoulder dysfunction over the past years. Both static and dynamic aspects of the coordinated shoulder motion depend on a properly functioning and positioned scapula. In particular, undo strain is placed on the rotator cuff with dysynchronous scapular motion. Furthermore, scapular protraction (the inability to properly retract the scapula) has numerous deleterious effects on the shoulder, such as a narrowed subacromial space with increased impingement, reduced isometric muscle strength, and increased strain on the anterior-inferior glenohumeral ligament.[1-2,6,8-10,12,15,17-18,20]

The spine scapula stabilizer brace, S3 (AlignMed, Inc. Santa Ana, CA), is designed to help restore normal shoulder kinematics. This brace attempts to achieve this objective with a Velcro strapping system coupled with proprioceptive padding and mesh vest to allow biofeedback to patients. This neural feedback, along with the vest's innate postural support, could potentially emphasize proper shoulder muscular mechanics. The vest comes in numerous sizes and is custom fit to each patient. Uhl, et al. evaluated the immediate dynamic effects of shoulder rotation in this brace system and found decreased internal rotation and increased posterior tilt of the scapula in 10 normal subjects[19], but the measurement of strength with and without the brace has not been studied. Thus, the purpose of this study is to measure internal and external shoulder strength in subjects with normal shoulders with and without the S3 brace.

Materials and Methods:

The investigation was approved by our institutional review board. Informed consent was received and the rights of the subjects were protected. The study design consisted of fourteen males (24-40 years, mean 32.5 years) without a previous history of shoulder, elbow, or cervical spine surgery, discomfort, or weakness. The brace was fitted by a company representative to insure proper application. Only the customized strap for scapular protraction was used even though several strapping methods are available with this orthotic (Figures 1,2).
All subjects were allowed to warm up and stretch their shoulders to their comfort level prior to testing. Each subject was asked to perform five maximal efforts of standing shoulder internal and external rotation within the scapular plane with and without the S3

brace. The standing position was chosen to avoid scapular stabilization from the seat back. In order to eliminate fatigue as a variable, the subjects were randomized to testing with or without the brace with a minimum of one week between data collection sessions. The dominant shoulder was the only side tested and this was performed at both 180 deg/sec and 300 deg/sec. A Biodex dynamometer7 was used to record data in an isokinetic resistance mode. A physical therapist trained and experienced with the Biodex dynamometer was used to properly setup and instruct each subject.

Means and standard deviations were calculated for Peak Torque (ft-lbs) and Peak Torque to Body Weight (%) for internal and external rotation at each speed with and without the brace. The means were compared using Student's t-Test with the significance level set at $p \leq .05$.

Results:

The means and standard deviations are listed in Table 1 for measurements with and without the brace. At both testing speeds the means for Peak Torque and Peak Torque to Body Weight increased significantly for internal and external rotation with the use of the brace. At 180 deg/sec, internal rotation peak torque increased from 42.2 to 53.7 ft-lbs ($p = .0003$). External rotation peak torque at 180 deg/sec increased from 29.8 to 36.07 ft-lbs ($p = .006$). At 300 deg/sec, internal rotation peak torque increased from 37.2 to 48.5 ft-lbs ($p = .005$) and external rotation peak torque increased from 27.1 to 34.7 ft-lbs with the use of the brace ($p = .007$). When peak torque was normalized to body weight, the same pattern of significance was seen.

Discussion:

Current shoulder rehabilitation programs focus on scapular stabilizers[4,11,14] to maximize function of the shoulder girdle complex and to decrease strain on injured or surgically repaired tissue in the shoulder.[1,13,16] A bracing system to increase proprioception and properly align the spine, trunk, and scapula could potentially aid in optimizing the function of the upper extremity in these patients. It has been shown that increased anterior shoulder muscle forces and decreased posterior scapular stabilizers create an imbalance around the shoulder leading to an increase in glenohumeral instability and increased strain on the anterior inferior glenohumeral ligament.[6,20] Thus, a proper balance of the shoulder musculature, which optimally positions the scapula, can potentially increase the effectiveness of shoulder rehabilitation programs.

Scapular dyskinesis, as described by Kibler and McMullen[3], results from an alteration of muscle coordination or activation either as a primary or compensatory impairment of the scapular stabilizing muscles.[13] Abnormal firing patterns of the main scapular stabilizing muscles (serratus anterior, upper and lower trapezius, and rhomboid muscles) has many deleterious effects on the shoulder, including decreased acromial elevation, loss of kinetic chain function, and loss of scapular retraction/protraction control.[3,12] Uhl, et. al showed in healthy, asymptomatic subjects that the S3 brace can reduce excessive internal rotation and anterior tilt of the scapula and possibly decrease

impingement.[19] However, the question of whether or not immediate shoulder strength is increased in the S3 brace has yet to be addressed in the literature. Our investigation demonstrates that this brace can also improve shoulder strength in internal and external rotation in asymptomatic individuals. By reducing scapular protraction, and thus placing the scapula in a more advantageous anatomical position, the rotator cuff and scapular musculature are allowed to function more efficiently, thereby increasing shoulder strength[5,17] and reducing problems associated with scapular protraction.

This investigation did have its limitations. We did not have a screening process to determine if each subject already had acceptable scapular kinematics and, thus, the addition of a scapular brace would unlikely to alter a normally functioning shoulder girdle. Furthermore, the effort exuded by the subjects was not normalized.

In conclusion, enhanced scapular proprioception increases the efficiency of shoulder function with increased strength of internal and external rotation in normal subjects. The authors recommend further studies of scapular stabilization devices in subjects with various symptomatic shoulder conditions which could be linked with scapulothoracic and glenohumeral dysynchrony (e.g. subacromial and subcoracoid impingement, multidirectional instability, thoracic outlet syndrome, and scapular winging). In addition, post-operative patients with rotator cuff repairs, glenohumeral stabilization procedures, clavicle fractures, and acromioclavicular joint reconstructions may benefit from the use of this type of brace during their rehabilitation.

References:

1. **Burkhart, S. S.; Morgan, C. D.; and Kibler, W. B.: The disabled throwing shoulder: spectrum of pathology Part III: The SICK scapula, scapular dyskinesis, the kinetic chain, and rehabilitation. *Arthroscopy,* 19(6): 641-61, 2003.**
2. **Happee, R., and Van der Helm, F. C.: The control of shoulder muscles during goal directed movements, an inverse dynamic analysis. *J Biomech,* 28(10): 1179-91, 1995.**
3. **Kibler, W. B., and McMullen, J.: Scapular dyskinesis and its relation to shoulder pain. *J Am Acad Orthop Surg,* 11(2): 142-51, 2003.**
4. **Kibler, W. B.; McMullen, J.; and Uhl, T.: Shoulder rehabilitation strategies, guidelines, and practice. *Orthop Clin North Am,* 32(3): 527-38, 2001.**
5. **Kibler, W. B.; Sciascia, A.; and Dome, D.: Evaluation of apparent and absolute supraspinatus strength in patients with shoulder injury using the scapular retraction test. *Am J Sports Med,* 34(10): 1643-7, 2006.**
6. **Labriola, J. E.; Lee, T. Q.; Debski, R. E.; and McMahon, P. J.: Stability and instability of the glenohumeral joint: the role of shoulder muscles. *J Shoulder Elbow Surg,* 14(1 Suppl S): 32S-38S, 2005.**
7. **Leggin, B. G.; Neuman, R. M.; Iannotti, J. P.; Williams, G. R.; and Thompson, E. C.: Intrarater and interrater reliability of three isometric dynamometers in assessing shoulder strength. *J Shoulder Elbow Surg,* 5(1): 18-24, 1996.**
8. **Ludewig, P. M., and Cook, T. M.: Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. *Phys Ther,* 80(3): 276-91, 2000.**
9. **Lukasiewicz, A. C.; McClure, P.; Michener, L.; Pratt, N.; and Sennett, B.: Comparison of 3-dimensional scapular position and orientation between subjects with and without shoulder impingement. *J Orthop Sports Phys Ther,* 29(10): 574-83; discussion 584-6, 1999.**
10. **McClure, P. W.; Michener, L. A.; Sennett, B. J.; and Karduna, A. R.: Direct 3-dimensional measurement of scapular kinematics during dynamic movements in vivo. *J Shoulder Elbow Surg,* 10(3): 269-77, 2001.**
11. **McMullen, J., and Uhl, T. L.: A Kinetic Chain Approach for Shoulder Rehabilitation. *J Athl Train,* 35(3): 329-337, 2000.**
12. **McQuade, K. J.; Dawson, J.; and Smidt, G. L.: Scapulothoracic muscle fatigue associated with alterations in scapulohumeral rhythm kinematics during maximum resistive shoulder elevation. *J Orthop Sports Phys Ther,* 28(2): 74-80, 1998.**
13. **Millett, P. J.; Wilcox, R. B., 3rd; O'Holleran, J. D.; and Warner, J. J.: Rehabilitation of the rotator cuff: an evaluation-based approach. *J Am Acad Orthop Surg,* 14(11): 599-609, 2006.**
14. **Moseley, J. B., Jr.; Jobe, F. W.; Pink, M.; Perry, J.; and Tibone, J.: EMG analysis of the scapular muscles during a shoulder rehabilitation program. *Am J Sports Med,* 20(2): 128-34, 1992.**
15. **Pink MM, P. J.: *Operative Techniques in Upper Extremity Sports Injuries*.**

Edited by Jobe FW, P. M., Glousman RE, Kvitne RS, Zemel NP, 109-123, St. Louis, MO, Mosby-Year Book, 1996.

16. **Rubin, B. D., and Kibler, W. B.: Fundamental principles of shoulder rehabilitation: conservative to postoperative management.** ***Arthroscopy,*** **18(9 Suppl 2): 29-39, 2002.**
17. **Smith, J.; Kotajarvi, B. R.; Padgett, D. J.; and Eischen, J. J.: Effect of scapular protraction and retraction on isometric shoulder elevation strength.** ***Arch Phys Med Rehabil,*** **83(3): 367-70, 2002.**
18. **Solem-Bertoft, E.; Thuomas, K.A.; Westerberg, C.E.: The influence of scapular retraction and protraction on the width of the subacromial space. An MRI Study.** ***Clin Orthoped Relate Res,*** **296: 99-103, 1993.**
19. **Uhl TL, K. W., Tripp BL, Spigelman TH, McClelland R: The Effectiveness Of A Scapular Brace On Scapular Kinematics. In** ***American Society of Shoulder and Elbow Therapists*****. Edited, 2005 Annual Conference Abstract.**
20. **Weiser, W. M.; Lee, T. Q.; McMaster, W. C.; and McMahon, P. J.: Effects of simulated scapular protraction on anterior glenohumeral stability.** ***Am J Sports Med,*** **27(6): 801-5, 1999.**