Evaluation of Shoulder Instability Braces

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The comparative abilities of three types of shoulder orthoses to limit motion following isokinetic exercise were studied on 10 male subjects. Maximum active abduction, forward flexion, and external rotation were measured under a control and three braced conditions. Braced conditions included Sawa, Duke Wyre, and Shoulder Subluxation Inhibitor. Subjects performed 10 repetitions each of flexion/extension and abduction/adduction exercise at isokinetic speeds of 120 and 180°/s. Data were analyzed using a paired t-test and ANOVA. Significant differences were found for each of the devices in pre/post goniometric measurements of forward shoulder flexion. Only the Sawa brace demonstrated significant pre/post change for shoulder abduction. No significant differences were detected in any of the devices for external rotation. A trainer who is selecting a motion-limiting shoulder device for an athlete returning to competition following injury should consider the “loosening” effect that may occur during activity as well as the desire for overhead motion.

An athlete is most vulnerable to suffering an anterior dislocation when the arm is abducted and externally rotated. Forced horizontal extension or a posterior blow to the shoulder with the arm in this position can take the arm past its physiological limits and dislodge the humeral head from the glenoid fossa.

Shoulder stabilization in athletics has included a variety of taping and strapping techniques and, more recently, the introduction of several braces. Whether utilized prior to or following surgical intervention or in place of surgery, shoulder braces may allow athletes with anterior glenohumeral instability to participate in sport. Although a variety of devices are available on the market, practitioners generally choose from a few commonly used and well-known shoulder braces.

Shoulder braces are used to limit the motion of the glenohumeral joint, thereby preventing the arm from achieving a position that might lead to subluxation or dislocation should a direct or indirect outside force be applied. For the glenohumeral joint, the position at which the ligaments and capsule are potentially compromised is the position of maximum tightness (abduction and external rotation) known as the “close-packed position” (1). As with other protective devices, a shoulder brace that is prescribed for an injured athlete returning to competition must allow safe and effective participation without placing opposing players at risk, and game officials...
must be satisfied that the brace meets the specifications of the rules governing the sport.

Three commonly prescribed devices for athletes are the Duke Wyre Shoulder Vest, the Sawa Shoulder Orthosis, and the Shoulder Subluxation Inhibitor (SSI). There are currently no objective standards on which to base shoulder brace selection, and literature on shoulder orthoses is limited. This study was undertaken to evaluate the effectiveness of three types of shoulder devices in maintaining predetermined limitations following isokinetic exercise in a controlled, nonathletic setting.

**Methods**

**Subjects**

Ten healthy male recreational athletes (average age = 27.2 ± 2.82 years, height = 180.3 ± 5.18 cm, weight = 79.9 ± 6.09 kg) volunteered as subjects. Subjects reported no history of glenohumeral joint instability, and each demonstrated active range of motion within normal limits: 170 to 180° abduction, 160 to 180° forward flexion, and 80 to 90° external rotation (1) (Table 1).

**Procedures**

Our experimental design included three dependent variables (maximum abduction, maximum forward flexion, and maximum external rotation) and one independent variable (type of shoulder brace) with three levels of treatment. Each subject performed consecutive isokinetic exercise at 120 and 180°/s and received treatments with three braces: Duke Wyre (C.D. Denison Orthopaedic Appliance Corporation, Baltimore, MD; Figure 1), Sawa Shoulder Brace (Brace International, Atlanta, GA; Figure 2), and Shoulder Subluxation Inhibitor (Boston Brace International, Inc., Avon, MA; Figure 3).

Treatment order was randomized for all subjects. All braces were applied and fitted by the same investigator according to manufacturers' specifications. Subjects wore T-shirts underneath the devices during testing. Active shoulder range

| Table 1  Mean ROM (in degrees) With No-Brace Condition and Three Braced Conditions, Pre and Post Isokinetic Exercise |
|----------|---------------|---------------|---------------|
|          | Abduction     | Flexion       | External rotation |
| No brace | 175.6         | 173.1         | 97.5           |
| Sawa     | Pre 73.3      | 81.9          | 85.6           |
|          | Post 81.1     | 94.2          | 88.6           |
| SSI      | Pre 103.1     | 111.8         | 87.8           |
|          | Post 107.0    | 126.1         | 93.2           |
| Duke Wyre| Pre 65.1      | 80.6          | 77.7           |
|          | Post 68.4     | 94.2          | 81.7           |
Figure 1 — Abduction measure of the Duke Wyre Shoulder Vest.

Figure 2 — Forward flexion measure of the Sawa Shoulder Brace.
of motion was measured with a standard goniometer by the same investigator for each subject prior to brace fitting, after brace fitting, and following isokinetic exercise. Subjects were measured while lying supine on a treatment table with knees flexed to 90°.

Measurements included the maximum active range of motion for forward flexion, abduction, and external rotation (at 0° horizontal extension). External rotation was measured in 90° of abduction for the no-brace condition and in maximum allowed abduction in each of the braced conditions. Each subject performed 20 isokinetic repetitions (Cybex II isokinetic dynomometer, Cybex Division of Lumex, Inc., Ronkonkoma, NY) for each experimental condition, including 10 repetitions each of flexion/extension and abduction/adduction at isokinetic speeds of 120 and 180°/s for each of the three braces (Figure 4).

Data Analysis
A paired t test was performed for each device and motion to determine if significant changes occurred in goniometric measurements of range of motion (ROM) from pre to post isokinetic exercise. A two-way analysis of variance (ANOVA) was used, with subject and device as independent variables and with ROM (change from pre to post) as the dependent variable.

Results
Results of the paired t tests evaluating ROM indicated that each of the three devices permitted significant (p < .05) increases in ROM from pre- to postexercise for the
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flexion motion. Only the Sawa brace demonstrated a significant ($p < .05$) change in ROM from pre to post for shoulder abduction. No significant pre to post differences in ROM were detected in any of the devices for external rotation. Unlike the other two braces, the Sawa brace demonstrated a greater change in abduction than in external rotation (Figure 5).

ANOVA indicated that for each type of motion, the amount of change for each brace was similar. The three devices did not differ significantly from one another in their pre to post ROM measurements for all three motions (flexion $p = .97$, abduction $p = .37$, external rotation $p = .78$; Table 1 and Figure 5).

Figure 4 — Isokinetic flexion/extension exercise.

(Degrees)

![Bar chart showing mean increases in ROM following exercise.](image)

- $a$ significant difference ($p < 0.05$)
- $b$ significant difference ($p < 0.01$)

Figure 5 — Mean increases in ROM following exercise.
Anterior glenohumeral dislocations account for as many as 84% of all shoulder injuries, while posterior dislocations account for only about 1.5% (5). Acromioclavicular and sternoclavicular injuries account for the remaining 12% and 2.5%, respectively (5). Recurrent dislocation, especially in athletes and persons younger than 20 years of age, is the most common complication following an acute traumatic anterior dislocation (5).

The purpose of shoulder bracing in athletics is to protect a previously injured athlete from experiencing further episodes of instability. Most often this has meant preventing the arm from achieving a position that would compromise the stability of the joint, namely the close-packed position of abduction and external rotation.

Little data exist in the literature regarding the use of shoulder orthoses. Sawa (3) reported no episodes of recurrent shoulder dislocation in major league amateur ice hockey players who returned to competition wearing the Sawa brace. Four of the 11 patients in the study had undergone surgical repair. A therapeutic regimen involving rest, proper nutrition, and muscle stimulation was used to enhance soft tissue repair before the athletes were returned to play with the shoulder device. The reported function of the Sawa orthotic device is “to stabilize and to restrict motion” (3).

The abilities of three types of shoulder braces to maintain predetermined motion limitations in forward flexion, abduction, and external rotation following isokinetic exercise were considered in this study. Isokinetic exercise was used to provide a controlled stress on the end ranges of motion for each brace in abduction and flexion. Our results indicate that each brace did undergo a loosening effect for each motion. All three braces allowed significant postexercise increases in forward flexion (Figure 5). We found this result to be of interest, because although forward flexion is not mentioned in the literature as a motion contributing to compromised anterior stability, two of the braces (Sawa and Duke Wyre) contained a means for controlling this motion through a “check reign” design.

More than likely, the check reign design found in the Sawa and Duke Wyre was utilized to control abduction. Our results showed the Duke Wyre to be effective in maintaining limited abduction; however, the Sawa allowed a significant ($p < .05$) increase in abduction following isokinetic exercise.

Of the three motions measured in this study, external rotation in abduction was the only motion that did not significantly increase in any of the three braces following exercise. This may be attributed to the fact that (a) none of the braces studied attempt to control this motion by design and (b) external rotation does not typically increase even if abduction is slightly increased. Aside from the difficulty in controlling this motion, external rotation is typically considered most “dangerous” for anterior instability when the arm achieves 90° of abduction.

Turkel et al. (4) reported that as the arm is progressively abducted, fewer structures function to limit external rotation. As abduction increases, the support function of the muscles, capsule, and ligaments is shifted from the superior to the inferior structures. At 0 and 45° of abduction, dislocation is prevented by the combined effects of the subscapularis, middle glenohumeral ligament, and superior fibers of the inferior glenohumeral ligament (4). At 90° of abduction, the inferior glenohumeral ligament blocks anterior dislocation (4). This broad ligament has been described as
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acting like a buttress on the anterior and inferior aspects of the joint that grips the humeral head firmly as the arm progressively abducts and externally rotates (2).

The findings of these authors suggest that an intact inferior glenohumeral ligament is the last line of defense for preventing anterior displacement once the arm is abducted past 90°, and that as long as this ligament remains intact, increased external rotation (even beyond 90°) will not threaten the stability of the shoulder (2, 4). Therefore, a more important motion to control than external rotation may be horizontal extension.

Although it is not included as a component of the “at-risk” position for anterior instability and was not measured in our study, forced horizontal extension in ≤90° of abduction and external rotation would certainly compromise glenohumeral stability by forcing the head of the humerus into the taut inferior glenohumeral ligament. This force could be either direct, from a posterior blow to the proximal humerus, or indirect, from a closed chain mechanism where the hand of an abducted and externally rotated arm is pulled back. With the arm in greater than 90° of abduction, forced horizontal extension combined with external rotation could produce enough stress to cause the inferior glenohumeral ligament to fail, thereby allowing the humeral head to dislodge anteriorly from the glenoid fossa.

Of the three devices tested, only the SSI limits horizontal extension. A posterior buttress in the shell of the SSI serves as a block when it is contacted by the mobile shell covering the glenohumeral joint (Figure 3). In addition to supporting the buttress, the hard shell plastic of the SSI may also prevent horizontal extension by absorbing any posterior blows to the proximal humerus.

Our examiner applied the braces to allow for “maximum safe motion within the design limits of the device” as would be done for a football player with anterior glenohumeral instability. The underarm check reign design described earlier (Sawa and Duke Wyre) restricts arm movements away from the body by connecting the distal humerus to the lateral torso at the chest (Figures 1 and 2). Regardless of the fitting technique, this method of restriction limits abduction and forward flexion to approximately the same extent, thereby limiting overhead arm motion. In contrast, the SSI utilizes pivot joints in the shell that can allow greater functional joint motion in the sagittal plane than in the frontal or at-risk plane. Adjustable hole settings are used to control maximum movement.

Summary

The high rate of reinjury in young patients increases the clinician’s challenge in safely and effectively returning athletes with glenohumeral instability to competition. Following an appropriate treatment and rehabilitation program, several factors should be considered before a shoulder brace is chosen for sports participation: the mechanism of injury, the sport (including demands, position played, and equipment regulations), and brace design.

Determining the exact mechanism of injury not only enables the clinician to prescribe appropriate treatment and rehabilitation but also assists in selection of the best method of preventing a recurrence. Assessing the athlete’s situation will help the clinician return the athlete safely and effectively while adhering to equipment regulations.

 Becoming familiar with a variety of shoulder braces, including their materials, designs, and cost, will better prepare the clinician to discuss options and risks
with athletes. Any device utilized by sports medicine professionals to return an athlete to competition should protect the injured area without allowing further injury. However, the device should not unnecessarily prevent the athlete from performing safe movements.

Each of the three braces studied limited motion in the sagittal and frontal plane. Due to its ability to maintain preset limitations in the frontal plane (limiting abduction) while at the same time allowing movement in the sagittal plane (permitting forward flexion), the SSI may be the most appropriate brace for the athlete desiring some degree of overhead arm motion. For example, the SSI brace may be more appropriate for returning a wide receiver to football activities than a brace which restricts overhead motion entirely. The SSI has the added benefit of a hard shell covering to protect against posterior blows received in football. A Sawa or Duke Wyre brace may be a more suitable choice for a football lineman or ice hockey player, for example, who is not as concerned with overhead arm motion.

Further studies should evaluate shoulder braces following actual sports participation rather than controlled isokinetic exercise, measure specific endpoints of motion in braces (including horizontal extension), use injured athletes as subjects, and test other braces currently in use.

References


Acknowledgments

We would like to acknowledge Dee Mahoney, MS, ATC, Patti Hunker, MS, ATC, and Kecia Sell, PT, ATC, for their assistance with data collection and David Nelson of Methodist Hospital in Indianapolis for his assistance with statistical analysis.

We would also like to thank the individual brace companies (Brace International, C.D. Denison Appliance Corp., and Boston Brace International) for donating braces for use in this study.

No monetary benefit was received by the authors for this study.