Immobilization in external rotation combined with abduction reduces the risk of recurrence after primary anterior shoulder dislocation

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Background: We aimed to compare the effectiveness of immobilization in abduction and external rotation vs immobilization in adduction and internal rotation after primary anterior dislocation of the shoulder.

Methods: The study randomized 102 patients (age range, 15-55 years) with the diagnosis of primary anterior dislocation of the shoulder to receive immobilization in adduction and internal rotation (AdIR, n = 51) using sling and swathe bandage or immobilization in abduction and external rotation (AbER, n = 51) with a stabilizer brace. Patients received a rehabilitation program 3 weeks after the intervention.

Results: After a 24-month follow-up, 33.3% in the AdIR group and 3.9% in the AbER group had recurrence (\(P < .001\)). The difference in the recurrence rate was greater in the subgroup aged between 31 and 40 years (44.8% in the AdIR group and 3.8% in the AbER group, \(P < .001\)). Ten patients in the AbER group (19.6%) and 3 in the AdIR group (5.8%) discontinued shoulder immobilization before 3 weeks (\(P = .03\)). In patients without recurrence, the anterior apprehension test was positive in 6 of 34 in the AdIR group (17.6%) and in 4 of 49 in the AbER group (8.1%, \(P = .19\)).

Conclusions: Immobilization with the shoulder joint in abduction and external rotation is an effective method to reduce the risk of recurrence after primary anterior shoulder dislocations and should be preferred to the traditional method of immobilization in adduction and internal rotation in clinical practice.

Level of evidence: Level I, Randomized Controlled Trial, Treatment Study.

Keywords: Shoulder dislocation; management; immobilization; braces; rehabilitation; clinical trial
The shoulder has the widest extent of motion, rendering it the most susceptible joint to instability in human body.\textsuperscript{12,16,17} The instability may be anterior, posterior, or multidirectional. Anterior traumatic dislocation constitutes 96\% of all shoulder dislocations\textsuperscript{7} and is correlated with ligament disruption, fractures, rotator cuff injuries, and neurologic involvement\textsuperscript{1,2,22}; consequently, pain, disability, and apprehension are present during some shoulder movements.\textsuperscript{32}

An acute shoulder dislocation is an emergency condition requiring urgent relocation. Several interventions have been suggested for the treatment of shoulder dislocations. Effective treatment aims at restoration of a completely functioning, pain-free, and stable shoulder joint, and includes conservative (nonsurgical) and surgical treatment.\textsuperscript{8}

The conventional nonsurgical method by sling stabilization with the arm positioned in adduction and internal rotation has been broadly used for primary anterior dislocation of the shoulder.\textsuperscript{26} The recurrence rate of this treatment is inappropriately high, at 33\% to 83\%, particularly in young and active individuals, and is reported to be between 66\% and 92\% in patients aged younger than 20 years.\textsuperscript{28,30} Obviously, this high recurrence rate is a main complication after dislocation. However, recent studies have entirely changed prior knowledge and the traditional treatment approach. Clinical and cadaveric investigations have demonstrated the potential benefits of stabilizing the shoulder joint in external rotation after a primary anterior dislocation.\textsuperscript{12,13,14,33}

The superior, middle, and inferior glenohumeral ligaments are important in maintaining shoulder stability. In an abducted shoulder, the inferior glenohumeral ligament reveals a distinct, functional, and anatomic arrangement to provide support of the humeral head in external rotation. When the humerus is abducted and externally rotated, the anterior band of the inferior glenohumeral ligament fans out and supports the humeral head anteriorly. Thus, the normal anatomic integrity of the ligament may be an important consideration in preventing and treating anterior shoulder instability.\textsuperscript{24,25}

Although several shoulder braces designed to stabilize the shoulder in external rotation have become commercially available, more investigation on stabilization at abduction plus external rotation in the primary anterior shoulder dislocation is required to provide important evidence for improving clinical treatment protocols regarding this position. To the best of our knowledge, this is the first randomized, controlled trial comparing the effectiveness of the nonsurgical treatments of immobilization in abduction and external rotation vs immobilization in adduction and internal rotation after the primary anterior shoulder dislocation. We aimed to compare functional outcome and stability results between these two positions of shoulder stabilization.

\begin{center}
\textbf{Materials and methods}
\end{center}

\begin{center}
\textbf{Study design and setting}
\end{center}

We conducted a prospective, randomized, controlled, clinical trial, called Shoulder Stabilizing Support (3S), to compare 2 nonsurgical treatments. Between October 2011 and March 2013, 135 consecutive patients with primary anterior dislocation of the shoulder were screened for inclusion in the study. The study was performed at the emergency department (ED) of a university-affiliated urban hospital that is a regional level II trauma center with annual census of 68,000 ED visits.

The study was conducted in cooperation with the International Conference on Harmonization Guidelines for Good Clinical Practice\textsuperscript{11} and the Declaration of Helsinki.\textsuperscript{3} Written informed consent was obtained from all patients.

\begin{center}
\textbf{Patient selection}
\end{center}

Study participants were enrolled on a rolling basis by screening of patients with primary unilateral anterior dislocation of the shoulder who presented to the ED within 6 hours after the injury. The patients were aged between 15 and 55 years and were willing to be followed up. Exclusion criteria were previous shoulder problems, surgical joint repair, multidirectional instability, shoulder injuries requiring surgical intervention, associated fractures of the shoulder according to results of routine radiographic examination, and the unwillingness to be monitored for 24 months.

\begin{center}
\textbf{Randomization and intervention}
\end{center}

The patients were randomly assigned (in a 1:1 ratio) to immobilization in adduction and internal rotation (AdIR group) or immobilization in abduction and external rotation (AbER group) according to a computer-generated randomization scheme. Each ED physician was provided with a set of opaque envelopes containing group assignment.

All patients underwent routine radiographic examination of anteroposterior, axillary, and scapular Y views and a neurovascular examination before and after reduction. The shoulders were reduced manually using the traction-countertraction maneuver or Kocher’s method. In the AdIR group, the arm was stabilized using sling and swathe bandage. The AbER method was performed by using a stabilizer brace with an adjustable angle of abduction. The shoulder was stabilized in 15\textdegree of abduction and 10\textdegree of external rotation. A similar immobilization position of external rotation using orthopedic braces has been described in previous reports.\textsuperscript{12,14,33}

The body of the shoulder stabilizer brace was made from hard polyethylene. The large portion of the brace covering the patient’s body stretched to the right border of sternum in the front and to the spinous process of thoracic vertebrae in the back. This part was fixed by Velcro (Velcro USA Inc, Manchester, NH, USA) to provide acceptable stabilization. Arm fixation was attached to the body with an adjustable metallic bar (Fig. 1).

\begin{center}
\textbf{Follow-up}
\end{center}

At 3 weeks postintervention, a clinical history assessment and physical examination were performed for each patient. We asked
the patients whether they had experienced any further dislocations after immobilization during the follow-up period. We also evaluated anterior apprehension to identify any residual shoulder instability after 3 weeks.

In the apprehension test, patient was positioned supine. This maneuver involved placing the arm in 90° of abduction and the elbow in 90° of flexion. We placed stress on the glenohumeral joint by applying an external rotator force until the patient became apprehensive.

In patients with anterior instability, the feeling that the shoulder would come out of joint was considered a positive test.6

To determine the cooperation rate in the immobilizer application, we asked the patients the following question: “Please indicate how many hours a day and for how long you wore the immobilizer.” Those who took off the immobilizer, except when they took a shower, during the 3 weeks were defined as noncooperative participants.

At the end of 3 weeks, both groups underwent an identical rehabilitation program including isometric and isotonic exercises under the control of a physiotherapist. It has been proposed not to initiate sportive activities for at least 3 months after the intervention. During 3 weeks, patients in both groups removed the immobilizer supports only while taking a shower and were advised to be cautious about hyperextension of the joint. They were asked not to change the position of the brace and to use the contralateral upper extremity to perform activities. Then, the patients were visited 1 or 2 more times to assess the joint range of motion. Patients in both groups who experienced recurrent symptomatic instability at any time during the study underwent surgical intervention according to the orthopedic surgeon’s discretion.

All patients were followed up for 24 months after the initial dislocation and were interviewed on the telephone. In addition, information regarding the functional outcome assessment was obtained at 33-month follow-up interviews. In the event that the patient could not be contacted, all efforts were made by the physicians to obtain a visit at the nearest clinic to the patient’s residential area, or a home visit was performed for evaluation.

**Outcome measure**

The primary outcome measure was the recurrence rate of dislocation, defined as the humeral head being completely or partially out of the glenoid socket that reduced spontaneously or by manual maneuver. Secondary outcome measures were the rate of positive anterior apprehension test results, rate of return to preinjury sports, proportion of noncooperative patients, and the functional assessment of the patients as measured with the Western Ontario Shoulder Instability Index (WOSI).18

The WOSI is a valid, reliable, and responsive disease-specific quality of life and functional measurement tool for patients with shoulder instability.19 This tool consists of 21 items in 4 domains related to (1) physical symptoms, (2) sports/recreation/work, (3) lifestyle, and (4) emotions. Each question is scored using a visual analog scale from 0 (normal) to 100 mm (worse score). The total score may be presented as a number between 0 and 2100 points (where 0 represents no deficit and 2100 the worst). The score can be converted to a percentage of normal function to facilitate interpretation.

**Statistical analysis**

The required sample size was calculated as 42 in each group to provide at least 80% power with the assumption that the recurrence rate was 30% in the AbER group and 60% in the AdIR group (2-sided, \( \alpha = 0.05 \)). Moreover, we assumed that approximately 15% of the patients would not complete the trial during the

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**Figure 1**  (A) An external rotation and abduction shoulder brace is shown with numbered components. (B) Frontal and lateral views show application of the brace in 15° of abduction and 10° of external rotation.
study period (follow-up rate of 85%). Accordingly, we estimated an enrollment of 102 patients would be required.

Baseline continuous variables were compared between groups by the 2-sample t test or the Wilcoxon-Mann-Whitney test, whenever appropriate. Categoric variables were compared using the χ2 test or the Fisher exact test. According to the trial protocol, all randomized patients who received one of the stabilization methods (intention-to-treat [ITT]) were evaluated. All tests of significance were 2-sided. A P value of <.05 was considered significant. Statistical analyses were performed using the IBM SPSS 21.0 software (IBM Corp, Armonk, NY, USA).

**Results**

The study screened 135 patients for inclusion; of these, 102 patients (91 males and 11 females) with the diagnosis of primary anterior dislocation of the shoulder were included.

Enrollment, treatment allocation, follow-up, and data analysis of all participants are summarized in Fig. 2. The mean ± standard deviation age was 35.7 ± 8.9 years. There were 72 (70.6%) right-sided dislocations and 30 (29.4%) left-sided dislocations. The etiologies of dislocations were sport activities for 69 patients (67.6%) and trauma (motor accident, and fall) for 33 (32.4%).

The 2 groups did not statistically significantly differ (P > .05) in demographic and baseline clinical characteristics (Table I). For reduction, the traction-countertraction maneuver was used in 79 patients (77.4%) and Kocher’s method in 23 (22.6%). Reduction in the ED was successful in all patients, and none required surgical intervention for reduction.

The primary outcome analysis showed the recurrence rate was significantly higher in the AdIR group (33.3%) than in the AbER group (3.9%; P < .001). The AbER method was associated with an absolute risk reduction of 29.4% and a relative risk reduction of 88.2% (ITT population). The recurrence rates stratified by age groups are reported in Table II. In the subgroup aged between 31 and 40 years, 1 recurrent dislocation occurred in AbER group, and 13 recurrent dislocations occurred in AdIR group (P < .001). Most of the patients experienced the first recurrent dislocation within 12 months. No patients were lost to follow-up at 24 months.

In subjects without recurrence, the anterior apprehension test result was positive in 6 of 34 patients (17.6%) in the AdIR group and in 4 of 49 patients (8.1%) in the AbER group (P = .19). There was significant between-group difference for the percentage of patients returning to preinjury sportive activities at the time of the 24-month follow-up (83.8% in AbER vs 31.5% in AdIR, P < .001).

A significant difference in the cooperation rate was observed between the study groups. Ten patients in the AbER group (19.6%) and 3 in the AdIR group (5.8%) discontinued shoulder immobilization before 3 weeks (P = .03). Among those who immobilized the shoulder for 3 weeks as instructed (cooperative group), the recurrence rate was 16 of 48 in the AdIR group (33.3%) and 1 of 41 in the AbER group (2.4%; per-protocol population P < .001).

Three of the 51 patients (5.8%) in the AbER group had transient shoulder rigidity that resolved by the time of follow-up at 24 months. No patient with a documented normal result on the neurologic examination before reduction developed a deficit after the intervention or during the follow-up period. Results of postreduction vascular examinations were normal in all patients, without pulse deficits.

Functional outcome results at 33 months of follow-up were available in 97 patients. The overall mean WOSI score was 210.15 ± 76.4 points (range, 44-460 points). There was a significant difference in the mean WOSI score between the AbER group (187.72 ± 67.5) and the AdIR group (230.92 ± 78.8, P = .004). Data of the scores for the WOSI subcategories by subcategories are reported in Table III.

**Discussion**

Dislocations of the shoulder joint are common medical conditions in an ED practice. Among nonsurgical interventions, immobilization in adduction and internal rotation after anterior dislocation of shoulder has been applied for more than 2000 years, since the era of Hippocrates. This method persists broadly in ED settings and orthopedic clinics; however, the redislocation rate is 68% to 94%, especially in young individuals and active athletes treated with this technique. Previous studies revealed that external rotation of the shoulder joint led to considerably better improvement rather than the internal rotation method. Itoi et al demonstrated that external rotation immobilization was more functional compared with the traditional method in providing sufficient anatomic improvement in a Bankart lesion and reducing the risk of recurrence.

In the present study, the recurrence rate was significantly higher after immobilization in adduction and internal rotation compared with the abduction and external rotation method. In addition, patients in the age group of 31 to 40 years experienced a higher rate of redislocation compared with other age groups. In a multicenter Swedish study, 255 patients (age range, 12-40 years) affected by primary anterior dislocations of the shoulder were monitored for 25 years after immobilization was achieved by tying the arm to the torso with use of a bandage. Recurrent dislocation had developed in 18 patients: 11 (12%) aged 12 to 22 years, 5 (10%) aged 23 to 29 years, and 2 (3%) aged 30 to 40 years (P < .001).

Moreover, in a prospective study of 40 patients with initial anterior dislocation of the shoulder, immobilization in internal rotation (n = 20) and external rotation (n = 20) were compared. The recurrence rate was 30% after internal rotation and 0% after external rotation after a mean 15.5 months follow-up (P = .008). The difference in recurrence
rate was greater among those who were aged <30 years (45% in the internal rotation group vs 0% in the external rotation group, \( P = .011 \)).

Our findings regarding the redislocation rate stratified by age groups were different from the reported studies. Several possibilities could account for the discrepancy, including the difference in distribution of age groups, the dissimilar follow-up periods, and the different immobilization techniques.

There is no definite standard method of immobilization in external rotation. We attempted to stabilize the shoulder in 10° of external rotation according to previous studies suggesting that external rotation close to the maximum angle was not well tolerated by the patients. Previously, Miller et al. measured the contact force between the Bankart lesion and the glenoid in cadaveric shoulders in 60° of internal rotation and 45° of external rotation. No contact force was measurable with the shoulder joint in internal rotation but was much greater when the shoulder was 45° externally rotated compared with a neutral position. Accordingly, immobilization in 10° of external rotation also provided positive contact force for healing of the shoulder lesion. We therefore selected 10° of external rotation in the present study. Because patients are not satisfied with immobilization that uses a large angle of external rotation, determining the least efficient angle of external rotation to improve patient cooperation is essential.

In the 3S study, we stabilized the shoulder for 3 weeks according to traditional practice concerning the appropriate period needed to provide soft tissue healing. Rowe compared 6 groups of patients stabilized for 1 to 6 weeks. Although the rate of recurrence was similar in all groups, the lowest rate was observed in patients treated by a sling (4 weeks), a sling and swathe (3 weeks), and a
strapping (3 weeks). The author stated that 3 weeks of immobilization might be an adequate period of time for healing to occur.\(^3\)

Patient cooperation with brace application is considered an essential factor in assessing a new device.\(^{12}\) This was demonstrated by the present clinical trial of the external rotation and abduction brace for anterior shoulder dislocation, which reported a 19.6% noncompliance rate. The brace was successful in providing and maintaining the appropriate position of external rotation and abduction and reducing the risk of redislocation. However, patient cooperation with the treatment protocol was considerably better in the AdIR group (sling and swathe technique) due to the cumbersome feature of the brace and limitations of the external rotation and abduction position. The most important limitation of external rotated stabilization is the unpleasant effect on the patient’s daily life. The major limitations are difficulty in walking through a doorway, difficulty in finding and keeping a comfortable sleeping position, and the risk of trauma in crowded locations. However, considering the reduced rates of redislocation by externally rotated immobilization, especially in young patients, using this technique of immobilization is more beneficial than traditional methods.\(^{33}\) Of note, explaining

### Table I  Baseline demographic and clinical features of the intention-to-treat study population

<table>
<thead>
<tr>
<th>Characteristics *</th>
<th>AbER group(^1) (n = 51)</th>
<th>AdIR group(^1) (n = 51)</th>
<th>Total (N = 102)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>36.11 ± 7.8</td>
<td>35.43 ± 10.0</td>
<td>35.77 ± 8.9</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44 (86.3)</td>
<td>47 (92.2)</td>
<td>91 (89.2)</td>
</tr>
<tr>
<td>Female</td>
<td>7 (13.7)</td>
<td>4 (7.8)</td>
<td>11 (10.8)</td>
</tr>
<tr>
<td>Etiology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport activities</td>
<td>31 (60.8)</td>
<td>38 (74.5)</td>
<td>69 (67.7)</td>
</tr>
<tr>
<td>Trauma</td>
<td>20 (39.2)</td>
<td>13 (25.5)</td>
<td>33 (32.3)</td>
</tr>
<tr>
<td>Side of dislocation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>33 (64.7)</td>
<td>39 (76.5)</td>
<td>72 (70.6)</td>
</tr>
<tr>
<td>Left</td>
<td>18 (35.3)</td>
<td>12 (23.5)</td>
<td>30 (29.4)</td>
</tr>
</tbody>
</table>

\(\text{AbER}, \text{ abduction and external rotation}; \text{AdIR}, \text{ adduction and internal rotation}.\)

* Continuous data are shown as mean ± standard deviation and categoric data as number or number (%).

\(^{1}\) The 2 groups did not differ significantly in clinical or demographic characteristics.

### Table II  Rate of redislocation stratified by age groups in the intention-to-treat population

<table>
<thead>
<tr>
<th>Age groups (y)</th>
<th>AbER group (n = 51)</th>
<th>AdIR group (n = 51)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>0/0</td>
<td>0/0</td>
<td>NA</td>
</tr>
<tr>
<td>21-30</td>
<td>1/16 (6.2)</td>
<td>3/18 (16.6)</td>
<td>.34</td>
</tr>
<tr>
<td>31-40</td>
<td>1/26 (3.8)</td>
<td>13/29 (44.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>≥41</td>
<td>0/9 (0.0)</td>
<td>1/4 (25.0)</td>
<td>.118</td>
</tr>
<tr>
<td>Total</td>
<td>2/51 (3.9)</td>
<td>17/51 (33.3)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

\(\text{AbER}, \text{ abduction and external rotation}; \text{AdIR}, \text{ adduction and internal rotation}; \text{NA}, \text{ not applicable}.\)

### Table III  Mean Western Ontario Shoulder Instability Index score for the stable shoulder at the 33-month follow-up (n = 97)

<table>
<thead>
<tr>
<th>Functional outcome</th>
<th>Item</th>
<th>Range (perfect-worst)</th>
<th>AbER group (n = 48)</th>
<th>AdIR group (n = 49)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Percent (mean)</td>
<td>Mean ± SD</td>
<td>Percent (mean)</td>
</tr>
<tr>
<td>Physical symptoms</td>
<td>10</td>
<td>0-1000</td>
<td>7.7</td>
<td>77.16 ± 34.9</td>
<td>9.4</td>
</tr>
<tr>
<td>Sport/recreation/work</td>
<td>4</td>
<td>0-400</td>
<td>9.4</td>
<td>37.62 ± 16.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>4</td>
<td>0-400</td>
<td>10.0</td>
<td>40.24 ± 13.8</td>
<td>11.5</td>
</tr>
<tr>
<td>Emotions</td>
<td>3</td>
<td>0-300</td>
<td>10.8</td>
<td>32.78 ± 12.7</td>
<td>10.3</td>
</tr>
<tr>
<td>Total WOSI score</td>
<td>21</td>
<td>0-2100</td>
<td>8.9</td>
<td>187.72 ± 67.5</td>
<td>11.0</td>
</tr>
</tbody>
</table>

\(\text{AbER}, \text{ abduction and external rotation}; \text{AdIR}, \text{ adduction and internal rotation}; \text{SD}, \text{ standard deviation}; \text{WOSI}, \text{ Western Ontario Shoulder Instability Index score}.\)
the significance of the brace usage to the patients may increase their cooperation and compliance.

This study has several limitations. First, the follow-up period was relatively short. Some numbers of recurrent dislocations will occur in the 2 to 5 years after the first dislocation. Thus, additional evaluation and randomized studies with a longer follow-up period are required to fully determine the instability outcomes.

Second, we did not assess different angles of external rotation and abduction position. Future evaluations should consider comparison of several immobilization angles to improve the validity of the resulting comparison.

Third, we did not document the ability of the brace to maintain the glenohumeral joint in external rotation. The brace actually might not maintain the extent of external rotation that could change when the participants performed their daily activities. However, we taught the patients to be careful with regard to the activities and sports to keep the external rotation position properly.

Conclusions

Immobilization in 15° of abduction and 10° of external rotation for 3 weeks reduced the relative risk of recurrence of a primary anterior shoulder dislocation compared with the risk associated with conventional immobilization in adduction and internal rotation. However, this beneficial treatment was associated with higher proportion of noncooperative patients than the conventional treatment.

Accordingly, owing to the effectiveness of abducted and externally rotated stabilization, this method should be more commonly included in treatment protocols with increasing clinical studies.

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