



# Immobilization in internal or external rotation does not change recurrence rates after traumatic anterior shoulder dislocation

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**Background:** The objective of this study was to systematically review and quantitatively synthesize the data on recurrence rates after shoulder immobilization in internal versus external rotation in first-time, traumatic shoulder dislocations.

**Materials and methods:** We performed a systematic search of the keywords “(((external rotation) OR internal rotation) AND immobilization) AND shoulder” in the online databases PubMed, EMBASE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and the Cochrane Library. Random-effects models were used to calculate the cumulatively pooled risk ratios (RRs) of recurrent shoulder dislocations. All analyses were also stratified by age.

**Results:** We included 5 studies with a total of 471 patients (230 internal rotation and 241 external rotation) published between 2001 and 2011 in English. The pooled random-effects RR for recurrence of shoulder dislocations at all ages was 0.74 (95% confidence interval [CI], 0.44-1.27;  $P = .278$ ). The RR was 0.70 (95% CI, 0.38 to 1.29;  $P = .250$ ) for patients aged 30 years or younger and 0.78 (95% CI, 0.32 to 1.88;  $P = .579$ ) for those aged older than 30 years.

**Conclusion:** The current best evidence does not support a relative effectiveness of immobilization in external rotation compared with internal rotation to avoid recurrent shoulder dislocations in patients with traumatic anterior shoulder dislocations.

Institutional review board approval was not necessary for this systematic review and meta-analysis.

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Shoulder dislocations are an important health care issue for several reasons. Anterior dislocation of the glenohumeral joint is the most common dislocation of a major joint and is a significant cause of morbidity and impaired shoulder function.<sup>2,3,12</sup> The recurrence rates after the initial traumatic event range from 20% and 94%,<sup>7,13</sup> depending primarily on patient age.<sup>6,22,32</sup> Traditionally, the first line of treatment for an anterior dislocation in a prior healthy shoulder is closed reduction and sling immobilization.<sup>1,20,21,33</sup> Controversy exists regarding the appropriate duration and position of immobilization. A recent meta-analysis in the *Journal of Bone and Joint Surgery* was able to show that there is no benefit in immobilization for longer than 1 week.<sup>21</sup> Yet, no evidence-based conclusion could be reached as to the position of immobilization.

A major complication of anterior dislocation, and the main reason for subsequent shoulder instability, is damage to the anterior tissues of the shoulder, specifically the anterior-inferior labrum and/or glenoid rim, better known as a Bankart lesion.<sup>23,28</sup> If this lesion heals, as it does in 50% to 80% of all patients, recurrent dislocations are less likely. In 1999, Itoi et al<sup>10</sup> made an argument that immobilization in external rotation would reduce damaged anterior-inferior tissues to the glenoid by ligamentotaxis, improve the healing rates of Bankart-type lesions, and thus result in a reduction of recurrence rates. A number of randomized controlled trials have tested this theory but have reached conflicting results.<sup>21</sup> It is the objective of this study to systematically review and quantitatively synthesize the data on recurrence rates after shoulder immobilization in internal versus external rotation in first-time, traumatic dislocators.

## Materials and methods

This study was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement published by the CONSORT (Consolidated Standards of Reporting Trials) group.<sup>16,19</sup>

## Systematic search and strategy

We conducted a systematic review of the literature using the online databases PubMed, Medline, EMBASE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and CCTR (Cochrane Controlled Trial Register). We searched these electronic databases online for “((external rotation) OR internal rotation) AND immobilization) AND shoulder” using these terms as keywords and exploded MeSH terms without restrictions in language or year of publication. We included only prospective,

controlled studies. Exclusion criteria were duplicates, no focus on clinical treatment or outcome, cadaveric studies, and studies with unacceptably high attrition during follow-up (>20%).

## Extraction of relevant data

Eligibility of studies was assessed independently and in duplicate (P.V. and A.M.M.) and cross-checked to avoid errors. Disagreement was resolved by discussion or, if necessary, with the help of the senior author (V.V.). The bibliographies of all included studies were reviewed for additional relevant studies. All searches were concluded by October 1, 2012. The following variables were extracted: randomization (yes/no), blinding (yes/no), attrition (yes/no), and power analysis (yes/no). Outcome data extracted were study size, years of follow-up, mean age, percent of female patients, and dislocations.

## Assessment of validity

We determined the level of evidence for all studies that were included, and internal validity was further assessed using a modified Jadad scale, which ranges from 0 points (poorest result) to 3 points (best result), attributing 1 point for each randomization, blinding, and attrition.<sup>11</sup>

## Publication bias

Another important problem that jeopardizes the validity of a meta-analysis is publication bias, which is bias attributable to unidentified or unpublished studies. Publication bias among the included studies was assessed graphically by use of funnel plots and mathematically by use of Egger weighted regression.<sup>4,30</sup>

## Study heterogeneity

The presence of between-study heterogeneity was qualified by the Cochrane Q test, by use of a *P* value of 10% to adjust for the low power of this test in small samples, and quantified with the *I*<sup>2</sup> index. To assess the potential sources of such heterogeneity, meta-regressions were performed.

## Quantitative data synthesis

To pool data, random-effects models by use of the DerSimonian and Laird (random-effects) method were constructed.<sup>31</sup> Such models postulate that the observed heterogeneity between studies in a meta-analysis is attributable to normally distributed individual effects around a common effect. This assumption was assessed graphically in the forest plots.

Data on recurrences were pooled as risk ratios (RRs) in a cumulative meta-analysis. In this type of meta-analysis, the data

of the individual studies were merged one by one in chronologic order rather than in one total. Because age has been shown to be a major risk factor in recurrent shoulder dislocations, meta-regression and a stratified subgroup analysis ( $\leq 30$  years of age and  $>30$  years of age) was performed to include this important confounder into our analysis.

We used a post hoc power calculation formula for a generic, 2-tailed  $z$  test for comparison of proportions of recurrences reported in the included studies to calculate the statistical power of our analysis *ex post*.

All analyses were performed per intention to treat; that is, participants were included in the analysis according to their initial allocation, producing more conservative results with larger  $P$  values.

All calculations were performed with Intercooled STATA 12 (StataCorp LP, College Station, TX, USA). The level of significance for pooled estimates was set at 5%.

## Results

### Study characteristics

Our search strategy generated 254 studies online and by citation tracking. After exclusion of duplicates, studies not focusing on clinical treatment or outcome, animal studies, studies without any intervention, and 1 study with unacceptably high attrition, 5 studies including 471 patients (230 internal rotation and 241 external rotation) remained for analysis.<sup>5,8,9,14,27</sup> Figure 1 shows the trial flow of study identification according to these criteria. The included studies were published between 2001 and 2011 in English (Table I).

### Description of included studies

Itoi et al<sup>8</sup> published the first human study on the subject in 2003 with 40 patients in 2 evenly sized groups of 20 patients each. Immobilization in internal rotation was performed with a sling and swathe, whereas immobilization in external rotation was performed with a “wire-mesh splint covered with a sponge”; each was continued for 3 weeks except for personal hygiene. The investigators found a significant reduction in dislocation recurrence after immobilization in external rotation, especially in patients aged younger than 30 years. The same group published a larger study in 2007 with 159 patients (74 internal rotation and 85 external rotation) using the same methods as described earlier, confirming their earlier findings.<sup>9</sup>

In 2009, Taşkoparan et al<sup>27</sup> presented their results of treating 33 patients with internal rotation ( $n = 17$ ) and external rotation ( $n = 16$ ). Immobilization in internal rotation was achieved with a waist-assisted sling, and immobilization in external rotation was achieved with a splint in  $10^\circ$  of external rotation. Both devices were worn for 3 weeks and only taken off for personal hygiene. Similar to Itoi et al<sup>8</sup>

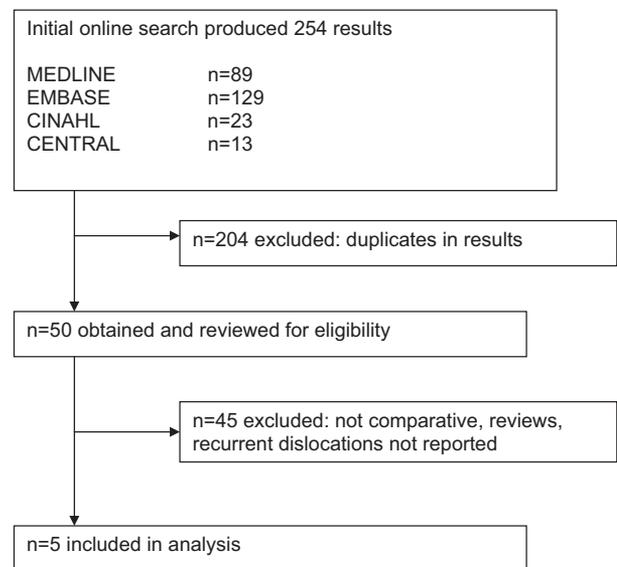


Figure 1 Study flow.

before, this group found a significant, beneficial effect of immobilization in external rotation.

Finestone et al<sup>5</sup> treated 51 patients and published their results in 2009. These patients were randomized to immobilization in internal rotation ( $n = 24$ ) and external rotation ( $n = 27$ ) at  $15^\circ$  to  $20^\circ$  for 4 weeks. In contrast to the earlier publications, this study found no difference in the rate of recurrence across the 2 groups ( $P = .74$ ). Liavaag et al<sup>14</sup> published a study of 188 patients in 2011. After an initial traumatic anterior dislocation, patients were treated with immobilization in either internal rotation ( $n = 95$ ) or external rotation ( $n = 93$ ) for 3 weeks. Immobilization in internal rotation was achieved with use of a normal collar or cuff or a sling and swathe, and immobilization in external rotation was achieved with the use of a commercially available shoulder immobilizer (UltraSling ER; DonJoy, Vista, CA, USA) at  $15^\circ$ . The primary outcome measure was a recurrent dislocation within 24 months of follow-up. Similar to Taşkoparan et al,<sup>27</sup> Liavaag et al found no difference between the 2 groups ( $P = .36$ ).

### Study quality

The mean Jadad score for the included trials was 1.6 points (95% confidence interval [CI], 0.6-2.6 points). Of the studies, 80% used a randomized design, but only 1 study (20%) used blinded outcome assessment. A sample size calculation was reported in 3 studies (60%). The quality of the included studies is reported in Table II.

### Publication bias

There was no evidence for publication bias ( $P = .252$ ) on Egger regression.

**Table I** Study characteristics

Authors	Duration of treatment (wk)	Follow-up (y)	Mean age (SD) (y)		% Female patients		Sample size (n)	
			IR	ER	IR	ER	IR	ER
Itoi et al, <sup>8</sup> 2003	3	1.3	38 (10.7)	40 (11.7)	30%	25%	20	20
Itoi et al, <sup>9</sup> 2007	3	2.2	37 (12.8)	35 (12.8)	33%	52%	74	85
Finestone et al, <sup>5</sup> 2009	4	3	20 (1.7)	20 (1.7)	—	—	24	27
Taşkoparan et al, <sup>27</sup> 2010	3	2	29 (11.2)	35 (19.5)	12%	0%	17	16
Liavaag et al, <sup>14</sup> 2011	3	2	27 (7.1)	27 (7.1)	19%	18%	95	93

ER, external rotation; IR, internal rotation.

## Heterogeneity

Between-studies heterogeneity was borderline significant ( $P = .055$ ) with an  $I^2$  index of 56.7%. Subgroup stratification showed that this heterogeneity stems from the young group of patients aged 30 years or younger with  $P = .024$  and an  $I^2$  index of 64.4% compared with  $P = .796$  and an  $I^2$  index of 0% for the patients aged older than 30 years.

## Quantitative data synthesis

The pooled, cumulative DerSimonian and Laird random-effects RR for recurrence of shoulder dislocations at all ages was 0.74 (95% CI, 0.44-1.27), not consistent with a statistically significant difference ( $P = .278$ ) (Fig. 2). The post hoc power for this inference test was 94.5%. In the meta-regression, we found a significant influence of age on the RR ( $P = .003$ ).

The pooled, cumulative DerSimonian and Laird random-effects RR for recurrence of shoulder dislocations for patients aged 30 years or younger was 0.70 (95% CI, 0.38-1.29) (Fig. 3). Again, this RR was not significant ( $P = .250$ ) with a power of 99.8%.

The pooled, cumulative DerSimonian and Laird random-effects RR for recurrence of shoulder dislocations for patients aged older than 30 years was 0.78 (95% CI, 0.32-1.88) at  $P = .579$ , but with a power of only 12.2% (Fig. 4).

## Discussion

### Summary of evidence

This study assessed the current evidence for immobilization in internal and external rotation after traumatic anterior shoulder dislocation. The current evidence does not support the superiority of immobilization in external rotation to reduce recurrent dislocations. However, the  $P$  values were borderline, and there was a significant effect of age on immobilization efficacy.

As mentioned earlier, the logic behind immobilization in external rotation is to anatomically reduce the anterior-inferior glenoid labrum defect. Itoi et al<sup>10</sup> coined the term

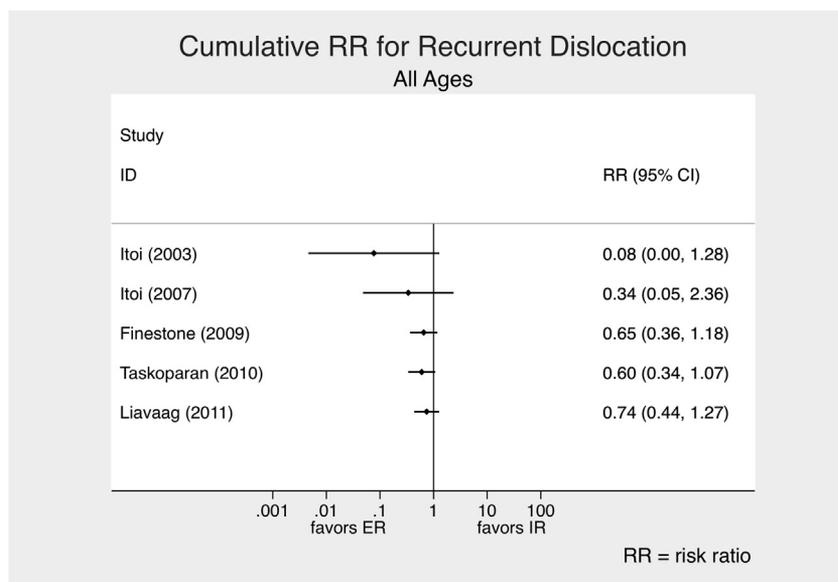
“coaptation” in a publication in 1999 in which they were able to show that a position of adduction and external rotation (the so-called coaptation zone) will approximate the edges of a simulated Bankart lesion without affecting the periarticular musculature. A secondary effect of this position is increased tension in the subscapularis muscle, which reduces hematoma formation and thus further improves coaptation. Seybold et al<sup>25</sup> were able to show that this position also reduces the labral lesion to the glenoid rim. Liavaag et al<sup>15</sup> confirmed these findings in 2009 in a magnetic resonance imaging study of 55 dislocated and reduced shoulders immobilized in external rotation. These findings were used to support the argument that recurrence rates of shoulder dislocations could be decreased through immobilization in 15° to 30° of external rotation.

These findings led to a number of case series and controlled studies to compare the effectiveness of immobilization in internal versus external rotation to prevent further dislocations. However, even among randomized controlled trials, there exists considerable conflict in the findings. A potential cause for such conflicting results is differences in study quality. However, our assessment showed that study quality was fairly homogeneous. Those studies that did not report sample size calculations produced significant results, thus ruling out insufficient power. Furthermore, only 1 study reported on blinding; however, attempting to conceal allocation to internal or external rotation is impractical.

A more likely explanation for conflicting findings is differences in the studied populations.<sup>27</sup> Our statistical analysis produced evidence for a significant level of mathematical heterogeneity, especially in the group of patients aged 30 years or younger. Assessment of the forest plot showed an even distribution of the individual study results around the pooled estimate, supporting the use of a random-effects model. We chose to assess age specifically as a confounder because its association with recurrence of shoulder dislocations after an initial traumatic anterior dislocation has been consistently and repeatedly proven.<sup>29</sup> We did see a change in the pooled estimates after stratification by age, supporting the role of age as a confounder, but the absolute size of this change in results was fairly small at 5% to 10%, suggesting additional covariates. Other likely factors of importance are the pattern of tissue damage (ie, osseous versus ligamento-labral Bankart

**Table II** Study quality

Authors	Randomized	Concealed allocation	Report of attrition	Power calculation	Jadad score	Level of evidence
Itoi et al, <sup>8</sup> 2003	1	0	0	0	1	II
Itoi et al, <sup>9</sup> 2007	1	0	1	1	2	II
Finestone et al, <sup>5</sup> 2009	1	0	1	1	2	II
Taşkoparan et al, <sup>27</sup> 2010	0	0	0	0	0	III
Liavaag et al, <sup>14</sup> 2011	1	1	1	1	3	I



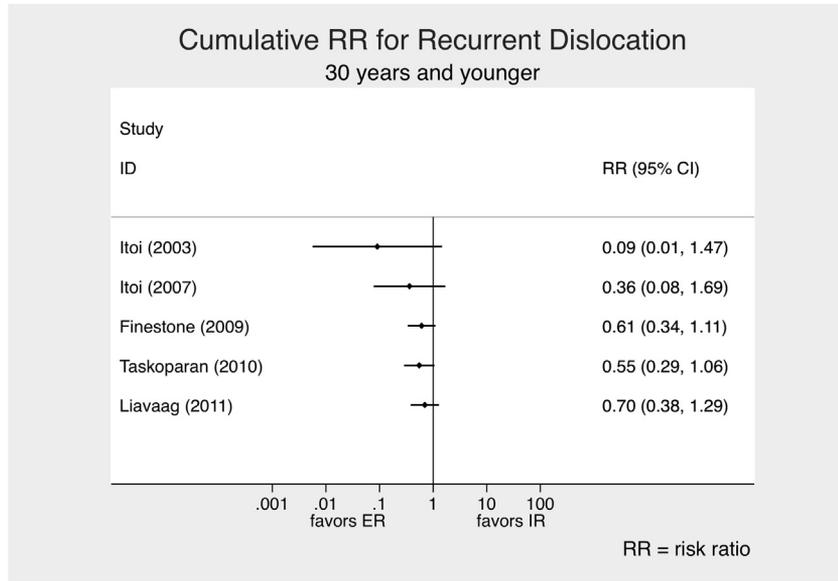
**Figure 2** Cumulative RR for recurrent dislocations after immobilization in internal rotation (*IR*) and external rotation (*ER*) for all ages. Cumulative RR means that study data are pooled one by one in chronologic order. This shows that even with the studies of Itoi et al<sup>8,9</sup> alone, a nonsignificant difference could have been shown in 2007. As more studies were published, the pooled estimate stayed stationary but the 95% CI (black vertical bar) shrunk.

lesions) and anatomic parameters such as the integrity and function of the subscapularis, as well as distention of the capsule and the glenohumeral ligaments.

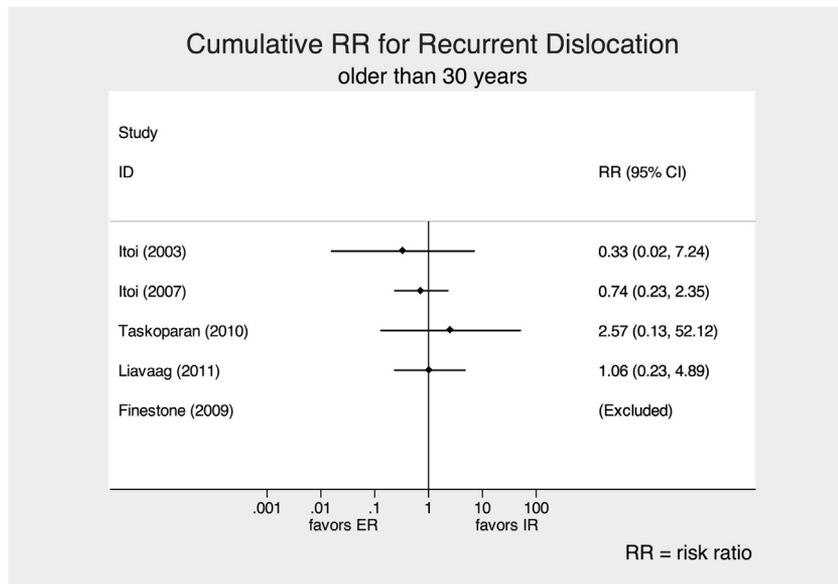
Although our study produced strong evidence contrary to earlier published differences in the effectiveness of external rotation compared with internal rotation in shoulder immobilization after traumatic anterior shoulder dislocation, we do not recommend that research on this issue should be abandoned. Our analysis had substantial power (>90%), suggesting that larger studies will not change the overall findings for effectiveness, even if individual studies produce significant *P* values as an effect of the play of chance. However, it is possible that identifying specific patient groups who respond more favorably to immobilization in external rotation might be a worthwhile endeavor. As mentioned earlier, age, injury patterns, and anatomy are potential factors involved. In addition, assessing patient compliance with a regimen of external rotation for 3 weeks and measuring the patient's general ligamentous laxity, using the Micheli score or Marshall test, for example,<sup>17</sup> could be other possible investigations. A solid body of basic science exists in support of immobilization in external rotation and will hopefully stimulate future studies.

## Limitations

Our study has some shortcomings. First, any meta-analysis is only as strong as the included primary studies. Second, the availability of covariates that might have affected the pooled results was limited. In addition, frank dislocation is a somewhat crude endpoint, whereas objective anterior instability in grades would have been a potentially more useful outcome measure. More specific shortcomings are the actual degree of immobilization because in external rotation using a commercial 15° sling, only 9.4° of external rotation is applied,<sup>26</sup> and the actual labral coaptation because Miller et al<sup>18</sup> found the maximum force of the subscapularis was reached in 45° of external rotation. This might further bias this work if the optimal external rotation for labral coaptation is 30° or even more. Next, the included studies did not assess possible aspiration of an interposing hematoma, which might serve as an obstacle,<sup>24</sup> and patient compliance, which is an important factor, differs among countries and regions. Finally, with only 5 primary studies, our overall sample size is somewhat restricted, and the short follow-up of 2 years in the included studies might not be suitable for



**Figure 3** Cumulative RR for recurrent dislocations after immobilization in internal rotation (*IR*) and external rotation (*ER*) for patients aged 30 years or younger. The pooled estimates are very similar to those for all ages, mostly because a large majority of patients with shoulder dislocations are adolescents and young adults.



**Figure 4** Cumulative RR for recurrent dislocations after immobilization in internal rotation (*IR*) and external rotation (*ER*) for patients aged older than 30 years.

final analysis of recurrent dislocation. However, we did find high values for post hoc power analysis.

**Conclusion**

The currently available best evidence does not support a relative effectiveness of immobilization in external rotation compared with internal rotation in reducing recurrent shoulder dislocations in patients with traumatic anterior shoulder dislocations. However, after we

reviewed the current clinical data and the available basic science, it is our opinion that a yet-to-be-determined subgroup of patients could benefit from such treatment. Future investigations are needed to test this hypothesis.

**Disclaimer**

The authors, their immediate families, and any research foundations with which they are affiliated have not

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