Position and Duration of Immobilization After Primary Anterior Shoulder Dislocation

A Systematic Review and Meta-Analysis of the Literature

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Background: Immobilization after closed reduction has long been the standard treatment for primary anterior dislocation of the shoulder. To determine the optimum duration and position of immobilization to prevent recurrent dislocation, a systematic review of the relevant literature was conducted.

Methods: Of 2083 published studies that were identified by means of a literature review, nine Level-I and Level-II studies were systematically reviewed. The outcome of interest was recurrent dislocation. Additional calculations were performed by pooling data to identify the ideal length and position (external or internal rotation) of immobilization.

Results: Six studies (including five Level-I studies and one Level-II study) evaluated the use of immobilization in internal rotation for varying lengths of time. Pooled data analysis of patients younger than thirty years old demonstrated that the rate of recurrent instability was 41% (forty of ninety-seven) in patients who had been immobilized for one week or less and 37% (thirty-four of ninety-three) in patients who had been immobilized for three weeks or longer ($p = 0.52$). An age of less than thirty years at the time of the index dislocation was significantly predictive of recurrence in most studies. Three studies (including one Level-I and two Level-II studies) compared recurrence rates with immobilization in external and internal rotation. Analysis of the pooled data demonstrated that the rate of recurrence was 40% (twenty-five of sixty-three) for patients managed with conventional sling immobilization in internal rotation and 25% (twenty-two of eighty-eight) for those managed with bracing in external rotation ($p = 0.07$).

Conclusions: Analysis of the best available evidence indicates there is no benefit of conventional sling immobilization for longer than one week for the treatment of primary anterior shoulder dislocation in younger patients. An age of less than thirty years at the time of injury is significantly predictive of recurrence. Bracing in external rotation may provide a clinically important benefit over traditional sling immobilization, but the difference in recurrence rates did not achieve significance with the numbers available.

Level of Evidence: Therapeutic Level II. See Instructions to Authors for a complete description of levels of evidence.

First-time anterior dislocations of the shoulder traditionally have been treated with closed reduction followed by a period of immobilization to prevent recurrent dislocation and to allow the soft tissues to heal. This is thought to be particularly important for younger patients, who have a high rate of recurrent instability[1-5]. However, the optimum duration of immobilization and its basic utility remain unproven[6-8], with differing data and recommendations[2-5,9-13]. More recently, the position of immobilization has come into question. Proponents of immobilization in external rotation have cited cadaver and magnetic resonance imaging (MRI) studies that have shown better approximation of the anterior soft tissues to the glenoid in this position compared with internal rotation[14-19], and this better approximation may allow for better healing[14,20,21].

To our knowledge, there have been no previous publications using combined data from multiple studies on the optimum position and duration of immobilization following primary anterior shoulder dislocation. We performed a systematic review and meta-analysis of the literature to determine if recommendations could be made for the treatment of first-time anterior shoulder dislocations. The primary outcome of interest was recurrent dislocation, and the primary aim was to

Disclosure: The authors did not receive any outside funding or grants in support of their research for or preparation of this work. Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity.

examine the best available evidence regarding the optimum position and duration of immobilization.

Materials and Methods

A search of Medline/PubMed, EMBASE, and the Cochrane database from the earliest recorded articles to the time of review (December 2009), using the search terms "shoulder AND dislocation" and "shoulder AND immobilization" in the manuscript title, initially produced 2083 citations for review. This list of citations was then restricted to prospective Level-I and Level-II studies dealing with shoulder immobilization for first-time anterior dislocations (Fig. 1). Retrospective trials, case series, review articles, and case reports were excluded from the analysis. The level of evidence for each study was assigned according to the guidelines of *The Journal of Bone and Joint Surgery* (American Volume). Although differentiation between Level-I and Level-II trials can be difficult, studies with more than twenty patients in each experimental group were classified as "large" (Level-I) studies, whereas studies with twenty patients or fewer in each group were classified as "small" (Level-II) studies, similar to methods used in other evidence-based reviews[22]. Some prospective studies were given Level-II ratings because of other reasons: unclear or <80% follow-up, unclear or incomplete randomization, and potential bias in study implementation.

This selection process produced nine manuscripts for detailed review. Each manuscript underwent thorough review with use of a previously described standard evaluation method that assesses methodological issues and statistical approach and seeks sources of bias[23]. The primary end point of interest was recurrence of dislocation following treatment; however, we also examined data regarding the duration and position of immobilization as well as age at the time of the initial dislocation. When possible, data were pooled to provide associations among studies and to strengthen recommendations.

Statistical data were analyzed with GraphPad software (GraphPad Software, LaJolla, California). The two-tailed Fisher exact test for categorical data was used to examine the associations between groups. The level of significance was set at $p < 0.05$. For each of the two pooled categorical results, the relative risk of recurrent instability, along with the corresponding 95% confidence interval value, were calculated for each contributing study. Heterogeneity of the individual study results was estimated by calculating both the I^2 statistic and the chi-square test of heterogeneity.

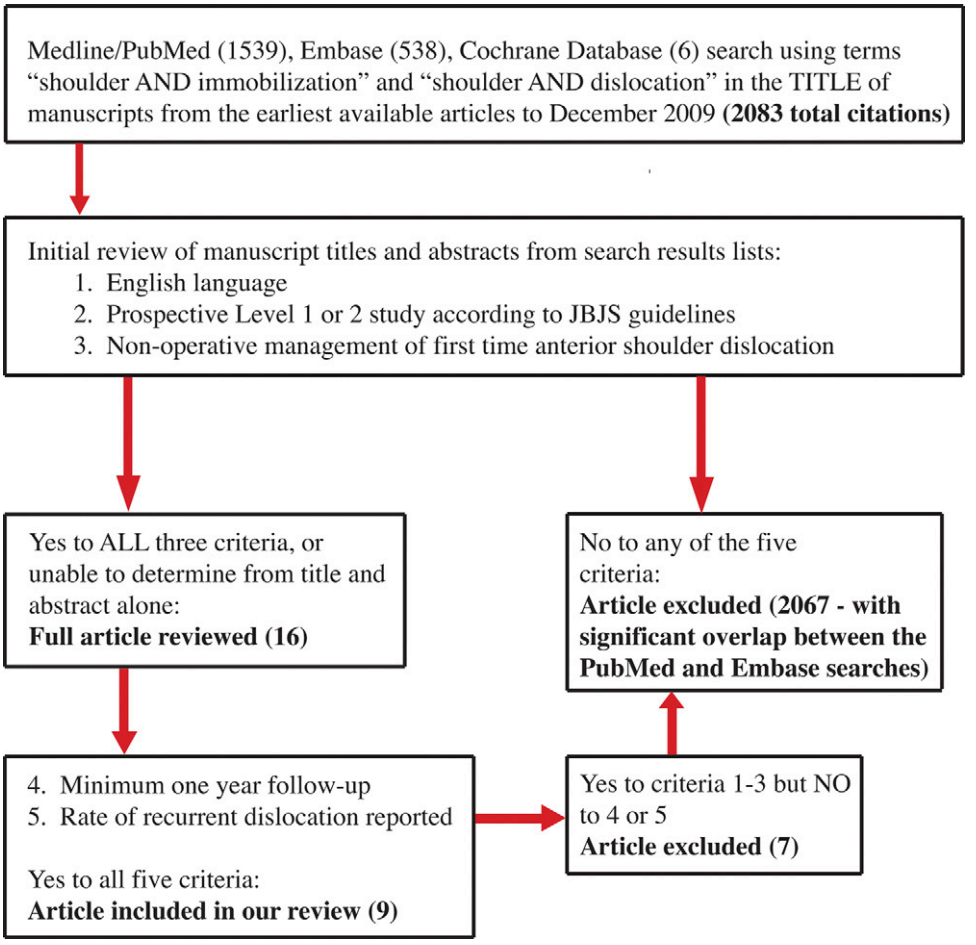

Fig. 1

Flow chart depicting the search methodology used to evaluate the 2083 citations involved in this review.

An I^2 statistic of >30% was considered indicative of at least moderate heterogeneity.

The individual study results were then combined with use of the Mantel-Haenszel method in fixed-effects models to generate overall relative risk estimates of recurrent instability along with the corresponding 95% confidence intervals. Fixed-effects models were used in both cases as neither demonstrated heterogeneity according to the value of I^2. Finally, for each comparison, a z test for overall effect was calculated to determine if there was a significant difference between the durations of immobilization as well as between the positions of immobilization. The pooled results were summarized into forest plots. All meta-analysis and graphing was performed with RevMan (version 5.0; The Cochrane Collaboration, Copenhagen, Denmark).

Source of Funding
No external funding support was received for this study.

Results

Our initial search of the literature returned 2083 studies examining the treatment of shoulder dislocations with immobilization. Nine prospective studies were identified, six of which were graded as Level I and three of which were graded as Level II (Table I). The method of immobilization in six studies was internal rotation only[9-13,24]. Of these, five compared immobilization for various periods of time. Three studies compared patients who were managed with immobilization in external rotation with those who were managed with immobilization in internal rotation[25-27].

Hovelius et al.

Hovelius et al. performed four studies in which they followed 257 patients after two, five, ten, and twenty-five-year intervals[9-12]. These patients, who were between twelve and forty years of age at the time of the injury, were placed into three groups. Group 1 included 112 patients who were managed with three to four weeks of immobilization in internal rotation. Group 2 included 104 patients who were given a sling and were told to wear it as needed for up to one week and to use the shoulder freely. Group 3 was a mixed-treatment group of forty-one patients including those who started in Group 1 but discontinued the sling earlier than three weeks, who had a history of epilepsy or alcoholism, who had early surgery for the treatment of displaced fractures, who had a history of previous shoulder subluxation, or who had a delay of longer than twenty-four hours before reduction. At the six larger hospitals, patients were randomized into two groups. At the other twenty-one hospitals, the patients were assigned to treatment either with or without immobilization according to the policy at each hospital[12]. Follow-up data were collected mainly by mail and telephone interviews. The authors obtained an excellent follow-up percentage at each time period (100% at two years, 99.6% at five years, 96% at ten years, and 89% at twenty-five years), with losses almost exclusively due to patient mortality. All of these studies were assigned a Level-I rating.

Using the authors' data, we calculated the recurrence risk in Groups 1 and 2 over the twenty-five-year period that the cohort was followed. At two and five years of follow-up the rate of recurrent dislocation did not differ among the three treatment groups. At ten and twenty-five years of follow-up the difference between Groups 1 and 2 was not significant (Table II).

TABLE I Methods of Immobilization Reported in Level-I and Level-II Studies

Study	N	Immobilization Method	Duration of Immobilization	Duration of Follow-up (% Follow-up)	Level of Evidence
Hovelius et al.[9] (1983)	257	Internal rotation	<1 week, 3 weeks, or mixed treatment	2 years (100%)	I
Hovelius et al.[10] (1987)	256	Internal rotation	<1 week, 3 weeks, or mixed treatment	5 years (99.6%)	I
Hovelius et al.[11] (1996)	247	Internal rotation	<1 week, 3 weeks, or mixed treatment	10 years (96%)	I
Hovelius et al.[12] (2008)	229	Internal rotation	<1 week, 3 weeks, or mixed treatment	25 years (89%)	I
Kiviluoto et al.[13] (1980)	226	Internal rotation	1 week or 3 weeks	1 year (uncertain)	II
Robinson et al.[24] (2006)	252	Internal rotation	4 weeks	4.3 to 9.4 years (100%)	I
Itoi et al.[25] (2003)	40	External rotation vs. internal rotation	3 weeks	1.3 years (100%)	II
Itoi et al.[26] (2007)	198	External rotation vs. internal rotation	3 weeks	2 years (80%)	II
Finestone et al.[27] (2009)	51	External rotation vs. internal rotation	4 weeks	2.8 years (100%)	I

TABLE II Rates of Recurrent Instability After Immobilization in Internal Rotation for One Week Compared with Three or Four Weeks

Study	Duration of Follow-up *(yr)*	Duration of Immobilization in Internal Rotation *(wk)*	Rate of Recurrence	P Value
Hovelius et al.[9] (1983)	2			0.88
		1	31% (32 of 104)	
		3	29% (33 of 112)	
Hovelius et al.[10] (1987)	5			0.89
		1	45% (47 of 104)	
		3	44% (49 of 112)	
Hovelius et al.[11] (1996)	10			0.89
		1	49% (49 of 99)	
		3	48% (54 of 112)	
Hovelius et al.[12] (2008)	25			0.88
		1	54% (48 of 89)	
		3	52% (47 of 90)	
Kiviluoto et al.[13] (1980)	1			0.34
		1	12% (22 of 180)	
		3	17% (8 of 46)	
Robinson et al.[24] (2006)	4.3 to 9.4	4	60% (150 of 252)	NA*

*NA = not applicable.

On the basis of these results, the authors concluded that the duration of immobilization did not have a significant effect on recurrent dislocation or the need for surgery at any time point in any age subgroup. In addition, the sex of the patient, bilaterality, the type of initial trauma, and participation in athletics did not have an effect on recurrence. Patients with a greater tuberosity fracture had a significantly lower rate of redislocation (0%; zero of thirty-two) than those who did not have a fracture (39%; seventy-four of 192)[9]. The presence of a humeral head depression fracture (Hill-Sachs lesion) was not consistently associated with increased recurrence; however, the authors noted that they included only Hill-Sachs lesions that were clearly visible on radiographs, and the true frequency of these lesions was likely underestimated. An age of less than thirty years at the time of the injury also was found to be an important risk factor for recurrence at all time points (Table III).

Kiviluoto et al.

Kiviluoto et al.[13] reported their findings for 226 patients who had sustained primary shoulder dislocations. The authors divided patients into three groups. All 127 patients over the age of fifty years were managed with immobilization in internal rotation for one week. The remaining ninety-nine patients under the age of fifty years were placed into two treatment groups: fifty-three were managed with immobilization for one week, and forty-six were managed with immobilization for three weeks. The groups were followed for one year. Patients with fractures that were visible on radiographs were excluded. This study was assigned a Level-II rating because of incomplete randomization and unclear follow-up percentages.

The overall recurrence rate was 13.3% (thirty of 226), and the recurrence rates were not significantly different between patients who were managed with immobilization for one week and those who were managed with immobilization for three weeks ($p = 0.34$) (Table II).

Recurrence was again noted to be significantly more common in younger patients; the rate of recurrent instability was 36% (nineteen of fifty-three) for patients under the age of thirty years at the time of the injury, compared with 6% (eleven of 173) for those who were thirty years or older at the time of the injury ($p < 0.0001$) (Table III). Also, a significant ($p < 0.05$) reduction in the rate of recurrence was noted in patients younger than thirty years of age who were managed with immobilization for three weeks (23%; six of twenty-six) as compared with those who were managed with immobilization for one week (50%; thirteen of twenty-six). The authors recommended that patients who are more than thirty years old should be managed with a sling for one week, whereas patients who are younger than thirty years old should have complete immobilization for three weeks.

Robinson et al.

Robinson et al.[24] reported on 252 patients with an age of fifteen to thirty-five years who were managed with a sling in internal rotation for four weeks after primary anterior shoulder dislocation. Patients with atraumatic dislocation, those who had early surgery for the treatment of anterior glenoid rim fractures

TABLE III Recurrent Instability Related to Age at Time of Injury for Patients Managed with Immobilization in Internal Rotation

Study	Duration of Follow-up *(yr)*	N	Age *(yr)*	Rate of Recurrence	P Value
Hovelius et al.[9] (1983)	2	257			<0.0001
			<30	57% (92 of 162)	
			≥30	24% (23 of 95)	
Hovelius et al.[10] (1987)	5	256			<0.0001
			<30	58% (103 of 162)	
			≥30	28% (26 of 94)	
Hovelius et al.[11] (1996)	10	247			<0.0001
			<30	62% (97 of 156)	
			≥30	23% (21 of 91)	
Hovelius et al.[12] (2008)	25	229			<0.0001
			<30	63% (95 of 152)	
			≥30	23% (18 of 77)	
Kiviluoto et al.[13] (1980)	1	226			<0.0001
			<30	36% (19 of 53)	
			≥30	6% (11 of 173)	
Robinson et al.[24] (2006)	2	252			0.0097
			<30	54% (117 of 218)	
			≥30	29% (10 of 34)	
Itoi et al.[26] (2007)	2.1	139			<0.0001
			<30	55% (43 of 78)	
			≥30	16% (10 of 61)	

and subluxation or displaced greater tuberosity fractures, and those with late presentation or acute rotator cuff tears were excluded. This prospective cohort study was given a prognostic Level-I designation.

Follow-up data for all 252 patients were compiled at multiple time points between 4.3 and 9.4 years following injury. One hundred and fifty patients (60%) had experienced at least one episode of recurrent instability at the time of most recent follow-up (Table II). Survival analysis predicted a 55.7% recurrence rate at two years after the injury and 66.8% at five years. Male sex and younger age were the only independent factors that were predictive of increased recurrence. Using the authors' data at two years after the injury, we found that 117 (54%) of 218 patients younger than thirty years of age at the time of the injury developed recurrent instability, compared with ten (29%) of thirty-four patients thirty years of age or older (Table III). This difference was significant ($p = 0.0097$).

TABLE IV Recurrent Instability After Immobilization in Internal Rotation versus External Rotation

Study	Duration of Follow-up	Position and Duration of Immobilization	N	No. of Recurrences	P Value
Itoi et al.[25] (2003)	15.5 mo				0.008
		Internal rotation, 3 weeks	20	6	
		External rotation, 3 weeks	20	0	
Itoi et al.[26] (2007)	2.1 yr				0.039
		Internal rotation, 3 weeks	39	15	
		External rotation, 3 weeks	61	12	
Finestone et al.[27] (2009)	2.8 yr				0.74
		Internal rotation, 4 weeks	24	10	
		External rotation, 4 weeks	27	10	

TABLE V Pooled Data on Recurrence Rates for Patients Managed with Immobilization in Internal Rotation for One Week versus Three Weeks or More

	Rate of Recurrence in Patients with an Age of <30 Years	
Studies with One Year or More of Follow-up	Immobilization for One Week or Less	Immobilization for Three Weeks or More
Hovelius et al.[9] (1983)	38% (27 of 71)	42% (28 of 66)
Kiviluoto et al.[13] (1980)	50% (13 of 26)	23% (6 of 27)
Total	41% (40 of 97)	37% (34 of 93)

Itoi et al.

The first randomized controlled trial comparing immobilization in internal rotation bracing versus external rotation bracing after primary anterior shoulder dislocation was described in 2003 by Itoi et al.[25]. Forty patients, twenty in each group, were managed with three weeks of either a sling in internal rotation (internal rotation group) or bracing in external rotation (external rotation group). The age range was seventeen to eighty-four years, and the mean duration of follow-up was 15.5 months (Table I). Two patients with displaced greater tuberosity fractures were excluded, but seven patients with nondisplaced greater tuberosity fractures and one with an anterior glenoid fracture were included. These fractures were equally distributed between groups. This study was assigned a Level-II rating because of its small size and short duration of follow-up.

Compliance was defined as poor (indicating that the immobilization device was used for less than one week) for five patients in the external rotation group and four in the internal rotation group. Recurrent instability was noted in six (30%) of twenty patients in the internal rotation group and in none of the twenty in the external rotation group ($p = 0.008$) (Table IV).

Itoi et al. later reported on an expanded trial involving 198 patients with an age of twelve to ninety years (mean, thirty-seven years) at the time of injury who were followed for an average of 25.6 months (range, twenty-four to thirty months)[26]. The number of patients with greater tuberosity or anterior glenoid fracture was not reported in this study. When published in *The Journal of Bone and Joint Surgery* in 2007, this study was given a therapeutic Level-II rating (Table I) because of a follow-up percentage of 80% and possible methodological bias contributing to a significantly worse rate of compliance in the group managed with a conventional sling as compared with that in the group managed with bracing in external rotation (53% compared with 72%; $p = 0.013$).

Intention-to-treat analysis demonstrated that the group that was managed with three weeks of immobilization with a sling and swathe (the internal rotation group) consisted of ninety-four patients with a rate of follow-up of 79% (seventy-four of ninety-four). Overall, 53% (thirty-nine) of seventy-four patients in this group were compliant with the protocol and the recurrence rate was 42% (thirty-one of seventy-four). The remaining 104 patients (the external rotation group) were managed with an external rotation brace for three weeks and had a follow-up rate of 82% (eighty-five of 104). The compliance rate was 72% (sixty-one of eighty-five), and the recurrence rate was 26% (twenty-two of eighty-five). Significant differences were observed between the groups in terms of compliance ($p = 0.013$) and recurrence ($p = 0.033$).

A per-protocol analysis, including only compliant patients, showed recurrence rates of 38% (fifteen of thirty-nine) in the internal rotation group and 20% (twelve of sixty-one) in the external rotation group ($p = 0.039$) (Table IV). Additional calculations demonstrated that the recurrence rate remained significantly less in the external rotation group as compared

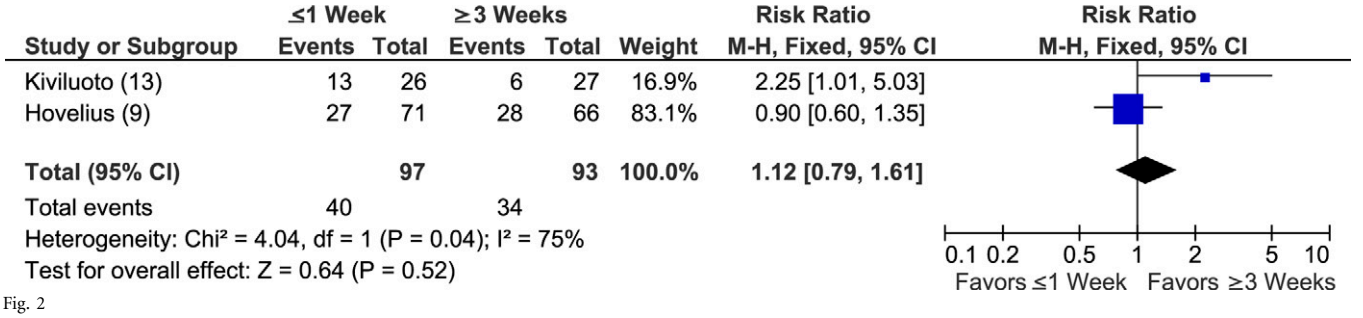

Fig. 2

Forest plot illustrating the relative risk of recurrent instability between patients less than thirty years of age who were managed with immobilization for one week or less and those who were managed with immobilization for three weeks or more. Boxes indicate the relative risk of instability calculated from the individual study results and vary in size to represent the weight of each particular study in the overall analysis. Horizontal lines illustrate the 95% confidence intervals. The diamond represents the 95% confidence interval of the overall relative risk of recurrent instability. M-H = Mantel-Haenszel, CI = confidence interval, and df = degrees of freedom.

TABLE VI Pooled Data on Recurrence Rates for Patients Managed with Immobilization in Internal Rotation versus External Rotation

Study	Recurrence Rate in Patients Immobilized in Internal Rotation	Recurrence Rate in Patients Immobilized in External Rotation
Itoi et al.[26] (2007)	38% (15 of 39)	20% (12 of 61)
Finestone et al.[27] (2009)	42% (10 of 24)	37% (10 of 27)
Total	40% (25 of 63)	25% (22 of 88)

with the internal rotation group if all patients who had been lost to follow-up were assumed to have had recurrent dislocations, but this was not so if all patients who had been lost to follow-up were assumed to have had no recurrences.

Finestone et al.

Another, more recent, randomized prospective study by Finestone et al.[27] included fifty-one male patients between the ages of seventeen and twenty-seven years who were randomized to two treatments after primary anterior shoulder dislocation (Table I). Patients with greater tuberosity fractures and those for whom a motor vehicle accident was the mechanism were excluded. One group consisted of twenty-four patients who were managed with an internal rotation sling for four weeks (internal rotation group) and were followed for an average of 30.8 months (range, twenty-four to forty-seven months). The other group consisted of twenty-seven patients who were managed with an external rotation brace for four weeks and were followed for an average of 35.8 months (range, twenty-four to forty-eight months). The rates of compliance (100%) and follow-up (100%) were excellent. This study was assigned a Level-I rating.

The recurrence rates were 42% (ten of twenty-four) in the internal rotation group and 37% (ten of twenty-seven) in the external rotation group (Table IV). This difference was not significant ($p = 0.74$). The authors concluded that, in this very active cohort, external rotation bracing was not more effective than immobilization in internal rotation for the prevention of recurrence. The overall recurrence rate of 39% was much lower than that previously cited for young active males. The investigators hypothesized that this may have been due to excellent adherence to immobilization and physical therapy protocols in this group consisting primarily of military recruits.

Meta-Analysis: Pooled Data and Calculations

Duration of Immobilization in Internal Rotation (Table V) (Fig. 2)

For patients who were managed with immobilization in internal rotation either for approximately one week or less or for three weeks or more, we pooled data from the relevant studies to determine the relative rate of recurrence at one to two years following the initial injury[9,13]. In order to reduce as much as possible the heterogeneity between patient groups in the studies by Hovelius et al.[9] and Kiviluoto et al.[13], we limited this pooled analysis to patients under the age of thirty years. The recurrence rate was 41% (forty of ninety-seven) for patients under the age of thirty years who were managed with immobilization for one week or less, compared with 37% (thirty-four of ninety-three) for patients under the age of thirty years who were managed with immobilization for three weeks or more (Table V). This difference was not found to be significant ($p = 0.52$) (Fig. 2).

Position of Immobilization: Internal Rotation versus External Rotation (Table VI) (Fig. 3)

We also pooled data from the studies that compared treatment in internal and external rotation[26,27]. We used the per-protocol analysis figures from the study of Itoi et al.[26] in an attempt to control for patient compliance and to provide the most accurate picture possible of the effectiveness of bracing in external rotation. The rate of recurrent instability was 40% (twenty-five of sixty-three) for patients who were managed with a con-

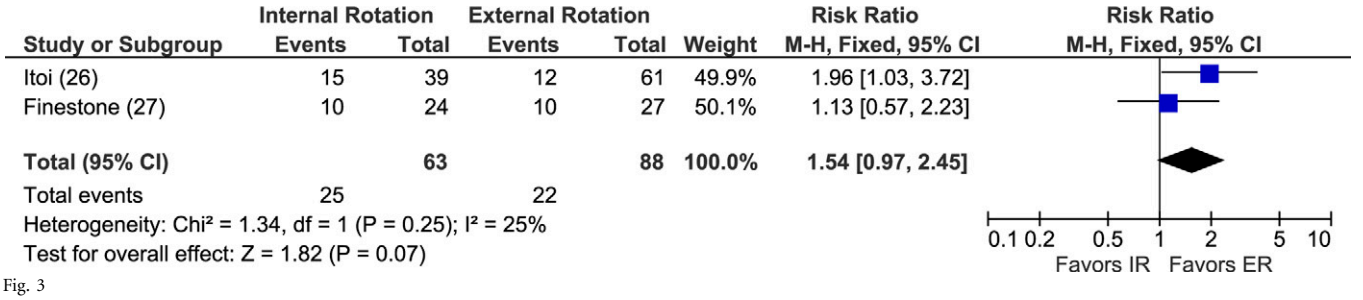

Fig. 3

Forest plot illustrating the relative risk of recurrent instability between patients managed with immobilization in internal versus external rotation. Boxes indicate the relative risk of instability calculated from the individual study results and vary in size to represent the weight of each particular study in the overall analysis. Horizontal lines illustrate the 95% confidence intervals. The diamond represents the 95% confidence interval of the overall relative risk of recurrent instability. M-H = Mantel-Haenszel, CI = confidence interval, df = degrees of freedom, IR = internal rotation, and ER = external rotation.

ventional sling, compared with 25% (twenty-two of eighty-eight) for those who were managed with immobilization in external rotation (Table VI). Meta-analysis demonstrated that this finding had a trend toward, but did not achieve, significance ($p = 0.07$) (Fig. 3).

Discussion

Although shoulder dislocations have been a recognized disorder since antiquity[28], no consensus has been reached on the optimum duration or position of immobilization following reduction to prevent recurrent instability or on the efficacy of immobilization. Earlier recommendations have ranged from no immobilization[29] to up to eight weeks of immobilization[2-5,9-13,30]. Rowe and Sakellarides[4] found no evidence supporting immobilization for more than three weeks, and other studies have not demonstrated any benefit in association with immobilization for any length of time[2,3]. Marans et al.[3] described twenty-one skeletally immature patients who were managed over a fifteen-year period. All patients had at least one recurrent dislocation. Immobilization for up to six weeks had no effect on recurrence. Henry and Genung[2] came to a similar conclusion in their study of 121 patients with shoulder dislocations that had occurred at an average age of nineteen years. The authors reported a 90% rate of recurrence for shoulders that were immobilized, compared with an 85% rate for shoulders that were not immobilized. The length of immobilization had no effect on recurrence rates.

Our review of the Level-I and Level-II literature identified six studies involving patients who were managed primarily with immobilization in internal rotation following first-time shoulder dislocations. Although four studies by the same primary author involved the same patient cohort[9-12], those studies were all classified as Level I and had excellent follow-up. Over a twenty-five-year period, those studies all demonstrated no difference in recurrent dislocation rates between patients managed with immobilization in internal rotation for one week and those managed with immobilization for three weeks or more. Level-II data reported by Kiviluoto et al.[13] demonstrated some benefit to a longer (three-week) period of immobilization in internal rotation compared with one week in younger patients; however, as a whole, there was no significant difference between groups managed for one week and those managed for three weeks in that cohort. In the sixth study, Robinson et al.[24] reported managing all patients with conventional sling immobilization for four weeks.

Patient age at the time of dislocation consistently has been found to be a significant predictor of recurrent dislocation[1-5,31,32]. The studies by Marans et al.[3] and Henry and Genung[2] demonstrated high redislocation rates in younger patients. While Simonet and Cofield[5] reported a lower overall recurrence rate in young patients, they still noted a high rate of recurrent dislocation (82%) in the athletic population. More recently, Hoelen et al.[31] and Ryf and Matter[32] specifically noted an increased risk of recurrent dislocation in patients younger than thirty years of age. Our review also demonstrated significantly higher rates of recurrent instability in patients who were less than thirty years of age at the time of injury and showed that this difference was consistent across multiple studies (Table III). Thirty years was chosen as the cutoff point for this portion of the analysis because comparative data for groups of patients older and younger than thirty years of age were consistently available in all studies, with the exception of the study by Finestone et al.[27], which included patients who were seventeen to twenty-seven years old.

Pooled data from the Level-I and Level-II studies indicate that there is no advantage to sling immobilization for more than one week in younger patients (Table V) (Fig. 2). We limited this analysis to patients under the age of thirty years in order to reduce significant heterogeneity between the patient groups in the studies by Hovelius et al.[9] and Kiviluoto et al.[13] caused by the large difference in the ages of patients included in those studies. We believe that, while this difference limited the numbers available for inclusion in the pooled analysis on the duration of immobilization, combining data from homogeneous patient groups greatly increases the strength of the results of this analysis. Still, sources of heterogeneity between these two patient groups do exist as reflected in the I^2 value of 0.75 for this analysis. We believe that this heterogeneity is likely because Hovelius et al.[9] used a method of randomization that may have resulted in heterogeneity between treatment groups. Patients managed at smaller hospitals in those studies were randomized to treatment either with or without immobilization according to the policy at each hospital[12]. As we are unaware of the specific treatment policies employed at each of those hospitals, this certainly could have resulted in selection bias, with patients having a "worse" injury being placed into the treatment group receiving a longer duration of immobilization. However, on the basis of our pooled data analysis, we conclude that the available Level-I and Level-II evidence does not support the use of shoulder immobilization in internal rotation for primary anterior shoulder dislocations for longer than one week in patients under the age of thirty years.

More recently, attention has shifted toward evaluating the proper position of immobilization following shoulder dislocation. Some authors have theorized that positioning the arm in external rotation rather than internal rotation places the torn labrum in closer proximity to the glenoid, which enhances healing[14,15,20,21]. Cadaver studies have confirmed this finding[14,16,17].

Only three Level-I and Level-II studies compared traditional immobilization in internal rotation with bracing in external rotation[25-27]. The two Level-II studies examined the same cohort[25,26]. We attempted to reduce heterogeneity of the data from those studies by using only the per-protocol results reported by Itoi et al.[26]. These data included results for only patients who were compliant, and the patients in the study by Finestone et al.[27] demonstrated 100% compliance, thereby eliminating any bias caused by this problem. Also, the patients in the study by Itoi et al.[26] were older and included patients with nondisplaced greater tuberosity fractures. In contrast, Finestone et al.[27] excluded all patients with greater tuberosity fractures. Thus, there was variability in those studies as reflected by the I^2 value of 25%, which nevertheless represents less than moderate heterogeneity.

Pooled data for patients who were compliant with the protocols did not demonstrate a significant advantage to external rotation bracing overall; however, the data did indicate an approximately 15% lower risk of recurrence in association with immobilization in external rotation, which may be clinically important (Table VI). Therefore, we conclude that the current best-available evidence does not definitively support external rotation bracing following an index glenohumeral dislocation over traditional sling immobilization.

The limitations of the present study include those inherent to any review and analysis of pooled data. Likely the most important of these is the limited number of high-quality prospective studies available on the subject of nonoperative treatment of primary anterior shoulder dislocation. We were only able to pool data from two studies each for our analyses of the duration and position of immobilization. As discussed above, the studies themselves compared groups of patients who were not completely homogeneous. It is also possible that differences in post-injury physical therapy regimens could have contributed to variations in recurrence rates among the studies. Despite these inconsistencies, this review does have some strengths. Using recurrent dislocation as our outcome of interest allows for consistency among the studies. In addition, we believe that the pooled data for immobilization in internal as opposed to external rotation is quite consistent with regard to the duration of follow-up as well as compliance. Additional study of this subject is needed in order to clarify whether there may be a specific population of patients who might substantially benefit from a longer duration of immobilization or positioning in external rotation.

In summary, the current Level-I and Level-II evidence suggests that there is no benefit to immobilization in internal rotation for more than one week as it pertains to recurrent instability in patients under thirty years of age. An age of less than thirty years at the time of the injury is also predictive of increased recurrence. Additionally, the best available evidence does show a clinical benefit to treatment in external rotation over conventional sling immobilization, but this advantage did not reach significance. ■

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