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THE ROLE OF POST-REDUCTION RADIOGRAPHS AFTER SHOULDER DISLOCATION

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□ **Abstract—We sought to determine whether post-reduction radiographs add clinically important information to what is seen on pre-reduction X-rays in Emergency Department (ED) patients with anterior shoulder dislocations. In this prospective, observational study, clinicians recorded preliminary pre-reduction and post-reduction X-ray readings on patients with shoulder dislocations. The films were subsequently reviewed by a blinded attending radiologist. Seventy-three patients presented to the ED with shoulder dislocations over an 18-month period; 55 of these patients had pre- and post-reduction X-rays and were included in the study. Eight of these patients had fractures seen on preliminary reading of post-reduction X-rays; one (1.8%, 95% confidence interval [CI] 0–9.7%) of these fractures was not seen on preliminary reading of pre-reduction films. On preliminary reading, all patients' shoulders were relocated on post-reduction X-rays (100%; 95% CI 93.5–100%). Forty of these patients had their X-rays read by a blinded attending radiologist. Sixteen fractures were seen on post-reduction X-rays, of which 6 (15.0%; 95% CI 5.7–29.8%) were not seen on pre-reduction X-rays. All patients (100%; 95% CI 91.2–100%) whose post-reduction films were read by blinded attending radiologists had shoulder relocation confirmed. In conclusion, although the majority (62.5%) of fractures associated with shoulder dislocations are seen on pre-reduction radiographs, more than one-third (37.5%) of fractures may be visible only on post-reduction X-rays. None of the fractures missed on pre-reduction X-rays changed patient management in the ED. There were no persistent shoulder dislocations found on post-reduction films. © 2007 Elsevier Inc.**

□ **Keywords—shoulder dislocation; pre-reduction radiographs; post-reduction radiographs; fracture; persistent dislocation**

INTRODUCTION

Shoulder dislocation is the most common large joint dislocation presenting to the Emergency Department (ED), affecting approximately 1.7% of the population (1–6). Shoulder dislocations are most commonly caused by trauma and are usually anterior (1,7). Mechanism of injury may include falling, assault, forceful pulling on the arm, throwing an object, reaching to catch an object, seizures, arm motion involved in activities of daily living such as reaching for a phone or turning over in bed, and many sports, both recreational and professional. Shoulder dislocations tend to recur, especially in young adults, so it is not unusual for the same patient to present to an ED repeatedly for this problem (1).

It is common practice for patients with presumed shoulder dislocation to undergo a pre-reduction X-ray study to establish dislocation and rule out fracture, followed by reduction of the dislocation by the emergency physician (or orthopedist if the reduction is difficult or complicated), followed by a post-reduction film to confirm reduction and again, rule out fracture (8). X-rays are time-consuming, expensive, and expose patients to ionizing radiation.

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We undertook a study to determine whether post-reduction X-rays add additional clinically important information over what is seen on pre-reduction films in patients with shoulder dislocations. We hypothesized that pre-reduction X-rays are highly sensitive for significant shoulder fractures; that clinicians can accurately determine when a shoulder is reduced without a post-reduction X-ray; and that fractures caused by reduction of shoulder dislocations are rare. If there is a low incidence of fractures on post-reduction X-rays not seen on pre-reduction films and clinicians can reliably determine reduction before post-reduction X-ray, then pre-reduction X-rays may be sufficient and post-reduction X-rays may be eliminated.

METHODS

Study Design

This prospective study included consecutive ED patients presenting with shoulder dislocations from June 1, 1999 until December 1, 2000. The study was approved by Boston Medical Center's Institutional Review Board. The study was approved with waiver of informed consent, as the study was observational.

Study Setting and Population

This study was performed at an urban teaching hospital with approximately 80,000 ED patient visits per year. All patients with radiographically confirmed shoulder dislocations were eligible for the study. Patients were excluded if either pre-reduction or post-reduction X-rays were not performed.

Study Protocol

ED clinicians (attending emergency physician or senior emergency medicine resident) were asked to fill out a data form whenever a shoulder dislocation was radiographically identified and treated, before post-reduction films were obtained. The data form included demographic information, mechanism of injury, prior history of shoulder dislocations, initial reading of the pre-reduction X-ray, method of reduction, sedation or analgesia given, and clinical assessment of whether the shoulder was reduced. After the patient's post-reduction film was obtained, the ED clinician was then asked to record the initial reading of the post-reduction X-ray on the data form. Clinically significant shoulder fractures were defined as those requiring orthopedic intervention after the shoulder dislocation was reduced. X-rays were subsequently independently reviewed by an attending radiologist, who noted the presence of dislocations and fractures. The radiologist was blinded to the post-reduction film until reading the pre-reduction X-ray. The ED log was reviewed on a daily basis for identification of patients with shoulder dislocations who were not entered into the study.

Data Analysis

Data forms were collected and the data entered into an Excel (Microsoft Corporation, Redmond, WA) database for analysis. We calculated the incidence and 95% confidence interval (CI) of new fractures seen on post-reduction X-rays as compared to pre-reduction X-rays. We also examined whether dislocation was still present on post-reduction X-rays, as compared to the clinician's assessment before post-reduction X-ray.

RESULTS

Seventy-three patients presented to the ED with shoulder dislocation over an 18-month period. Sixteen patients were excluded from analysis. Fourteen were reduced without obtaining pre-reduction films, one pregnant patient had no pre- or post-reduction films, and for one patient, pre- and post-reduction X-rays were documented on the ED chart as having been performed, but the post-reduction films were lost and no reading could be found. Of the 57 remaining patients, 16 did not have a radiology attending final reading of the pre- and post-reduction X-rays, because the films could not be located.

Of the 57 patients with pre- and post-reduction X-rays, one patient had a posterior dislocation and was excluded from the analysis. The mean and median age was 39 years (range 15–76 years, 95% CI 32–45), and 71% were male. The most common mechanism of injury was fall from standing or sitting (39.3%). Fifty-five of the dislocations were anterior (98.2%); one was luxatio erectae (1.8%). Opiates were the most commonly used sedative agent, either alone (42.6%) or in combination with a benzodiazepine (31.5%). The most common method used for reduction was traction-countertraction (46%) (Table 1).

Incidence of Fractures on Post-reduction X-Rays: Initial Reading

Of the 56 patients with shoulder dislocations who had pre- and post-reduction X-rays, 48 (86%) were negative for fracture by pre-reduction initial reading, and 8 had fractures (3 greater tuberosities, 3 Hill-Sachs or Bankhart, 1 neck and greater tuberosity, and 1 suspicious

Table 1. Side of Dislocation, Mechanism of Injury, Type of Dislocation, Sedation, and Reduction Method

	Number (%)
Side	
Left	32 (57)
Right	24 (43)
Total	56 (100)
Mechanism of injury	
Arm motion	9 (16)
Assault	4 (7.0)
Fall from standing or sitting	22 (39)
Fall from height	7 (12.5)
Pedestrian struck by car	2 (3.6)
Bicycle/rollerblade/skateboard	1 (1.8)
Sports injury	6 (11)
Other trauma	4 (7.1)
Unknown	1 (1.8)
Total	56 (100)
Type of dislocation	
Anterior	55 (98.2)
Luxatio erectae	1 (1.8)
Total	56 (100)
Sedation	
None	3 (5.6)
Benzodiazepine	5 (9.3)
Benzodiazepine and opiate	17 (31.5)
Benzodiazepine, opiate, and NSAID*	2 (3.7)
Benzodiazepine and NSAID*	1 (1.9)
Opiate	23 (42.6)
Opiate and NSAID*	1 (1.9)
Intra-articular lidocaine	2 (3.7)
Total	54† (100)
Reduction method	
Traction counter-traction	26 (46)
Hennepin	15 (27)
Scapular manipulation	9 (16)
Milch	3 (5.4)
Reduced by orthopedics	2 (3.6)
Spontaneous	1 (1.8)
Total	56 (100)

* Non-steroidal anti-inflammatory drug.
† Sedation not entered on data sheet for two patients.

fragment). One patient did not have the initial reading of the post-reduction film recorded either on ED chart or data form. Among the 55 patients with both a pre- and post-reduction X-ray initial reading recorded, there were 8 fractures seen on post-reduction wet reading. There was one (1.8%; 95% CI 0–9.7%) fracture visualized on post-reduction X-ray that was previously not noted (Table 2); this was a Hill-Sachs fracture. There was also one pre-reduction X-ray initial reading of questionable Bankhart fracture that was interpreted as negative for fracture on post-reduction initial reading.

All 55 patients (100%; 95% CI 93.5–100%) who had an initial reading of post-reduction films had shoulder relocation confirmed.

Incidence of Fractures on Post-Reduction X-Rays: Radiology Attending Reading

Among the 40 patients with a pre- and post-reduction independent radiology attending reading (excluding the one posterior dislocation), 11 fractures were identified on pre-reduction X-ray (2 greater tuberosity fractures, 8 Hill-Sachs or Bankhart fractures, and 1 glenoid fracture [not Bankhart]). Sixteen fractures were identified on post-reduction X-ray; of these, 6 (15.0%; 95% CI 5.7–29.8%) were not seen on pre-reduction X-ray (Table 3). Five of these were Hill-Sachs or Bankhart fractures, and one was a glenoid fracture (not Bankhart). One fracture that was seen on pre-reduction X-ray was not seen on post-reduction X-ray.

All 40 patients (100%; 95% CI 91.2–100%) whose films were independently read by an attending radiologist had shoulder relocation confirmed. No patient with post-reduction films had persistent dislocation.

DISCUSSION

The need for pre- and post-reduction X-rays in shoulder dislocations has been questioned over the past decade

Table 2. Initial Reading Fracture Data for 55 Patients with Shoulder Dislocations

	Post-reduction Initial Read					
	No Fracture	Greater Tuberosity Fracture	Hill-Sachs/ Bankhart Fracture	Neck and Greater Tuberosity Fracture	Suspicious Fragment	Total
Pre-reduction initial read						
No fracture	**46**	0	1	0	0	47
Greater tuberosity fracture	0	**3**	0	0	0	3
Hill-Sachs/Bankhart fracture	1	0	**2**	0	0	3
Neck and greater tuberosity fracture	0	0	0	**1**	0	1
Suspicious fragment	0	0	0	0	**1**	1
Total	47	3	3	1	1	55

Patients for whom the initial reading before and after reduction were in agreement are represented in bold type, on the diagonal. Patients in whom there was a fracture observed on post-reduction X-ray but not on pre-reduction X-ray are represented to the right of the diagonal, and patients in whom there was a fracture observed on pre-reduction X-ray but not on post-reduction X-ray are represented to the left of the diagonal.

Table 3. Blinded Radiology Attending Pre- and Post-Reduction X-Ray Reading Fracture Data for 40 Patients with Shoulder Dislocations

	Post-reduction Radiology Attending Read				
	No Fracture	Greater Tuberosity Fracture	Glenoid Fx (not Bankhart)	Hill-Sachs/Bankhart Fracture	Total
Pre-reduction radiology attending read					
No fracture	**23**	0	1	5	29
Greater tuberosity fracture	0	**2**	0	0	2
Glenoid Fx (not Bankhart)	0	0	**1**	0	1
Hill-Sachs/Bankhart fracture	1	0	0	**7**	8
Total	24	2	2	12	40

Patients for whom the blinded radiology attending reading before and after reduction were in agreement are represented in bold type, on the diagonal. Patients in whom there was a fracture observed on post-reduction X-ray but not on pre-reduction X-ray are represented to the right of the diagonal, and patients in whom there was a fracture observed on pre-reduction X-ray but not on post-reduction X-ray are represented to the left of the diagonal.

(8–10). Post-reduction radiographs are generally obtained because the clinician wants to confirm that the shoulder has been reduced and to demonstrate that no new fractures have occurred during the reduction. We found one Hill-Sachs fracture on initial reading of post-reduction X-rays that was missed on pre-reduction X-rays. We found six fractures on blinded attending reading of post-reduction X-rays that were missed on pre-reduction X-rays; 5 were Hill-Sachs or Bankhart fractures and one was a glenoid fracture (not Bankhart). None of these fractures affected ED management or required urgent orthopedic evaluation. There were no patients who demonstrated persistent dislocation on post-reduction films.

In a study by Hendey, the clinician was able to tell clinically that the shoulder was reduced in 174/175 cases of anterior shoulder dislocation; in one patient, persistent dislocation was identified on post-reduction films (8). Seventeen fractures, including 14 Hill-Sachs deformities, two Bankart fractures, and one greater tuberosity chip fracture, were seen on post-reduction films but were not noted on pre-reduction X-rays. There was no change in patient management caused by the post-reduction X-ray findings, with the exception of the one patient with persistent dislocation (8).

In another study by Hendey, 98 patients with shoulder dislocations were evaluated with pre- and post-reduction clinical assessments and pre- and post-reduction X-rays (9). Twenty-eight of these patients had recurrent dislocations with no new trauma; none of these patients had an unsuspected fracture. None of these 28 patients had persistent dislocation on post-reduction film. The other 70 patients with shoulder dislocations had either no history of shoulder dislocation or had new trauma or both. Ten of these patients had a fracture-dislocation; none of these was missed on pre-reduction films. One of these patients had a persistent dislocation on post-reduction films, even though the clinician had clinically determined with confidence that the shoulder was reduced (9).

Emond et al. retrospectively reviewed cases of anterior shoulder dislocation over a 5-year period, looking for factors associated with a clinically important fracture-dislocation as compared to a non-complicated shoulder dislocation (10). He found three factors to have significant association with clinically important fracture-dislocations of the shoulder: age $\geq$ 40 years, first episode of dislocation, and mechanism of injury (fall more than one flight of stairs, fight or assault, motor vehicle collision) (10).

Anterior shoulder dislocations frequently recur (11–14). Although shoulder dislocations are usually treated conservatively (reduction and sling), some authors consider early surgical stabilization after first-time anterior dislocation (15,16). Consideration of surgical repair after the first dislocation is especially important in young, athletic patients (17–19). The Bankhart fracture has been implicated as a cause of recurrent shoulder dislocations and may be a factor in deciding on surgical repair (12). Hill-Sachs deformity is also associated with recurrent shoulder dislocations (20).

Elderly patients sustaining their first anterior dislocation are generally not considered to be at high risk for recurrent dislocations (12). A study by Gumina, however, reports a recurrence rate of 20% for anterior shoulder dislocation in elderly patients, so shoulder stabilization surgery may be required in elderly patients as well (although not usually after the first dislocation) (21).

LIMITATIONS

This study has several limitations. It is interesting to note that in the ED at our institution, some shoulder dislocations were reduced without pre-reduction X-rays (14 of

73 patients), and in the case of a pregnant woman, a shoulder dislocation was reduced without pre- or post-reduction X-rays. We did not expect to find that 15 of 73 (20.5%) patients with a final diagnosis of shoulder dislocation were reduced without pre-reduction radiographs. We did compare the two groups of patients (those with and without pre-reduction radiographs). The median age of the patients who had pre-reduction X-rays was 39 years, compared to the median age of the patients who did not have pre-reduction X-rays, which was 28 years ($p = 0.0364$). There were no other statistically significant differences between these two groups (gender, side of dislocation, mechanism of injury, reduction method). What became apparent in reviewing the data is that some of the attending emergency physicians at our institution prefer to reduce shoulder dislocations without X-rays to avoid delay in treatment and the muscle spasm that ensues. In fact, more than the usual number of pre-reduction films may have been obtained in our department due to the prompting on the data forms to fill out the results of the pre- and post-reduction X-rays.

Of the 57 patients who underwent pre- and post-reduction X-rays, in only 41 cases could both sets of X-rays be recovered for a blinded re-read by a radiologist. The study was performed before the institution of a digital radiography system at our hospital.

The data sheet included whether immediate surgical intervention was indicated, but there was no follow-up after the patients left the hospital. Twelve-month follow-up to include incidence of recurrent dislocation and surgical stabilization would have provided useful information.

CONCLUSIONS

In this study, although the majority of fractures (62.5%) associated with shoulder dislocation were seen on pre-reduction X-rays, an additional 37.5% of fractures were seen only on post-reduction films; 83% of these fractures missed on pre-reduction films were Hill-Sachs or Bankhart fractures. None of the fractures seen on post-reduction X-rays that were not visible on pre-reduction X-rays required immediate orthopedic intervention. No patient who was thought by the clinician to be reduced had a persistent dislocation. In conclusion, foregoing post-reduction X-rays will miss almost one-third of fractures associated with anterior shoulder dislocation, but will not affect ED management. Prompt orthopedic follow-up is important to determine whether a surgical stabilization procedure to prevent recurrent dislocation is indicated.

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