Delays to initial reduction attempt are associated with higher failure rates in anterior shoulder dislocation: a retrospective analysis of factors affecting reduction failure

Avinash Kanji,[1,2] Paul Atkinson,[2,3,4,5] Jacqueline Fraser,[3,4] David Lewis,[2,3] Susan Benjamin[2,5]

[1]Faculty of Medicine, University College Cork, Cork, Ireland
[2]Department of Emergency Medicine, Horizon Health Network, Saint John, New Brunswick, Canada
[3]Department of Emergency Medicine, Dalhousie University, Saint John, New Brunswick, Canada
[4]Discipline of Emergency Medicine, Memorial University, Saint John, New Brunswick, Canada
[5]New Brunswick Trauma Program, Saint John Regional Hospital, Saint John, New Brunswick, Canada

Correspondence to
Dr Paul Atkinson, Professor, Department of Emergency Medicine, Dalhousie University, Saint John Regional Hospital, 400 University Avenue, Saint John, New Brunswick, Canada E2L 4L4;
paul.atkinson@dal.ca

Received 17 February 2015
Revised 8 June 2015
Accepted 9 June 2015

To cite: Kanji A, Atkinson P, Fraser J, *et al*. *Emerg Med J* Published Online First: [*please include* Day Month Year] doi:10.1136/emermed-2015-204746

ABSTRACT

Introduction Little is understood about the relationship between delay to treatment and initial reduction success for anterior shoulder dislocation. Our study examines whether delays to initial treatment, from injury and hospital presentation, are associated with higher reduction failure rates for anterior shoulder dislocation.

Methods A retrospective database and chart review was performed for patients undergoing intravenous sedation for attempted reduction of anterior shoulder dislocation in the emergency department (ED). Stepwise regression analysis was performed to identify predictors of reduction failure. Key variables analysed were the duration of the wait in the ED, the interval between the time of injury and first intervention and the interval from time of injury to arrival at the ED. Possible confounding variables analysed included age, gender, dose of sedative agent, qualifications of the reducing physician and whether the dislocated shoulder was recurrent.

Results The duration of the intervals from injury to first reduction attempt and from arrival at the ED to first reduction attempt were both independent predictors of a higher reduction failure rate (OR=1.07, 95% CI 1.02 to 1.13; OR=1.19, 95% CI 1.05 to 1.34). Every interval of 10 min increased the odds of a failed reduction attempt by 7% and 19%, respectively. Overall, shoulder reduction was successful during the initial sedation event in 97 cases (92%) and unsuccessful in nine cases (8%).

Conclusions Delays to first reduction attempt either from the time of injury or within the ED are associated with a lower reduction success rate for anterior shoulder dislocations.

Key messages

What is already known on this subject?
Anterior shoulder dislocations are a common joint dislocation seen in the emergency department (ED). The failure rate for closed reduction in the ED is low. Although these injuries are triaged as urgent, there is little published evidence describing the impact of timely reduction on success rates for closed reduction.

What might this study add?
This retrospective study of patients undergoing procedural sedation for anterior shoulder dislocation found an association between treatment delays and initial reduction failure rates. The results of this study support the established 'truism' that these injuries should be treated as quickly as possible after arrival to the ED.

INTRODUCTION

Anterior shoulder dislocations are the most common type of joint dislocation seen in the emergency department (ED). Recent studies estimate the overall incidence rate to be between 23.1 and 23.9 per 100 000 person-years, with young men and elderly women at particular risk.[1 2] While closed reductions are generally achieved on the first attempt, failed attempts may add to patient discomfort, increase the burden on hospital resources and increase the risk of complications, such as neurovascular damage.[3 4] It is therefore important to identify the factors that impact the success rate of closed reductions.

Few studies to date have interrogated the common medical intuition that the longer the delay from time of injury, the more difficult it is to achieve a closed reduction. In a randomised control trial comparing the Milch and the Stimson technique, Amar *et al*[5] found that a shorter interval from the time of injury to the time of the first reduction attempt is associated with a higher reduction success rate (OR=7.16; CIs were not reported). As Rumian *et al*[6] note, delays to joint reduction increase the risk of adverse effects resulting from the compression of neurovascular structures, muscle spasm and tightness associated with tissue stretch. Little is understood about either the possible complications that may arise as a result of delays to treatment or the relationship between delay and shoulder reduction success. Our study examines the possible relationship between delays to treatment and closed reduction failure rates.

METHODS

We performed a structured retrospective database and chart review of patients presenting to the Saint John Regional Hospital from 2009 to 2012 with an anterior shoulder dislocation. Our primary variable of interest was the time interval from injury to initial sedation attempt. The secondary variable of

interest was the time interval between arrival at the ED and first procedural sedation. The outcome variable was reduction failure. Our study was limited to patients whose first shoulder reduction attempt was performed under intravenous sedation with analgesia. The time of initial procedural sedation, which is routinely and reliably documented in the chart, was used as a surrogate for the time of the first closed reduction attempt. We defined the failure of the initial attempt as the clinically determined failure to achieve a successful closed reduction of the shoulder during the initial procedural sedation event.

Patients diagnosed with a fracture of the greater tuberosity, a Hills-Sachs lesion, those transferred from a satellite hospital or whose initial reduction was performed without intravenous sedation were excluded (see figure 1). In addition, cases where there was insufficient data on the time of injury, the time of arrival or the time of initial sedation were omitted from our analysis. The sample size was determined by the cases that presented during the study period.

Stepwise logistical regression was performed to identify independent predictors of reduction failure. The delay variables tested were the interval from time of arrival at ED to first sedation, the interval from injury to first sedation and the interval from injury to arrival at the ED. Additional variables assessed were age, gender, whether the shoulder dislocation was recurrent, dose of sedative agent and whether the physician performing the procedure was a resident (postgraduate specialist trainee). Separate regression analyses were conducted where there was collinearity between the delay variables. Significance of individual variables was assessed with the Wald Z test. Interaction variables were considered where relevant. Stepwise Akaike Information Criterion and Bayesian Information Criterion were used in model selection. Model fit compared with the null model was assessed with the likelihood ratio test. Overall goodness-of-fit of the model was assessed with the Le Cessie–van Houwelingen–Copas–Hosmer global goodness-of-fit test. Difference between the model's predicted probabilities and observed endpoints was tested with the c index (area under receiver operating characteristic (ROC) curve). Statistical analysis was performed on R(V.3.1.2). The Institute for Digital Research and Education at University College, Los Angeles (UCLA) provides further information on the interpretation of logistical regression ORs under 'logistical regression with a single continuous predictor variable'.[7]

Data abstraction was performed using standardised data collection forms and methodology.[8] Each record was checked independently by two data collectors. Data collectors were blinded to outcomes when deciding which patients met inclusion and exclusion criteria. The opinion of a third independent physician was sought in cases where there was disagreement. The Horizon Health research ethics board granted ethical approval.

RESULTS

One hundred and six of the 120 patients screened met the inclusion criteria (see figure 1). Shoulder reduction was

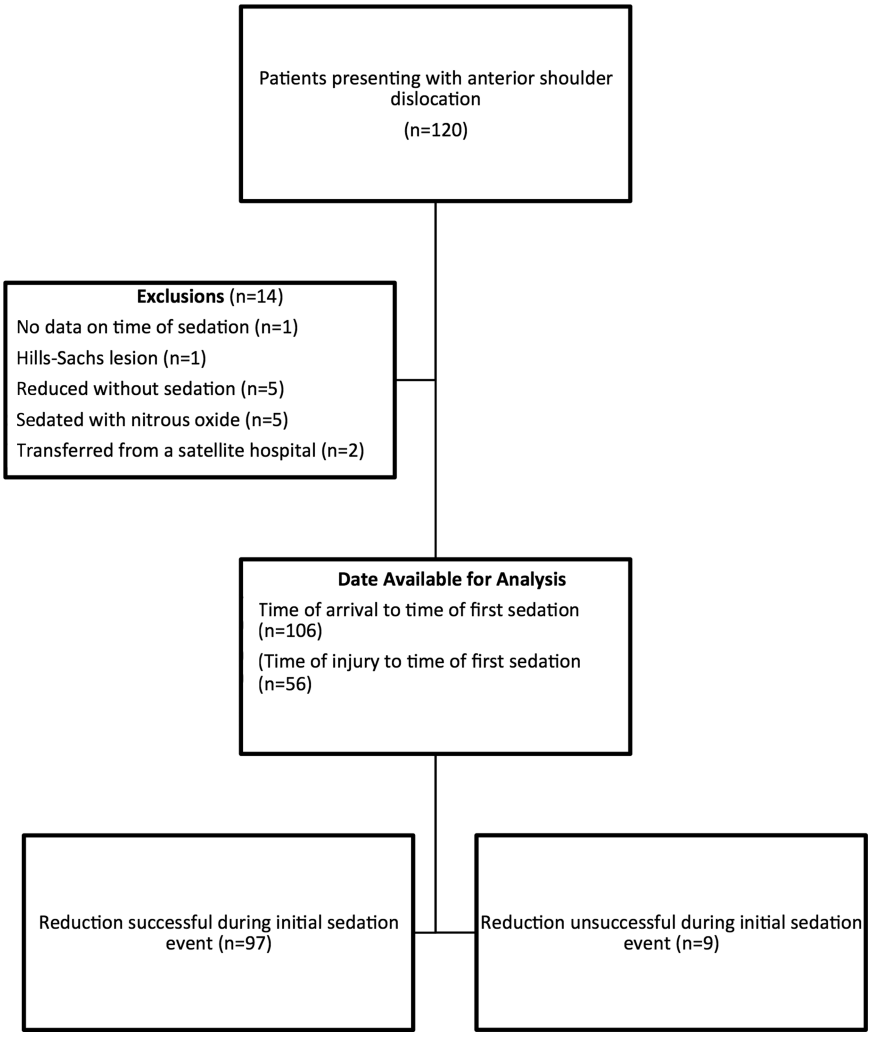

Figure 1 Patient inclusions and exclusions.

successful during the initial sedation event in 97 cases (92%) and unsuccessful in nine cases (8%). Of all the variables assessed, the delay variables were the only independent predictors of reduction failure; longer intervals from time of injury to first sedation (OR=1.07; 95% CI 1.02 to 1.13) and from time of arrival at the ED to first sedation (OR=1.19; 95% CI 1.05 to 1.34) were both associated with a higher likelihood of reduction failure (see table 1). In logistical regression, the OR is a function of the predictor variable, thus for every 10 min increase in the delay from injury, or from arrival at the ED, to first sedation, the likelihood of a failed reduction attempt increases by 7% and 19%, respectively. When the time from injury to first sedation variable was decomposed into its constituent variables, the interval from injury to arrival at ED and the interval from arrival at ED to time of initial sedation, both were significant predictors of reduction failure (OR=1.07, 95% CI 1.01 to 1.14 and OR=1.28, 95% CI 1.01 to 1.63, respectively). Figures 2 and 3 demonstrate median times from injury and ED presentation to first sedation in patients grouped by successful reduction (group 1; median 75 min, IQR 57 to 103) and failure (group 2; median 26, IQR 125 to 154) at first attempt (see table 2).

DISCUSSION

The literature on anterior shoulder reductions identifies muscle relaxation as a key factor in the success of closed reduction attempts.[6 9] As there are numerous factors that could affect muscle relaxation such as patient discomfort, pharmacological interventions, and muscle stretch, it is unlikely that the interval between injury and medical intervention has a direct effect on reduction success, unmediated by other factors. The question that motivated our research, therefore, was whether the delay to treatment is a contributing factor to reduction failure.

Our findings are consistent with the established 'truism' that delays to treatment may contribute to the increased difficulty in achieving a successful reduction. The results show that longer delays to initial medical intervention, as measured from both the time of injury and the time of arrival at the ED, are associated with higher reduction failure rates. It is difficult to determine, however, whether the lower success rates are a true effect of delay or an association. It is also difficult to determine whether the interval from injury to arrival at the ED and the interval from arrival to intervention are equally important in their association with decreasing success rates. Nevertheless, that both of the above variables were found to be independent predictors of reduction failure suggests that longer ED wait times may play an important part in the association of delays with higher failure rates.

The main study weaknesses were the small sample size and the low ratio of reduction failures to successes. Both factors may have contributed to type II error. As this was a retrospective study, the most consistent and accurate measure for the time of first reduction attempt was the time of initial sedation. A consequence of this approach is that reduction failure was defined as the failure to achieve closed reduction during a single sedation event. As it was possible for multiple reduction attempts to be performed during a single sedation event, it is possible that certain reduction failures may have been classified as successes in our analysis. Thus, although our measure of reduction failure was specific, it was less sensitive to the actual failure rate. Given that our analysis measured the association to reduction failure as opposed to success, one would expect the actual association between delays to intervention and reduction failure to be stronger than reported in our study.

Table 1 Association of independent variables with reduction failure

	OR	95% CI	p Value (Wald Z)
Age	1.01	0.98 to 1.04	0.444
Gender	1.34	0.25 to 7.05	0.726
Recurrent dislocation	1.51	0.38 to 5.95	0.559
Resident	0.43	0.05 to 3.59	0.433
Sedative agent	1.00	0.98 to 1.01	0.636
Time of arrival to first sedation	1.19	1.05 to 1.34	0.006
Time of injury to first sedation	1.07	1.02 to 1.13	0.010
Time of injury to time of arrival	1.07	1.01 to 1.14	0.026

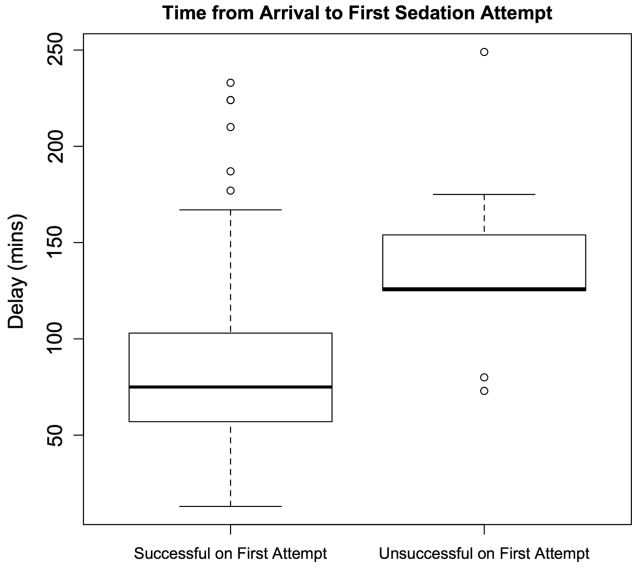

Figure 2 Median time from emergency department arrival to first sedating agent in patients grouped by successful reduction (group 1) and failure (group 2) at first attempt.

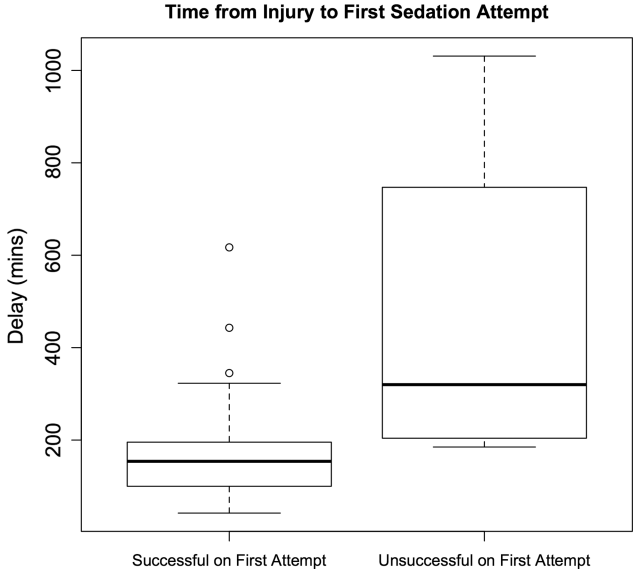

Figure 3 Median time from injury to first sedating agent in patients grouped by successful reduction (group 1) and failure (group 2) at first attempt.

Table 2 Group characteristics

	Group 1 (successful initial reduction)	Group 2 (unsuccessful initial reduction)
Number of subjects (n)	97	9
Characteristics		
Age, median (IQR)	22.5 (18 to 51.5)	21 (17.5 to 68.5)
Male, n (%)	80 (82%)	7 (78%)
Recurrent dislocations	44 (45%)	5 (56%)
Resident, n (%)	22 (23%)	1 (11%)
Sedative agent dose (mg), median (IQR)	100 (70–140)	90 (80–100)

A second variable that may have affected the sensitivity of our measurement of reduction failure was that failure during a sedation event was determined clinically as opposed to radiologically. Without radiographic verification of reduction success, it is possible that some shoulder reductions were falsely classified as successes. Again, the above argument is evidence that our measurement of reduction failure is conservative, and that the association is probably stronger than our findings suggest.

More research is needed to determine whether association between the delay to intervention and reduction failure is generalisable across all reduction techniques and anaesthetic interventions.

One possible source of bias that our study did not account for is the difference between shoulder reduction techniques. At present, there is no conclusive evidence that favours one reduction technique over any other.[10] It is likely that the physician skill and familiarity with a particular technique are key factors in reduction success. Our study assumes that the choice of reduction technique was determined by physician preference and institutional norms. The physician's status as a resident was not found to be an independent predictor of reduction failure.

Our analysis found that a lower sedative dose is not predictive of reduction failure. This evidence, however, does not preclude failure to achieve adequate sedation as a confounding factor for reduction failure; first, there are numerous factors that contribute to sedation that we could not account for in our analysis. Second, while there is some evidence that intravenous analgesia and sedation is associated with a higher success rate compared with reduction with analgesia alone,[11 12] the relationship between sedation and reduction success is largely unknown. Our study assumes that the overseeing physician achieved a level of sedation appropriate for a shoulder reduction attempt. Moreover, as the delay variables are measured with respect to the initiation of the procedural sedation event, it is unlikely that patient-level delays in achieving adequate sedation affected our results.

A larger prospective study is needed to corroborate the findings of this paper and to ascertain the possible long-term complications of a delay to treatment, such as shoulder instability and arthropathy.

CONCLUSION

Our findings suggest that delays to treatment are associated with reduced initial reduction success rates for anterior shoulder dislocations in the ED. Further prospective studies are needed to corroborate these findings. That anterior shoulder dislocations disproportionally affect younger patients involved in sports and elderly patients suggests that there are potential gains in advocating for prompt treatment of shoulder dislocations in public health policy. Initial reduction failure prolongs patient discomfort, consumes additional resources and prolongs patient stay. Triage prioritisation and documenting time of injury may facilitate more timely reduction and could lead to an increase in closed reduction success rates.

Acknowledgements The authors wish to thank Dr Paul Vanhoutte for his advice and review of the manuscript.

Contributors AK contributed to the review and analysis of the data, review of the literature and writing of the manuscript; JF and SB collected the data and reviewed the manuscript; DL assisted with the literature review and reviewed the manuscript. PA conceived the idea, assisted with the literature review, reviewed and analysed the data and reviewed the manuscript.

Competing interests None declared.

Ethics approval Horizon Health Network Research Ethics Board File #2010-1487.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Zacchilli MA, Owens BD. Epidemiology of shoulder dislocations presenting to Emergency Departments in the United States. *J Bone Joint Surg Am* 2010;92:542–9.
2 Leroux T, Wasserstein D, Veillette C, *et al*. Epidemiology of primary anterior shoulder dislocation requiring closed reduction in Ontario, Canada. *Am J Sports Med* 2014;42:442–50.
3 Stayner LR, Cummings J, Andersen J, *et al*. Shoulder dislocations in patients older than 40 years of age. *Orthop Clin North Am* 2000;31:231–9.
4 Visser CPJ, Coene LN, Brand R, *et al*. The incidence of nerve injury in anterior dislocation of the shoulder and its influence on functional recovery: a prospective clinical and EMG study. *J Bone Joint Surg [Br]* 1999;81-B:679–85.
5 Amar E, Maman E, Khashan M, *et al*. Milch vs. Stimson technique for nonsedated reduction of anterior shoulder dislocation: a prospective randomized trial and analysis of factors affecting success. *J Shoulder Elbow Surg* 2012;21:1443–9.
6 Rumian A, Coffey D, Fogerty S, *et al*. Acute first-time shoulder dislocation. *Orthop Trauma* 2011;25:363–8.
7 Logistic regression single continuous predictor variable. Institute for Digital Research and Education (IDRE). UCLA (cited 11 May 2015). http://www.ats.ucla.edu/stat/mult_pkg/faq/general/odds_ratio.htm
8 Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. *Ann Emerg Med* 2014;64:292–8.
9 Lachance P. Reduction of shoulder dislocation: are communication and adequate relaxation more important than technique? *Can Fam Physician* 2012;58:1189–90.
10 Kuhn JE. Treating the initial anterior shoulder dislocation: an evidence-based medicine approach. *Sports Med Arthosc Rev* 2006;14:192–8.
11 Hames H, McLeod S, Millard W. Intra-articular lidocaine versus intravenous sedation for the reduction of anterior shoulder dislocations in the emergency department. *CJEM* 2011;13:378–83.
12 Kosick J, Shamsa F, Raphael E, *et al*. Anesthetic methods for reduction of acute shoulder dislocations: a prospective randomized study comparing intraarticular lidocaine with intravenous analgesia and sedation. *Am J Emerg Med* 1999;17:566–70.