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Title: EPIDEMIOLOGY OF GLENOHUMERAL DISLOCATION AND SUBSEQUENT INSTABILITY IN AN URBAN POPULATION

Article Type: Original Article

Keywords: Epidemiology; Glenohumeral Dislocation; Instability; Urban Population; Outcome; Service Planning

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Abstract: Background: Glenohumeral dislocation is the most commonly encountered adult joint instability. Our Country and worldwide epidemiology is unclear and often limited to young, active groups that are not representative of general populations. Information regarding epidemiology and outcome from a first dislocation is useful for trauma service planning and patient counseling. We aimed to calculate the incidence of shoulder instability following first dislocation in our urban population and to investigate predictors of recurrent instability.
Methods: A prospectively collected trauma database was retrospectively examined to identify patients with a first time dislocation. Demographics, subsequent dislocation and instability details were collected from electronic patient records.
Results: In a 38-month study period there were 329 first dislocations in a population of 475,147 with mean follow-up 28.5 months (range 10-50). The overall incidence for first time dislocations in this population was 21.9 per 100,000 population, of which 7.9% underwent re-dislocation and 6.1% had further symptomatic instability. 18.8% had associated greater tuberosity fractures, 8.8% sustained a nerve injury while 2.7% were posterior dislocations. A bimodal distribution was observed for males (peak incidence per 100,000 of 42.1 and 50.9 in 15-24 and 85+ age groups respectively), and unimodal for females (peak 45.7 in the 65-74 age group).
Conclusion: We demonstrate a previously unreported burden of dislocation in older age groups, and suggest a rate of recurrence lower than previously reported in our country. The age group at highest risk of recurrent dislocation and instability was the 15-19 year group. Gender was not a significant predictor of instability.

To Whom it may concern,

Regarding;

‘ EPIDEMIOLOGY OF GLENOHUMERAL DISLOCATION AND SUBSEQUENT INSTABILITY IN AN URBAN POPULATION’

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This work has been presented by the authors in the form of a Podium Presentation at the British Elbow and Shoulder Society meeting in Dublin, 2016.

The manuscript submitted has been read and approved by all authors, and each author listed believes that the manuscript represents honest and original work.

We look forwards to hearing from you,

Thank you, and with kind regards,

Mr J.G. Jefferies

Conflict of Interest Statement:

The Authors:

1. Mr David Shields : This author, their immediate family, and any research foundation with which they are affiliated did not receive any finanacial payments or other benefits from any commercial entity related to the subject of this article.

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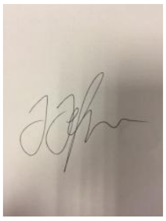
2. Mr James Jefferies: This author, their immediate family, and any research foundation with which they are affiliated did not receive any finanacial payments or other benefits from any commercial entity related to the subject of this article.

 18.4.17

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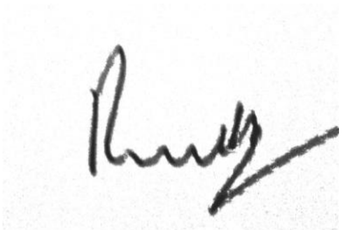 20.04.2017

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5. Mr Paul Jenkins: This author, their immediate family, and any research foundation with which they are affiliated did not receive any finanacial payments or other benefits from any commercial entity related to the subject of this article.

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No outside funding or grants were received that assisted in this study.

***Response to Reviewers**

Dear Editor and Reviewers

Thank you for your encouraging comments regarding this manuscript. We have considered your comments and make the below changes to issues which you have raised accordingly:

In response to “Line 84 The definition of a dislocation was radiological evidence of a glenohumeral dislocation. And definition of 'instability' was to being history of instability symptoms or stabilization surgery performed or planned in this article. But the diagnosis of shoulder instability should be based on not only the history but also the physical examinations such as apprehension test, Jobe's relocation test or jerk test, etc.”
Indeed examination findings were a trigger for the diagnosis of instability and this has been clarified on line 87.

In response to “Line 188 '~is may be due to be due to true differences~' typo in English” This has been corrected to *‘this may be due to true differences’*

In response to “This is relatively short term fu (28 months) period, please comment this in the study limitations in discussion.” A sentence stating ‘A final limitation of this study to note is the duration of follow up of 28 months’ has been added on line 266.

In response to the standardized revision instructions, the manuscript has been checked again for written English prose, measurement accuracy and statistical presentation.

*Title Page (including author information)

EPIDEMIOLOGY OF GLENOHUMERAL DISLOCATION AND SUBSEQUENT INSTABILITY IN AN URBAN POPULATION

Running Title: Epidemiology of glenohumeral dislocation, subsequent instability

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There are no acknowledgements to be made of others. The above named authors are the sole contributors to this article.

*FIGURE 4 to be published in color please

Epidemiology of Glenohumeral Dislocation, subsequent Instability

Running Title: Epidemiology of glenohumeral dislocation, subsequent instability

Abstract

Background: Glenohumeral dislocation is the most commonly encountered adult joint instability. Our Country and worldwide epidemiology is unclear and often limited to young, active groups that are not representative of general populations. Information regarding epidemiology and outcome from a first dislocation is useful for trauma service planning and patient counseling. We aimed to calculate the incidence of shoulder instability following first dislocation in our urban population and to investigate predictors of recurrent instability.

Methods: A prospectively collected trauma database was retrospectively examined to identify patients with a first time dislocation. Demographics, subsequent dislocation and instability details were collected from electronic patient records.

Results: In a 38-month study period there were 329 first dislocations in a population of 475,147 with mean follow-up 28.5 months (range 10-50). The overall incidence for first time dislocations in this population was 21.9 per 100,000 population, of which 7.9% underwent re-dislocation and 6.1% had further symptomatic instability. 18.8% had associated greater tuberosity fractures, 8.8% sustained a nerve injury while 2.7% were posterior dislocations. A bimodal distribution was observed for males (peak incidence per 100,000 of 42.1 and 50.9 in 15-24 and 85+ age groups respectively), and unimodal for females (peak 45.7 in the 65-74 age group).

Conclusion: We demonstrate a previously unreported burden of dislocation in older age groups, and suggest a rate of recurrence lower than previously reported in the UK. The age group at highest risk of recurrent dislocation and instability was the 15-19 year group. Gender was not a significant predictor of instability.

Level of evidence: Level II, Retrospective Design, Prognosis Study

Keywords: Epidemiology; Glenohumeral Dislocation; Instability; Urban Population; Outcome; Service Planning

Glenohumeral joint (GHJ) dislocation, frequently referred to as shoulder dislocation, is common due to limited anatomical constraints which allow large range of motion but result in vulnerability in sporting activities. The reported incidence varies greatly in the published literature, depending on populations studied, but is estimated to be between 11 and 51 per 100,000 population[1,4,10,15,16,25]. The rate is significantly higher in military and athletic groups[16,17]. The epidemiology in our country's population is derived from one urban population based study[4]. The natural history of GHJ dislocation is described in two further studies[7,18].

There is the potential for neurovascular injury, repeat dislocations, instability, arthrosis, rotator cuff and labral pathology to follow a first GHJ dislocation. The reported frequency of instability following a primary dislocation depends on age and gender with an inverse relationship between age and stability[18]. The same study concluded that a 15 year old male in their population had a 86% chance of developing instability within 2 years of the primary dislocation and it's not until beyond age 27 that a male will have a less than 50% chance of developing instability[18]. These estimates may influence the decision to undertake primary stabilization procedures as a prophylaxis against recurrent instability.

The aim of this study was to examine the current epidemiology of a first GHJ dislocation in a population of UK patients. Further to this we intended to report the incidence of recurrence with investigation predictors of recurrent dislocation and instability.

Materials and Methods

A retrospective data collection was performed on prospectively collected information at two adjacent UK based metropolitan university teaching hospitals based in Glasgow, UK. These hospitals provided orthopedic services for two emergency departments (ED) and a minor injuries unit.

Following a glenohumeral dislocation, the initial management in the ED consisted of assessment of neurological status and radiological findings, reduction under conscious sedation and immobilization in a sling, avoiding external rotation. Patients were subsequently reviewed in an orthopedic trauma or shoulder clinic and assessed for the presence of a rotator cuff tear and any neurological deficit.

Patients who have presented with a shoulder dislocation, following reduction, are referred for follow up at these two hospitals. All referrals are prospectively recorded in an administrative database and electronic patient record (Bluespier).

Research ethics committee (REC) approval was not required as there was no contact with patients, allocation or concealment of treatment and only routine outcome metrics were collected such as demographics and recurrence.

The dataset was examined over its 38 month timespan to identify patients, aged 15 and over, who presented with a glenohumeral dislocation. The exclusion criteria were previous glenohumeral dislocation or ipsilateral injury to upper limb (excluding a greater tuberosity fracture). The electronic patient record was examined to determine the presence of a greater tuberosity fracture and/or neurological deficits such as axillary nerve palsy. The notes were also examined to determine if, and when, a patient represented with a further episode of actual glenohumeral dislocation (radiologically proven) or instability. Where no further presentations occurred, the national PACS (Picture Archiving and Communication System) was checked to determine whether the patient had had a further episode of dislocation or instability elsewhere in the country. The definition of a dislocation was radiological evidence of a glenohumeral dislocation with or without a history of trauma. Patients who presented with a first time dislocation had their x-rays, clinical and physiotherapist notes further reviewed to establish a diagnosis of recurrence and ongoing instability. Recurrence was defined as a radiologically confirmed or history of second dislocation, with instability being history of instability symptoms, instability on examination or stabilization surgery performed or planned. The mean follow-up period was 28.5 months (range 10 – 50, SD 11.11).

During the 38 month period, 572 patients presented to both hospitals with suspected shoulder dislocation or instability. Of these, 240 were excluded for the following reasons: 5 were under 15 years old, 134 presented with recurrent dislocations and 104 with no evidence of a dislocation. The study group therefore consisted of 329 primary glenohumeral dislocations.

Population incidences were calculated using the mid-year population estimates for the combined catchment area of both hospitals. The total adult (15+ years) population was 475,147. This data was supplied from the Health Board Business Intelligence Department. These were divided into 5 and 10 year age ranges. The incidence was defined as the number of first-time glenohumeral dislocations occurring in a year, divided by the annual eligible population. Ninety-five percent confidence intervals were calculated using the following formula: $\sqrt{(p(1-p)/n)}$ where p=incidence (as a decimal proportion) and n=population size. This population was also estimated in the population data from Business Intelligence and defined as “cross-boundary population”. The proportion of patients in our dataset from out with the catchment area was calculated and compared with the population estimates. Geographic analysis of the origin of these patients revealed that 17% came from out with the described geographic areas, not uncommon with upper limb injuries and ‘walking wounded’. The population denominator is based upon an estimation of 14% cross boundary patients, therefore our dataset may overestimate the incidence slightly. Adjustment for the additional 3% of cross-boundary patients would change the incidence by 0.6/100,000 per year

The prevalence of recurrent dislocation and instability was calculated as a “raw” prevalence and also using survivorship methodology (Kaplan-Meier). This methodology takes account of the differing periods of follow-up, and consequential risk of achieving a particular outcome. A multivariate analysis was performed to assess whether any demographic or injury factors were independently associated with recurrent dislocation or instability. A Cox Regression method was used. All variables were entered into the model in one step. Those factors with a p value of less than 0.05 were identified as significant predictors of recurrent dislocation. The analysis was performed with SPSS (v19, SPSS Inc, Illinois)[8] and R (version 3.2.5)[22].

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Results

The incidence of a primary glenohumeral dislocation was 21.9 per 100,000 population (95% CI 17.7 to 26.1). The mean age at presentation was 51 years (range 15 to 96, SD 21.5). There were 199 males and 130 females. There was a bimodal distribution in men and a unimodal distribution in women (Figure 1). The peak incidence in women was in the 65 to 74 year age group. The incidence was greater in men than women in the 15 to 44 year old age groups, and in the very elderly (85 years+). The incidence in women exceeded men in the 55 to 74 year age group. There were (2.7%) posterior dislocations. The greater tuberosity was fractured in (18.8%) patients of which 2 had operative intervention. There was an axillary nerve injury in (8.8%). Overall, the majority of dislocations resulted from simple falls, followed by sporting injuries (Table 1).

Overall, there were 26 (7.9%) patients who suffered at least one further dislocation, with a mean time to dislocation of 10.0 months. There were five (1.5%) patients who underwent primary stabilization without a further episode of dislocation. There were a further 15 (4.6%) patients who represented with symptoms of instability alone. The overall rate of redislocation, instability and/or surgical intervention was 14% (Figure 2). In the 35 year old and under group, 17 (15.7%) redislocated, 10 (9.3%) had surgery for symptomatic instability and 6 (5.6%) had symptoms of instability but declined surgery (Table2).

The cumulative redislocation rate at one year was 4.7%, at two years was 5.9%, and at four years was 8.7% (Table 3)(Figures 3.1, 3.2). There was a significant difference between mechanism of injury for both recurrent instability and dislocation (Table 1).

Age was the only independent predictor of recurrent instability with the youngest age group (15-19 years) at greater risk than the oldest group (OR 7.4, 95% CI 2.7 to 20.7, $p<0.001$) (Table 4)(Figure 4). Similarly, age was the only independent predictor of any instability, but both the 15-19 year age group and the 20-24 group were are increased risk (Table 4). Gender was not an independent predictor for either re-dislocation or any instability (Table 4).

Discussion

The overall incidence of primary dislocations in our urban population was 21.9/100,000 per year. This is similar to other population studies; 17.0 in Denmark, 1989[11], 23.9 in North America, 2010[25], 26.2 in Norway 2011[13], 23.1 in Canada 2014[12] thus adding validity to these results. The rate of recurrent instability within the 2 year time period was 14%, with patients 35 or under having a lower instability rate than previously described (33% versus 59.5%)[18].

Glenohumeral dislocation is a common condition, however the management depends on a multitude of factors including patient expectation, chance of recurrence, activity profile, rotator cuff integrity. Often age is used as surrogate marker for these and as such many published studies have a preference for studying younger patients. The data we have collected indicates that the experience within our urban population is lower than previously estimated in our country. Furthermore whilst primary dislocation is a significant burden for the young, there is a second peak of incidence in the elderly which is not well addressed in the literature. The management of dislocation in this elderly group has not been born out well in the literature, and management in our unit depends on perceived degree of cuff degeneration, with further evaluation with MRI arthrogram or use of anterior deltoid exercises in those with presumed pre-existing cuff insufficiency, however the evidence for this is somewhat limited.

Other studies have shown higher incidences of dislocation, but have been in American collegiate athletes (all instability events, 0.12 per 1000 athlete exposures[16]), Iranian wrestlers (dislocations, 4 from 495 per year or 0.03 per 100,000 exposures)[10] and

American military (2.8% over a 9 month period, extrapolated to 3733/100,000 per year)[17].

In 2013, Hindle et al[4] investigated all appendicular joint dislocations in their population over a one year period, using a methodology very similar to this study, i.e. interrogating a prospectively collected database and comparing to population data within the captive populations of those three hospitals. The epidemiology of glenohumeral dislocation was the most common of all joints (n=317, 32.5%), however the incidence of 51.2 per 100,000/year is over double our experience. It is very unlikely that such a striking difference in incidence is due to minute methodological differences or sampling error and this may be due to true differences in population characteristics between the 2 areas. One hypothesis that may explain the higher incidence in the study by Hindle et al[4] is a relatively low proportion of elderly and high frequency of sporting injuries in their population.

Robinson et al prospectively followed a cohort of 252 adults (15-35 years) who sustained an anterior dislocation of the shoulder for 5 years[18]. They found that 66.8% of these patients suffered instability, of which 53.2% was due to repeat dislocations. Subgroup analysis of this age group within our cohort revealed an instability rate of 33.0% of which the overall redislocation rate was 17.0% and symptomatic instability was 16.0%. The follow up of our series is shorter (28 months), however as noted in Robinson’s paper, 86% of all dislocations occurred within this period.

The methodology of Robinson’s study is robust however perhaps the nature of proactively looking for signs or symptoms of instability patients gives a incidence of problems in patients who would otherwise never present to healthcare services with 'asymptomatic' instability. There were, however, over 7 re-dislocations for every subluxation indicated that subluxation without ongoing dislocation being a rarer entity. As such our study investigated primarily re-dislocations and those with symptomatic instability, we found the rate of ongoing morbidity much lower than Robinson et al. This would indicate that patients may not be at as high a risk as previously thought, (such as the 86% chance of a 15 year old male developing instability after a first time dislocation) however repeated instability, even asymptomatic ones may be associated with arthropathy in the long term[7,19,20].

The rate of instability following first time dislocation in Robinson's paper is higher than other studies which may in part be due to the prospective nature of the study and there are no comparable series available in the literature, with dislocation being 89% of all presentations of repeat instability. It is not possible with our methodology to quantify the role of patients undergoing stabilization or being assessed for recurrent instability in the non-NHS sector. Athletic patients who sought treatment in the private sector after their first dislocation would not be detected in this dataset. Several randomized trials published indicating rates of non-operative between 18.2% and 39.2%[2,3,9,13,21,24] with no difference between position and an overall rate 29.1% on meta-analysis of 632 participants[23] . The patients in these studies were followed up for a minimum of 2 years and had a mean age of 30.1 years with an overall rate of recurrent dislocation in similar to the 31% instability rate of our patient group at mean 28 months.

This study provides evidence that the incidence of shoulder dislocation in the UK may not be as high as previously thought, and this may be due to differences in the population, activities and comorbidity in different populations. The burden of dislocation within the elderly has been under-recognized, particularly in females 45 and over, thus resources should be directed to investigate potential sequelae within these patients, such as arthrosis and rotator cuff tears. Finally, the rate of instability and re-dislocation is lower than noted previously primary stabilization may not be warranted following a first dislocation in the general population.

The main strength of this study is the inclusive nature of follow up, being able to pick up patients representing throughout the country. A limitation of this study, and indeed any epidemiological study is the applicability to a nationwide population. Whilst it is impractical to gain a true incidence of shoulder instability following dislocation throughout our entire population, we believe this study represents a typical city population given its similarity to estimates in other cities globally[1,2,14,18,19], contrasting to previous estimates in the UK[5,9]. The mean follow-up of 28 months with 62.3% having passed the 2 year follow up beyond which previous studies indicate the incidence of re-dislocation plateaus[7,18](Figure 3.1). The use of the Kaplan-Meier method accounts for variation in follow-up (Figures 3-4).

The primary measure of this study was 'all cause' symptomatic instability, comprised of dislocation and reported instability. X-ray proven dislocation is relatively straight forward to measure if the investigators have access to a captive dataset. However patients who have recurrent instability frequently reduce the joint without presenting to healthcare services, therefore any study evaluating the prognosis or ongoing instability will be limited[5,6]. Robinson et al prospectively followed up a large group of first time dislocations and found, however the methodology may reduce the threshold for which a patient is prepared to volunteer a problem which would be considered subclinical. An observational study of actual healthcare seeking behavior after a first dislocation may provide a more pragmatic estimation of the real burden of disease and healthcare utilization.

Whilst our digital notes and national x-ray archive is useful for observing patients presenting to NHS services, we are unable to get information from those patients presenting to other countries nor the private sector for review of instability symptoms or stabilization. However patients presenting with dislocation will present to NHS emergency services, and indeed those having any follow up in the outpatient sector will have archived imaging. Thus only those who have subjective instability after their index dislocation would present only to the private sector and be lost to follow up in this study. A final limitation of this study to note is the duration of follow-up of 28 months.

Conclusion

The overall rate of dislocation in our country varies between regions with our experience of an urban population being lower than previously thought. There is a second peak of incidence in the elderly, the consequences of which have not been thoroughly investigated in published literature. The disease burden of recurrent instability is borne predominantly by young patients, with sporting activities being the primary mechanism. The risk of ongoing instability decreases with age however we did not find gender to influence this risk. Whilst the overall rate of instability following dislocation is lower than other studies within the UK, it is similar to other studies internationally validating the results of this study.

References

1. Cofield WTSRH. Prognosis in anterior shoulder dislocation. Am J Sports Med. American Orthopaedic Society for Sports Medicine; 1984 Jan 1;12(1):19–24.

2. Finestone A, Milgrom C, Radeva-Petrova DR, Rath E, Barchilon V, Beyth S, et al. Bracing in external rotation for traumatic anterior dislocation of the shoulder. J Bone Joint Surg Br. 2009 Jul;91(7):918-21. doi: 10.1302/0301-620X.91B7.22263.

3. Heidari K, Asadollahi S, Vafaee R, Barfehei A, Kamalifar H, Chaboksavar ZA, et al. Immobilization in external rotation combined with abduction reduces the risk of recurrence after primary anterior shoulder dislocation. J Shoulder Elbow Surg 2014 Jun;23(6):759–66. doi: 10.1016/j.jse.2014.01.018

4. Hindle P, Davidson EK, Biant LC, Court-Brown CM. Appendicular joint dislocations. Injury. Elsevier Ltd; 2013 Aug 1;44(8):1022–7. doi: 10.1016/j.injury.2013.01.043.

5. Hovelius L. Incidence of Shoulder Dislocation in Sweden. Clinical Orthopaedics and Related Research. 1982 Jun 1;166:127.

6. Hovelius L, Nilsson J-Å, Nordqvist A. Increased mortality after anterior shoulder dislocation: 255 patients aged 12–40 years followed for 25 years. Acta Orthop. 2009 Jul 8;78(6):822–6. doi: 10.1080/17453670710014617.

7. Hovelius L, Rahme H. Primary anterior dislocation of the shoulder: long-term prognosis at the age of 40 years or younger. Knee Surg Sports Traumatol Arthrosc. 2016 Feb;24(2):330–42. doi: 10.1007/s00167-015-3980-2.

8. IBM SPSS Statistics for Macintosh. SPSS Statistics. 20 ed. Armonk, NY, USA: IBM Corp.

9. Itoi E, Hatakeyama Y, Sato T, Kido T, Minagawa H, Yamamoto N, et al. Immobilization in external rotation after shoulder dislocation reduces the risk of

recurrence. A randomized controlled trial. J Bone Joint Surg Am. J Bone Joint Surg Am 2007;89:2124-31. DOI:10.2106/JBJS.F.00654

10. Kordi R, Heidarpour B, Shafiei M, Rostami M, Mansournia MA. Incidence, Nature, and Causes of Fractures and Dislocations in Olympic Styles of Wrestling in Iran A 1-Year Prospective Study. Sports Health 2012;4:217–21. DOI:10.1177/1941738111424693

11. Krøner K, Lind T, Jensen J. The epidemiology of shoulder dislocations. Archives of Orthopaedic and Trauma Surgery. Springer-Verlag; 1989;108(5):288–90.

12. Leroux T, Wasserstein D, Veillette C, Khoshbin A, Henry P, Chahal J, et al. Epidemiology of primary anterior shoulder dislocation requiring closed reduction in Ontario, Canada. Am J Sports Med. 2014 Feb;42(2):442–50. doi: 10.1177/0363546513510391.

13. Liavaag S, Brox JI, Pripp AH, Enger M, Soldal LA, Svenningsen S. Immobilization in external rotation after primary shoulder dislocation did not reduce the risk of recurrence: a randomized controlled trial. J Bone & Joint Surgery 2011;93(10):897-904. doi: 10.2106/JBJS.J.00416.

14. Liavaag S, Svenningsen S, Reikerås O, Enger M, Fjalestad T, Pripp AH, et al. The epidemiology of shoulder dislocations in Oslo. Scand J Med Sci Sports. 2011 Dec;21(6):e334-40. doi: 10.1111/j.1600-0838.2011.01300.x.

15. Nordqvist A, Petersson CJ. Incidence and causes of shoulder girdle injuries in an urban population. J Shoulder Elbow Surg. 1995 Mar;4(2):107–12.

16. Owens BD, Agel J, Mountcastle SB, Cameron KL, Nelson BJ. Incidence of Glenohumeral Instability in Collegiate Athletics. Am J Sports Med. 2009 Sep 1;37(9):1750–4. doi: 10.1177/0363546509334591

17. Owens MBD, Duffey ML, Nelson LBJ, DeBerardino LTM, Taylor CRDC, Mountcastle SB. The Incidence and Characteristics of Shoulder Instability at the United

States Military Academy. Am J Sports Med. 2007;35(7):1168–73. DOI: 10.1177/0363546506295179

18. Robinson CM, Howes J, Murdoch H, Will E, Graham C. Functional outcome and risk of recurrent instability after primary traumatic anterior shoulder dislocation in young patients. J Bone Joint Surg Am. The Journal of Bone and Joint Surgery 2006 Nov;88(11):2326–36. DOI:10.2106/JBJS.E.01327

19. Rowe CR, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. J Bone Joint Surg Am. 1978 Jan;60(1):1–16.

20. Samilson RL, Prieto V. Dislocation arthropathy of the shoulder. J Bone Joint Surg Am. 1983 Apr;65(4):456–60.

21. Taşkoparan H, Kılınçoğlu V, Tunay S, Bilgiç S, Yurttaş Y, Kömürcü M. Immobilization of the shoulder in external rotation for prevention of recurrence in acute anterior dislocation. Acta Orthop Traumatol Turc. 2010;44(4):278–84. doi: 10.3944/AOTT.2010.2274

22. R Team: A Language and Environment for Statistical Computing. 3rd ed. Vienna, Austria: R Foundation for Statistical Computing. Available from: http://www.R-project.org/

23. Whelan DB, Kletke SN, Schemitsch G, Chahal J. Immobilization in External Rotation Versus Internal Rotation After Primary Anterior Shoulder Dislocation: A Meta-analysis of Randomized Controlled Trials. Am J Sports Med. 2016 Feb;44(2):521–32. doi: 10.1177/0363546515585119.

24. Whelan DB, Litchfield R, Wambolt E, Dainty KN, JOINTS (Joint Orthopaedic initiative for National Trials of the Shoulder. External Rotation Immobilization for Primary Shoulder Dislocation: A Randomized Controlled Trial. Clinical

Orthopaedics and Related Research. 2014;472(8):2380–6. doi: 10.1007/s11999-013-3432-6.

25. Zacchilli MA, Owens BD. Epidemiology of Shoulder Dislocations Presenting to Emergency Departments in the United States. J Bone Joint Surg Am. 2010;92(3):542–9. doi: 10.2106/JBJS.I.00450.

Figure and Table Legends:

Figure 1. Distribution of Dislocation by Gender and Age.

Figure 2. Proportion of dislocation and additional symptomatic instability per age group.

Figure 3.1. Cumulative Dislocation with time (Kaplan-Meier method).

Figure 3.2. Cumulative 'all cause' instability (dislocation and non-dislocating symptomatic instability) with time (Kaplan-Meier method)

Figure 4. Recurrent 'all cause' instability (dislocation and non-dislocating symptomatic instability) per age group (Kaplan-Meier method)

Table 1. Age and outcome, by mechanism of injury.

Table 2. Proportion of patients who redislocated or developed symptomatic instability per age group.

Table 3. Cumulative redislocation and all instability rates (Kaplan-Meier method)

Table 4. Predictors of recurrent dislocation and all instability (Cox Regression models)

Figure (No.1)

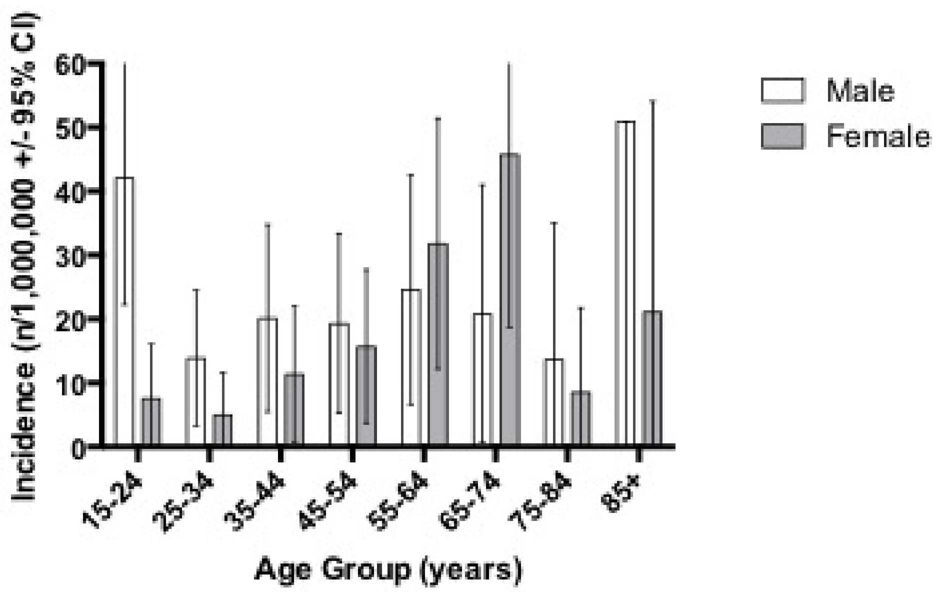

Figure 1. Distribution of Dislocation by Gender and Age.

Figure (No.2)

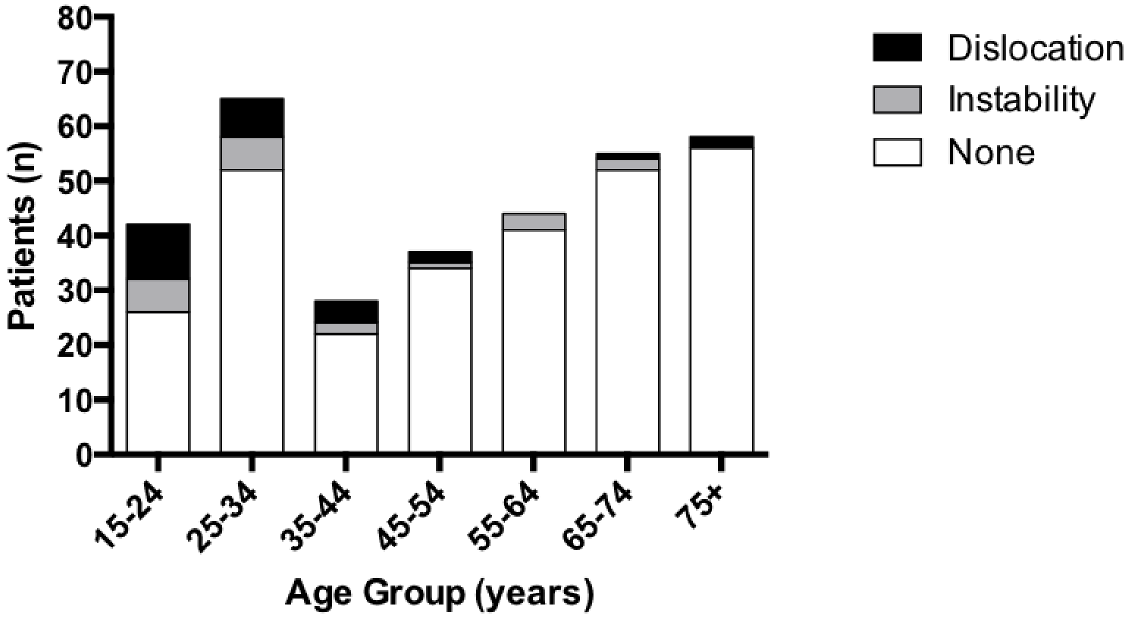

Figure 2: Proportion of dislocation and additional symptomatic instability per age group

Figure (No.3.1)

Figure 3.1: Cumulative dislocation with time (Kaplan-Meier method)

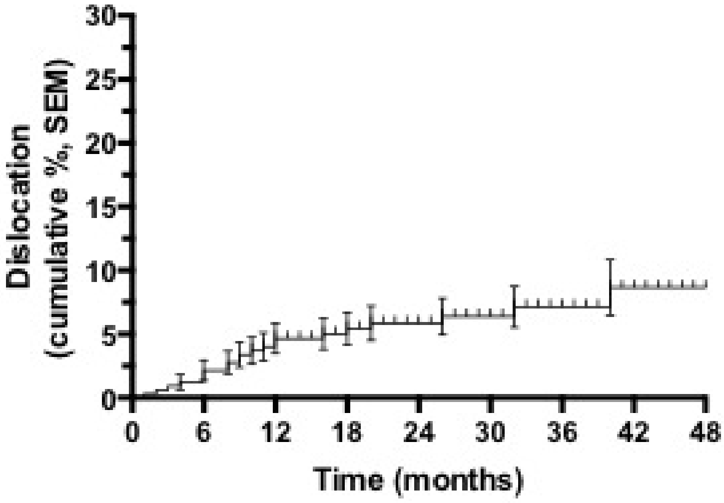

Figure (No.3.2)

Figure 3.2: Cumulative 'all cause' instability (dislocation and non-dislocating symptomatic instability) with time (Kaplan-Meier method)

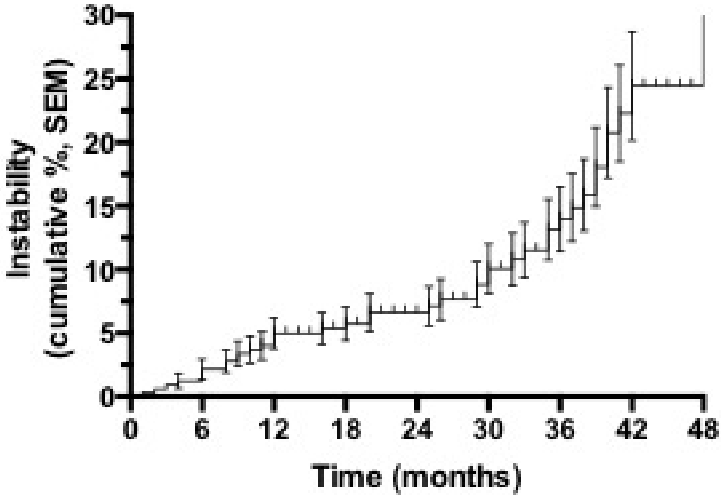

Figure (No.4)

<u>Figure 4: Recurrent 'all cause' instability (dislocation and non-dislocating symptomatic instability) per age group (Kaplan-Meier method)</u>

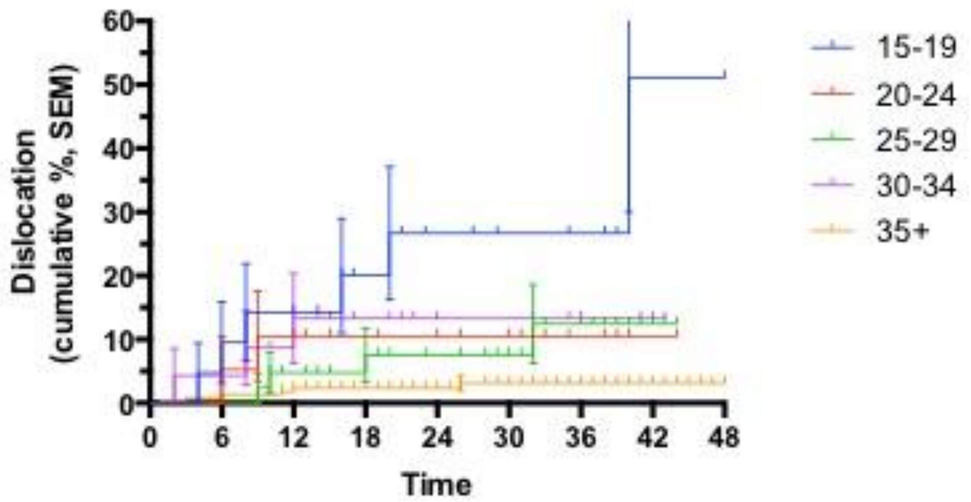

Table 1: Age and outcome, by mechanism of injury (* ANOVA, § Chi-square)

Mechanism	**Age (mean, SD)**	**Redislocation (n,%)**	**Any Instability (n, %)**
Fall<2m (n=214)	60.6, 17.9	7, 3.3	16, 17.4
Sport (n=60)	28.5, 12.3	7, 11.5	13, 21.3
Direct trauma (n=26)	33.2, 15.5	5, 19.2	8, 30.8
Fall from height (n=11)	49.4, 22.0	1, 9.1	2, 18.2
Seizure (n=10)	41.4, 13.8	4, 40.0	4, 40.0
RTC (n=6)	34.5, 16.5	2, 33.3	3, 50.0
Other (n=2)	45.5, 29.0	0, 0	0, 0
P Value	<0.0001*	<0.0001§	<0.0001§

Table 2: Proportion of patients who redislocated or developed symptomatic instability per age group

Age range	Redislocation (n, %)	Other Instability (n, %)	Total instability (n, %)
15-19 (n=22)	7 (31.8%)	4 (18.2%)	11 (50%)
20-24 (n=20)	3 (15%)	3 (15%)	6 (30%)
25-29 (n=20)	4 (9.5%)	7 (16.7%)	11 (26.2%)
30-35 (n=24)	3 (12.5%)	2 (8.3%)	5 (20.8%)
>35 (n=221)	9 (4.1%)	4 (1.8%)	13 (5.9%)

Table 3: Cumulative redislocation and all instability rates (Kaplan-Meier method).

Age Range (years)	15-19	20-24	25-29	30-34	35+
Dislocation					
6 Months	9.5%	5.3%	0%	4.3%	1.4%
1 Year	14.3%	10.5%	4.8%	13.3%	2.3%
18 Months	20.0%	10.5%	7.6%	13.3%	2.3%
2 Years	26.7%	10.5%	7.6%	13.3%	2.3%
3 Years	26.7%	10.5%	12.4%	13.3%	3.1%
4 Years	51.1%	10.5%	12.4%	13.3%	3.1%
Any Instability					
6 Months	9.5%	5.3%	0%	4.3%	1.4%
1 Year	14.3%	10.5%	4.8%	17.8%	2.3%
18 Months	20.0%	10.5%	7.6%	17.8%	2.3%
2 Years	26.7%	10.5%	10.5%	17.8%	2.3%
3 Years	38.9%	34.9%	22.2%	17.8%	7.1%
4 Years	84.7%	67.5%	43.0%	17.8%	12.4%

Table 4: Predictors of recurrent dislocation and all instability (Cox Regression models)

	Dislocation		Any Instability	
Variable	**Odds Ratio**	**P Value**	**Odds Ratio**	**P Value**
Age				
15-19	7.4 (2.7 to 20.7)	<0.001	5.7 (2.5 to 12.8)	<0.001
20-24	3.7 (0.8 to 12.7)	0.074	4.2 (1.6 to 10.9)	0.003
25-29	1.9 (0.6 to 6.3)	0.319	2.3 (0.98 to 5.2)	0.056
30-34	3.1 (0.8 to 11.6)	0.098	2.6 (0.87 to 8.0)	0.088
35+	1.0		1.0	
Gender				
Male	1.8 (0.7 to 5.2)	0.245	1.6 (0.8 to 3.4)	0.179
Female	1.0		1.0	