


Early complications of acromioclavicular joint reconstruction requiring reoperation

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Received: 23 January 2016 / Accepted: 8 June 2016 / Published online: 16 June 2016
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Abstract

Purpose Prior studies have reported high complication rates with acromioclavicular joint reconstruction (ACJR). However, many of these reports have suffered from small sample sizes and inclusion of older surgical techniques. The purpose of this study was to determine the rates of early complications requiring reoperation in patients treated with ACJR.

Methods From 2007 to 2011, patients who were treated with ACJR were identified using the PearlDiver database, a large insurance database in the USA. The following reoperations were then queried from this patient cohort: irrigation and debridement within 30 days of index surgery, manipulation under anaesthesia (MUA) of the shoulder joint within 3 months of index surgery, and revision ACJR, distal

clavicle excision, and removal of hardware within 6 months of index surgery.

Results In total, 2106 patients treated with ACJR were identified. The reoperation rates for irrigation and debridement, MUA, revision ACJR, distal clavicle excision, and removal of hardware were 2.6, 1.3, 4.2, 2.8, and 6.2 %, respectively. Patients ≥ 35 years of age and females more likely to undergo a reoperation after ACJR. Specifically, patients ≥ 35 years of age were more likely to undergo MUA and revision ACJR, while patients ≥ 50 years of age were more likely to undergo an irrigation and debridement. Females were more likely than males to undergo revision ACJR and distal clavicle excision.

Conclusions Older patients and females were more likely to experience postoperative complications requiring reoperations, including revision ACJR, distal clavicle excision, and irrigation and debridement. By analysing a large cohort of patients across multiple centres and providers, this study provides valuable insight into the recent complication profiles of ACJR, allowing surgeons to appropriately counsel patients on the risks of these procedures.

Level of evidence IV.

Keywords Acromioclavicular · Reconstruction · Shoulder · Complications · Reoperation

Abbreviations

ACJR Acromioclavicular joint reconstruction
CPT Current procedural terminology
MUA Manipulation under anaesthesia

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Introduction

Acromioclavicular joint (ACJ) injuries represent 12 % of all patients presenting with shoulder girdle dysfunction and 40–50 % of all athletic shoulder injuries [1]. The majority of these injuries can be treated conservatively, but there is continued debate regarding the optimal treatment for type III dislocations. Much of this controversy can be attributed to historical reports of high postoperative complication rates after ACJ reconstruction (ACJR) without improvement in functional outcomes. However, many of the highest complication rates are reported in older studies on patients treated with Kirschner wire or screw fixation, and a multitude of newer surgical techniques, including those using synthetic grafts, suture buttons, suture anchors, and allograft tendon or a combination thereof, have been developed and popularized in the last decade [2–9]. Despite numerous case series evaluating such techniques, most have suffered from small sample sizes, making it difficult to evaluate the true rate of complication and reoperation using these methods. The purpose of this study was to determine the rates of early complications requiring reoperation in patients treated with ACJR.

Materials and methods

Patients treated with ACJR were retrospectively identified within the PearlDiver Patient Record Database (PearlDiver Technologies, Warsaw, IN, USA) using current procedural terminology (CPT) codes. To our knowledge, this database is the largest private-payer database in the USA, with UnitedHealth Group comprising the largest number of patient records. From 2007 to 2011, the database captured 24.6–26.3 million patients, representing approximately 9 % of the US population younger than 65 years of age and approximately 13 % of the US population with private insurance, according to data from the US Census Bureau.

To ensure appropriate study inclusion, pre-determined CPT codes were used to identify patients who experienced a postoperative complication after ACJR during the aforementioned study period. In our experience, the use of International Classification of Disease, Ninth Revision (ICD-9) codes to query postoperative complications in the PearlDiver database results in low incidence rates, likely due to under-reporting by physicians or lack of documentation [10, 11]. Thus, only CPT codes were used. Between 2007 and 2011, 2106 patients treated with ACJR (CPT 23550, 23552) were identified. Patients <35 years of age comprised 44.2 % of the cohort. Males accounted for 84.1 % of all patients. Those treated with an irrigation and debridement for postoperative infection or haematoma were

elicited within 30 days of the index surgery. Patients treated with manipulation under anaesthesia (MUA) of the shoulder joint were elicited within 3 months of the index surgery. Patients treated with revision ACJR and distal clavicle excision for failed primary reconstruction and patients treated with removal of hardware were elicited within 6 months of the index surgery. These patient groups were then further stratified by age and sex. IRB approval was not needed for this study because the PearlDiver is a publically available database.

Statistical analysis

Fisher's exact test or Chi-square test was used to examine the association between categorical variables with small and large sample sizes, respectively. All statistics were performed using GraphPad Prism version 5.0 (San Diego, CA, USA). Significance was set at the $p < 0.050$ level.

Results

Postoperative rates of reoperation after ACJR are listed in Table 1. The overall rate of postoperative complications requiring reoperation (excluding removal of hardware) was 10.9 %. Postoperative rates of reoperation by age and sex are listed in Table 2. Patients ≥ 35 years of age experienced a higher overall rate of postoperative complications requiring reoperation (excluding removal of hardware) than those <35 years of age (13.6 vs. 7.8 %; $p < 0.001$). When patients were further stratified by age to <29 and ≥ 50 years of age, patients ≥ 50 years of age were more likely than those <29 years of age to sustain a postoperative infection requiring irrigation and debridement (3.5 vs. 1.5 %; $p = 0.026$).

Females experienced a higher overall rate of postoperative complication requiring operation (excluding removal of hardware) than males (16.7 vs. 9.8 %; $p < 0.001$). Females were more likely than males to undergo revision ACJR and distal clavicle excision. Thus, females were more likely

Table 1 Rates of reoperation after ACJR

Reoperation	Rate (%)
Irrigation and debridement	2.6
Manipulation under anaesthesia, shoulder joint	1.3
Revision ACJR	4.2
Distal clavicle excision	2.8
Removal of hardware	6.2

ACJR acromioclavicular joint reconstruction

Table 2 Rates of reoperation after ACJR according to age and sex

Reoperation	<35 years old (%)	≥35 years old (%)	<i>p</i> value	Males (%)	Females (%)	<i>p</i> value
Irrigation and debridement	1.9	3.2	n.s.	2.4	3.6	n.s.
Manipulation under anaesthesia, shoulder joint	0.5	1.9	0.014	1.2	1.8	n.s.
Revision ACJR	3.1	5.2	0.019	3.7	6.9	0.009
Distal clavicle excision	2.2	3.3	n.s.	2.5	4.5	0.043
Removal of hardware	7.0	5.7	n.s.	6.2	6.9	n.s.

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than males to undergo revision surgery for failed primary reconstruction (11.3 vs. 6.2 %; $p < 0.001$).

When accounting for both age and sex, there were no significant differences in the rates of reoperation between males and females <35 years of age. However, females ≥35 years of age were more likely to undergo revision ACJR (8.4 vs. 4.5 %; $p = 0.029$) and distal clavicle excision (6.2 vs. 2.6 %; $p = 0.011$) compared to males ≥35 years of age. Thus, females ≥35 years of age were twice as likely to undergo revision surgery for failed primary reconstruction than males ≥35 years of age (14.7 vs. 7.1 %; $p < 0.001$).

Discussion

This study examined 2106 ACJR using a large national database from a recent 4-year time period, with removal of hardware (6.2 %), revision ACJR (4.2 %) and distal clavicle excision (2.8 %), being the most common reoperations. Patients ≥35 years of age and females were more likely to undergo a reoperation after primary ACJR compared to patients <35 years of age and males, respectively. Optimal surgical treatment of ACJ injuries remains controversial as evidenced by the myriad of described techniques. Over the past half century, there has been a shift in treatment methodology from primarily operative to nonoperative for type III injuries [12]. Much of this stems from studies reporting relatively high complication rates after ACJR and outcomes similar to that of nonsurgical treatment [13, 14]. However, many of the highest complication rates are reported in older studies describing wire or screw fixation, and newer surgical techniques, including those using synthetic grafts, suture anchors, and allograft tendon, have been developed and popularized in the last decade. Current studies of newer surgical techniques suffer from small sample sizes, making it difficult to ascertain the true rate of reoperation with these methods.

Postoperative infection rates range from 0 to 13 %, although the majority of studies do not distinguish infections that were treated with operative washout [3, 6, 15–27]. In the largest series to date, Kienast et al. [20] reported

a 0.9 % rate of deep infection requiring surgical debridement in 225 patients treated with hook plate fixation. Other smaller series of patients treated with hook plate fixation report a 7.4–13 % rate of postoperative infection requiring surgical debridement [17, 24]. Our rate of 2.6 % is comparable to that found in the shoulder arthroplasty literature, where a recent large database study reported a deep postoperative infection rate of 2.0 % [28]. Although postoperative adhesive capsulitis is commonly recognized after ACJR [29], there are very few reports in the literature describing its treatment with MUA, which is consistent with the low incidence found in our study [30]. The mechanism of failure and loss of reduction after ACJR is varied and unique to the implant and fixation method used during the index surgery [14]. Loss of reduction has been reported as the most common complication following ACJR, although not all patients develop symptoms [2, 3, 9, 15, 17–27, 31–33]. Consistent with the results in our study (7.0 %), reported rates of revision ACJR and distal clavicle excision for failed primary reconstruction range from 6 to 26 % for various techniques, despite the lack of strong evidence and consistent outcomes associated with revision surgery [5, 23, 29, 34, 35]. Finally, hook plate fixation, which typically is a two-stage procedure involving removal of the implant 3–6 months after the index surgery, was likely used in a proportion of patients being treated in this study, which had a high rate of hardware removal (6.2 %). However, because the database does not provide information on the surgical technique that was used, this cannot be confirmed.

To our knowledge, this is one of the first single studies to examine the age and sex of patients sustaining postoperative complications after ACJR. A similar analysis in other studies would likely prove difficult due to their smaller sample sizes. As expected, reoperation rates for postoperative infection, adhesive capsulitis, and failure of reconstruction were lower in younger patients compared to older patients, which is consistent with that seen in other shoulder surgeries [36–38]. Schliemann et al. [7] reported superior functional outcomes in younger patients who underwent coracoclavicular ligament reconstruction using a flip button repair technique but did not report whether age had a significant impact on complications or surgical

revision. Interestingly, females were more likely than males to require revision ACJR and distal clavicle excision after primary ACJR. This phenomenon may be attributed to decreased bone mineral density and the effects of female predominant hormones on generalized ligamentous laxity, potentially contributing to loss of reduction [39, 40]. Further studies are needed to establish the reasons for this discrepancy between males and females.

There are several limitations to this study. First, data on patient medical comorbidities, injury classification or severity, laterality of injury, arm dominance, preoperative status of the shoulder, time from injury to surgery, surgical technique, and postoperative protocol were not available through the database. The lack of data on surgical technique is particularly limiting given the myriad of methods available, each with their own specific complication profile. Although the lack of laterality information can introduce false positives from operations on the contralateral side, this risk was lessened by searching for complications only in the early postoperative period. Second, as with any insurance records database, the results may be subject to errors in coding. Third, the database does not include equal representation across the US population, as the southern region is over-represented in the PearlDiver Database due to increased penetrance of the UnitedHealth group in southern states relative to other regions of the country, where competitors such as BlueCross, Aetna, and Kaiser Permanente own larger market shares. Fourth, the database does not include Medicare, Medicaid, workers' compensation or uninsured populations, and current data suggest clear differences in clinical outcomes following surgical intervention in these patients relative to the general population [41, 42]. Nevertheless, despite these limitations, the principal advantage of a study design using a large national database is that it facilitates analysis of widespread trends across multiple centres and providers, thereby providing an overview of current complication profiles. Furthermore, by analysing a large cohort of patients, this study affords a population size and level of statistical power that is not easily achieved through standard review of patient records. Understanding of the potential complications associated with current surgical techniques allows surgeons to appropriately counsel patients on the risks of ACJR.

Conclusions

The rates of reoperation from an analysis of 2106 ACJR were consistent with ranges reported in the literature. Older patients and females were more likely to experience postoperative complications requiring reoperations, including revision ACJR, distal clavicle excision, and irrigation and debridement. Further studies are needed to establish the

reasons for the discrepancy in complication rates between males and females. By analysing a large cohort of patients across multiple centres and providers, this study provides valuable insight into the recent complication profiles of ACJR, allowing surgeons to appropriately counsel patients on the risks of these procedures.

Author contributions All authors were involved in writing the manuscript as well as the conception and design of the study. Additionally, BRB, JRC, CRI, and JCW contributed to data collection, DW and BEB contributed to analysis and interpretation, and DW and FAP contributed to critical revision of the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest DW, BEB, JRC, CRI, FAP declare that they have no competing interests. JCW holds stock options from PearlDiver Technologies Inc.

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