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Surgical management of midshaft clavicle nonunions is associated with a higher rate of short-term complications compared with acute fractures

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Background: Little is known about the perioperative complication rates of the surgical management of midshaft clavicle nonunions. The purpose of the current study was to report on the perioperative complication rates after surgical management of nonunions and to compare them with complication rates of acute fractures using a population cohort.

Methods: The American College of Surgeons National Surgical Quality Improvement Program database was queried to identify patients who had undergone open reduction–internal fixation of midshaft clavicle fractures between 2007 and 2013. Patients were stratified by operative indication: acute fracture or nonunion. Patient characteristics and 30-day complication rates were compared between the 2 groups using univariate and multivariate analyses.

Results: A total of 1215 patients were included in our analysis. Of these, 1006 (82.8%) were acute midshaft clavicle fractures and 209 (17.2%) were midshaft nonunions. Patients undergoing surgical fixation for nonunion had a higher rate of total complications compared with the acute fracture group (5.26% vs. 2.28%; $P = .034$). On multivariate analysis, patients with a nonunion were at a >2-fold increased risk of any postsurgical complication (odds ratio, 2.29 [95% confidence interval, 1.05-5.00]; $P = .037$) and >3-fold increased risk of a wound complication (odds ratio, 3.22 [95% confidence interval, 1.02-10.20]; $P = .046$) compared with acute fractures.

Conclusion: On the basis of these findings, patients undergoing surgical fixation for a midshaft clavicle nonunion are at an increased risk of short-term complications compared with acute fractures. This study provides additional information to consider in making management decisions for these common injuries.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Clavicle; nonunion; database; complication rate; NSQIP; retrospective

This study is exempt from Institutional Review Board approval.

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Clavicle fractures are among the most common skeletal injuries, accounting for up to 10% of all adult fractures.[15,16] Previously, clavicle nonunion was thought to be a rare occurrence; however, recent studies have demonstrated a nonunion rate between 4.5% and 15%.[2,5,12] Nonoperative management of displaced midshaft clavicle fractures may also result in residual loss of shoulder strength and range of motion, cosmetic deformity, and late return of function.[1,11,14] Operative fixation has been shown to result in better functional outcomes and lower rates of nonunion compared with nonoperative management.[1,2,21] This understanding has led to an increase in popularity of open reduction–internal fixation (ORIF) for acute fractures with an emphasis on identifying patients who are at increased risk of nonunion.[13]

ORIF for acute midshaft clavicular fractures consists of either plate fixation or intramedullary nailing.[6] Operative fixation for nonunions uses these same basic techniques in uncomplicated cases without shortening.[9] Biomechanical studies have suggested that a 10% reduction in clavicle length results in altered scapular kinematics.[10] To prevent this, bone grafting is used to restore natural anatomy in nonunion cases with shortening.[9]

Perioperative complications that follow primary fixation of clavicle fractures are considered rare, and incidences have been described.[4,7,8] However, little is known about the perioperative complications associated with the surgical management of clavicle nonunions, with the majority of literature existing as small case series or case reports.[3,9,18,20] The purpose of the current study was to investigate the complication rates for operative management of midshaft clavicle nonunions using a large population cohort.

Methods

Data collection and patient selection

We queried the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database using *Current Procedural Terminology* codes 23515 (open treatment of clavicular fracture, with or without internal or external fixation), 23480 (osteotomy, clavicle, with or without internal fixation), and 23485 (osteotomy, clavicle, with or without internal fixation; with bone graft) to retrospectively identify patients undergoing ORIF of the clavicle between 2007 and 2013. Patients were excluded if they had an open fracture or a fracture of the acromial or sternal end of the clavicle or if the operative indication was for any reason other than nonunion or acute clavicle fracture. Patients were divided into 2 groups: those undergoing ORIF for an acute midshaft clavicle fracture and those undergoing ORIF for a midshaft clavicle nonunion. Patient demographics, preoperative comorbidities, preoperative laboratory values, and operative variables were stratified on the basis of operative indication.

Outcomes

The 30-day complication rates for all variables specifically collected in the NSQIP database were calculated for patients after clavicle ORIF for nonunion and acute midshaft fracture. The category "deep wound infection" was a composite of deep incisional surgical site infection (SSI) and organ/space SSI and included any patient who required a subsequent operation to manage a postoperative infection. The category "wound complication" was a composite of deep wound infection, superficial incisional SSI, and wound dehiscence. The category "subclavian vessel injury" was generated by identifying patients who required another surgical service to repair damaged vessels intraoperatively. The category "pneumothorax" was generated by identifying patients with the postoperative diagnosis of pneumothorax and any patients requiring chest tube placement for a pneumothorax. The composite category "total complications" included any 30-day complication specifically recorded in the NSQIP database, subclavian vessel injury, and postoperative pneumothorax. A single patient could have potentially experienced more than 1 complication but was counted only once for the composite calculations.

Statistical analysis

Patient demographics, preoperative comorbidities, preoperative laboratory values, and operative variables were compared between the nonunion and acute clavicle fracture groups using a Student *t*-test for continuous variables and Fisher exact test for categorical variables. Unadjusted individual and total complication rates were calculated for each group. A multivariate logistic regression analysis was performed to control for confounding variables. All variables recorded for >80% of patients and found to have a P value < .2 on univariate analysis were included in the final model. Multivariate logistic regression analysis was used to calculate an odds ratio (OR) and 95% confidence interval (CI) for total complications, wound complications, and 30-day reoperation rates according to operative indication.

Stata (version 13.0; StataCorp, College Station, TX, USA) was used for all statistical analysis. Continuous variables were tested for normality using the Shapiro-Wilk test. Standard techniques were used including Student *t*-test or nonparametric equivalent for continuous variables and Fisher exact test for categorical variables. P value < .05 was used to determine significance on multivariate and univariate analysis.

Results

A total of 1439 patients undergoing operative fixation for a closed midshaft clavicle fracture were initially identified for inclusion in our study. After exclusion criteria were applied, 1215 patients remained for further analysis (Table I). Of

Table I Exclusion criteria

	Cohort size	No. excluded
Pre-exclusion	1439	
Open fractures		17
Acromial or sternal end fractures		118
Surgical indication other than acute fracture or nonunion		89
Final cohort	1215	