

# Comparison of Complication Rates of Intramedullary Pin Fixation Versus Plating of Midshaft Clavicle Fractures in an Active Duty Military Population

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*Military service members have increased requirements of shoulder weight bearing to perform duties. Operative intervention has increased for treatment of displaced middle one-third clavicle fractures. Complications of operatively treated clavicle fixation have not been extensively studied. A retrospective, longitudinal cohort chart evaluation was conducted of all active duty members undergoing fixation of middle one-third clavicle fractures, for complications between intramedullary pin fixation and plate constructs. This review found 62 patients meeting inclusion criteria. Thirty-three patients underwent intramedullary pin fixation with Hagie pins and 31 patients underwent precontoured superior clavicle plate fixation of their middle one-third clavicle fractures. Complications included wound infection, skin and/or soft tissue irritation, and need for unplanned hardware removal. The overall complication rate was 31% in the plate fixation group versus 9% in the intramedullary pin group ( $p = .024$ ). All patients achieved fracture union with return to duty; however, increased overall complications were seen in the plate fixation group. (Journal of Surgical Orthopaedic Advances 22(1):77–81, 2013)*

Key words: clavicle, intramedullary, military, operative fixation

Fractures of the clavicle are the most common fractures among adults and children with 80% to 85% of these fractures involving the midportion of the clavicle (1–6). These injuries are typically associated with high-energy falls or blunt force trauma to the shoulder girdle (7). Historically, midclavicle fractures were treated nonoperatively (8). However, in recent studies operative plate fixation has yielded improved functional outcomes in the short term and decreased rate of malunion and nonunion compared with nonoperative treatment (1). Nonoperative management has been associated with decreased endurance strength, specifically in forward flexion, abduction, and rotation, which can impose major limitations on

active duty military personnel (9). Additional research has also demonstrated the utility of intramedullary fixation in the treatment of clavicle shaft fractures, with comparable clinical outcomes to plate fixation and similarly reduced rates of malunion and nonunion compared with nonoperative treatment (2, 9).

Today's military population is an all-volunteer force of very active, young adults who have unique daily work requirements. Within the current Global War on Terrorism, the physical demands of military service members have intensified; all service members have deployment requirements that mandate dismounted activities, wearing of body armor, and use of rucksacks to complete their mission requirements. Given increased load-bearing demands of the shoulder for military personnel and the high incidence of clavicle fractures within this young, active population, operative fixation is frequently utilized to allow military personnel to resume military duty. However, prior evaluations of plate fixation in active duty military personnel have also raised concerns, particularly with regard to plate prominence and soft tissue irritation. In their military cohort, Huh et al. demonstrated that although approximately 75% of patients were satisfied based on subjective clinical measures, nearly a third of patients (29%) were unable to wear protective body armor or ruck sack (32%) after clavicular plate fixation (10). To our knowledge, no current study has compared rates of hardware-related

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The thoughts and ideas published in this article are those of the authors and do not reflect those of the U.S. Army, Department of Defense, or the United States Government.

The authors have no financial disclosures and did not receive contributions or grants for this research.

Received for publication October 1, 2012; revision received November 19, 2012; accepted for publication December 14, 2012.

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1549-825X/13/2201-0077\$22.00/0

DOI: 10.3113/JSOA.2013.0077

complications between different surgical constructs in military personnel.

To this end, the purpose of our study is to evaluate the complication rates and morbidity of intramedullary fixation compared with plate fixation in middle one-third clavicle fractures. The null hypothesis was that there would be no significant difference in the complication rate between the different operative treatment options for midshaft clavicle fractures.

## Materials and Methods

This is a single-center, retrospective, longitudinal cohort study. The study was reviewed and received approval by the institutional review board. All active duty service members undergoing operative fixation of the clavicle were identified from the surgical scheduling databank and screened for study consideration.

### Inclusion Criteria

Patients were included in the study if they (*a*) were a current active duty military member at the time of the injury, operation, and follow-up; (*b*) had an isolated 100% displaced midshaft fracture of the clavicle (no cortical contact between the main proximal and distal fragments, with or without comminution); (*c*) were 18 years of age or greater; and (*d*) sustained the injury between the dates of July 1998 and July 2010 and underwent operative fixation of the clavicle fracture.

### Exclusion Criteria

Patients were excluded from the study if they (*a*) were not on active duty status or not a member of the United States military at the time of the injury, operation, or for follow-up; (*b*) had no documented date of injury, operative report, or follow-up to radiographic union; (*c*) were less than 18 years of age; (*d*) had a fracture of the medial or lateral one-third of the clavicle; (*e*) had an ipsilateral upper limb injury or a polytrauma; or (*f*) delayed presentation at the time of treatment (e.g., more than 2 weeks from injury).

### Surgical Technique

Given the retrospective nature of this study and multiple operating surgeons, surgical technique was not standardized. Intramedullary fixation involved retrograde rigid Hagie pin placement through a mini-open approach after closed reduction (Figs. 1 and 2). Plate osteosynthesis involved open reduction and fixation with both 3.5-mm



**FIGURE 1** Displaced right middle one-third clavicle fracture before fixation.



**FIGURE 2** Right clavicle fracture after intramedullary Hagie pin fixation.

pelvic reconstruction plates or 3.5-mm precontoured low-contact, dynamic compression plating, with or without lag screw fixation or locking screw placement (Figs. 3 and 4).

### Complications

Complications for this study were defined as (*a*) skin or soft tissue irritation and/or skin breakdown, (*b*) wound infection, (*c*) unplanned hardware removal for any reason, and (*d*) nonunion (defined as lack of callus formation on two cortices at 6 months on plain radiographs). These were determined by retrospective review of the electronic medical record. Patients were also specifically asked about their hardware pain and irritation on clinical follow-up, and this was documented in the medical record. For skin and soft tissue irritation and/or skin breakdown,



**FIGURE 3** Displaced left middle one-third clavicle fracture before fixation.



**FIGURE 4** Left clavicle fracture after plate fixation.

documented specific complications were the inability to tolerate individual body armor use, rucksack wear, or military activities involving weight bearing on the shoulder based on subjective responses to provider questions. In the evaluation of these procedures, the second surgery to remove the intramedullary Hagie pin fixation from the clavicle was not considered a complication because it was a planned procedure that can be performed in clinic or operating room with only mild sedation.

### Statistical Analysis

Statistical analysis was performed on the two fixation groups using a chi-square test with a Fisher exact test. A *p* value of less than .05 was considered statistically significant. Patient sex, age, and operative fixation complication rates were analyzed for differences.

## Results

### General Characteristics

There were 65 active duty patients who underwent operative fixation of middle one-third clavicle fractures between July 1998 and July 2010 and were included in the study. Of the 61 males and 4 females included in the study, 34 patients underwent intramedullary Hagie pin fixation and 31 patients underwent superior clavicle plate fixation of their middle one-third clavicle fractures. One patient in the pin fixation group was lost to follow-up after pin placement with no records or radiographic follow-up after initial surgery secondary to reassignment to a new military post. Two patients were eliminated from the plate fixation group because of presence of ipsilateral side upper extremity trauma, leaving 33 intramedullary pin fixation patients and 29 plate fixation patients who were evaluated in this study for complications 1 year after surgery. Patient characteristics are described in Table 1. All patients had their intramedullary Hagie pin fixation removed in the operating room with light sedation. All fractures went on to radiographic healing with no malunions or nonunions. There was no difference between the fixation groups with regard to age or sex (*p* = .112).

### Complications

Overall, there was a statistically higher complication rate in the plate fixation group compared with the pin fixation group (*p* = .024). The most frequent complication in both operative groups was symptomatic hardware and soft tissue irritation within the first year. The majority of the symptoms were produced from the pressure of body armor and rucksack wear during training. There were a total of seven patients (24%) who required treatment or permanent activity limitations for symptomatic hardware in the plate fixation group. Two patients (7%) had elective removal of their plates after fracture union. Three patients (9%) in the intramedullary pin group developed complications within

**TABLE 1** Demographic comparison of both treatment groups

Parameters	Pin Fixation	Plate Fixation
Total number of patients	33	29
Sex		
Male	32	26
Female	1	3
Age		
Mean	25.2	26.9
Range	18–51	20–49
Overall mean		26.0
Overall age range		18–51

1 year of the procedure (Table 2). Two patients had symptomatic hardware in the pin fixation group. Both of these patients were placed on limited duty until fracture union and had the pin removed as scheduled with no further pain. Another patient in the pin fixation group had a wound infection after surgery that was successfully treated with oral antibiotics and local wound care. Once fracture union was achieved, this patient underwent pin removal as planned with no subsequent infection. Additionally, one patient in the intramedullary pin treatment group did not return for pin removal for 18 months; however, he had no skin or soft tissue irritation or complaints of pain. His pin was removed with evidence of union of his clavicle fracture and no evidence of infection. In both the plate fixation and intramedullary pin groups there were no malunions or nonunions.

## Discussion

Recently, the operative treatment of displaced midshaft clavicle fractures has been shown to have superior results over nonoperative treatment. McKee et al. (9) demonstrated that nonoperative treatment of displaced midshaft clavicle fractures was inferior to plate fixation with regard to patient and clinical outcomes. In the nonoperative group, there was a 63% complication rate compared with 37% of patients in the plate fixation group at 1 year. In our study, symptomatic hardware after operative treatment had a complication rate of 16% (10 out of 62 patients), with both operative treatment options having complications. Complications encountered with operative fixation included soft tissue irritation, symptomatic hardware, wound infection, and hardware removal. Our most common complication was symptomatic hardware and soft tissue irritation (14.5%).

In our plate fixation group, we noted complications consistent with prior studies that showed “irritable” hardware as the most common complication (2, 11–13). Ferran et al. (11) reported that 53% of their patients requested plate removal secondary to irritation and Liu et al. (2) had a 20% plate removal rate. In our study, 31% of patients with plate fixation had a complication and 7%

(2 of 29) had removal of the plate secondary to irritation. However, in our study population, the main cause of plate complications were soft tissue irritation secondary to the load-bearing demands placed on the clavicle. These complications were not reported in studies by Harnroongroj and Vanadurongwan (13) and Collinge et al. (12). The increased complication rate in our population is most likely attributable to the increased daily demands of weight bearing with individual body armor and rucksacks that are not present in most civilian populations.

Intramedullary pin fixation has been shown to have complication rates ranging from 24% to 50% in recent studies, with skin breakdown, scar numbness, pin breakage, and hardware irritation frequently reported (2, 11, 14). As a result, we recommend routine intramedullary pin removal after radiographic union to avoid excessive implant-related complications with prolonged pin retention. In our study, there was a 9% complication rate for pin fixation to include a superficial infection and symptomatic hardware. In our study, the removal of the pin after fracture healing was a planned procedure and was not considered a complication, as opposed to previous studies (11). With all 33 patients in the intramedullary pin fixation group of our study, after pin removal there were no operative, bony, or skin complications from the procedure.

In previous studies, nonunion and malunion rates of operatively treated clavicles was seen in up to 10% of patients treated with plating (2, 15, 16) and 17% of those treated with intramedullary fixation (2, 17). In the present study, both fixation groups had no malunion or nonunions (100% union) of clavicle fractures within 1 year of completion of the fixation. This is consistent with more recent studies by Ferran et al. (11) and Strauss et al. (14), which had 100% union with intramedullary pin fixation. Authors have attributed this previously high nonunion rate with operative fixation to inadequate internal fixation (18, 19). In the present study, both operative procedures were successful in the treatment of the middle one-third clavicle fractures with the rapid return of personnel to weight-bearing status with minimal complications.

As with all retrospective studies, there are limitations present. First, patients were not randomized to determine the type of fixation that was utilized for the treatment of their clavicle fractures. Additionally, there is no comparison to a nonoperative treatment arm, which can also have high rates of cosmetic deformity (32.5%), chronic pain (25.3%), and potential mechanical irritation caused by persistent callus (20). Second, the fixation of the clavicle fractures was determined by the staff surgeon, based on the surgical treatment option that the surgeon felt was most appropriate for treatment of the fracture pattern, which potentially introduces selection bias. Third, scheduled removal of the intramedullary pin was not considered

**TABLE 2** Complications rates by fixation method

Adverse Event	Pin Fixation (n = 33)	Plate Fixation (n = 29)	p Values
Symptomatic hardware and soft tissue irritation	6% (2)	24% (7)	.07
Skin infection	3% (1)	0% (0)	1.0
Premature removal of hardware	0% (0)	7% (2)	.215
Overall complication rate	9% (3)	31% (9)	.029

a complication because it could be performed with minor sedation, while removal of clavicular plate fixation was considered a complication. Fourth, medical records and radiographs were reviewed to only determine the presence of fracture healing, documented complications, and inability to perform military activities, and the time to radiographic union is unknown. Fifth, there were no validated, prospectively gathered, patient-reported measures to fully assess the ability of the service member to perform military duties after operative fixation. A prospective randomized study of military personnel with outcome evaluations and direct evaluation of weight bearing associated with rucksack and body armor wear is necessary to further evaluate the preferred operative fixation method for military personnel.

## Conclusion

Displaced clavicular shaft fractures are commonly seen in the physically active military population. The results of the current study indicate that both plating and pin fixation of middle one-third clavicle fractures provide predictably high rates of radiographic union, although plate fixation results in statistically significant higher overall complication rate. Future randomized prospective studies with larger patient populations are needed to further evaluate short-term and long-term clinical outcomes of plating and intramedullary fixation of middle one-third clavicle fractures. With the evolution of military equipment and work demands on all military personnel, future studies would help to yield more definitive conclusions concerning the appropriate operative treatment option of midshaft clavicle fractures in military personnel.

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