J. Dhaka National Med. Coll. Hos. 2017; 23 (01): 22-25

Original Article

Prospective analysis of primary open reduction and internal fixation by reconstruction plate for the treatment of midshaft clavicular fractures with greater than 100% displacement in active adult patients

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Abstract

Clavicle fracture is one of the most common bony injuries, rarely requires internal fixation. The most frequent indication for open reduction and internal fixation is non-union. Thompson1, based on review of 135 non-unions, found 117 (90%) were middle-third fractures with greater than 100% displacement. He estimated the incidence of this fracture type to be only 3% of all Clavicle fractures and suggested that consideration be made for primary internal fixation in this group. In this study, primary Open reduction and internal fixation by reconstruction plate was done in 26 patients with mid-shaft fracture of the clavicle with greater than 100% displacement. All the patients were followed up for one year to see the consequences of treatment. All the fractures were united. Average duration of fracture union was 16.2±2.2 weeks. Only one patient developed delayed union. There were no symptomatic malunion. All the patients regained full range of movements at the end of follow up. Functional outcomes of the patients were excellent with the mean Disabilities of Arm, Shoulder and Hand score of 6.4±2.4 and the mean Constant score of 90.4 ±4.2 points for the injured side at one year. So we recommended that primary Open reduction and internal fixation by reconstruction plate is a good option of treatment for mid-clavicular shaft fracture with greater than 100% displacement.

Material and Methods

This prospective study was carried out in different private hospitals in Dhaka and Narayanganj from January 2012 to December 2015. We reviewed the results of twenty six cases of midclavicular fractures with greater than 100% displacement, which were treated with primary open reduction and internal fixation by reconstruction plate placed over the superior surface of clavicle. The patients were evaluated at regular intervals; final follow up for each patient was at one year. Functional assessment was conducted with use of The Disabilities of Arm, Shoulder and Hand (DASH) score and Constant score. Union was evaluated with use of plain radiographs.

Inclusion Criteria

- Fracture of the middle third of the clavicle (Allman classification: Group-1) 2 with greater than100% displacement
- Age 18-50 yr
- Fresh injuries, not more than 2 weeks old
- Ability to provide informed consent
- Ability to comply with follow-up

Exclusion Criteria

- Non-midshaft fracture (Allman classification: Group-2 and Group-3)
- Age: <18yr and >50yr
- Polytrauma
- Open fracture
- Pathological fracture
- Preexisting shoulder pathology on affected side
- Fracture >2 weeks old
- Neurovascular disorder
- Head injury at time of trauma
- Medical contraindications to general anesthesia

Results

The age of the patients at the time of injury varied between 18 to 50 years with average of 36.6 years. Among 26 patients, twenty (76.92%) were male and six cases (23.08%) were female. All patients were right-handed. Twelve fractures (46.15%) involved the right clavicle (on the dominant side) and Fourteen (53.85%) involved the left clavicle (on the non-dominant side)

Causes of injury:
In this study, thirteen patients (50%) developed fractures as a result of road traffic accident. Other causes were fall onto shoulder in eight patients (30.77%), direct blow on the point of shoulder in three patients (11.54%) and fall on outstretched hand in two cases (7.69%).

Range of Motion:
Motion of the injured shoulder averaged 159.6 ± 6° of forward flexion, 163.2 ± 9° of abduction, 89.8 ± 10° of external rotation and 69.5 ± 9° of internal rotation. None of these values were significantly different from those of the contralateral, uninjured shoulder.

Union:
Average duration of fracture union was 16.2±2.2 weeks. Delayed union occurred in one case (3.84%).

Clavicle Length Measurements:
Radiographic measurements at the final visit revealed no significant shortening of the injured clavicles as compared with the contralateral uninjured clavicles; in only 1 case (3.84%), shortening of 11 mm developed without any functional deficit.

Complications:
In this study, no major complications occurred. One patient (3.84%) developed superficial wound infection that required surgical dressing and antibiotics. One patient (3.84%) developed delayed union which united at 25 weeks. Shortening of 11mm developed in one case (3.84%). Scar-related symptoms occurred in one patient (3.84%) because of tender scar and keloid formation. Two patients (7.69%) presented a prominent hardware and required removal of implant after union was completed. Three patients (11.54%) had residual skin numbness caudal to the incision.

Patient-Oriented Outcomes:
The mean DASH score at the final visit was 6.4±2.4. Functionally this was very acceptable and similar to the normative value for the general population. The mean Constant score was 91.1 ± 3.1 points for the uninjured side and 90.4 ±4.2 points for the injured side. No significant difference in Constant score was found between the sides ($p = 0.3$), and the scores for both sides were similar to published normative values.

Discussion
Middle-third fractures are the most common clavicle fractures, accounting for approximately 80% of all fractures. Most (97%) of the fractures in this group are not completely displaced and can be treated conservatively without surgery. However, of middle-third clavicle fractures are completely displaced and shortened. This small group of fractures accounts for 90% of nonunion in middle-third fractures and therefore may warrant early open reduction and internal fixation.[3]

Non-union rate of 15% was reported in 52 patients with widely displaced middle-third clavicle fractures treated without surgery.[4] All fractures with an initial shortening >2cm resulted in non-union. Similar studies reported seven non-union (11%) and nine symptomatic malunion (13.8%) out of 65 patients.[5] Another study reported twelve nonunions (34%) and four symptomatic malunions (11%) out of the thirty-five non-operatively treated patients.[6] 17.4% non-union was reported in nonoperatively treated displaced midshaft clavicular fractures.[7,8] Studies of non-operative treatment of completely displaced, mid-shaft fractures of the clavicle were recently summarized in a meta-analysis that found a nonunion rate of 15.1% following non-operative care. Hill et al[4] were the first to use a patient-oriented outcome measure and found that 31% of patients described unsatisfactory outcome after non-operative care of displaced clavicle fractures. High prevalence of nonunion, symptomatic malunion and unsatisfactory patient-oriented outcome following non-operative treatment support primary internal fixation of completely displaced midshaft clavicular fractures (Allman classification: Group-1) in active adult patients.

The type of internal fixation may be intramedullary or plate fixation. In our study, we used reconstruction plate which was easily contoured because of its malleable properties. All patients were active adult with mean age (and SD) of 36.6 yrs ±5.6 ranging from 18 to 50 yrs. Among them, twenty (76.92%) were male and six cases (23.08%) were female.

In this study, the leading cause of fractures was road traffic accident; thirteen fractures (50%) resulted from RTA.[9] and RTA was described the most common cause of injury for clavicular fractures.[10]

In this series, the mean time for fracture healing (radiographic union) was 16.2±2.2 weeks. Delayed union occurred in one case (3.84%). One study treated 33 clavicle fractures with internal fixation by reconstruction plate; the mean time for fracture healing was 16.8 weeks.[11] Non union was reported in 16.4 weeks of the mean time for fracture healing in sixty seven operated patients.[5] They had two nonunions (2.98%). In our

study, all fractures were united. Similar result were reported in 20 (100% union) fresh fractures following plate fixation.[12] Some also reported 100% union in 28 fresh fractures following plate fixation.[7]

We observed some post-surgical and hardware-related complications in this study. One patient (3.84%) developed superficial wound infection that responded to surgical dressing and antibiotics in two weeks. Other complications were delayed union in one patient (3.84%) which united at 25 weeks, shortening of 11mm in one case (3.84%), tender scar and keloid formation in one patient (3.84%), prominence of the hardware in two patients (7.69%) and residual skin numbness caudal to the incision in three patients(11.54%). Canadian Orthopaedic Trauma Society studied sixty two patients of displaced midshaft clavicular fracture with plate fixation and observed that five patients (8.06%) had local irritation and/or prominence of the hardware, three (4.84%) had a wound infection, and one (1.61%) had mechanical failure. In this study, no patient developed deep infection or hardware failure.[13]

DASH disability/symptom score is designed upon asking questionnaires on 30 items about the patient's symptoms as well as his/her ability to perform certain activities. Scaling was ranked from 0 indicating least disability to 100 indicating most disability.[14] In our study, the mean DASH score at one year was 6.4. In another series, the mean DASH score at one year was 3.4 in 86 operated patients.[15] In other series, the mean six-month DASH score was 9.9 in 33 patients with plate fixation.[11] All the scores were similar to the normative value for the general population.

The Constant-Murley score (CMS) is a 100-points scale composed of a number of individual parameters: pain (15 points), activities of daily living (20 points), strength (25 points) and range of motion (40 points).The higher the score, the higher the quality of the function.[16] In our study, the mean Constant score at one year was 90.4 ±4.2 points for the injured side and 91.1 ± 3.1 points for the contralateral uninjured shoulder. $p = 0.3$, which means that there were no significant differences in functional outcomes of the patients between healthy uninjured side and operated injured side conducted by Constant-Murley score. In one study, the Constant-Murley score at one year was 96 in fifty eight patients treated with open reduction and plate fixation.[17] In another series, the mean Constant score at one year was 87.8 ($n = 86$).[15] All the scores were similar to the normative value.

In this study, primary Open reduction and internal fixation by reconstruction plate was done in 26 patients with mid-shaft fracture of the clavicle with greater than 100% displacement. The results were encouraging. All fractures were united. No patient had shoulder droop, and none had impairment of range of motion or shoulder strength. At one year after the injury, all the patients were satisfied with the appearance as well as function of the shoulder. DASH score and Constant score at one year showed that the functional outcomes of shoulder were excellent.

Conclusion

There is a high prevalence of symptomatic malunion and nonunion after traditional nonoperative treatment of midshaft clavicular fractures with greater than 100% displacement; primary open reduction and internal fixation by reconstruction plate results in low rate of malunion and nonunion with excellent functional outcome. This study supports primary open reduction and internal fixation by reconstruction plate as a reliable option of treatment for midshaft clavicular fractures with greater than 100% displacement in active adult patients.

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