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ORIGINAL STUDY

The outcome comparison of headless screws and Mini-plate for treating type B3 distal humerus fractures

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The purpose of this retrospective study was to evaluate the outcome of headless screws and Mini-plate for treating Type B3 fractures of distal humerus. Seventeen patients with type B3 fracture were included and divided into headless screws group and Mini-plate group. Outcome was evaluated using Mayo Elbow Performance Score (MEPS), Short form 36 questionnaire (SF-36), visual analog score (VAS), and range of motion (ROM) at 12 months' follow-up. All patients received a minimum follow-up of 12 months. Postoperative complications mainly included elbow stiffness, heterotrophic ossification and elbow instability. At 12months' follow-up, the MEPS and physical components score of SF-36 in Mini-plate group were significantly higher than that in screw group. Moreover, cases undergoing Mini-plate treatment showed a tendency towards improved ROM of elbow and VAS. The Mini-plate was superior to headless screws on elbow function restoration in the management of type B3 distal humerus fractures.

Keywords: humeral fractures ; Type B3 fractures ; Mini-plate ; headless screws.

INTRODUCTION

Coronal shear fractures of distal humerus are specifically classified as type B3 fractures (AO/OTA) and further subdivided into capitellar, trochlea and combined fractures *(19)*. The injury mechanism of coronal fractures refers to the direct axial compression transmitted from the radial head to the capitellar and trochlea, commonly caused by a fall onto an outstretched arm with the forearm partially pronated. Type B3 fractures are rare and more common in women, representing 1% of all elbow fractures and 6% of distal humerus fractures *(4,17)*. Various classification systems for these injuries have been described. Bryan and Morrey proposed a classification system (type I- type III) on the basis of radiographs. A further modification by McKee et al. *(10)* (type IV) was introduced as the trochlea fracture involved. Recently, Dubberley et al. *(3)* proposed a new classification system (type I- type III) that emphasized the occurrence of posterior condylar comminution. Isolated capitellar fractures remain rare and usually are associated with concomitant injuries (medial/lateral collateral ligament, radial head fractures and humeral condyle fractures *(2,13)*. Varied treatment options have

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been proposed, including conservative treatment, fragment excision, arthroscopic reduction, internal fixation and total elbow arthroplasty *(5,18)*. Conservative treatment is seldom adopted due to the poor outcomes. Simple fragment excision only performed when internal fixation is impossible with severe comminution or limited amount of subchondral bone. Headless screws, Kirschner wires, cancellous screws and locking plate have been widely used and become more popular recently *(2,14)*. Some studies suggest that isolated capitellar or trochlea fractures with complete fragment, can be treated with headless screws and have achieved high union rate and good outcomes *(18)*. But, when posterior condylar of humerus is incomplete, screws alone can hardly obtain effective fixation. Up to now, very few studies have reported outcomes of Mini-plate for treating type B3 fractures. In this study, we retrospectively compared F3® Mini plate with Acutrak headless screws in the management of type B3 distal humerus fractures.

PATIENTS AND METHODS

Between 2003 and 2014, 17 patients with type B3 fractures were reviewed. Fracture type and concomitant injuries were determined based on anteroposterior/ lateral radiographs, CT scans and three dimensional (3D) reconstruction technique. All patients were surgically treated by the same medical team

Design of the study

This was a retrospective study of type B3 fractures of distal humerus we performed in our trauma lever I center.

Inclusion criteria

Type B3 distal humerus fractures. Surgical treated by Acutrak screws or F3® plate. No previous injuries or surgery in ipsilateral elbow, and no serious cardiac or mental problems.

Exclusion criteria

Open fractures, pathological fractures, incomplete clinical records, children with capitellar fractures, severe cognitive impairment.

Surgical techniques

Lateral approach was applied in most cases while posterior approach through olecranon osteotomy was applied when posterior trochlea and median part of trochlea were involved. A lateral skin incision was located at 5cm proximal to the elbow extending towards the radial head. The incision can be extended toward the proximal end of the humerus by splitting the origin of the radial wrist extensors. Pronating the forearm to move the radial nerve away from the operative region. Distal humerus articular was exposed through Kocher interval and fragments were temporarily fixated using K-wires. After checking fracture reduction using C-arm fluoroscopy, 3.5 mm standard headless compression screws (Acutrak)were used to stabilize the fracture, the screws were inserted in an anterior to posterior direction through at least 2 different angles. For plate group, additional F3® Fragment Plating System (Zimmer Biomet) were applied to provide posterior support and lateral stability (Fig 1). Concomitant injuries were fixated simultaneously.

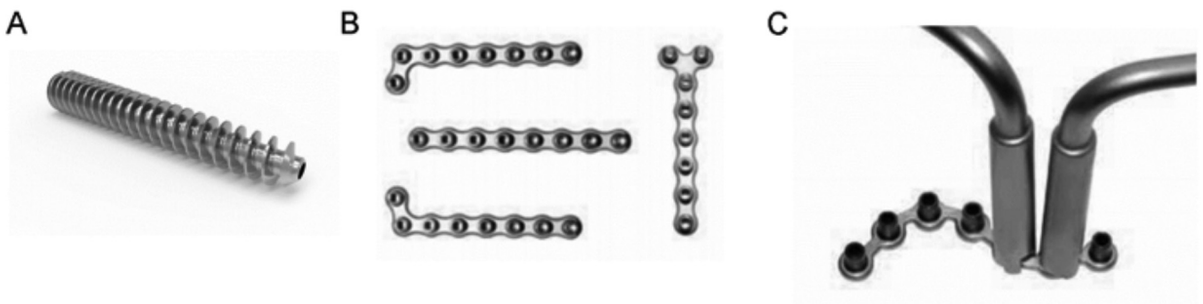

Fig. 1. — 3.5 mm Acutrak headless screws (A) and F3® Fragment Plating System (Zimmer Biomet) (B). This kind of mini-plate with easy-moulding property (C) offers strong fixation and minimum tissue irritation

Postoperative management

Postoperatively, the elbow was immobilized in an arm sling with approximately 90° of elbow flexion for 1 week. Active rehabilitation program was initiated once the sling was removed.

Radiographic and functional evaluation

Anteroposterior and lateral radiographs of the elbows were evaluated for fracture healing assessment and the presence of periarticular ossification. Degenerative changes were evaluated using the Broberg and Morrey classification. Visual analog score (VAS) and elbow range of motion (ROM) were recorded at the 12 months' follow-up. Stability of the elbow was evaluated on the basis of physical examination while functional outcome was evaluated according to Mayo Elbow Performance Score (MEPS) and Short form 36 questionnaire (SF-36).

Statistical analysis

All statistical analyses were performed using the SPSS 19.0 in this study. T test was used to compare the difference between groups for normally distributed data. For abnormally distributed data, Mann–Whitney U test was performed to compare the difference. $P < 0.05$ was considered to be statistically significant.

Ethics

The study design was approved by the Institutional Review Board of the Shanghai Tenth People's Hospital of TongJi University. The procedures were in accordance with the ethical standards of committee of Shanghai Tenth People's Hospital on human experimentation, and with the Helsinki Declaration.

RESULTS

All fractures healed and every patient received a minimum of 12 months' follow-up (13.82 ± 2.27). Representative cases were shown in Fig 2 and Fig 3. According to AO/OTA classification, 17 type B3 fractures were subdivided into 7 type B3.1 and 10 type B3.3 fractures. Lateral approach was applied in 14 patients while posterior approach was used

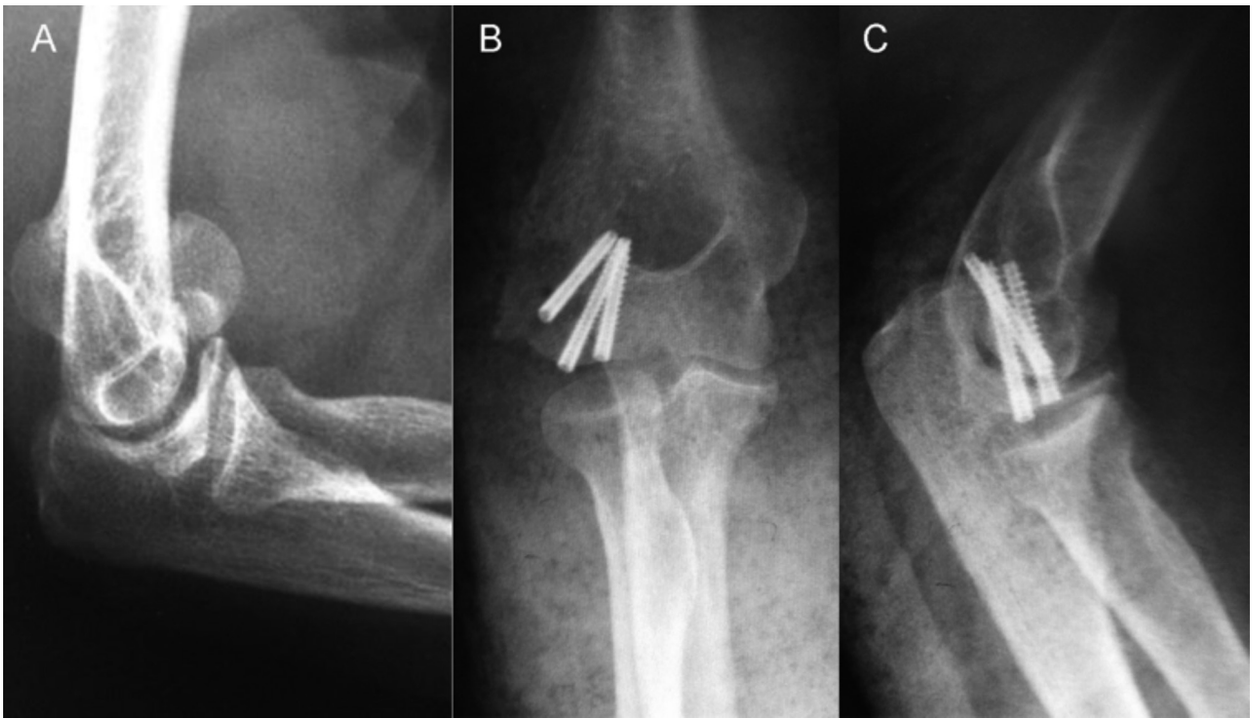

Fig. 2. — Representative case of type B3.1 fracture treated with Acutrak headless screws. Lateral view of the fracture (A). Antero-posterior view (B) and lateral view (C) of sagittal fixation with headless screws

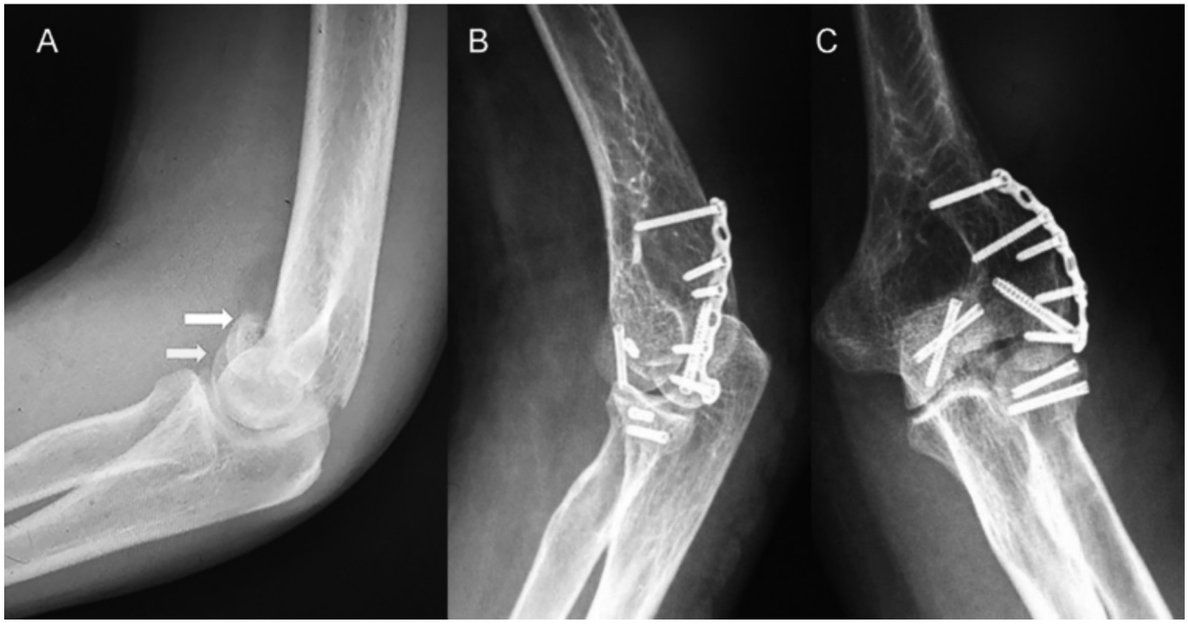

Fig. 3. — Representative case of type B3.3 fracture treated with F3® plate and headless screws. Classical "double arc" sign that has capitellar (yellow arrow) and trochlea (white arrow) involvement (A). Antero-posterior view (B) and lateral view (C) of multiple plane fixation using F3® plate and headless screws. Concomitant injury (radial head fracture) was simultaneously fixed

in 3 cases with posterior trochlea and median part of trochlea involved. Concomitant injuries included 3 radial head fractures (Mason type I, type II), 3 condyle fracture of humerus and 1 ligament injury. Elbow stiffness, elbow instability and heterotrophic ossification were the major complications following surgery. Demographic and clinic details were shown in Table I. At 12 months' follow-up, the MEPS averaged 84.44 ± 5.27 in plate group, higher than 78.13 ± 4.58 in screw group (P = 0.019). The mental components score (MCS) of SF-36 reached 61.29 ± 11.40 (Plate) and 53.37 ± 6.38 (Screw) (P = 0.103), while a significant higher physical components score (PCS) of SF-36 was obtained in plate group (66.00 ± 6 .74) compared with screw group (55.00 ± 8.87, P = 0.011). Moreover, cases undergoing Mini-plate treatment showed a tendency towards improved ROM of elbow and VAS, despite the statistical difference was not significant (Table 2)

DISCUSSION

The management of type B3 coronal fractures include conservative and operative techniques. Several studies have reported outcomes after closed reduction with 2-4 weeks immobilization. Not surprisingly, failure to obtain anatomic reduction (success rates as low as 50%) is the main disadvantage of non-operative treatment with longer duration of immobilization. Persistent immobilization no less than 3 weeks may contribute to elbow stiffness and reduced elbow ROM *(12)*. Cutbush K et al. *(1)* have proposed that 3 weeks or less of immobilization is insufficient for the fracture union. Too early elbow exercise within this period may increase the risk of fracture displacement. Good to excellent results of non-operative treatment are more likely achieved in patients with simple fractures (especially for type B3.1) that only have the capitellar involvement without associated injuries.

Operative management comprises of fragment resection, open reduction and internal fixation (ORIF), arthroscopic reduction and internal fixation (ARIF) and elbow athroplasty. There is concern that resection of the capitellar fragment may cause valgus deformity and instability of the elbow *(6,11)*. However, Sabo MT et al. *(15)* have suggested that the capitellar does not contribute significantly to

Table I. — Demographic and clinic

	Headless Screws	Mini-Plate	P
Cases	8	9	
Gender			0.486
male	4(50%)	3(33%)	
female	4(50%)	6(67%)	
Fracture type			0.819
Type 3.1	3(38%)	4(44%)	
Type 3.3	5(62%)	5(56%)	
Age (years)	35.75±5.55	34.22±5.14	0.564
Concomitant injury			0.656
radial head fracture	1(13%)	2(22%)	
humeral condyle fracture	2(25%)	1(11%)	
ligament injury	0(0%)	1(11%)	
Complications			0.223
elbow stiffness	0(0%)	1(11%)	
elbow instability	1(13%)	0(0%)	
heterotrophic ossification	1(13%)	0(0%)	
Follow-up (months)	13.38±2.13	14.22±2.44	0.460

Table II. — Outcome assessment

	Headless Screws	Mini-Plate	P
MEPS	78.13±4.58	84.44±5.27	0.019*
SF-36			
MCS	53.37±6.38	61.29±11.40	0.103
PCS	55.00±8.87	66.00±6.74	0.011*
VAS	0.83±0.47	0.59±0.36	0.245
ROM			
flexion	96.00±8.59	106.11±10.02	0.042
extension	3.88±2.23	6.67±3.39	0.067
pronation	69.25±4.06	71.00±5.43	0.468
supination	58.00±10.47	61.89±15.22	0.554

MEPS Mayo Elbow Performance Score. SF-36 Short form 36 questionnaire.
MCS Mental Components Score. PCS physical components score.
VAS Visual Analog Score. ROM Range of Motion.

elbow stability. Moreover, the exposed cancellous bone in direct contact with soft tissues may lead to articular adhesions *(17)*. It should be pointed out that fragment resection either by open technique or arthroscopically can be a reasonable option when the severity of the comminution preclude the fixation.

Elbow athroplasty is performed only for the elderly with comminuted fractures when the osteosynthesis is impossible. ORIF has been regarded as the most promising operative management to achieve stable anatomic reduction and to avoid valgus deformity, elbow instability. The implants include cancellous

screws, headless screws, Herbert screws, Kirschner wires and locking compression plate *(9)*. Heck S et al. *(7)* have reported the good clinical results achieved by using fine-threaded Kirschner wires. Vaishya R et al. *(18)* have applied headless double-threaded compression screws in the management of capitellar fractures, obtaining favorable outcomes. Besides, Singh AP et al. *(16)* have reviewed patients with satisfactory outcomes following Herbert screws treatment. There still exist controversy regarding direction of screws insertion. Both in-out direction and out-in direction for screws insertion have merits and drawbacks. From posterior to anterior (out-in), cartilage damage could be avoided and screws are more easily to remove, but injury of posterior soft tissue is inevitable. From anterior to posterior (in-out), more strength of fixation is acquired with little damage on the cartilage *(8)*. In our practice, we prefer the in-out insertion, for the reason that the main blood supply of the capitellar is from posterior soft tissues, and anterior fixation can be easily performed. Osteonecrosis, implant failure and posttraumatic osteoarthritis rarely occurred.

Usually, for isolated capitellar and trochlea fractures, application of headless screws or Herbert screws could achieve favorable outcomes *(14,16)*. But for comminuted fractures or have lateral condyle of the humerus involvement, especially for Dubberley type B fractures with incomplete posterolateral condyle of the humerus, screws can hardly acquire ideal strength of fixation and the outcome might benefit from additional plate application. F3® Fragment Plating System we used in this study offers low profile but strong fixation in a locked plating construct, easy- moulding, and is perfect for non-load bearing stabilization and fixation of small bone fragments. Up to present, very few studies have reported F3® plate in the management of distal humerus fractures. In our study, we reported 17 cases of type B3 fractures undergoing internal fixation of Acutrak headless screws and F3®plate. We assessed the overall elbow-specific functional outcomes using MEPS, VAS, ROM and SF-36 as well. We observed better elbow function restoration, higher MEPS and PCS of SF-36 in groups treated with F3® plate. Moreover, the F3® plate group showed a tendency towards improved ROM of elbow and VAS, despite the statistical difference was not significant. Additional plate application could not only play a role in anterior anti-sliding stability but provide lateral and posterior support. Furthermore, multiple plane fixation of the fracture by combination of Acutrak screws and F3® plate, could obtain maximum strength of fixation and stability than monoplane fixation (sagittal) achieved in screws, more like the theory applied in vertical fixation of dual plates in the treatment of intercondylar fracture of humerus. We concluded that F3® plate was superior to Acutrak headless screws on elbow function restoration in treating type B3 distal humerus fractures.

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