

1 **Modified Tension Band Wiring (MTBW) in Adult Distal Humeral Fractures A2 and C1 (AO)**

2 **Abstract**

3 **Background:** Distal humeral fractures are seen in approximately two percent of adults fractures and
4 nearly one-third of humeral fractures. Modified Tension Band Wiring (MTBW) is evaluated for
5 early movement and complications in fixation of the distal humeral fractures type A2 and C1 (AO).

6 **Methods:** 25 Patients underwent Open Reduction & Internal Fixation (ORIF) with MTBW and
7 incidence of complications were evaluated.

8 **Results:** The mean age were 53.7 years. 16 cases had C1 and nine patients A2. The mean tourniquet
9 time was 43 minutes. All cases radiologically healed. The mean union time was 12.24 weeks and
10 the mean follow up was 13.72 months. The mean lack of extension was 18° and the mean flexion
11 was 124°. The mean range of motion was 106°. Wound haematoma and dehiscence were seen in
12 two cases and improved after conservative treatment. All Neurapraxia were resolved within two
13 weeks to three months. Non-union of olecranon osteotomy site was seen in one case that treated by
14 the same technique. In four patients due to range of motion less than 100°, device removal was
15 performed at 6 months after surgery with enhancement of the range of motion nearly 12°. No
16 serious complications as nonunion of fracture site, malunions and deep infection were observed.

17 **Conclusion:** MTBW in fixation of these fractures is strong enough to allow gentle early motion and
18 cost effective. The surgery duration, tourniquet time and damage caused by soft tissue stripping are
19 reduced.

20 **Key words:**

21 Distal humerus, Fracture, Tension band wiring, AO, Periosteal stripping.

22 **Level of evidence:** Level IV, Case Series with no control group.

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27 **Introduction :**

28 Distal humeral fractures are approximately 2% of adults fractures and nearly one-third of humeral
29 fractures. It is caused by high-energy event among the younger population or minor fall in older
30 persons. Different treatments including closed reduction, external fixation, open reduction and
31 internal fixation and arthroplasty are proposed (1). Open reduction and internal fixation is
32 recommended in the case of unstable and displaced fractured in patients with good function in their
33 upper limb, with the aim of achieving stable anatomic reduction to allow early gentle range of
34 motion (2,3). Results of other studies indicate double-sided plate for fixation is biomechanically
35 preferred compared to other methods(4,5,6). Although Modified Tension Band Wiring (MTBW)
36 has provided acceptable outcome regarding the fixation of distal humeral fractures(7,8,9), in the
37 current study, this technique is evaluated for early movement and complications in fixation of the
38 distal humeral fractures type A2 and C1 in AO classification.

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40 **Materials and Methods:**

41 A cohort study was conducted among 32 patients with distal humeral fractures A2 and C1 (AO),
42 referred to author's hospital between February 2007 to February 2015. Patients underwent open
43 reduction and internal fixation with MTBW method by one surgeon (SK). The eligibility criteria
44 included : Adults distal humeral fractures type A2 and C1 classification AO with the displacement
45 more than two mm in articular surface or more than five mm in metaphyseal region without
46 comminution (10). Patients were excluded in the event of the open fracture, vascular involvement,
47 previous surgery of the elbow and poor skin condition, and without consent or follow-up.
48 Seven patients were excluded due to open fractures (two cases), ankylosis (one case), vascular
49 involvement (two cases)and two cases didn't continue to follow up. All patients underwent open
50 reduction and internal fixation with MTBW. Visit, operation and follow-up of patients was
51 performed by a single surgeon and patients were followed for an average of 13.27 months.

52 **Approach:** Under general anesthesia in lateral position (shoulder, elbow 90°- 90°) with a tourniquet
53 and side arm, elbows were operated with posterior approach. At first the ulnar nerve was released,
54 thereafter, olecranon Chevron osteotomy was done. Medial and lateral edges of the triceps muscle
55 from inter-muscular septum were isolated and raised. In the next step, distal humeral articular
56 fracture was fixed by partial threaded cancellous screw perpendicular to fracture line, medial to
57 lateral or vice versa. The reconstructed articular surface was fixed to medial and lateral columns
58 with 2 K-wire size 2 – 2.5 mm, as the tip of the pin protruded about five mm from the opposite
59 cortex. Then by MTBW technique tied by the # 18 wire around 2 medial-distal pins to two medial-
60 proximal pins (from lateral pins that protrude medially) with double loops and compressed it
61 symmetrically(Figure-1). The same procedure was repeated for the lateral aspect. Distal tips were
62 bent and cut. After washing the surgical site, Olecranon osteotomy was fixed by MTBW(Figure-2).
63 At the end of fixation, range of motion, varus and valgus stability of the elbow were tested.
64 Furthermore, Ulnar nerve was protected in its place by one suture to soft tissue. If there was any
65 preoperative neurological symptoms, the nerve was transferred to the anterior part. Drain and
66 subcuticular skin were sewn and arm splinted in 70 to 90 degrees. Drain was removed after 48
67 hours and the patients were trained for gentle passive and active assisted movement. Sutures were
68 removed at days 10-14 and splint was changed to Jones bandage. As the follow-up, the patients
69 were visited at weeks 4-12 every two weeks, then months 4, 6 and 12 and examinations were
70 recorded.

71 During the follow-up, the incidence of complications including stiffness, infection, haematoma,
72 wound dehiscence, pin loosening and movement, loss of reduction, failure of fixation, non-union,
73 malunions, vascular injury, heterotopic ossification and nerve damage were evaluated (11).

74 **Results:**

75 A total of 25 patients(Table 1) with a mean age of 53.7 (35-85)years. Female to male ratio were
76 almost the same (13 to 12). 16 cases (64%) C1 and 9 patients (36%) A2. The average (range) of
77 tourniquet time was 43 (30-90) minutes. All patients reached clinical healing which were verified

78 by radiological follow-up examination as well. The mean time to union was 12.24 (8-16) weeks and
79 the average time of follow up was 13.72 (6-24) months. The mean lack of extension was 18 (5-40)
80 degrees and the mean flexion was 124 (115-135) degrees. Our results revealed mean range of
81 motion was 106 degrees (90-120) degrees. Although wound haematoma and dehiscence were seen
82 among two patients, they improved after the evacuation of haematoma and conservative treatment.
83 Ulnar neuropathy due to trauma were reported in two cases and one occurred after surgery. In
84 addition, all Neurapraxia were resolved within two weeks to three months. One patient had non-
85 union of olecranon osteotomy that treated by the same technique. In four patients (16%) due to
86 range of motion less than 100 degrees, device removal was performed at six months after surgery
87 that lead the increase of the range of motion by 12 degrees. No serious complications as nonunion
88 of the fracture site, malunions and deep infection were observed.

89 **Discussion:**

90 In general, due to high mechanical strength, orthogonal or parallel Locking Compression
91 Plate(LCP)is a standard method for fixation of these fractures(4,5,6), but this technique increases
92 cost, operation time, soft tissue injury and periosteal stripping.
93 The aim of tension band wiring is to converting tensile force to compressive force across the
94 reduced fracture plane(12). Various methods of fixation and limited internal fixation with screws,
95 pins or one plate are described but not enough stable to begin early range of motion (12-15).
96 Although cross pinning fixation of the supracondylar humeral fracture has excellent results in
97 children, this method of fixation is not effective among adults(3,16). MTBW is cost effective,
98 strong and secure method to allow gentle early motion in fixation of distal humeral fractures type
99 A2 and C1(AO Classification).This technique reduces the duration of the surgery and tourniquet
100 time and damage caused by soft tissue stripping that usually used in plate fixation. The tools and
101 surgical skill requirements are simplified.

102 Morrey et al. found that average motion (flexion - lack of extension) of at least 100 degrees is
103 enough for doing about 15 daily activities (7). After Examining the joint movements in these
104 patients, we found these results (Table 2).
105 According to the protocol by Morrey, approximately 21 (84%) patients achieved good range of
106 motion. The pins in the majority of cases, such as internal fixation of the patella or olecranon
107 underwent subsequent removal. Pin removal is more simple and convenient than plate removal,
108 however, in some patients that second surgery for removing the implant is not possible, this method
109 is not without morbidity.

110 Huoben et al. reported patients with plates and patients with the tension band wiring had similar
111 outcomes (8). Zhao et al, demonstrated good to excellent outcomes in the majority of patients with
112 intra-articular comminuted fracture by using the same method (9). Allende et al. found that adding
113 tension band wiring to other fixation technique is notified particularly in patients with osteoporosis
114 (7).

115 In the current study, no major complications as non-union of fracture site, malunion, deep infection
116 and permanent nerve injury were observed . Due to the range of motion less than 100 degrees,
117 device removal was performed in four patients (16%) at 6 months after surgery with the progress of
118 the range of motion by 12 degrees.

119 The limitations of this study are its retrospective nature, a relatively small number of cases, and lack
120 of a control group.

121 **Conclusion:**

122 MTBW in fixation of distal humeral fractures type A2 and C1 (AO classification) is strong enough
123 to allow gentle early motion and cost effective. The surgery duration, tourniquet time and damage
124 caused by soft tissue stripping are reduced.

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MTBW in Distal Humeral Fracture A2 & C1

177 Figure 1: MTBW. Left side: Triangular construct (medial and lateral columns with trochlea). Right
178 side: Fixation of articular segments with cannulated screw and then to columns by modified tension
179 band wiring.

180 Figure 2: Pre-operative radiographic AP and Lat views (a and b). Post operative radiographic AP
181 and Lat views (c and d).