

RESEARCH ARTICLE

Modified Tension Band Wiring in Adult Distal Humeral Fracture Types A2 and C1

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Received: 30 September 2017

Accepted: 14 November 2018

Abstract

Background: Distal humeral fractures accounts for approximately 2% of all fractures and nearly one-third of humeral fractures in adults. In this regard, Modified Tension Band Wiring (MTBW) technique was used for the fixation of the distal humeral fractures type A2 and C1 (AO) to evaluate the early movement and complications of the patients.

Methods: This study was conducted on 25 patients, who were subjected to open reduction and internal fixation using MTBW techniques, to evaluate the incidence of complications.

Results: The mean age of the participants was 53.7 years. Out of 25 patients, 16 cases had C1 and 6 individuals suffered from A2. The mean tourniquet time was 43 min. The mean union time was 12.24 weeks and the mean duration of the follow-ups was 13.72 months. The mean values for the lack of extension, flexion, and range of motion were 18°, 124°, and 106°, respectively. Wound haematoma and dehiscence were observed in two cases, who were treated after conservative treatment. During 15-90 days, there were no signs of neurapraxia injuries. The non-union of olecranon osteotomy site was seen in one case, who was treated by the MTBW technique. Since the range of motion was less than 100° in 4 patients, device removal was performed 6 months after the surgery when the range of motion was increased by nearly 12°. Moreover, patients were diagnosed with no serious complications, such as the nonunion of fracture site, malunions, and deep infection. The radiological examination of the patients revealed the success of their treatment.

Conclusion: Based on the obtained results, it can be concluded that MTBW is an effective technique in fracture fixation, which allows gentle early motion. Moreover, this cost-effective technique decreased the surgery duration, tourniquet time, and damage caused by soft tissue stripping.

Level of evidence: IV

Keywords: AO, Distal humerus, Fracture, Periosteal stripping, Tension band wiring

Introduction

Distal humeral fractures accounts for approximately 2% of all fractures and nearly one-third of humeral fractures in adults. The incidence of distal humerus fractures is due to the high-energy trauma among the younger population or minor falls in older individuals. A large number

of suggested therapeutic approaches for this issue include closed reduction, external fixation, open reduction and internal fixation, and arthroplasty (1). Open reduction and internal fixation is recommended in the case of unstable and displaced fractured in patients with good function in their upper limb. This

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approach aims to achieve stable anatomic reduction, which allows the early gentle range of motion (2, 3). According to the literature, double-sided plate for fixation is biomechanically preferred, compared to other methods (4-6). Although Modified Tension Band Wiring (MTBW) has provided acceptable outcomes regarding the fixation of distal humeral fractures, the current study aimed to evaluate this technique in terms of early movement and complications in the fixation of the distal humeral fractures type A2 and C1 in AO classification (7-9).

Materials and Methods

This cohort study was conducted on 32 patients with distal humeral fractures A2 and C1 (AO), referring to 5 Azar Hospital, Gorgan, Iran from February 2007 to February 2015. Patients underwent open reduction and internal fixation using MTBW method by one surgeon (SK). The inclusion criteria were distal humeral fractures type A2 and C1 classification (AO) in adults and displacement of more than 2 mm in articular surface or more than 5 mm in metaphyseal region without comminution (10). The exclusion criteria included open fracture, vascular involvement, previous surgery of the elbow, poor skin condition, and reluctance of the patients to participate in the study or follow-ups.

Accordingly, seven patients were excluded due to open fractures (two cases), ankylosis (one case), vascular involvement (two cases), and lack of participation in the follow-up (two cases). All patients were subjected to open reduction and internal fixation using MTBW technique. A single surgeon visited, performed

operation, and conducted follow-up session for all the patients. The investigated patients were followed up for an average of 13.27 months.

Approach: Under general anesthesia in lateral position (shoulder, elbow 90°-90°) with a tourniquet and sidearm, elbows were operated with posterior approach. At first, the ulnar nerve was released, and olecranon Chevron osteotomy was performed subsequently. The medial and lateral edges of the triceps muscle from intermuscular septum were isolated and elevated at this stage. Following that the distal humeral articular fracture was fixed by partial threaded cancellous screw perpendicular to fracture line, medial to lateral, or vice versa. The reconstructed articular surface was fixed to medial and lateral columns with 2 K-wire (size: 2-2.5 mm) as the tip of the pin protruded about 5 mm from the opposite cortex. Therefore, 2 pins that penetrate med-distal, protrude lat-proximal as well as 2 pins that penetrate lat-distal, protrude med-proximal. In medial side, 2 pins proximally and 2 pins distally tied with wire and symmetrically compressed [Figure 1]. The same procedure was repeated for the lateral side; in addition, distal tips were bent and cut in this procedure. After washing the surgical site, Olecranon osteotomy was fixed using MTBW technique [Figure 2]. Finally, the range of motion, varus, and valgus stability of the elbow were tested at the end of fixation. Furthermore, ulnar nerve was protected in its place by one suture to soft tissue. In case of any preoperative neurological symptoms, the nerve was transferred to the anterior part. Drain and subcuticular skin were sewn and arm splinted at 70-90°. Drain was removed after 48 h and

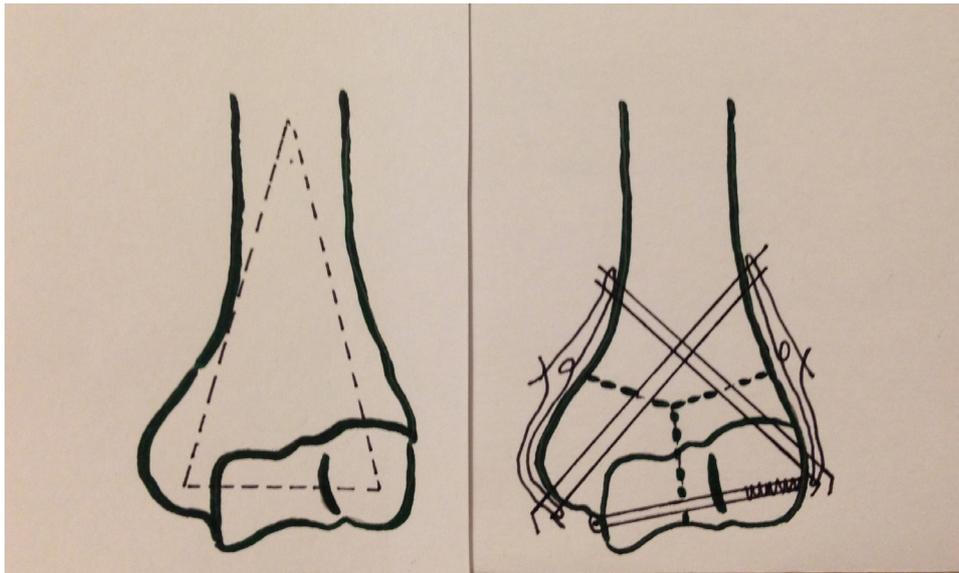


Figure 1. Application of modified tension band wiring technique (Left side: Triangular construct [medial and lateral columns with trochlea]; Right side: Fixation of articular segments using cannulated screw and supra condylar columns).



(a)



(b)



(c)



(d)

Figure 2. Preoperative radiographic anteroposterior and lateral views (a and b); Postoperative radiographic anteroposterior and lateral views (c and d).

the patients were trained for gentle passive and active assisted movement. After 10-14 days, sutures were removed and splint was changed to Jones bandage. Considering the follow-up sessions, the investigate patients were visited every two weeks during the 4-12 postoperative weeks, and at months 4, 6, and 12. The surgeon recorded the outcomes of the surgery at the given times.

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

Results

A total of 25 patients with a mean age of 53.7 years (range: 35-85 years) participated in this study [Table 1]. Female to male ratio was 13 to 12. Out of 25 patients, 16

cases (64%) had C1 and 6 (36%) individuals suffered from A2. The mean of tourniquet time was 43 min (range: 30-90 min).

The mean time to union was 12.24 weeks (range: 8-16 weeks) and the mean duration of follow-ups was 13.72 months (range: 6-24 months). The mean values for the lack of extension, flexion, and range of motion were 18o (5-40 o), 124o (115-135 o), and 106o (90-120 o), respectively.

Although wound haematoma and dehiscence were observed in two patients, they were treated after the evacuation of haematoma and conservative therapeutic procedures. The incidence of ulnar neuropathy was reported in two cases due to trauma and one case after the surgery. During 15-90 days, there were no signs of neuropathia injuries. One patient had non-union of olecranon osteotomy that was treated by the same technique. Since the range of motion was less than 100o in 4 patients, device removal was performed 6 months after

Table 1. Demographic characteristics of the patients and post operative clinical and radiographic assessment

Patient No	Age	gender	AO	Tourniquete (min)	Radiologic Union	Follow-up (month)	Lack of Extension (Deg)	Flexion (Deg)	Range of motion	N. Damage	Wound h. & Dehis.
1	45	M	C1	45	8	12	10	120	110	Y	N
2	56	M	C1	35	12	12	5	120	115	N	N
3	44	F	C1	40	10	18	10	125	115	N	N
4	35	F	C1	40	16	12	35	130	95	N	N
5	49	M	A2	30	16	24	15	120	105	N	Y
6	85	M	C1	50	12	12	25	115	90	N	N
7	78	F	C1	40	12	9	10	115	105	N	N
8	62	F	A2	35	12	6	20	130	110	N	N
9	40	M	A2	40	16	9	30	135	105	N	N
10	50	F	A2	30	8	12	5	125	120	N	N
11	39	F	C1	30	10	18	10	120	110	N	N
12	41	M	C1	35	12	24	5	120	115	N	N
13	72	F	A2	50	12	18	30	120	90	N	N
14	62	M	C1	90	10	12	40	130	90	N	N
15	46	F	A2	45	12	12	10	120	110	N	N
16	51	F	C1	45	16	10	25	130	105	N	N
17	60	F	C1	40	12	12	20	130	110	N	N
18	67	F	A2	50	12	18	20	125	105	N	Y
19	54	M	A2	40	10	12	5	115	110	N	N
20	60	M	A2	30	12	9	15	135	120	N	N
21	48	M	C1	40	10	9	15	125	110	N	N
22	39	M	C1	30	12	12	20	125	105	N	N
23	58	M	C1	50	16	18	25	130	105	N	N
24	48	F	C1	70	16	24	30	130	100	N	N
25	55	F	C1	45	12	9	15	125	110	N	N

Table 2. Post operative average motion of the patients according to Morrey 's concept

Average Motion	Satisfaction	Patients
>120°	Excellent	Cases 2
100°-119°	Good	Cases 19
80°-99°	Fair	Cases 4
<80°	Bad	—

the surgery when the range of motion was increased by nearly 120. Moreover, patients were diagnosed with no serious complications, such as nonunion of the fracture site, malunions, and deep infection. The radiological examination of the patients revealed the success of their treatment.

Discussion

In general, Locking Compression Plate is a standard method for fracture fixation due to its high mechanical strength, as well as orthogonal or parallel plating; however, this technique increases the cost of treatment, operation time, soft tissue injury, and periosteal stripping (4-6).

On the other hand, tension band wiring aims to convert tensile force to compressive force across the reduced fracture plane (12). Although various methods of fixation and limited internal fixation with screws, pins, or one plate have been introduced, these methods were not successful to maintain the early range of motion (12-15). For instance, the cross-pinning fixation of the supracondylar humeral fracture has excellent results in children; however, this method of fixation is not effective for adults (3, 16). The MTBW is a cost-effective, strong, and secure method to allow gentle early motion regarding the fixation of distal humeral fractures type A2 and C1(AO Classification). This technique reduces the duration of the surgery, tourniquet time, and the damage caused by soft tissue stripping (commonly occurred in plate fixation). Moreover, it requires simple methods of surgery and tools.

Morrey et al. found that average motion (flexion, lack of extension) of at least 100° is enough for doing about 15 daily activities, which was in line with the obtained results of the current study [Table 2] (7). According to

Morrey, approximately 21 (84%) patients achieved good range of motion and the pins in the majority of cases, such as the internal fixation of the patella or olecranon, were removed. Pin removal is more convenient than plate removal; however, in some patients plate removal is not possible and may lead to morbidity.

In a study conducted by Huoben et al., the surgical outcomes of the patients with plates and patients with the tension band wiring were similar (8). The obtained results of a study performed by Zhao et al. demonstrated good to excellent outcomes in the majority of patients with intra-articular comminuted fracture by using crossed K-wires and double tension band osteosynthesis (9). Allende et al. found that tension band wiring accompanied by other fixation technique can significantly improve the status of patients with osteoporosis (7).

Patients in the present study revealed no major complications, including non-union of fracture site, malunion, deep infection, and permanent nerve injury were observed. Since the range of motion was less than 100o in 4 patients (16%), device removal was performed 6 months after the surgery when the range of motion was increased by nearly 120. However, it should be noted that the present study suffered from some limitations, including its retrospective nature, relatively small number of participants, and the lack of a control group.

Based on the obtained results, it can be concluded that MTBW is an effective technique in fracture fixation, which allows gentle early motion. Moreover, this cost-effective technique decreased the surgery duration, tourniquet time, and damage caused by soft tissue stripping.

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