



Comparison of Tension Band Wiring and Precontoured Locking Compression Plate Fixation in Mayo Type IIA Olecranon Fractures

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Aim of the present study was to compare the clinical and radiographic outcome of tension band wiring and precontoured locking compression plate fixation in patients treated surgically for an isolated olecranon fractures type IIA according to the Mayo classification.

Of 26 patients presenting with an isolated Mayo type IIA olecranon fracture, 13 underwent fixation with a precontoured locking compression plate (group A), 13 patients were treated with tension band wiring (group B). At a mean follow-up of 43 months, patients were clinically and radiographically re-examined using the DASH score, the Mayo Elbow Performance score (MEPS) and anteroposterior and lateral radiographs.

The mean DASH score was 14 points in group A and 12.5 points in group B. Regarding the MEPS, 92% of the patients in group A achieved a good to excellent results in comparison to 77% in group B. No significant differences between the two groups could be detected regarding the clinical and radiographic outcome. Implant-related irritations requiring hardware removal occurred more frequently in group B (12 vs. 7). Procedure and implant related costs were significantly higher in group A.

Tension band wiring is still a preferable surgical method to treat simple isolated olecranon fractures. The patient must be informed that in all likelihood implant removal will be required once the fracture has healed. Fixation with precontoured locking compression plates does not provide better functional and radiographic outcome but is more expensive than tension band wiring.

Key words : olecranon fracture ; tension band wiring ; Mayo classification ; locking compression plate.

INTRODUCTION

Fractures of the elbow account for up to 7% of all fractures in adults, with approximately 37% affecting only the olecranon. A classification in the clinical practice is the Mayo classification, which takes the degree of displacement, stability and comminution into account (15). Whereas Mayo type I fractures are non-displaced and stable, type II fractures

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are unstable and displaced but with intact collateral ligaments preventing dislocation of the elbow joint, in type III fractures the elbow joint is unstable. The fracture types are further subdivided into A (no comminution) and B (comminuted fractures). Type III fractures are associated with poorer results due to the instability of the elbow joint (22).

All olecranon fractures are intraarticular fractures and therefore treated operatively in order to restore congruency of the joint surface, prevent posttraumatic degeneration and to regain absolute stability. Various surgical techniques have been described to treat olecranon fractures (2-4,8,10,14,23). Tension band wire fixation (TBW), originally described by Weber and Vasey (25), is the most common technique particularly in non-comminuted fractures. However, complications such as anterior interosseous nerve injury and impaired forearm rotation have been described (5-6,11). In recent years, precontoured locking plates have been developed. These plates offer superior fixation strength particularly in osteoporotic bones due to the fixed angle construct. Good results have been reported but there is little evidence regarding its superiority in comparison to other fixation techniques (1).

Aim of the present study was therefore to compare the clinical and radiographic outcome of TBW and precontoured locked plate fixation in surgically treated patients with an isolated olecranon fracture type IIA according to the Mayo classification.

PATIENTS AND METHODS

Between 2002 and 2011, 71 patients were treated surgically for an olecranon fracture. Only those patients were included in the study, which presented with an isolated olecranon fracture type IIA according to the Mayo classification and underwent surgical treatment with either TBW or precontoured dorsal locking compression plate fixation (LCP). Patients with concomitant lesions, open fractures or previous injury of the affected arm were excluded from the study.

47 patients were included in the study, of which 26 could be re-examined. One patient died between surgery and follow-up, 10 patients could be contacted neither by mail nor by phone and the other patients refrained from taking part in the study. Fracture classification was based on the preoperative x-rays taken in the standard antero-

Table I. – Demographic characteristics of the two groups

	Group A (LCP)	Group B (TBW)
Number of patients	13	13
Age at trauma (years)	48.6 (18-87)	38.1 (18-67)
Gender		
female	n = 7	n = 6
male	n = 6	n = 7
Mechanism of injury		
simple fall	n = 7	n = 5
bicycle accident	n = 5	n = 7
sports injury	n = 1	n = 1
Follow-up (months)	27.4 (13-40)	60.9 (19-120)

posterior (a.p.) and lateral views. Of the remaining 26 patients, 13 patients underwent fixation with a LCP (group A), 13 patients were treated with TBW (group B). Demographic characteristics of the two groups are illustrated in Table I.

The SF-36 questionnaire was used to determine differences in general health between the two groups as they slightly differ in age at trauma.

Clinical examination included ROM using a goniometer, elbow stability tests and neurologic examination. Two validated scoring systems were used to determine the functional outcome: The Disability of the Arm, Shoulder and Hand questionnaire (DASH) and the Mayo elbow performance score (MEPS) (12,16,19). Radiographic examination included a.p. and lateral views of the elbow in order to detect non-unions, inadequacy or loss of reduction, heterotopic ossifications and signs of posttraumatic arthritis.

Furthermore, complications such as nerve injury, infections and hardware-related complications were noted.

Written consent to use their data was obtained from all patients prior to the follow-up examination.

Statistical analysis

The Mann-Whitney-U test was used to detect any significant differences in functional and radiographic outcome between the two groups. The level of significance was set at 0.05. A Bonferroni-Holm procedure was conducted to control the familywise error rate.

Statistical analysis was performed with IBM SPSS Statistics 20 (IBM, Chicago, IL, USA).

RESULTS

Clinical results

The SF-36 questionnaire did not show any significant differences between the two groups regarding general health, vitality, pain, physical function and well-being.

The mean elbow flexion was 144° (range, 130-150°, SD 6.7) in group A and 141° (range, 95-150°, SD 5.6) in group B. The median elbow extension deficit was 6.5° (range, 0-30°, SD 6.9) in group A and 5° (range, -10-20°, SD 7.1) in group B. The mean pronation was 83° (range, 50-90°, SD 11.7) in group A and 82° (range, 65-90°, SD 6.6) in group B. The mean supination was 84° (range, 60-90°, SD 8.6) in group A and 82° (range, 70-90°, SD 6.6) in group B, respectively. No significant differences between the two groups for any direction of motion could be found ($p > 0.05$ in each test). Furthermore, there were no significant differences between the affected and the unaffected arm in the same individuals ($p = 0.283$).

The mean DASH score in group A was 14 points (range 0-45, SD 13.6) and 12.5 points (range, 0-37, SD 8.7) in group B. Again, these results did not differ significantly between the two groups ($p = 0.781$).

Results of the MEPS were illustrated in Fig. 1. Although more patients of group A achieved excellent results, there was no significant difference in comparison to group B ($p = 0.454$).

Radiographic results

Fracture healing was achieved in all patients regardless of the procedure. No gap formation or a secondary loss of reduction could be observed at final follow-up radiographs. Signs of posttraumatic arthritis were evident in 5 patients treated with LCP, whereas only 2 of the patients in the TBW group appeared to have arthritic changes. However, this difference was statistically not significant ($p = 0.158$). Heterotopic ossifications were non-significantly more often found in patients of group A ($p = 0.068$).

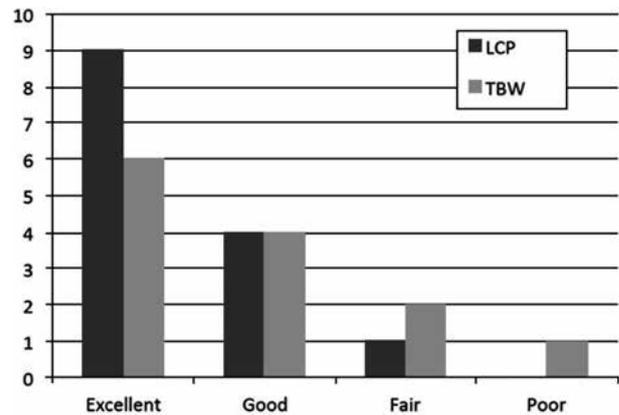


Fig. 1. – Results of the Mayo Elbow Performance Score with regard to the surgical procedure.

Complications and revisions

Six patients in group A required plate removal because of implant related skin irritation and pain on pressure, i.e. when leaning on the flexed elbow. The mean interval from primary surgery to implant removal was 15.4 months. Two patients complained of ongoing pain after implant removal. In group B, 12 patients had the implant removed after a mean of 13.5 months. Main reasons for removal were painful irritations and expected improvement in range of motion after removal due to prior impingement of the k-wires in the fossa olecrani of the humerus. In group B, 5 patients suffered from ongoing local pain after implant removal. Two patients presented with persistent limited range of motion at follow-up, although the impinging implant was removed.

Complications are listed in Table II. Two patients in group A and 4 patients in group B needed surgical revision other than hardware removal due to implant-related irritations.

The average operative time in group A was almost twice as long as in group B (121 vs. 88 minutes ; $p = 0.001$). However, implant costs were significantly higher in group A (approximately 300 € vs. 50 €).

Table II. – Complications related to the two different surgical procedures.

Complication	Group A (LCP)	Group B (TBW)
Implant irritation (with subsequent removal)	7	12
k-wire migration	(not applicable)	1
Infection	1	1
Haematoma	2	0
Hardware failure	1 (iatrogenic)	1 (second trauma)
Non-infected bursitis	0	1
Radioulnar synostosis	1	0

DISCUSSION

There is only one study that compared TBW with one-third tubular 3.5 mm plates, published by Hume and Wiss (13) in 1992. After experiencing a considerable amount of complications after TBW, particularly k-wire migration requiring removal, these authors sought for different options of olecranon fracture fixation. In their series of 41 patients treated with either TBW (n = 19) or plate fixation (n = 22), they found a higher complications rate for the TBW group. Symptomatic implant irritation occurred in 8 patients of the TBW group compared to only one patient in the plate fixation group. Range of motion did not differ significantly. However, superior clinical results were found for the plate fixation group.

Although another plate was used in the present study, the results are comparable with those of Hume and Wiss. Implant removal was required more frequently the TBW group compared to the LCP group. Furthermore, the revision rate (in addition to implant removal due to irritation) was higher in the TBW group (4 vs. 2). Similarly, Villanueva *et al* (24) reported on a series of 37 patients treated with TBW for an olecranon fracture. Hardware removal was necessary in 17 patients (46%). In 3 cases, skin breakdown had developed at the time of removal. In comparison, only 2 of 18 patients required hardware removal in a series of patients treated with locked plate fixation for comminuted fractures of the olecranon (9).

Considering the high frequency of implant irritations, Chalidis *et al* (7) raised the question if TBW is still the “gold standard” in the treatment of olecranon fractures. In their series, 53 of 62 patients (85.5%) achieved a good to excellent MEPS at a long-time follow-up. Again, implant removal was performed in 82.3% of the patients with 34 of them still complaining about mild pain at the olecranon during daily activities. With regard to an overall satisfaction rate of 9.3 out of 10, this mild pain seems not to affect patients’ subjective outcome considerably.

One explanation of the high rate of k-wire migration may be the position of the wires in relation to the axis of the ulna. Some authors prefer to place the wires down the long axis of the ulna in order to prevent nerve and vessel injury (18). Mullett *et al* (17) could demonstrate that the rate of k-wire migration was three times lower when the wire penetrated the anterior cortex of the ulna as recommended by the AO. However, Chalidis *et al* (7) did not find a significant difference in k-wire migration with regard to anterior cortex penetration. The present study supports the data by Mullett *et al* (17). In all patients, both k-wires perforated the anterior ulnar cortex and wire migration was only observed in one patient.

In contrast to previous reports (20), no nerve injury was observed in the present study. With the use of MRI, Prayson *et al* (21) could define a safe zone for anterior ulnar cortex perforation which should not be more than 1 cm of protrusion at a dis-

tance of 1.5 cm distal to the coronoid process. In addition, Catalano *et al* (6) described in an anatomic study a safe angle between the k-wire axis and the long axis of the ulna of 20° to 30° on the lateral view of the elbow.

Taking the clinical and radiographic outcome as well as complications and procedure related costs into account, the only disadvantage of the TBW in the treatment of Mayo type IIA fractures is the high revision rate due to implant-related complications. Therefore, a proper surgical technique is mandatory. K-wires must be bent approximately 180° and advanced into the tip of the olecranon in order to bury them securely under the soft tissue of the triceps muscle insertion site.

Some limitations apply to the present study. With almost 9 years, the period of patients' enrollment is relatively long. However, only those patients were included in the study who sustained an isolated olecranon fracture Mayo type IIA with no previous injury to the same extremity. Comparability of the two procedures is ensured in this way.

Of 47 patients who were suitable for the study, only 26 could be re-examined. However, with 26 patients included, there was still enough power to detect statistically significant differences between the two groups regarding clinical and radiographic outcome.

Another weakness is the difference in age of the two groups with patients in group A being approximately 10 years older than those in group B. An explanation may be the frequent use of locked plate fixation in patients with reduced bone mineral density. These patients are usually older and female, representing the difference in gender distribution of the two groups (Table I). However, the SF-36 questionnaire was used to assess differences between the two groups regarding general health and did not reveal a significant difference.

In conclusion, TBW is still a preferable surgical method to treat simple isolated olecranon fractures. The patient must be informed that implant removal will be required once the fracture has healed. Fixation with precontoured LCP does not provide better functional and radiographic outcome but is more expensive than TBW.

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