Fractures Of The Olecranon – Cerclage Compression Wiring vs Plating

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Abstract- Background: There is still no generally accepted osteosynthesis of the displaced fractures of the olecranon – compression cerclage wiring (CCW) or plate. Some studies find the lower risk for failure and for symptomatic hardware removal as advantages of the plate, others – the lower rate of infections as advantages of the CCW. Additionally, most studies report similar functional results.

Aim: To compare the clinical results, as well as the rates of non-anatomic reduction and implant failure after osteosynthesis of olecranon fractures by CCW *vs* plate.

Materials and methods: For a period of 5 years (2020-2024), 111 patients with olecranon fractures were operated in First clinic of orthopaedic trauma, "N. I. Pirogov" Emergency Hospital. In all cases open reduction was performed, with plate osteosynthesis in 71 patients and tension band wiring in 40. Of them, 94 patients (63 with plates and 31 with CCW) were followed until fracture union.

Results: The patients with CCW showed significantly higher rates of non-anatomic reduction (step-off >2 mm or diastasis >3 mm) – 9/31 (29.03%) vs 5/63 (7.93%) for the patients with plates (p=0.003449). The rate of complications (K-wire migration, secondary loss of reduction and non-union) was higher in the CCW group – 4/31 (12.9%) and 3/63 (4.76%) for the plate osteosynthesis, but the difference was not statistically significant (p=0.078756). Reoperations (mostly hardware removals) were done in 13/63 (20.63%) of the patients with plates and in 11/31 (35.48%) of the patients with CCW (p=0.047922).

Discussion: This study shows significantly higher risk for non-anatomic reduction in patients with CCW. This can be attributed to the use of the plate as a stable reduction template.

Conclusion: The higher rate of non-anatomic reduction in patients with CCW, found in our study, is an argument in favor of plate osteosynthesis in patients with fractures of the olecranon, especially in cases with comminution.

Keywords— Olecranon fracture, Compressive cerclage wiring, Locked plating

1. INTRODUCTION

Cerclage compression wiring (CCW) of the olecranon, formerly known as tension band wiring (TBW) is probably the most widely used procedure for the treatment of displaced, 2-part olecranon fractures. Alternatively, plate osteosynthesis allows for better fracture reduction and stability, and is preferred for comminuted fractures and fractures, associated with ulnohumeral instability[1]. Apart from these two methods, in recent years a number of alternative fixation options have emerged, including intramedullary nailing[2] and suture anchor fixation[3]. Still, none of these has gained widespread acceptance. A number of comparative studies, mostly retrospective, of CCW and plate fixation have been published[4-6], and generally they find no difference with regard to the functional results.

Proponents of the CCW often emphasize that it is a simple and cheap method with biomechanical advantages, namely the presumed conversion of triceps tensile force into compression at the fracture site with active extension of the elbow joint, first postulated by Pauwels in the 1930s. Recently though, two landmark biomechanical studies have discarded this concept. The first, published by P. Brink. et al[7] in 2013, showed no increase of the compression at the fracture during active flexion of the elbow joint and some increase of the compression between 30 and 120 degrees during active extension, but only when the humerus is vertical (directed up) and the forearm is actively extended and passively flexed by gravity – a position, quite unsuitable for postoperative rehabilitation. The other, published by Zderic et al. in 2017[8], studied the TBW principle in transverse fractures of the patella, and found homogenous pressure distribution over the whole fracture area during knee motion, and concluded that TBW fulfills from a biomechanical point of view the requirements for sufficient fixation stability in transverse patella fracture, but should be considered a static fixation principle, not a dynamic one.

In a prospective randomized trial of 67 patients, Duckworth et al.[9] found no difference in the DASH and MEPS scores at 1 year between CCW and plate osteosynthesis in Mayo 2A olecranon fractures. The overall complication rate was higher in the CCW group, predominantly because of a significantly higher rate of symptomatic hardware removal, but the infection rate, on the other hand, was higher in the plate group.

A number of other studies have shown higher complication rates for the CCW – pin migration to an average of 4 mm for short intramedullary pins, 1.5 mm for bicortical pins and 1.3 mm for long intramedullary pins (Huang et al., 2010[10]), restricted ROM to an average of 125 degrees (Koiwa et al, 2024[11]), mild pain after pin removal in 34/51 pts (Chalidis et al, 2008[12]).

2. Materials and methods

To determine if any difference exists between CCW and plate osteosynthesis of olecranon fractures with respect to the functional results (measured by the Mayo Elbow Performance Score), quality of reduction, complications and removal rate in patients with olecranon fractures, we conducted a retrospective study of 111 patients, operated on for olecranon fractures in "N. I. Pirogov" Emergency Hospital over a 5-year period,

between 2020 and 2024. Of the 111 patients identified, 94 had follow-up X-rays until fracture union. The average age of the patients was 57.6 years (range – 17-95 years). The females were 69, with average age 62 years (20-95), the males were 42, with average age 50 years (17-83). Of the 94 radiographically followed patients, only 32 agreed to come for a final follow-up exam, during which the range of motion and the Mayo Elbow Performance Score were recorded.

The patients were distributed into 2 groups – Group A (CCW) and Group B (Plating). Group A included 31 patients, followed radiographically (of the total of 40 patients with fractures, stabilized with CCW, 9 were lost to follow-up); Group B included 63 patients, followed radiographically (of the total of 71 patients with fractures, stabilized with plate, 8 were lost to follow-up) (fig. 1 Patient follow-up).

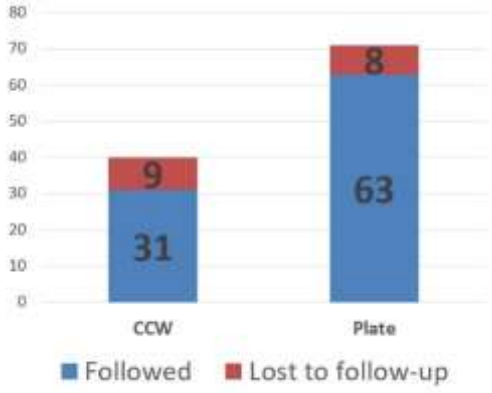


Fig. 1 Patient follow-up

The fractures were classified according to the Mayo classification (fig 2).

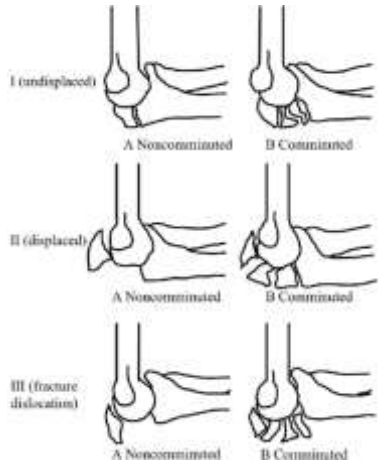


Fig. 2 Mayo classification of the olecranon fractures

The distribution of the patients according to the Mayo type and the implants used is shown in figure 3.

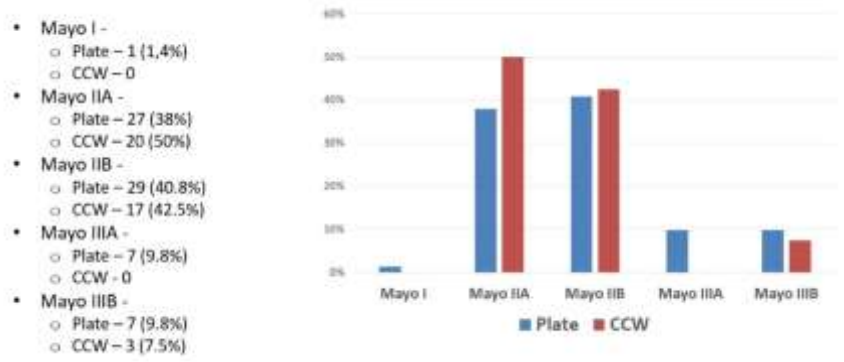


Fig. 3 Distribution of the patients according to the Mayo type and the implants used (shown as percentage of all patients – both followed and non-followed, n=111)

The quality of reduction was assessed on the postoperative and the final X-rays. "Poor reduction" was defined as one with > 2 mm intraarticular step or > 3 mm of diastasis, or X-ray signs of ulnotrochlear incongruity.

Available for functional assessment were only 32 patients. The outcome measure was performed using the Mayo Elbow Performance Score (MEPS, table 1).

Variable	Definition	Points
Pain (max. 45 pts)	None	45
	Mild	30
	Moderate	15
	Severe	0
ROM (max. 20 pts)	> 100 degrees	20
	50-100 degrees	15
	< 50 degrees	5
Stability (max. 10 pts)	Stable joint	10
	Moderately unstable joint	5
	Grossly unstable joint	0
Function (max. 25 pts)	Comb hair	5
	Feed	5
	Hygiene	5
	Shirt buttoning	5
	Shoe lacing	5
> 90 – excellent; 75-89 – good; 60-74 – fair; < 59 – poor		

Table 1. Mayo Elbow Performance Score (MEPS)

For the statistical analysis, the p value was calculated using the Z-test.

3. RESULTS

Quality of reduction

Non-anatomic reduction was found in a total of 14 patients (14.9%). Of them, 9 (29.03%) were from group A (CCW), and 5 (7.93%) were from group B (plate osteo-synthesis), fig. 4 and 5.



Fig. 4 Non-anatomic reduction – articular diastasis >3 mm.



Fig. 5 Non-anatomic reduction – articular step >2 mm and joint incongruity, indicative of decreased height of the olecranon

The statistical analysis showed that the rate of non-anatomic reduction was higher in group A (CCW), and the difference is significant (p=0.003449, fig 6)

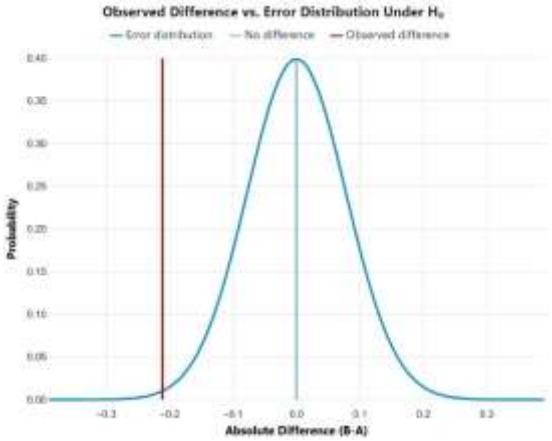


Fig. 6 Statistically significant higher rate of non-anatomic reduction in group A (CCW), p=0.003449

Complications

As the study was retrospective and based mostly on the follow-up X-rays, only X-ray complications could be assessed. Complications (K-wire migration, secondary loss of reduction and non-union) were found in a total of 7/94 patients (7.45%). Of these 7, 4 of the complications were in group A (CCW) – 12.9% (fig. 7), and 3 were in group B (plate) – 4.76% (fig. 8).



Fig. 7 Secondary dislocation after compressive cerclage wiring of an olecranon fracture.



Fig 8 Secondary dislocation and non-union after plating of an olecranon fracture

Regarding the total number of complications, the rate was higher in the CCW group, but without reaching statistical significance (p=0.078756, fig. 9).

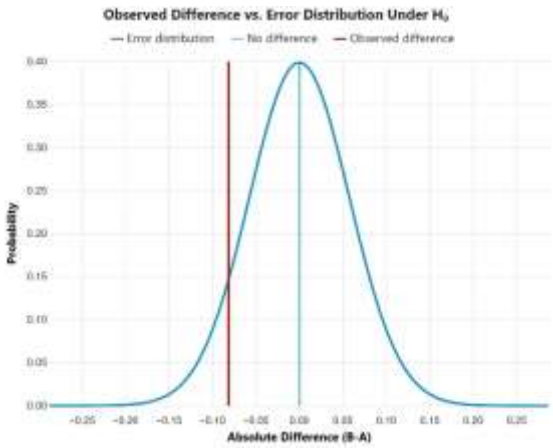


Fig. 9 Statistically non-significant higher rate of complications (K-wire migration, secondary loss of reduction and non-union) in group A (CCW), p=0.078756

Of the complications found, we see the K-wire migration in group A (CCW) as a minor one. Without accounting for it, the number of complications was 2 in group A (2 cases of secondary loss of reduction, 6.45%) and 3 in group B (3 cases of loss of reduction with 1 non-union, 4.76%). This way, regarding only the serious complications, the difference was not statistically significant (p=0.365681, fig. 10).

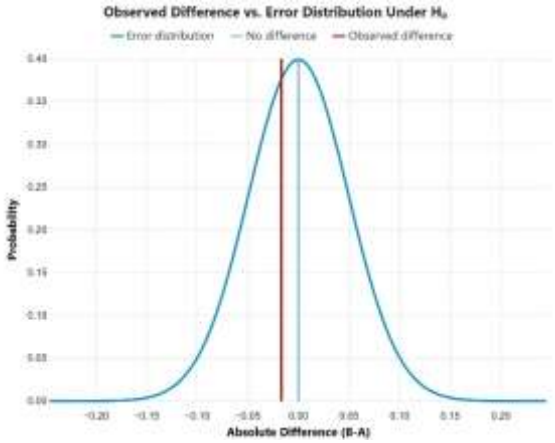


Fig. 10 Lack of statistical significance in the rate of serious complications (loss of reduction and non-union), p=0.365681

Secondary surgeries were performed in 11 patients from group A (CCW, 35.48%), and in 13 patients from group B (plate, 20.63%). The difference in the number of secondary surgeries is statistically significant (p=0.047922, fig. 11).

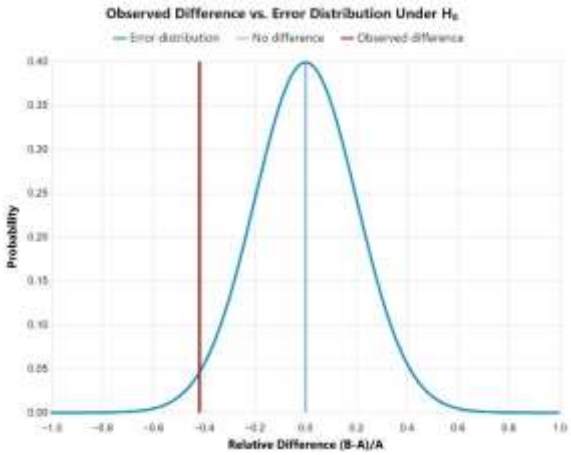


Fig. 11 Statistically significant higher rate of secondary surgeries in group A (CCW, p=0.047922)

In group A all 11 secondary surgeries were for hardware removal, while in group B (plate) 2 of the 13 secondary surgeries were for reosteosynthesis due to secondary loss of reduction, and 11 – for hardware removal.

Functional results

Only 32 patients (13 from group A and 19 from group B) agreed to come for a final follow-up exam, during which ROM measurement and MEPS were taken. For the range

of motion, the results were 141.8° in group A and 143.2° in group B. The difference was not statistically significant (p=0.416, fig. 12).

For the Mayo Elbow Performance Score, the results were 96.4 (excellent) in group A and 98.2 (excellent) in group B. The difference was not statistically significant (p=0.375, fig. 13).

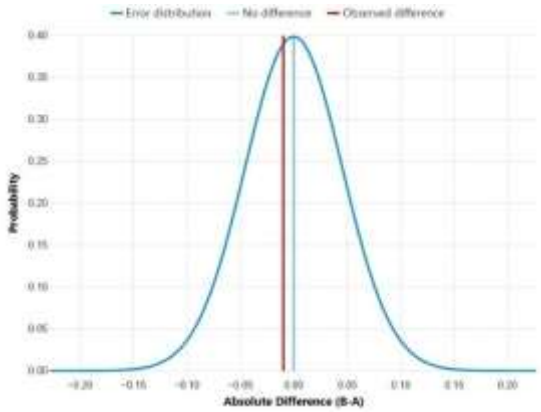


Fig. 12 Lack of statistical significance for the range of motion between group A and group B (p=0.416)

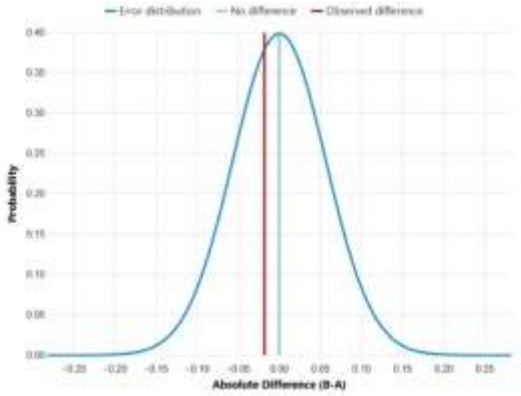


Fig.13 Lack of statistical significance for the MEPS score between group A and group B (p=0.375)

4. DISCUSSION

Before the introduction of modern plates, CCW, formerly known as tension-band wiring, was the most widely used method for fixation of olecranon fractures and was considered the gold standard.[12] Apart from its perceived biomechanic advantages, which were recently challenged by Brink[7] and Zderic[8], another advantage over non-locking plates is that it minimizes the periosteal stripping around the fracture.[13] Still, the method has some drawbacks – the stability it provides might be insufficient in comminuted fractures and fractures with less than 10% of the height of the olecranon preserved, which is usually associated with ulnohumeral dislocation.[14] The pre-contoured locking plates show higher stability and better purchase, especially in osteoporotic bone.[15,16] While this has been proven by multiple studies, a debatable question is whether the stability provided by CCW is sufficient. A meta-analysis of 13 biomechanical studies by Cutter et al. showed that although plating displays increased stability along the posterior cortex, there is no significant difference between CCW, intramedullary screw, and plate constructs in their ability to maintain fracture reduction at the articular surface during simulated physiologic loading.[17]

Other considerations in the choice of implant are the complication rates, including non-unions and secondary dislocations, and the need for secondary surgeries, mostly for implant removal. A meta-analysis by Bethel et al. revealed that CCW resulted in a significantly higher percentage of complications, removal of hardware, and reoperations compared to plate fixation.[19] Furthermore, a prospective randomized controlled trial by Duckworth et al.[9] in 2017 found that patients with Mayo 2A fractures (displaced without comminution) had comparable functional outcomes and ROM at 1 year after CCW and nonlocking plate fixation. However, significantly higher complication rates (63% vs. 38%; p=0.042) and removal of symptomatic hardware (50.0% vs. 22%; P=0.021) were observed after CCW. Avisar et al in 2024 similarly reported no differences in ROM or functional outcomes between CCW and locking plate fixation for Mayo 2A fractures, but significantly greater removal of hardware after CCW (OR: 9.6; p=0.002).

Our study showed some advantages of plate fixation over CCW – namely the higher rate of anatomic reduction in the plating group, which could be attributed to the use of anatomically pre-contoured plates, and higher complication rate with CCW. The former seems to be a genuine advantage of plating, as in our study it does not seem to be related to the fracture comminution – for the plating group, 3 out of 5 non-anatomic reductions (60%) were in Mayo subtype B fractures, while for the CCW 5 out of 9 non-anatomic reductions (55.5%) were in Mayo subtype B fractures.

The overall rate of complications is higher in the CCW group, although statistically non-significant. Furthermore, we see the K-wire migration as a minor complication, as in our study none of the migrations was sufficient to cause skin penetration, and when we account only for the serious complications, which are the secondary loss of reduction and non-union, then the complication rate between CCW and plating is similar, and this is consistent with the results reported in the literature – that plating is associated with fewer, but more serious complications. The number of secondary surgeries is also in compliance with this finding – the percentage of secondary surgeries was much

higher in the CCW group (35.48% vs 20.63%), but they were all for hardware removal, while in the plating group 2 of the secondary surgeries were revision ones – for reosteosynthesis in patients with secondary loss of reduction.

Only one complication in each group was in patients aged 70 or above – a finding which is somewhat contradictory to literature, although this should be interpreted cautiously due to the small number of events. A large retrospective study by Parkes et al.[20] found that in 177 olecranon fractures in patients aged >70, those treated with CCW showed a 26% failure rate in fixation resulting in the need for revision surgery, whereas plate fixation exhibited an 8% failure rate – a clear advantage of locked plating in patients with osteoporotic bone.

As the study assesses mostly radiographic complications, many complications (such as wound healing problems, soft tissue irritation, infection, pain and ulnar neuropathy) are underreported.

The functional results were excellent and very similar between the two groups. However, the functional assessment also represents the main limitation of our study. Of all 94 patients, followed radiographically, only 32 were willing to come for functional assessment, and they were mostly the ones with excellent X-ray results. None of the patients with serious complications (loss of reduction and non-union) came for functional assessment.

5. CONCLUSION

In our study, the main advantage of plating was found to be the superior fracture reduction, which did not appear to be explained solely by fracture morphology and could be attributed to the use of pre-contoured plates. As our study has some drawbacks – being a single-center retrospective study with major loss to follow-up for functional assessment, we cannot give strong recommendations for preference of one method over the other, but we still think that plating could be considered in olecranon fractures, where more difficult reduction is expected, i.e. the B-subtypes in the Mayo classification, the ones with ulnohumeral instability (types 3A and 3B), and, as suggested by prior literature (although not supported by our study, which might be due to the small number of events) – for all patients, aged 70 and above. CCW, on the other hand, can be considered for younger patients with 2-part fractures (Mayo 2A).

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