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Treatment of displaced olecranon fractures: a systematic review

Review of treatment of olecranon fractures

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Declaration of conflicting interests

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Abstract

Background and Aims: The incidence of olecranon fractures is rising. Displaced fractures are usually operated either by tension band wiring or plate fixation. The aim of this review is to evaluate the best current evidence on the management of displaced olecranon fractures.

Materials and Methods: Randomized controlled trials were systematically gathered in May 2018 from CENTRAL, MEDLINE, Embase, CINAHL, Scopus, and PEDro databases. The methodological quality of articles was assessed according to the Cochrane Collaboration's domain-based framework. Prospero database registration number: CRD42018096650.

Results: Of 1518 identified records finally five were relevant. Four trials were found on tension band wiring (TBW): two compared TBW with plate fixation (PF) (N=108), one compared PF with an olecranon memory connector (N=40) and one trial compared TBW with a modified TBW called Cable Pin System (N=62). In addition, one trial compared operative and conservative treatment in elderly (N=19). The risk of bias was considered low in two and high in three of the trials. The follow-up time was 5 to 36 months and outcome measures varied from patient-rated and physician-rated measures to radiological outcomes. In the **analysis**, there was no difference between TBW and PF. The data was insufficient for further quantitative analysis.

Conclusion: No differences were found in clinical or patient rated outcome measures between the two most frequent fixation methods (TBW and PF) of displaced olecranon fractures. Current data is not sufficient to evaluate other treatment methods, however, **conservative treatment might serve as an option for selected patients in the elderly population.**

Keywords: olecranon fracture, elbow fracture, tension band wiring, plate fixation, conservative treatment, systematic review

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Introduction

The incidence of olecranon fractures, especially in the elderly, is rising (1,2). Displaced fractures have traditionally been treated operatively to re-establish the congruency of the ulnar joint-surface and to re-attach the triceps tendon (3). The most frequent operative methods for fixation of a displaced fracture are tension band wiring (TBW) and plate fixation (PF). According to previous observational studies, both of these methods seem to achieve adequate union and functioning but are also associated with high rates of re-operations due to operative complications and removal of the prominent metalwork after fracture union (4,5). As relying on observational, mainly retrospective studies, previous reviews and a meta-analysis (3,5) have shown a lack of level I/II evidence to support one implant over another. In a Cochrane review of RCTs from 2014 authors stated that no sufficient evidence based on randomized, controlled trials yet existed (6).

In addition of these two main fixation options (TBW and PF), also other operative techniques and instruments have been suggested. Further, based on data from small retrospective series in the elderly, it seems that conservative treatment could provide a good functional outcome with a low complication burden in this population (7,8).

In this review, we aim to evaluate the current evidence of the treatment of displaced olecranon fractures based on randomized controlled studies.

Materials and Methods

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Search Criteria

Inclusion criteria for this review were based on PICOS framework (Population, Intervention, Comparison, Outcome, Studies) as follows:

Population: adults (>18y) with acute, traumatic and displaced olecranon fracture excluding multiple and open fractures and fractures associated with malignancy.

Intervention: operative treatment using tension band wiring or plate fixation.

Comparison: any other treatment (also tension band wiring or plate fixation when not used as intervention).

Outcome: any outcome.

Studies: RCTs and if under five, controlled studies with at least ten participants in any language with English abstract excluding conference proceedings, theses, reviews, case studies etc.

Search Methods for Identification of Studies

The CENTRAL (Cochrane Central Register of Controlled Trials), MEDLINE, Embase, CINAHL (Cumulative Index to Nursing and Allied Health Literature), PEDro (Physiotherapy Evidence Database), and Scopus databases were searched in May 2018 unrestricted by date. Search clauses for each database are shown in Table 1. To avoid missing relevant studies, use of limits was restricted and further selection was conducted manually. The references of identified studies were also checked for relevancy.

Study Selection and Methodological Quality Assessment

After saving all identified records to citation manager EndNote software (X7.2; Thomson Reuters, New York, NY, USA) two authors (I.R. and K.L.) performed a crude exclusion of irrelevant records, duplicates, clear conference proceedings, theses, reviews, posters and expert opinions based on titles (Fig. 1). Two

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independent reviewers (I.R. and A.M.) screened all the remaining 81 records based on titles and abstracts, and then screened the full texts of the selected potentially relevant studies. The same independent reviewers also rated the methodological quality of the included five trials (Table 2). Disagreements between reviewers were resolved by consensus or by a third reviewer (K.L.).

Data were extracted from included studies using a standardized form based on recommendations in the *Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0* (9). The methodological quality was assessed according to the Cochrane Collaboration's domain-based evaluation framework (9). Following main domains were assessed: (1) selection bias (randomized sequence generation and allocation concealment), (2) performance bias (blinding of participants and personnel), (3) detection bias (blinding of outcome assessment), (4) attrition bias (incomplete outcome data, e.g., due to dropouts), (5) reporting bias (selective reporting) and (6) other sources of bias. The scores for each bias domain and the final score of risk of systematic bias were graded as low, high, or unclear risk (9). The registration number of this review (Prospero database) is CRD42018096650.

Treatment methods included to the study

Tension band wiring (TBW)

In traditional tension band wiring, two parallel Kirschner wires are inserted in a longitudinal direction from the proximal fragment of the olecranon extra-articularly, into the ulna more distally. The wires can be placed through the anterior cortex or straight down the shaft of the ulna. A transverse tunnel is drilled in the ulnar shaft about 4 cm distal to the fracture site and then a flexible cerclage wire (usually 1.0mm or 1.2mm) is passed through the tunnel and posterior to the two Kirschner wires in a figure of eight. The wire is tensioned, and all wire ends trimmed and buried into the triceps tendon. (10)

Plate fixation (PF)

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In plate fixation, the fracture is reduced and a pre-contoured dorsal proximal ulnar plate is applied.

Aiming for a stabile construct, the plate is fixated with screws. (10)

Outcome measures

Any patient-reported, physician-reported or other clinical or radiological outcome measures with also indicators of mobility and complications were included. Mainly used scores were "the Disabilities of the Arm, Shoulder and Hand" (DASH) questionnaire (12,13) which is a patient rated outcome measure (PROM) with a sum score 0-100 (0 = no, 100 = severe disability), and two physician-based measures "the Mayo Elbow performance score" (MEPS) (14) (5 = worst, 100 = best: pain 0-45, range of motion 5-20, stability 0-10, functions 0-25) and "Broberg and Morrey score" (B&M) (15,16) (0-100, 0 = worst, 100 = best: range of motion 0-40, strength 0-20, stability 0-5 and pain 0-35) .

Statistical analysis

A meta-analysis was inapplicable due to the dissimilarities of the included RCTs. The effect sizes of the outcomes of the included studies could not be calculated either, because baseline values were not reported. **Analysis** of studies was reported by absolute numbers with per cents and mean values with standard deviations.

Results

Of the 1518 records identified in the search, five were finally considered relevant for **analysis** (Figure 1) (10,11,17–19). The pooled patient population of these RCTs involved 229 patients (Table 3): 85 in TBW, 75 in PF, 61 in different operations, and 8 in conservative treatment group (10,11,17–19). The size of study populations varied from 19 (11 cases vs 8 controls) (11) to 67 (34 cases vs 33 controls) (10). **The**

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types of the fractures were classified according to Mayo (20,21) (Table3). The duration of follow-up ranged from about five months (19) to three years (17) (Table 3). Three studies compared TBW to plate fixation (10,18) or to modified technique of TBW; Cable Pin System (CPS) (19). One study compared PF (plate fixation) to olecranon memory connector (OMC) (17) and one compared operative treatment to conservative treatment (11). The risk of bias was considered high in three of the five trials (Table 2) (10,17,18). A meta-analysis was not applicable due to lacking baseline values and differing outcome measures.

Outcome scores

Overall, all included studies showed a good prognosis despite of the chosen treatment (Table 4). When different operative techniques were compared (10,17–19) there were no **statistically significant** between-group differences in patient-rated scores (DASH) (10,17) or in the range of motion (10,17,18). Physician-rated scores (B&M or MEPS) were **statistically** similar when comparing TBW and PF (10), but had a statistically significant difference in the studies comparing PF to olecranon memory connector (OMC) (17) and TBW to Cable Pin System (CPS) (19). In both studies, the result of MEPS was better in the control group (OMC or CPS) with a 7 to 8 % between-group difference and a highly overlapping standard deviation (17,19). Fracture healing time was rated in one study (19), and was reported to be shorter in CPS than in TBW group (about a one week's mean difference). The results of one study comparing TBW and PF (18) favored PF in clinical and radiographic results, when assessed in three categories: good/fair/poor.

When comparing operative and conservative treatment (a collar cuff sling for two weeks) in elderly, there were no between-group differences in patient- or physician-based outcome evaluations or range of motion (11).

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Reoperations and complications

In comparison of complication rates, reoperations in TBW groups due to prominent metalwork varied from 16 to 50 % across studies reaching 27 % (23 of 85) of all participants in TBW groups (10,18,19) (Table 5). In PF groups, removal rates were lower. Some plates had to be removed because of prominence (10,11) and one study reported 22 % removal rate (10). Infection rates varied from 0 to 14 % (10,11,17–19). Loss of reduction was more common in TBW groups than in control treatments (10,11,18,19). The study comparing operative and conservative treatment in elderly was interrupted because of the high complication rate in operative group (11).

Discussion

The four main findings of our systematic review of RCTs on displaced olecranon fractures were 1) the lack of high-quality evidence, 2) a good prognosis with all studied treatment options, 3) rather high complication rates after operations, and 4) small and clinically non-significant difference or no difference at all in the **outcomes** between the studied treatment options. Unfortunately, current evidence did not enable us to pool the results for a more accurate meta-analysis.

Our results are highly comparable with the only one previous systematic review of RCTs on operative treatment of olecranon fractures, where the search was performed in September 2014 (6). In contrary to this previous Cochrane review, we excluded high-bias-risk quasi-RCTs. Additionally, we focused on displaced fractures with a long-term follow-up, and to studies comparing either PF or TBW to other treatment options. Three studies were included in both systematic reviews. Two recent studies, both from one study group in United Kingdom published in 2017, enabled us to include conservative treatment option into the current review.

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As in 2014 (6), all studies are small (19 to 67 participants), and have inadequately reported blinding of clinicians and participants, possibly influencing the patient- and physician-reported outcome measures. Each of our five RCTs evaluated either differing treatments (TBW vs PF, PF vs OMC, TBW vs CPS or operation vs conservative treatment), or when comparing same treatments (TBW vs PF in two studies), the outcome measures were not comparable; validated questionnaires and range of motion in one, and combined clinical results in the other. Even if the authors of the previous review (6) stated that weaknesses of the included high-bias-risk studies highly affected the reliability of their conclusions, they wanted to help clinicians with a quantitative evaluation. As studies included in our and in the previous review did not have any baseline measurements before the treatment, the comparison of between-group differences is based on the follow-up measurements only, and has a higher risk of bias than when comparing the change of baseline values between two groups. In our study, we did not compensate the lack of meta-analysis with other types of quantitative reporting.

Based on our results current evidence, or lack of evidence, does not support changing treatment practices in working age patient populations. Comparably to earlier data, there were no significant differences between operative treatment methods, usually TBW, PF or their modifications in adults with displaced olecranon fractures (4,22,23). Both methods, TBW and PF, achieve adequate union and elbow function but are associated with high rate of re-operations because of infections or removal of the prominent metal devices after fracture union. Authors of one study concluded that modification of TBW (CPS) was better than standard TBW (19), and authors of another study that a novel invention resembling TBW (OMC) was superior to locking PF (17). In both studies, the between-group differences in the follow-up values were under 10 % with highly overlapping **standard deviation**. Positive results with OMC were reported by the designers of this technique, and their findings should be confirmed before implementing OMC to clinical practice. The clinical relevance concerning the reported superiority

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of PF in radiological outcomes in one included study remains questionable since there were no acceptable limits reported. In addition, radiological results were not compared to the functions (18). Compared to earlier reviews, we were able to include more recent RCTs and conservative treatment to our review.

We found two new studies after the review in 2014. One low-bias-risk study compared PF and TBW, and found similar patient rated outcomes and clinical functions after both operation techniques (10). The other new study was planned to compare conservative and operative treatment in the elderly (11). This study questions the treatment paradigm of displaced olecranon fractures and is in line with previous retrospective studies showing no patient- or physician-rated benefit of operative treatment over conservative treatment. The study was prematurely discontinued after only 19 participants due to complications in the operative treatment arm. Reconstruction of articular surface is important in the active elbow loading working-age population. However, conservative treatment may yield satisfactory outcomes in daily activities, and may be considered as a potential treatment in the elderly population.

In all studies, complications after operative treatment were common, especially after TBW. The soft tissue coverage of the olecranon is very thin, and operative hardware (wires, plates, screws or pins) are prone to **cause** problems under the skin. Hardware prominence remained the most common adverse effect in this review **frequently** leading to re-operations, and assessing and reporting of complications is recommended also in future RCTs.

We acknowledge that our study had several limitations. In a wide systematic review as ours, the results always depend on the search clauses and used databases. Even if we kept the search wide, and if we assume that these five studies reflect this patient population, we only have information of some outcome measures. While the evidence is still limited, results may change after high-quality,

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low-**bias**-risk-studies. The short-term **outcome** was not in the scope of this review, and we consider long-term **outcome** more important when choosing treatment options. To more definite conclusions, meta-analysis on only low-**bias**-risk RCTs would be needed, however, this is not possible based on current studies. Despite the weaknesses, this review is the first update of reviewing RCTs after year 2014 (6). **Previously the most frequently used method of care for olecranon fractures was operative treatment. However, the proportion of conservative treatment is increasing among low demand patients and therefore, we feel that this review is valuable addition to the previous literature.**

In conclusion, the evidence is insufficient to draw robust conclusions on the clinical superiority of one treatment over another. The current literature supports standard fixation methods (TBW and PF) on displaced olecranon fractures in adults. In the elderly population, conservative treatment may be a potential treatment option to avoid unnecessary operations and complications.

Authors' contributions

All authors have substantially contributed in designing the study, and acquiring, analyzing and interpreting the data. All authors have also participated in drafting the manuscript and revising it critically for important intellectual content. All authors have given their final approval of the submitted version of the manuscript.

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