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Review Article

Metal Tension-Band Wires vs Tension-Band Sutures in the Fixation of Olecranon Fractures: A Systematic Review

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Abstract

Background: Tension-Band Wiring (TBW) is the treatment of choice for displaced, non-comminuted olecranon fractures. Due to the high complication rate involved with TBW, particularly the need for re-operative hardware removal, an alternate method using a high-strength, non-metallic Tension-Band Suture (TBS) construct has been precipitated. There is currently no literature comparing and evaluating these 2 particular techniques, therefore, this systematic review aims to address this.

Methods: 6 databases were searched (MEDLINE, Embase, Web of Science, Cochrane Library, The CRD and Clinicaltrials.gov). Titles, abstracts and full articles were then systematically screened against the eligibility criteria. The primary outcomes studied were reported postoperative functional outcomes, and complication rates.

Results: From 2538 identified abstracts, 5 studies met our eligibility criteria. Only one study compared TBW with TBS and concluded that in paediatric patients, there is a lack of benefit from TBS due to a similar rate of reoperation for hardware removal. 4 studies solely analysed TBW. In TBW, the rate of reoperation reached as high as 76.5% with the need for hardware removal being the most common indication.

Conclusion: This review was required to highlight the alarming paucity of studies analysing TBS fixation in the treatment of non-comminuted olecranon fractures. Based on the included studies, it is difficult to conclude an advantage for either TBW or TBS due to the lack of standardised measuring of functional outcomes and comparative studies. There is potential for a reduced rate of reoperation in TBS, however, there is a great need for more robust studies analysing this technique.

Keywords: Olecranon; Non-comminuted; Displaced; Fracture; Tension-band; Wire fixation; Suture fixation; Orthopaedics; Surgery

Introduction

Olecranon fractures are a common form of upper limb trauma. There is a reported incidence of 12 per 100 000 population, with this affecting males and females of all ages [1]. The mechanism of injury has a bimodal age distribution. In younger patients, the injury is often from high-energy direct trauma to the posterior elbow, for instance a road-traffic accident, whereas in the elderly population, fractures tend to arise from low-energy trauma such as a fall onto an outstretched hand [2]. The Mayo classification is commonly used to classify isolated olecranon fractures and guide treatment options [3]. Conservative treatment options are explored for undisplaced fractures (Mayo 1) and patients unfit for surgery. Tension-Band Wiring (TBW) is the mainstay of treatment for displaced, non-comminuted olecranon fractures (Mayo 2A and 3A), with comminuted fractures (Mayo 2B and 3B) usually undergoing plate fixation [4].

TBW involves the use of intramedullary Kirschner wires (K-wires) and metal wire tension-bands [5]. Despite TBW being the popular choice for non-comminuted olecranon fracture fixation, there are high complication rates ranging up to 82.3%. Common complications reported include pain and loss in the range of movement of the elbow. The pain can be attributed to the metal irritating the overlying soft tissue, or the protrusion of K-wires. Most significantly, this often results in the need for re-operation to remove the metal tension-band wire [6,7]. This has precipitated the use of an alternative method for the tension-band construct, namely the use of FiberWire or a different high strength Tension-Band Suture (TBS). Theoretically, this will reduce the described complications posed by the use of a metal tension-band [8]. However due to the current paucity in the literature, there is a lack of consensus regarding both the reduced complication rate, and whether functional outcomes are affected with this alternative technique.

At the time of writing this article, to our knowledge, there is currently no review comparing and evaluating the use of metal tension-band wiring and tension-band sutures in the treatment of non-comminuted olecranon fractures. This article aims to address this by reviewing studies of these two techniques and comparing their functional outcomes and complication rates. This will help ascertain whether the use of tension-band sutures provide a viable surgical option to reduce the complications of classical metal tension-band wiring, without compromising functional outcomes.

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Methods

Search Strategy

The protocol for this review has been published on PROSPERO under the registration ID CRD42020190507. Six databases (MEDLINE, Embase, Web of Science, Cochrane Library, The Centre for Reviews and Dissemination (CRD) and Clinicaltrials.gov) were systematically searched on 15th January 2021. All articles were searched and selected on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) criteria and Assessing the Methodological Quality of Systematic Reviews (AMSTAR) guidelines [9,34]. References from any eligible articles and relevant orthopaedic guidelines were also searched, as well consulting experts in the field of orthopaedics. The titles of the articles identified from the database searches were initially screened, and then the abstracts of those shortlisted were further screened by three authors (RS, AD, VS). Each full manuscript of the final articles was then assessed against eligibility criteria by two different authors, and any dispute was discussed between all authors and settled by a consensus (RS, AD, VS, SR, RC, SR). Data from the eligible articles was initially inputted into a pre-defined, piloted spreadsheet, with an additional author (SS) reviewing this.

Eligible Studies

All original research studies comparing fixation with a metal tension-band wire and a tension-band suture for the treatment of non-comminuted olecranon fractures, were considered for inclusion. Similarly, single-arm studies involving either technique were also considered. Only studies involving human participants after the year 2000 were included to reflect modern practice. Furthermore, only studies with statistical analysis, and in the English language or with an accessible English translation were included. Biomechanical and cadaveric studies were excluded due to the lack of applicable functional analysis. Studies which did not separate analysis of comminuted and non-comminuted fractures, and patients with treated associated upper limb injuries were also excluded due to their additional impact on functional outcomes.

Eligible Participants

The eligible participants were males or females, of any age, with a diagnosed non-comminuted olecranon fracture (Mayo 1, 2A, 3A) requiring tension-band fixation.

Eligible Interventions and Comparators

The eligible intervention was tension-band fixation with a metal Tension-Band Wire (TBW), for the treatment of non-comminuted olecranon fractures. The eligible comparator was tension-band fixation a Tension-Band Suture (TBS), as opposed to a metal tension-band, for the treatment of non-comminuted olecranon fractures.

Outcome Measures

The primary outcome measures were both functional outcomes and complications. The functional outcomes measured included the Disabilities of the Arm, Shoulder, Hand (DASH) score, Range of Movement (ROM) in flexion, extension, pronation and supination, the Mayo Elbow Performance Score (MEPS) and any other measurements of elbow function specified, both quantitative and qualitative. The DASH score is a self-reported questionnaire, consisting of 30 questions, which aids measuring the patient's impairment and level of disability. There is also a shortened 11 question version called the Quick DASH which is used [10]. The ROM measures the degree of flexion and extension of the elbow, and the degree of supination and pronation of the forearm as well as the functional arc of movement. The MEPS is a tool that has four components: pain, ROM, stability and daily function. A total of 100 points are possible, with a score of less than 60 considered poor, between 60 and 74 considered fair, between 75 and 89 considered good, and a score between 90 and 100 considered as excellent [11].

Complications measured were any reported post-surgical adverse events, including pain, protrusion of K-wires. Furthermore, the need for additional surgery and rate of reoperation were recorded where possible, including hardware removal or fixation revision.

Assessment of Risk of Bias

The assessment of risk bias was conducted using two tools. The ROBINS-1 was used for comparative, non-randomised studies, whereas the MURAD tool was used for single-arm studies [12,13].

Data Analysis

A narrative synthesis comparing and discussing the comparator and intervention was conducted. Quantitative data in the form of means, medians and ranges have been presented in tables. Where possible, probability values, confidence intervals and standard deviations have been stated. A Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) analysis was also conducted to assess the quality of the studies, and aid forming a conclusion [14].

Results

Study Characteristics

Figure 1 illustrates the PRISMA flowchart for the selection of studies. 2538 articles were identified from the 6 databases, using the search strategy provided in Appendix A. Eventually, five studies were included in the qualitative synthesis of this review [15-19]. A further four studies were used in the discussion but not included in the results, due to the lack of statistical analysis [20-23] (Figure 1).

Table 1 highlights the baseline characteristics of the five included studies. All five studies were observational, with four being retrospective and one being prospective. Four studies were case-series analysing TBW [15-18], and one study was a case-control study comparing TBW and TBS [19]. The one comparative study focused only on paediatric patients [19]. The mean follow up ranged from 6 months to 18 years, and one study reported a median follow up of 8.5 months (Table 1).

Functional Outcomes

Three of the included studies reported functional outcomes, as highlighted in (Table 2). All three studies focused solely on the classical TBW technique [16-18]. Function was assessed at different stages of time, ranging from 2 weeks to 30 years. Two studies reported mean DASH scores of 9 and 16, with an overall range of 0-83. These two studies also reported mean MEPS of 96 and 87, with the same range in both studies of 45-100 [16,18]. Whilst all three studies analysed range of elbow movement post-operatively, the measurement of ROM in each study varied, with the deficit in elbow motion, overall mean flexion to extension arc, and individual mean extension and flexion

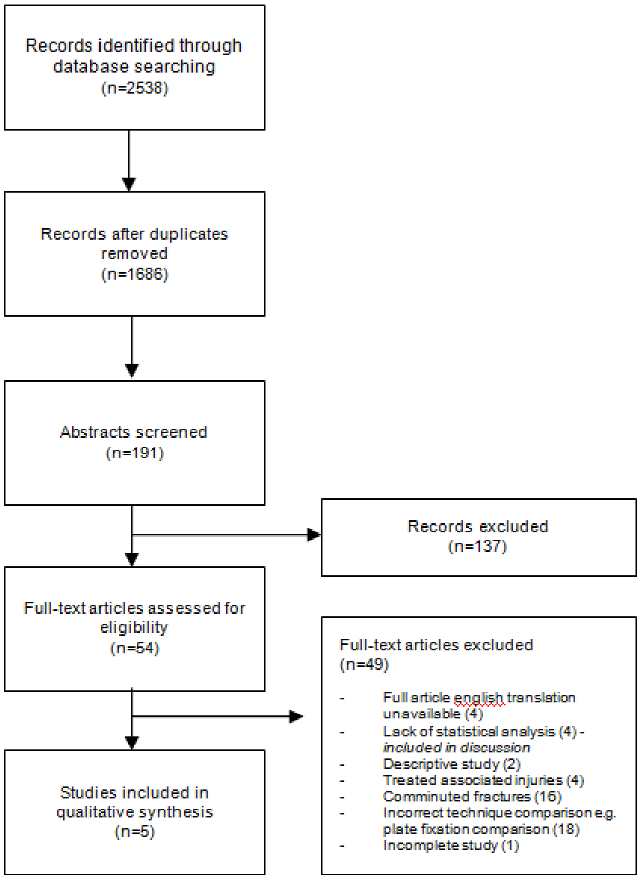

Figure 1: PRISMA flowchart of studies identified, screened and included.

values all being reported. One study reported a mean elbow extension of 6 degrees, and elbow flexion of 133 degrees [16], and one study reported 85% of the participants having a less than 20 degree deficit in elbow motion post-operatively, with the remaining 15% having a more than 20 degree deficit [17]. The third study reported an overall mean flexion to extension arc of 139 degree [18] (Table 2).

Complications

All five of the included studies reported post-operative complications, as illustrated in (Table 3) [15-19]. Four of the included studies focused solely on TBW, with one study comparing TBW and TBS. In the comparative study, 70.6% of patients in the TBW arm required hardware removal, compared to the 58.5% in TBS (p=0.2107). However, 5.9% of patients in the TBW arm required revision fixation compared to 13.8% in patients who had TBS (p=0.1863). Whilst this indicates more patients who had TBW required hardware removal, compared with TBS, fewer TBW patients required revision fixation. This gave overall rates of reoperation of 76.5% in TBW and 72.4% in TBS (p=0.6134) [19]. In TBW, the need for hardware removal was the most common complication, being reported in two studies as being required in 67.4% and 70.6% of patients [15,19]. Two studies also reported 43.5% and 15% of TBW patients having skin irritation, and these two studies also reported complications of K-wire protrusion and migration as 30.4% and 10% [15,17]. Skin perforation or breakdown was reported in two studies as 6.5% and 13% [15,16]. The overall rate of reoperation in TBW was reported in 4 studies, with the rate ranging from 3.8% to 76.5% of patients [15,16,18,19] (Table 3).

Study Conclusions

The one included comparative study concluded there was no role for TBS fixation in the treatment of olecranon fractures [19]. Three studies concluded TBW provides satisfactory and reliable clinical results [15-17], with one of these studies stating the high rate of metal removal may justify exploring other fixation methods [15]. One study concluded the technical aspects of TBW should not be focused on and that TBW is an effective treatment [18]. The GRADE analysis for each study is reported in Table 4. Four studies were deemed low quality [15-17], and one study was deemed moderate quality [18]. Three studies were weak for using TBW [16,18], and one study was strong for using TBW [15,17], whilst the comparative study was weak for using TBW over TBS [19] (Table 4).

Risk of Bias

Tables 5 and 6 indicate the risk of bias in the five included studies. Regarding the four single-arm studies, two studies were deemed low risk of bias [16,17], and there were some concerns with two studies using the MURAD tool [15,18]. The non-randomised comparative study was deemed a moderate risk of bias, using the ROBINS-I tool [19] (Table 5 and 6).

Discussion

Summary of Findings

To our knowledge, there is currently no review comparing and evaluating the use of metal Tension-Band Wires (TBW) and Tension-Band Sutures (TBS) in the treatment of non-comminuted olecranon fractures. This present review aims to fill this gap in the literature. Five studies met the eligibility criteria, with four of these

Table 1: Baseline characteristics of included studies.

Study ID (Authors and Year of Publication)	Country	Type of study		Recruitment Period	Techniques involved	Patient Characteristics			Mean follow up period
						No. of Patients	Mean Age (years)	Sex	
Romero et al. (2000) [15]	Denmark	Observational Case-series	Retrospective	NR	TBW	46 TBW	Median 69	15 M 31F	Median 8.5 months
Villanueva et al. (2006) [16]	Spain	Observational Case series	Retrospective	1996-98	TBW	37 TBW	63	13 M 24 F	4 years
Khan et al. (2014)[17]	Pakistan	Observational Case series	Prospective	2012-2013	TBW	20 TBW	38	16M 4F	6 months
Claessen et al. (2017 18]	Netherlands	Observational Case series	Retrospective	1974-1997	TBW	26 TBW	34	17 M 9 F	18 years
Perkins et al. (2018) [19]	USA	Observational Case-control	Retrospective	2008-2017	TBW vs TBS	29 TBS 17 TBW	TBW 12.9 TBS 12	36 M 10 F	9.1 months

TBW = Tension-Band Wire; TBS = Tension-Band Suture; M = Males; F = Females

Table 2: Functional outcomes reported in the included studies.

Study ID	Technique	Number of Participants	Time to Function Assessment	Mean DASH score	Mean MEPS	Range of Motion
Villanueva et al. (2006) [16]	TBW	23	3-6 years	16 (0-83)	87 (45-100)	Mean Elbow Extension = 6° (0°- 20°) Mean Elbow Flexion = 133° (100°- 145°)
Khan et al. (2014) [17]	TBW	20	2-24 weeks	NR	NR	< 20° deficit in elbow motion = 85% patients > 20° deficit in elbow motion = 15% patients
Claessen et al. (2017) [18]	TBW	26	10-30 years	9 (0-65)	96 (45-100)	Mean Flexion-Extension arc = 139° (95°-150°)

NR = Not reported; DASH = Disabilities of the Arm, Shoulder, Hand; MEPS = Mayo Elbow Performance Score
TBW = Tension-Band Wire; TBS = Tension-Band Suture

Table 3: Complications reported in the included studies.

Study ID	Number of Participants		Complications Reported (%)		Overall Rate of Reoperation (%)	
	TBW	TBS	TBW	TBS	TBW	TBS
Romero et al (2000) [15]	46	-	Hardware Removal = 67.4 Metalware skin irritation = 43.5 Protrusion = 30.4 Aseptic Bursitis = 8.7 K Wire Skin Perforation = 6.5 Delayed Union = 6.5 Transitory Joint Effusion = 6.5 Unacceptable displacement = 4.4 Muscular Atrophy = 2.2	-	71.7	-
Villanueva et al (2006) [16]	23	-	Skin Breakdown = 13.0 Total Degenerative diseases = 17.4	-	43.5	-
Khan et al (2014) [17]	20	-	Symptomatic Skin Irritation = 15.0 Superficial Skin infection = 10.0 Proximal migration of K wire = 10.0	-	NR	-
Claessen et al (2017) [18]	26	-	Technical Defect = 11.5	-	3.8	-
Perkins et al (2018) [19]	17	29	Hardware Removal = 70.6 Revision Fixation = 5.9	Hardware Removal = 58.5 Revision Fixation = 13.8	76.5	72.4

NR = Not Reported; TBW = Tension-Band Wire; TBS = Tension-Band Suture

being single arm studies analysing classical TBW, and one study retrospectively comparing TBS and TBW. The four single arm studies did not consistently report functional outcomes for an in-depth analysis to be possible, but described a range of complications including the need for hardware removal and skin irritation, and a rate of reoperation reaching up to 76.5% of patients [15-18]. The one comparative study concluded that TBS did not have a significantly lower rate of reoperation and no additional benefit, when compared with TBW [19]. The results highlight the paucity of studies with statistical analysis, particularly for the TBS technique.

Studies without Statistical Analysis

Four studies identified in the article screening did not have statistical analysis, however fulfilled the remainder of the eligibility criteria [20-23]. Whilst these studies cannot be used in the results of this review, they remain useful for discussion. (Table 6) highlights these studies. All four studies were retrospective case series, with three analysing TBS and one study focussing on TBW. In the three TBS studies, the mean follow up ranged from 14.9 weeks to 24.5 months, with one study reporting a median follow up of 4 months [21-23]. The TBW study reported a mean follow up of 6 years [20] (Table 7).

In terms of functional outcomes, the TBW study reported a mean DASH score of 12 [20], and two of the TBS studies reported mean MEPS of 96.6 and 85 [21,23]. All four studies measured range of motion. In TBS, mean elbow flexion ranged from 129 to 143.8 degrees and mean extension ranged from -3 to -4.8 degrees, with the flexion-extension arc ranging from 127 to 139 degrees [21-23]. In the TBW study, there was a 3 degree loss in elbow flexion and forearm pronation, and a 4 degree loss in elbow extension and forearm supination [20] (Table 7).

All four studies reported complications and rates of reoperation. In TBS, one study reported posterior cortical diastasis in 24.1% of patients and non-union in 17.2% [22], with another TBS study reporting delayed union in 18.2% of patients [23]. One study reported 16% of patients receiving TBS had proximal migration of K-wires, with 8% requiring hardware removal [21]. Comparatively, the TBW study reports the need for hardware removal in 35.3% of patients [20]. In terms of reoperation, rates ranged between 0% and 8% in TBS [21-23], compared to 35.3% in the TBW study [20] (Table 7).

Table 4: Conclusions and GRADE analysis of the included studies.

Study ID	Study Conclusion	GRADE Analysis
Romero et al. (2000) [15]	TBW of olecranon fractures yields reliable results in terms of fixation and healing, and does not have a high rate of complications, but the high rate of removal of metalware may justify the exploration of other methods of fixation.	Low Quality Weak for using TBW
Villanueva et al. (2006) [16]	Our results, as well as the results of other investigators, show that TBW provides satisfactory clinical results and healing rates for most olecranon fractures. However, the heterogeneous nature of olecranon fractures and the potential for development of posttraumatic osteoarthritis should be recognized.	Low Quality Weak for TBW
Khan et al. (2014) [17]	Tension-band wiring fixation remains the “gold standard” for the treatment of displaced and minimally comminuted olecranon fractures despite the introduction of new implants designed specifically to address the complications of TBW	Low Quality Strong for using TBW
Claessen et al. (2017) [18]	A rating of the technical aspects of TBW for olecranon fractures was unreliable and did not correlate with subjective and objective outcomes. Emphasis on specific technical aspects of fixation might be confusing for trainees and could distract them from the principles of effective treatment.	Low Quality Weak for TBW
Perkins et al. (2018) [19]	Overall, we found no direct benefits of tension band suture fixation versus wire fixation and therefore do not feel it has a role in the treatment of olecranon fractures.	Low Quality Weak for using TBW over TBS

TBW = Tension-Band Wire; TBS = Tension-Band Suture

Table 5: Murad Risk of Bias breakdown for the single-arm studies.

Study ID	Selection	Ascertainment		Causality				Reporting	Overall Risk of Bias
	Do the patients represent the whole experience of the centre?	Was the exposure adequately ascertained?	Was the outcome adequately ascertained?	Were other alternative causes that may explain the observation ruled out?	Was there a challenge/ rechallenge phenomenon?	Was there a dose-response effect?	Was follow-up long enough for outcomes?	Is there sufficient details to allow other investigators to replicate the research?	
Romero et al. (2000) [15]	Yes	Yes	Some concerns	Yes	N/A	N/A	Yes	Yes	Some concerns
Villanueva et al. (2006) [16]	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Low risk
Khan et al. (2014) [17]	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Low risk
Claessen et al. (2017) [18]	Some concerns	Yes	Yes	Yes	N/A	N/A	Yes	Some concerns	Some concerns

Table 6: ROBINS-1 Risk of Bias breakdown for the comparative study.

Study ID	Pre-intervention		At intervention	Post-intervention				Overall Risk of Bias
	Bias due to confounding	Bias in selection of participants to the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	
Perkins et al. (2018) [19]	Low	Moderate	Moderate	Low	Low	Low	Low	Moderate

Functional

Three of the included studies reported a range of functional outcomes, however all three studies focused on TBW only [16-18]. Due to the lack of included TBS studies with statistical analysis, it is difficult to compare the impact of each technique on the function of the elbow. The three TBW studies concluded that the classical TBW technique yields good functional outcomes, and this is in agreement with other studies analysing the TBW technique [6,24,25].

In terms of TBS, [26]. compared the biomechanics of TBS and TBW, and concluded there was no significant difference in strength or fatigue patterns of the two different constructs, and equally if screws or K-wires were used [26]. This demonstrates the underlying potential that TBS does not compromise the same good functional outcomes yielded by classical TBW, however this must be tested in the clinical environment. Whilst there were no included studies analysing the functional outcomes of TBS, three of the studies in Table X without statistical analysis further show the potential TBS has by reporting similar ranges of DASH scores, MEPS and ROM to the included TBW studies [20-22]. However, it must be emphasised that due to several limitations, a comparison of the functional outcomes between the two techniques was not possible.

The first, and most significant, limitation of comparing the functional outcomes is the lack of studies analysing TBS with statistical analysis, and furthermore, comparative studies analysing both TBS and TBW. Without statistical analysis, it is difficult to validate the included studies and reliably use their findings to form conclusions. Secondly, functional outcomes were reported in a range of methods. The included studies varied in their use of DASH scores and MEPS, without consistently reporting both scores. Furthermore, range of motion was reported differently in the 3 included studies. This inconsistent reporting was similar in the four discussed studies in table X [20-23]. When analysing range of motion, a comparison to the non-injured arm, or a pre-operative comparison is more useful than simply stating the postoperative range of motion, as normal range can vary between patients. This resulted in very small sample sizes for each functional outcome, which prevented a comparison of the techniques. [27]. further demonstrate the wide range of methods to measure elbow function, including a Subjective Elbow Value (SEV) which correlates well with the MEPS and DASH tools, but did not feature in any of the included studies [27]. Finally, studies reported

Table 7: Studies discussed but not included due to lack of statistical analysis.

Study ID	Technique	Study Type	No of Participants (M/F)	Mean Age (years)	Mean Follow Up	Mean DASH	Mean MEPS	Range of Motion	Complications (%)	Rate of Reoperation (%)
Rokouz et al. (2016) [20]	TBW	Retrospective Case Series	M= 7 F= 10	58.5 (31-88)	6 Years (0.3-14)	12 (0-55)	NR	Elbow Flexion Loss: 3° Elbow Extension Loss: 4° Forearm Pronation Loss: 3° Forearm Supination Loss: 4°	Hardware Removal: 35.3	35.3
Rodriguez et al. (2019) [21]	TBS	Retrospective Case Series	M=4 F=21	68 (32-90)	24.5 Months (12-36)	NR	96.6	Elbow Flexion: 143.8° (130-150). Elbow Extension :-4.8° (0 to -20) Elbow Flexion-Extension arc: 139° (130-150).	Proximal Migration: 16.0 Hardware Removal: 8.0 Loss of Reduction: 4.0	8
García-Elvira et. al (2020) [22]	TBS	Retrospective Case Series	M=3 F=26	75.24	Median: 4 Months (95% CI :4;6)	NR	NR	Elbow Flexion: 129° (100-145) Elbow Extension: -3° (-20-0) Forearm Pronation: 78° (65-80) Forearm Supination: 77° (70-80)	Posterior Cortical Diastasis: 24.1 Non-Union: 17.2 Pseudoarthrosis: 3.4 Wound infection: 3.4	6.8
Thiruvasagam et al. (2020) [23]	TBS	Retrospective Case Series	M=3 F=8	68	14.9 Weeks (2-24)	NR	85 (75-100)	Elbow Flexion-Extension Arc: 127° (60-160)	Delayed Union: 18.2 Articular Step: 9.1	0

functional outcomes at very inconsistent times, ranging from 2 to 24 weeks in one study [17], and 10 to 30 years in another study [18]. This will affect the functional outcomes because the patient's elbow function may be worse immediately after the operation, because of the presence of post-surgical inflammation and if there has not been enough recovery time to reduce this inflammation [28].

Complications

Five included studies analysed complications of classical TBW [15-19], and one of these studies compared this with TBS [19]. The most commonly reported complications were the need for hardware removal, revision fixation, and the presence of skin irritation and breakdown. The need for hardware removal in classical TBW is a vastly reported complication, with rates reaching as high as 82.3%. Hardware removal is required for several reasons, including migration of K-wires, prominence of the metal tension-band or K-wires leading to skin irritation and breakdown [6]. The need for re-operation has several negative implications, including increased inconvenience for the patient, use of hospital resources and financial cost [29,30]. reported 85% of their patients reported symptoms before fracture union, therefore this highlights the problem that any additional intervention, including hardware removal, could further affect healing of the fracture [30].

TBS is theorised to decrease the need for hardware removal due to lack of a metal tension band implant [31]. The one included study comparing TBW and TBS supported this by demonstrating a 12.1% lower rate of hardware removal in TBS (p=0.217). However, this study concluded no additional benefit of TBS because it had a 7.9% higher rate of revision fixation (p=0.1863) and therefore, there was no significant difference in rate of reoperation between the two techniques (p=0.6134) [19]. This contrasts the findings from Phadnis et al. which reported a significantly lower rate of reoperation in TBS when compared with TBS (p=0.002), with the need for revision fixation not being reported in any TBS patients [31]. This study was not included due to a lack of separate analysis of patients with comminuted and non-comminuted fractures. Furthermore, these two studies differ in patient populations, with Perkins et al. only analysing paediatric patients, and the Phadnis et al. study is further limited because some patients received an additional osteotomy. When considering the three TBS studies which did not have statistical analysis, the rate of reoperation in TBS ranged from 0% to 8% [21-23]. When compared with the included TBW studies and the discussed Roukouz et al. study, which reported hardware removal in 35.3% of patients, this highlights the potentially lower rate of reoperation in TBS compared with TBW, contrasting the findings of Perkins et al [15-20]. However, there must be future research into the TBS technique with statistical analysis to allow a definitive comparison of the two techniques.

Strengths and Limitations

The present review provides an up to date analysis of two techniques for a common injury and highlights several gaps in the literature. There is currently no other review comparing the classical metal Tension-Band Wire fixation (TBW) and Tension-Band Suture (TBS) fixation in the treatment of non-comminuted olecranon fractures. However, this review presents some limitations, of which some have been previously described.

The major limitation is the lack of studies analysing the TBS technique, and furthermore, studies comparing this with the TBW technique. Only one study comparing TBS and TBW was included, and this study solely focused on paediatric patients [19]. Therefore, there were no included studies analysing TBS in adults. Four studies could only be discussed but not included in the results, due to the lack of statistical analysis [20-23]. Studies with low sample numbers and a lack of statistical analysis, such as case reports and small case series, cannot be used to accurately evaluate and compare techniques in detail. Of the five included studies, four were low quality and one was moderate. Whilst studies of this kind are useful for discussion, there is a need for comparative studies, especially the gold standard, Randomised Controlled Trials (RCTs). RCTs are able to identify specific causes of any results seen, and reduce bias. The lack of included TBS studies enabled this current review to only highlight and discuss the potential of TBS, without confidently comparing it to TBW. A greater number of comparative studies taking place will add to the evidence base to further guide clinicians. Furthermore, 16 studies were excluded due to the lack of a separate analysis for comminuted and non-comminuted fractures, resulting in a reduced number of included studies. It is important to distinguish between these fracture types because functional outcomes are likely to differ and the mainstay treatment for comminuted fractures is plate fixation, as opposed to TBW and therefore, should not be compared to non-comminuted fractures [4,32]. Further research should address this and analyse these fracture types separately.

The current review is further limited by the inconsistent reporting of outcomes, as previously described. Particularly with the functional outcomes, studies varied in their methods of analysing post-operative function of the elbow and when function was assessed. Therefore, this makes it difficult to quantitatively analyse the studies and form conclusions.

The included studies reported a large range of mean follow-up times from 6 months to 18 years. It is useful to observe both the immediate and the long-lasting effects of a technique, however, it makes it difficult to compare studies at opposite ends of the time-scale.

Whilst Perkins et al. and the three TBS studies without statistical analysis describe techniques which do not use a metal tension-band, K-wires, screws or pins are commonly still used which can still cause symptoms which require the need for metal removal [19,21-23]. Nimura et al. describe a technique which completely avoids the use of metal implants, by using only a suture retriever and two FiberWire sutures [33]. There is paucity in the literature describing and evaluating this exciting completely metal-free technique, and therefore this should be an important focus for future research.

Conclusion

This review was required to highlight the paucity of studies analysing tension-band suture fixation in the treatment of non-comminuted olecranon fractures. There is potential for reduced rates of reoperation when compared with classical metal tension-band wiring, without compromising functional outcomes, however our results would greatly benefit from more studies with statistical analysis and standardised reporting of outcomes. This research should act as a prompt for more robust studies comparing these two techniques, especially RCTs, to help guide the method of tension-band fixation in the treatment of non-comminuted olecranon fractures.

Disclosure

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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