



An evaluation of treatment options for medial, midshaft, and distal clavicle fractures: a systematic review and meta-analysis

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Background: The majority of clavicle fractures are midshaft injuries, although fractures of the distal or medial fragment also occur. The aim of this study was to review the current evidence on these injuries to help inform future treatment plans.

Methods: We searched for studies comparing interventions for medial, midshaft, or distal clavicle fractures; however, we did not identify any comparative studies on medial fractures and performed a secondary search on this topic. We conducted Bayesian network meta-analyses, although this was not feasible with studies on medial fractures and we described their results qualitatively.

Results: For midshaft fractures, we found statistically significant improvements in function and time to radiographic union with plating, an elastic stable intramedullary nail (ESIN), and the Sonoma CRX intramedullary nail over nonoperative treatments. Both plating and an ESIN also showed significantly lower risks of nonunion and malunion relative to nonoperative methods. For distal fractures, a locking plate (LP) with or without coracoclavicular (CC) suturing yielded significantly better outcomes over K-wires with or without tension bands, CC suturing alone, an LP with a CC screw, a hook plate, and a sling. For medial fractures, plating may result in more favorable functional and union-related outcomes, although implant irritation may occur. In addition, K-wires, tension bands, and a screw with sutures demonstrated success when plating was technically not feasible in a few cases, whereas treatment with a sling may result in reduced function and a higher risk of complications relative to surgery.

Conclusion: This study can provide guidance on the management of medial, midshaft, and distal clavicle fractures. The current evidence suggests that plating, an ESIN, and a CRX intramedullary nail are all good options for midshaft fractures; an LP with or without CC suturing should be preferred for distal fractures; and plating is also acceptable for medial fractures, provided that the patient is deemed suitable for surgery and has the adequate bone stock and sufficiently sized medial fragment necessary to implant the device. Patient preferences for certain outcomes should be considered, which may result in different treatment recommendations.

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Clavicle fractures are common, comprising 2%–4% of all fractures.³⁶ The majority are midshaft fractures; however, injuries to the distal or medial fragment also occur.^{64,110} Clavicle fractures mostly occur in male individuals younger

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than 30 years, with an increased incidence, regardless of sex, above age 70 years.³⁶ Historically, nonoperative methods were used to treat these injuries, as they were seen to have low rates of nonunion.^{61,70,92} However, some studies have shown unsatisfactory results with such treatments, including pain, cosmetic complaints, and brachial plexus irritation.^{27,42} Recent studies have suggested that surgery shows certain benefits, such as a quicker return of function, increased patient satisfaction, and fewer complications.^{55,80,110} Given the expected increase in the population of higher-risk

groups, identifying an optimal treatment plan will become of greater importance.⁵²

Multiple interventions are available to treat clavicle fractures, and options can vary depending on the location of the injury (ie, medial, midshaft, or distal).^{28,47,62,80} Determining the best approach is a complex decision, as both patient-reported and clinical outcomes are important to consider. Past trials and reviews have compared different operative techniques with each other or compared surgery with nonoperative protocols^{28,31,32}; however, there exist few reviews that have examined these specific interventions all at once.

The aim of this systematic review and meta-analysis was to compare management options for medial, midshaft, and distal clavicle fractures to help inform future treatment plans.

Methods

Literature search

We searched the Embase, MEDLINE, and Cochrane databases (Supplementary Appendix S1), from database inception to March 14, 2019. We also identified a recent review on distal fractures with similar methodology and eligibility criteria⁷ and performed an update of their search on March 15, 2019. After article screening, we did not identify any comparative studies on medial fractures; therefore, we performed another search (Supplementary Appendix S2) on April 9, 2019, for studies on this injury.

Eligibility criteria

Initially, we included studies that (1) were comparative, examining at least 2 treatments for medial, midshaft, or distal clavicle fractures; (2) had an experimental or observational study design; (3) focused on skeletally mature patients; and (4) were published in English. As stated earlier, after article screening, we did not find any comparative studies on medial clavicle fractures. We performed another search for such studies using similar eligibility criteria, except that these studies were case series or case reports.

Article selection

Two reviewers screened titles, abstracts, and full-text articles, with discrepancies resolved through discussion.

Data extraction

We extracted study characteristics (ie, author, location, study length, and inclusion and exclusion criteria), patient characteristics (ie, age, sex, and fracture type), and outcome data (ie, patient-reported pain or function, time to union or return to work, and complications).

Statistical analysis

For midshaft and distal fractures, we conducted random-effects Bayesian network meta-analyses, with 95% credible intervals (CrIs). We calculated risk ratios for dichotomous variables and mean differences for continuous data. We represented heterogeneity as I^2 values and calculated the surface area under the cumulative ranking curve (SUCRA) values.⁵³ We conducted analyses using the “gemtc” package in R (version 3.5.0 [2018]; R Foundation for Statistical Computing, Vienna, Austria). For medial fracture studies, we described their results qualitatively.

Results

Search results

Our search retrieved 983 references, but 125 were duplicates. We included 117 for full-text review. We then deemed 62 articles eligible, with 52 on midshaft fractures and 10 on distal fractures; however, for distal fractures, we already identified 5 of them from the prior review, leaving 5 new studies on distal fractures. In addition, another study on midshaft fractures was identified by one of us from another source, leaving 53 included articles on midshaft fractures in this review (Fig. 1).^{1-4,6,9,11-15,17,19,20,24-26,34,35,37,38,40,41,43,44,46,50,54,56-60,65,68,71,73,75,77,79,80,83,84,87,91,93,94,97,100-103,108} One article was a secondary publication of a study, so we included 52 unique studies.⁷³

From the study by Boonard et al⁷ on distal fractures, we included 11 studies. After updating their search, we retrieved 18 references for screening but 2 were duplicates. We included 4 for full-text review. We then deemed 3 articles eligible, although 1 was a duplicate of an already included study, so only 2 were new studies. Thus, in addition to the 5 studies from our first search, we identified 18 studies on distal fractures (Fig. 2).^{10,18,21,22,29,30,39,45,48,69,74,82,85,86,90,104,106,107}

From the medial fracture search, we retrieved 354 references; however, 8 were duplicates and 60 were conference abstracts or reviews. We included 51 articles for full-text review and deemed 16 eligible for inclusion (Fig. 3).^{5,8,23,49,51,63,67,76,78,81,88,89,95,99,105,109}

Study characteristics

The characteristics of the studies on midshaft fractures are shown in Table I. The studies were published from 1987 to 2019, and sample sizes ranged from 22 to 302 patients. Six interventions were identified: elastic stable intramedullary nail (ESIN), intramedullary pin (IMP), Sonoma CRX intramedullary nail (CRX; Sonoma Orthopedic Products, Santa Rosa, CA, USA), plating, figure-of-8 bandage (F8B), and sling. Some studies evaluated the use of an F8B and sling in combination. In terms of patient demographic characteristics, the average age across studies ranged from 24 to 60 years (median, 36 years) and the proportion of male patients ranged from 10% to 100% (median, 79%). The outcomes reported on that we analyzed were as follows: pain and function (at ≤ 4 , 6, 12, 24, 52, and >52 weeks), time to radiographic union, time to return to work, delayed union, malunion, nonunion, refracture, revision, and symptoms.

The studies on distal fractures were published between 2002 and 2018, and sample sizes ranged from 15 to 116 patients (Table II). The interventions compared in the studies were as follows: coracoclavicular suturing (CCSu) alone, CCSu with a locking plate (CCSu-LP), CCSu with K-wires (CCSu-KW), coracoclavicular screw fixation with an LP (CCSc-LP), a hook plate (HP), K-wires (KW) alone, a locking plate (LP) alone, tension bands with K-wires (TB-KW), and a sling. The average age of patients ranged from 34 to 51 years (median, 42 years), and the percentage of male patients ranged from 45% to 95% (median, 68%). In terms of fracture classification, patients predominantly had Neer type II fractures, with rates ranging from 60% to 100% of patients (median, 100%) across studies, but a small proportion sustained Neer type V fractures (range, 0%-40%; median, 0%). The studies provided sufficient data on function (at 3 months, 6 months, and ≥ 1 year of follow-up); time to radiographic union; and the risks of hardware problems, nonunion, refracture, revision, and symptoms.

The studies on medial fractures were published between 2004 and 2019 (Table III). The interventions were as follows: plating, tension bands (TB), KW, a screw and sutures, and a sling. Across the

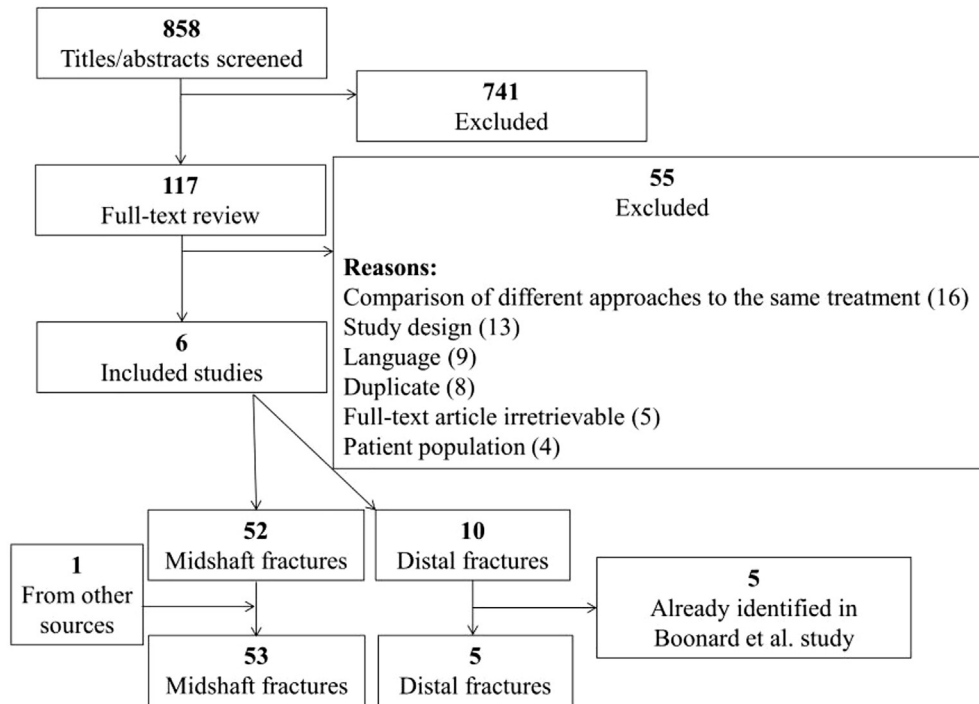


Figure 1 Flow diagram of included studies from initial search.

case reports, the age of patients ranged from 17 to 63 years, and among the remaining studies, the mean age ranged from 34 to 56 years. The patients were predominantly men, as the subjects of 5 of the 6 case reports were men and, across the remaining studies, the proportion of men ranged from 64% to 100%. The outcomes reported on were pain and function, radiographic union, return to prior activities, and various complications.

Outcomes

Midshaft fractures

Pain. No statistically significant differences in pain were found between treatments at any follow-up visit. In terms of effect estimates, plating was ranked highest at $\leq 4, 6,$ and 12 weeks whereas

the ESIN was highest at 24, 52, and >52 weeks (Table IV, Supplementary Fig. S1).

Function. No statistically significant differences in function were found between treatments at ≤ 4 weeks, although plating was ranked highest (Table IV, Supplementary Fig. S2). For function at 6 weeks, both the ESIN and plating had significantly higher scores compared with the sling (Table IV; Fig. 4, a). At 12 weeks, scores were significantly higher with the CRx relative to the F8B (Table IV; Fig. 4, b). Function at 24 weeks was significantly lower with both the sling and F8B compared with the CRx, ESIN, and plating (Table IV; Fig. 4, c); the CRx also demonstrated significantly higher scores than the F8B-sling combination, IMP, and plating at this follow-up point. Both the CRx and plating showed significantly greater function than the sling at 52 weeks (Table IV; Fig. 4, d). At visits at >52 weeks, both the ESIN and plating showed significantly improved function relative to the sling (Table IV; Fig. 4, e).

Time to radiographic union. The sling demonstrated a significantly later time to radiographic union relative to the CRx, ESIN, plating, and IMP (Table IV; Fig. 5). In addition, the CRx showed a significantly earlier time to union than the F8B.

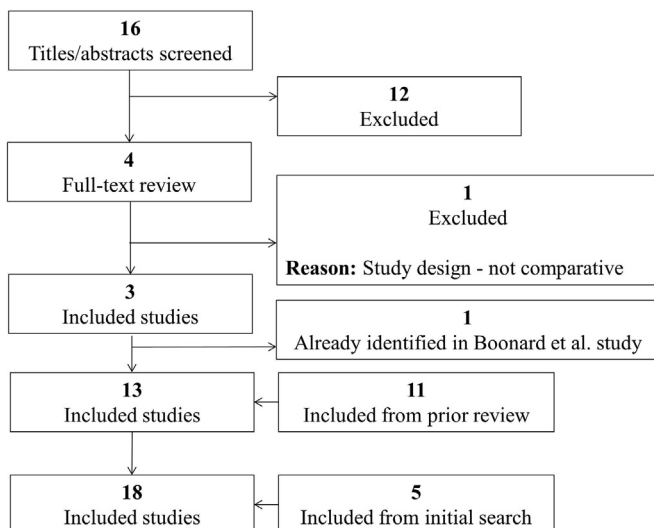


Figure 2 Flow diagram of included studies from distal clavicle fracture search.

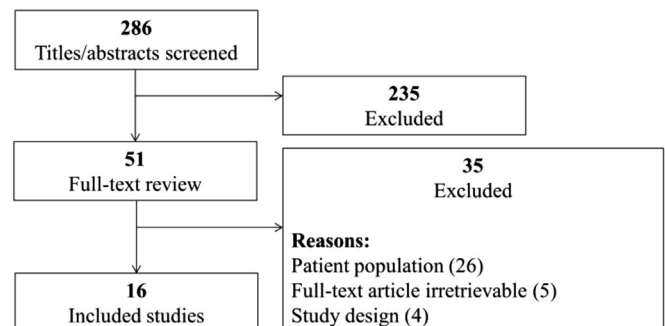


Figure 3 Flow diagram of included studies from medial clavicle fracture search.

Table 1
Study characteristics of midshaft clavicle fracture studies

Authors, year	Location of study	Study design	Sample size	Treatments evaluated	Length of study follow-up	Age, yr	Male sex, %
Ahrens et al, ¹ 2017	United Kingdom	Randomized trial	302	Plate	9 mo	Mean, 36 ± 12	86
Andersen et al, ² 1987	Denmark	Randomized trial	61	F8B	3 mo	Mean, 36 ± 12	88
				Sling		Median, 19 (range, 14-81)	NR
Andrade-Silva et al, ³ 2015	Brazil	Randomized trial	59	Plate	12 mo	Median, 19 (range, 14-66)	85
				ESIN		Mean, 31 ± 12	73
Assobhi, ⁴ 2011	Finland	Randomized trial	38	Plate	12 mo	Mean, 28 ± 9	89
				ESIN		Mean, 33 ± 6 (range, 26-49)	84
Bhardwaj et al, ⁵ 2018	India	Randomized trial	69	Plate	24 mo	Mean, 30 ± 5 (range, 24-45)	22
				Sling		Mean, 32	39
Calbiyik et al, ⁹ 2017	Turkey	Randomized trial	75	CRx	12 mo	Mean, 38 ± 11	60
				Plate		Mean, 42 ± 14	63
Chen et al, ¹¹ 2018	China	Randomized trial	54	Plate	Mean, 15 mo (range, 12-24 mo)	Mean, 39 ± 7	59
				ESIN		Mean, 39 ± 11	56
Chen et al, ¹² 2011	China	Randomized trial	60	ESIN	Mean, 15 mo (range, 10-20 mo)	Mean, 39 ± 12	53
				Sling		Mean, 38 ± 13	53
Chen et al, ¹³ 2012	China	Observational	141	ESIN	24 mo	Mean, 34 (range, 20-59)	72
				Plate		Mean, 37 (range, 19-63)	73
Chu et al, ¹⁴ 2018	Taiwan	Observational	120	Plate	6 mo	Mean, 46 ± 17	63
				F8B		Mean, 50 ± 15	73
Coppa et al, ¹⁵ 2017	Italy	Observational	58	IMP	Mean, 47 mo (range, 23-74 mo)	Mean, 40 ± 16	93
				F8B		Mean, 37 ± 16	83
Eden et al, ¹⁷ 2015	Germany	Observational	102	F8B	12 mo	Mean, 41 ± 18	NR
				Plate		Mean, 38 ± 15	
Ersen et al, ¹⁹ 2015	Turkey	Randomized trial	60	ESIN	Mean, 8 mo (range, 6-12 mo)	Mean, 34 ± 15	79
				F8B		Mean, 39 (range, 16-75)	83
Ferran et al, ²⁰ 2010	United Kingdom	Quasi-randomized	32	Sling	12 mo	Mean, 29 (range, 15-72)	82
				IMP		Mean, 24 (range, 13-42)	82
Fu et al, ²⁴ 2012	Taiwan	Observational	103	Plate	Mean, 15 mo (range, 12-153 mo)	Mean, 35 (range, 16-53)	87
				IMP		Mean, 35 ± 15	72
Fuglesang et al, ²⁵ 2017	Norway	Randomized trial	123	Plate	12 mo	Mean, 40 ± 15	66
				ESIN		Mean, 35 (range, 16-59)	81
Hanselman et al, ²⁶ 2016	United States	Observational	157	Plate	Up to 5 yr	Mean, 36 (range, 16-57)	90
				IMP		NR	NR
Jones et al, ³⁴ 2014	United Kingdom	Observational	57	Plate	Mean, 30 mo (range, 12-54 mo)	Mean, 27 ± 8	84
				ESIN			
Judd et al, ³⁵ 2009	United States	Randomized trial	70	IMP	12 mo	Mean, 28 (range, 19-40)	93
				Sling		Mean, 25 (range, 17-41)	89
Khorami et al, ³⁷ 2014	Iran	Randomized trial	87	F8B	6 mo	Mean, 32	77
				Plate		Mean, 31	71
King et al, ³⁸ 2019	Turkey	Randomized trial	87	CRx	15 mo	Mean, 29 ± 14	74
				Plate		Mean, 35 ± 12	54
Kleweno et al, ⁴⁰ 2011	United States	Observational	32	IMP	Mean, 8 mo (range, 3-28 mo)	Mean, 35 (range, 16-56)	71
				Plate		Mean, 17 mo (range, 4-58 mo)	83
Kulshrestha et al, ⁴¹ 2011	India	Observational	73	Plate	18 mo	Mean, 28 (range, 16-46)	96
				Sling		Mean, 32 ± 6	86
Lechler et al, ⁴³ 2016	Germany	Observational	47	ESIN	Mean, 38 mo	Mean, 33 ± 5	72
				Plate		Mean, 36 ± 15	64
Lee et al, ⁴⁴ 2008	Taiwan	Quasi-randomized	103	IMP	12 mo	Mean, 39 ± 15	66
				Plate		Mean, 40	63
Lee et al, ⁴⁶ 2007	Taiwan	Quasi-randomized	69	IMP	30 mo	Mean, 38	59
				Plate		Mean, 60 (range, 50-81)	57
Liu et al, ⁵⁰ 2010	Taiwan	Observational	110	ESIN	Mean, 18 mo (range, 12-27 mo)	Mean, 57 (range, 52-79)	63
				Plate		Mean, 34 ± 14 (range, 16-65)	49
McKee et al, ⁵⁴ 2007; Schemitsch et al, ⁷³ 2011	Canada	Randomized trial	132	Sling	12 mo	Mean, 32 ± 10 (range, 17-58)	69
				Plate		Mean, 34	86
Melean et al, ⁵⁶ 2015	Chile	Randomized trial	76	Sling	12 mo	Mean, 34	NR
				Plate		Mean, 37 ± 11	
Mirzatoolei, ⁵⁷ 2011	Iran	Randomized trial	60	Plate	12 mo	Mean, 38 ± 13	10
				Sling		Mean, 35	21
Napora et al, ⁵⁸ 2018	United States	Observational	138	Plate	≥12 mo	Mean, 36	NR
				Sling		Range, 16-71	
						Range, 16-71	

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Table 1 (continued)

Authors, year	Location of study	Study design	Sample size	Treatments evaluated	Length of study follow-up	Age, yr	Male sex, %
Narsaria et al, ⁵⁹ 2014	India	Randomized trial	66	Plate	24 mo	Mean, 40 ± 11 (range, 18–64)	79
				ESIN		Mean, 39 ± 9 (range, 20–62)	73
Naveen et al, ⁶⁰ 2017	India	Nonrandomized controlled trial	60	F8B and sling	6 mo	Mean, 35	90
Qvist et al, ⁶⁵ 2018	Denmark	Randomized trial	150	Plate	12 mo	Mean, 32	87
				Sling		Mean, 39 (range, 18–60)	92
Robinson et al, ⁶⁸ 2013	United Kingdom	Randomized trial	200	Plate	12 mo	Mean, 40 (range, 18–60)	100
				Sling		Mean, 33 ± 13	88
Saha et al, ⁷¹ 2014	India	Quasi-randomized	80	Plate	24 mo	Mean, 32 ± 11	87
				ESIN		Mean, 33 ± 13 (range, 15–58)	NR
Shetty et al, ⁷⁵ 2017	India	Randomized trial	30	F8B and sling	6 mo	Mean, 33 ± 12 (range, 15–55)	NR
				Plate		NR	NR
Silva et al, ⁷⁷ 2011	Brazil	Randomized trial	22	Plate	6 mo	NR	NR
Smekal et al, ⁷⁹ 2011	Austria	Randomized trial	120	ESIN	24 mo	Mean, 38 ± 15	85
				Sling		Mean, 37 ± 13	90
Smekal et al, ⁸⁰ 2009	Austria	Randomized trial	60	ESIN	24 mo	Mean, 40 ± 15	87
				Sling		Mean, 36 ± 12	87
Tabatabaei and Shalamzari, ⁸³ 2011	Iran	Nonrandomized controlled trial	68	IMP	Mean, 14 mo	Mean, 29	84
Tamaoki et al, ⁸⁴ 2017	Brazil	Randomized trial	117	Plate	12 mo	Mean, 27	84
				F8B		Mean, 35 ± 13	81
Tarnq et al, ⁸⁷ 2012	Taiwan	Observational	57	Plate	12 mo	Mean, 31 ± 10	90
				ESIN		Mean, 47 (IQR, 37–59)	56
Tutuhaturnewa et al, ⁹¹ 2017	The Netherlands	Observational	278	Sling	Median, 26 mo (range, 15–41 mo)	Mean, 38 (IQR, 27–58)	40
				Plate	Median, 27 mo (range, 18–37 mo)	Median, 42 (IQR, 26–56)	78
van der Meijden et al, ⁹³ 2015	The Netherlands	Randomized trial	120	Plate	12 mo	Mean, 38 ± 15	91
				ESIN		Mean, 40 ± 13	97
Van Der Ven Denise et al, ⁹⁴ 2015	The Netherlands	Observational	97	Sling	Mean, 60 mo	Mean, 41 ± 15	85
Virtanen et al, ⁹⁷ 2012	Finland	Randomized trial	60	Plate	12 mo	Mean, 41 ± 13	90
				Sling		Mean, 33 ± 12	88
Wang et al, ¹⁰⁰ 2015	Taiwan	Observational	55	Plate	12 mo	Mean, 41 ± 11	86
				ESIN		Mean, 35 (range, 16–60)	70
Wenninger et al, ¹⁰¹ 2013	United States	Observational	65	IMP	12 mo	Mean, 42 (range, 16–66)	68
				Plate		Mean, 25 (range, 18–51)	97
Wijdicks et al, ¹⁰² 2012	The Netherlands	Observational	90	Plate	Median, 8 mo (IQR, 2–13)	Mean, 27 (range, 20–49)	90
				ESIN	Median, 6 mo (IQR, 5–12)	Mean, 39 ± 14	77
Woltz et al, ¹⁰³ 2017	The Netherlands	Randomized trial	160	Sling	12 mo	Mean, 33 ± 16	70
				Plate		Mean, 37 ± 13	89
Zehir et al, ¹⁰⁸ 2015	Turkey	Randomized trial	45	CRx	Mean, 12 mo	Mean, 38 ± 13	93
				Plate	Mean, 14 mo	Mean, 33 ± 9	58
						Mean, 32 ± 8	57

F8B, figure-of-eight bandage; NR, not reported; ESIN, elastic stable intramedullary nail; CRx, Sonoma CRx intramedullary nail; IMP, intramedullary pin; IQR, interquartile range.

Time to return to work. The ESIN was ranked highest for the outcome of time to return to work, but we did not find any statistically significant differences between the ESIN, F8B, plating, and sling (Table IV, Supplementary Fig. S3).

Delayed union. For delayed union, none of the pair-wise comparisons in this analysis were statistically significant, but plating was ranked highest (Table IV, Supplementary Fig. S4).

Malunion. Plating demonstrated a significantly lower risk of malunion compared with both the sling and F8B-sling combination, whereas the ESIN had a significantly lower risk relative to the F8B-sling combination only (Table IV, Fig. 6).

Nonunion. Both plating and the ESIN showed a significantly reduced risk of nonunion compared with the sling, F8B, and F8B-sling combination (Table IV, Fig. 7); plating was ranked highest. The IMP, sling alone, and F8B alone all had a significantly lower risk relative to the F8B-sling combination.

Refracture. We found no significant differences between the ESIN, IMP, plating, and sling for the incidence of refracture (Table IV, Supplementary Fig. S5).

Revision. There were no statistically significant differences between the ESIN, F8B, IMP, and plating in the risk of revision (Table IV, Supplementary Fig. S6).

Symptoms. In terms of persistent symptoms following treatment, no statistically significant differences were found between the CRx, ESIN, F8B, IMP, plating, and sling (Table IV, Supplementary Fig. S7).

Distal fractures

Function. We found no statistically significant results between interventions in functional scores at 3 months (Table V, Supplementary Fig. S8). CCSu was ranked highest, followed by the HP, CCSu-LP, LP, TB-KW, and finally, CCSu-LP.

For function at 6 months, we found no statistically significant differences between interventions (Table V, Supplementary Fig. S8).

Table II
Study characteristics of distal clavicle fracture studies

Authors, year	Study location	Study design	Sample size	Interventions	Length of follow-up	Age, yr	Male sex, %
Chen et al, ¹⁰ 2014	Taiwan	Observational	94	CC suture	Mean, 38 mo (range, 24–64 mo)	Mean, 43 (range, 18–75)	70
Erdle et al, ¹⁸ 2017	Germany	Observational	32	Hook plate	Mean, 37 mo (range, 24–68 mo)	Mean, 48 (range, 28–78)	57
				Hook plate	Mean, 54 mo (range, 25–111 mo)	Mean, 44 ± 15	88
Flinkkila et al, ²² 2002	Finland	Observational	39	Locking plate		Mean, 44 ± 14	88
				Hook plate	Mean, 2 yr (range, 1–2 yr)	Mean, 43 (range, 18–71)	94
Flinkkila et al, ²¹ 2015	Finland	Observational	40	K-wire	Mean, 6 yr (range, 3–12 yr)	Mean, 35 (range, 17–68)	73
				CC suture	Mean, 32 mo	Mean, 39 ± 14	95
Hsu et al, ³⁰ 2010	Taiwan	Randomized trial	65	Hook plate	Mean, 62 mo	Mean, 45 ± 13	68
				Hook plate	6 mo	Mean, 43 ± 13 (range, 22–67)	60
Hsu et al, ²⁹ 2018	Taiwan	Observational	72	TB and K-wire		Mean, 41 ± 14 (range, 22–67)	77
				CC suture	12 mo	Mean, 42 ± 16	70
Klein et al, ³⁹ 2010	United States	Observational	38	Hook plate	Mean, 12 mo (range, 2–47 mo)	Mean, 48 ± 20	59
				CC suture and locking plate		Mean, 43	61
Lee et al, ⁴⁵ 2009	Taiwan	Observational	66	Hook plate	Mean, 26 mo (range, 12–64 mo)	Mean, 43 (range, 18–70)	56
				TB and K-wire		Mean, 36 (range, 18–70)	45
Leu et al, ⁴⁸ 2012	Taiwan	Observational	45	Hook plate	Mean, 15 mo (range, 12–25 mo)	Mean, 41 ± 18	52
				TB and K-wire		Mean, 41 ± 14	50
Rokito et al, ⁶⁹ 2003	United States	Observational	30	Sling	Mean, 54 mo (range, 30–90 mo)	Mean, 47 (range, 26–68)	63
				CC suture	Mean, 60 mo (range, 12–107 mo)	Mean, 36 (range, 22–47)	57
Seyhan et al, ⁷⁴ 2015	Turkey	Observational	36	CC suture and locking plate	24 mo	Mean, 38 (range, 20–55)	71
				CC screw and locking plate		Mean, 36 (range, 34–41)	75
Souza Vilela et al, ⁸² 2015	Brazil	Observational	15	TB and K-wire		Mean, 34 (range, 26–44)	60
				CC suture and K-wire	Two different sets of values reported:	Mean, 34 (range, 19–57)	69
Tan et al, ⁸⁵ 2012	China	Observational	42	Locking plate	Mean, 23 mo (range, 14–32 mo)	Mean, 34 (range, 19–57)	
				Hook plate	Mean, 27 mo (range, 18–36 mo)		
Tang et al, ⁸⁶ 2018	China	Observational	40	Hook plate	Mean, 22 mo (range, 12–48 mo)	Mean, 42 ± 11 (range, 21–65)	65
				Locking plate	Mean, 22 mo (range, 12–48 mo)	Mean, 40 ± 10 (range, 22–61)	68
Tang et al, ⁸⁶ 2018	China	Observational	40	CC suture and locking plate	Mean, 16 mo (range, 12–27 mo)	Mean, 43 ± 6	NR
				Locking plate		Mean, 43 ± 5	
Tsuei et al, ⁹⁰ 2010	Taiwan	Randomized trial	29	K-wire	Mean, 45 mo (range, 10–85 mo)	Mean, 39 ± 15 (range, 23–56)	64
				TB and K-wire		Mean, 39 ± 14 (range, 21–61)	73
Wu et al, ¹⁰⁴ 2011	Taiwan	Observational	116	Hook plate	Mean, 23 mo	Mean, 49 ± 16	60
				TB and K-wire	Mean, 26 mo	Mean, 51 ± 18	71
Xiong et al, ¹⁰⁶ 2018	China	Observational	58	CC suture	Mean, 57 mo (range, 7–160 mo)	Mean, 42 ± 14	NR
				Hook plate		Mean, 47 ± 16	
Yan et al, ¹⁰⁷ 2017	China	Randomized trial	72	Locking plate		Mean, 38 ± 15	
				CC suture	24 mo	Mean, 38 (range, 20–55)	71
				Hook plate		Mean, 35 (range, 21–56)	67

CC, coracoclavicular; TB, tension band; NR, not reported.

CCSu was again ranked highest, followed by CCSu-LP, the HP, CCSc-LP, and TB-KW.

For function at follow-up ≥ 1 year, we noted statistically significant findings between some of the pair-wise comparisons (Table V, Fig. 8). KW demonstrated significantly worse outcomes than CCSu, CCSu-LP, the HP, and the LP; the LP was also significantly better than TB-KW. The corresponding SUCRA values were 87% for the LP, 83% for CCSu-LP, 73% for CCSu, 45% for CCSc-LP, 43% for the HP, 32% for CCSu-KW, 31% for TB-KW, and 5% for KW.

Time to radiographic union. We did not find any significant differences in the time to radiographic union between treatments (Table V, Supplementary Fig. S9). CCSu-LP was ranked highest for this outcome, followed by CCSc-LP, TB-KW, the HP, KW, the LP, and finally, CCSu.

Hardware complications. There was 1 statistically significant comparison, demonstrating that KW resulted in a greater risk of

hardware complications than the HP (Table V, Fig. 9). The corresponding SUCRA values were 73% for the HP, 60% for the LP, 60% for CCSu-LP, 53% for CCSu, 45% for TB-KW, and 10% for KW.

Nonunion. Both the LP and CCSu-LP had significantly lower risks of nonunion compared with each of the following: CCSc-LP, TB-KW, HP, CCSu, and sling (Table V, Fig. 10). Only the LP showed a significantly lower risk of this event relative to KW. The LP and CCSu-LP had the highest SUCRA values, at 91% and 88%, respectively, followed by KW (55%), the HP (45%), CCSc-LP (30%), TB-KW (22%), and finally, CCSu (19%).

Refracture. TB-KW demonstrated a significantly lower risk of refracture compared with CCSu, CCSu-LP, the HP, and KW; both the LP and KW had significantly lower risks relative to CCSu and the HP (Table V, Fig. 11). The SUCRA values were 94% for TB-KW, 77% for the LP, 65% for KW, 32% for CCSu-LP, 19% for CCSu, and 12% for the HP.

Table III
Study characteristics of medial clavicle fracture studies

Authors, year	Study location	Study design	Sample size	Interventions	Length of follow-up	Age, yr	Male sex, %
Bartonicek et al, ⁵ 2010	Czech Republic	Case series	4	Tension band, sling	Range, 12–24 mo	Mean, 45	100
Bourghli and Fabre, ⁸ 2012	France	Case report	1	K-wires	8 mo	29	100
Frima et al, ²³ 2018	Switzerland	Case series	15	Locking plate	Mean, 39 mo (range, 9–79 mo)	Mean, 52	100
Li et al, ⁴⁹ 2019	China	Case report	1	Locking plate	6 mo	56	100
Low et al, ⁵¹ 2008	Australia	Case series	4	Locking plate, screw and sutures	Mean, 3 yr (range, 8 mo to 10 yr)	Mean, 43	100
Oe et al, ⁶³ 2012	Germany	Case series	9	Locking plate	Mean, 38 mo (range, 14–52 mo)	Mean, 36	89
Robinson et al, ⁶⁷ 2004	United Kingdom	Case series	24	Sling	24 wk	Median, 52	67
Siebenlist et al, ⁷⁶ 2013	Germany	Case report	1	Locking plate	1 yr	63	100
Singh et al, ⁷⁸ 2012	United Kingdom	Observational cohort	4	Sling	Range, 12–28 mo	NR	NR
Smelt et al, ⁸¹ 2017	United Kingdom	Case report	1	Locking plate	2 wk	17	100
Teng and Liu, ⁸⁸ 2013	Taiwan	Case report	1	Locking plate	4 yr	29	0
Titchener et al, ⁸⁹ 2019	United Kingdom	Case series	7	Locking plate	Median, 31 mo (range, 24–45 mo)	Mean, 34	86
Van Tongel et al, ⁹⁵ 2018	Belgium	Observational cohort	55	Sling	Mean, 49 mo (range, 6–101 mo)	Mean, 56	64
Wang et al, ⁹⁹ 2015	China	Case report	1	Locking plate	12 mo	40	100
Xie et al, ¹⁰⁵ 2018	China	Case series	6	Locking plate	Mean, 12 mo (range, 10–14 mo)	Mean, 46	83
Zheng et al, ¹⁰⁹ 2018	China	Case series	12	Locking plate	Mean, 23 mo (range, 12–30 mo)	Mean, 44	83

NR, not reported.

Revision. Regarding the risk of revision, CCSu-LP demonstrated a significantly lower risk than all other interventions included in the analysis (Table V, Fig. 12). The SUCRA values were 99% for CCSu-LP, 55% for CCSu, 52% for the HP, 46% for KW, 33% for TB-KW, and 14% for CCSc-LP.

Symptoms. In the analysis of persistent symptoms, CCSu-LP showed a significantly lower risk than CCSc-LP, CCSu, the HP, and TB-KW; CCSc-LP, the HP, and TB-KW each had a significantly lower risk compared with CCSu only (Table V, Fig. 13). The corresponding SUCRA values were 99% for CCSu-LP, 69% for the HP, 47% for TB-KW, 33% for CCSc-LP, and 0.3% for CCSu.

Medial fractures

Across all studies on patients with medial fractures, 85 patients were managed with a sling, 57 were treated with plating, 2 received TB, 1 was treated with KW, and 1 received a screw and suturing.

Pain. The visual analog scale (VAS) scores for pain on activity following nonoperative therapy in the study by Bartonicek et al⁵ were 1 of 10 for 1 patient and 2 of 10 for the other patient at 18 and 13 months, respectively. Regarding plating, in the case reports by Li et al⁴⁹ and Smelt et al⁸¹, the patients reported no pain at 2 and 8 weeks, respectively, whereas the patient in the report by Teng and Liu⁸⁸ still had pain at 6 months, although a nonunion was also diagnosed in this patient. Low et al⁵¹ showed an average VAS score for pain on activity of 0.75 of 10 at a mean follow-up of 3.3 years (range, 8 months to 10 years) for patients treated with plating, whereas Zheng et al¹⁰⁹ reported average scores of 3.4, 3, and 2.1 at 3, 6, and 12 months, respectively. The final VAS score was 0 for both patients who had TB in the study by Bartonicek et al⁵. The patient treated with KW in the report by Bourghli and Fabre⁸ had no pain by 3 months. The patient treated with a screw and sutures had a VAS score of 0.75 at latest follow-up.⁵¹

Function. The 2 patients managed nonoperatively in the study by Bartonicek et al⁵ had Disabilities of the Arm, Shoulder and Hand (DASH) scores of 27.1 at 18 months and 33.3 at 13 months. Among studies that examined plating, 1 case report found a DASH score of 23.33 at 8 weeks⁴⁹ whereas the average DASH and QuickDASH (short version of DASH questionnaire) scores at later follow-up assessments (approximately 1 year or later) ranged from 8.6 to 13.5^{51,63,105} and from 0.66 to 0.81,^{23,89} respectively.; The DASH

scores of the 2 patients treated with TB were 25.8 (at 2 years) and 24.2 (at 18 months).⁵ The patient treated with a screw and sutures had a DASH score of 9 at latest follow-up.⁵¹

Return to work or activities. Studies investigating plating reported that all patients returned to their preinjury level of work or activity following treatment.^{51,76,89,99} The patient treated with KW was able to return to work by 8 months.⁸ The patient treated with a screw and suturing also returned to the previous occupation and activity level.⁵¹

Radiographic union. Regarding patients managed nonoperatively, Robinson et al⁶⁷ found a nonunion in 2 of 24 patients at the 24-week follow-up, and there were 4 nonunions and 1 malunion among the 55 patients investigated by Van Tongel et al⁹⁵; however, all 4 patients in the study of Singh et al⁷⁸ had a successfully united fracture. Most plating studies reported successful union among all patients,^{23,51,76,89,99,105,109} but there were 2 exceptions: The patient in the report by Teng and Liu⁸⁸ experienced a nonunion at 6 months after plating, and a nonunion occurred in 1 of 9 patients in the study by Oe et al⁶³. The patient treated with KW had complete union by 3 months.⁸ The case treated with a screw and suturing had successful union as well.⁵¹

Other complications. Bartonicek et al⁵ reported 1 case of clavicle shortening in a patient treated nonoperatively. In the study by Frima et al²³, plating caused implant irritation in 8 of 15 patients, leading to implant removal in 7, and there was also 1 case of implant failure and deep infection that required revision surgery. The patient treated with a plate in the case report by Teng and Liu⁸⁸ underwent revision for nonunion with a partial claviclectomy, and Zheng et al¹⁰⁹ encountered a redislocation of the sternoclavicular joint in 1 patient (of 12), but this occurred after plate removal. In contrast, other studies on plating revealed no complications or revisions following the procedure.^{51,76,89,105} Bartonicek et al also reported slight hypertrophy of the medial clavicle in a patient managed with TB at the 2-year follow-up. No complications were reported in the case treated with a screw and suturing.⁵¹

Discussion

Midshaft fractures

Operative interventions showed significant improvements over nonoperative methods in terms of early and long-term function,

Table IV
Effect estimates of all pair-wise comparisons for midshaft clavicle fractures

Outcome	Comparison	MD or RR [95% CrI]
Pain score (0-100) at ≤4 wk	ESIN vs. F8B	MD, 0.61 [-11.75 to 12.77]
	ESIN vs. plate	MD, 9.49 [-2.53 to 21.63]
	ESIN vs. sling	MD, 2.09 [-11.99 to 16.18]
	F8B vs. plate	MD, 8.91 [-1.09 to 18.86]
	F8B vs. sling	MD, 1.45 [-7.85 to 11.33]
Pain score (0-100) at 6 wk	Plate vs. sling	MD, -7.42 [-17.4 to 3.17]
	ESIN vs. F8B	MD, -9.18 [-42.54 to 24.17]
	ESIN vs. plate	MD, 3.07 [-30.08 to 36.55]
	ESIN vs. sling	MD, 3.14 [-46.86 to 52.71]
	F8B vs. plate	MD, 12.36 [-8.65 to 33.27]
Pain score (0-100) at 12 wk	F8B vs. sling	MD, 12.31 [-30.14 to 54.83]
	Plate vs. sling	MD, 0.05 [-36.96 to 36.81]
	ESIN vs. F8B	MD, -1.04 [-25.69 to 23.38]
	ESIN vs. plate	MD, 6.03 [-18.98 to 30.30]
	ESIN vs. sling	MD, 4.67 [-25.81 to 34.93]
Pain score (0-100) at 24 wk	F8B vs. plate	MD, 7.09 [-7.63 to 21.26]
	F8B vs. sling	MD, 5.71 [-14.61 to 26.08]
	Plate vs. sling	MD, -1.32 [-21.51 to 18.99]
	ESIN vs. F8B	MD, -5.60 [-20.91 to 9.60]
	ESIN vs. plate	MD, -1.46 [-16.74 to 13.55]
Pain score (0-100) at 52 wk	F8B vs. sling	MD, 4.14 [-5.03 to 13.16]
	ESIN vs. F8B	MD, -2.78 [-10.79 to 5.34]
	ESIN vs. plate	MD, -3.29 [-11.24 to 4.88]
	ESIN vs. sling	MD, -7.26 [-18.80 to 4.32]
	F8B vs. plate	MD, -0.51 [-5.25 to 4.23]
Pain score (0-100) at >52 wk	F8B vs. sling	MD, -4.49 [-14.19 to 5.22]
	Plate vs. sling	MD, -3.95 [-12.41 to 4.52]
	ESIN vs. plate	MD, -9.98 [-23.86 to 4.04]
	ESIN vs. sling	MD, -7.96 [-26.96 to 10.83]
	Plate vs. sling	MD, 2.00 [-11.11 to 14.97]
Function score (0-100) at ≤4 wk	ESIN vs. F8B	MD, 5.40 [-23.72 to 34.69]
	ESIN vs. IMP	MD, 15.17 [-30.04 to 60.34]
	ESIN vs. plate	MD, -2.72 [-24.36 to 20.11]
	ESIN vs. sling	MD, 28.63 [-2.71 to 60.30]
	F8B vs. IMP	MD, 9.70 [-44.29 to 63.45]
	F8B vs. plate	MD, -8.04 [-36.92 to 21.63]
	F8B vs. sling	MD, 23.21 [-20.15 to 66.15]
	IMP vs. plate	MD, -17.86 [-67.07 to 32.03]
	IMP vs. sling	MD, 13.39 [-19.27 to 46.33]
	Plate vs. sling	MD, 31.33 [-7.71 to 69.54]
	CRx vs. ESIN	MD, 9.46 [-12.59 to 30.83]
	CRx vs. F8B	MD, 17.05 [-7.41 to 41.30]
	CRx vs. F8B + sling	MD, 17.93 [-7.07 to 42.87]
	CRx vs. IMP	MD, 10.36 [-20.38 to 40.70]
	CRx vs. plate	MD, 11.04 [-9.78 to 31.58]
CRx vs. sling	MD, 20.16 [-1.61 to 42.08]	
Function score (0-100) at 6 wk	ESIN vs. F8B	MD, 7.67 [-6.13 to 21.53]
	ESIN vs. F8B + sling	MD, 8.54 [-7.37 to 24.26]
	ESIN vs. IMP	MD, 0.87 [-22.86 to 24.60]
	ESIN vs. plate	MD, 1.60 [-5.31 to 8.51]
	ESIN vs. sling*	MD, 10.73 [1.21 to 20.35]
	F8B vs. F8B + sling	MD, 0.90 [-18.47 to 20.27]
	F8B vs. IMP	MD, -6.72 [-32.91 to 19.45]
	F8B vs. plate	MD, -6.07 [-19.06 to 7.05]
	F8B vs. sling	MD, 3.09 [-11.74 to 17.99]
	F8B + sling vs. IMP	MD, -7.54 [-34.40 to 19.18]
	F8B + sling vs. plate	MD, -6.91 [-21.04 to 7.39]
	F8B + sling vs. sling	MD, 2.23 [-13.68 to 18.32]
	IMP vs. plate	MD, 0.69 [-22.26 to 23.48]
	IMP vs. sling	MD, 9.79 [-11.73 to 31.50]
	Plate vs. sling*	MD, 9.12 [1.66 to 16.66]
Function score (0-100) at 12 wk	CRx vs. ESIN	MD, 7.88 [-5.32 to 21.12]
	CRx vs. F8B*	MD, 14.89 [0.22 to 29.65]
	CRx vs. F8B + sling*	MD, 17.86 [1.07 to 34.49]
	CRx vs. IMP	MD, 5.16 [-16.23 to 26.52]
	CRx vs. plate	MD, 9.98 [-2.42 to 22.53]
	CRx vs. sling	MD, 12.88 [-0.16 to 26.24]
	ESIN vs. F8B	MD, 7.07 [-1.27 to 15.43]
	ESIN vs. F8B + sling	MD, 9.96 [-1.83 to 21.96]
	ESIN vs. IMP	MD, -2.66 [-20.27 to 15.17]
	ESIN vs. plate	MD, 2.12 [-2.25 to 6.65]
	ESIN vs. sling	MD, 5.03 [-0.49 to 10.74]

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Table IV (continued)

Outcome	Comparison	MD or RR [95% CrI]
Function score (0-100) at 24 wk	F8B vs. F8B + sling	MD, 2.92 [-10.79 to 16.62]
	F8B vs. IMP	MD, -9.74 [-28.31 to 8.90]
	F8B vs. plate	MD, -4.95 [-12.88 to 3.11]
	F8B vs. sling	MD, -2.03 [-9.98 to 5.98]
	F8B + sling vs. IMP	MD, -12.63 [-33.22 to 7.97]
	F8B + sling vs. plate	MD, -7.82 [-18.99 to 3.37]
	F8B + sling vs. sling	MD, -4.90 [-16.65 to 6.84]
	IMP vs. plate	MD, 4.79 [-12.59 to 22.03]
	IMP vs. sling	MD, 7.69 [-9.03 to 24.55]
	Plate vs. sling	MD, 2.91 [-1.16 to 7.01]
	CRx vs. ESIN	MD, 8.01 [-1.56 to 17.68]
	CRx vs. F8B*	MD, 14.65 [4.70 to 24.79]
	CRx vs. F8B + sling*	MD, 13.39 [2.04 to 24.53]
	CRx vs. IMP*	MD, 12.18 [1.16 to 23.34]
	CRx vs. plate*	MD, 9.99 [0.87 to 19.27]
Function score (0-100) at 52 wk	CRx vs. sling*	MD, 14.59 [4.97 to 24.49]
	ESIN vs. F8B*	MD, 6.65 [1.90 to 11.39]
	ESIN vs. F8B + sling	MD, 5.35 [-1.74 to 12.25]
	ESIN vs. IMP	MD, 4.13 [-2.53 to 10.96]
	ESIN vs. plate	MD, 1.97 [-0.81 to 4.79]
	ESIN vs. sling*	MD, 6.58 [2.60 to 10.65]
	F8B vs. F8B + sling	MD, -1.30 [-9.04 to 6.16]
	F8B vs. IMP	MD, -2.54 [-9.93 to 4.96]
	F8B vs. plate*	MD, -4.68 [-8.75 to -0.57]
	F8B vs. sling	MD, -0.09 [-5.19 to 5.14]
	F8B + sling vs. IMP	MD, -1.23 [-10.03 to 7.92]
	F8B + sling vs. plate	MD, -3.37 [-9.63 to 3.24]
	F8B + sling vs. sling	MD, 1.22 [-5.77 to 8.52]
	IMP vs. plate	MD, -2.14 [-8.40 to 4.00]
	IMP vs. sling	MD, 2.47 [-3.93 to 8.84]
Plate vs. sling*	MD, 4.60 [1.45 to 7.86]	
Function score (0-100) at >52 wk	CRx vs. ESIN	MD, 2.53 [-3.42 to 8.43]
	CRx vs. F8B	MD, 4.27 [-2.62 to 11.20]
	CRx vs. IMP	MD, 3.52 [-3.48 to 10.63]
	CRx vs. plate	MD, 2.84 [-2.01 to 7.70]
	CRx vs. sling*	MD, 5.82 [0.31 to 11.47]
	ESIN vs. F8B	MD, 1.72 [-3.81 to 7.37]
	ESIN vs. IMP	MD, 0.99 [-5.07 to 7.08]
	ESIN vs. plate	MD, 0.28 [-3.00 to 3.74]
	ESIN vs. sling	MD, 3.29 [-0.87 to 7.67]
	F8B vs. IMP	MD, -0.72 [-7.68 to 6.28]
	F8B vs. plate	MD, -1.42 [-6.36 to 3.55]
	F8B vs. sling	MD, 1.56 [-3.55 to 6.85]
	IMP vs. plate	MD, -0.70 [-5.72 to 4.34]
	IMP vs. sling	MD, 2.30 [-2.89 to 7.61]
	Plate vs. sling*	MD, 3.00 [0.33 to 5.73]
Time to radiographic union, wk	ESIN vs. F8B	MD, 0.98 [-12.32 to 14.47]
	ESIN vs. IMP	MD, -0.85 [-9.71 to 8.16]
	ESIN vs. plate	MD, 0.11 [-2.43 to 2.92]
	ESIN vs. sling*	MD, 4.75 [1.56 to 8.04]
	F8B vs. IMP	MD, -1.85 [-11.78 to 8.15]
	F8B vs. plate	MD, -0.82 [-14.06 to 12.27]
	F8B vs. sling	MD, 3.81 [-9.82 to 17.15]
	IMP vs. plate	MD, 0.99 [-7.46 to 9.57]
	IMP vs. sling	MD, 5.63 [-3.47 to 14.56]
	Plate vs. sling*	MD, 4.63 [1.56 to 7.54]
	CRx vs. ESIN	MD, -4.50 [-10.33 to 1.61]
	CRx vs. F8B*	MD, -10.44 [-19.73 to -1.04]
	CRx vs. IMP	MD, -4.73 [-12.23 to 2.78]
	CRx vs. plate	MD, -5.38 [-10.73 to 0.00]
	CRx vs. sling*	MD, -11.37 [-17.79 to -4.73]
Function score (0-100) at 12 wk	ESIN vs. F8B	MD, -5.96 [-14.21 to 1.94]
	ESIN vs. IMP	MD, -0.24 [-6.32 to 5.51]
	ESIN vs. plate	MD, -0.89 [-3.63 to 1.63]
	ESIN vs. sling*	MD, -6.88 [-10.55 to -3.27]
	F8B vs. IMP	MD, 5.70 [-3.50 to 14.86]
	F8B vs. plate	MD, 5.08 [-2.54 to 12.69]
	F8B vs. sling	MD, -0.91 [-9.22 to 7.71]
	IMP vs. plate	MD, -0.63 [-5.89 to 4.61]
	IMP vs. sling*	MD, -6.62 [-12.93 to -0.05]
	Plate vs. sling*	MD, -5.99 [-9.67 to -2.15]

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Table IV (continued)

Outcome	Comparison	MD or RR [95% CrI]
Time to return to work, wk	ESIN vs. F8B	MD, -2.80 [-6.16 to 0.37]
	ESIN vs. plate	MD, -1.30 [-4.04 to 1.48]
	ESIN vs. sling	MD, -2.44 [-5.77 to 0.76]
	F8B vs. plate	MD, 1.49 [-0.64 to 3.90]
	F8B vs. sling	MD, 0.35 [-2.16 to 3.00]
	Plate vs. sling	MD, -1.14 [-3.10 to 0.71]
Delayed union	CRx vs. ESIN	RR, 1.21 [0.00 to 473]
	CRx vs. F8B	RR, 1.63 [0.00 to 1097]
	CRx vs. IMP	RR, 0.41 [0.00 to 270]
	CRx vs. plate	RR, 2.80 [0.02 to 523]
	CRx vs. sling	RR, 1.30 [0.01 to 408]
	ESIN vs. F8B	RR, 1.34 [0.03 to 183]
	ESIN vs. IMP	RR, 0.34 [0.00 to 50]
	ESIN vs. plate	RR, 2.32 [0.11 to 81]
	ESIN vs. sling	RR, 1.06 [0.08 to 22]
	F8B vs. IMP	RR, 0.25 [0.00 to 40]
	F8B vs. plate	RR, 1.77 [0.03 to 50]
	F8B vs. sling	RR, 0.81 [0.01 to 37]
	IMP vs. plate	RR, 6.82 [0.13 to 804]
	IMP vs. sling	RR, 3.11 [0.06 to 463]
	Plate vs. sling	RR, 0.46 [0.04 to 5.15]
Malunion	ESIN vs. F8B + sling*	RR, 0.11 [0.00 to 0.93]
	ESIN vs. IMP	RR, 1.09 [0.16 to 6.30]
	ESIN vs. plate	RR, 2.27 [0.84 to 6.11]
	ESIN vs. sling	RR, 0.59 [0.21 to 1.65]
	F8B + sling vs. IMP	RR, 10 [0.83 to 395]
	F8B + sling vs. plate*	RR, 20 [3.19 to 679]
	F8B + sling vs. sling	RR, 5.40 [0.75 to 183]
	IMP vs. plate	RR, 2.08 [0.46 to 11]
	IMP vs. sling	RR, 0.54 [0.11 to 3.32]
	Plate vs. sling*	RR, 0.26 [0.14 to 0.49]
	Nonunion	ESIN vs. F8B*
ESIN vs. F8B + sling*		RR, 0.00 [0.00 to 0.13]
ESIN vs. IMP		RR, 0.69 [0.20 to 2.18]
ESIN vs. plate		RR, 1.67 [0.89 to 3.39]
ESIN vs. sling*		RR, 0.38 [0.19 to 0.79]
F8B vs. F8B + sling*		RR, 0.00 [0.00 to 0.51]
F8B vs. IMP		RR, 2.66 [0.63 to 13]
F8B vs. plate*		RR, 6.36 [2.18 to 24]
F8B vs. sling		RR, 1.46 [0.46 to 5.78]
IMP vs. F8B + sling*		RR, 0.00 [0.00 to 0.18]
Plate vs. F8B + sling*		RR, 0.00 [0.00 to 0.08]
Sling vs. F8B + sling*		RR, 0.00 [0.00 to 0.34]
IMP vs. plate		RR, 2.41 [0.96 to 6.89]
IMP vs. sling		RR, 0.55 [0.20 to 1.68]
Plate vs. sling*		RR, 0.23 [0.15 to 0.35]
Refracture	ESIN vs. IMP	RR, 1.73 [0.13 to 32]
	ESIN vs. plate	RR, 1.03 [0.23 to 5.87]
	ESIN vs. sling	RR, 2.77 [0.38 to 37]
	IMP vs. plate	RR, 0.59 [0.06 to 5.42]
	IMP vs. sling	RR, 1.60 [0.15 to 21]
	Plate vs. sling	RR, 2.69 [0.56 to 20]
Revision	ESIN vs. F8B	RR, 3.16 [0.29 to 104]
	ESIN vs. IMP	RR, 0.17 [0.00 to 2.44]
	ESIN vs. plate	RR, 1.09 [0.37 to 3.35]
	ESIN vs. sling	RR, 0.83 [0.23 to 2.90]
	F8B vs. IMP	RR, 0.05 [0.00 to 1.60]
	F8B vs. plate	RR, 0.34 [0.01 to 3.86]
	F8B vs. sling	RR, 0.26 [0.01 to 3.07]
	IMP vs. plate	RR, 6.30 [0.61 to 189]
	IMP vs. sling	RR, 4.72 [0.40 to 144]
	Plate vs. sling	RR, 0.76 [0.38 to 1.37]
	Symptoms	CRx vs. ESIN
CRx vs. F8B		RR, 0.90 [0.00 to 245]
CRx vs. IMP		RR, 0.86 [0.00 to 118]
CRx vs. plate		RR, 0.43 [0.00 to 46]
CRx vs. sling		RR, 2.04 [0.01 to 608]
ESIN vs. F8B		RR, 2.80 [0.07 to 145]
ESIN vs. IMP		RR, 2.69 [0.17 to 46]
ESIN vs. plate		RR, 1.35 [0.13 to 14]

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Table IV (continued)

Outcome	Comparison	MD or RR [95% CrI]
	ESIN vs. sling	RR, 6.30 [0.22 to 372]
	F8B vs. IMP	RR, 0.96 [0.04 to 20]
	F8B vs. plate	RR, 0.48 [0.02 to 9.49]
	F8B vs. sling	RR, 2.24 [0.05 to 193]
	IMP vs. plate	RR, 0.50 [0.11 to 2.20]
	IMP vs. sling	RR, 2.31 [0.13 to 85]
	Plate vs. sling	RR, 4.62 [0.38 to 121]

MD, mean difference; RR, risk ratio; CrI, credible interval; ESIN, elastic stable intramedullary nail; F8B, figure-of-eight bandage; CRx, Sonoma CRx intramedullary nail; IMP, intramedullary pin.

* Statistically significant.

time to radiographic union, and reduction in certain complications. Specifically, plating, the ESIN, and the CRx consistently demonstrated more favorable function than nonoperative therapies over time; the IMP also showed greater function than nonoperative treatments from 6 weeks onward, but its effects were never statistically significant. Moreover, operative treatments demonstrated a significantly earlier time to radiographic union than the sling. Therefore, for patients who seek a quicker recovery, operating would be the best approach. Plating, the IMP, and the ESIN also showed lower risks of nonunion and malunion relative to nonoperative therapies, but only plating had a statistically significant effect compared with each nonoperative treatment. Of note, there were no data for the CRx to include in the analyses of nonunion and malunion. Though not statistically significant, our analysis also revealed that although plating was associated with an increase in ongoing symptoms, except compared with the ESIN, it also had the least risk of a delayed union and revision surgery. Plating showed significant improvements in the greatest number of comparisons across multiple outcomes, followed by the ESIN. The CRx also showed promise as a treatment; however, there is currently limited evidence on this method. Although the IMP similarly showed some statistically significant findings, its effects were not as impressive.

Prior reviews have also demonstrated that operative interventions show improvements over nonoperative treatments in terms of functional outcomes, time to union, and fewer complications, such as nonunion.^{16,66,96} Virtanen et al⁹⁶ found that the results of surgery showed better function and a lower likelihood of delayed union and nonunion. Duan et al¹⁶ suggested that plating results in fewer complications and more satisfaction than use of a sling. More recently, Rehn et al⁶⁶ found that nonoperatively treated patients had more nonunions but that operative intervention may increase the risk of minor complications.

In a review, Wang et al⁹⁸ suggested that treatment with intramedullary (IM) implants, compared with plating and nonoperative treatment, is the optimal approach. However, they grouped all nonoperative therapies (ie, sling and F8B) and all the various IM devices (ie, IMP and ESIN), and these conclusions were based on nonunion and infection rates, which were higher with plating than with IM fixation but not statistically significant. Jiang et al³³ conducted a network meta-analysis on function and also suggested that IM fixation resulted in more favorable outcomes, but they grouped treatments in a similar fashion to Wang et al (ie, any IM device) and only included studies that used the Constant-Murley score.

Distal fractures

We found that functional improvement at earlier visits may be best achieved with CCSu, although these results were not

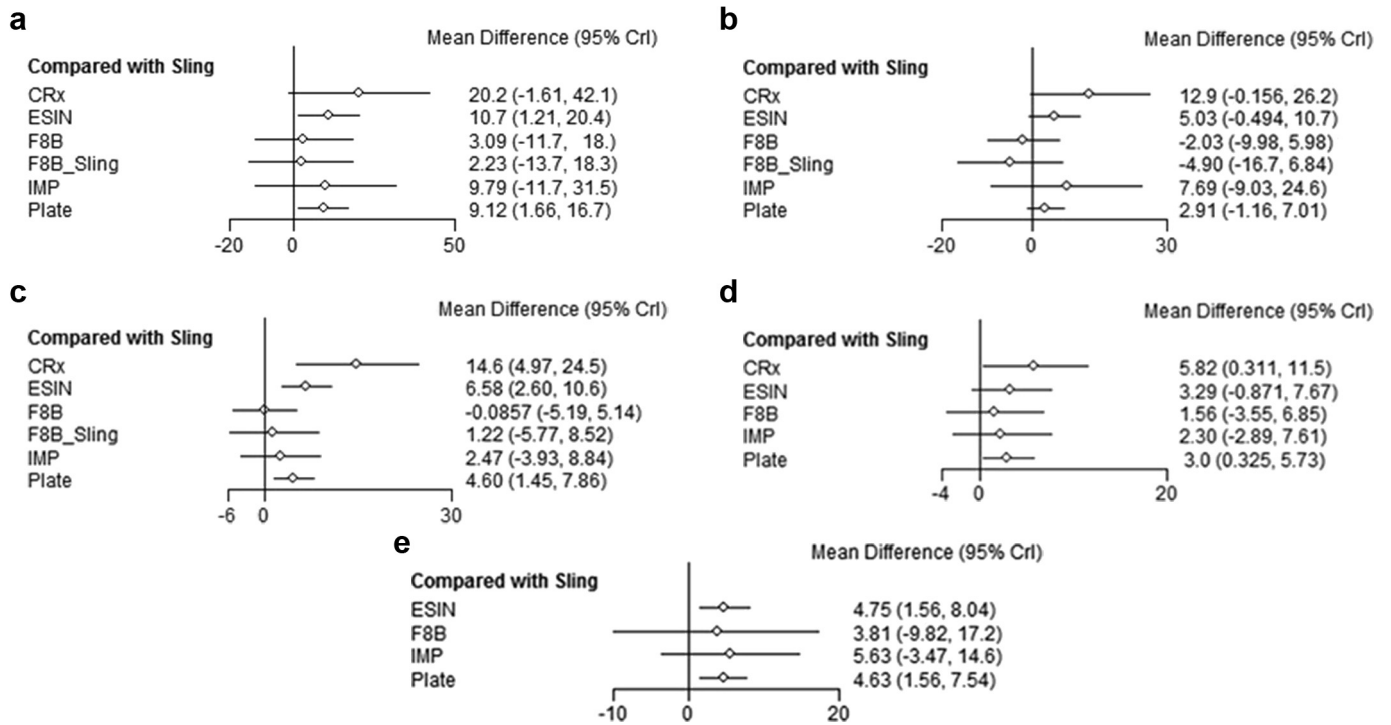


Figure 4 Forest plot of function at 6 weeks (a), 12 weeks (b), 24 weeks (c), 52 weeks (d), and >52 weeks (e) for midshaft clavicle fractures. *CrI*, credible interval; *CRx*, Sonoma CRx intramedullary nail; *ESIN*, elastic stable intramedullary nail; *F8B*, figure-of-8 bandage; *F8B Sling*, figure-of-8 bandage with sling; *IMP*, intramedullary pin.

statistically significant. At ≥ 1 year, functional scores were significantly worse with KW than with CCSu, CCSu-LP, the HP, and the LP, whereas functional scores with TB-KW were significantly worse than with the LP only. Of note, CCSu-LP was ranked third and second at 3 and 6 months, respectively, and there were no functional data for the LP at 6 months. No significant findings were observed for time to radiographic union, but CCSu-LP showed the earliest time to union and CCSu alone resulted in the longest time. The HP demonstrated the least risk of hardware problems, but this was only significant compared with KW, and the LP and CCSu-LP were ranked second and third, respectively, in this analysis. The risk of a nonunion was most favorable with the LP and CCSu-LP, whereas the sling and CCSu were ranked lowest for this outcome. The LP was ranked second, after TB-KW, for the risk of refracture, whereas CCSu and the HP were ranked lowest. For both the risk of reoperation and symptomatic hardware, CCSu-LP was ranked highest with significantly lower risks than with all other interventions (there were no data for locked plating alone to include in these analyses); CCSu was ranked lowest and had a significantly higher risk of symptomatic hardware compared with all other treatments. Such results suggest that, for early and sustained functional improvement and limited complications, the LP with or without

CCSu may provide the most optimal outcome. CCSu alone and the HP may be viable alternatives as well, although CCSu alone appears to be associated with union-related issues and continued symptoms, and both CCSu alone and the HP may have a higher likelihood of refracture.

The network meta-analysis by Boonard et al⁷ on distal fractures included 11 studies and evaluated (1) coracoclavicular (CC) fixation, (2) an HP, (3) an LP, (4) TB, and (5) KW. Similarly to our analysis, the authors concluded that CC fixation and the LP were better than both the HP and TB for function and that the LP was associated with a lower risk of complications. Although we came to the same general conclusions, there were some differences in our methodology. First, Boonard et al did not consider some treatments as combination therapies, such as CC fixation with an LP and TB with KW. We considered each combination therapy a treatment node to ensure the effects were exclusively attributed to each unique therapy. Second, Boonard et al analyzed different functional measures separately (ie, Constant-Murley and UCLA scores) and did not evaluate function across different time points. We converted functional measures to a common scale and analyzed these data at 3 months, 6 months, and ≥ 1 year to determine differences occurred over time. Finally, Boonard et al evaluated the risk of any

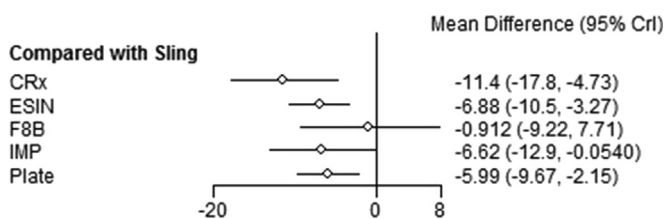


Figure 5 Forest plot of time to radiographic union for midshaft clavicle fractures. *CrI*, credible interval; *CRx*, Sonoma CRx intramedullary nail; *ESIN*, elastic stable intramedullary nail; *F8B*, figure-of-8 bandage; *IMP*, intramedullary pin.

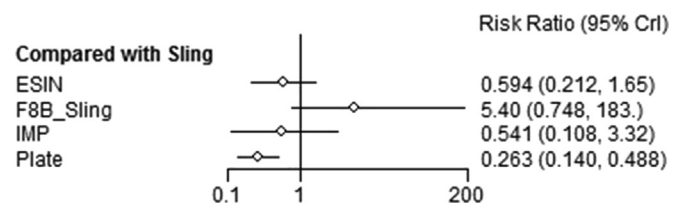


Figure 6 Forest plot of malunion for midshaft clavicle fractures. *CrI*, credible interval; *ESIN*, elastic stable intramedullary nail; *F8B Sling*, figure-of-8 bandage with sling; *IMP*, intramedullary pin.

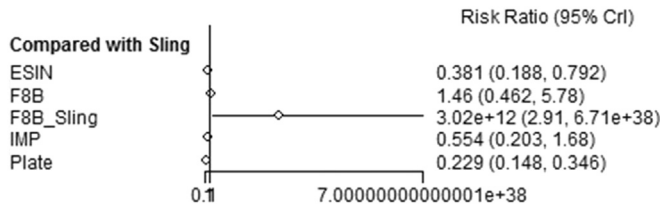


Figure 7 Forest plot of nonunion for midshaft clavicle fractures. CrI, credible interval; ESIN, elastic stable intramedullary nail; F8B, figure-of-8 bandage; F8B Sling, figure-of-8 bandage with sling; IMP, intramedullary pin.

complication, whereas we assessed specific complications to determined whether particular events were more—or less—likely following a particular treatment.

Medial fractures

Plating appears to be associated with better functional scores than both the sling and TB. In addition, plating, a screw and suturing, and KW were positively associated with a patient’s return to his or her previous occupation or activity level; however, the latter 2 treatments were limited to evidence from case reports. Surgical intervention also appears to lessen the risk of nonunion and malunion relative to nonoperative therapy. With plating, the most common complaint in 1 study was implant irritation, which led to subsequent implant removal, and there were also 2 cases that underwent revision; however, other studies reported no complications or revisions following plating. The authors of some studies indicated why they selected certain treatments, suggesting that they may have preferred another treatment under other circumstances. Bourghli and Fabre⁸ stated that they used KW instead of plating because the fracture was too severely comminuted. Low et al⁵¹ used a screw and suturing instead of plating because the patient had poor bone stock. The patients treated nonoperatively in the study by Bartonicek et al⁵ were deemed unfit for surgery: Both patients were elderly, and 1 underwent a prior coronary bypass and the other was a heavy drinker. In other cases, the surgeon chose TB instead of plating because the medial fragment in these patients was too short and there was inadequate bone stock.

The evidence on medial fractures is very limited. Part of the reason for this may be its extremely low prevalence, representing <3% of clavicle fractures.⁷² Our review suggests that plating, given the proper indications, offers the best outcome; however, implant irritation can occur, which is usually resolved with implant removal. Other surgical procedures (ie, TB, KW, screws and suturing) seem to perform well too, but these options may only be preferred in situations in which plating is contraindicated, and the evidence on these treatments is limited to just a few case reports.

Strengths and limitations

Our review differentiated between clavicle fracture types (ie, midshaft, distal, and medial) as they are not the same injury. We conducted a comprehensive comparative analysis, for midshaft and distal fractures, of various interventions. We also examined numerous outcomes to best inform treatment decisions when weighing the risks and benefits of these therapies. We were very specific in our categorization of interventions, including combination therapies, so that our results were less likely to be confounded by variations in treatment techniques or characteristics.

Table V Effect estimates of all pair-wise comparisons for distal clavicle fractures

Outcome	Comparison	MD or RR [95% CrI]
Function score (0-100) at 3 mo	CCSc-LP vs. CCSu	MD, -17.08 [-40.91 to 6.50]
	CCSc-LP vs. CCSu-LP	MD, -10.00 [-23.05 to 2.90]
	CCSc-LP vs. HP	MD, -12.03 [-31.93 to 8.05]
	CCSc-LP vs. LP	MD, -9.33 [-27.77 to 9.04]
	CCSc-LP vs. TB-KW	MD, -5.60 [-19.25 to 8.05]
	CCSu vs. CCSu-LP	MD, 7.04 [-16.60 to 30.85]
	CCSu vs. HP	MD, 5.11 [-7.67 to 17.91]
	CCSu vs. LP	MD, 7.71 [-19.13 to 34.49]
	CCSu vs. TB-KW	MD, 11.50 [-7.82 to 30.75]
	CCSu-LP vs. HP	MD, -1.99 [-21.90 to 17.80]
	CCSu-LP vs. LP	MD, 0.66 [-12.30 to 13.56]
	CCSu-LP vs. TB-KW	MD, 4.39 [-9.25 to 18.02]
Function score (0-100) at 6 mo	HP vs. LP	MD, 2.65 [-20.93 to 26.38]
	HP vs. TB-KW	MD, 6.40 [-8.04 to 20.75]
	LP vs. TB-KW	MD, 3.72 [-15.07 to 22.30]
	CCSc-LP vs. CCSu	MD, -8.14 [-22.79 to 6.63]
	CCSc-LP vs. CCSu-LP	MD, -3.69 [-11.43 to 4.07]
	CCSc-LP vs. HP	MD, -4.51 [-17.27 to 8.09]
	CCSc-LP vs. TB-KW	MD, 1.01 [-7.95 to 9.91]
	CCSu vs. CCSu-LP	MD, 4.48 [-10.29 to 19.00]
	CCSu vs. HP	MD, 3.70 [-3.77 to 11.19]
	CCSu vs. TB-KW	MD, 9.15 [-2.42 to 20.70]
	CCSu-LP vs. HP	MD, -0.76 [-13.46 to 11.85]
	CCSu-LP vs. TB-KW	MD, 4.69 [-4.25 to 13.70]
Function score (0-100) at ≥ 1 yr	HP vs. TB-KW	MD, 5.47 [-3.49 to 14.36]
	CCSc-LP vs. CCSu	MD, -3.09 [-12.00 to 5.57]
	CCSc-LP vs. CCSu-KW	MD, 2.13 [-10.47 to 14.45]
	CCSc-LP vs. CCSu-LP	MD, -4.42 [-11.57 to 2.44]
	CCSc-LP vs. HP	MD, 0.15 [-7.83 to 8.09]
	CCSc-LP vs. KW	MD, 6.91 [-2.65 to 16.58]
	CCSc-LP vs. LP	MD, -4.92 [-13.41 to 3.41]
	CCSc-LP vs. TB-KW	MD, 1.45 [-6.13 to 8.70]
	CCSu vs. CCSu-KW	MD, 5.22 [-5.83 to 16.34]
	CCSu vs. CCSu-LP	MD, -1.37 [-8.69 to 6.01]
	CCSu vs. HP	MD, 3.22 [-0.55 to 7.20]
	CCSu vs. KW*	MD, 9.98 [2.86 to 17.52]
Time to radiographic union, wk	CCSu vs. LP	MD, -1.78 [-8.35 to 4.68]
	CCSu vs. TB-KW	MD, 4.52 [-1.05 to 10.10]
	CCSu-KW vs. CCSu-LP	MD, -6.61 [-17.63 to 4.25]
	CCSu-KW vs. HP	MD, -1.99 [-12.37 to 8.52]
	CCSu-KW vs. KW	MD, 4.75 [-7.10 to 17.00]
	CCSu-KW vs. LP	MD, -7.03 [-16.11 to 1.90]
	CCSu-KW vs. TB-KW	MD, -0.72 [-11.64 to 10.23]
	CCSu-LP vs. HP	MD, 4.60 [-1.51 to 10.83]
	CCSu-LP vs. KW*	MD, 11.36 [3.11 to 19.84]
	CCSu-LP vs. LP	MD, -0.44 [-6.61 to 5.65]
	CCSu-LP vs. TB-KW	MD, 5.89 [-0.19 to 11.97]
	HP vs. KW*	MD, 6.74 [0.58 to 13.06]
HP vs. LP	MD, -5.04 [-10.41 to 0.13]	
HP vs. TB-KW	MD, 1.32 [-2.84 to 5.14]	
KW vs. LP*	MD, -11.80 [-20.02 to -3.95]	
KW vs. TB-KW	MD, -5.45 [-12.11 to 0.95]	
LP vs. TB-KW*	MD, 6.36 [0.26 to 12.49]	
CCSc-LP vs. CCSu	MD, -7.57 [-27.81 to 12.10]	
CCSc-LP vs. CCSu-LP	MD, 3.37 [-8.06 to 14.90]	
CCSc-LP vs. HP	MD, -3.75 [-20.40 to 12.78]	
CCSc-LP vs. KW	MD, -3.94 [-20.40 to 12.48]	
CCSc-LP vs. LP	MD, -4.53 [-24.85 to 12.72]	
CCSc-LP vs. TB-KW	MD, -3.34 [-15.76 to 9.03]	
CCSu vs. CCSu-LP	MD, 10.93 [-8.75 to 31.22]	
CCSu vs. HP	MD, 3.82 [-7.16 to 14.76]	
CCSu vs. KW	MD, 3.61 [-15.39 to 22.86]	
CCSu vs. LP	MD, 3.27 [-12.59 to 15.56]	
CCSu vs. TB-KW	MD, 4.26 [-11.30 to 19.90]	
CCSu-LP vs. HP	MD, -7.09 [-23.77 to 9.37]	
CCSu-LP vs. KW	MD, -7.28 [-23.67 to 9.13]	
CCSu-LP vs. LP	MD, -7.86 [-28.23 to 9.75]	
CCSu-LP vs. TB-KW	MD, -6.67 [-18.90 to 5.60]	
HP vs. KW	MD, -0.16 [-15.58 to 15.25]	
HP vs. LP	MD, -0.52 [-11.23 to 6.73]	
HP vs. TB-KW	MD, 0.45 [-10.65 to 11.36]	
KW vs. LP	MD, -0.36 [-19.96 to 15.57]	
KW vs. TB-KW	MD, 0.61 [-10.44 to 11.35]	

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Table V (continued)

Outcome	Comparison	MD or RR [95% CrI]
Hardware complications	LP vs. TB-KW	MD, 1.00 [−11.49 to 16.90]
	CCSu vs. CCSu-LP	RR, 1.43 [0.00 to 523]
	CCSu vs. HP	RR, 2.03 [0.02 to 217]
	CCSu vs. KW	RR, 0.10 [0.00 to 24]
	CCSu vs. LP	RR, 1.45 [0.00 to 545]
	CCSu vs. TB-KW	RR, 0.73 [0.00 to 145]
	CCSu-LP vs. HP	RR, 1.40 [0.04 to 59]
	CCSu-LP vs. KW	RR, 0.07 [0.00 to 7.77]
	CCSu-LP vs. LP	RR, 1.03 [0.03 to 39]
	CCSu-LP vs. TB-KW	RR, 0.50 [0.01 to 43]
	HP vs. KW*	RR, 0.05 [0.00 to 0.93]
	HP vs. LP	RR, 0.72 [0.02 to 29]
	HP vs. TB-KW	RR, 0.35 [0.05 to 3.71]
	KW vs. LP	RR, 14 [0.13 to 1510]
Nonunion	KW vs. TB-KW	RR, 6.69 [0.48 to 179]
	LP vs. TB-KW	RR, 0.49 [0.01 to 41]
	CCSc-LP vs. CCSu	RR, 0.76 [0.01 to 68]
	CCSu-LP vs. CCSc-LP*	RR, 0.00 [0.00 to 0.97]
	CCSc-LP vs. HP	RR, 2.05 [0.03 to 156]
	CCSc-LP vs. KW	RR, 4.06 [0.03 to 608]
	LP vs. CCSc-LP*	RR, 0.00 [0.00 to 0.51]
	CCSc-LP vs. TB-KW	RR, 0.84 [0.02 to 44]
	CCSu-LP vs. CCSu*	RR, 0.00 [0.00 to 0.90]
	CCSu vs. HP	RR, 2.66 [0.64 to 15]
	CCSu vs. KW	RR, 5.26 [0.35 to 120]
	LP vs. CCSu*	RR, 0.00 [0.00 to 0.14]
	CCSu vs. TB-KW	RR, 1.12 [0.10 to 15]
	CCSu-LP vs. HP	RR, 0.00 [0.00 to 2.32]
Refracture	CCSu-LP vs. KW	RR, 0.00 [0.00 to 6.23]
	CCSu-LP vs. LP	RR, 6.36 [0.00 to 2.29 × 10 ²⁰]
	CCSu-LP vs. TB-KW*	RR, 0.00 [0.00 to 0.77]
	HP vs. KW	RR, 1.95 [0.19 to 26]
	LP vs. HP*	RR, 0.00 [0.00 to 0.09]
	HP vs. TB-KW	RR, 0.42 [0.06 to 10]
	LP vs. KW*	RR, 0.00 [0.00 to 0.93]
	KW vs. TB-KW	RR, 0.21 [0.01 to 4.48]
	LP vs. TB-KW*	RR, 0.00 [0.00 to 0.19]
	CCSu vs. CCSu-LP	RR, 2.44 [0.08 to 144]
	CCSu vs. HP	RR, 0.76 [0.13 to 4.10]
	KW vs. CCSu*	RR, 0.00 [0.00 to 0.85]
	LP vs. CCSu*	RR, 0.00 [0.00 to 0.52]
	TB-KW vs. CCSu*	RR, 0.00 [0.00 to 0.00]
Revision	CCSu-LP vs. HP	RR, 0.32 [0.01 to 5.53]
	KW vs. CCSu-LP	RR, 0.00 [0.00 to 4.26]
	LP vs. CCSu-LP	RR, 0.00 [0.00 to 1.82]
	TB-KW vs. CCSu-LP*	RR, 0.00 [0.00 to 0.00]
	KW vs. HP*	RR, 0.00 [0.00 to 0.57]
	LP vs. HP*	RR, 0.00 [0.00 to 0.34]
	TB-KW vs. HP*	RR, 0.00 [0.00 to 0.00]
	LP vs. KW	RR, 0.00 [0.00 to 9.55 × 10 ⁹]
	TB-KW vs. KW*	RR, 0.00 [0.00 to 0.38]
	TB-KW vs. LP	RR, 0.00 [0.00 to 1.07 × 10 ¹⁵]
	CCSu vs. CCSc-LP	RR, 0.07 [0.00 to 40]
	CCSu-LP vs. CCSc-LP*	RR, 0.00 [0.00 to 0.01]
	HP vs. CCSc-LP	RR, 0.08 [0.00 to 25]
	KW vs. CCSc-LP	RR, 0.11 [0.00 to 116]
TB-KW vs. CCSc-LP	RR, 0.31 [0.01 to 13]	
Symptoms	CCSu-LP vs. CCSu*	RR, 0.00 [0.00 to 0.45]
	CCSu vs. HP	RR, 0.85 [0.04 to 14]
	CCSu vs. KW	RR, 0.64 [0.00 to 91]
	CCSu vs. TB-KW	RR, 0.23 [0.00 to 38]
	CCSu-LP vs. HP*	RR, 0.00 [0.00 to 0.28]
	CCSu-LP vs. KW*	RR, 0.00 [0.00 to 0.28]
	CCSu-LP vs. TB-KW*	RR, 0.00 [0.00 to 0.05]
	HP vs. KW	RR, 0.76 [0.01 to 45]
	HP vs. TB-KW	RR, 0.28 [0.00 to 21]
	KW vs. TB-KW	RR, 0.36 [0.00 to 130]
	CCSc-LP vs. CCSu*	RR, 0.00 [0.00 to 0.18]
	CCSu-LP vs. CCSc-LP*	RR, 0.00 [0.00 to 0.01]
	CCSc-LP vs. HP	RR, 4.26 [0.12 to 198]
	CCSc-LP vs. TB-KW	RR, 1.80 [0.10 to 39]
CCSu-LP vs. CCSu*	RR, 0.00 [0.00 to 0.00]	
HP vs. CCSu*	RR, 0.00 [0.00 to 0.03]	

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Table V (continued)

Outcome	Comparison	MD or RR [95% CrI]
	TB-KW vs. CCSu*	RR, 0.00 [0.00 to 0.08]
	CCSu-LP vs. HP*	RR, 0.00 [0.00 to 0.07]
	CCSu-LP vs. TB-KW*	RR, 0.00 [0.00 to 0.03]
	HP vs. TB-KW	RR, 0.42 [0.05 to 3.32]

MD, mean difference; RR, risk ratio; CrI, credible interval; CCSc, coracoclavicular screw fixation; LP, locking plate; CCSu, coracoclavicular suturing; HP, hook plate; TB, tension band; KW, K-wires.

* Statistically significant.

A disadvantage of our study is that it includes mostly low-quality studies; however, this is reflective of the current state of the evidence and highlights the need for more high-quality trials. Moreover, because of the limited data, the precision around the effect estimates was very low, and the inclusion of additional evidence in the future may impact the results. In addition, for medial fractures, we found no studies directly comparing treatments, meaning that our conclusions were based on case series and case reports and we could not compare these treatments via a meta-analysis. Another consideration is that fracture characteristics (pattern, stability, amount of displacement, and so on) can play a role in treatment decisions; thus, these data may not be applicable to every patient who sustains a clavicle fracture. The availability of or preference for some of these interventions in certain geographic regions can also influence the applicability of our results. For example, none of the studies evaluating the ESIN for midshaft fractures were conducted in North America. Hence, it is difficult to determine whether the ESIN would be a viable option for North American patients, as their physical characteristics and behaviors may be different from those of patients from other countries; North American surgeons may see less promising results with the ESIN in their patients. Finally, we only included articles published in English and therefore may have missed studies published in other languages.

Conclusion

This study provides evidence to inform treatment decisions for midshaft, distal, and medial clavicle fractures; however, additional high-quality evidence would be impactful. More specifically, future studies should be large (ie, greater sample sizes), multicenter randomized trials. The current evidence suggests that surgery with plating, surgery with an ESIN, and surgery with a CRx are all good options for midshaft fractures; an LP with or without CC suturing should be preferred for distal fractures; and plating is also acceptable for medial fractures, provided that the patient is deemed suitable for surgery and has

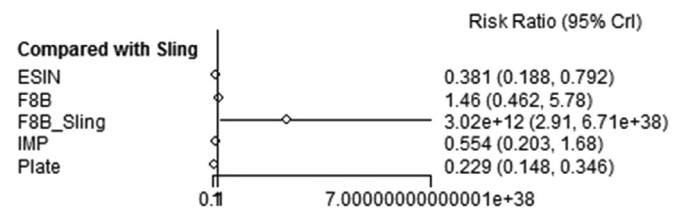


Figure 8 Forest plot of function at ≥1 year for distal clavicle fractures. CrI, credible interval; CCSu, coracoclavicular suturing; CCSc, coracoclavicular screw fixation; LP, locking plate; KW, K-wires; HP, hook plate; TB, tension band.

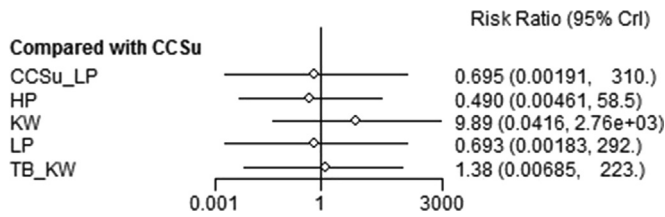


Figure 9 Forest plot of hardware complications for distal clavicle fractures. *CrI*, credible interval; *CCSu*, coracoclavicular suturing; *LP*, locking plate; *HP*, hook plate; *KW*, K-wires; *TB*, tension band.

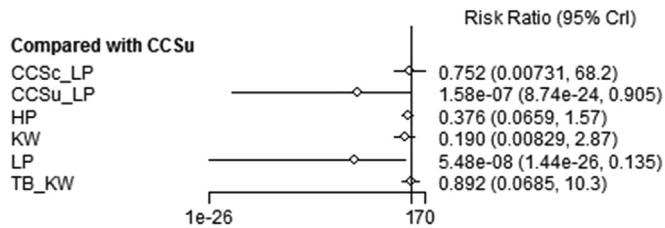


Figure 10 Forest plot of nonunion for distal clavicle fractures. *CrI*, credible interval; *CCSu*, coracoclavicular suturing; *CCSc*, coracoclavicular screw fixation; *LP*, locking plate; *HP*, hook plate; *KW*, K-wires; *TB*, tension band.

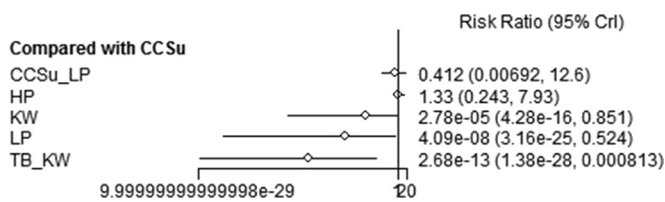


Figure 11 Forest plot of refracture for distal clavicle fractures. *CrI*, credible interval; *CCSu*, coracoclavicular suturing; *LP*, locking plate; *HP*, hook plate; *KW*, K-wires; *TB*, tension band.

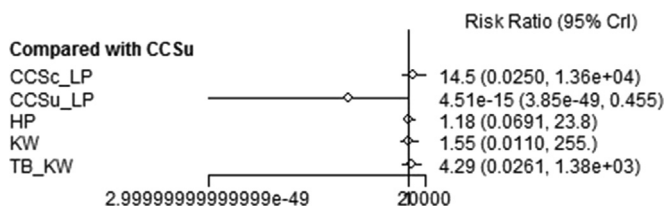


Figure 12 Forest plot of revision for distal clavicle fractures. *CrI*, credible interval; *CCSu*, coracoclavicular suturing; *CCSc*, coracoclavicular screw fixation; *LP*, locking plate; *HP*, hook plate; *KW*, K-wires; *TB*, tension band.

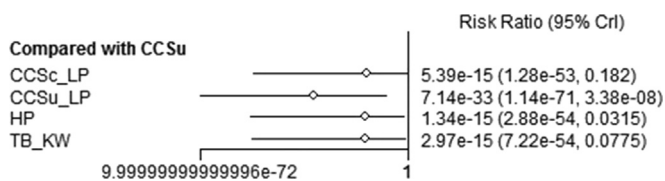


Figure 13 Forest plot of symptoms for distal clavicle fractures. *CrI*, credible interval; *CCSu*, coracoclavicular suturing; *CCSc*, coracoclavicular screw fixation; *LP*, locking plate; *HP*, hook plate; *TB*, tension band; *KW*, K-wires.

the adequate bone stock and sufficiently sized medial fragment necessary to implant the device. Patient preferences for certain outcomes should be considered, which may result in different treatment recommendations.

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