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Scaphoid fractures: anatomy, diagnosis and treatment

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Chapter

11

Non-operative treatment for acute scaphoid fractures: a systematic review and meta-analysis of randomized clinical trials

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Abstract

Background Recommendations for cast immobilization of acute scaphoid fractures vary substantially. We reviewed data from randomized controlled trials comparing nonoperative treatment methods for acute scaphoid fractures to determine the best available evidence.

Methods A systematic search of the medical literature from 1966 to 2010 was performed. Two authors independently screened titles and abstracts, reviewed articles, assessed methodological quality according to the Grading of Recommendations Assessment Development and Evaluation system, and extracted data. The primary outcome parameter was nonunion. Data were pooled using random-effects models with standard mean differences for continuous and risk ratios for dichotomous variables, respectively. Heterogeneity across studies was assessed with calculation of the I^2 statistic.

Results The search resulted in five potentially eligible trials of which four met our inclusion criteria. In total, 523 patients were included in four trials including two evaluating below-elbow casting versus above-elbow casting; one trial comparing below-elbow casting including the thumb versus excluding the thumb; and one trial comparing fractures with a below-elbow cast with the wrist in 20-degrees flexion to 20-degrees extension, with both types excluding the thumb. There were no significant differences in union rate, pain, grip strength, time to union, or osteonecrosis for the various nonoperative treatment methods.

Conclusions There is no evidence from randomized controlled trials on physician-based or patient-based outcome to favor any nonoperative treatment method for acute scaphoid fractures.

Introduction

Fractures of the carpal scaphoid are common, especially in young active adults, and there is lack of consensus regarding optimal treatment.¹⁻⁴ Reported union rates for non-operative treatment of scaphoid fractures are over 90%,^{1,5-7} but most studies do not account for displacement—the rate of union may approach 100% for stable non-displaced fractures that are adequately protected.^{8,9} Screw fixation of (non-) displaced fractures is increasingly popular as a way to limit cast immobilization and, in some cases, facilitate return to athletics or work,^{1,10} but there is no evidence to date that surgery improves the long-term prognosis.^{3,11-13} Immobilization techniques vary according to inclusion of the elbow,^{14,15} inclusion of the thumb,^{16,17} materials,^{18,19} and duration of immobilization.⁵

This systematic review and meta-analysis evaluates evidence from randomized controlled trials comparing non-operative treatment methods for acute scaphoid fractures.

Material and Methods

The study is reported following the guidelines of the Quality of Reporting of Meta-analyses (QUOROM).²⁰ This consists of a qualitative way to present the abstract, introduction, methods, results, and discussion sections of a report of a meta-analysis.

Types of studies, participants, and interventions

All randomized or quasi-randomized (methods of allocating participants to a treatment which are not strictly random; e.g. date of birth, hospital record number or alternation) controlled trials which compare different methods of non-operative treatment for acute scaphoid fractures (displaced and non-displaced fractures according to the inclusion criteria of the respective authors) in adult patients were included in this study. Trials including children, patients with congenital deformities, and patients with degenerative conditions and patients with delayed treatment (treatment initiated greater than 4 weeks from injury) or delayed union and nonunion were excluded.

Types of outcome measures

Primary outcome measure

Nonunion; defined as: 1) failure of the fracture to unite more than six months post injury, with radiographic evidence of fracture line or pain at the fracture site, or 2) when an endpoint is reached as defined by a change from non-operative to operative treatment earlier than six months after injury because of persistent nonunion according to treating physician's (subjective) opinion.



Secondary outcome measures

- Functional outcome (based on validated hand and wrist function scores)
- Patient satisfaction
- Pain
- Range of motion
- Grip Strength
- Time to union
- Malunion
- Return to work
- Return to previous activity
- Avascular necrosis (AVN)

Search methods for identification of studies

Our methods for identification of studies were similar to the Cochrane Bone, Joint and Muscle Trauma Group methods used in reviews. A systematic search, from inception of the database in 1966 to July 27, 2010, was performed. Databases included the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, and reference lists of articles. Researchers in the field were contacted to inquire about any additional unpublished trials or trials in progress.

Selection of studies

Two authors (JND and GAB) assessed abstracts of all studies identified by the initial search. Full copies of the report of potentially relevant studies were independently assessed by two authors (JND and GAB) using the above criteria. Disagreements were resolved by discussion, with arbitration by a third author (RWP) where differences of opinion remained.

Assessment of methodological quality

The quality of the selected studies was independently assessed, without masking the source of authorship of the trial reports, by two authors (JND and GAB) using a quality assessment tool derived from the Grading of Recommendations Assessment Development and Evaluation (GRADE) Working Group.²¹ To evaluate the methodological quality of the selected studies we scored the methods of allocation and blinding, and the loss to follow-up. The GRADE criteria were used to evaluate the quality of evidence by outcome. Disagreement was resolved by discussion and, if necessary, followed by scrutiny by an independent third author (RWP).

Data collection

Two authors (JND and GAB) independently extracted data from all eligible studies using a piloted data extraction form. Disagreement was resolved as above. For all continuous outcomes, means and standard deviations were extracted for analysis. If means and confidence intervals were reported instead, standard deviations were calculated from these values. Incomplete data (e.g. means without standard deviations) could not be used and were excluded from this meta-analysis.

Data analysis

For both treatment groups in each study, standard mean differences (SMD) and 95% confidence intervals (CIs) were calculated for continuous outcomes, and risk ratios (RR, i.e. relative risk)²² and 95% CIs for dichotomous outcomes using a random effects model. Treatment effect was defined as significant if $p < 0.05$. Heterogeneity between studies was tested using both the chi-square test (with significance defined as $p < 0.10$) and the I^2 tests (with substantial heterogeneity defined as values greater than 50%).²³

Results

Literature Search

The search resulted in five potentially eligible studies of which four met our inclusion criteria (Figure 1).^{14-16,19,24}

One study was excluded.¹⁹ This study evaluated two different casting materials -focused rigidity casting (FRC) versus standard casting-. Two hundred consecutive patients were randomized to have either a standard cast consisting of synthetic or plaster-of-Paris, or a focused rigidity cast of synthetic material to treat a variety of fractures. Twenty-three of these patients (12 patients had FRC) were treated for scaphoid fractures with significantly better patient satisfaction scores for focused rigidity casting. This study was excluded because material of casting was evaluated rather than different types or modalities of casting.

Four randomized controlled trials were evaluated.^{14-16,24} In total, 523 patients were included in four trials including two evaluating below-elbow casting versus above-elbow casting (75 fractures treated with an above-elbow cast including the thumb; versus 76 in a below-elbow cast including the thumb); one trial comparing below-elbow casting including the thumb versus below-elbow casting not including the thumb (143 with a below elbow cast including the thumb; and 148 with a dorsal plaster splint that did not include the thumb); and one trial comparing 58 fractures with a below elbow cast



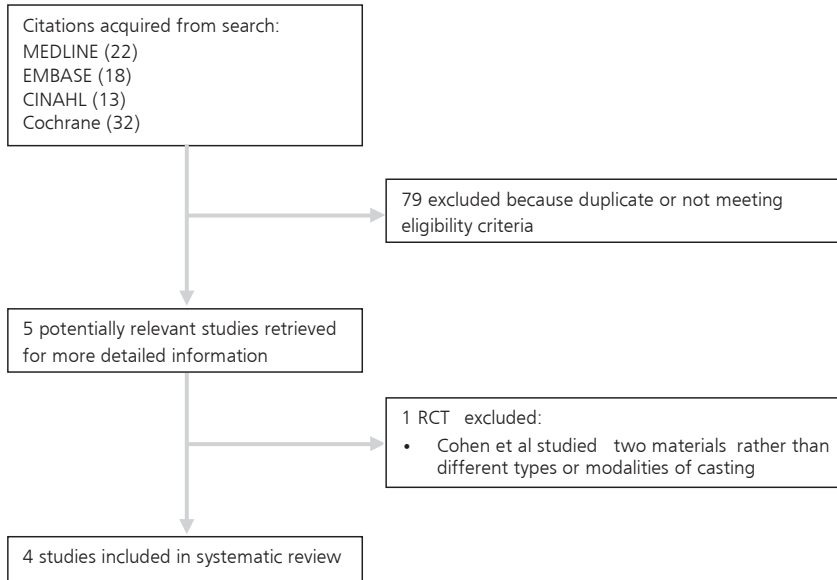


Figure 1. Quality of Reporting of Meta-analyses (QUOROM) statement flow diagram of included and excluded studies.

not including the thumb with the wrist positioned in 20 degrees of flexion; and 63 with a below elbow cast with the wrist positioned in 20 degrees of extension.

Description of included studies

Study characteristics are summarized in Table 1.

Alho et al. reported 99 patients (15 women and 84 men) with a mean age of 31 years (range, 16 to 71 years) with 100 fractures of the scaphoid.¹⁴ Thirty-six fractures were non-displaced (18 versus 18 patients), 60 were displaced (33 below-elbow versus 27 above-elbow cast) and 4 were fragmented (2 versus 2 patients). They randomly allocated 53 patients to treatment in a plaster cast from below the elbow to the interphalangeal joint of the thumb and 47 patients were immobilized in an above-elbow cast, preventing pronation and supination but allowing extension and flexion of the elbow to some extent. If consolidation was not achieved in 3 months, osteosynthesis was performed. Bony union did not occur within 3 months in 8 cases where after an osteosynthesis was performed (2 below-elbow and 6 above-elbow cast). Patients were followed-up for at least 3 months; there were no patients lost to follow-up.

Clay et al. randomly allocated 392 patients with acute (less than 14 days old) non-displaced fractures diagnosed on scaphoid radiographs of the scaphoid to either a forearm cast leaving the thumb free or by a conventional 'scaphoid' plaster incorporating the thumb as far as its interphalangeal joint.¹⁶ Both methods were below-elbow casts with the wrist held in 30 degrees dorsiflexion. The follow-up group

Table 1. Characteristics of included RCT's								
Study Author	Year	Number of Fractures			Mean Age	% Female	Fracture type	Displacement*
		Total	Below elbow	Above elbow				
Alho	1975	100	53	47	31	7	All types	64
Gellman	1989	51	23	28	30	10	All types	None
		Total	Thumb	No Thumb				
Clay	1991	292	144	148	30	24	All types	n/a
		Total	Wrist Flexion	Extension				
Hambidge	1999	121	58	63	30	22	All (proximal pole excluded)	None

*Displacement is defined as more than 1 mm

n/a: not available

consisted of 292 patients (70 women and 222 men) with a mean age of 29.7 years (range, 16 to 71 years). One-hundred forty-eight patients were allocated to the Colles' group (68% were transverse fractures, 19% horizontal oblique, 7% of the distal pole, 5% vertical oblique and 1% of the proximal pole) and 144 to the 'scaphoid' group (58% were transverse fractures, 21% horizontal oblique, 11% of the distal pole, 4% vertical oblique and 6% of the proximal pole). Patients were followed for 6 months; 25% was lost to follow-up.

Gellman et al. reported on 51 patients (5 women and 46 men) with an average age of 30 years (range, 14 to 37 years) who had sustained an acute (less than 14 days old) non-displaced fracture (10% of the proximal third, 78% of the middle third, 10% of the distal third, and one (2%) of the tuberosity of the scaphoid).¹⁵ Fractures having more than one millimeter displacement on plain radiographs were not included. Twenty-eight patients were randomized to treatment with a long above-elbow cast including the thumb cast and 23 to a below-elbow cast including the thumb. The wrists that were treated with an above-elbow cast were placed in a below-elbow cast after six weeks until union. The average duration of follow-up for each group was 12 months (range, 6 to 24 months); no patients were lost to follow-up.

Hambidge et al. reported on 121 patients with a mean age of 30 years (range, 16 to 76 years) with an acute (within two weeks of injury) fracture of the scaphoid, excluding fractures of the proximal pole and those which were lost to follow-up before the assessment at six months. Twenty-two percent (26 fractures) occurred in women and 78% (95 fractures) in men. Fifty-eight patients were allocated to treatment in a below elbow cast not including the thumb with the wrist positioned either in 20 degrees



of flexion (54 waist fractures and 4 fractures of the distal pole) and 63 patients to a below elbow cast not including the thumb with the wrist positioned in 20 degrees of extension in 20 degrees extension (57 waist fractures and 6 of the distal pole). Patients were followed-up for 6 months; the percentage of patients lost to follow-up was not reported.

Outcome measure reporting

Reported outcomes of included studies are summarized in Table 2.

All four selected studies reported our selected primary outcome measure, nonunion assessed on plain radiographs.^{14-16,24} Functional outcome was assessed by one study according to the methods, however not reported in the results section of their paper.¹⁵ None of the studies reported patient-based validated outcome measures such as the Disabilities of the Arm, Shoulder and Hand (DASH) scores, nor physician-based outcome measures such as the Modified Mayo Wrist Score (MMWS) or the Modified Gartland and Werley Score (MGWS). Patient satisfaction was not reported by any of the studies.

Pain, range of motion and grip strength was reported by one study.²⁴ Two studies reported time to union,^{14,16} one reported avascular necrosis (AVN)¹⁶ and two reported immobilization time.^{14,15} None of the studies reported the rate of malunion, time off work, return to previous activity, or costs. All studies reported complications.^{14-16,24}

Table 2. Reported outcomes of selected studies				
Outcomes reported	Alho	Gellman	Clay	Hambidge
Functional outcome		*		
Patient satisfaction				
Pain				x
Range of motion				x
Grip strength				x
Time to union	x		x	
Nonunion	x	x	x	x
AVN			x	
Immobilisation time	x	x		
Return to work				
Return to previous activity				
Costs				

*Functional outcome was assessed according to the methods, however were not reported in Results section.

Methodological quality

The methodological quality of the eligible trials was very limited (Table 3). Even though all studies were randomized controlled trials, concealment of allocation was unclear in all studies.^{14-16,24} The evaluators were not blinded. Three studies reported loss to follow-up, ranging from 0%^{14,15} to 25%¹⁶ and one study²⁴ loss to follow-up was an exclusion criterion and the percentage of lost patients was not reported.²⁴ None of the four studies clearly stated that their analysis was based on intention-to-treat principles, but there was no cross-over in any of the studies.^{14-16,24} The quality assessments of all outcome measurements as well as the effect of treatment of surgical versus non-operative treatment are described in Tables 4-6.

Characteristics	Alho	Gellman	Clay	Hambidge
Concealment of treatment allocation	U	U	U	U
Patients blinded	-	-	-	-
Caregivers blinded	-	-	-	-
Outcome assessors blinded	-	-	-	-
Loss to follow-up	0%	0%	25%	U*

U: unknown; *Patients that were lost to follow-up before the final assessment at six months were excluded from the study. The percentage of patients that was excluded was not reported.

Primary outcome

Below-elbow versus above-elbow casting^{14,15}

Alho and colleagues¹⁴ and Gellman and colleagues¹⁵ compared above- and below-elbow casts that included the thumb. The data were pooled with substantial heterogeneity –substantial variation in outcomes- between treatment groups ($I^2=68\%$). There were no significant differences in the rates of nonunion between below-elbow casting (4 events of nonunion in 76 patients) and above-elbow casting (6 events of nonunion in 75 patients) (RR=1.02, 95% CI= [0.05, 19.23], $p=0.99$, $I^2=68\%$) (Figure 2).

*Thumb 'scaphoid' casting versus no-thumb 'Colles' type' casting*¹⁶(below elbow)

There was no significant difference in the rate of nonunion between below elbow casts that included (14 events of nonunion in 143 patients) or did not include the thumb (15 events of nonunion in 148 patients) (RR=0.97, 95% CI= [0.48, 1.93], $p=0.92$, $I^2=NA$) (Figure 3).



Table 4 GRADE quality assessment of trials for impact of below-elbow casting versus above-elbow casting for acute scaphoid fractures.

Quality assessment						
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations
Nonunion (follow-up 3-24 months ¹ ; evidence of nonunion on plain radiographs in 4 views)						
2	randomised trials	serious ^{2,3,4}	no serious inconsistency ⁵	no serious indirectness	serious ⁶	none
AVN (follow-up 6-24 months; plain radiographs in four views)						
1	randomised trials	serious ^{2,3,4}	no serious inconsistency	no serious indirectness	serious ⁶	none

¹ Alho et followed patients for at least 3 months, Gellman et al followed patients for an average of 12 months (range, 6 to 24 months).

² Allocation concealment is unclear in both studies

³ Patients not blinded in any study

⁴ Outcome assessors were not blinded for type of casting

⁵ Alho et al included displaced and nondisplaced fractures, while Gellman et al included nondisplaced fractures only, so heterogeneity between these studies can be explained.

⁶ Confidence interval includes possible benefits from both types of treatment

Table 5 GRADE quality assessment of trials for impact of scaphoid type casting (including the thumb) versus Colles' type casting (excluding the thumb) for acute scaphoid fractures.

Quality assessment						
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations
Nonunion (follow-up mean 6 months; evidence of nonunion on plain radiographs in 4 views)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	serious ⁵	none

¹ Allocation concealment is unclear

² Patients not blinded

³ Outcome assessors not blinded

⁴ 25% were lost to follow-up

⁵ Confidence interval includes possible benefits from both types of treatment

Summary of findings					Importance
No of patients		Effect		Quality	
below-elbow casting	above-elbow casting	Relative (95% CI)	Absolute		
4/76 (5.3%)	6/75 (8%)	RR 1.02 (0.05 to 19.23)	2 more per 1000 (from 76 fewer to 1458 more)	⊕⊕○○ LOW	CRITICAL
4/23 (17.4%)	3/28 (10.7%)	RR 1.62 (0.4 to 6.53)	66 more per 1000 (from 64 fewer to 593 more)	⊕⊕○○ LOW	CRITICAL

Summary of findings					Importance
No of patients		Effect		Quality	
scaphoid type casting (including the thumb)	Colles' type casting (excluding the thumb)	Relative (95% CI)	Absolute		
14/143 (9.8%)	15/148 (10.1%)	RR 0.97 (0.48 to 1.93)	3 fewer per 1000 (from 53 fewer to 94 more)	⊕○○○ VERY LOW	CRITICAL



Table 6 GRADE quality assessment of trials for impact of Colles' type casting in wrist flexion versus Colles' type casting in wrist extension for acute scaphoid fractures.

Quality assessment						
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations
Nonunion (follow-up mean 6 months; evidence of nonunion on plain radiographs in 4 views)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	serious ⁵	none
Grip strength (follow-up mean 6 months; measured with: kg; Better indicated by lower values)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	serious ⁵	none
Pain (follow-up mean 6 months; measured with: Pain at 6 month follow-up; range of scores: 0-4; Better indicated by lower values)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	serious ⁵	none
Wrist flexion (follow-up mean 6 months; Better indicated by lower values)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	serious ⁵	none
Wrist extension (follow-up mean 6 months; Better indicated by lower values)						
1	randomised trials	very serious ^{1,2,3,4}	no serious inconsistency	no serious indirectness	no serious imprecision	none

- ¹ Allocation concealment is unclear
- ² Patients not blinded
- ³ Outcome assessors not blinded
- ⁴ Unknown number of patients were lost to follow-up
- ⁵ Confidence interval includes possible benefits from both types of treatment

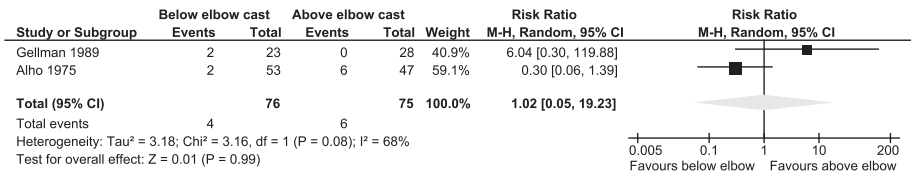


Figure 2. There were no significant differences in the rates of nonunion between below-elbow casting and above-elbow casting.

Summary of findings					Importance
No of patients		Effect		Quality	
Colles' type casting in wrist flexion	Colles' type casting in wrist extension	Relative (95% CI)	Absolute		
5/58 (8.6%)	8/63 (12.7%)	RR 0.68 (0.24 to 1.96)	41 fewer per 1000 (from 97 fewer to 122 more)	⊕○○○ VERY LOW	CRITICAL
58	63	-	SMD 0.33 lower (0.69 lower to 0.03 higher)	⊕○○○ VERY LOW	CRITICAL
58	63	-	SMD 0.33 higher (0.10 lower to 0.76 higher)	⊕○○○ VERY LOW	CRITICAL
58	63	-	SMD 0.08 higher (0.44 lower to 0.27 higher)	⊕○○○ VERY LOW	CRITICAL
58	63	-	SMD 1.03 lower (1.41 to 0.65 lower)	⊕⊕○○ LOW	CRITICAL

Wrist flexion versus wrist extension²⁴ (thumb free, below elbow)

There was no significant difference in the rate of nonunion between casting in flexion (5 events of nonunion in 58 patients) and extension (8 events of nonunion in 63 patients) (RR=0.68, 95% CI= [0.24, 1.96], p=0.47 I²=NA) (Figure 4).

Secondary outcomes

Below-elbow versus above-elbow casting^{14,15}

Gellman et al. reported on the occurrence of avascular necrosis (AVN)¹⁵ and there was no significant difference between below- versus above-elbow casting (RR=1.62, 95% CI= [0.40, 6.53], p=0.50, I²=NA). Alho and colleagues¹⁴ and Gellman and colleagues¹⁵ both reported time to union (Alho: mean 8.3 weeks below-elbow vs.



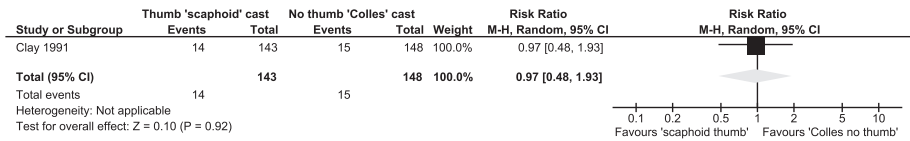


Figure 3. There were no significant differences in the rates of nonunion between patients treated with casting incorporating the thumb versus casting leaving the thumb free.

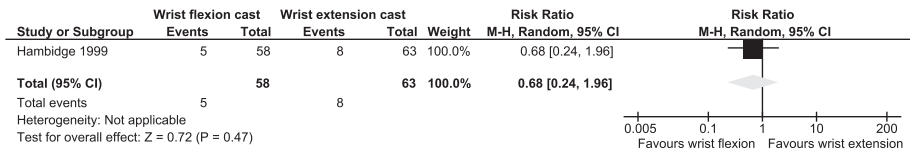


Figure 4. There were no significant differences in the rates of nonunion between patients treated with Colles' type casting (below-elbow, leaving thumb free) in wrist flexion versus wrist extension.

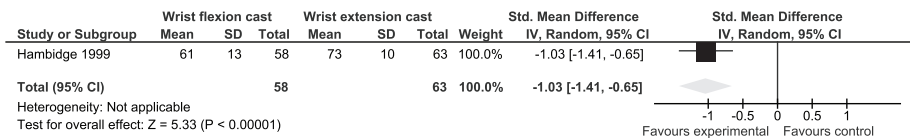


Figure 5. Wrist extension was significantly more limited in patients that were immobilized in flexion versus patients that were immobilized in wrist extension.

8.0 weeks above-elbow,¹⁴ and Gellman 12.7 weeks vs. 9.5 weeks¹⁵), but no standard deviations were provided.

Thumb 'scaphoid-type' casting versus no-thumb 'Colles' type' casting¹⁶(below-elbow)

The only other outcome besides nonunion reported for thumb versus no-thumb casting was immobilization time (mean 9.6 week thumb versus 9 weeks no-thumb) and no standard deviations were reported.¹⁶

Wrist flexion versus wrist extension²⁴ (no-thumb, below-elbow)

Hambidge et al. reported on grip strength (SMD=-0.33, 95% CI=[-0.69, 0.03], p=0.07, I²=NA), pain (SMD=0.33, 95% CI=[-0.10, 0.76], p=0.13, I²=NA), wrist flexion (SMD=-0.08, 95% CI=[-0.44, 0.27], p=0.65, I²=NA) and there were no significant differences between casting with the wrist immobilized in flexion versus the wrist immobilized in wrist extension. Wrist extension however was significantly more limited in patients that were immobilized in flexion in this study (SMD=-1.03, 95% CI=[-1.41, -0.65], p < 0.00001, I²=NA) (Figure 5).

Discussion

Key findings

According to the best available –but few and low to very low level of- evidence trials, this meta-analysis reveals that (1) none of the non-operative treatment modalities for acute scaphoid fractures demonstrates significantly lower rates of nonunion; (2) there are no significant differences between non-operative treatment modalities with regard to our selected secondary outcomes pain, grip strength, time to union, AVN, immobilization time and range of motion, with the exception of wrist extension which was significantly more limited in patients that are immobilized in flexion when compared to casting in wrist extension.

Strengths and limitations

The data pooled for below- versus above- elbow casting showed substantial heterogeneity ($I^2 = 68\%$) between treatment groups in rates of nonunion.^{14,15} In 1975, open reduction and internal fixation for displaced scaphoid fractures was not well established. Alho¹⁴ included 18 non-displaced and 33 displaced fractures in the below-elbow group and 18 non-displaced and 27 displaced fractures in the above-elbow group with a 92% union rate within 7 weeks. Eight patients in both groups had persistent nonunion after 3 months and were treated operatively. The authors were not specific if these fractures were non-displaced¹⁴ and therefore subgroup analysis was not possible.

In 1989, Gellman et al only included non-displaced fractures in their study. The authors concluded that immobilization of non-displaced scaphoid fractures in an above-elbow cast improves the rate of union and decreases the time to union. In particular, the authors advise above-elbow casting for fractures of the proximal and middle third of the scaphoid.¹⁵ If we remove data from Alho from our meta-analysis, there is still no significant difference between below-elbow casting (2 events of nonunion in 23 patients) versus above-elbow casting (0 events of nonunion in 28 patients) with the numbers available from Gellman's study alone (RR=6.04, 95% CI= [0.30, 119.88], $p=0.24$). We consider the variability in fracture type –displaced and non-displaced scaphoid fractures were both included– to be the main factor for the variation in rates of nonunion generating substantial heterogeneity. Even though heterogeneity was substantial, we considered pooling of data from these studies and identifying sources of heterogeneity was the best option for meta-analysis. However, conclusions from this substantial heterogeneous outcome must be interpreted with caution.²⁵

Our meta-analysis was based on low to very low quality evidence (according to the GRADE system) for treatment effect with any of the selected outcome measurements, and we can only give 'weak' recommendations regarding the best non-operative



treatment options for acute scaphoid fractures.²⁵ Required data on our primary outcome measurement, nonunion, were reported in all four studies, but data for secondary outcome measures was very limited.

Previous literature

A recent survey of current UK practice showed a lack of consensus in non-operative management of scaphoid fractures.²⁶ The rationale for above-elbow casting is diminished rotational stress upon the fracture site through the volar radiocarpal ligament caused by pronation and supination of the forearm, based on evidence from cadaver studies.^{27,28} The rationale for immobilization of the thumb is that shear stresses are reduced given that motion of the first (thumb) metacarpal is transmitted to the carpal scaphoid through ligamentous attachments to its distal pole and volar tubercle. We found inadequate data to determine whether immobilization of the elbow or thumb affects outcome.

To the best of our knowledge, there are no previously performed meta-analyses on conservative treatment for acute scaphoid fractures. In a systematic review and meta-analysis of operative- and conservative treatment of acute scaphoid fractures Yin et al³ included three^{15,16,24} of four^{14,16,24} studies on conservative treatment that were included in this review. The main objective of their review was to assess the effect of operative versus non-operative treatment of acute scaphoid fractures. The effect of different casting methods on rates of nonunion, grip strength and range of motion of the wrist was also assessed. The authors concluded that limited conclusions could be drawn from the study by Gellman et al¹⁵ on above- versus below-elbow casting because of the small numbers involved, but omitted to include one-hundred scaphoid fractures that were allocated to above- and below-elbow casting by Alho et al.¹⁴ Recently, the American Journal of Hand Surgery published two narrative reviews.^{11,12} Although conclusions of Ram and colleagues¹¹ and Grewal and colleagues¹² do not differ much from our conclusions, our literature research and meta-analysis have additional methodological rigor, as we used guidelines from the QUORUM and GRADE working groups.

Implications for future research

Future trials need a clear and reproducible definition of the so-called scaphoid waist, accurate and reliable methods for diagnosing and excluding displaced fractures, accurate and reliable methods for diagnosing nonunion, optimal quality of design execution, and reporting of the trial according to established guidelines, and adequate power. The type of immobilization could also be evaluated from the standpoint of disability and patient satisfaction. One could argue that patients would be more satisfied and less disabled with a below-elbow cast or with the thumb free. Finally,

we encourage future research groups to report their outcome data using means and standard deviations to increase generalizability of results.

Recommendation for clinical practice

Neither above-elbow nor below-elbow casting, nor 'scaphoid-type' cast (including thumb) or 'Colles-type' casting (not including thumb) differed significantly and patients casted in wrist extension did have significantly less functional limitation in term of range of motion. Given the inadequate data, the only recommendation is that the treatment variations studied all seem acceptable and patients and surgeons can continue to follow their preferences pending better data.

Conclusion

Based on limited methodological quality primary studies, the occurrence of scaphoid nonunion did not favor any of the studied non-operative treatment modalities. There is no evidence from prospective randomized controlled trials on physician-based functional outcome or patient-based outcome to favor any non-operative treatment for acute scaphoid fractures. Strong recommendations regarding treatment should not be made based on low quality of evidence.²⁵

Acknowledgments

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