**MANAGEMENT OF FRACTURE DISLOCATIONS OF THE LITTLE FINGER METACARPAL
CARPOMETACARPAL JOINT: A SYSTEMATIC REVIEW**

Authors:

WA Cobb¹, L Dingle², R Zarb Adami³, J Rodrigues J⁴

¹Kellogg College; University of Oxford; Oxford

²St John's Hospital at Howden; Livingston; Scotland

³Addenbrooke's Hospital; Cambridge

⁴Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences
(NDORMS); University of Oxford; Oxford

Corresponding author:

Jeremy Rodrigues

j.n.rodrigues@doctors.org.uk

Plastic Surgery Department, John Radcliffe Hospital,

Headley way, Headington, Oxford, OX3 9DU

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33 **Twitter handles:**

34 @mrjnrodrigues

35 Jeremy Rodrigues

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MANAGEMENT OF FRACTURE-DISLOCATIONS OF THE LITTLE FINGER METACARPAL

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SUMMARY

Fracture-dislocations of the carpometacarpal joint (CMCJ) of the little ray involve dorsal subluxation of the metacarpal base, and they may be associated with injury of neighbouring CMCJs. Different treatment options are described, with no clear consensus on their management. This study presents a systematic review of comparative studies describing the management of these injuries.

A bespoke search strategy was applied across multiple databases. Results were screened against specified stepwise inclusion criteria, and data were extracted independently by two authors with discrepancy resolution by a third.

Of 437 search results, six comparative studies were identified. Comparisons included non-operative or early mobilisation versus fixation K-wires or open reduction and internal fixation . Conclusions were mixed, all studies had critical or significant risks of bias (using the ROBINS-I tool) and there was heterogeneity between studies.

Level of evidence: 4

INTRODUCTION

Fracture-dislocations of the little finger carpometacarpal joint (fifth CMCJ) are commonly missed (Henderson and Arafa, 1987), meaning that their true incidence is difficult to determine. Subluxation or dislocation of the joint may be associated with fractures of the metacarpal. Axial force along the fifth metacarpal is the usual the mechanism, with dorsal and proximal subluxation of the metacarpal often persisting due to forces exerted by the *extensor carpi ulnaris*, which inserts into the fifth metacarpal base. (Niechajev, 1985). An analogy can be made to the displacement seen with intra-articular fractures of the thumb metacarpal base (Bennett's fractures),(Petrie and Lamb, 1974) giving rise to the term 'baby Bennett's fractures'. Whilst the fifth ray may be affected solely, the other CMCJs may also be injured concurrently. Missing the diagnosis results in impaired function and weak grip, which can be improved if the diagnosis is subsequently made (Henderson and Arafa, 1987), suggesting that these injuries are important to recognise.

Treatment options for these injuries include non-operative management, closed reduction with Kirschner wire fixation (K-wire), and open reduction with internal fixation (ORIF). Whilst authors may describe a new treatment technique, there is particular value in studies in which two or more techniques are compared side-by-side, as this allows for more objective comparison and may avoid issues from single-arm cohorts where publication bias may be more likely.

This study systematically reviews the comparative literature evidence in order to compare the relative outcomes of methods for treating fifth CMCJ fracture/subluxations.

METHODS

A review protocol was designed which complied with the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) guidelines.(Moher et al., 2015)

A bespoke search strategy was designed that used multipurpose fields to combine index and free text searching. The following terms were used:

‘Metacarpus’ OR ‘Metacarpal’

AND ‘Fracture’ OR ‘Subluxation’ OR ‘Dislocation’

AND ‘Little’ OR ‘Fifth’.

The search was first run on 25 November 2015 and re-run on 15 January 2017. The following databases were searched in parallel: Allied and Complementary Medicine (AMED) from 1985 to November 2015, EMBASE (1980 to 2015 Week 47), Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) (1946 to Present). No language restrictions were imposed, and where required non-English language abstracts were translated electronically. The United Kingdom Clinical Research Collaboration (UKCRC) Registered Clinical Trials Unit Network was also searched.

Duplicate search results were removed electronically and then checked by hand. The retrieved article abstracts were then screened, using stepwise inclusion criteria, by two researchers independently with disagreements resolved by a third. The final pool of retrieved studies comprised human studies where either the entire or part of the cohort or specific sub-group data were included on management of fifth metacarpal base fracture/subluxation/dislocation injuries. Where abstracts were unclear, full text articles were checked. Reference lists in the final included articles were also checked for additional articles. If further data were required, the authors of primary studies were contacted.

107

108 From the final included articles, data, such as the key results, were extracted independently
109 by two researchers who were plastic surgery registrars with interest in hand surgery.

110 Studies of specific treatment descriptions that lack any comparator were ultimately
111 excluded. Many operative strategies have been described and may have established
112 evidence of safety and feasibility, but these studies lack external validity because it is
113 impossible without a comparator to determine the superiority of a single management
114 modality over another.

115

116 Risk of bias for each study was assessed using the Risk Of Bias In Non-randomised Studies -
117 of Interventions (ROBINS-I) tool (Sterne et al., 2016) by one researcher (a plastic surgery
118 registrar) with an interest in hand surgery. This tool was developed by members of the Cochrane
119 Bias Methods Group and the Cochrane Non-Randomised Studies Methods Group in 2016 and
120 is easy to use, accessible, and designed for systematic reviews. It involves assessing the risk
121 of bias in seven domains for outcomes in a study, performed for each study outcome. Risk
122 of bias is ranked low, moderate, serious or critical. Sometimes a judgement could not be
123 made as the study did not contain necessary information.

124

125 If appropriate, head-to-head meta-analysis or frequentist network meta-analysis would be
126 performed; but when it was not suitable for meta-analysis due to bias in included studies,
127 narrative synthesis would be performed.

128

RESULTS

Search Results

437 articles were retrieved after duplicates had been electronically removed (Figure 1). Ten abstracts were translated into English electronically. No trials of fifth CMCI injury were identified on the UKCRC Registered Clinical Trials Unit Network. Three other studies were added after reviewing the reference lists of the final articles, from which two were included.(Gehrmann et al., 2015, Lawlis and Gunther, 1991) During manual screening for duplicates a further eight studies were removed. After further screening, 141 studies were found to not be studies of human fifth metacarpal injuries and were excluded. A further 186 studies were excluded as they lacked fracture/subluxation/dislocation injuries of the fifth metacarpal base. Finally, 99 more studies were excluded due to lack of any comparative methodology to assess between separate treatment groups (see Appendix). The final six studies made arm-to-arm comparisons between treatment groups, see Table 1.(Frick et al., 2011, Gehrmann et al., 2015, Kjaer-Petersen et al., 1992, Lawlis and Gunther, 1991, Petrie and Lamb, 1974, Schortinghuis and Klasen, 1997)

All six studies were non-randomised cohort studies, four of which were retrospective, and in two the full study design was not clear.

Specific study questions were not always identifiable – on review of the full texts, the primary question in two studies was whether the configuration of injury was relevant.(Gehrmann et al., 2015, Kjaer-Petersen et al., 1992) One study's primary interest was whether surgery was required to treat these injuries.(Petrie and Lamb, 1974) The other

three studies explored whether open reduction internal fixation (ORIF) was effective in managing these injuries.(Frick et al., 2011, Lawlis and Gunther, 1991, Schortinghuis and Klasen, 1997)

The outcomes varied between studies, with only one (Gehrmann et al., 2015) using a patient-reported outcome measure: The Disabilities of the Arm, Shoulder and Hand, though the rationale for this choice was not fully explained.

Study designs were variable and often lacked detail. Two studies (Frick et al., 2011, Gehrmann et al., 2015) assessed outcomes within 18 months, whereas others assessed longer term outcomes (mean follow up of several years). In two studies, different management was used for different injury patterns.(Frick et al., 2011, Kjaer-Petersen et al., 1992) In a further two studies, all patients had failed management by closed reduction, but no further descriptions of the choice of treatment were provided.(Gehrmann et al., 2015, Lawlis and Gunther, 1991) In two studies the treatment provided was not described in detail.(Petrie and Lamb, 1974, Schortinghuis and Klasen, 1997)

Study participant characteristics varied. All studies had more male than female participants, and most were young. Some studies only selected patients with injuries to the fifth ray.(Petrie and Lamb, 1974) or fifth and fourth rays.(Gehrmann et al., 2015, Kjaer-Petersen et al., 1992, Schortinghuis and Klasen, 1997) In the other two studies, patients with injuries to any of the long finger rays were eligible.(Frick et al., 2011, Lawlis and Gunther, 1991)

Risks of biases of included studies

177 For all studies included, at least one domain was at critical risk of bias, or two or more
178 domains were at serious risk of bias. In all critical risks of bias, injury pattern was the
179 confounder responsible.(Frick et al., 2011, Gehrmann et al., 2015, Kjaer-Petersen et al.,
180 1992, Schortinghuis and Klasen, 1997) In these studies treatment allocation varied by injury
181 pattern, despite injury pattern being expected to affect clinical outcomes.(Kjaer-Petersen et
182 al., 1992) The consequence of this confounder is to potentially bias towards better
183 outcomes for closed reduction and plaster/non-operative management in all of these
184 studies.

185

186 Outcome measurements were unblinded in all studies, and treatment choices being
187 compared would be identifiable (e.g. due to additional scars from open surgery). Therefore,
188 the risk of bias was raised to 'serious' for all subjectively reported outcomes.

189

190 None of the articles had protocols that were demonstrably developed *a priori*, and so all
191 were assessed as being at least at moderate risk of bias attributed to the selection of
192 reported outcomes. In some studies, there was a disparity between the planned methods
193 and reported results, which increased this to 'serious' risk of bias.

194

195 A summary of risks of bias is included in Table 2. Instead of detailing individual outcomes,
196 each article's highest risk is listed.

197

198 **Study findings**

199 Due to heterogeneity across aspects including study design, the eligibility criteria,
200 interventions to be compared, and risks of bias, neither head-to-head nor network meta-

201 analyses were conducted. Instead a narrative synthesis was performed.

202

203 The two studies that were not at critical risk of bias may provide more reliable data.(Sterne
204 et al., 2016) One supported the use of ORIF as a suitable management option for this
205 injury.(Lawlis and Gunther, 1991) In the ORIF group. 12/15 had “excellent” outcomes,
206 compared with 1/3 in the closed group. This study included injuries to all finger rays rather
207 than just the fifth ray. Furthermore, no statistical analysis was performed to support this
208 conclusion, which was based on comparison of 15 ORIF patients to three treated closed. As
209 part of the present study, a Fisher’s exact test was run for the data and generated $p=0.172$,
210 i.e. the difference between the treatments was not statistically significant.

211

212 The other study (Petrie and Lamb, 1974) concluded that surgical intervention may not be
213 necessary to achieve satisfactory outcomes for fifth CMCI injuries. Non-operative
214 treatment in this study did not involve closed reduction and plaster immobilisation, instead
215 it allowed free unprotected mobilisation. Again, no statistical analysis was performed.
216 Group sizes in this study were small (14 conservatively managed vs four operatively
217 managed). Rationale for choosing surgery was not clear for some participants. The
218 mobilisation group returned to work at an average of 3 weeks compared to an average of 7
219 weeks in the K-wire group. In the mobilisation group, grip strength was diminished less
220 despite greater radiological displacement (average of 4.5cmHg loss of grip strength using
221 bespoke system akin to a sphygmomanometer) compared with an average of 14cmHg loss
222 of grip strength in the K-wire group.

223

224 The other four studies (Frick et al., 2011, Kjaer-Petersen et al., 1992, Schortinghuis and

Klasen, 1997), had a critical risk of bias, and so their findings must be interpreted with great caution or disregarded completely.(Sterne et al., 2016) These studies also typically had small sample sizes, and only a single study included any statistical analysis,(Gehrmann et al., 2015) where the analysis was just applied to the comparison between isolated fifth ray injuries and combined fourth and fifth ray injuries. No analysis of treatment comparisons was reported. The authors concluded that combined fourth and fifth ray injuries behaved similarly to isolated fifth ray injuries (Gehrmann et al., 2015). The other three articles drew the conclusion that fixation (especially with open reduction) was effective in managing CMCJ dislocations in general.(Frick et al., 2011, Kjaer-Petersen et al., 1992, Schortinghuis and Klasen, 1997)

DISCUSSION

This review has confirmed that there is a marked paucity of clinical evidence to inform best care for fracture-dislocations of the fifth ray CMCJ. The comparative evidence that exists is of poor quality (level IV evidence, GRADE Low quality), with marked risks of bias. The authors drew mixed conclusions regarding the optimal management, recognising limitations within their studies.

Another review article (Büren et al., 2016) concluded that non-operative treatment was rarely appropriate, but it was not conducted in a systematic fashion and omitted articles included in the present systematic review. Management was only briefly covered as other aspects of the care pathway were also considered. The conclusion that operative management is required to treat fifth CMCJ injuries appears in line with current practice given that more severe injuries were often treated operatively in most of the studies included in our review.(Frick et al., 2011, Gehrmann et al., 2015, Kjaer-Petersen et al., 1992, Schortinghuis and Klasen, 1997) However, the present systematic review has demonstrated that this is not evidence-based.

The limited literature evidence available suggests that better functional outcomes might be achieved by early mobilisation and conservative management despite poorer anatomical restoration. How to best assess function needs consideration. Only one patient-reported outcome measure was used in the studies included here. The appropriateness of individual patient-reported outcome measures for injuries of the fifth metacarpal base is beyond the scope of this article, although this is an important area to address in the future. Surrogate

261 measures, such as 'return to work' may be complex to interpret, as they are influenced by
262 factors such as the type of work that the patient did, whether illness compensation is
263 available (be that state-provided or through personal insurance), and whether the patient is
264 self-employed. It also does not assess return to activities outside of work, which may be
265 important to patients and to society and the economy.

266

267 The need for anatomical reduction is not certain, but good outcomes have been achieved
268 with treatment strategies that aim for anatomical restoration.

269

270 However, in contrast, non-operative treatment involving full mobilisation resulted in good
271 outcomes.(Petrie and Lamb, 1974) If the non-operative treatments in other included
272 articles are considered a reflection of clinical practice, closed reduction and plaster
273 immobilisation may be the most common non-operative treatment. The superiority of
274 either free mobilisation vs closed reduction and plaster vs operative treatment cannot
275 presently be determined.

276

277 The heterogeneity seen between included studies also highlights the variation seen
278 clinically. As well as there being limited evidence to support one treatment strategy over
279 others in general, it is unclear whether different injury patterns are best treated differently.
280 For example, do injuries affecting more than one joint (e.g. ring CMCJ as well as little CMCJ)
281 systematically behave differently from isolated little CMCJ injuries?

282

283 The ROBINS-I tool was used to assess risk of bias in this review. This relatively new tool has
284 the advantage of assessing different domains of risk of bias individually. By doing this, the

signal of important “critical” or “serious” risks of bias are not diluted by other risks of bias being low. As a result, the reader can assess the acceptability of an article’s risks of bias and not rely on a single overall assessment or the reviewer’s interpretation. One disadvantage of ROBINS-I in this review is that the risks of bias in each domain are supposed to be reported for each outcome in each included study. This may be unduly detailed, and in this case, most outcomes in a study had the same risks of bias, making it unnecessary. As a compromise, the highest risk of bias in every domain for each included study has been provided here.

Until better quality evidence becomes available, the pros and cons of all treatment strategies (free mobilisation, closed reduction and plaster, closed reduction and K-wire fixation or open reduction and internal fixation) should be considered in shared decision-making and on a case-by-case basis. There is an urgent need for higher quality comparative data, randomised or non-randomised, to understand these injuries and to inform management decisions for patients with them.

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STUDY	METHODS	PARTICIPANTS	INTERVENTIONS	OUTCOMES	NOTES
Frick et al., 2011	Retrospective case note review. Non-randomised. Mean follow-up: 5 months	100 participants, 98 males: 2 females, mean age 28 (range: 18-74) Little ray CMCI injuries with or without other CMCI injuries	Closed: Reduction & K-wires (60/100) Open: Reduction & K-wires (17/100) or screw (13/100)	Pain during grip: Open: 7/35, Closed: 10/56 Loss of full flexion: Open: 1/35, Closed: 1/56 Subjective strength loss: Open: 8/35, Closed: 12/56 Imperfect reduction: Open: 8/40, Closed: 24/60	Pure dislocations were mainly treated closed (11/12 dislocations) Conflicts of interest declared (none)
Gehrmann et al., 2015	Study design unclear. Non-randomised.	39 consecutive participants, all males, mean age:	Closed reduction and plaster: 5/39	Disabilities of the Arm, Shoulder and Hand (DASH) function	All operative cases failed initial attempt at

Mean	31 (range	Closed	patient-	non-
follow-up:	18-93)	reduction and	reported	operative
17.6 months	Little ray	K-wire (10/39)	outcome	treatment.
	CMCJ	Open	measure	Incomplete
	injuries, or	reduction and	(PROM): Non-	reporting
	ring and	K-wire (18/39)	operative:	of
	little ray	Open	mean 10.4	outcomes
	CMCJs	reduction and	(range 3.3 to	by
	injuries	K-wire &	17.5), closed	treatment
		screw/plate	reduction and	groups.
		(4/39)	K-wire: mean	Conflicts of
		Open	9.3	interest
		reduction and	(range 0.8 to	declared
		plate (2/39)	13.3)	(none)
			Grip strength:	
			group data	
			not	
			presented.	
			Radiographic	
			changes:	
			group data	
			not	
			presented.	

Kjaer- Petersen et al., 1992	Study design not clear. Probably retrospectiv e and non- randomised. Mean follow-up: 52 months	64 participants, 49 males: 15 females, median age: 38 (range: 9- 88) Little ray CMCJ injuries only	No reduction, & plaster (POP, 11/64) Closed reduction & plaster (CRPOP, 25/64) Closed reduction & K- wire (CRIF, 9/64) Open reduction & K- wire (ORIF, 19/64)	Pain: POP: 1/9, CRPOP: 9/20, CRIF: 2/8, ORIF: 7/15 X-ray changes: not presented by group	Undisplace d fracture preference: no reduction, & plaster Displaced fracture preference: closed/open reduction, & K-wires Method of fixation varied with fracture pattern: if multi- fragmentar y, inter- metacarpal
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					fixation used. No declaration of conflicts of interest. Incomplete reporting of outcomes by treatment groups.
Lawlis & Gunther, 1991	Retrospectiv e case note review. Non- randomised. Follow-up: 69.6 – 90 months	20 participants, 17 males: 3 females, mean age: 32 (range: 13-67) CMCJ injury of any non- thumb	No treatment (1/20) Closed reduction and plaster (3/20) Open reduction and K-wire (15/20) Arthrodesis (1/20)	Bespoke classification into: Excellent outcome: none: 0/1, closed: 1/3, ORIF: 12/15, arthrodesis: 1/1	All patients failed closed reduction alone initially. Conflicts of interest declared (none)

finger,	Good
including	outcome:
multiple	none: 0/1,
CMCJs	closed: 0/3,
	ORIF: 0/15,
	arthrodesis:
	0/1
	Satisfactory
	outcome:
	none: 0/1,
	closed: 0/3,
	ORIF: 1/15,
	arthrodesis:
	0/1
	Unsatisfactor
	y outcome:
	none: 1/1,
	closed: 2/3,
	ORIF: 1/15,
	arthrodesis:
	0/1
	Percentage of
	extension

and flexion:

reported

inconsistently

Grip strength:

reported

inconsistently

Time to

return to

work:

included

unemployed,

not

synthesised

Need for

further

reconstructio

n: none: 0/1,

closed: 2/3,

ORIF: 1/15,

arthrodesis:

0/1

Petrie & Lamb, 1974	Retrospective follow-up study. Non-randomised. Mean follow-up: 54 months	23 participants, 15 males: 8 females, mean age: 43 (range: 16-69) Little ray CMCJ injuries only	Unrestricted mobilisation (14/19) Closed reduction and transverse K-wire fixation (4/19)	Severe pain duration: non-operative: 4 weeks, K-wire: 0 weeks Moderate pain duration: non-operative: 4 weeks, K-wire: 5 weeks Time off work: non-operative: 3 weeks, K-wire: 7 weeks Loss of grip strength: non-operative:	No details of treatment choice rationale. No declaration of conflicts of interest.
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				4.5cmHg, K- wire: 14cmHg Shortening on X-ray: non- operative: 3.3mm, K- wire: 1.3mm	
Schortinghu is & Klasen, 1997	Retrospectiv e follow-up study. Non- randomised. Mean follow-up: 79 months	15 participants, all males, mean age: 25.3 (range 19-39) Little ray CMCJ injuries and/or ring ray CMCJ injuries	Open reduction and internal fixation (11/15) Closed reduction and plaster (4/15)	Full subjective “functional recovery”: Open: 9/11, Closed: 4/4 Degenerative arthritis on X- ray: Open: 0/11, Closed: 1/4 Range of motion: incompletely reported	No details of treatment choice rationale. Incomplete reporting of outcomes. No declaration of conflicts of interest.

STUDY	BIAS DOMAIN	RISK OF BIAS	JUSTIFICATION OF RISK
Frick et al., 2011	Confounding	Critical	Different interventions were used for different injury patterns, with pure dislocations generally treated closed. Injury pattern likely to affect outcome. Likely to favour closed reduction.
	Selection	No information	Unclear basis for recruitment of patients into study
	Intervention classification	Low	Intervention status is well-defined and based on information from the time of intervention
	Deviation from intervention	Low	No clear deviations from intervention
	Missing data	No information	No information describing whether further participants might have been available
	Measurement	Serious	Subjective outcomes with

	of outcome		unblinded assessors
	Selection of reported result	Moderate	No clear evidence of <i>a priori</i> analysis plan
Gehrmann et al., 2015	Confounding	Critical	Different interventions were used for different injury patterns, with pure dislocations generally treated closed. Injury pattern likely to affect outcome. Likely to favour non-operative.
	Selection	Low	Consecutive patients
	Intervention classification	Low	Intervention status is well-defined and based on information from the time of intervention
	Deviation from intervention	Low	No clear deviations from intervention
	Missing data	Low	No clear missing data from consecutive participants
	Measurement of outcome	Serious	Subjective outcomes with unblinded assessors for some outcomes.

			(Unblinded participants for DASH score represents moderate risk)
	Selection of reported result	Serious	Grip strength and radiological outcomes were not presented by treatment groups
Kjaer-Petersen et al., 1992	Confounding	Critical	Different interventions were used for different injury patterns. Injury pattern likely to affect outcome. Likely to favour no reduction and plaster.
	Selection	Low	Methods imply that all eligible patients were identified and included
	Intervention classification	Low	Intervention status is well-defined and based on information from the time of intervention

	Deviation from intervention	Low	No clear deviations from intervention
	Missing data	Moderate	Slight differences in missing data between intervention groups
	Measurement of outcome	Serious	Subjective outcomes with unblinded assessors.
	Selection of reported result	Serious	Radiological outcomes not presented by treatment group
Lawlis & Gunther, 1991	Confounding	Serious	All patients had failed initial closed reduction in isolation. However, rationale for treatment choice not described
	Selection	Low	Methods imply that all eligible patients were identified
	Intervention classification	Low	Intervention status is well-defined and based on information from the time

			of intervention
	Deviation from intervention	Low	No clear deviations from intervention
	Missing data	No information	20/34 patients included, but detail of missing participants not provided
	Measurement of outcome	Serious	Subjective outcomes with unblinded assessors
	Selection of reported result	Moderate	No clear evidence of <i>a priori</i> analysis plan
Petrie & Lamb, 1974	Confounding	Serious	Confounding expected, but no rationale for treatment choice described
	Selection	No information	Unclear basis for recruitment of patients into study
	Intervention classification	Low	Intervention status is well-defined and based on information from the time of intervention
	Deviation from intervention	Low	No clear deviations from intervention

	Missing data	No information	19/23 patients included, but detail of missing participants not provided
	Measurement of outcome	Serious	Subjective outcomes with unblinded assessors
	Selection of reported result	Moderate	No clear evidence of <i>a priori</i> analysis plan
Schortinghuis & Klasen, 1997	Confounding	Critical	Different interventions were preferred for different clinical circumstances. Injury pattern likely to affect outcome. Likely to favour closed reduction and plaster
	Selection	Low	Methods imply that all eligible patients were identified
	Intervention classification	Low	Intervention status is well-defined and based on information from the time of intervention
	Deviation from	Low	No clear deviations from

	intervention		intervention
	Missing data	Low	No clear missing data
	Measurement of outcome	Serious	Subjective outcomes with unblinded assessors
	Selection of reported result	Serious	Range of motion not presented fully by treatment group.

Table 2: Consolidated summary of risks of bias in included studies, based on ROBINS-I tool domains