

Supplement to the Treatment of Pediatric Diaphyseal Femur Fracture

e-Appendix

- Detailed Data Tables
- Guideline Appendices

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DETAILED DATA TABLES

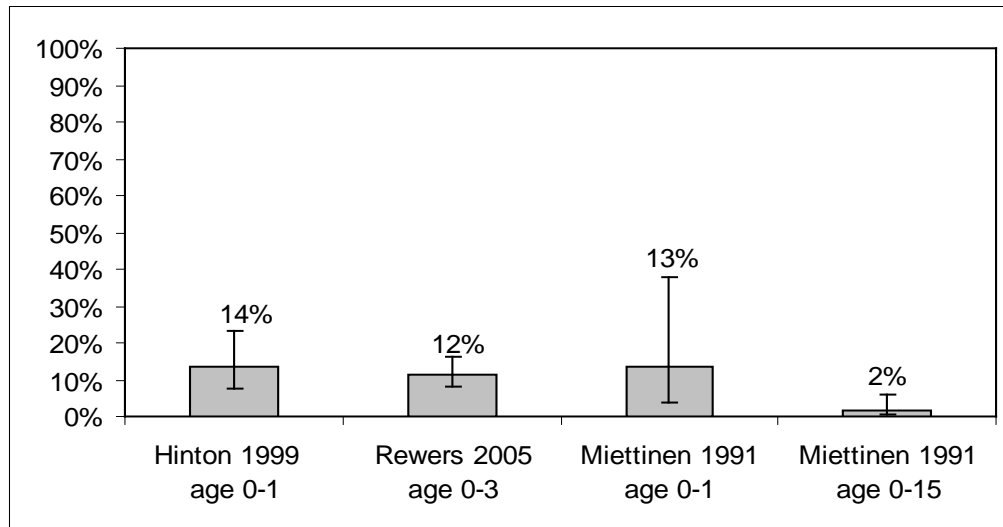
CHILD ABUSE

Table 1. Incidence of Diaphyseal Femur Fractures Caused by Child Abuse

Study	Age Group	Fractures	Fractures Caused by Child Abuse	% of Fractures Caused by Child Abuse
Miettinen	0-15 yrs.	114	2	2%
Rewers	0-3 yrs.	243	28	12%
Miettinen	0-1 yr.	15	Not Reported specific to this age group*	Up to 13%
Hinton	0-1 yr.	73	10	14%

* The authors of this study, Miettinen H., Makela E. A., and Vainio J. (1991), actually reported 2 cases of child abuse in 114 patients, one boy and one girl, 0-15 years of age. While they reported the incidence by age and gender, the authors did not report the distribution by cause of injury. For this calculation, the assumption was therefore made that both cases of child abuse that were reported, occurred in the 0-1 year old age group.

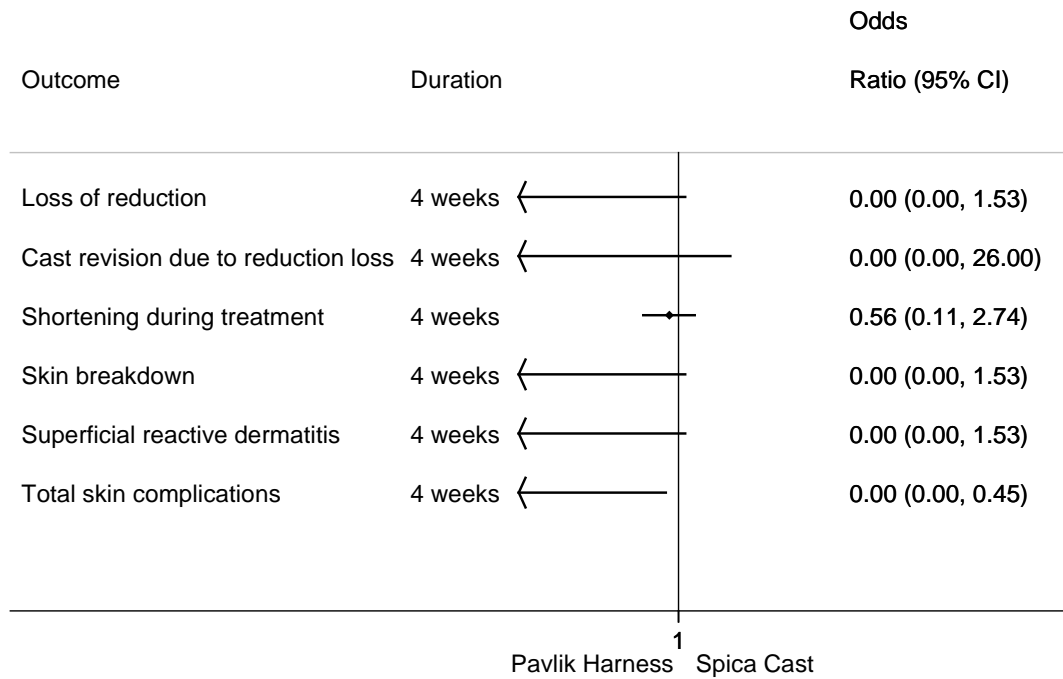
Figure 1. Incidence of Diaphyseal Femur Fractures Caused by Child Abuse



*AAOS computed the 95% Confidence Intervals from published data

INFANT FEMUR FRACTURE

Figure 2. Pavlik Harness vs. Spica Cast



Note on figures: Appendix contains information on how to interpret forest plots such as the one above as well as explanations of symbols used in this guideline's figures and tables.

EARLY OR DELAYED SPICA CASTING

2020 Update Additional Evidence

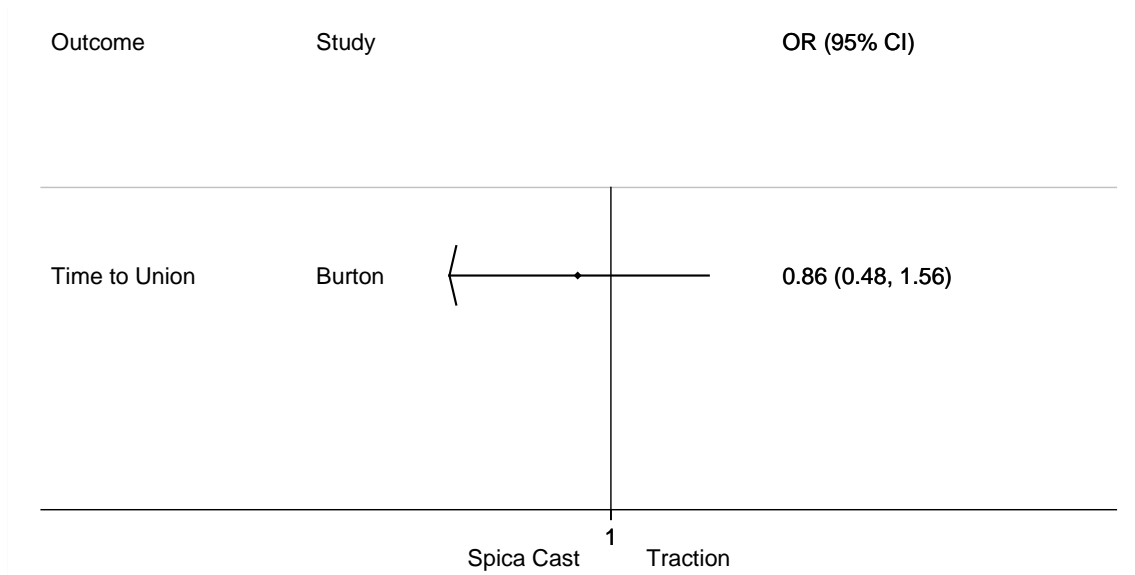
Authors	Article Title	Periodical	Year	Quality Evaluation Score	Age Range
Siddiqui, A. Pirwani M. Naz N. Rehman ASoomro Y.	Skin traction followed by Spica cast versus early Spica cast in femoral shaft fractures of Children	Pak j surg	2008	Moderate Quality	3-10yrs

Table 2. Summary of Evidence

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Burton	II	183	Spica Cast vs. Traction	Time to Union (n/a)	○
Burton	II	183		Shortening (at Union)	○
Rasool	II	170		Shortening at (6 wk)	○
Burton	II	183		Varus angulation (at Union)	○
Rasool	II	170		Varus angulation (6 wk)	○
Burton	II	183		Valgus angulation (at Union)	○
Rasool	II	170		Valgus angulation (6 wk)	○
Burton	II	183		Anterior Bowing (at Union)	○
Rasool	II	170		Anterior Bowing (6 wk)	○
Burton	II	183		Posterior Bowing (at Union)	○
Rasool	II	170		Posterior Bowing (6 wk)	○
Rasool	II	170		Infectious disease contraction (6 wk)	● sc
Rasool	II	170		Pressure from ring of splint (6 wk)	○
Rasool	II	170		Blisters (6 wk)	○
Rasool	II	170		Spica softening (6 wk)	● t
Rasool	II	170		Plaster breakage (6 wk)	● t
Rasool	II	170	Soilage (6 wk)	○	

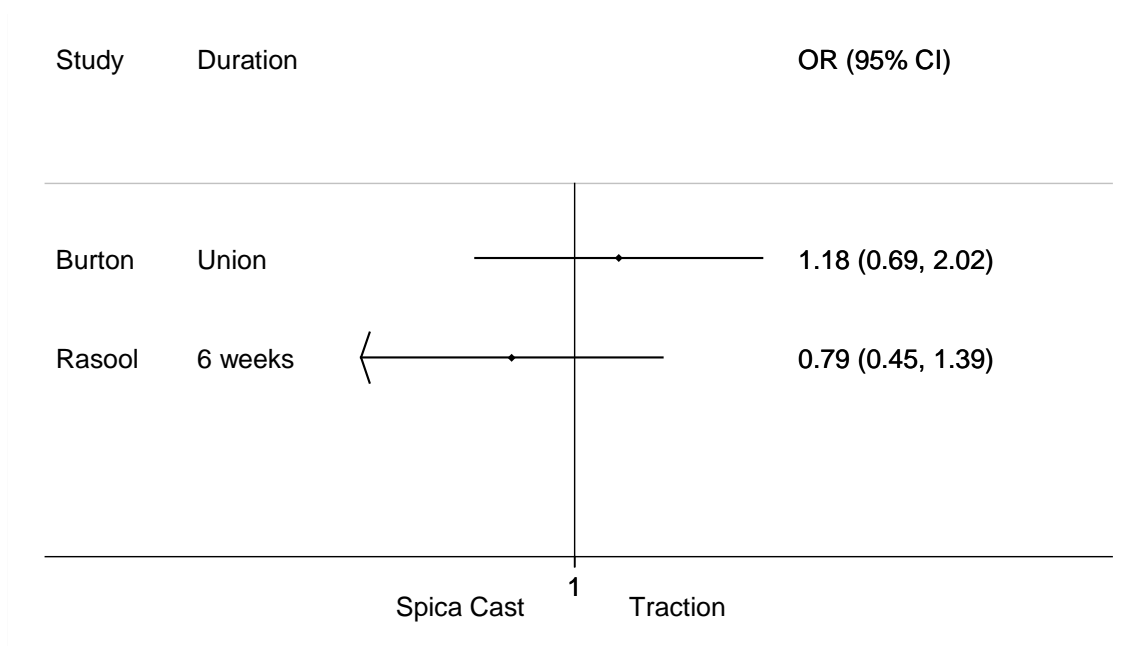
● = result is statistically significant n/a = not applicable sc = spica cast
 ○ = result is not statistically significant nr = not reported t = traction

Figure 3. Time Immobilized (Time to Union)



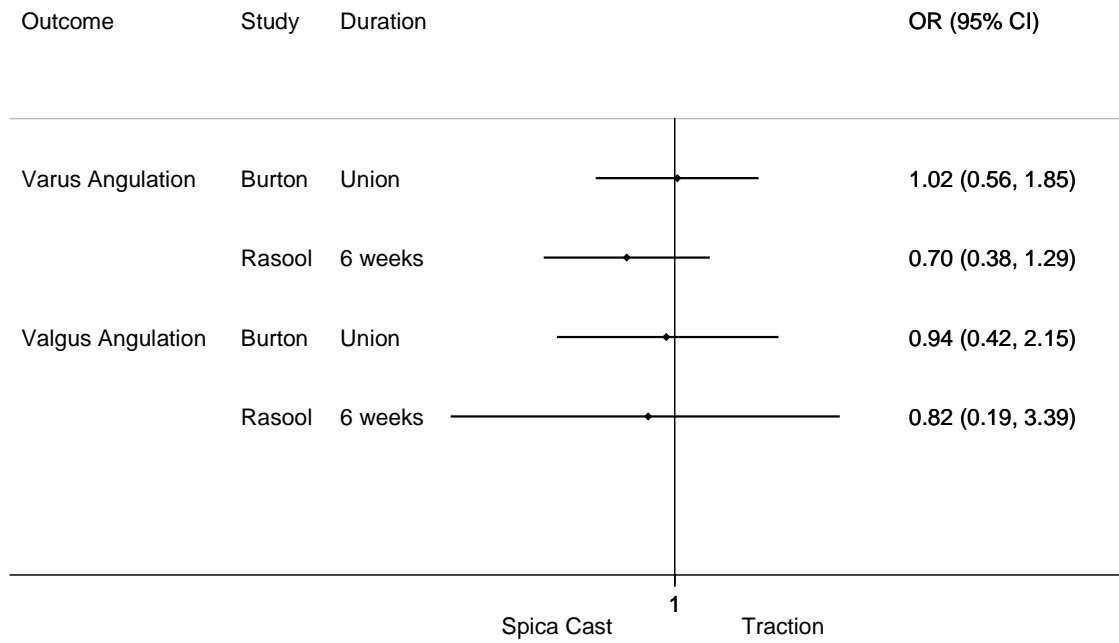
*Odds Ratio from ordered logistic regression (AAOS calculation)

Figure 4. Shortening



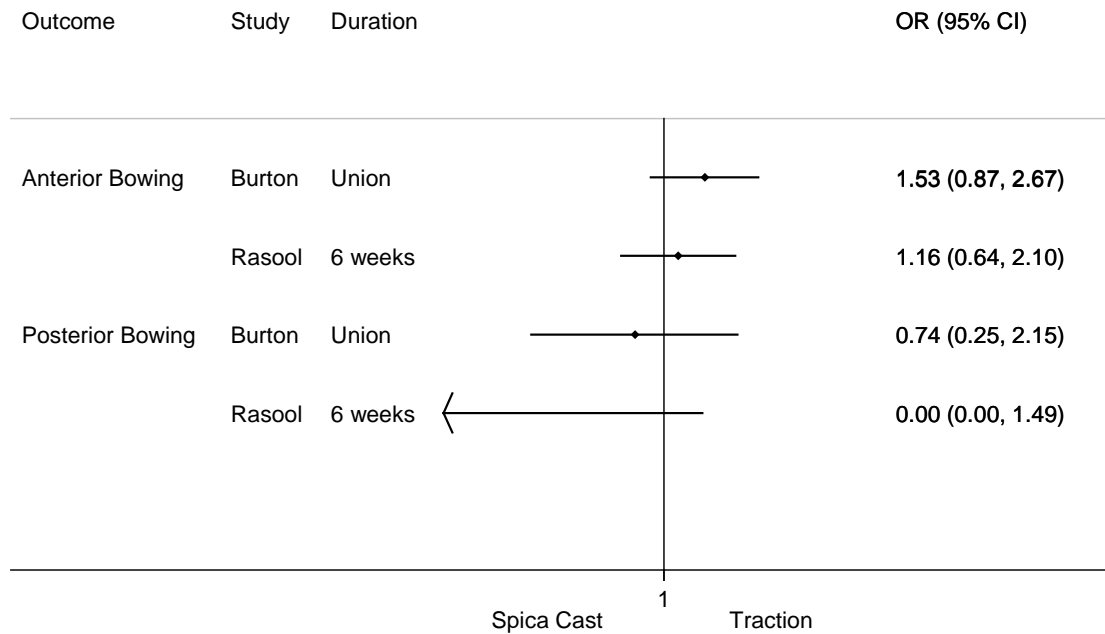
*Odds Ratios from ordered logistic regression (AAOS calculation)

Figure 5. Angulation



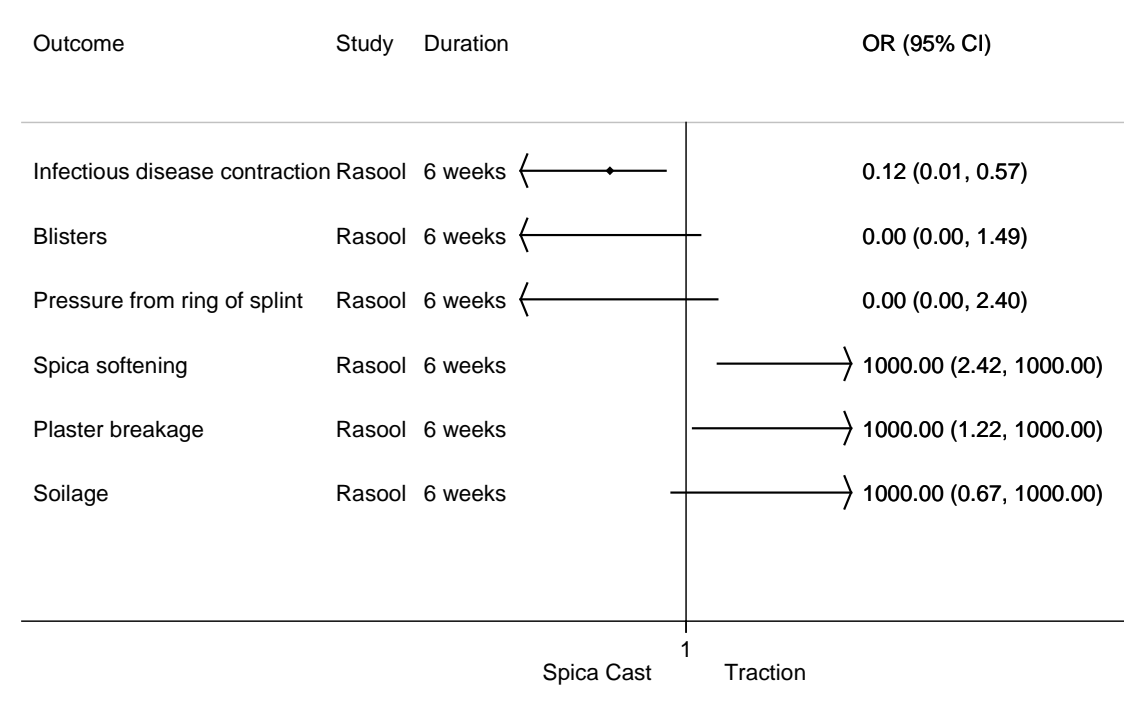
*Odds Ratios from ordered logistic regression (AAOS calculation)

Figure 6. Bowing



*Anterior Bowing Odds Ratios from ordered logistic regression (AAOS calculation)

Figure 7. Complications



ELASTIC INTRAMEDULLARY NAILS

2020 Update Additional Evidence

Authors	Article Title	Periodical	Year	Quality Evaluation Score	Age Range
Ahmad, I.; Gilani, H. U. R.; Rasool, K.; Rasool, A.	Comparison of titanium elastic nailing vs hip spica cast in treatment of femoral shaft fractures in children between 6-12 years of age	Pakistan Journal of Medical and Health Sciences	2015	Moderate Quality	6-12yrs
Naseem, M.; Moton, R. Z.; Siddiqui, M. A.	Comparison of titanium elastic nails versus Thomas splint traction for treatment of pediatric femur shaft fracture	J Pak Med Assoc	2015	High Quality	6-12yrs
Soleimanpour, J.; Ganjpour, J.; Rouhani, S.; Goldust, M.	Comparison of titanium elastic nails with traction and spica cast in treatment of children's femoral shaft fractures	Pak J Biol Sci	2013	High Quality	6-12 year

Table 3. Summary of Updated Findings for Titanium Elastic Nailing

Study	Quality	N	Comparison	Outcome	Author p-value	Result
Shemshaki,H.R., 2011	Moderate	46	TEN vs. Traction + spica casting	Hopital Stay (days)	<0.001	TEN
				Time to start walking with aids(days)	<0.001	TEN
				Time to start walking independently (days)	<0.001	TEN
				Time to return to school (days)	<0.001	TEN
				Knee range of motion (degrees)	0.078	NS
				Malunion	0.117	NS
				Infection	0.117	NS
				Parent satisfaction-excellent	0.003	TEN

Table 4. Flexible Intramedullary Nailing and Patients' Weight

Treatment	n	Mean weight (excellent/satisfactory outcome)	Mean weight (poor outcome)	p-value
Titanium Elastic Nailing	222	39 kg (range 17 to 95.2)	54 kg (range 22.3 to 95.2)	0.003

Summary of Evidence:

For summary of significant outcomes see Table 7 on page 10.
 For summary of nonsignificant outcomes see Table 8 on page 11.
 For summary of High quality evidence see Table 9 on page14.
 For summary of High Qualityevidence see Table 10 on page 15.
 For summary of High Quality evidence see Table 11 on page 17.

Table 5. Summary of Significant Outcomes with Level of Evidence

TREATMENT FAVORED				
	<i>Flexible Nails</i>	<i>External Fixation</i>	<i>Spica Cast</i>	<i>Traction (+ Casting)</i>
<i>Flexible Nails</i>	N/A	Loss of movement at knee (post-op)/III		Irritation at nail entry site/II
<i>External Fixation</i>	Time to full knee movement/III Return to school/III	N/A	Duration of treatment/I Pin-tract infections/I	Duration of treatment/III Duration of treatment/III
<i>Spica Cast</i>		Malunion/I Anterior/Posterior Angulation/I	N/A	
<i>Traction (+ Casting)</i>	Walking with aids/II Walking independently/II Walking independently/II Return to school/II Angular deformity/III Flynn's outcome/III Acceptable scar/III	Patient satisfaction/III	Blisters/superficial ulcers/II Knee flexion contraction/II Overall short-term complications/II	N/A

*Number of outcomes examined: 100

**Number of significant outcomes: 21

***Number of studies:10

****Number of nonsignificant outcomes:

Flexible nails: 49

External fixation: 26

Spica cast: 27

Traction and casting: 56

Table 6. Summary of Nonsignificant Outcomes with Level of Evidence

<i>Comparisons</i>	<i>External Fixation</i>	<i>Spica Cast</i>	<i>Traction + Casting</i>		
<i>Flexible Nails</i>	Full Weight bearing (n/a)/III		Severe knee stiffness (1 yr)/II	Overgrowth 9-10 mm (8.5 mo)/III	Minor complications (nr)/ III
	Re/antecurvatum malalignment 5 to 10 degrees (nr)/III		Unequal length or unacceptable angulation (6 mo)/II	Shortening 7-8 mm (8.5 mo)/III	Remove/reinsert traction pin (nr)/III
	Varus/valgus malalignment 5 to 10 degrees (nr)/III		Shortening (6 mo)/II	Age-defined malunion (8.5 mo)/III	Nonfemoral lower ext. stress fx. (nr)/III
	Limb length discrepancy up to 1 cm (final review)/III		Malrotation (6 mo)/II	Coronal malunion (8.5 mo)/III	Infected pin site (nr)/III
	Pain (final review)/III		Delayed union (1 yr)/II	Sagittal malunion (8.5 mo)/III	Pin track infection (2 yr)/III
	Loss of movement at hip (post-op)/III		Loss of reduction (1 yr)/II	Leg length discrepancy > 1cm (2 yr)/III	Skin irritation (2 yr)/III
	Foot drop (nr)/III		Pressure ulcer (1 yr)/II	Would choose same treatment (nr)/III	Persistent drainage from pin site (nr)/III
	Early removal of nail (nr)/III		Refracture (1 yr)/II	Mean leg length discrepancy (2 yr)/III	Proudflesh (nr)/III
	Superficial infection (nr)/III	No studies	Second Surgery (1yr)/II	Major complications (8.5 mo)/III	Pin migration (nr)/III
	Deep Infection (nr)/III		Pin end irritation (6 mo)/II	Refracture (8.5 mo)/III	Pain syndrome (nr)/III
	Refracture (nr)/III		Nail removal due to irritation (1 yr)/II	Osteoclasia (8.5 mo)/III	Cast wedging/fx. manipulate (8.5 mo)/III
			Infection (6 mo)/II	Pulmonary embolism (8.5 mo)/III	Revision of nail (8.5 mo)/III
			Overall complications (1 yr)/II		Broken nail (2 yr)/III

Table 8. Summary of Nonsignificant Outcomes with Level of Evidence (continued)

<i>Comparisons</i>	<i>External Fixation</i>	<i>Spica Cast</i>	<i>Traction + Casting</i>
<i>External Fixation</i>	N/A	Malunion inc. rotation (2 yr)/I Leg length discrepancy ≥ 2 cm (2 yr)/I Varus/valgus angulation $\geq 10^\circ$ (2 yr)/I Rotational Malunion (2 yr)/I Treatment alteration (2 yr)/I Unacceptable loss of reduction (2 yr)/I RAND overall (2 yr)/I Duration of treatment (n/a)/I Behavioural Questionnaire (post-hosp)/I Parent Satisfaction (2 yr)/I Child Satisfaction (2 yr)/I Refracture (2 yr)/I	Total treatment days until union/III Reoperation (until union)/III Patient Satisfaction/III

Table 8. Summary of Nonsignificant Outcomes with Level of Evidence (continued)

<i>Comparisons</i>	<i>External Fixation</i>	<i>Spica Cast</i>	<i>Traction + Casting</i>
<i>Spica Cast</i>	N/A	N/A	<p>Shortening (1 yr)/II Union time (n/a)/II Coronal angulation (1 yr) /II Sagittal angulation (1 yr)/II Excessive override (3 mo)/II Varus angulation > 10° (3 mo)/II Valgus angulation > 10° (3 mo)/II Posterior angulation > 10° (3 mo)/II Delayed union (3 mo)/II Readmission for manipulation (3 mo)/II Pin-tract infection (3 mo)/II Post-cast fracture of ipsi. limb (3 mo)/II Spinal muscular atrophy(3 mo)/II Fever of unknown origin (3 mo)/II Cast sore (3 mo)/II</p>

*Number of outcomes examined: 100

**Number of significant outcomes: 21 (See Table 6)

***Number of studies:10

****Number of nonsignificant outcomes:

Flexible nails: 49

External fixation: 26

Spica cast: 27

Traction and casting: 56

Table 7. Summary of High Quality Evidence

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Wright	High	101	External Fixation vs. Early Spica Cast	Malunion (2 yr)	● ef
Wright	High	101		Malunion inc. rotation (2 yr)	○
Wright	High	101		Leg length discrepancy ≥ 2 cm (2 yr)	○
Wright	High	101		Ant/post. angulation $\geq 15^\circ$ (2 yr)	● ef
Wright	High	101		Varus/valgus angulation $\geq 10^\circ$ (2 yr)	○
Wright	High	101		Rotational Malunion (2 yr)	○
Wright	High	101		Treatment alteration (2 yr)	○
Wright	High	101		Unacceptable loss of reduction (2 yr)	○
Wright	High	101		RAND overall (2 yr)	○
Wright	High	101		RAND physical subscale (2 yr)	○
Wright	High	101		Duration of treatment (n/a)	● sc
Wright	High	101		Behavioural Questionnaire (post-hosp)	○
Wright	High	101		Parent Satisfaction (2 yr)	○
Wright	High	101		Child Satisfaction (2 yr)	○
Wright	High	101		Refracture (2 yr)	○
Wright	High	101		Pin-tract infections (2 yr)	● sc

● = result is statistically significant n/a = not applicable ef = external fixation
○ = result is not statistically significant nr = not reported sc = spica cast

Table 8. Summary of Moderate Quality Evidence

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Domb	Moderate	49	Dynamic vs. Static External Fixation	Early Callus (n/a)	○
Domb	Moderate	49		Complete Healing (n/a)	○
Domb	Moderate	49		Removal of external fixator (n/a)	○
Domb	Moderate	49		Full weight bearing (n/a)	○
Domb	Moderate	49		Angulation (nr)	○
Flynn	Moderate	83	Traction and cast vs. Flexible Nails	Severe knee stiffness (1 yr)	○
Flynn	Moderate	83		Unequal length or unacceptable angulation (6 mo)	○
Mehdinasab	Moderate	66		Shortening (6 mo)	○
Mehdinasab	Moderate	66		Malrotation (6 mo)	○
Flynn	Moderate	83		Delayed union (1 yr)	○
Flynn	Moderate	83		Loss of reduction (1 yr)	○
Flynn	Moderate	83		Walking with aids (n/a)	● fn
Flynn	Moderate	83		Walking independently (n/a)	● fn
Mehdinasab	Moderate	66		Walking independently (n/a)	● fn
Flynn	Moderate	83		Return to school	● fn
Flynn	Moderate	83		Pressure ulcer (1 yr)	○
Flynn	Moderate	83		Refracture (1 yr)	○
Flynn	Moderate	83		Second surgery (1 yr)	○
Flynn	Moderate	83		Irritation at nail entry site (1 yr)	● t/c
Mehdinasab	Moderate	66		Pin end irritation (6 mo)	○
Flynn	Moderate	83		Nail removal due to irritation (1 yr)	○
Mehdinasab	Moderate	66		Infection (6 mo)	○
Flynn	Moderate	83		Overall complications (1 yr)	○

● = result is statistically significant

n/a = not applicable

fn = flexible nails

○ = result is not statistically significant

nr = not reported

t/c = traction and cast

(continued next page)

Table 10. Summary of Moderate Quality Evidence (continued)

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Ali	Moderate	66	Early spica cast vs. traction	Shortening (1 yr)	○
Ali	Moderate	100		Union time (n/a)	○
Ali	Moderate	66		Coronal angulation (1 yr)	○
Ali	Moderate	66		Sagittal angulation (1 yr)	○
Ali	Moderate	100		Blisters/superficial ulcers (until union)	● sc
Curtis	Moderate	91	Early pontoon spica cast vs. traction, then spica cast	Excessive override (3 mo)	○
Curtis	Moderate	91		Varus angulation > 10° (3 mo)	○
Curtis	Moderate	91		Valgus angulation > 10° (3 mo)	○
Curtis	Moderate	91		Posterior angulation > 10° (3 mo)	○
Curtis	Moderate	91		Delayed union (3 mo)	○
Curtis	Moderate	91		Knee flexion contraction > 20° (3 mo)	● psc
Curtis	Moderate	91		Readmission for manipulation (3 mo)	○
Curtis	Moderate	91		Pin-tract infection (3 mo)	○
Curtis	Moderate	91		Post-cast fracture of ipsi. limb (3 mo)	○
Curtis	Moderate	91		Spinal muscular atrophy(3 mo)	○
Curtis	Moderate	91		Fever of unknown origin (3 mo)	○
Curtis	Moderate	91		Cast sore (3 mo)	○
Curtis	Moderate	91		Overall short-term complication (3 mo)	● psc

● = result is statistically significant n/a = not applicable sc = spica cast
 ○ = result is not statistically significant nr = not reported psc = (pontoon) spica cast

Table 9. Summary of Low Quality Evidence

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Nork	Low	29	External fixation vs. traction and cast	Total treatment days (until union)	○
Nork	Low	29		Reoperation (until union)	○
Hedin 2004	Low	59	External fixation vs. home traction	Duration of treatment (n/a)	● t
Hedin 2004	Low	66		Patient satisfaction (nr)	○
Hedin 2004	Low	59	External fixation vs. hospital traction	Duration of treatment (n/a)	● t
Hedin 2004	Low	66		Patient satisfaction (nr)	● ef
Buechsensc.	Low	71	Flexible nails vs. traction and cast	Overgrowth 9-10 mm (8.5 mo)	○
Buechsensc.	Low	71		Shortening 7-8 mm (8.5 mo)	○
Buechsensc.	Low	71		Age-defined malunion (8.5 mo)	○
Buechsensc.	Low	71		Coronal malunion (8.5 mo)	○
Buechsensc.	Low	71		Sagittal malunion (8.5 mo)	○
Song	Low	51		Angular deformity (2 yr)	● fn
Song	Low	51		Leg length discrepancy > 1cm (2 yr)	○
Song	Low	51		Flynn's outcome (2 yr)	● fn
Buechsensc.	Low	43		Would choose same treatment (nr)	○
Buechsensc.	Low	43		Acceptable scar (nr)	● fn
Song	Low	51		Mean leg length discrepancy (2 yr)	○
Buechsensc.	Low	71		Major complications (8.5 mo)	○
Buechsensc.	Low	71		Refracture (8.5 mo)	○
Buechsensc.	Low	71		Osteoclasia (8.5 mo)	○
Buechsensc.	Low	71		Cast wedging/fx. manipulate (8.5 mo)	○
Buechsensc.	Low	71		Revision of nail (8.5 mo)	○
Song	Low	51		Broken nail (2 yr)	○
Buechsensc.	Low	68		Pulmonary embolism (8.5 mo)	○

● = result is statistically significant n/a = not applicable t = traction ef = external fixation

○ = result is not statistically significant nr = not reported fn = flexible nails

(continued next page)

Table 11. Summary of Low Quality Evidence (continued)

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Buechsensc.	Low	71	Flexible nails vs. traction and cast	Minor complications (nr)	○
Buechsensc.	Low	71		Remove/reinsert traction pin (nr)	○
Buechsensc.	Low	71		Nonfemoral lower ext. stress fx. (nr)	○
Buechsensc.	Low	71		Infected pin site (nr)	○
Song	Low	51		Pin track infection (2 yr)	○
Song	Low	51		Skin irritation (2 yr)	○
Buechsensc.	Low	71		Persistent drainage from pin site (nr)	○
Buechsensc.	Low	71		Proud flesh (nr)	○
Buechsensc.	Low	71		Pin migration (nr)	○
Buechsensc.	Low	71		Pain syndrome (nr)	○
Wall	Low	104		Titanium vs. stainless steel flexible nail	Malunion (1 yr)
Wall	Low	104	Osteotomy (1 yr)		○
Wall	Low	104	Infection (1 yr)		○
Wall	Low	104	Implant revision (1 yr)		○
Wall	Low	104	Nail irritation (1 yr)		○
Wall	Low	104	Nail breakage (1 yr)		○
Wall	Low	104	Delayed union (3 mo)		○
Wall	Low	104	Minor complications (1 yr)		○
Rasit	Low	40	Immediate vs. delayed spica cast	2nd surgery/loss of reduction(2 wk)	○
Rasit	Low	40		Angulation > 20° (2 wk)	○
Sturdee	Low	56	Early intervention vs. traction	Pain (3 mo)	○
Sturdee	Low	56		Malunion (3 mo)	○
Sturdee	Low	56		Pin-site infections (until union)	○
Sturdee	Low	56		Broken external fixation pin (until union)	○
Sturdee	Low	56		Refracture (until union)	○
Sturdee	Low	56		Reapplication of traction pin (until union)	○
Sturdee	Low	56		Pressure sores (until union)	○

● = result is statistically significant n/a = not applicable ss = stainless steel

○ = result is not statistically significant nr = not reported

(continued next page)

Table 11. Summary of Low Quality Evidence (continued)

Author	Level of Evidence	n	Comparison	Outcome (follow-up duration)	Result
Barlas	Low	40	Flexible nailing vs. external fixation	Full weight bearing (n/a)	○
Barlas	Low	40		Time to full knee movement (n/a)	● fn
Barlas	Low	40		Return to school (n/a)	● fn
Barlas	Low	40		Re/ante-curvatum malalignment 5° to 10° (nr)	○
Barlas	Low	40		Varus/valgus malalignment 5° to 10° (nr)	○
Barlas	Low	40		Limb length discrepancy, up to 1 cm (final review)	○
Barlas	Low	40		Pain (final review)	○
Barlas	Low	40		Loss of movement at hip (post-op)	○
Barlas	Low	40		Loss of movement at knee (post-op)	● ef
Barlas	Low	40		Foot drop (nr)	○
Barlas	Low	40		Early removal of nail (nr)	○
Barlas	Low	40		Superficial infection (nr)	○
Barlas	Low	40		Deep infection (nr)	○
Barlas	Low	40		Refracture (nr)	○

● = result is statistically significant n/a = not applicable fn = flexible nailing
 ○ = result is not statistically significant nr = not reported ef = external fixation

Figure 8. External Fixation vs. Spica Cast - binary outcomes (Wright et al.²²)

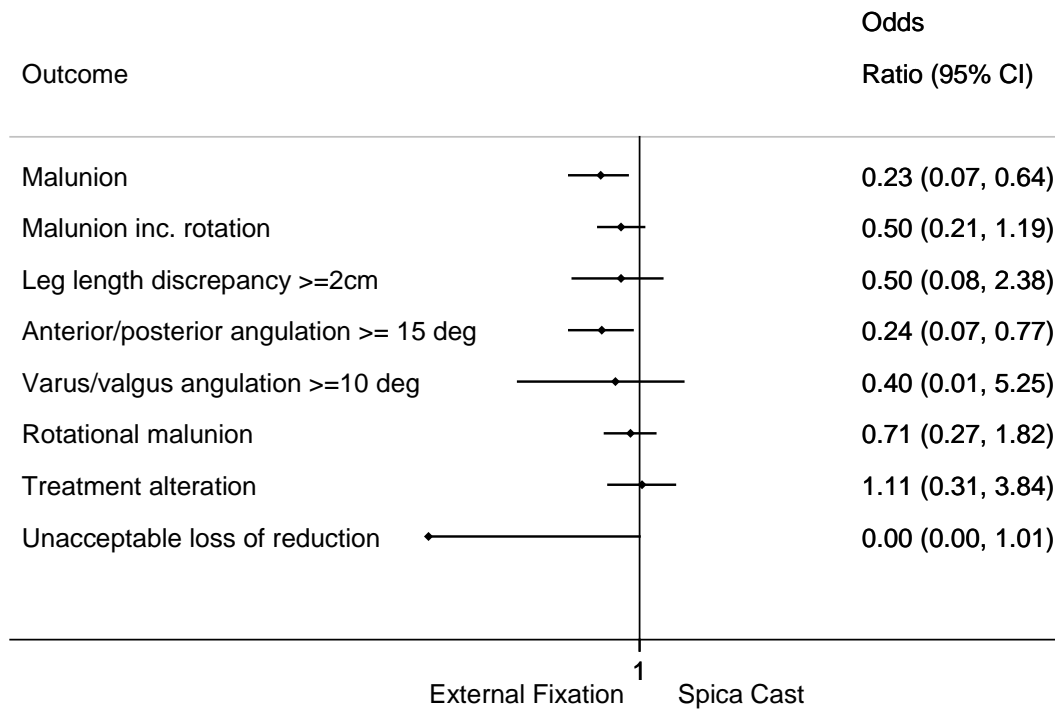


Figure 9. External Fixation vs. Spica Cast -continuous outcomes (Wright et al.²²)

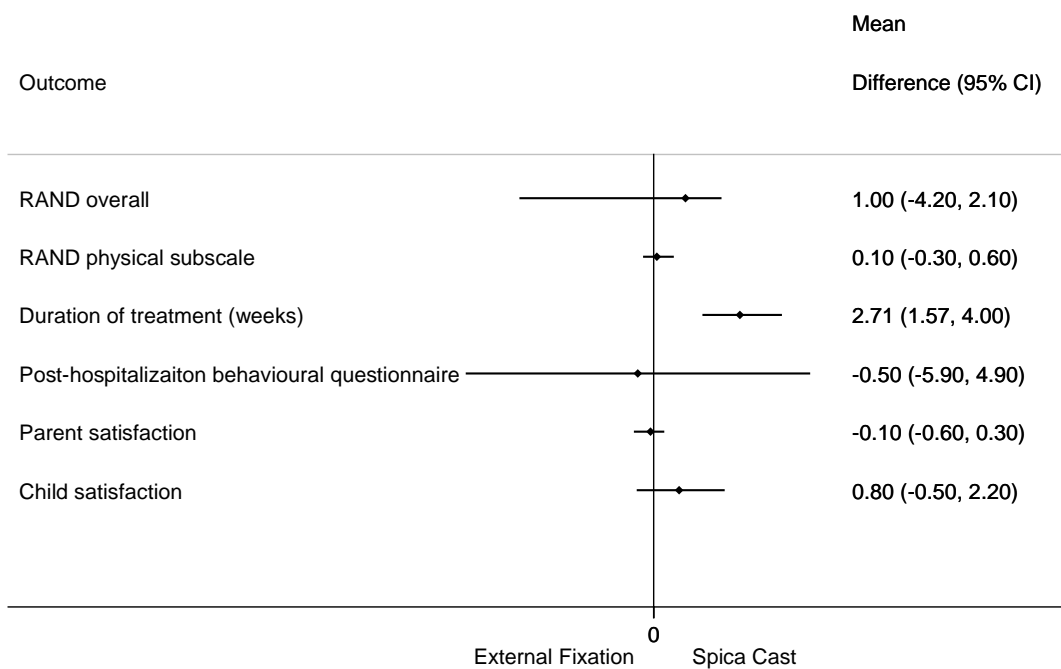


Figure 10. External Fixation vs. Spica Cast - Complications (Wright et al.²²)

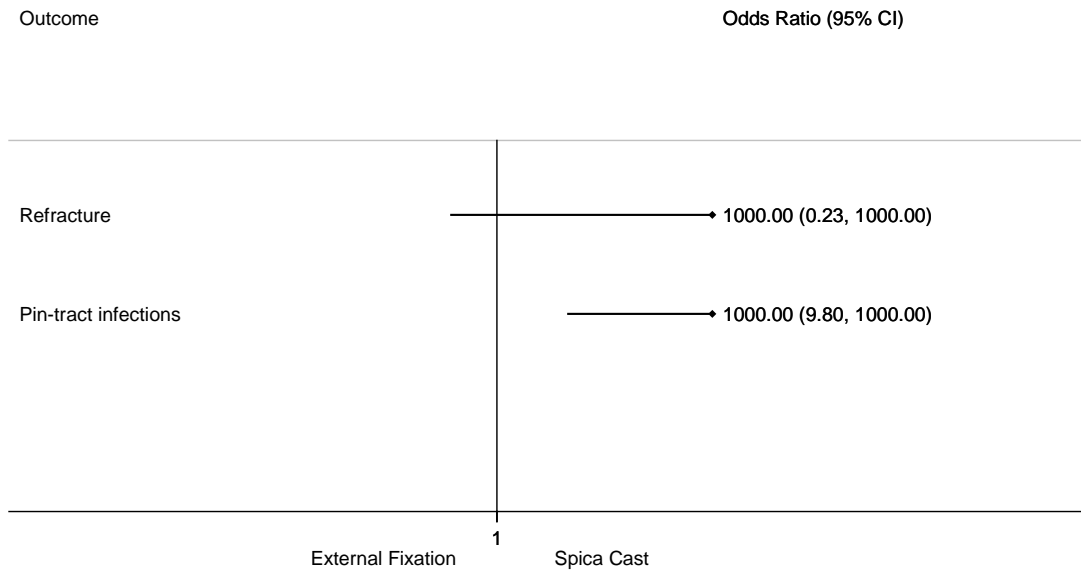


Figure 11. Dynamic vs. Static External Fixation (Domb et al.²⁸)

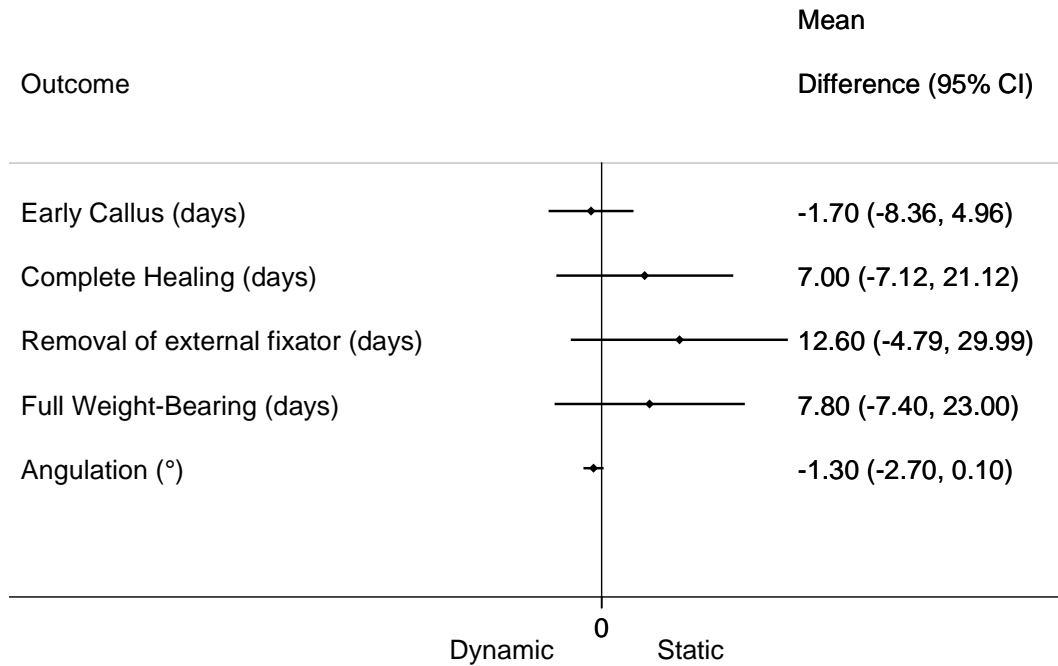


Figure 12. Traction & Cast vs. Flexible Nails –binary outcomes

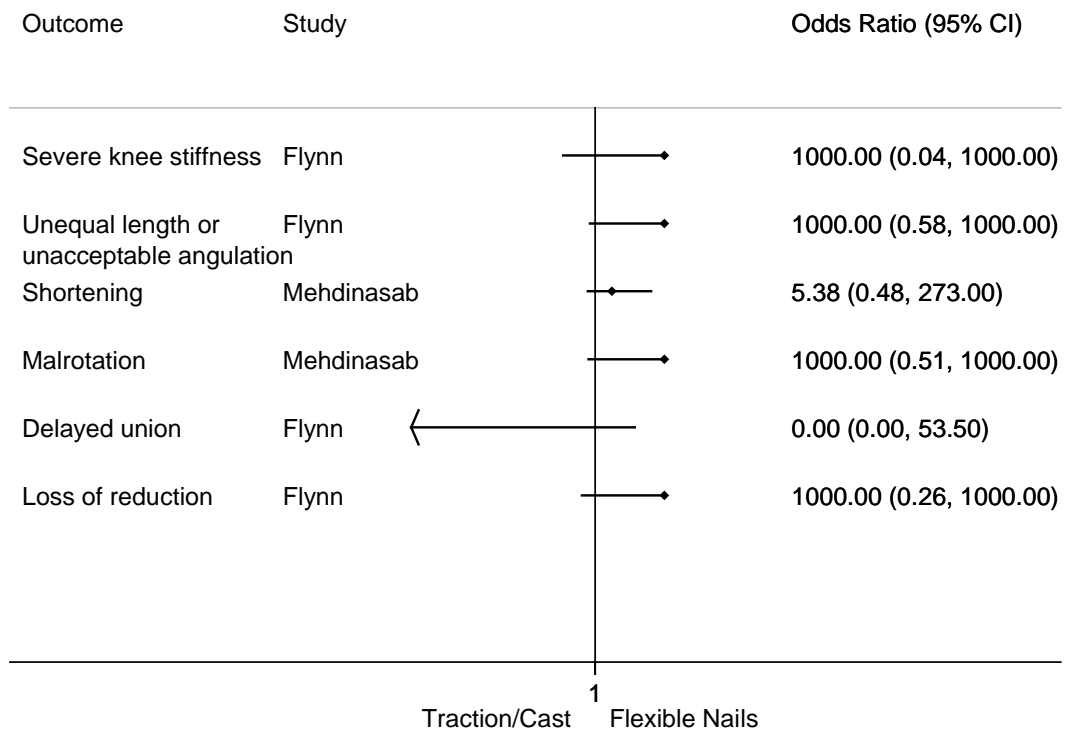


Figure 13. Traction & Cast vs. Flexible Nails – continuous outcomes

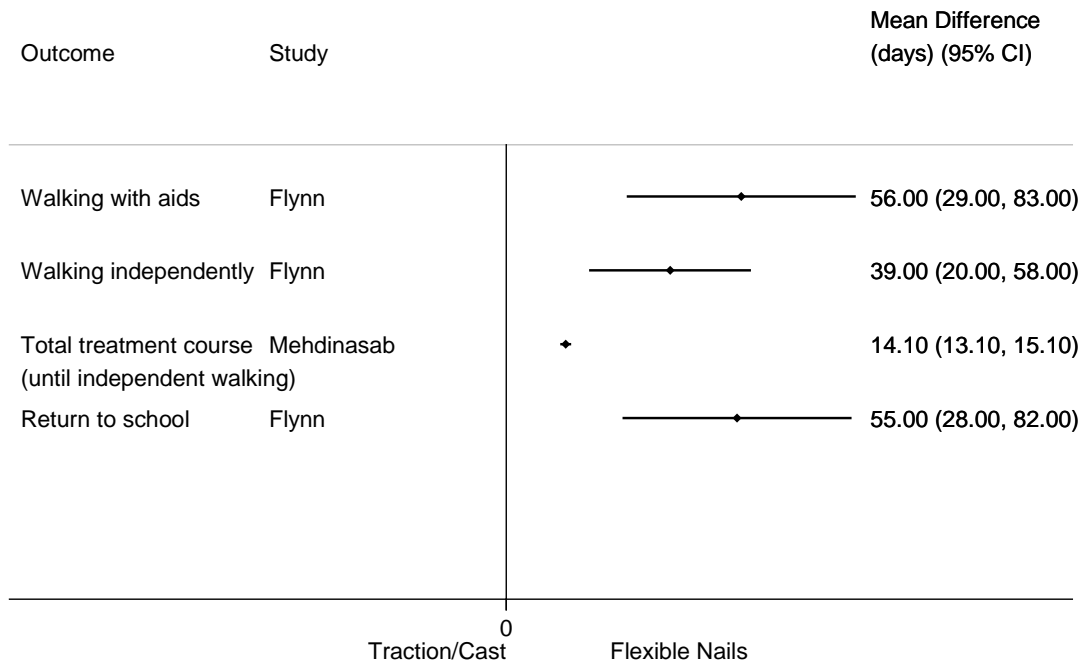


Figure 14. Traction & Cast vs. Flexible Nails - Complications

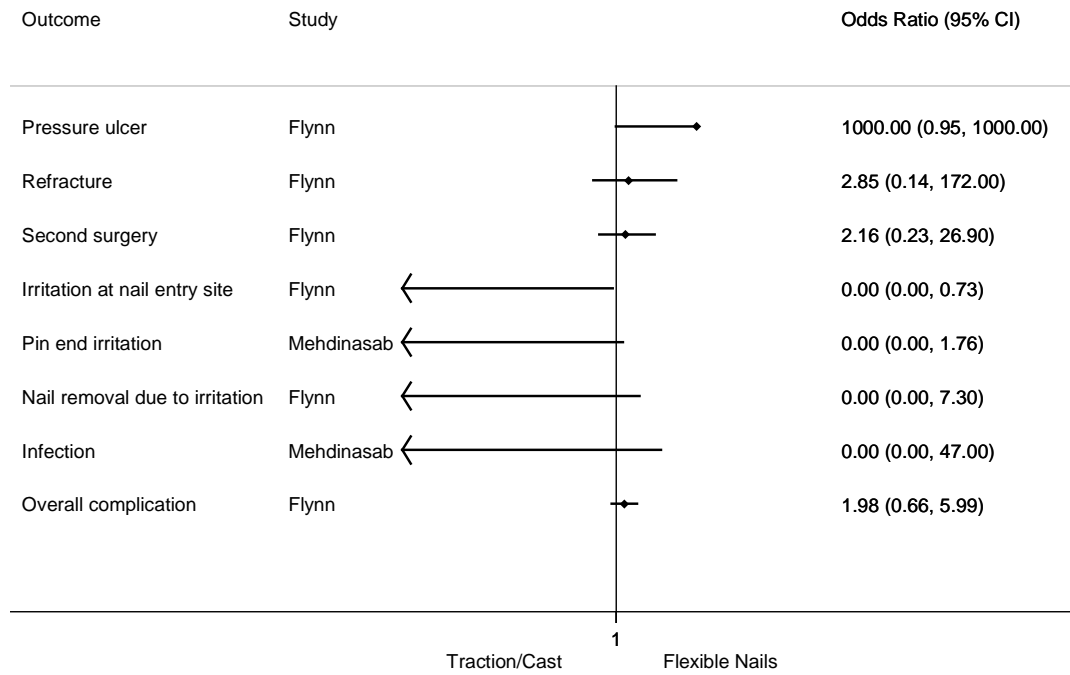


Figure 15. Early Spica Cast vs. Traction - continuous outcomes (Ali et al.³⁰)

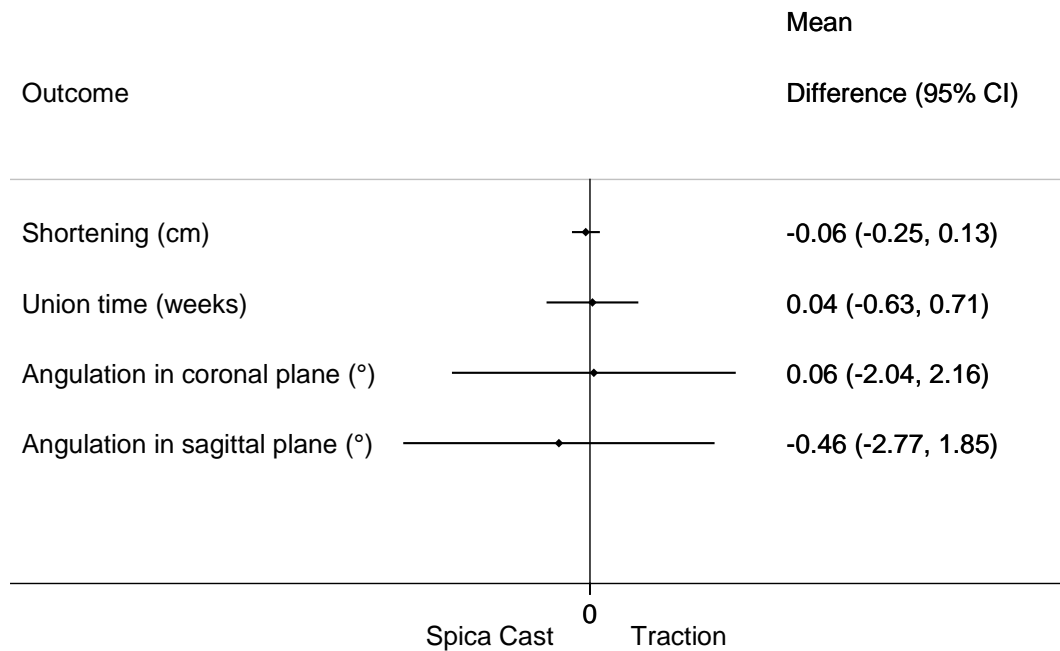


Figure 16. Early Spica Cast vs. Traction -Complications (Ali et al.³⁰)



Figure 17. Early Pontoon Spica vs. Traction/Cast – Short-term Complications (Curtis et al.³¹)

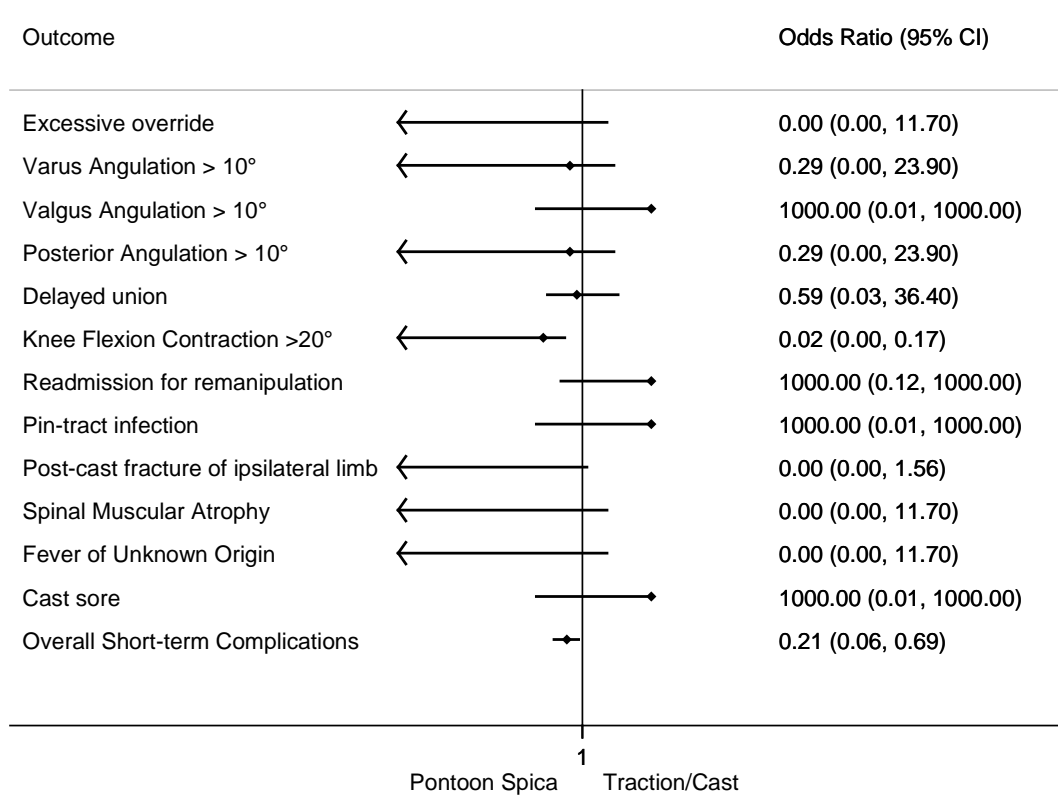


Figure 18. External Fixation vs. Traction & Cast - Treatment Length (Nork et al.³²)

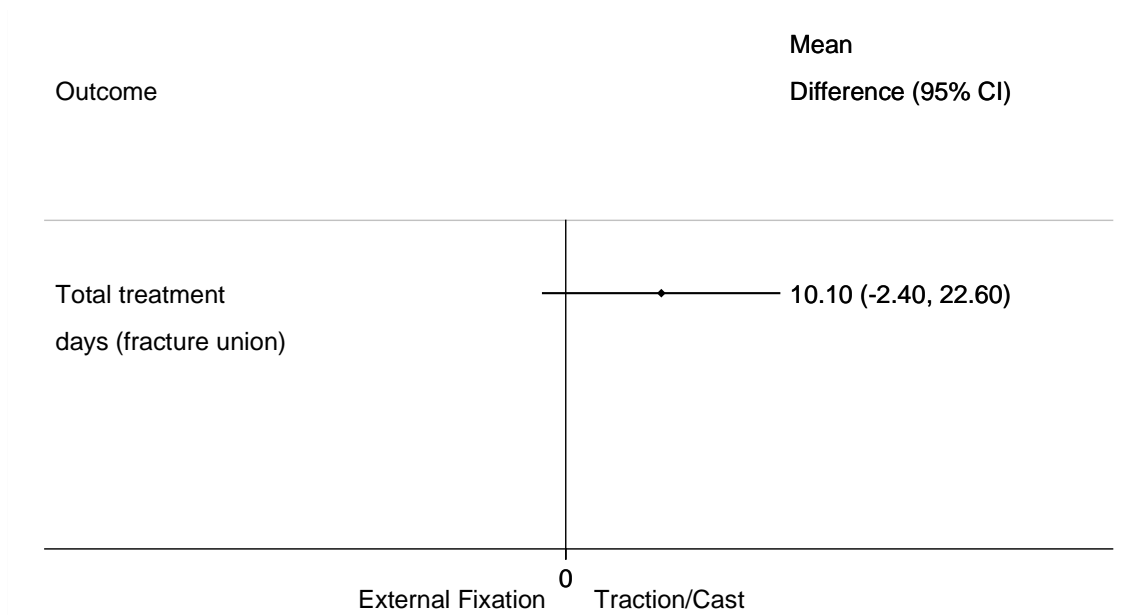


Figure 19. External Fixation vs. Traction & Cast – Complications (Nork et al.³²)

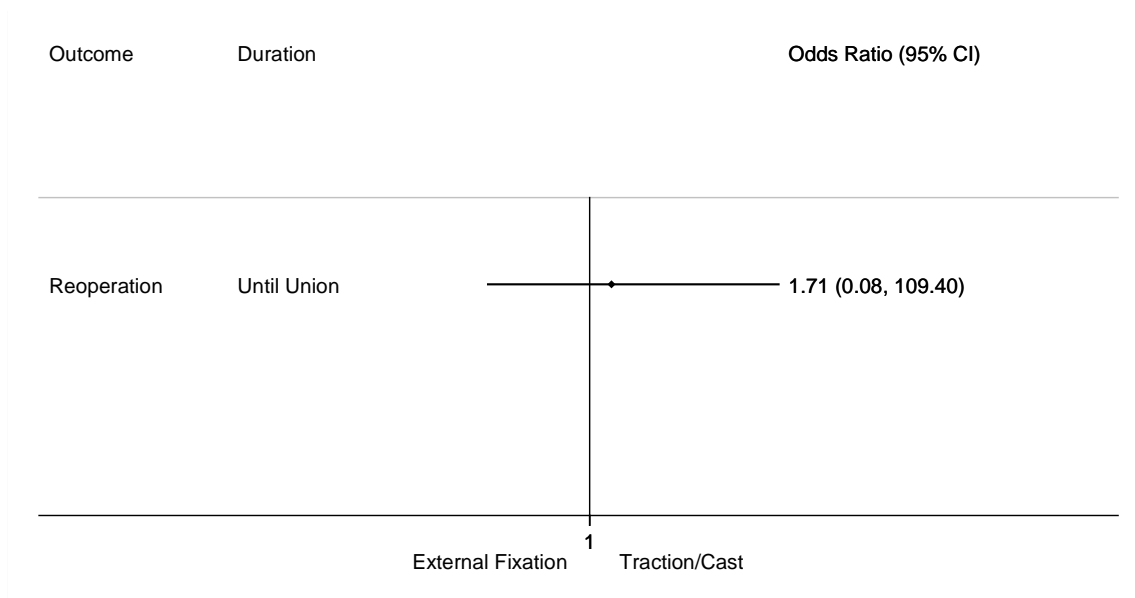


Figure 20. External Fixation vs. Traction - Treatment Length (Hedin et al.³⁴)

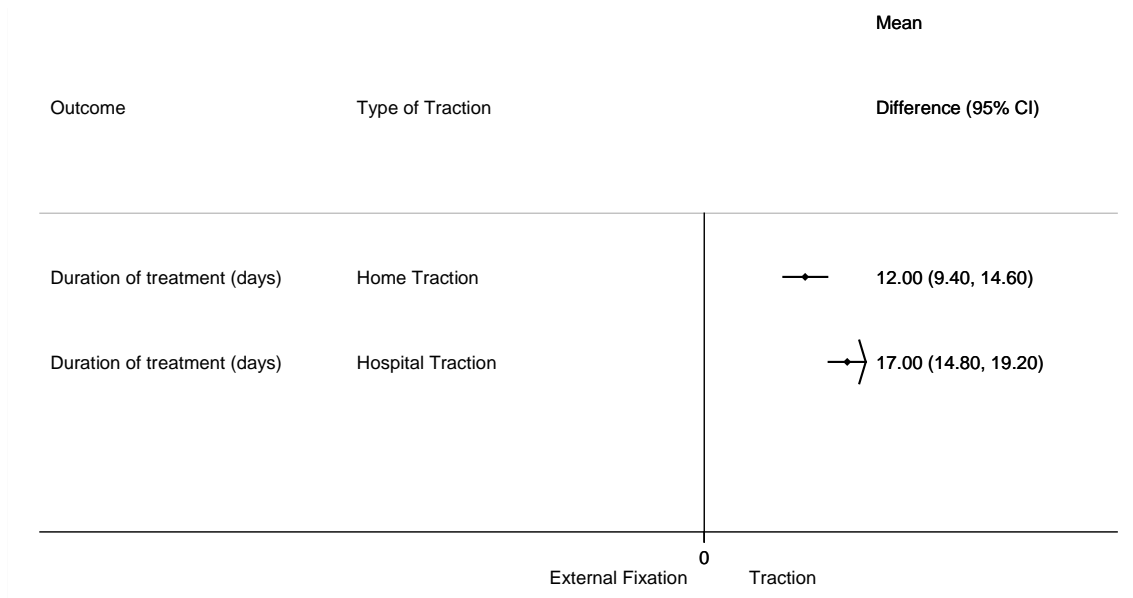


Figure 21. External Fixation vs. Traction - Patient Satisfaction (Hedin et al.³⁴)

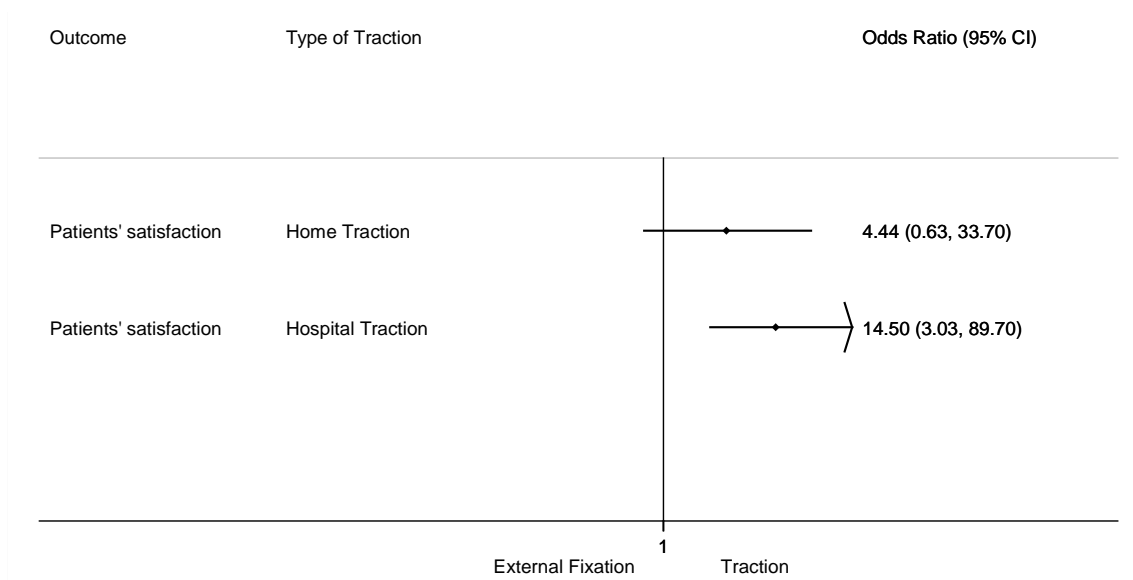


Figure 22. Flexible Nails vs. Traction & Cast - binary outcomes

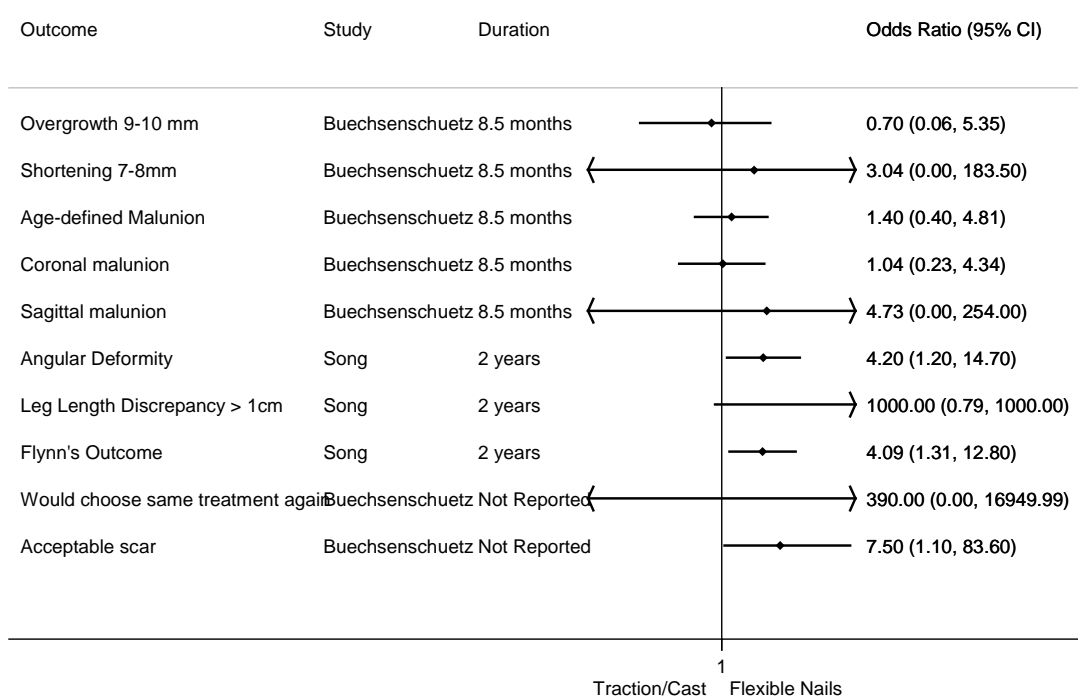


Figure 23. Flexible Nails vs. Traction & Cast -Leg Length Discrepancy (Song et al.³³)

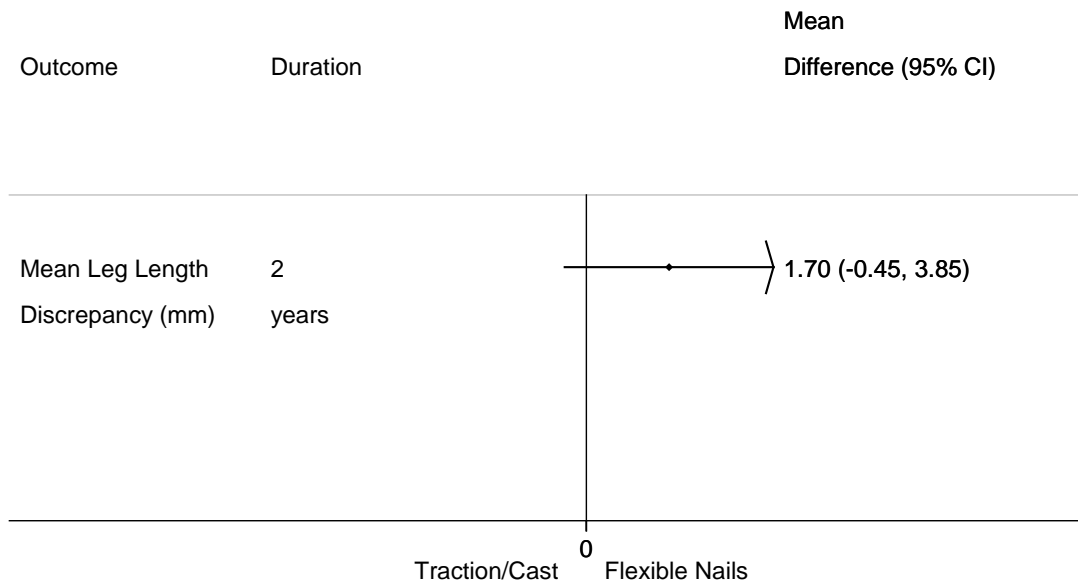


Figure 24. Flexible Nails vs. Traction & Cast - Major Complications

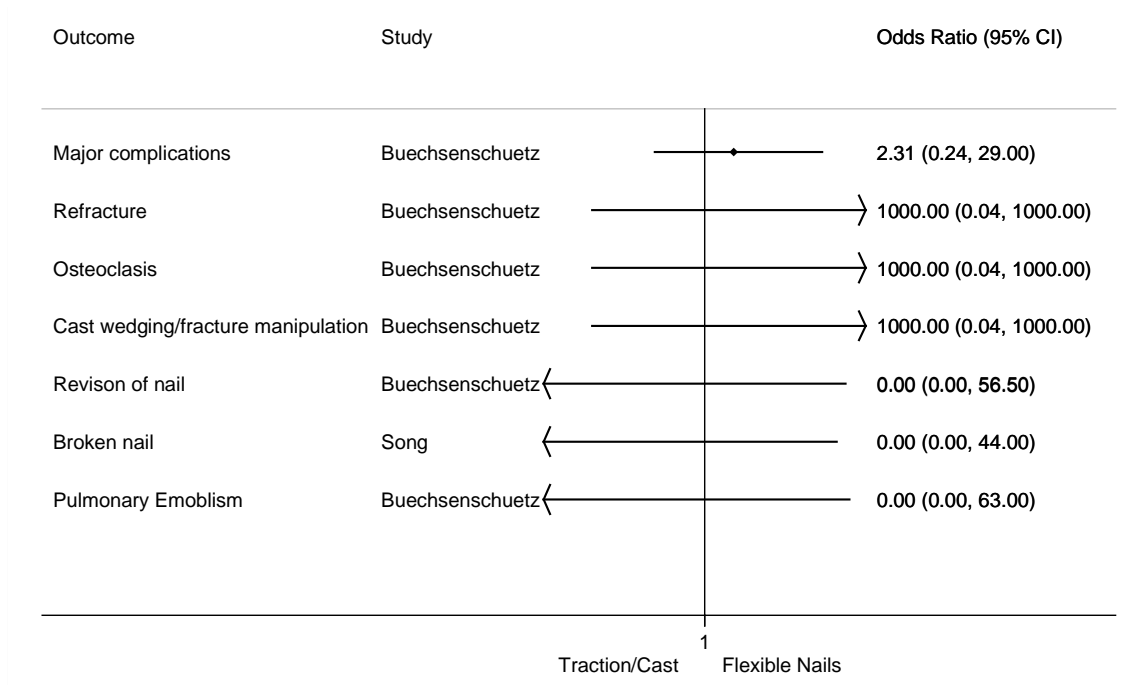


Figure 25. Flexible Nails vs. Traction & Cast - Minor Complications

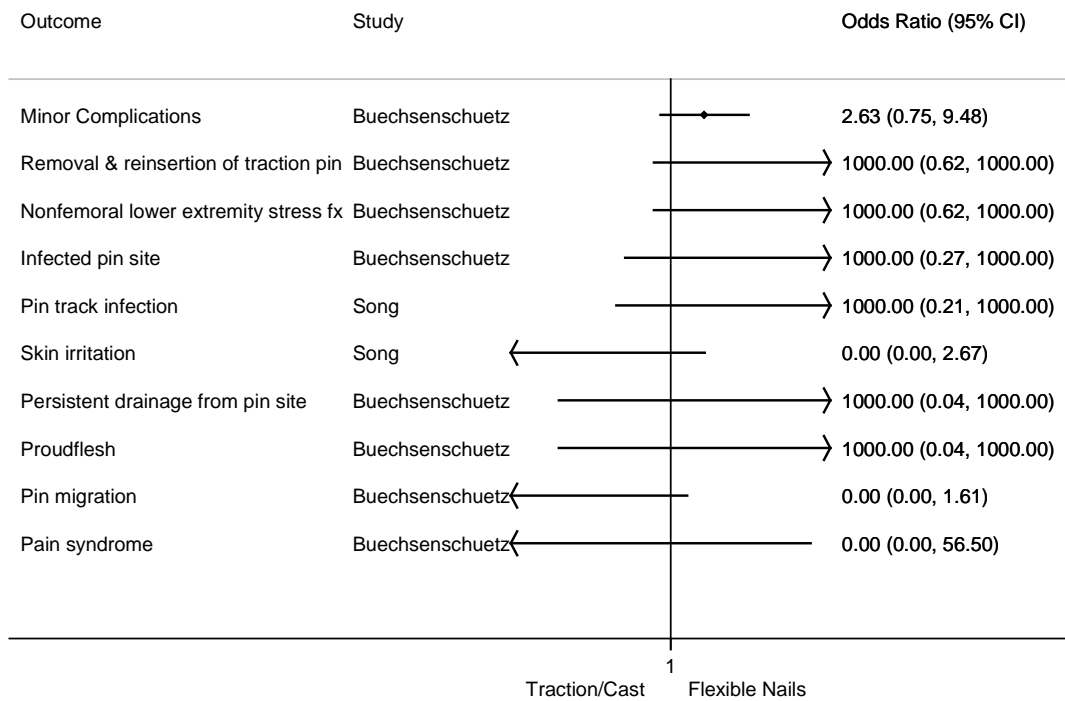


Figure 26. Titanium vs. Stainless Steel Flexible Nails – Complications (Wall et al.³⁷)

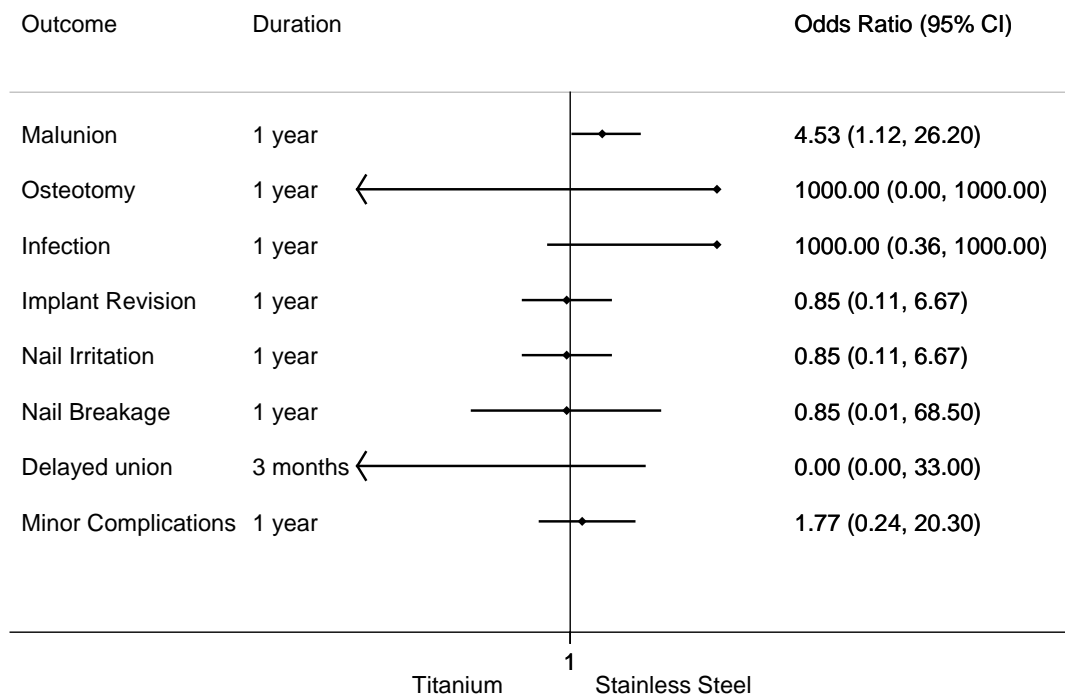


Figure 27. Immediate vs. Delayed Spica Cast - Complications (Rasit et al.³⁵)

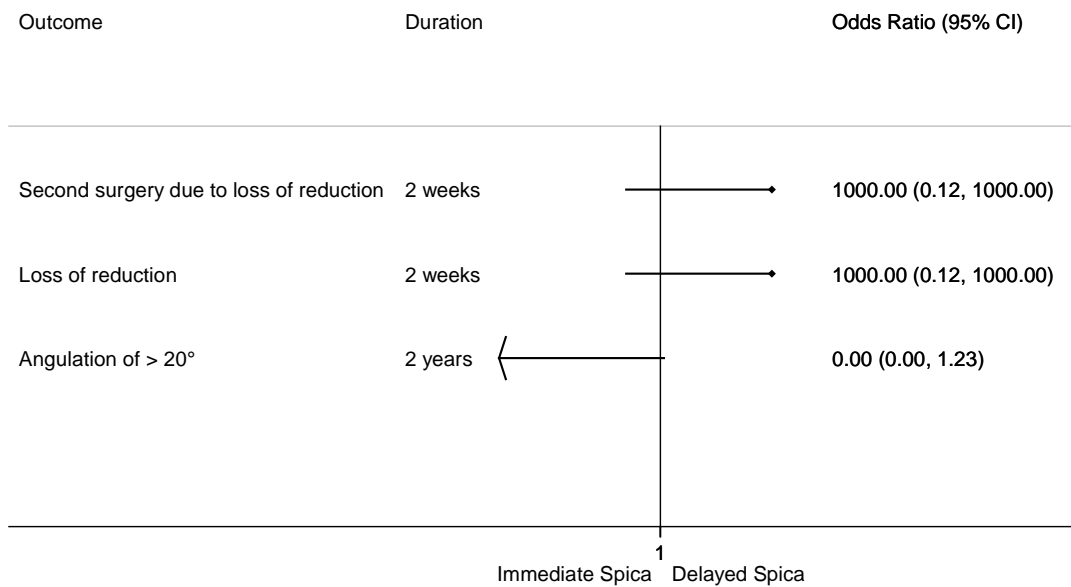


Figure 28. Early Intervention vs. Traction (Sturdee et al.³⁶)

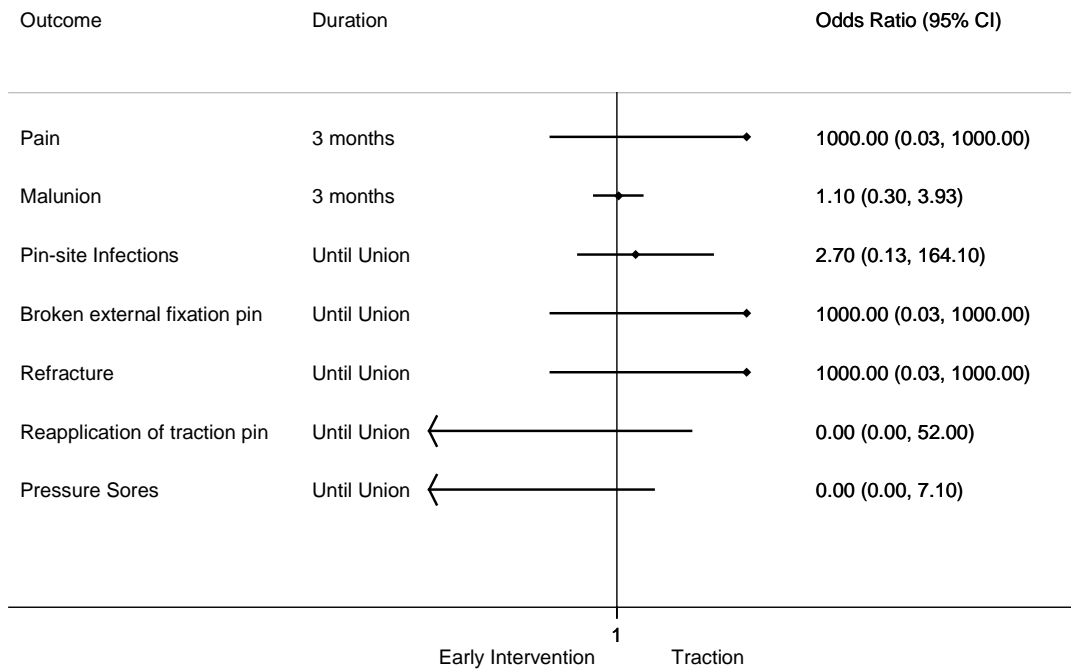
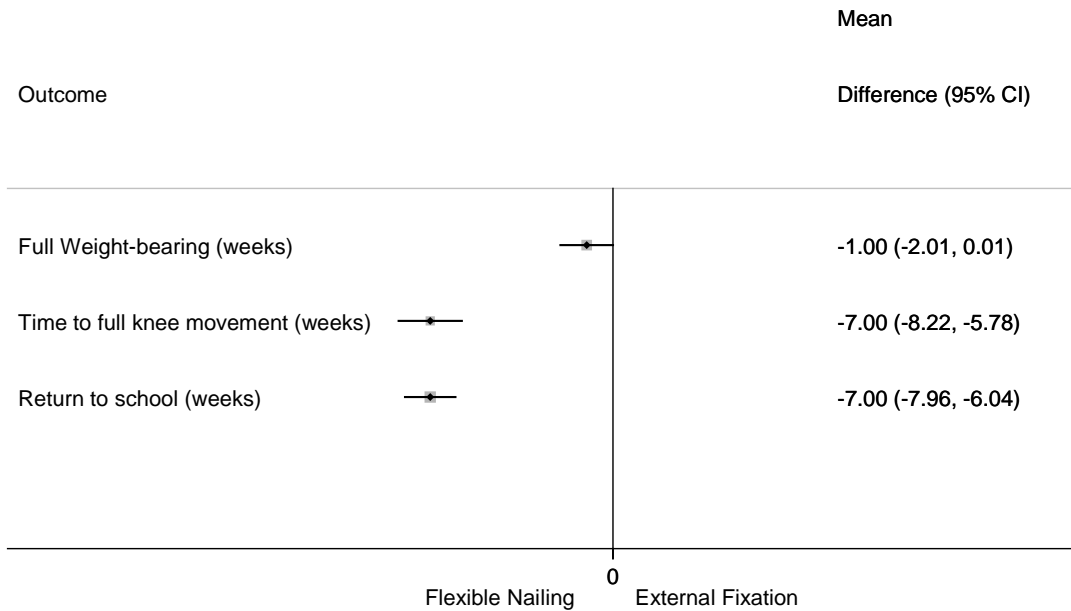


Figure 29. Flexible Nailing vs. External Fixation - Continuous Outcomes (Barlas et al. 2006²⁶)



*Standard deviations estimated from range

Figure 30. Flexible Nailing vs. External Fixation -Binary Outcomes (Barlas et al. 2006²⁶)

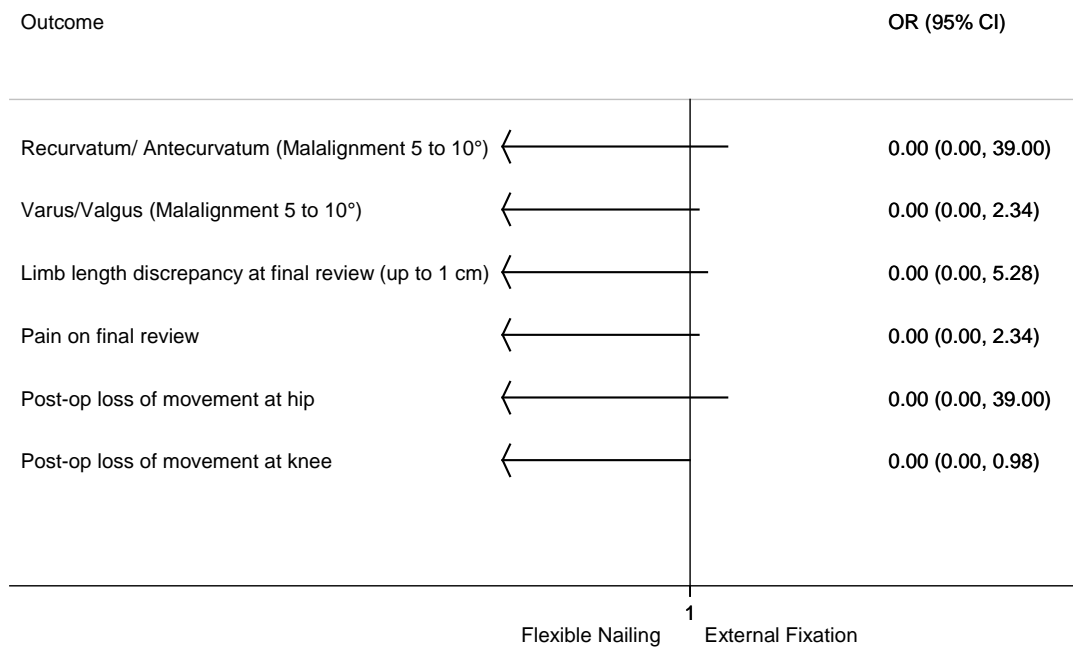
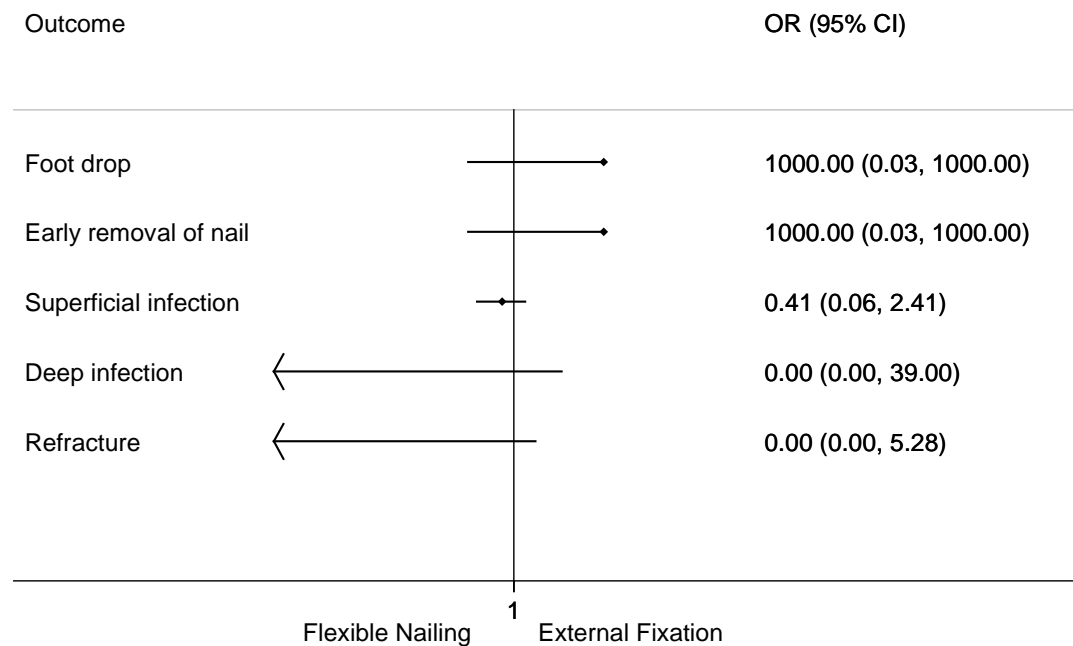


Figure 31. Flexible Nailing vs. External Fixation - Complications (Barlas et al. 2006²⁶)



ORIF PEDIATRIC FEMUR FRACTURES

SUPPORTING EVIDENCE

Table 10. Flexible Intramedullary Nailing and Patients' Weight

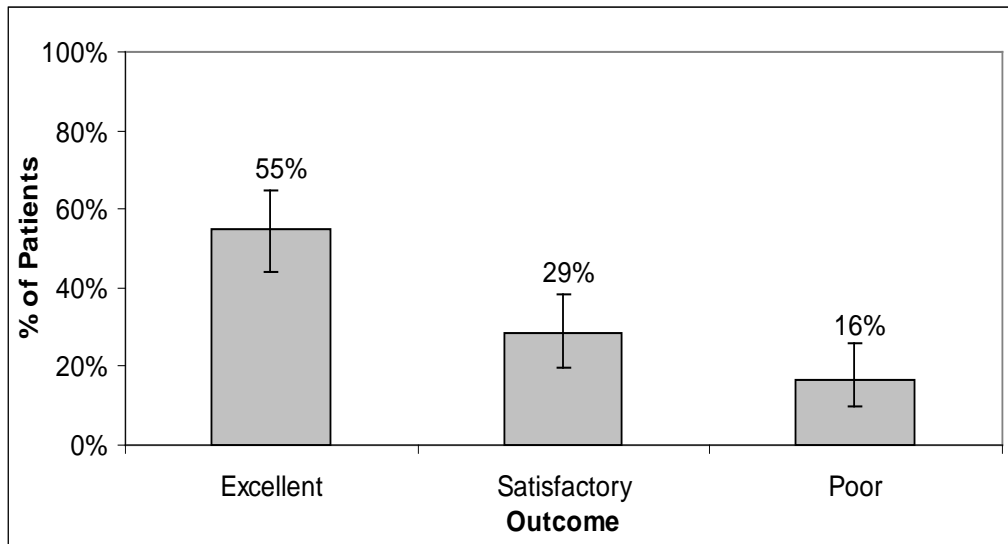
Treatment	n	Mean weight (excellent/satisfactory outcome)	Mean weight (poor outcome)	p-value
Titanium Elastic Nailing	222	39 kg (range 17 to 95.2)	54 kg (range 22.3 to 95.2)	0.003

Table 11. Traction vs. Piriformis Entry Rigid Nailing (Herndon et al.³⁹)

Outcome	Duration	n	Mean Difference (95% CI)	% (Traction)	% (Rigid Nails)	Favors
Healing (weeks)	(<1 to 7 yrs. follow up)	44	1.5 (0.5, 2.5)	n/a	n/a	IM Nailing
Malunion			n/a	29.0%	0.0%	IM Nailing
Shortening >2cm				20.8%	0.0%	N/S
Varus >10°				12.5%	0.0%	N/S
Valgus >10°				4.2%	0.0%	N/S
Anterior angle >20°				8.3%	0.0%	N/S
Pressure sore				4.2%	0.0%	N/S
Pin track infection				4.2%	0.0%	N/S
Limp				8.3%	0.0%	N/S
Second Surgery				8.3%	0.0%	N/S
Growth plate arrest				0.0%	0.0%	N/S

*N/S = no significant difference

Figure 32. Titanium Elastic Nailing Outcomes Among Age 11+ (Moroz et al.²⁷)



* AAOS computed the 95% confidence intervals from published data

Table 12. Rigid Trochanteric Entry Nailing Outcomes (Kanellopoulos et al.⁴⁰)

Outcome	Duration	n	Mean	%
Secondary Healing	n/a	20	9 weeks (8-13)	n/a
Weight Bearing (full)	6 weeks	20	n/a	80%
Full Range of Motion	6 weeks	20	n/a	100%
Return to Preinjury Activity	29 months	20	n/a	100%
Limp	29 months	20	n/a	0%
Delayed or Nonunion	13 weeks	20	n/a	0%
Deep infections	29 months	20	n/a	0%
Hip Osteonecrosis	29 months	20	n/a	0%

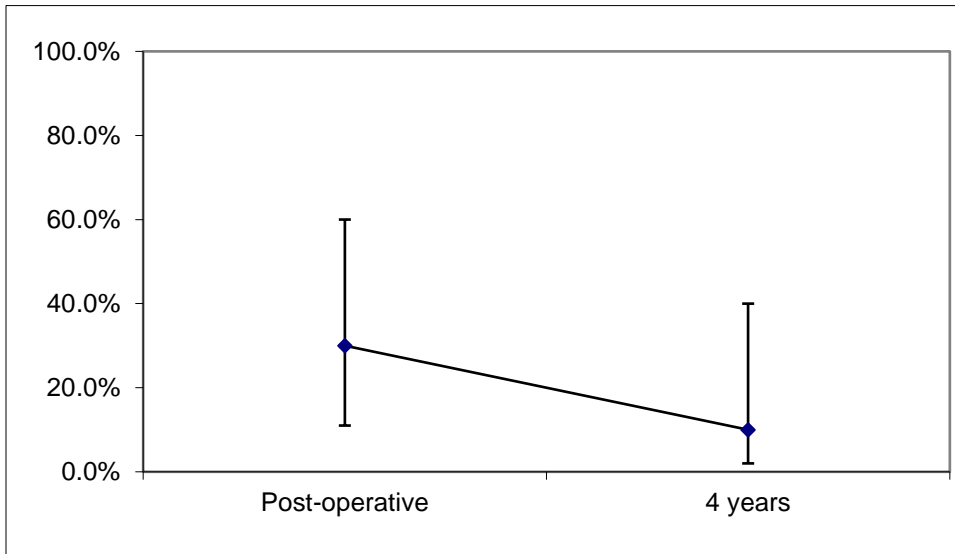
Table 13. Rigid Near Piriformis Entry Nailing Outcomes (Buford et al.³⁸)

Outcome	Duration	n	Mean	%
Time to healing	n/a	54	6 weeks	n/a
Gait disturbance	20 months	54	n/a	0%
Hip pain	20 months	54	n/a	0%
Significant leg length discrepancies	20 months	54	n/a	0%
Nonunion	20 months	54	n/a	0%
Infection	20 months	54	n/a	0%
Subclinical avascular necrosis	20 months	54	n/a	4%
Postoperative nerve palsies	20 months	54	n/a	0%
Acetabular dysplasia	20 months	54	n/a	0%
Refracture through nail site	20 months	54	n/a	2%

Table 14. Bridge Plating Outcomes (Agus et al.⁴¹)

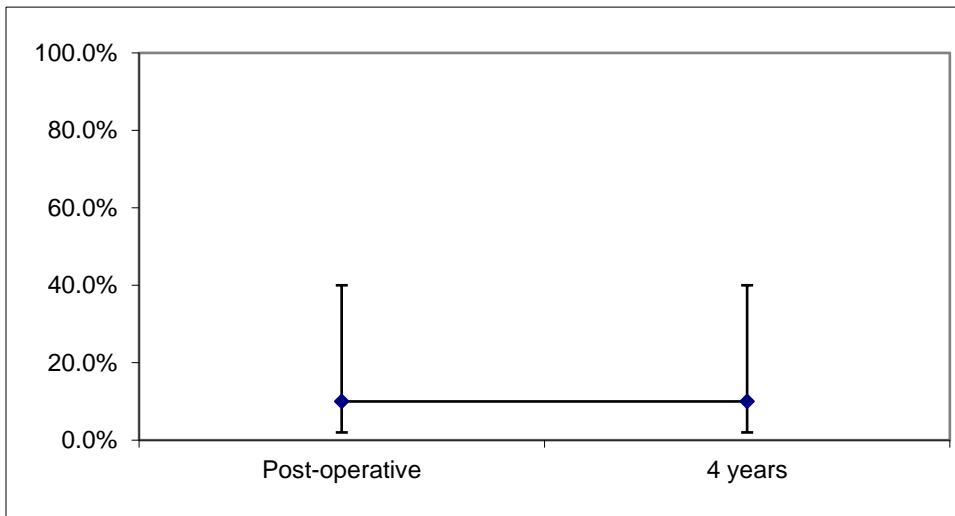
Outcome	Duration	n	Mean (95% CI)	%
Time to grade 2 callus (weeks)	n/a	10	9.1 (7.7, 10.5)	n/a
Complete radiographic healing time (weeks)	n/a	10	13.4 (11.4, 15.4)	n/a
Broken plates	4 years	10	n/a	0.0%
Refractures	4 years	10	n/a	0.0%
Femoral length inequality (cm)	4 years	10	0.6 (0.4, 0.8)	n/a
Increased torsion	4 years	10	n/a	50.0%
Decreased torsion	4 years	10	n/a	50.0%
Torsion diff b/w injured/uninjured limb (absolute value)	4 years	10	4.5° (0, 9.7)	n/a
Limp	4 years	10	n/a	0.0%

Figure 33. Bridge Plating - Percentage of Patients with Frontal Plane Angulation (Agus et al.⁴¹)



*AAOS computed the 95% confidence intervals from published data

Figure 34. Bridge Plating - Percentage of Patients with Sagittal Plane Angulation (Agus et al.⁴¹)



* AAOS computed the 95% confidence intervals from published data

PAIN CONTROL

Figure 35. Hematoma Block vs. Control - Time until First Post-Operative Narcotic Dose

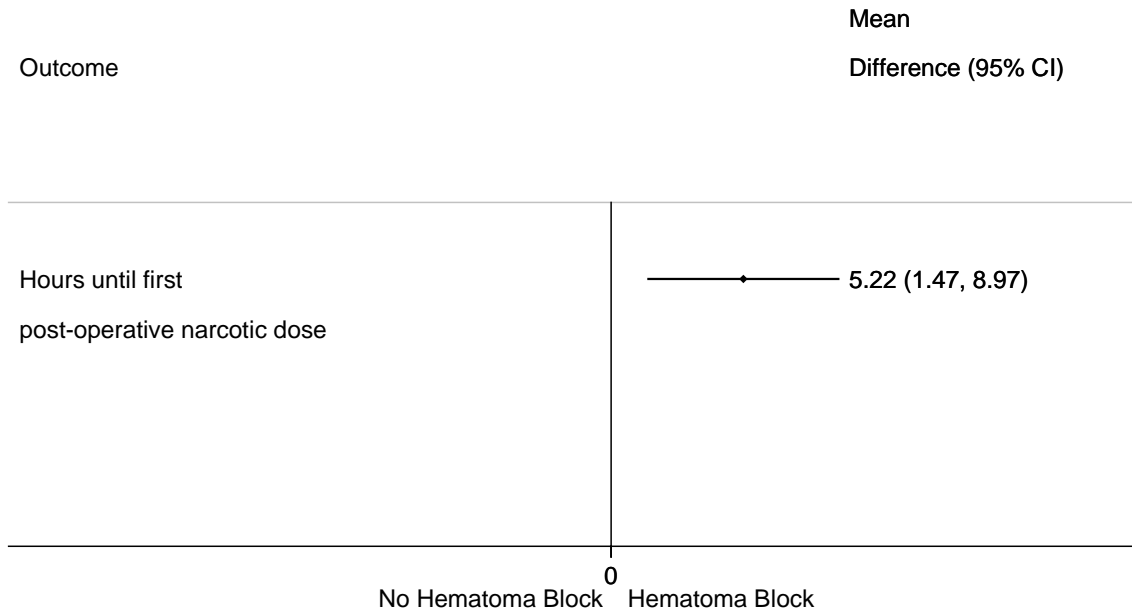


Figure 36. Hematoma Block vs. Control - Post-Operative Narcotic Requirement

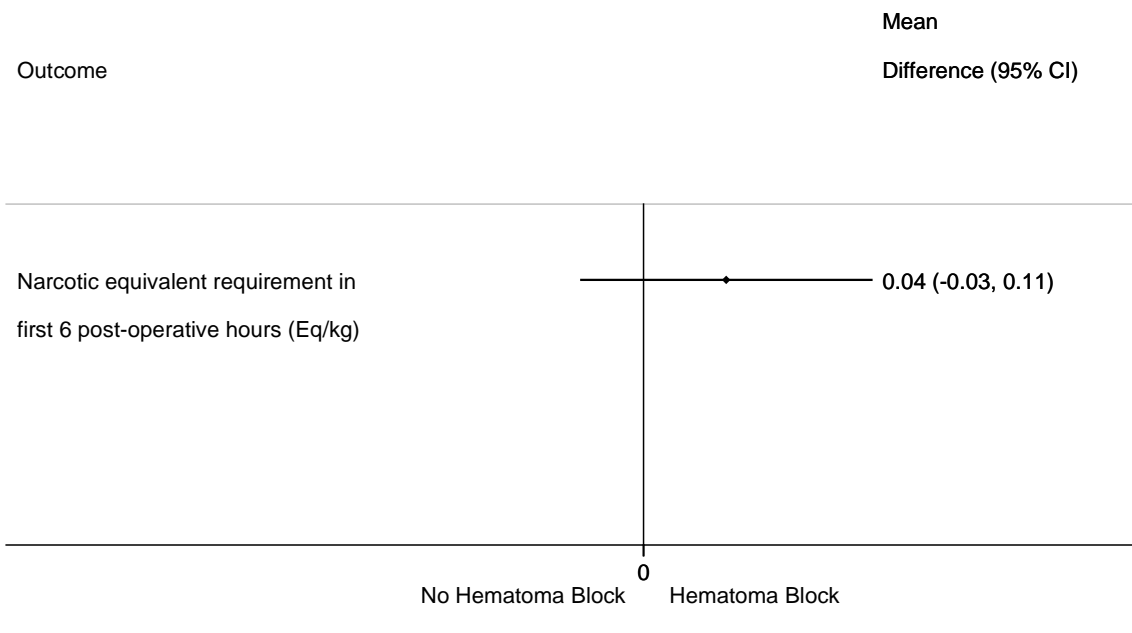


Figure 37. Hematoma Block vs. Control - Binary Outcomes

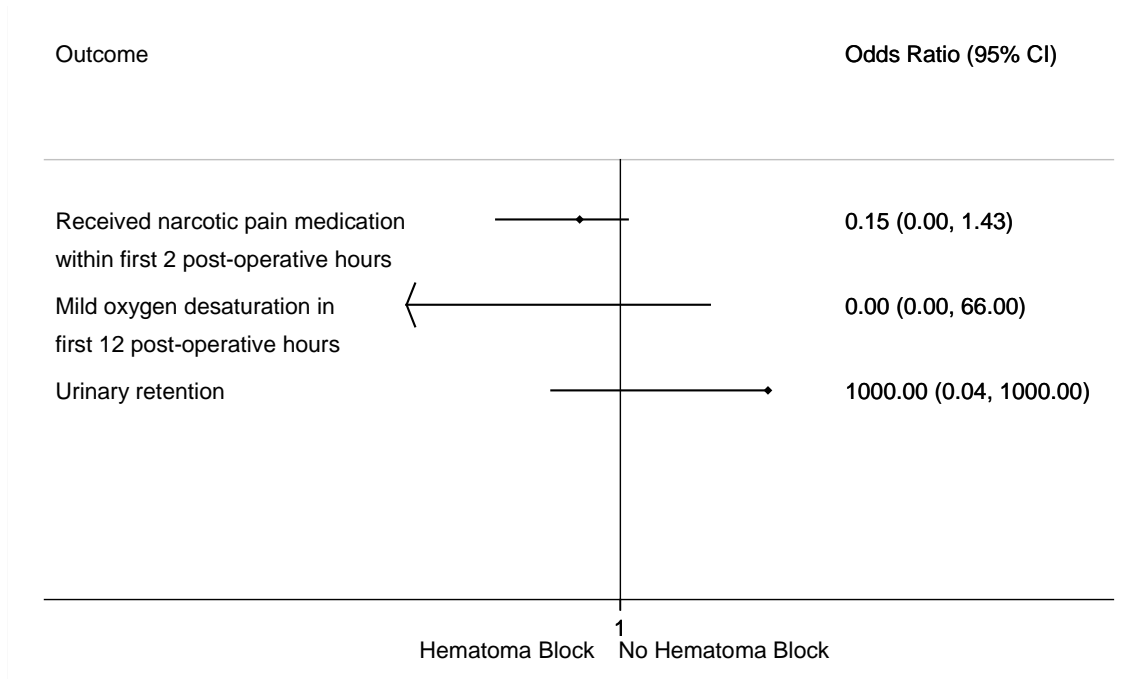
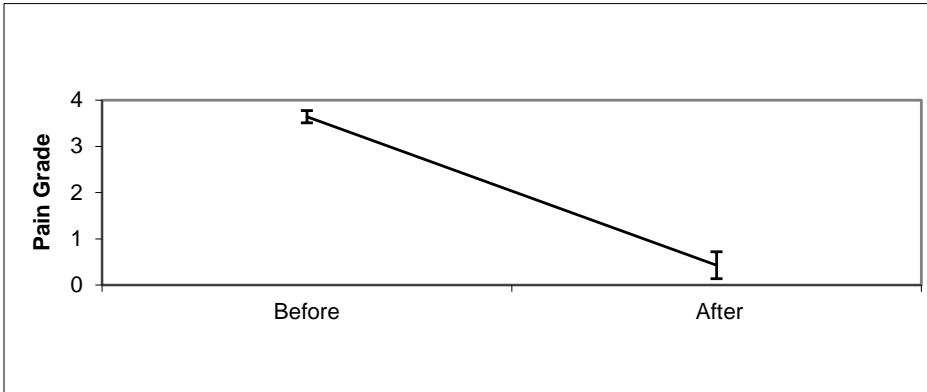


Figure 38. Femoral Nerve Block – Pain Relief



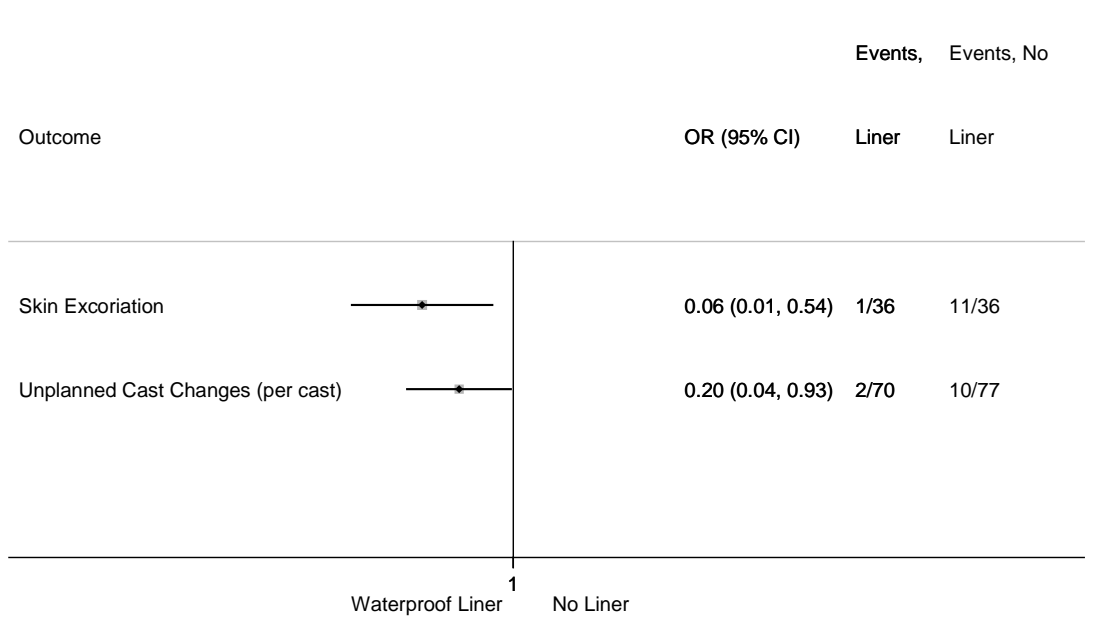
*p<.001 (AAOS calculation); AAOS computed the 95% confidence intervals from published data

Table 15. Femoral Nerve Block Complications

Outcome	n	%
Failed block	14	7%
Femoral artery puncture		7%
ECG changes		0%
Seizure		0%
Respiratory Rate Abnormality		0%
Adverse Sequelae		0%
Neurologic Abnormality (at discharge)		0%

WATERPROOF CASTING

Figure 39. Waterproof Liner vs. No Waterproof Liner



APPENDIX I

AAOS BODIES THAT APPROVED THE 2020 GUIDELINE UPDATE

Committee on Evidence Based Quality and Value

The committee on Evidence Based Quality and Value (EBQV) consists of twenty-three AAOS members who implement evidence-based quality initiatives such as clinical practice guidelines (CPGs), systematic literature reviews (SRs) and appropriate use criteria (AUCs). They also oversee the dissemination of related educational materials and promote the utilization of orthopaedic value products by the Academy's leadership and its members.

Council on Research and Quality

The Council on Research and Quality promotes ethically and scientifically sound clinical and translational research to sustain patient care in musculoskeletal disorders. The Council also serves as the primary resource for educating its members, the public, and public policy makers regarding evidenced-based medical practice, orthopaedic devices and biologics, regulatory pathways and standards development, patient safety, and other related important research and quality areas. The Council is comprised of the chairs of the committees on Devices, Biologics, and Technology, Patient Safety, Research Development, U.S. and chair and section leaders of the Evidence Based Quality and Value committee. Also, on the Council are the second vice-president, three members at large, and representatives of the Diversity Advisory Board, Women's Health Issues Advisory Board, Board of Specialty Societies (BOS), Board of Councilors (BOC), Communications Cabinet, Orthopaedic Research Society (ORS), Orthopedic Research and Education Foundation (OREF).

Board of Directors

The 17-member Board of Directors manage the affairs of the AAOS, set policy, and oversee the Strategic Plan

APPENDIX II

LITERATURE SEARCHES

The search for eligible literature began with a search of the following databases on May 8, 2008, and updated on October 6, 2008, November 27, 2013, and April 6, 2020:

- PubMed (from 1966 through April 6, 2020)
- EMBASE (from 1966 through April 6, 2020)
- CINAHL (from 1982 through April 6, 2020)
- The Cochrane Central Register of Controlled Trials (through November 27, 2013)

The original search (after removal of duplicates) yielded 1153 articles, of which 270 were retrieved and evaluated. The full search strategies are listed below. The updated search conducted in November 2013 yielded an additional 316 articles published after the original search.

All literature searches were supplemented with manual screening of bibliographies in publications accepted for inclusion into the evidence base. In addition, the bibliographies of recent systematic reviews and other review articles were searched for potentially relevant citations.

GENERAL SEARCH

PubMed was searched using the following strategy:

(diaphyseal OR diaphysis OR shaft OR diaphysial) AND fracture AND (femur OR femoral OR thigh) NOT "comment"[Publication Type] NOT "editorial"[Publication Type] NOT "letter"[Publication Type] NOT "Addresses"[Publication Type] NOT "News"[Publication Type] NOT "Newspaper Article"[Publication Type] AND ((("1966/1/1"[EDat]:"2008/10/01"[EDat]) AND (Humans[Mesh]) AND (English[lang]) AND ((infant[MeSH] OR child[MeSH] OR adolescent[MeSH])))

EMBASE was searched using the following strategy:

(diaphyseal OR ('diaphysis'/exp OR 'diaphysis') OR shaft OR diaphysial) AND ('fracture'/exp OR 'fracture') AND (('femur'/exp OR 'femur') OR femoral OR ('thigh'/exp OR 'thigh')) AND ([article]/lim OR [review]/lim) AND [english]/lim AND [humans]/lim AND ([infant]/lim OR [child]/lim OR [adolescent]/lim) AND [embase]/lim AND [1966-2008]/py

CINAHL was searched using the following strategy:

(diaphyseal OR diaphysis OR shaft OR diaphysial) AND fracture AND (femur OR femoral OR thigh)

Cochrane Central Register of Controlled Trials was searched using the following strategy:

(diaphyseal OR diaphysis OR shaft OR diaphysial) AND fracture AND (femur OR femoral OR thigh)

WATERPROOF CAST LINER SEARCH

A search for literature pertaining to cast liners began with a search of the following databases on August 6, 2008, and updated on October 7, 2008, November 27, 2013, and April 6, 2020:

PubMed was searched using the following strategy:
cast AND (liner OR waterproof)

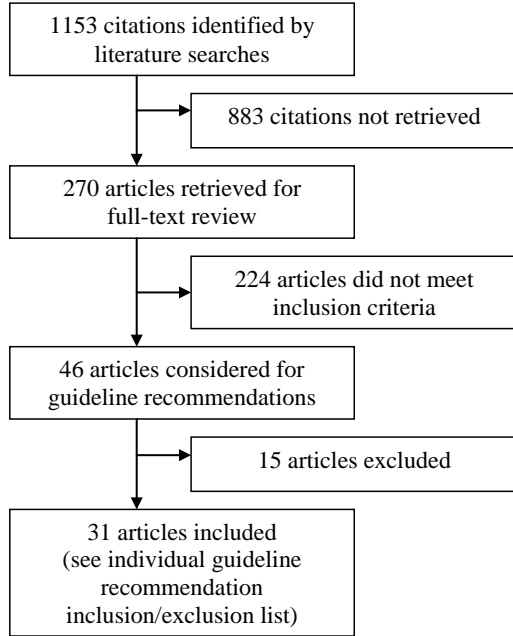
EMBASE was searched using the following strategy:
cast AND (liner OR waterproof) AND [english]/lim AND [humans]/lim AND [embase]/lim

CINAHL was searched using the following strategy:
Cast AND (liner OR waterproof)

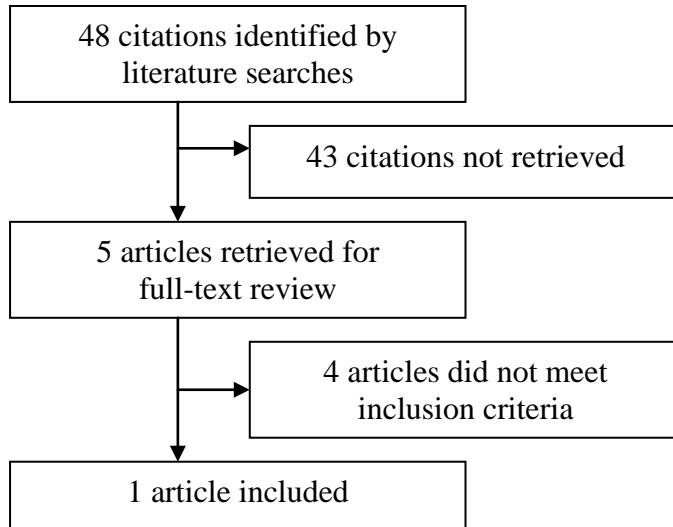
Cochrane Central Register of Controlled Trials was searched using the following strategy:
Cast AND (liner OR waterproof)

APPENDIX III STUDY ATTRITION FLOWCHARTS

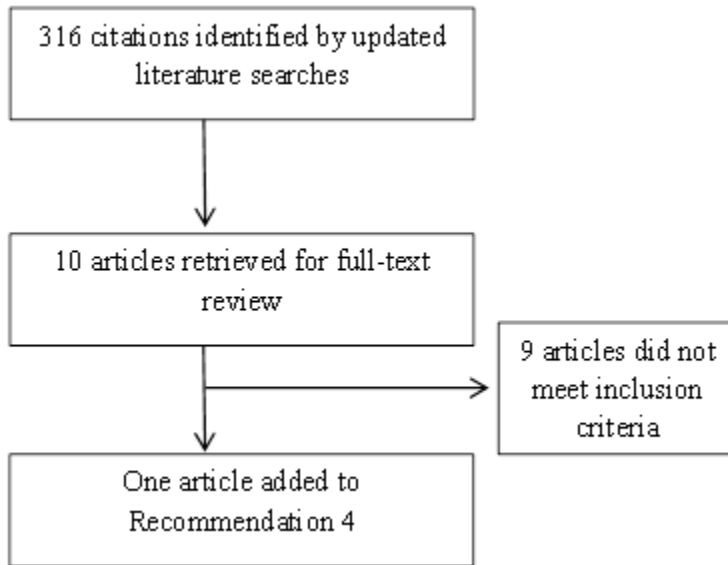
ORIGINAL 2008 LITERATURE SEARCH FLOWCHART



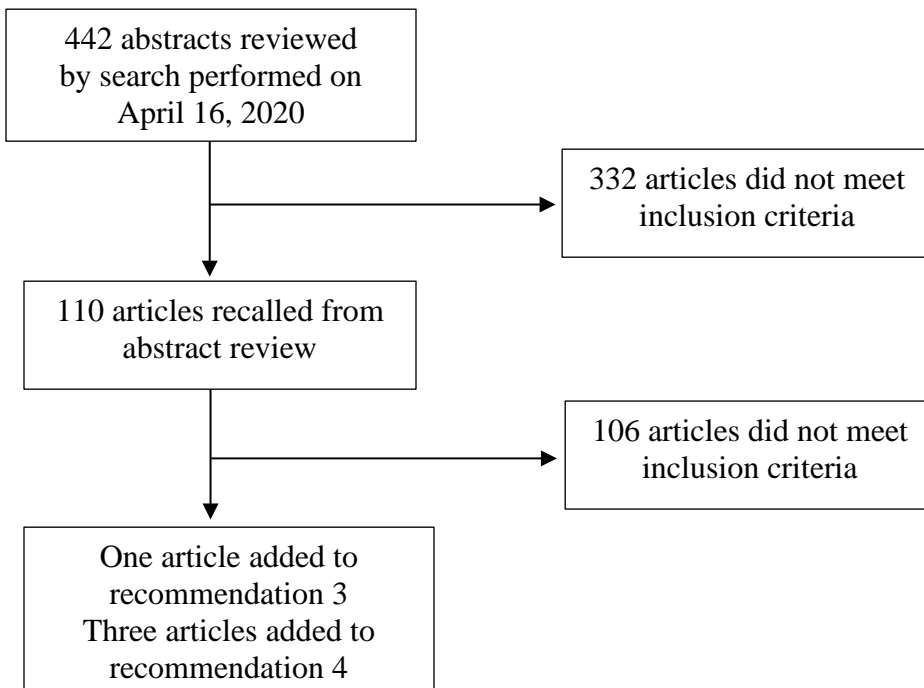
WATERPROOF CAST LINER SEARCH FLOWCHART



UPDATED 2013 LITERATURE SEARCH FLOWCHART



UPDATED 2020 LITERATURE SEARCH FLOWCHART



APPENDIX IV

DATA EXTRACTION ELEMENTS

The data elements below were extracted into electronic forms in Microsoft® Excel from published studies. The extracted information includes:

Study Characteristics (for all relevant outcomes in a study)

- methods of randomization and allocation
- use of blinding (patient, caregiver, evaluator)
- funding source/conflict of interest
- duration of the study
- number of subjects and follow-up percentage
- experimental and control groups
- *a priori* power analysis

Patient Characteristics (for all treatment groups in a study)

- patient inclusion/exclusion criteria
- age
- weight
- surgical complications
- adverse events

Results (for all relevant outcomes in a study)

- duration at which outcome measure was evaluated
- mean value of statistic reported (for dichotomous results)
- mean value of measure and value of dispersion (for continuous results)
- statistical test p-value

APPENDIX V
FORM FOR ASSIGNING GRADE OF RECOMMENDATION
(INTERVENTIONS)

GUIDELINE RECOMMENDATION _____

PRELIMINARY GRADE OF
RECOMMENDATION: _____

STEP 1: LIST BENEFITS AND HARMS

Please list the benefits (as demonstrated by the systematic review) of the intervention

Please list the harms (as demonstrated by the systematic review) of the intervention

Please list the benefits for which the systematic review is not definitive

Please list the harms for which the systematic review is not definitive

STEP 2: IDENTIFY CRITICAL OUTCOMES

Please circle the above outcomes that are critical for determining whether the intervention is beneficial and whether it is harmful

Are data about critical outcomes lacking to such a degree that you would lower the preliminary grade of the recommendation?

What is the resulting grade of recommendation?

STEP 3: EVALUATE APPLICABILITY OF THE EVIDENCE

Is the applicability of the evidence for any of the critical outcomes so low that substantially worse results are likely to be obtained in actual clinical practice?

Please list the critical outcomes backed by evidence of doubtful applicability:

Should the grade of recommendation be lowered because of low applicability?

What is the resulting grade of recommendation?

STEP 4: BALANCE BENEFITS AND HARMS

Are there trade-offs between benefits and harms that alter the grade of recommendation obtained in STEP 3?

What is the resulting grade of recommendation?

STEP 5 CONSIDER STRENGTH OF EVIDENCE

Does the strength of the existing evidence alter the grade of recommendation obtained in STEP 4?

What is the resulting grade of recommendation?

NOTE: Because we are not performing a formal cost analyses, you should only consider costs if their impact is substantial.

APPENDIX VI PEER REVIEW PANEL FOR THE ORIGINAL 2009 GUIDELINE

Participation in the AAOS peer review process does not constitute an endorsement of this guideline by the participating organization.

Peer review of the draft guideline is completed by an outside Peer Review Panel. Outside peer reviewers are solicited for each AAOS guideline and consist of experts in the guideline's topic area. These experts represent professional societies other than AAOS and are nominated by the guideline Work Group prior to beginning work on the guideline. For this guideline, five outside peer review organizations were invited to review the draft guideline and all supporting documentation. All five societies participated in the review of the Treatment of Pediatric Diaphyseal Femur Fractures guideline draft and four consented to be listed as a peer review organization in this appendix. One organization did not give explicit consent that the organization name could be listed in this publication. The organizations that reviewed the document and consented to publication are listed below:

American Academy of Pediatrics, Section on Orthopaedics

European Paediatric Orthopaedic Society

Orthopaedic Trauma Association

American Osteopathic Academy of Orthopedics

Individuals who participated in the peer review of this document and gave their consent to be listed as reviewers of this document are:

James Breivis, MD, San Francisco, CA

Blair C. Filler MD, Los Angeles, CA

J. Eric Gordon MD, St. Louis MS

Michael Heggeness MD, Houston, TX

Harvey Insler MD, Erie, PA

John Kirkpatrick MD, Jacksonville, FL

Pierre Lascombes MD, Nancy France

David A. Podenswa MD, Dallas, TX

Charles A Reitman MD, Houston, TX

Debra K. Spatz, D.O, Prince Frederick, MD

Again, participation in the AAOS guideline peer review process does not constitute an endorsement of the guideline by the participating organizations or the individuals listed above.

PUBLIC COMMENTARY FOR ORIGINAL 2009 GUIDELINE

A period of public commentary follows the peer review of the draft guideline. If significant non-editorial changes are made to the document as a result of public commentary, these changes are also documented and forwarded to the AAOS bodies that approve the final guideline. Public commentators who gave explicit consent to be listed in this document include the following:

Participation in the AAOS guideline public commentary review process does not constitute an endorsement of the guideline by the participating organizations or the individual listed nor does it in any way imply the reviewer supports this document.

Jeffrey Anglen MD, Indianapolis, IN
Howard R. Epps MD, Houston TX
M. Bradford Henley MD MBA, Seattle WA
William C McMaster MD, Orange, CA
Jack R. Steel MD, Huntington WV

J. Mark Melhorn MD, Wichita, KS on behalf of:
The American Academy of Disability Evaluating Physicians

**APPENDIX VII
STRUCTURED PEER REVIEW FORM**

Reviewer Information:

Name of Reviewer _____
Address _____
City _____ State _____ Zip Code _____
Phone _____ Fax _____
E-mail _____

Specialty Area/Discipline: _____
Work setting: _____
Credentials: _____

May we list you as a Peer Reviewer in the final Guidelines? Yes No

Are you reviewing this guideline as a representative of a professional society? Yes No

If yes, may we list your society as a reviewer of this guideline? Yes No

Reviewer Instructions

Please read and review this Draft Clinical Practice Guideline and its associated Technical Report with particular focus on your area of expertise. Your responses are confidential and will be used only to assess the validity, clarity, and accuracy of the interpretation of the evidence. If applicable, please specify the draft page and line numbers in your comments. Please feel free to also comment on the overall structure and content of the guideline and Technical Report.

If you need more space than is provided, please attach additional pages.
Please complete and return this form electronically to weis@aaos.org or fax the form back to Jan Weis at (847) 823-9769.

Thank you in advance for your time in completing this form and giving us your feedback. We value your input and greatly appreciate your efforts. Please send the completed form and comments by **Month, Day, Year**

Please indicate your level of agreement with each of the following Statements, by placing an “X” in the appropriate box.

	Very much agree	Moderately agree	Moderately disagree	Very much disagree
1. The recommendations are clearly stated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. There is an explicit link between the recommendations and the supporting evidence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Given the nature of the topic and the data, all clinically important outcomes are considered	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The guideline’s target audience is clearly described	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The patients to whom this guideline is meant to apply are specifically described	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The criteria used to select articles for inclusion are appropriate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The reasons why some studies were excluded are clearly described	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. All important studies that met the article inclusion criteria are included	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. The validity of the studies is appropriately appraised	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. The methods are described in such a way as to be reproducible.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. The statistical methods are appropriate to the material and the objectives of this guideline	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Important parameters (e.g., setting, study population, study design) that could affect study results are systematically addressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Health benefits, side effects, and risks are adequately addressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. The writing style is appropriate for health care professionals and patients	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. The grades assigned to each recommendation are appropriate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

COMMENTS

Please provide a brief explanation of both your positive and negative answers in the preceding section. If applicable, please specify the draft page and line numbers in your comments. Please feel free to also comment on the overall structure and content of the guideline and Technical Report

OVERALL ASSESSMENT

Would you recommend these guidelines for use in practice? (check one)

Strongly recommend _____

Recommend (with provisions or alterations) _____

Would not recommend _____

Unsure _____

COMMENTS:

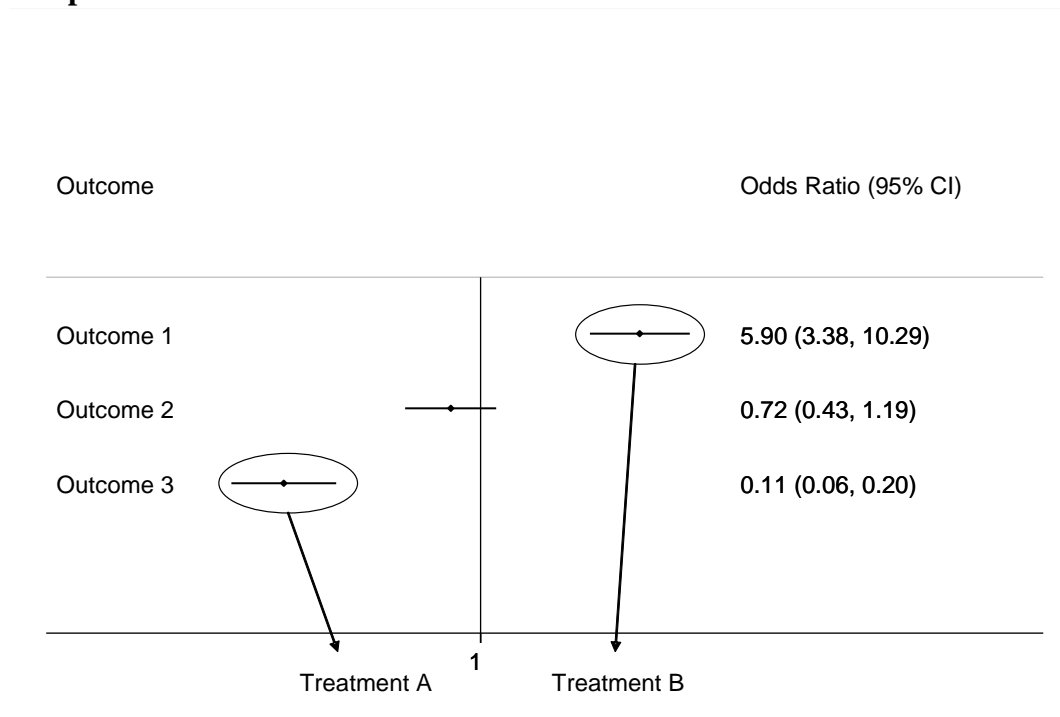
Please provide the reason(s) for your recommendation.

APPENDIX VIII INTERPRETING THE FOREST PLOTS⁴⁹



Throughout the guideline we use descriptive diagrams or forest plots to present data from studies comparing the differences in outcomes between two treatment groups. In this guideline there are no meta-analyses (combining results of multiple studies into a single estimate of overall effect), so each point and corresponding horizontal line on a sample plot should be viewed independently. In the example below, the odds ratio is the effect measure used to depict differences in outcomes between the two treatment groups of a study. In other forest plots, the point can refer to other summary measures (such as the mean difference or relative risk). The horizontal line running through each point represents the 95% confidence interval for that point. In this graph, the solid vertical line represents “no effect” where the Odds Ratio, OR, is equal to one. When mean differences are portrayed, the vertical line of no effect is at zero.

For example, in the figure below the odds of a patient experiencing Outcome 1 are 5.9 times greater for patients who received Treatment B than for patients who received Treatment A.. This result is statistically significant because the 95% Confidence Interval does not cross the “no effect” line. In general, the plots are arranged such that results to the left of the “no effect” line favor Treatment A while results to the right favor Treatment B. In the example below, the odds ratio for Outcome 1 favors Treatment B, the odds ratio for Outcome 3 favors Treatment A, and the odds ratio for Outcome 2 does not favor either treatment because the 95% CI crosses the “no effect” line (i.e. the difference is not statistically significant).

Sample Plot



DESCRIPTION OF SYMBOLS USED IN FIGURES AND TABLES

Symbol	Description
OR	Odds Ratio = The odds in Group B divided by the odds in Group A, where the odds is the probability of the outcome occurring divided by the probability of the outcome not occurring.
95% CI	95% Confidence Interval = A measure of uncertainty of the point estimate: if the trial were repeated an infinite number of times, then the 95% CI calculated for each trial would contain the true effect 95% of the time.
	An arrow in a forest plot indicates that the 95% confidence interval continues beyond the range of the graph.
	An open circle in a Summary of Evidence Table indicates that the result is not statistically significant.
● fn	A filled-in circle in a Summary of Evidence Table indicates that the result is statistically significant in favor of the listed treatment (in this example, in favor of fn = flexible nails)

APPENDIX IX CONFLICT OF INTEREST

All members of the AAOS work group disclosed their conflicts of interest prior to the development of the recommendations for this guideline. Conflicts of interest are disclosed in writing with the American Academy of Orthopaedic Surgeons via a private on-line reporting database and also verbally at the recommendation approval meeting. Members of all AAOS Work Groups are required to disclose their conflicts of interest at the same level and depth of detail as the AAOS Board of Directors.

AAOS DISCLOSURE PROGRAM INFORMATION

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Disclosure Items: (n) = Respondent answered 'No' to all items indicating no conflicts. 1=Board member/owner/officer/committee appointments; 2= Medical/Orthopaedic Publications; 3= Royalties; 4= Speakers bureau/paid presentations; 5A= Paid consultant; 5B= Unpaid consultant; 6= Research or institutional support from a publisher; 7= Research or institutional support from a company or supplier; 8= Stock or Stock Options; 9= Other financial/material support from a publisher; 10= Other financial/material support from a company or supplier.

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APPENDIX XI

INCONCLUSIVE RECOMMENDATIONS REMOVED FROM UPDATED GUIDELINE

The recommendations listed below were published in the original 2009 guideline, but removed from the updated guideline due to a lack of evidence.

- We are unable to recommend for or against early spica casting for children age six months to five years with a diaphyseal femur fracture with greater than 2 cm of shortening.
- We are unable to recommend for or against patient weight as a criterion for the use of spica casting in children age six months to five years with a diaphyseal femur fracture.
- We are unable to recommend for or against using any specific degree of angulation or rotation as a criterion for altering the treatment plan when using the spica cast in children six months to five years of age.
- We are unable to recommend for or against removal of surgical implants from asymptomatic patients after treatment of diaphyseal femur fractures.
- We are unable to recommend for or against outpatient physical therapy to improve function after treatment pediatric diaphyseal femur fractures.
- We are unable to recommend for or against the use of locked versus non-locked plates for fixation of pediatric femur fractures.