

Aftercare following syndesmotic screw placement; a systematic review

T. Schepers MD PhD¹, E.M.M. Van Lieshout PhD², J.P. Van der Linden MD³, V.M. De Jong MD¹,
J.C. Goslings MD PhD¹

1. Trauma Unit, Department of Surgery, Academic Medical Center, Amsterdam, The Netherlands
2. Department of Surgery-Traumatology, Erasmus MC, University Medical Center Rotterdam,
The Netherlands
3. Department of Orthopaedics, Reinier de Graaf Groep Delft, The Netherlands

Corresponding author:

T. Schepers

Academic Medical Center

Trauma Unit, Department of Surgery

Meibergdreef 9

PO Box 22660

1100 DD Amsterdam

The Netherlands

email:t.schepers@amc.nl

Abstract

Introduction For ankle fractures in general there have been several studies on immobilization (e.g., cast or boot) versus early motion following surgical treatment. However, no studies have been performed to determine the best aftercare strategy for surgically treated patients with ankle fractures with concomitant acute distal tibiofibular syndesmotom injuries. The aim of the current review was to compare the functional outcome of ankle fractures with syndesmotom injury treated with cast or boot versus early motion.

Material and methods Systematic review using the electronic databases from January 1, 2000 to September 1, 2012 of 'the Cochrane Library', 'Pubmed Medline', 'EMbase', and 'Google Scholar'. Studies included where those in which ankle fractures with acute distal tibiofibular syndesmotom injuries were treated with one or more syndesmotom screws, with a mean follow-up of at least twelve months and at least 25 patients included. Functional outcome as measured with the American Orthopaedic Foot Ankle Society Hindfoot score, Olerud-Molander Ankle Score and Short Musculoskeletal Function Assessment were compared.

Results A total of nine studies were identified with 531 patients. The number of included patients ranged from 28 to 93. Mean follow-up was between 12 and 101 months. Three studies used an early motion protocol (195 patients), and six studies (336 patients) immobilized for at least six weeks. For the AOFAS the mean scores for immobilization were 86 to 91 points and for early motion 84 to 89. For the OMAS the scores for immobilization were 47 to 90 and for early motion 46 to 82 points. The SMFA scores for immobilization were 11 and for early motion they ranged between 12 and 27 points.

Conclusion No apparent differences could be detected in the literature considering functional outcome between immobilization versus an early motion protocol in ankle fractures with acute distal tibiofibular syndesmotom injuries treated with a syndesmotom screw. There is however a lack of level one and two studies on this subject.

Introduction

Throughout the last years various aspects of the treatment of patients with acute syndesmotic injury have been investigated and more evidence is becoming available on the best treatment strategy. For ankle fractures in general there have been several studies on immobilization (*i.e.*, cast or boot) versus early motion following surgical treatment. However, considering the aftercare of surgically treated ankle fractures with concomitant acute distal tibiofibular syndesmotic injuries there have been no studies to determine the best strategy.

In case of a ruptured distal tibiofibular syndesmotic-complex the anatomy is frequently restored and supported using a syndesmotic screw [1]. One millimeter of lateral displacement of the talus gives a significant decrease in tibiotalar area of contact, which might lead to early joint degeneration [2-4]. Because of the trapezoid shape of the talus, the fibula and tibia move in relation to each other at the level of the syndesmosis. In a recent study, during each dorsal to plantar flexion 2mm lateral, 1.5mm ventral, and 0.5mm cranial movement was seen and simultaneously, four degrees of exorotation of the fibula could be observed [5]. These movements might lead to secondary displacement or recurrent syndesmotic diastasis, therefore temporarily immobilization of the ankle joint during several weeks is frequently advised. The duration that this support is needed, or in other words the time the ligaments need to heal, is estimated between 6 to 12 weeks [6-7]. On the other hand, in the joint the cartilage layer is fed via diffusion, and the pressure created by weight bearing (and to some extent by motion) works as a pumping mechanism to exchange nutrients and waste-products. Joint immobilization impairs the articular cartilage layer, and the effects last for a long period of time, even after restarting unprotected weightbearing [8-10].

There is currently no clear evidence that either immobilization or early motion following the treatment of ankle fractures with syndesmotic injuries improves the functional outcome. The aim of the current literature review was therefore to compare the functional outcome of ankle fractures with syndesmotic injuries treated with immobilization or early motion exercise.

Material and Method

A systematic review was performed using a literature search to identify studies in which ankle fractures with acute distal tibiofibular syndesmotic injury were treated with a syndesmotic screw. The electronic databases from January 1, 2000 up to September 1, 2012 of 'the Cochrane Library', 'Pubmed Medline', 'EMbase', and 'Google Scholar' were explored using the combination of the following search-terms and Boolean operators: syndesmo* OR tibiofibular AND ankle OR distal fibula AND screw.

In addition, the reference lists of all identified articles were reviewed to find additional publications. Only full text studies were included. Each manuscript was reviewed by two observers (TS, JPL) and was found eligible when it concerned (1) the treatment of ankle fractures with concomitant acute syndesmotic disruption, (2) use of a rigid syndesmotic fixation (e.g., bolt, metallic or bioabsorbable screw) as a surgical technique, (3) reported aftercare strategy in the manuscript or after contacting the corresponding author, (4) reporting of a commonly used functional outcome score, (5) at least 25 patients included in the study, and (6) mean follow-up of at least twelve months.

The data extracted per included study were the number of patients, the duration of follow-up (months), the type of aftercare (immobilization for at least six weeks versus early motion within two weeks), the type of outcome scoring system, and the mean number of points with standard deviation (SD) if available. Only those scoring systems were analyzed that were used both in one or more immobilized studies and in functional aftercare studies. If an article made a comparison between two subgroups (e.g., metallic versus bioabsorbable, intact/broken/removed screws, or anatomical versus malreduced fibula in the tibial incisura) the individual scores were reported.

Results

Twenty-three studies were excluded because of one or more of the reasons described in the method section [11-33]: 1. No outcome score was used [11-17]; 2. use of an infrequently applied outcome score [18-20], a modified score [21-22], or reporting results only as satisfactory [23], making comparison impossible; 3. No information on aftercare could be obtained [24]; 4. Less than 25 patients were described [16, 20, 25-31], or 5. The mean follow-up was less than 12 months [11, 13, 21, 32], 6. Same study population as in a long-term follow-up study [33].

A total of nine studies that fulfilled the inclusion criteria were identified with 531 patients (Table 1). The number of included patients ranged from 28 to 93. The reported duration of follow-up per study varied between 12 and 101 months. Three studies used an early motion protocol (195 patients), with in two cases a splint for two weeks or less for wound protection. Six studies (336 patients) immobilized for at least six weeks. The scores used in both early motion and immobilization patients were the American Orthopaedic Foot Ankle Society Hindfoot score (AOFAS), the Olerud-Molander Ankle Score (OMAS), and the Short Musculoskeletal Function Assessment questionnaire (SMFA) [34-41].

The mean outcome scores and SD (if available) for the individual studies are presented in Figure 1. For the AOFAS the mean scores for immobilization were 86 to 91 points and for early motion 84 to 89. For the OMAS the scores for immobilization were 47 to 90 and for early motion 46 to 82 points. The SMFA scores for immobilization were 11 and for early motion they ranged between 12 and 27 points. No apparent difference in outcome could be detected for studies using an immobilization versus early motion protocol.

Discussion

The aim of this review study was to determine which aftercare would give the best functional results at follow-up following the fixation of an ankle fracture with acute distal tibiofibular syndesmotom rupture using a syndesmotom screw. Considering the AOFS, OMAS, and the SMFA there was no apparent difference in outcome between immobilization and early motion. The small differences detected were much smaller than the SD's available per score (AOFAS 11.6-13.6; OMAS 4.9-28.5; SMFA 10.6-23.3). This might imply that these small differences were probably not statistically significant nor clinically relevant.

We realize that several biases are present in the current review. A systematic review is as strong as the weakest included study, which means that the current study provides Level-4 evidence. Selection bias might have been introduced upon including some and excluding other studies. We tried to minimize this using a thorough literature search and strict inclusion criteria of studies with sufficient follow-up and number of patients.

Thomas *et al.* performed a meta-analysis including nine randomised studies comparing immobilization and early motion following operative treatment of ankle fractures. [42]. Three studies reported the inclusion of patients treated for syndesmotom instability [43-45]. The other studies excluded syndesmotom injuries or did not report including them. In this meta-analysis [42] only at short-term follow-up an improved range of motion was seen in the early motion group, but no difference in outcome, nor a difference in range of motion after one year could be detected. However, the early motion group showed a four-fold increase in wound complications, which was a statistically significant difference. Most studies included in the current review did not report on post-operative wound complications, making comparison impossible.

Because of the trapezoid shape of the talus, the fibula and tibia move in relation to each other at the level of the syndesmosis with every full range of motion at the ankle joint, which eventually leads (in case of a retained syndesmotic screw) to breakage in 7 to 29 percent of cases [12-13, 18, 21, 33, 36]. In case of early breakage or loosening recurrent syndesmotic diastasis might occur, which is also seen in 6.6 -15.8 percent with premature screw removal between six to eight weeks [19, 46]. This supports the idea of temporary immobilization. Whether or not protected weightbearing leads to early loosening or breakage is not known [47-49]. Other possible benefits from temporary immobilization are the prevention of ankle equinus deformity in patients who are less able to follow exercise protocols. Secondly temporary immobilization might prevent against secondary dislocation in less cooperative patients. How long this immobilization should be is unknown, as a prolonged immobilization (beyond six weeks) in operatively treated patients with ankle fractures can cause less favorable outcome [50].

The treatment of acute syndesmotic injuries knows many different strategies and for most sub-items (e.g., screw diameter, number of cortices, or level of insertion) of the overall treatment no standardization is available. Several studies using questionnaires [1, 51-53] have shown this, and the variety in aftercare protocols for all included studies in the current review supports this.

Probably more important than the way the screw is placed, what type is used, or how the aftercare is performed, is reducing the fibula in an anatomical position in the incisura fibularis of the tibia and avoiding complications [37, 39]. As these factors negatively influences outcome and are influenced by the surgeon.

In conclusion, this review shows there is little difference in function outcome scores between immobilization versus early motion following the treatment of ankle fracture with concomitant syndesmotic injury.

References

1. Schepers, T., et al., *The management of acute distal tibio-fibular syndesmotic injuries: Results of a nationwide survey*. Injury, 2012. **43**(10): p. 1718-23.
2. Ramsey, P.L. and W. Hamilton, *Changes in tibiotalar area of contact caused by lateral talar shift*. J Bone Joint Surg Am, 1976. **58**(3): p. 356-7.
3. Thordarson, D.B., et al., *The effect of fibular malreduction on contact pressures in an ankle fracture malunion model*. J Bone Joint Surg Am, 1997. **79**(12): p. 1809-15.
4. Harris, J. and L. Fallat, *Effects of isolated Weber B fibular fractures on the tibiotalar contact area*. J Foot Ankle Surg, 2004. **43**(1): p. 3-9.
5. Huber, T., W. Schmoelz, and A. Bolderl, *Motion of the fibula relative to the tibia and its alterations with syndesmosis screws: A cadaver study*. Foot Ankle Surg, 2012. **18**(3): p. 203-9.
6. Hubbard, T.J. and C.A. Hicks-Little, *Ankle ligament healing after an acute ankle sprain: an evidence-based approach*. J Athl Train, 2008. **43**(5): p. 523-9.
7. Oryan, A., A. Moshiri, and A.H. Meimandi-Parizi, *Short and long terms healing of the experimentally transverse sectioned tendon in rabbits*. Sports Med Arthrosc Rehabil Ther Technol, 2012. **4**(1): p. 14.
8. Shimizu, T., et al., *Experimental study on the repair of full thickness articular cartilage defects: effects of varying periods of continuous passive motion, cage activity, and immobilization*. J Orthop Res, 1987. **5**(2): p. 187-97.
9. Vanwanseele, B., E. Lucchinetti, and E. Stussi, *The effects of immobilization on the characteristics of articular cartilage: current concepts and future directions*. Osteoarthritis Cartilage, 2002. **10**(5): p. 408-19.
10. Iqbal, K., Y. Khan, and L.A. Minhas, *Effects of immobilization on thickness of superficial zone of articular cartilage of patella in rats*. Indian J Orthop, 2012. **46**(4): p. 391-4.
11. Mendelsohn, E.S., et al., *The Effect of Obesity on Early Failure after Operative Syndesmosis Injuries*. J Orthop Trauma, 2012.
12. Hamid, N., et al., *Outcome after fixation of ankle fractures with an injury to the syndesmosis: the effect of the syndesmosis screw*. J Bone Joint Surg Br, 2009. **91**(8): p. 1069-73.
13. Moore, J.A., Jr., et al., *Syndesmosis fixation: a comparison of three and four cortices of screw fixation without hardware removal*. Foot Ankle Int, 2006. **27**(8): p. 567-72.
14. Kukreti, S., A. Faraj, and J.N. Miles, *Does position of syndesmotic screw affect functional and radiological outcome in ankle fractures?* Injury, 2005. **36**(9): p. 1121-4.
15. Kaukonen, J.P., et al., *Fixation of syndesmotic ruptures in 38 patients with a malleolar fracture: a randomized study comparing a metallic and a bioabsorbable screw*. J Orthop Trauma, 2005. **19**(6): p. 392-5.
16. Heim, D., V. Schmidlin, and O. Ziviello, *Do type B malleolar fractures need a positioning screw?* Injury, 2002. **33**(8): p. 729-34.
17. Thordarson, D.B., et al., *Bioabsorbable versus stainless steel screw fixation of the syndesmosis in pronation-lateral rotation ankle fractures: a prospective randomized trial*. Foot Ankle Int, 2001. **22**(4): p. 335-8.
18. Bell, D.P. and M.K. Wong, *Syndesmotic screw fixation in Weber C ankle injuries--should the screw be removed before weight bearing?* Injury, 2006. **37**(9): p. 891-8.
19. Hsu, Y.T., et al., *Surgical treatment of syndesmotic diastasis: emphasis on effect of syndesmotic screw on ankle function*. Int Orthop, 2011. **35**(3): p. 359-64.
20. Sproule, J.A., et al., *Outcome after surgery for Maisonneuve fracture of the fibula*. Injury, 2004. **35**(8): p. 791-8.
21. Cottom, J.M., et al., *Transosseous fixation of the distal tibiofibular syndesmosis: comparison of an interosseous suture and endobutton to traditional screw fixation in 50 cases*. J Foot Ankle Surg, 2009. **48**(6): p. 620-30.

22. Kennedy, J.G., et al., *Evaluation of the syndesmotom screw in low Weber C ankle fractures*. J Orthop Trauma, 2000. **14**(5): p. 359-66.
23. Kabukcuoglu, Y., et al., *The ANK device: a new approach in the treatment of the fractures of the lateral malleolus associated with the rupture of the syndesmosis*. Foot Ankle Int, 2000. **21**(9): p. 753-8.
24. Karapinar, H., et al., *Effects of three- or four-cortex syndesmotom fixation in ankle fractures*. J Am Podiatr Med Assoc, 2007. **97**(6): p. 457-9.
25. Hovis, W.D., et al., *Treatment of syndesmotom disruptions of the ankle with bioabsorbable screw fixation*. J Bone Joint Surg Am, 2002. **84-A**(1): p. 26-31.
26. Mohammed, R., S. Syed, and S.A. Ali, *Evaluation of the syndesmotom-only fixation for Weber-C ankle fractures associated with syndesmotom injury*. Injury Extra, 2010. **41**: p. 185.
27. Thornes, B., et al., *Suture-button syndesmosis fixation: accelerated rehabilitation and improved outcomes*. Clin Orthop Relat Res, 2005(431): p. 207-12.
28. Pakarinen, H.J., et al., *Syndesmotom fixation in supination-external rotation ankle fractures: a prospective randomized study*. Foot Ankle Int, 2011. **32**(12): p. 1103-9.
29. Rao, S.E., S. Muzammil, and K. A.H., *Syndesmosis fixation in bimalleolar Weber C ankle fractures; comparison of 3.5 and 4.5-mm screws*. Prof Med J, 2008. **15**: p. 49-53.
30. Rao, S.E., S. Muzammil, and K. A.H., *Technique of syndesmotom screw insertion in weber C ankle fractures*. J Surg Pak, 2009. **14**: p. 58-62.
31. Coetzee, J.C. and P. Ebeling, *Treatment of syndesmoses disruptions: A prospective, randomized study comparing conventional screw fixation vs TightRope® fiber wire fixation-medium term results*. SA Orthop J, 2009. **8**: p. 32-37.
32. Miller, A.N., et al., *Functional outcomes after syndesmotom screw fixation and removal*. J Orthop Trauma, 2010. **24**(1): p. 12-6.
33. Hoiness, P. and K. Stromsoe, *Tricortical versus quadricortical syndesmosis fixation in ankle fractures: a prospective, randomized study comparing two methods of syndesmosis fixation*. J Orthop Trauma, 2004. **18**(6): p. 331-7.
34. Ahmad, J., et al., *Bioabsorbable screw fixation of the syndesmosis in unstable ankle injuries*. Foot Ankle Int, 2009. **30**(2): p. 99-105.
35. De Vil, J., et al., *Bolt fixation for syndesmotom injuries*. Injury, 2009. **40**(11): p. 1176-9.
36. Manjoo, A., et al., *Functional and Radiographic Results of Patients with Syndesmotom Screw Fixation: Implications for Screw Removal*. Journal of Orthopaedic Trauma, 2010. **24**(1): p. 2-6.
37. Sagi, H.C., A.R. Shah, and R.W. Sanders, *The Functional Consequence of Syndesmotom Joint Malreduction at a Minimum 2-Year Follow-Up*. Journal of Orthopaedic Trauma, 2012. **26**(7): p. 439-443.
38. Sinisaari, I.P., P.M. Luthje, and R.H. Mikkonen, *Ruptured tibio-fibular syndesmosis: comparison study of metallic to bioabsorbable fixation*. Foot Ankle Int, 2002. **23**(8): p. 744-8.
39. Weening, B. and M. Bhandari, *Predictors of functional outcome following transsyndesmotom screw fixation of ankle fractures*. J Orthop Trauma, 2005. **19**(2): p. 102-8.
40. Wikeroy, A.K., et al., *No difference in functional and radiographic results 8.4 years after quadricortical compared with tricortical syndesmosis fixation in ankle fractures*. J Orthop Trauma, 2010. **24**(1): p. 17-23.
41. Egol, K.A., et al., *Outcome after unstable ankle fracture: effect of syndesmotom stabilization*. J Orthop Trauma, 2010. **24**(1): p. 7-11.
42. Thomas, G., H. Whalley, and C. Modi, *Early mobilization of operatively fixed ankle fractures: a systematic review*. Foot Ankle Int, 2009. **30**(7): p. 666-74.
43. Cimino, W., D. Ichertz, and P. Slabaugh, *Early mobilization of ankle fractures after open reduction and internal fixation*. Clin Orthop Relat Res, 1991(267): p. 152-6.

44. Egol, K.A., R. Dolan, and K.J. Koval, *Functional outcome of surgery for fractures of the ankle. A prospective, randomised comparison of management in a cast or a functional brace.* J Bone Joint Surg Br, 2000. **82**(2): p. 246-9.
45. Finsen, V., et al., *Early postoperative weight-bearing and muscle activity in patients who have a fracture of the ankle.* J Bone Joint Surg Am, 1989. **71**(1): p. 23-7.
46. Schepers, T., et al., *Complications of syndesmotic screw removal.* Foot Ankle Int, 2011. **32**(11): p. 1040-4.
47. Beumer, A., et al., *Screw fixation of the syndesmosis: a cadaver model comparing stainless steel and titanium screws and three and four cortical fixation.* Injury, 2005. **36**(1): p. 60-4.
48. Gardner, R., et al., *Stabilisation of the Syndesmosis in the Maisonneuve Fracture - a Biomechanical Study Comparing Two-Hole Locking Plate and Quadricortical Screw Fixation.* J Orthop Trauma, 2012.
49. Stewart, C., et al., *Axial load weightbearing radiography in determining lateral malleolus fracture stability: a cadaveric study.* Foot Ankle Int, 2012. **33**(7): p. 548-52.
50. Van Schie-Van der Weert, E.M., et al., *Determinants of outcome in operatively and non-operatively treated Weber-B ankle fractures.* Arch Orthop Trauma Surg, 2012. **132**(2): p. 257-63.
51. Bava, E., T. Charlton, and D. Thordarson, *Ankle fracture syndesmosis fixation and management: the current practice of orthopedic surgeons.* Am J Orthop (Belle Mead NJ), 2010. **39**(5): p. 242-6.
52. Monga, P., et al., *Management of distal tibio-fibular syndesmotic injuries: a snapshot of current practice.* Acta Orthop Belg, 2008. **74**(3): p. 365-9.
53. Wood, G.C.A. and Y.A. Feldman, *Indications and use of the ankle syndesmosis screw: a multi-regional survey.* Foot and Ankle Surgery, 2004. **10**: p. 65-69.

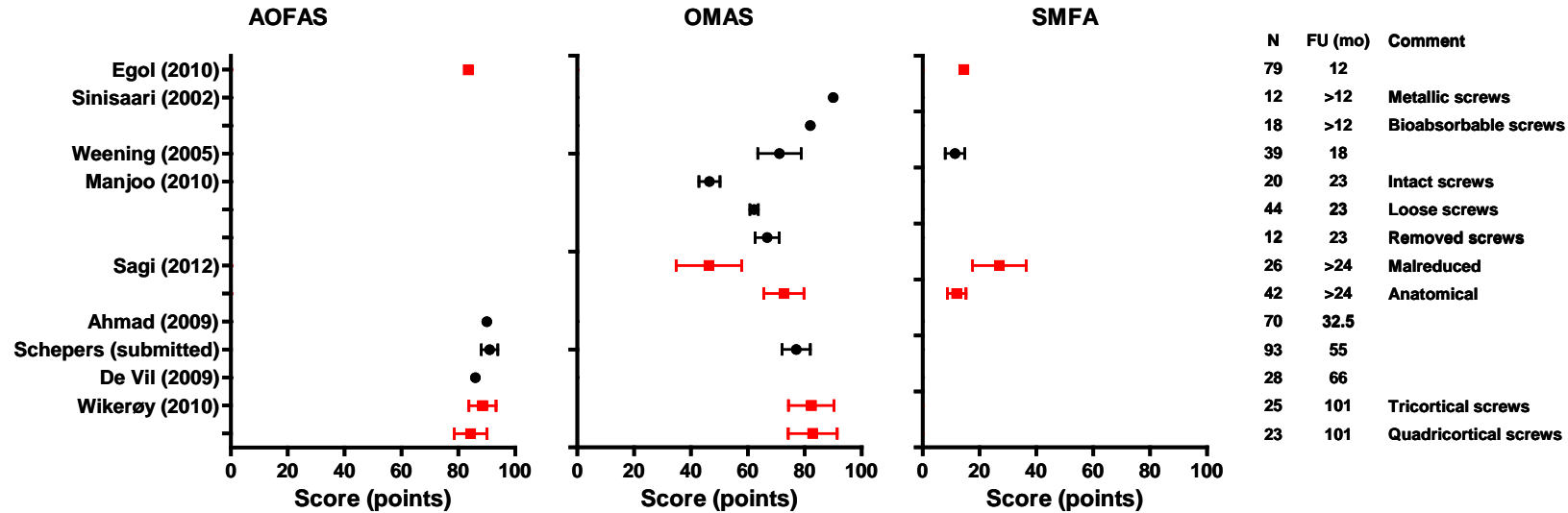
Table 1. Included studies on syndesmotic injury treatment and their aftercare protocol

Study (year)	Patients	Screw characteristics ¹	Mean follow-up (months)	Aftercare	Score (max)	Mean score (range/SD)
Sinisaari (2002) [38]	12		> 12	Immobilization	OMAS (100)	90 (70-100)
	18	Absorbable		BKC 6w, WB after 4w		82 (25-100)
Weening (2005) [39]	39		18	Immobilization	OMAS (100)	74.1±23.4
				NWB cast/boot 6-12w ²	SMFA (0)	11.4±10.6
Ahmad (2009) [34]	70	Absorbable	32.5	Immobilization	AOFAS (100)	90 (44-100)
			(range 12 - 74)	Boot. NWB 6w, PWB 6w		
De Vil (2009) [35]	28	Bolt	66	Immobilization	AOFAS (100)	86 (33-100)
			(range 24 - 139)	NWB BKC 6w		
Egol (2010) [41]	79		12	Early mobilization	AOFAS (100)	83.5
				NWB 8-10w; cast 1-1.5w, functional brace	SMFA (0)	14.5
Manjoo (2010) [36]	20	Intact	23	Immobilization	OMAS (100)	46.5±7.9
	44	Fractured or loose	(range 12-32)	NWB BKC 6w, FWB in boot		62.2±4.9
	12	Removed				66.8±6.7
Wikerøy (2010) [40]	25	Tricortical	101	Early mobilization	OMAS (100)	82.3±19.4
			(range 92-107)	PWB 6w, FWB after 8w	AOFAS (100)	88.5±11.6
	23	Quadricortical				82.8±19.9
Sagi (2012) [37]	26	Malreduced	> 24	Early mobilization	SMFA (0)	27±23.3
				Splint 2w; NWB 10w, FWB after 12w ²	OMAS (100)	46.3±28.5
	42	Anatomical				12±10.6
Schepers (submitted)	93		55	Immobilization	AOFAS (100)	91±14 (19-100)
			(range 19-102)	Splint 2w; NWB cast 4w, FWB after 6w	OMAS (100)	77±24 (5-100)*

NWB, Non Weight Bearing; PWB, Partial Weight Bearing; FWB, Full Weight Bearing; BKC, Below Knee Cast; AOFAS, American Orthopaedic Foot Ankle Society Hindfoot score; OMAS, Olerud-Molander Ankle Score; SMFA, Short Musculoskeletal Function Assessment

¹ In case of specific screw-characteristics as mentioned in the manuscript; ² Personal communication

Figure 1. Forest plot for the AOFAS, OMAS, and SMFA score in order of follow-up duration



Data are shown as mean score with 95% confidence interval

Black line, immobilization; Red line, functional aftercare

AOFAS, American Orthopaedic Foot Ankle Society Hindfoot score; OMAS, Olerud-Molander Ankle Score; SMFA, Short Musculoskeletal Function Assessment; N, number of patients; FU, Follow-up