Trends in Managing Ankle Fracture with Diastasis. Radiological Assessment

Adnan Abdilmajjed Faraj, FRCS (Orth&Tr.) Consultant Orthopaedic surgeon

James Ricketts MB.Ch.B, Core training year 1 doctor, UK.

Orthopaedic department, Scarborough Hospital, Woodland Drive, Scarborough, UK, YO12 6QL

Abstract:

Introduction: There are many controversial issues in the management of high fibular ankle fractures. The aim of current study to compare treatment options.

Material and Methods: Ninety patients with high fibular ankle diastasis fractures were treated in the York and Scarborough NHS Trust between 2011-2014. The reviews included assessment of the radiographs on the patient archiving and communication system (PACS) and the patient's notes using Core patient data base (CPD). Mean follow up period was of 2.9 years.

Results: Eighty two patients, who sustained Weber C ankle fractures, underwent open reduction and internal fixation of fibula, in 8 patients with high fibular fracture, only diastasis screw was used without plate fixation.

Those who have had lateral malleolar fracture fixation required additional diastasis fixation in 51 patients (57%). The methods of diastasis fixation, was with using a screw passed through fibular plate (55%), or using a screw without plate fixation (15%) and using tight rope fixation.

When a screw was used for diastasis fixation, the screw was passed through 3 cortices (80%); in the remaining the screw fixed four cortices.

The average distance of the diastasis screws from the tibial plafond articular surface was 2.39 cm.

Eighteen diastasis screws were removed at an average time of 31 weeks' post-surgery.

Conclusion: Radiological improvement following surgery for Weber C ankle fracture was within the accepted variations, there was no difference between tight rope and screw syndesmotic fixation. Diastasis screws can be keeping without removing especially when tricortical fixation is used and the screws inserted just above syndesmosis. Only (50%) of unstable ankle fracture required diastasis fixation.

Keywords: Diastasis, Ankle, Weber c, Fixation, Tightrope.

Introduction:

Approximately one in seven ankle fractures is accompanied by a distal tibiofibular syndesmotic disruption. When, after stable fixation of the fractured malleoli, persistent instability of the distal tibiofibular joint is identified perioperatively, additional stabilization is indicated. In most cases the syndesmotic ligaments are left untouched and a so-called 'syndesmotic positioning screw' is placed to restore and maintain a congruent mortise [(1)].

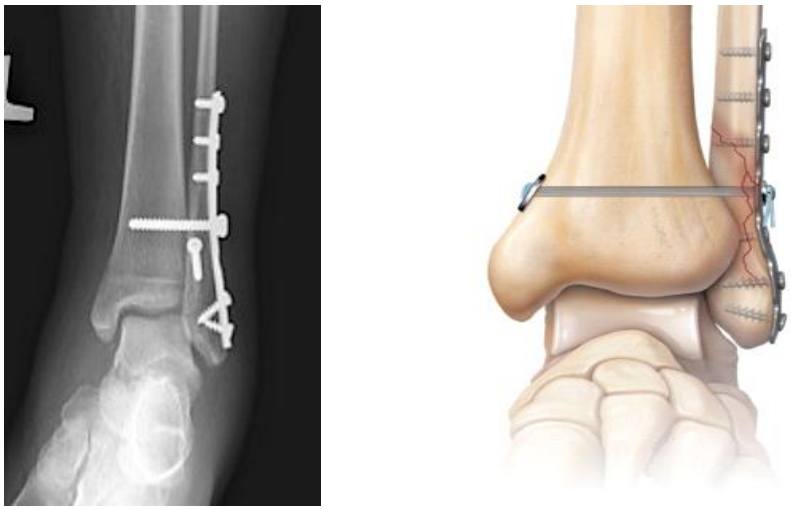

Figure (1): diastasis screw fixation using tricortical screw trhough the plate or using right rope.

The theoretical and technical aspects of syndesmotic screw placement have been subject to numerous clinical and biomechanical investigations, in an attempt to solve some of the controversies concerning syndesmotic screw usage. A 4.5-mm screw apparently provides greater resistance to shear stress than a 3.5-mm screw [(2)]; however, this does not implicate a biomechanical advantage. The level of placement probably does not affect outcome, three-cortical versus four-cortical screw placement does not affect biomechanical stability or influence outcome [(3, 4, 5, 6)].

Two syndesmotic screws provide more stability than one [(7)], which seems beneficial in more proximal fibular (Dupuytren and Maisonneuve) fractures and neuropathic fracture dislocation in the diabetic patient [(8)]. Bioabsorbable screws are biomechanically and clinically equivalent to stainless steel syndesmotic screws [(8, 9, 10, 11, 12, 13)]. The use of a suture device seems to provide equal [(14)] or improved [(15)] outcome compared to a four-cortical syndesmotic screw. The position of the foot during insertion of the syndesmotic screw does not influence the range of motion or outcome [(16, 17, 18, 19)]. Finally, based on CT scanning, (16-52%) of syndesmoses are not reduced anatomically [(20, 21)], which will most likely negatively affect outcome [(22)].

Proponents of the policy removing diastasis screw state that tibiofibular movement is affected by leaving the screw in place and dorsiflexion is hampered [(23)], to save the patient another operation with its complications however, there are opponents to this concept and prefer removing the syndesmotic screw prior to weight-bearing at 6–8 weeks [(24)].

The aim of the current paper is to study the pattern of ankle diastasis, the trend in its management and the removal of the diastasis screw if used.

Methods:

Between January 2011 and July 2014, 94 patient sustaining ankle fractures with diastasis were included in this study. Four patients were excluded from the study; one with bilateral injury, and three patients with complex tibio-fibular Pilon type injuries. The study was conducted in Scarborough Hospital, North Yorkshire, UK. The patients were

surgically treated in York-Scarborough Hospital. The medial malleolar fracture is fixed using two parallel malleolar screws and the lateral fibular fracture were treated using a neutralization one third tubular or locking (osteopenic bone) plate, augmented by interfragmentary screw(s) fixation when possible. In cases of diastasis, transfibular screws were inserted through the plate. Postoperative policy was to keep the patient non weight bearing in plaster of Paris or fibre glass for a total period on 6 weeks; the wound was checked two weeks after surgery, where the cast is changed. *Demographic data and clinic notes retrieved from PACS*. The radiographic analysis of the x-ray and the electronic medical records of all these patients were reviewed.

The type of the fracture was classified according to AO classification (ref). The radiographs taken were anteroposterior, lateral, sometimes mortice views. The fractures were all Weber C fractures. X-rays reviewed on PACS. Radiographs taken for these patients were on admission, at time of review following the removal of cast in the fracture clinic review, and at time of syndesmosis screw removal (if removed).

Radiographic assessment aimed at measuring the ankle mortice, fibular shortening and overall reduction, figure (2). This radiological assessment is well documented in literature.

Plain anteroposterior radiograph of the ankle with ankle mortice disruption, demonstrating different radiographic analysis used in this paper. Tibio- fibular clear space (a) (≤6mm), Ti b fib overlap (b) (1-10mm), Medial mortise width (e) (4-5 mm), Talocrural angle (d) (8-15º) and Talar tilt angle (c) (0-5º).

Results:

The radiographs and medical notes were reviewed by the authors. Average follow up of our patients was 2.9 years (1.1 – 5.03). Average age 44.7 (16-91). There were 40 male and 50 female patients. The right ankle was broken in 42 patients and the left in 48 patients,

Radiographic analysis of the ankle fracture according to AO classification:

- AO- C1: Forty-one patients sustained AO1 fracture with mean age of 45.6 (16-91), 17 males and 24 female patients. The left ankle was affected in 24 patients, the right in 17. The AO1 classification was Lauge-Hansen pronation external rotation grade 3 in 27 patients and Lauge-Hansen pronation external rotation grade 4 in 14.

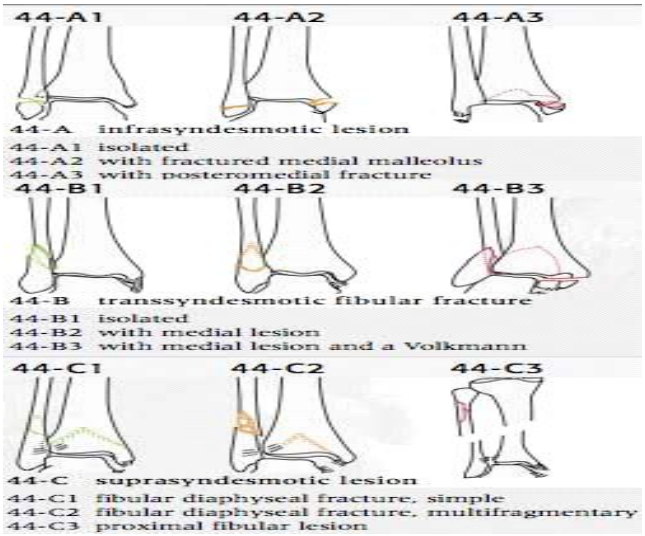

Figure (3): AO classification of ankle fracture.

- The following procedures were performed:
- Open reduction using fibular plate and screw fixation in 37 patients, no plate was used in four patients. Fibular fracture lag screws were used in 26 patients; no lag screw was used in 15 patients.
- Syndesmotic fixation was performed in only 21 patients, in eight patient's tightrope (in three patients, two tight ropes) were used and cortical screw was used in 13 patients. The average screw placement above the tibial articular line was 2.26 cm (1.1 – 5.2 cm). In two patients, two syndesmotic screws were used.
- The tight ropes were left, 5 diastasis screws among the 13 were removed, among which there were 3 broken screws; none of these patients were symptomatic.

AO C-2:

Forty-eight patients sustained AO2 fracture with mean age of 44.2 (17-85), 22 male and 26 female patients. The left ankle was affected in 2 patients, the right in 25. The AO3 classification was Lauge-Hansen pronation external rotation grade 3 in 24 patients and Lauge-Hansen pronation external rotation grade 4 in 24.

The following procedures were performed:

- Open reduction using fibular plate and screw fixation in 40 patients, no plate was used in eight patients. Lag screws were used in fibular fracture fixation in 14 patients; no lag screw was used in 34 patients.
- Syndesmotic fixation was performed in only 29 patients (in seven patient's tightrope (1 x 2) was used and cortical screw was used in 22 patients. The average screw placement above the tibial articular line was 2.7 cm (1.2-3.4 cm). Five patients had two parallel syndesmotic screws.
- Twelve syndesmotic screws were removed, out of which 11 screws were broken, none was symptomatic.

AO C 3:

A thirty-one years old male patient sustained AO3 (grade 3) fracture. One syndesmotic screw was inserted 2.2cm above the tibial articular surface; the screw was not removed table (1).

The reasons for plate metal work removal; in 7 the cause was not documented, in one there was screw loosening, three patients had broken screw/ plate, two patients underwent implants removal because of tenderness over screw (1), one had infection and two patients who had ankle stiffness and with altered sensation. One patient had plate impingement.

Table (1): The radiologic assessment of preoperative and postoperative readings in both AO C1-2 paients were as follows.

C1	OVERALL	Tib-fib Clear space (up to 6 mm)	Overlap (1 up to 10 mm)	Medial mortise (up to 4-5 mm)	Talocrural angle 8-15^0	Talar tilt up to 5^0
	Pre, n = 41	6.5 (2.8 – 15.2)	1.4 (-9.6 – 9)	5.7 (2.5 – 13.8)	9.4 (1.3 – 17.5)^o	2.6 (0.3 – 6.9)^o
	Post, n = 38	5.1 (2.6 – 10.5)	3.3 (-3.7 – 7.9)	2.9 (0.6 – 5)	11.7 (0.6 – 21.5)^o	1.6 (0.1 – 4.4)^o
	Screw, n = 3 (5 total)	4.1 (3.1 – 5.1)	1.3 (0 – 2.3)	3.9 (2.7 – 5.2)	9.1 (3.8 - 13.3)^o	5.4 (1.6 – 12.8)^o
C2						
	Pre, n = 48	6.8 (2.9 – 11.9)	1.8 (-4.9 – 8.5)	6.1 (1.4 – 6.1)	6.8 (0.5 – 15.6)	3.3 (0.1 – 12.6)
	Post, n =	4.9 (2 – 8.6)	2.9 (-3.7 – 7.8)	3.4 (1.7 – 6.9)	10.6 (3.1 – 18.5)	1.8 (0.0 – 7.4)
	Screw, n =	5.4 (4.1 – 6.7)	2.1 (0.0 – 7.5)	4.0 (2.4 – 6.5)	13.0 (6.0 – 15.8)	1.4 (0.1 – 4.7)
C3						
	Pre, n = 1	7.2	2.2	4.6	10.3	3.1
	Post, n = 1	6.5	1.2	4.9	7.9	4.8

Table (2): Complications encountered.

Complication	Syndesmosis screw, n = 36	Tightrope, n = 15	Neither, n = 39
Screw loosening	1 (2.8%)	0	0
Syndesmosis screw broke	5 (13.9%)	0	0
Paraesthesia	4 (11.1%)	0	2 (5.1%)
Pain over metalwork	5 (13.9%	2 (13.3%)	5 (13.0%)
Infection	1 (2.8%)	0	4 (10.2%)
Osteopenia	2 (5.6%)	0	0
Stiffness/ Reduced ROM	3 (8.3%)	1 (6.7%)	1 (2.6%)
Persistent swelling	3 (8.3%)	1 (6.7%)	3 (7.7%)
Ankle impingement	1 (2.8%)	0	0
Scar pain	0	0	1 (2.6%)

Discussion:

The current paper investigates the radiological changes following surgery for high fibular fracture. Although the literature recommends diastasis screw fixation in all patients, only 51 out of 90 patients in this series underwent diastasis screw fixation, with good outcome in both groups.

There have been concerns about removal of diastasis screws and its impact on the radiological changes. In a study on 166 mature patients with ankle fractures with syndesmotic disruption undergoing fixation with diastasis screw, which eventually was removed at mean period of 3 months following surgery, the mortice remained intact when the screw(s) were removed. Radiographic assessment at this stage showed a slightly lower tibia-fibula overlap (OL) of less than 1mm and slightly greater tibia-fibula clear space (CS) of 0.5mm compared to when the screw was retained [25]. In the current study, the mean tibiofibular overlap following diastasis screw removal (at a mean duration following surgery of seven months); the tibiofibular overlap was slightly reduced; however the tibiofibular clear space remained the same. The medial clear space in AO-C2 fracture was slightly increased from a mean of 4.9 to 5.4 mm. Patients with broken screws were asymptomatic. There seem to be a case for using tightropes for the fact that, there is no need for its removal.

We agree with other authors that there are no differences in functional outcomes comparing loose or fractured screws with removed screws [26]. In a comprehensive literature search was conducted in the electronic databases of the Cochrane Library, PubMed Medline and EMbase from January 2000 to October 2010. A total of seven studies were identified in the literature. Studies found no difference in outcome between retained or removed screws. Patients with screws that were broken, or showed loosening, had similar or improved outcome compared to patients with removed screws. Removal of the syndesmotic screws, when deemed necessary, is usually not performed before 8–12 weeks [27].

Depending on the duration of follow-up, (7-29%) of syndesmotic screws left in place break, with no apparent difference between tricortical and quadricortical screws. However, synostosis might occur more frequently in quadricortical screws [26]. In a study by Heim et al., syndesmotic screws were placed tricortically and showed loosening in (91%) of the patients. Screw removal, when intact after 4-6 months, might be justified if the positioning screw gives rise to physical complaints, e.g., when dorsiflexion is hampered or outcome appears to be affected [26].

Only two out of 35 patients who underwent diastasis screw fixation had quadricortial fixation in this series, albeit the number is not equal, there was no difference in the outcome with tricortical screws, in this series.

We found no difference using tight rope compared to screw fixation, despite the concerns reported about possible soft tissue complications when tight rope is used [28, 29].

The limitations in this study are the lack of clinical assessment and outcome measure at the last period of follow-up. The medical notes however were reviewed for all patients.

Conclusion:

The radiological improvement following open reduction and internal fixation of Weber C fractures is evident in this study. The diastasis screw was inserted just above the inferior tibiofibular articulation; none of the patients with broken diastasis screw were symptomatic. Further studies can be performed comparing the fractured side to the normal side.

References:

[1]. Dattani R, Patnaik S, Kantak A, Srikanth B, Selvan TP. Injuries to the tibiofibular syndesmosis. J Bone Joint Surg Br. 2008; 90(4):405–410. doi: 10.1302/0301-620X.90B4.19750. [Cross Ref]

[2]. Hansen M, Le L, Wertheimer S, Meyer E, Haut R. Syndesmosis fixation: analysis of shear stress via axial load on 3.5-mm and 4.5-mm quadricortical syndesmotic screws. J Foot Ankle Surg. 2006; 45(2):65–69. doi: 10.1053/j.jfas.2005.12.004. [Cross Ref}

[3]. Thompson MC, Gesink DS. Biomechanical comparison of syndesmosis fixation with 3.5- and 4.5-millimeter stainless steel screws. Foot Ankle Int. 2000; 21(9):736–741.

[4]. Kukreti S, Faraj A, Miles JN. Does position of syndesmotic screw affect functional and radiological outcome in ankle fractures? Injury. 2005; 36(9):1121–1124. doi: 10.1016/j.injury.2005.01.014

[5]. Nousiainen MT, McConnell AJ, Zdero R, McKee MD, Bhandari M, Schemitsch EH. The influence of the number of cortices of screw purchase and ankle position in Weber C ankle fracture fixation. J Orthop Trauma. 2008; 22(7):473–478. doi:

[6]. Hoiness P, Engebretsen L, Stromsoe K. Soft tissue problems in ankle fractures treated surgically. A prospective study of 154 consecutive closed ankle fractures. Injury. 2003; 34(12):928–931. doi: 10.1016/S0020-1383(02)00309-1. [Cross Ref]7. Xenos JS, Hopkinson [7]. WJ, Mulligan ME, Olson EJ, Popovic NA. The tibiofibular syndesmosis. Evaluation of the ligamentous structures, methods of fixation, and radiographic assessment. J Bone Joint Surg Am. 1995; 77(6):847–856.

[8]. Thordarson DB. Ankle fractures in diabetics. Techn Foot Ankle Surg. 2004; 3(3):192–197. doi: 10.1097/01.btf.0000135273.06340.0f.

[9]. Cox S, Mukherjee DP, Ogden AL, Mayuex RH, Sadasivan KK, Albright JA, Pietrzak WS. Distal tibiofibular syndesmosis fixation: a cadaveric, simulated fracture stabilization study comparing bio-absorbable and metallic single screw fixation. J Foot Ankle Surg. 2005; 44(2):144–151. doi: 10.1053/j.jfas.2005.01.010.

[10]. Hovis WD, Kaiser BW, Watson JT, Bucholz RW. Treatment of syndesmotic disruptions of the ankle with bioabsorbable screw fixation. J Bone Joint Surg Am. 2002; 84-A (1):26–31.

[11]. Kaukonen JP, Lamberg T, Korkala O, Pajarinen J. 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):392–395. doi: 10.1097/01.bot.0000155313.50627.f6.

[12]. Sinisaari IP, Luthje PM, Mikkonen RH. Ruptured tibiofibular syndesmosis: comparison study of metallic to bioabsorbable fixation. Foot Ankle Int. 2002; 23(8):744–748.

[13]. Thordarson DB, Samuelson M, Shepherd LE, Merkle PF, Lee J. 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):335–338.

[14]. Cottom JM, Hyer CF, Philbin TM, Berlet GC. 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):620–630. doi: 10.1053/j.jfas.2009.07.013.

[15]. Thornes B, Shannon F, Guiney AM, Hession P, Masterson E. Suture-button syndesmosis fixation: accelerated rehabilitation and improved outcomes. Clin Orthop Relat Res. 2005; 431:207–212. doi: 10.1097/01.blo.0000151845.75230.a0.
[Cross Ref
[16]. Beumer A, Campo MM, Niesing R, Day J, Kleinrensink GJ, Swierstra BA. Screw fixation of the syndesmosis: a cadaver model comparing stainless steel and titanium screws and three and four cortical fixation. Injury. 2005; 36(1):60–64. doi: 10.1016/j.injury.2004.05.024.
[17]. Karapinar H, Kalenderer O, Karapinar L, Altay T, Manisali M, Gunal I. Effects of three- or four-cortex syndesmotic fixation in ankle fractures. J Am Podiatr Med Assoc. 2007; 97(6):457–459.
[18]. Moore JA, Jr, Shank JR, Morgan SJ, Smith WR. Syndesmosis fixation: a comparison of three and four cortices of screw fixation without hardware removal. Foot Ankle Int. 2006; 27(8):567–572.
[19]. Tornetta P, 3rd, Spoo JE, Reynolds FA, Lee C. Overtightening of the ankle syndesmosis: is it really possible? J Bone Joint Surg Am. 2001; 83-A (4):489–492.
[20]. Gardner MJ, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG. Malreduction of the tibiofibular syndesmosis in ankle fractures. Foot Ankle Int. 2006; 27(10):788–792.
[21]. Wikeroy AK, Hoiness PR, Andreassen GS, Hellund JC, Madsen JE. 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):17–23. doi: 10.1097/BOT.0b013e3181bedca1.
[22]. Bragonzoni L, Russo A, Girolami M, Albisinni U, Visani A, Mazzotti N, Marcacci M. The distal tibiofibular syndesmosis during passive foot flexion. RSA-based study on intact, ligament injured and screw fixed cadaver specimens. Arch Orthop Trauma Surg. 2006; 126(5):304–308. doi: 10.1007/s00402-006-0131-8.
[23]. Egol KA, Pahk B, Walsh M, Tejwani NC, Davidovitch RI, Koval KJ. Outcome after unstable ankle fracture: effect of syndesmotic stabilization. J Orthop Trauma. 2010; 24(1):7–11. doi: 10.1097/BOT.0b013e3181b1542c.
[24]. Miller AN, Paul O, Boraiah S, Parker RJ, Helfet DL, Lorich DG. Functional outcomes after syndesmotic screw fixation and removal. J Orthop Trauma. 2010; 24(1):12–16. doi: 10.1097/BOT.0b013e3181c6e199.
[25]. Mon. P, Kumar A, Simons A, Panikker V. Management of distal tibiofibular syndesmotic injuries: a snapshot of current practice. Acta Orthop Belg. 2008;74(3):365–369.
[26]. Gennis E, Koenig S, Rodericks D, Otlans P, Tornetta P 3rd.The Fate of the Fixed Syndesmosis Over Time. Foot Ankle Int. 2015 Oct;36(10):1202-8.
[27]. Manjoo A, Sanders DW, Tieszer C, MacLeod MD. Functional and radiographic results of patients with syndesmotic screw fixation: implications for screw removal. J Orthop Trauma. 2010 Jan;24(1):2-6. doi: 10.1097/BOT.0b013e3181a9f7a5.
[28]. Nousiainen MT, McConnell AJ, Zdero R, McKee MD, Bhandari M, Schemitsch EH. The influence of the number of cortices of screw purchase and ankle position in Weber C ankle fracture fixation. J Orthop Trauma. 2008; 22(7):473–478.
[29]. H.J.S. Willmott. B Singh, L.A. David. Outcome and complications of treatment of ankle diastasis with tightrope fixation. Injury**.** Injury, /2009; 40(11):1204-6. DOI: 10.1016/j.injury.2009.05.008.