



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

## Trauma Case Reports

journal homepage: [www.elsevier.com/locate/tcr](http://www.elsevier.com/locate/tcr)

## Case Report

Transverse Weber A fracture atrophic non-union. A single centre case series<sup>☆</sup>Lucy Amos<sup>\*</sup>, Eamon Ramhamadany, Richard Gadd, Carolyn Chadwick, Mark Davies

Department of Trauma and Orthopaedics, Northern General Hospital, Herries Road, Sheffield S5 7AU, UK

## ARTICLE INFO

## Keywords:

Non-union

Ankle fracture

Fibula blood supply

## ABSTRACT

**Introduction:** Weber A ankle fractures are isolated fibula fractures distal to the level of the ankle joint line. They are regarded as stable injuries that usually heal successfully without intervention. We have identified several patients that have developed symptomatic atrophic non-union of transverse Weber A fractures that are not simple avulsion fractures of the anterior talo-fibular ligament. We explored variations to the blood supply of the distal fibula as a potential cause of this rare complication.

**Cases:** Five patients presented with ongoing ankle pain following a period of non-operative management. All shared a similar transverse atrophic non-union fracture pattern.

Surgical management with open reduction and internal fixation with or without the use of bone graft achieved successful union and resolution of symptoms in all cases.

**Conclusions:** Atrophic fracture non-unions usually result from a disruption to the blood supply at the site of injury. The arterial supply to the distal fibula consists of a complex of arterial loops which usually enable fracture healing. However, there are anatomical variations to the blood supply that potentially could account for the rare outcome of non-union of Weber A fracture patterns. Weber A fractures are generally benign ankle fractures that heal well with non-operative treatment. No alterations should be made to the management of such injuries, but patients should be counselled about the risk of a symptomatic non-union outcome.

## Introduction

A Weber A ankle fracture is an isolated fibula injury distal to the tibial plafond. An avulsion fracture of the origin of the anterior talo-fibular ligament (ATFL) from the distal fibula is common following an inversion injury but is not regarded as a true Weber A fracture. In the absence of deltoid ligament injury, Weber A fibula fractures are considered stable and are typically treated non-operatively [1] with an elasticated support bandage, cast or walker boot, and go on to unite.

Conventionally, non-union is defined as complete absence of bone healing. Non-union can be hypertrophic, oligotrophic or atrophic in nature. Atrophic non-union usually results from a disruption to the blood supply or bone biology at the fracture site [1]. Non-union of distal fibula fractures are rare occurring in 0.3–5.4%, tending to occur either proximal to the level of the syndesmosis or with associated tibial fractures [2].

We identified several patients with symptomatic atrophic non-union of Weber A fractures. For this study, we define these fractures

<sup>☆</sup> This work has not been presented in whole or in part at any meeting.

<sup>\*</sup> Corresponding author.

E-mail address: [lucy.amos@nhs.net](mailto:lucy.amos@nhs.net) (L. Amos).

<https://doi.org/10.1016/j.tcr.2021.100604>

Accepted 30 December 2021

Available online 4 January 2022

2352-6440/© 2021 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Table 1**  
Patient demographics, duration of symptoms and treatment.

Case	Age & gender	Side	Co-morbidities	Smoking status	Time to non-union	Operation	Time from operation to discharge
1	38F	Right	Nil	No	4 months	ORIF with plate and ipsilateral calcaneal bone grafting	3 months
2	28M	Left	Overweight	No	10 months	ORIF with compression screw and calcaneal bone grafting	3 months
3	45F	Right	Nil	No	3 months	ORIF with compression screw and neutralisation plate and supplementary iliac crest graft	1.5 months
4	20F	Right	Nil	No	8 months	ORIF with compression screw	2 months
5	46F	Left	Overweight	No	12 months	ORIF with two plates used in compression	3 months

as isolated fibula fractures distal to the level of the tibial plafond, not including simple avulsion fractures of the origin of the ATFL. We explore the variations in blood supply to the fibula to identify a potential explanation for this rare complication.

## Cases

Five cases of symptomatic Weber A fracture non-unions were seen (Table 1). These all occurred secondary to an inversion injury. All patients sustained a transverse fracture of the distal fibula that proceeded to non-union. All cases were initially managed non-operatively and allowed to bear weight in a walker boot. Despite this management, each patient continued experiencing ankle pain. Clinical examination and radiographs confirmed non-union (Fig. 1).

Given that each individual was symptomatic, further treatment with open reduction internal fixation (ORIF) was undertaken. Through a direct lateral approach, the non-union was identified and mobilised, the fracture ends freshened and reduced anatomically. Compression fixation was achieved using a plate, screw, or combination of both (Fig. 2). Adjunctive autologous bone graft was used in three cases. All progressed to full union after operative intervention and successfully discharged with resolution of symptoms.

## Discussion

Evidence suggests that infrasydesmotic injuries have favourable outcomes with non-operative treatment. However, up to one third of patients have ongoing pain or instability [2,3]. Khurana et al. reported 12 distal fibula fracture non-unions, all successfully treated with ORIF [4]. The fracture pattern was not specified. Our study specifically focussed on transverse Weber A fracture non-union.

### Possible anatomical considerations

Avulsion fractures of the distal fibula involving the origin of the ATFL are well documented [3]. These fractures show a small bony fragment anterior to the distal fibula metaphysis. Patients may present with ankle instability although some complain of discomfort. The larger fragments associated with a transverse fracture are less common. Non-union of the Weber A fractures seen in our case series is extremely rare and their management is infrequently reported [2]. Seven cases of these fibula non-unions have previously been reported, four treated with ORIF using compression screws and plates and three using a fibula nail [2,5–7].

Several causes of fracture non-unions have been implicated. Patient factors include smoking, diabetes and obesity. Inadequate blood supply, displacement and instability of the fracture are known risks [1,2]. Our series of patients are young, fit, non-smokers with no significant co-morbidities.

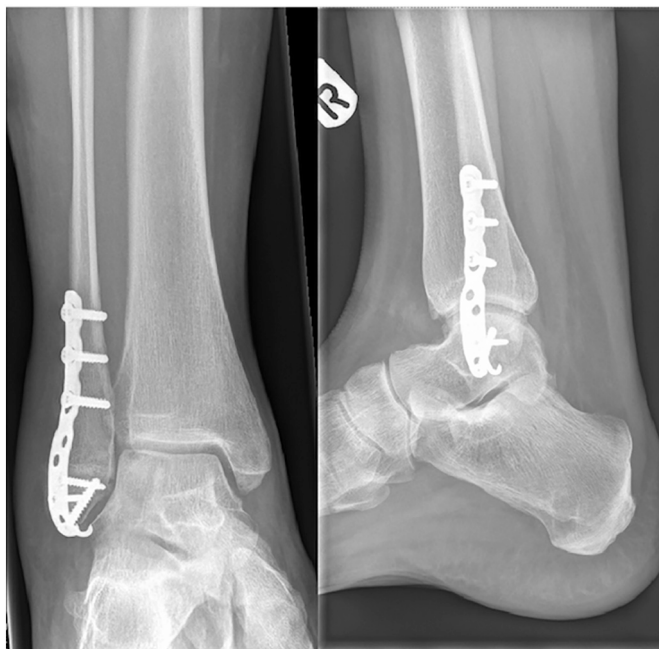
All cases in our series were atrophic non-unions. These are primarily caused by an inadequate blood supply to the fracture site [1]. Although the middle third of the fibula is well vascularised with nutrient and periosteal vessels, this supply diminishes distally [6,7]. If this is then disrupted following a fracture, there may be inadequate vascularization of the fracture, increasing the risk of non-union.

The blood supply to the distal fibula composes a complex of arterial loops. The anterior lateral malleolar artery (ALMA) plays an important role in vascularisation of the distal fibula. It arises from the anterior tibial artery (ATA), commonly below the level of the ankle joint and sends a transverse branch anteriorly to the lateral malleolus. It forms an anastomosis known as the lateral malleolar rete with the perforating peroneal artery (PPA), which arises from the peroneal artery (PA), and small retrograde branches of the lateral tarsal artery (LTA). This common arterial configuration provides a satisfactory blood supply for Weber A fracture healing [8,9] (Fig. 3).

However, studies [8,9] have highlighted anatomical variations of the vascular supply to the distal fibula. The ALMA can be injured during simple ankle sprains [8]. We propose that in two anatomic variants, disruption of the ALMA could be a causative factor for non-union in the transverse Weber A fractures. The ALMA can originate more proximally at the level of the ankle joint in 19% of patients,



Fig. 1. Anterior-posterior radiographs of the five cases of transverse Weber A fractures at non-union.



**Fig. 2.** Anterior-posterior radiographs of example of a united Weber A fracture following open reduction and internal fixation for non-union.

and in 8% is absent [9]. Therefore in 19% of individuals, if the ALMA arises proximal to the Weber A fracture, this could disrupt blood flow through the anastomosis to the distal fibula metaphysis and lead to non-union. In those individuals where the ALMA is absent, then there may be insufficient flow for bone healing [9] (Fig. 3).

Elliot et al. have challenged the perception that most non-unions are due to insufficient mechanical stability and that atrophic non-unions possess a satisfactory blood supply [10]. We believe that Weber A fractures are mechanically stable and thus unite in most cases. Mechanical instability alone cannot explain why a rare number of these fractures fail to unite. However, plating these non-unions during ORIF reduces the strain environment and thereby increases mechanical stability.

Conservative treatment is usually adequate and advised for stable Weber A fractures [1], particularly given surgical risks. However, once non-union is established and symptomatic, further intervention is likely required [2]. All patients in this series underwent an ORIF, with or without bone grafting. Depending on patient preference, conservative management was trialled. However, ultimately due to failed conservative management, all patients proceeded to surgical intervention.

## Conclusion

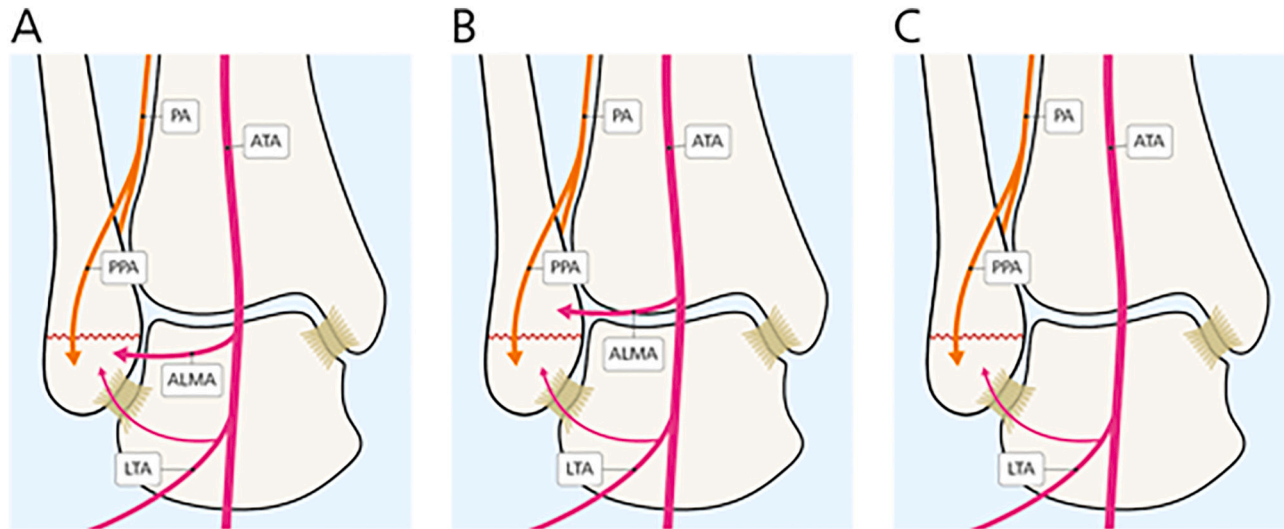
The Weber A non-union fracture patterns in previous studies are not detailed; but suggest that ORIF and fibula nails can be successful surgical techniques in symptomatic patients [2,5]. Our preferred surgical technique is ORIF with or without autologous bone graft. All patients in our series successfully united without complications.

This case series is particularly interesting as there are very few isolated cases of this type discussed in the literature, none with multiple patients presenting with transverse Weber A fractures progressing to non-union. This is the first paper to explore a potential disruption to the distal fibula vasculature as a cause for this rare finding.

Weber A fractures of the ankle are normally considered benign with good clinical outcomes. However, our series demonstrates that patients with this transverse fracture pattern should be counselled on the risk of symptomatic non-union. However, we do not feel that initial management of the fracture should alter from non-operative methods.

## Declaration of competing interest

None.



**Fig. 3.** Blood supply to distal fibula and anatomical variations.

A – The most common arterial blood supply to the distal fibula with the ALMA arising below the level of the ankle joint. A branch of the LTA provides some peripheral supply through the ligaments comprising the lateral ankle capsule.

B – The most common anatomical variant in blood supply (19% of population). The ALMA originates at the level of the ankle joint.

C - The absent ALMA (8% of population).

Arterial abbreviations: ALMA - anterior lateral malleolar artery; ATA - anterior tibial artery; LTA - lateral tarsal artery; PA - peroneal artery; PPA - perforating peroneal artery.

## Acknowledgements

We would like to thank Brian Parkinson for developing the anatomical images used in this case series.

## References

- [1] R.W. Bucholz, J.D. Heckman, Ch.M. Court-Brown, Tornetta P. Lippincott, Rockwood and green's fractures, in: Adults, 7th ed, Williams & Wilkins, 2010.
- [2] A.K. Bhadra, C.S. Roberts, P.V. Giannoudis, Nonunion of fibula: a systematic review, *Int. Orthop.* 36 (9) (2012) 1757–1765.
- [3] A. Dobbe, L.A. Beaupre, K.A. Almansoori, T.-S. Fung, A.V. Scharfenberger, Functional outcomes of isolated infrasyndesmotic fibula fractures, *Foot Ankle Orthop.* 5 (1) (2020), 2473011419892227.
- [4] S. Khurana, R. Karia, K.A. Egol, Operative treatment of nonunion following distal fibula and medial malleolar ankle fractures, *Foot Ankle Int.* 34 (3) (2013) 365–371.
- [5] T.J. Batten, C. Scott-Davies, M. Butler, S.W. Parsons, R.P. Walter, Percutaneous screw fixation for painful non-union of lateral malleolus ankle fractures, *Injury* 49 (10) (2018) 1936–1941.
- [6] R. Sundling, N. Cheney, Danis-Weber a non-union in a teenager: a case report and review of literature, *MOJ Orthop. Rheumatol.* 7 (4) (2017) 00278.
- [7] E.F. Walsh, C. DiGiovanni, Fibular nonunion after closed rotational ankle fracture, *Foot Ankle Int.* 25 (7) (2004) 488–495.
- [8] R.M. Marks, C.C. Stroud, D. Walsh, Pseudoaneurysm of the lateral malleolar artery after an ankle sprain: case report and review of the literature, *Foot Ankle Int.* 20 (11) (1999) 741–743.
- [9] A.S. Kelikian, S.K. Sarrafian, Sarrafian's anatomy of the foot and ankle: descriptive, topographic, functional, 2nd ed, Lippincott Williams & Wilkins, 2011.
- [10] D. Elliott, K. Newman, D. Forward, et al., A unified theory of bone healing and nonunion: BHN theory, *Bone Joint J.* 98 (7) (2016) 884–891.