The acute management of ankle fractures (Augment) study: A prospective trainee led national collaborative audit of the Boast 12 guidelines

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ARTICLE INFO

Article history:
Received 7 May 2020
Received in revised form
19 October 2020
Accepted 5 November 2020
Available online xxx

Keywords:
Fracture fixation
Orthopaedic procedures
Audit
Ankle
Collaborative

ABSTRACT

Background: Ankle fractures are one of the most common fractures in adults aged 20–65 years. The British Orthopaedic Association (BOA) and British Orthopaedic Foot and Ankle Society (BOFAS) jointly produced Standards for Trauma (BOAST) BOAST 12, with the aim of reducing morbidity by standardising care of these injuries. The primary aim of the AUGMENT study was to determine the extent and clinical effect of variation from BOAST 12.

Methods: AUGMENT was a multi-centre prospective trainee led audit of consecutive patients presenting with an ankle fracture within a four-week period. Data were collected on patient demographics, comorbidities, management and 12-week outcome. The BOAST 12 standards were divided into four subgroups; documentation, imaging, management and follow-up. Percentage compliance with each subgroup was analysed. A multivariate logistic regression analysis was used to determine impact of overall compliance on likelihood of discharge in follow-up period.

Findings: 971 patients were included across 52 sites. The overall rate of BOAST 12 compliance was 41.7%. Variations in practice were observed in clinical documentation, especially of neurovascular status, (40.7%) and VTE assessment (61.5%). Patient management compliance with all 16 of the BOAST 12 standards was associated with a higher rate of discharge during the 12-week follow-up period ($p = 0.005$).

Conclusion: AUGMENT has demonstrated that the management of ankle fractures is variable across the UK. Over half of patients had aspects of their care that were not BOAST 12 compliant. When compliance was observed, it was associated with earlier discharge from orthopaedic care.

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https://doi.org/10.1016/j.surge.2020.11.001

Please cite this article as: Fennelly JT et al., The acute management of ankle fractures (Augment) study: A prospective trainee led national collaborative audit of the Boast 12 guidelines, The Surgeon, https://doi.org/10.1016/j.surge.2020.11.001

Introduction

The ankle is one of the most common sites of fracture in adults aged 20–65 years old, with an annual incidence amongst the UK population of 122 per 100,000[1]. Distribution is bimodal, with an early peak in young male victims of high energy trauma and a later peak in older females more likely associated with lower energy falls and osteoporotic bone.[1] Clinical features include bony tenderness over either malleolus or an inability to bear weight immediately following injury.[2]

Ankle fractures are a heterogenous group of injuries, the majority involve hindfoot inversion with disruption of the anterior inferior tibiofibular ligament and associated fracture of the lateral malleolus. The level of the fibular fracture relative to the tibiofibular syndesmosis forms the basis of the Danis-Weber classification, which may be used to infer the likely degree of ligamentous disruption and inherent instability of the fracture.[3]

As part of their Standards for Trauma, the British Orthopaedic Association (BOA) and British Orthopaedic Foot and Ankle Society (BOFAS) jointly produced BOAST 12 (Appendix 1).[4] These guidelines aimed to reduce morbidity by standardising care of this broad range of injuries from presentation to discharge. The aim of the AUGMENT collaborative audit was to determine the extent and effect of variation from BOAST 12 guidelines in the management of ankle fractures across the United Kingdom. The primary objective of the study was to assess national compliance with BOAST 12 guidelines for the management of ankle fractures in the United Kingdom. The secondary objective of this study was to determine if compliance with BOAST 12 guidelines was associated with reduced time to discharge from orthopaedic follow-up and reduced rates of complications.

Methods

This study was a prospective trainee led national audit overseen by a national committee following the collaborative research model.[5,6] The study is reported in line with STROBE guidance.[7]

Patients

All consecutive patients presenting to collaborating sites within 24 h of sustaining an ankle fracture within a four week period (05.11.2018 to 03.12.2018) were included. Patients were identified from the Emergency Department, fracture clinic and inpatient orthopaedic records, and followed up to 12 weeks post-injury. Patients under 16 years of age and those with pilon or open fractures were excluded, reflecting the remit of BOAST 12 guidance.

Data collection

Patient data collected from initial presentation included age, sex, smoking status, premorbid mobility and medical comorbidities including cardiorespiratory diseases, peripheral vascular disease and diabetes. Use of radiographic imaging was documented, as were the pattern of ankle fracture and the initial management that followed. Ankle fracture patterns were recorded based on the patient notes as documented by the assessing Orthopaedic Surgeon. When there was no recorded fracture pattern in the notes, data was logged as unknown. Outcome data were then collected at 12 weeks post injury based on clinical consultation letters. Patients fell into one of three categories at this point: 1) still requiring follow-up due to injury; 2) still requiring follow-up of secondary medical complications; or 3) no longer requiring orthopaedic or medical follow-up. Patients no longer requiring orthopaedic follow-up were deemed to have returned to normal ankle function. The 16 recommendations within BOAST 12 were divided into four themes that were used to structure our data collection tool and analysis: documentation, imaging, management, follow-up (Appendix 2).

All data were anonymised and stored online by collaborators through a secure server running the Research Electronic Data Capture (REDCap) web application. All transmission and storage of data by this system was encrypted and compliant with international data protection guidelines.[8] Data from the study were retained on the University of Sheffield servers.

An independent evaluator at each participating hospital assessed 25% of the patient data collected in order to ensure accuracy and improve validity.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics v26 (IBM, Armonk. New York). Descriptive analyses were used to assess complication incidence and overall compliance with BOAST 12. Multivariate logistic regression analysis was performed and standardised for patient age and geographical site in order to assess the effect of compliance with BOAST 12 on patient outcome ($p < 0.05$ was deemed significant). Covariates included comorbidities and concurrent injuries (Table 1). Relationships between variables were assessed using Chi squared (X^2), or Fisher's Exact test when numbers were small.

Ethical approval

Each centre was required to register the audit with their hospital's Clinical Audit department, seek approval from their Caldicott Guardian and have a named supervising consultant.

Results

A total of 246 collaborators were recruited from 88 sites including major trauma centres (MTCs) and district general hospitals (DGHs) across the United Kingdom (Fig. 1). 210 collaborators from 52 sites ultimately contributed data (Appendix 3).

1021 cases were identified, of which 971 (95.1%) met inclusion criteria (Fig. 2). Table 1 outlines key demographic information with management strategies presented in Table 2.

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Table 1 – Baseline characteristics of the study population.

			BOAST compliant (N = 402, 41.4%)	BOAST non-compliant (N = 569, 58.6%)	All patients (N = 971, 100.0%)	P value
Age	Mean and SD		52.1 ± 19.6	49.6 ± 19.8	50.6 ± 19.8	0.076
Sex	Male	Number (%)	144 (35.8)	246 (43.2)	390 (40.2)	0.020
	Female	Number (%)	258 (64.2)	323 (56.8)	581 (59.8)	
Weber Classification	A	Number (%)	74 (18.4)	162 (28.5)	236 (24.3)	0.002
	B	Number (%)	240 (59.7)	281 (49.4)	521 (53.7)	
	C	Number (%)	65 (16.1)	87 (15.3)	152 (15.7)	
	Unknown	Number (%)	23 (5.7)	39 (6.9)	62 (6.4)	
Side	Right	Number (%)	202 (50.2)	280 (49.2)	482 (49.6)	0.147
	Left	Number (%)	200 (49.8)	285 (50.0)	485 (50.0)	
	Both	Number (%)	0 (0.0)	4 (0.8)	4 (0.4)	
Injury Pattern	Isolated	Number (%)	370 (92.0)	521 (91.6)	891 (91.8)	0.790
	Polytrauma	Number (%)	32 (8.0)	48 (7.0)	80 (8.2)	
Diabetes Mellitus	NIDDM	Number (%)	20 (5.0)	27 (4.7)	47 (4.8)	0.696
	IDDM	Number (%)	11 (2.7)	11 (1.9)	22 (2.3)	
Chronic Obstructive Pulmonary Disease	Number Diagnosed (%)		12 (3.0)	20 (3.5)	32 (3.3)	0.649
Ischaemic Heart Disease	Number Diagnosed (%)		23 (5.7)	23 (4.0)	46 (4.7)	0.225
Hypertension	Number Diagnosed (%)		89 (22.1)	107 (18.8)	196 (20.2)	0.202
Peripheral Vascular Disease	Number Diagnosed (%)		7 (1.7)	11 (1.9)	18 (1.9)	0.827
Peripheral Neuropathy	Number Diagnosed (%)		8 (2.0)	9 (1.6)	17 (1.8)	0.633
Chronic Kidney Disease	Number Diagnosed (%)		6 (1.5)	12 (2.1)	18 (1.9)	0.483
Rheumatoid Arthritis	Number Diagnosed (%)		4 (1.0)	8 (1.4)	12 (1.2)	0.568
Osteoporosis	Number Diagnosed (%)		23 (5.7)	29 (5.1)	52 (5.4)	0.670
Alcohol Excess	Current	Number (%)	35 (8.7)	32 (5.6)	77 (7.9)	0.000
	Ex	Number (%)	6 (1.5)	9 (1.6)	15 (1.5)	
	Never	Number (%)	359 (89.3)	496 (87.2)	855 (91.1)	
	Unknown	Number (%)	2 (0.5)	32 (5.6)	34 (3.6)	
Steroid Use	Current	Number (%)	11 (2.7)	17 (3.0)	28 (2.9)	0.004
	Ex	Number (%)	9 (2.2)	12 (2.1)	21 (2.2)	
	Never	Number (%)	381 (94.8)	518 (91.0)	899 (92.6)	
	Unknown	Number (%)	1 (0.2)	22 (4.2)	23 (2.4)	
Smoking Status	Current	Number (%)	56 (13.9)	58 (10.2)	114 (11.7)	0.000
	Ex-Smoker	Number (%)	33 (8.2)	30 (5.3)	63 (6.5)	
	Non-Smoker	Number (%)	311 (77.4)	447 (78.6)	758 (78.1)	
	Unknown	Number (%)	2 (0.5)	34 (6.0)	36 (3.7)	

Objective 1: compliance with BOAST 12 and return to function

Overall compliance with all BOAST 12 criteria was 41.4%. Multivariate logistic regression analysis demonstrated that full compliance was associated with patients being discharged before 12 weeks post-injury (P = 0.005, OR 0.493, CI 0.301–0.807).

Documentation

This subsection included documentation of comorbidities, mechanism of injury and initial examination. Full BOAST 12 compliance was observed in only 59.3% of cases. Details regarding integrity of the skin, the patient's neurovascular status or comorbidities were omitted in 40.7% (n = 395) of patients notes.

Imaging

The majority of patients (96.5%) had satisfactory mortise and true lateral radiographs performed, in keeping with BOAST 12 guidance. 49 patients (5%) presented with obvious deformity and neurovascular and/or soft tissue compromise. Only 16 (32%) of these patients underwent immediate reduction to correct the deformity prior to obtaining radiographs. A higher rate of overall complications was observed in those patients that received imaging prior to a reduction attempt being made (24%) compared to patients that underwent an immediate reduction attempt first (6.3%) (p = 0.13). In particular, soft tissue complications such as wound infections, blistering and ulcers were more common in patients that received imaging prior to a reduction attempt (15%) compared to patients that underwent reduction immediately (0%) ($p = 0.12$). At the end of the 12-week period, 37.5% of patients that underwent immediate reduction and 51.5% of patients that received imaging prior to reduction still required orthopaedic follow-up (p = 0.38).

There was a posterior malleolar fracture fragment observed on plain radiographs in 190 (19.8%) cases with 40.5% having a subsequent CT scan as suggested by BOAST 12. Of the patients who underwent operative intervention, 93.8%

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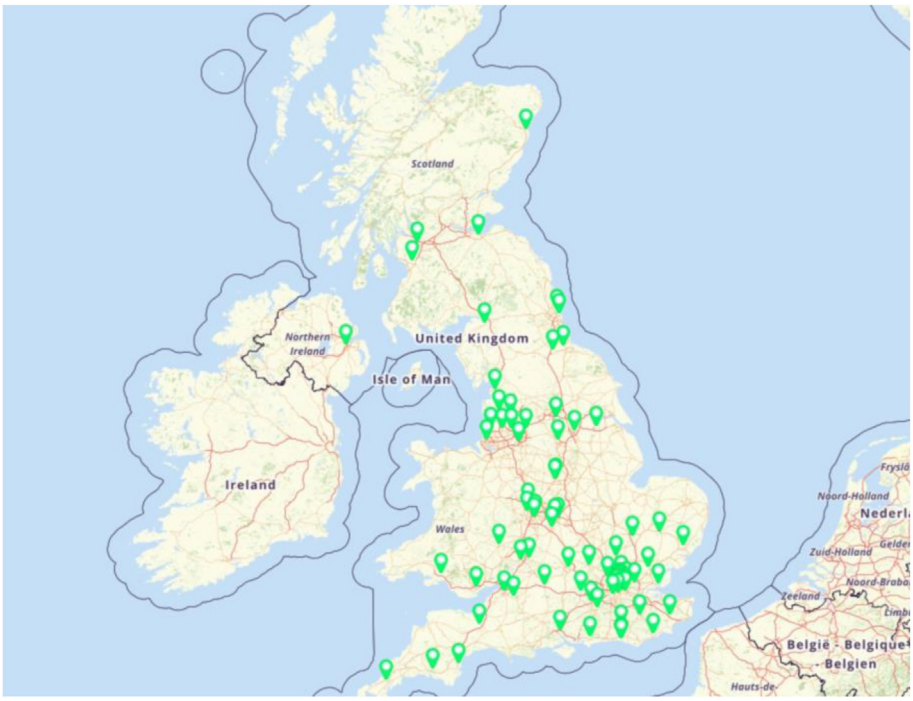

Fig. 1 – A map of the UK with the 88 hospital sites that signed up to recruit patients indicated in green markers.

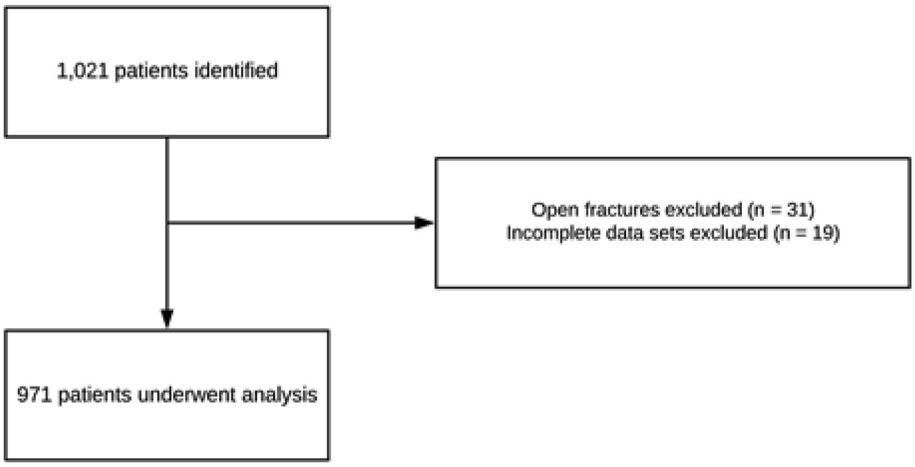

Fig. 2 – A flow-diagram of the patients identified and excluded from the AUGMENT collaborative study.

had intra-operative images saved as part of the medical record.

Management

96.0% of patients had a clear plan for immobilisation and weight bearing status on discharge from the Emergency Department (ED). The majorities of patients with Weber A fractures, which are inherently stable if in isolation, were placed in walking boots (74.6%) and were able to bear weight from ED (69.1%). The overall rate of documented VTE assessment was 61.5% in this study. In total 647 (66.6%) patients were advised to partially (8.5%) or strictly non-weight bear (58.1%) in a below knee cast or walking boot. 188 (29.1%) of these patients did not have a documented VTE assessment according to local policy. Of the 459 (70.9%) patients that did have a documented VTE assessment: 39 (6.0%) had pre-existing comorbidities for which they already required routine thromboprophylaxis; 5 (0.8%) had comorbidities which conferred a high risk of bleeding e.g. active gastric ulceration, and were not suitable for VTE thromboprophylaxis. Non-ambulatory patients (either partially or strictly non-weight bearing) who did not have any of the previously listed contraindications were subsequently prescribed prophylaxis according to local protocols (as per NICE[9]) in only 64.9% of cases. In the 212 (35.1%) non ambulatory patients who did not receive prophylaxis, despite no

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Table 2 – Fracture patterns and subsequent management.

Injury Type	Non Operative, n = 586 (%)	Operative (%), n = 365	Total Cases (%), n = 971
Weber A	220 (37.5)	16 (4.4)	236 (24.3)
Weber B	299 (51.0)	222 (60.8)	521 (53.7)
Weber C	46 (7.8)	106 (29.0)	152 (15.7)
Type Unknown	41 (7.0)	21 (5.8)	62 (6.4)

apparent bleeding risk, there was 1 (0.47%) recorded incident of VTE.

Follow-up

96.8% of the 365 patients who underwent operative intervention received follow-up within six weeks of surgical intervention. Conservatively managed patients received follow-up within six weeks of initial presentation in 75.1% of cases (n = 586). Of the remaining 24.9% (n = 146) of conservatively managed patients who did not receive follow-up, the majority (n = 97, 66.4%) had Weber A injuries managed in a walking boot. Overall compliance with follow-up recommendations for patients with operatively managed and conservatively managed injuries was 90.7% (n = 874).

Objective 2: complication rates

The rate of complications across patients managed operatively, non-operatively and overall were 12.1% (n = 365), 3.1% (n = 586) and 6.5% (n = 971) respectively (Table 3). Although a higher complication rate was observed in patients managed strictly as per BOAST compared to those who were not, this was not statistically significant (8.2% vs 5.3%, X^2 (1, $N = 971$) = 3.3, $p = 0.07$).

Key complications for patients managed operatively included infection and wound healing problems, with 19 (4.9%) developing superficial infections, 2 (0.5%) deep ankle infections, and 2 (0.5%) wound dehiscence. The incidence of these complications were twice as high in those patients treated according to BOAST, but this relationship was insignificant (7.7% vs 3.8%, X^2 (1, $N = 365$) = 2.7, $p = 0.12$).

Early radiological indications of delayed union were also observed predominantly in the operatively managed group (1.4%, vs 1.2%, X^2 (1, $N = 971$) = 0.0, $p = 0.77$) and in those patients in the BOAST compliant subgroup (1.9% vs 0.7%, X^2 (1, $N = 971$) = 3.2, $p = 0.07$). There was no significant difference in risk factors for delayed union identified between the two groups (Table 4). One case of malunion was observed in a patient whose treatment was BOAST non-compliant and had refused operative intervention on initial presentation. There was a similar incidence of pressure sores secondary to cast immobilisation in patients managed non-operatively and operatively (0.5% vs 0.3%, X^2 (1, $N = 971$) = 0.3, $p = 0.60$). There was also little variation in patients who were managed according to BOAST versus those who were not (0.5% vs 0.4%, X^2 (1, $N = 971$) = 0.1, $p = 0.73$).

Medical complications of treatment were observed in both subgroups. Six patients (0.6%) developed VTE with the majority (n = 4, 66.6%) having not been assessed for VTE risk or received subsequent prophylaxis if eligible (n = 2, 50.0%). The relationship between VTE incidence and VTE assessment in accordance with BOAST was insignificant (X^2 (1, $N = 971$) = 2.0, $p = 0.16$). 75% of patients diagnosed with VTE had a history of

Table 3 – Complications across all patients.

	Operative Management, n = 365 (%)		Conservative Management, n = 606 (%)		Total number, n = 971 (%)
	BOAST Compliance		BOAST Compliance		
	Yes (n = 208)	No (n = 157)	Yes (n = 194)	No (n = 412)	
Superficial Wound Infection	13 (6.3)	5 (3.2)			18 (1.9)
Deep Wound Infection	1 (0.5)	1 (0.6)			2 (0.2)
Wound Dehiscence	2 (1.0)	0 (0.0)			2 (0.2)
VTE	1 (0.5)	3 (1.9)	0 (0.0)	2 (0.5)	6 (0.6)
Signs of Slow Union	5 (2.4)	0 (0.0)	3 (1.5)	4 (1.0)	12 (1.2)
Malunion	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Compartment Syndrome	1 (0.5)	1 (0.6)	0 (0.0)	0 (0.0)	2 (0.2)
Pressure Sore Secondary To Cast	1 (0.5)	0 (0.0)	1 (0.5)	2 (0.5)	4 (0.4)
Nerve Injury	1 (0.5)	1 (0.6)	0 (0.0)	0 (0.0)	2 (0.2)
Revision Surgery	2 (1.0)	0 (0.0)			2 (0.2)
Ankle Contracture	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)
Chronic Regional Pain Syndrome	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)
Amputation	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.1)
Respiratory Infection	0 (0.0)	1 (0.6)	0 (0.0)	3 (0.7)	1 (0.1)
Urinary Tract Infection	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Myocardial Infarction	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.1)
Cerebrovascular Accident	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Death Within 30 Days	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.2)	2 (0.2)
Overall Number of Complications	29 (13.9)	15 (9.6)	4 (2.0)	15 (3.6)	63 (6.5)
	44 (12.0)		19 (3.1)		

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Table 4 – Risk factors for delayed union (Fisher's Exact Test).

		Conservative Management, n = 15	Operative Management, n = 8	P Value
Diabetes Mellitus	IDDM	1 (6.7)	0 (0.0)	0.29
	NIDDM	1 (6.7)	3 (37.5)	
Smoking	Current	0 (0.0)	1 (12.5)	1.00
	Ex	3 (20.0)	1 (12.5)	
Steroid Use	Current	1 (6.7)	0 (0.0)	0.52
	Ex	1 (6.7)	0 (0.0)	

smoking and this was identified as a significant risk factor (X^2 (1, $N = 971$) = 10.8, $p = 0.004$).

One patient (0.1%) underwent a below knee amputation due to a deep infection following operative intervention. Two patients (0.2%) died during the study: one of chest sepsis during conservative management and the other suffered a fatal intra-operative myocardial infarction.

Discussion

AUGMENT is the only prospective study to evaluate national compliance with the BOAST 12 standards and to assess the clinical impact of compliance in terms of treatment outcomes; namely time to discharge and complication rates. Compliance with all 16 of the BOAST 12 criteria was seen in 41.4% of included patients, with these patients being more likely to be discharged from orthopaedic care at 12 weeks following injury.

Documentation of patient assessment and clinical care were key areas of inconsistency between the included sites. Whilst no literature currently exists regarding the documentation of neurovascular status in patients with ankle fractures, a retrospective study of paediatric patients with supracondylar humeral fractures reported that only 8.8% and 13.9% had complete pre-operative neurological or vascular assessments respectively.[10] The robustness of documentation is vital not only for communication, planning and triage between clinicians, but is a key determinant in cases of litigation[11]: £180,528,000 was paid out by NHS Resolution 2017/18 for orthopaedic cases alone. Poor communication or documentation was implicated in an estimated 40% of these claims,[11,12] which has influenced recommendations on documentation within trauma guidelines from the BOA and the Getting It Right First Time initiative in elective surgery.[13]

According to the BOAST 12 guidance, reduction of clinically deformed ankles should be performed urgently, with radiographs obtained prior to this only if they will not result in unacceptable delay. Obtaining radiographs theoretically allows better understanding of fracture configuration and pattern of dislocation, and thus may improve the chances of successful reduction.[14] Two recent studies in separate UK Major Trauma Centres have shown a significant delay in mean time to reduction whilst awaiting pre-reduction radiographs.[15,16] Obtaining pre-reduction radiographs yielded similar success rates in reduction in one study[16] and increased reduction attempts in the other.[14] The delay in reduction resulted in greater soft tissue swelling and poorer performance in patient reported outcome measures.[16] The above studies therefore suggest that obtaining pre-reduction radiographs in a clinically deformed foot is not advantageous. Despite this, over two thirds of patients from our study with a visibly deformed ankle had pre-reduction radiographs obtained, potentially delaying their time to adequate reduction. We observed higher incidences of wound infections, blistering and ulcers in these patients, as may be anticipated from the literature. This may explain why this subgroup of patients was more likely to require ongoing orthopaedic follow-up at 12 weeks than patients who received immediate reduction. It should be noted that in some centres obtaining a radiograph may not cause significant delays to reduction, but we would suggest that this may be an appropriate topic for local audit to ensure that this is the case.

The use of weight bearing casts and splints in patients with stable ankle fractures has been shown to be associated with shorter periods of rehabilitation and quicker improvement in clinical function.[17] The majority of patients with stable injuries within this study were accordingly allowed to fully weight bear from the ED. For patients with unstable fracture patterns who require a period of non-weight bearing, chemical thromboprophylaxis is indicated by NICE[8] where risk of VTE outweighs the risk of bleeding. A recent cochrane review demonstrated that patients provided with prophylactic low molecular weight heparin throughout their time in a cast experienced a VTE rate of 0–37%, which was significantly lower than their control counterparts (4.3–40%).[18] BOAST 12 takes the pragmatic approach that VTE risk assessment should follow agreed local protocols, which allows for a degree of variation across sites. Within this context we identified VTE rates of 0.6% across all patients, with 50% of those affected having not received prophylaxis despite being non ambulatory and having no contraindications. This incidence is comparable to a large retrospective study of ankle injuries, where VTE was diagnosed in 0.38% of patients with 65% of those affected not having received chemical prophylaxis.[19]

Patients with stable ankle fractures often receive numerous fracture clinic appointments[20] and have serial radiographs taken which have little impact on fracture management.[21] BOA guidance suggests patients with an acute orthopaedic injury are reviewed in a fracture clinic within 72 h of presentation.[22] Some sites have established virtual fracture clinics which have improved BOA compliance[23] and reduced treatment times for stable ankle fractures treated with removable splints.[24] Such virtual fracture clinics also allow patients with stable injuries to be discharged remotely, without further unnecessary visits.[24] Within this study, patients with Weber A injuries were often discharged from the initial ED visit without routine further follow-up, which is in

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keeping with this recent change in practice. By reducing the overall burden on fracture clinics, it would be possible to improve compliance and ensure all unstable injuries are seen within 72 h of initial presentation or 6 weeks of operative intervention.

Our identified complication rates compare favourably to the 36% reported amongst operatively managed patients in a large 8-year single centre retrospective study by Macera et al.,[25] although our 12-week follow-up period only identified immediate and early post-operative complications. We demonstrated no statistically significant decrease in overall complication rates amongst patients managed strictly as per BOAST guidelines, but the low number of complications identified during our short follow-up period may limit the validity of the results.

We recognise that there are a number of limitations in this study. Although we tried to ensure quality control of data collection through a separate validator, we do not know about the accuracy of documentation or the number of missed cases. This was demonstrated by a number of ankle fractures being classified as "unknown" according to the documented medical records which may have impacted the overall data interpretation. Some patients will have been lost to follow-up as they were followed-up elsewhere, or presented to a different care provider with complications. Secondly, whilst we have demonstrated that BOAST compliance is associated with a greater probability of being discharged by 12 weeks post injury, more evidence may be required to define an association with functional improvement. Finally, as no data was collected prior to the implementation of BOAST 12 guidelines, we cannot make any direct comparisons for patient outcomes before and after BOAST 12 intervention. Further research is needed to gain insight into the surgical decision-making process and considerations that guide the definitive management of acute ankle fractures such as patient factors, hospital resources and surgical experience.

Conclusion

AUGMENT has demonstrated that overall compliance with BOAST 12 guidance is variable. Compliance with these guidelines is associated with patients being less likely to require orthopaedic follow-up three months post injury, highlighting the importance of adherence. Key areas of inconsistency include the application of VTE risk assessments and provision of prophylaxis, as well as in quality of documentation which may leave trusts medicolegally vulnerable. Future research seeking patient reported outcome data may be of value in ascertaining whether compliance with BOAST 12 is reflected in subjective experience and functional improvements.

Authors' contributions

The AUGMENT steering group (Ward AE, Price MJ, Stedman T, Fennelly J, Gourbault L) were responsible for the design of the work and acquisition of data by implementation of the study. All members were involved in the creation of data collection tools. AE Ward designed the project and produced an initial protocol to guide discussion and implementation of the study. MJ Price was responsible for preparation of the protocol manuscript for submission. All members revised the manuscript critically for important content throughout and prior to submission. All members of the steering group granted final approval of the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to accuracy or integrity are appropriately investigated and resolved, in keeping with the ICMJE's recommendations on authorship.

Augment collaborative

The AUGMENT steering committee is chaired by an orthopaedic specialty registrar (Ward AE) with two further specialty registrars (Price MJ and Stedman T) and two core trainees (J.T Fennelly and L.J. Gourbault). The project is advised by a consultant foot & ankle surgeon and supported by the White Rose Surgical Collaborative (WRSC) and BOFAS.

Data were collected by the AUGMENT collaborative, consisting of 246 junior doctors and medical students in teams at their respective hospitals, with a nominated consultant supervisor at each site. All committee, advisory and collaborative members will receive acknowledgement of authorship in subsequent publications.

Declaration of Competing Interest

None declared.

Acknowledgements and contributions

Ward AE conceived the study and led the project throughout. The AUGMENT steering group (Ward AE, Price MJ, Stedman T, Fennelly J, Gourbault L) were responsible for the implementation of the study, including the creation of data collection tools. Ward AE led data analysis. All authors revised the manuscript prior to submission. All members of the steering group granted final approval of the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to accuracy or integrity are appropriately investigated and resolved, in keeping with the ICMJE's recommendations on authorship.

The AUGMENT steering group are hugely grateful to all 210 collaborators who contributed to this study and without who it would have not been possible.

The AUGMENT study group is grateful for the advice and support of Mr Chris Blundell, Consultant Orthopaedic Foot & Ankle Surgeon at Sheffield Teaching Hospitals and Mr Ioannis Aktselis, Consultant Orthopaedic Foot & Ankle Surgeon at Stoke Mandeville Hospital. Additional project support was received from British Orthopaedics Foot and Ankle Society and the White Rose Surgical Research Collaborative.

Please cite this article as: Fennelly JT et al., The acute management of ankle fractures (Augment) study: A prospective trainee led national collaborative audit of the Boast 12 guidelines, The Surgeon, https://doi.org/10.1016/j.surge.2020.11.001

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.surge.2020.11.001.

REFERENCES

1. Donken CCMA, Al-Khateeb H, Verhofstad MHJ, van Laarhoven CJHM. Surgical versus conservative interventions for treating ankle fractures in adults. *Cochrane Database Syst Rev* 2012;**15**(8):8470.
2. Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. *BMJ* 2003 Feb;**326**(7386):417.
3. Goost H, Wimmer MD, Barg A, Kabir K, Valderrabano V, Burger C. Fractures of the ankle joint: investigation and treatment options. *Deutsches Arzteblatt international* 2014;**111**(21):377–88. https://doi.org/10.3238/arztebl.2014.0377.
4. British Orthopaedic Association Audit Standards for Trauma. *Boast 12: the management of ankle fractures* [Internet]. BOA. [cited 2019 Sep 1]. Available from: https://www.boa.ac.uk/wp-content/uploads/2016/09/BOAST-12-Ankle-Fractures.pdf; 2016.
5. Bhangu A, Kolias AG, Pinkney T, Hall NJ, Fitzgerald JE. Surgical research collaboratives in the UK. *Lancet* 2013;**382**:1091–2.
6. Jamjoom AAB, Phan PNH, Hutchinson PJ, Kolias AG. Surgical trainee research collaboratives in the UK: an observational study of research activity and publication productivity. *BMJ Open* 2016;**6**:e010374. https://doi.org/10.1136/bmjopen-2015-010374.
7. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008;**61**(4):344–9.
8. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)-a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf* 2009;**42**(2):377–81.
9. *Venous thromboembolism overview - NICE Pathways* [Internet]. [cited 2020 May 1]. Available from: https://pathways.nice.org.uk/pathways/venous-thromboembolism.
10. Mayne AIW, Perry DC, Stables G, Dhotare S, Bruce CE. Documentation of neurovascular status in supracondylar fractures and the development of an assessment proforma. *Emerg Med J* 2013;**30**(6):480–2.
11. National Health Service. *NHS litigation authority annual report and accounts 2017/18* [Internet]. [cited 2020 May 1]. Available from: https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc_100063314046.0x000001; 2018.
12. Handling clinical negligence claims in England. *National Audit Office (NAO) report* [Internet]. National Audit Office; 2020 [cited 2020 May 1]. Available from: https://www.nao.org.uk/report/handling-clinical-negligence-claims-in-england/.
13. *Litigation [Internet]. Getting It Right First Time - GIRFT* [cited 2020 May 1]. Available from: https://gettingitrightfirsttime.co.uk/cross-cutting-stream/litigation/.
14. Hastie GR, Divecha H, Javed S, Zubairy A. Ankle injury manipulation before or after X-ray-does it influence success? *Injury* 2014;**45**(3):583–5.
15. O'Dowd D, Brewer P, Davies M, Leese K, Chadwick C, Davies H, et al. Are ankle dislocations being diagnosed and reduced in a timely manner? [Internet] *Orthopa Proceed* 2017 Dec 1 [cited 2020 May 1];99-B(SUPP_21):6–6. Available from: https://online.boneandjoint.org.uk/doi/abs/10.1302/1358-992X.2017.21.006.
16. Wicks L, Faroug R, Richler-Potts D, Bowden A, Issac R, Mangwani J. Should pre-manipulation radiographs be obtained in ankle fracture-dislocations? *Foot (Edinb)* 2018;**36**:10–4.
17. Port AM, McVie JL, Naylor G, Kreibich DN. Comparison of two conservative methods of treating an isolated fracture of the lateral malleolus. *J Bone Joint Surg Br* 1996;**78**:568–72.
18. Zee AAG, van Lieshout K, van der Heide M, Janssen L, Janzing HMJ. Low molecular weight heparin for prevention of venous thromboembolism in patients with lower-limb immobilization. *Cochrane Database Syst Rev* 2017;**8**:CD006681. https://doi.org/10.1002/14651858.CD006681.pub4.
19. Prince III RM, Lubberts B, Buda M, Guss D, DiGiovanni CW. Symptomatic venous thromboembolism after non-operatively treated foot or ankle injury. *J Orthop Res* 2019;**37**:190–6. https://doi.org/10.1002/jor.24149.
20. Martin, A.G. Weber B ankle fracture: an unnecessary fracture clinic burden. Injury, Volume 35, Issue 8, 805 - 880
21. van Gerven P, Weil NL, Termaat MF, Rubinstein SM, El Moumni M, Zuidema WP, et al. Routine follow-up radiographs for ankle fractures seldom add value to clinical decision-making: a retrospective, observational study. *J Foot Ankle Surg* 2018;**57**(5):957–60. https://doi.org/10.1053/j.jfas.2018.03.035.
22. BOA Standards for Trauma (BOASTs). *Boast 7: fracture clinic services*. British Orthopaedic Association; August 2013 (cited June 2020), http://www.boa.ac.uk/publications/boast-7-fracture-clinic-services.
23. Holgate J, Kirmani S, Anand B. Virtual fracture clinic delivers British Orthopaedic Association compliance. *Ann R Coll Surg Engl* 2017;**99**(1):51–4. https://doi.org/10.1308/rcsann.2016.0255.
24. Vardy J, Jenkins PJ, Clark K, Chekroud M, Begbie K, Anthony I, et al. Effect of a redesigned fracture management pathway and 'virtual' fracture clinic on ED performance. *BMJ Open* 2014;**4**:e005282. https://doi.org/10.1136/bmjopen-2014-005282.
25. Macera A, Carulli C, Sirleo L, Innocenti M. Postoperative complications and reoperation rates following open reduction and internal fixation of ankle fracture. *Joints* 2018;**6**(2):110–5.

Please cite this article as: Fennelly JT et al., The acute management of ankle fractures (Augment) study: A prospective trainee led national collaborative audit of the Boast 12 guidelines, The Surgeon, https://doi.org/10.1016/j.surge.2020.11.001