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ORIGINAL ARTICLE

A Stability-Based Management Protocol for Isolated Lateral Malleolar Ankle Fractures at the Level of the Syndesmosis Reduces the Need for Surgical Intervention

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Abstract

Purpose The study aimed to establish and subsequently improve the rate of stability assessments of fractures with uncertain stability and the impact on the avoidance of potentially unnecessary surgery.

Methods Two independent audit cycles were conducted from October 2019 to May 2020. All patients had closed isolated lateral malleolar fractures at the level of the tibiotalar syndesmosis involving skeletally mature bone. A stability-based management protocol was introduced, incorporating an education programme and management guideline.

Results 75 ankles fractures were included. In the initial audit cycle, 13 patients did not undergo stability X-rays within 2 weeks of injury. Interestingly, only one stability assessment was performed for five operated ankles in the first audit, versus a 100% compliance rate in the second cycle. We observed more accurate documentation following education and awareness of clinical importance.

Conclusion By implementing a stability-based management guideline, there was an improvement in compliance with guidance towards stability assessments of ankle fractures. This potentially led to the avoidance of unnecessary surgery on fractures where stability assessments supported non-operative management.

Keywords Ankle fractures · Weight-bearing · X-rays · Documentation · Weber B · Syndesmosis · Stress view · Fixation · Stiffness · Unstable

Introduction

Ankle fractures are among the most common trauma-related injuries that present to emergency departments in the UK [1]. An epidemiological survey of all fractures in the UK showed that between 1990 and 2001, ankle fractures comprised 22.6% of all lower limb fractures [2]. It is estimated that the mean hospital cost for each patient undergoing ankle fracture fixation is £4465.76 per stay [3]. Most of these injuries involve fractures of the malleoli, with 70% involving the lateral malleolus in isolation and a minority exhibiting a combination of the three [4]. An unstable talocrural mortise, if left untreated, can precipitate the onset of arthritis and a negative impact on pain and functional outcomes [5, 6].

Multiple operative and non-operative treatment modalities have been recommended in the management of ankle fractures, each having their unique set of complications that need to be evaluated before choosing the most ideal regimen. This leaves surgeons with a complex, multi-factorial, patient-centred decision-making process. Obviously deformed ankles presenting to the emergency department require prompt manipulation and reduction to minimise overlying soft tissue damage [6]. These injuries are inarguably unstable and are typically managed operatively. Isolated fibular fractures below the level of the syndesmosis are categorically regarded as stable that may be managed conservatively with relative immobilisation techniques such as plasters and walking boots, or even with the RICE

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protocol (rest, ice, compression, and elevation) alone [6, 7]. Complications in both conservatively and surgically managed ankles are shown in Table 1 [6]. Operative treatment bears its own risk of specific complications affecting 5–40% of surgically treated patients [8]. Major adverse events are defined as ones requiring re-intervention, and these have been shown to occur in up to 17.6% of cases [9, 10]. Due to this extensive operative complication profile, conservative management is prioritised when possible. Hence, it is incumbent upon the surgeon to justify the risks of operative versus non-operative management in a shared decision-making patient-centred approach.

Ankle stability is a fundamental concept in the management of ankle fractures. In the majority, there is preservation of the natural ankle stabilisation methods; the deep deltoid ligament acts to prevent lateral displacement of the talus with the inferior tibiofibular ligaments contributing a relatively secondary role [11]. The definition of a stable ankle fracture is one where displacement of the talus in the mortise under normal loading of the joint does *not* occur [12]. This is reflected by the medial and superior clear spaces through weight-bearing mortise view plain radiograph [13]. Gougoulias et al. proposed further subclassifying Lauge–Hansen SER IV-type injuries into IV-A and IV-B [4]. This is based on the principle that the deep posterior tibiotalar ligament (PTTL) is normally fully taut in the plantigrade position and, in this position, it acts to prevent lateral talar displacement.

Theoretically, stable ankle fractures may not need cast immobilisation, periods of non-weight-bearing, or open reductions and internal fixations (ORIF) to prevent talar displacement, even in the presence of a displaced fibula [11]. Harper et al. described the appearance of a laterally displaced distal fibula to be due to internal rotation of the proximal fragment rather than external rotation of the distal fragment itself [14]. Mobilising stable ankle fractures tends to stabilise the fracture further through axial loading by seating the talus more deeply into the normal contours of the mortise [15]. Multiple stress tests have been suggested to distinguish unstable fractures from stable ones [16]. However, many have proved to be unreliable and hence it is widely agreed that weight-bearing mortise and lateral views can be reliably used [4].

Table 1 Complications in conservatively and surgically managed ankle fractures

Conservative	Operative
Persistent pain	Complications as for conservatively managed ankle fractures, including:
Stiffness	Insufficient Primary Osteosynthesis
Non-union	Infection
Delayed union	Re-fracture
Secondary displacement	Tendinous Insufficiency
Post-traumatic arthritis	Sensory deficit
Deep venous thrombosis	Tarsal tunnel syndrome
Pulmonary embolism	Complex regional pain syndrome

Pragmatic trials on the management of unstable ankle fractures, such as the Ankle Injury Management (AIM) and Fractured Ankle Management Evaluation (FAME) trials, have been and are in the process of being conducted [17, 18]. National guidance on the management of ankle fractures, such as NICE Guidelines on non-complex ankle fractures and the 'BOA Standards for Trauma—The Management of Ankle Fractures' (BOAST), provide guidelines on the management of stable and unstable ankle fractures without stating the definition of stability or a method for its assessment. Previous national audits, such as the BOTA WAX and the AUGMENT national audits, demonstrated a variation in practice with regard to many components of ankle fracture management. Although individual surgeons may have engrained beliefs, this variation in practice represents a clinical equipoise in the orthopaedic trauma community which would benefit from further research and more targeted recommendations [19, 20]. Given that isolated lateral malleolar fractures at the level of the syndesmosis are commonly encountered injuries with varying existing modalities of management, we carried out a quality improvement project to highlight the importance of assessing for stability through a stability-based management protocol for ankle fractures. This was in accordance with the BOAST guidelines on the Management of Ankle Fractures [21]. The aim of this study was to assess the impact of this management protocol on the rate of stability assessments of ankle fractures where there is uncertainty of fracture stability and the impact this has had on operative management.

Materials and Methods

Two independent audit cycles were performed. Each cycle covered a total period of 16 weeks. Local approval from the audit department was obtained at both arms of the closed audit loop. Data for the first audit loop were collected retrospectively and included patients presenting from 1st October 2019 to 31st January 2020. The second audit cycle was carried out prospectively from 1st February 2020 to 31st May 2020. Data were collected from the local trauma, outpatient clinic, and accident and emergency databases. Both audit cycles utilised the same inclusion and exclusion criteria (Table 2). The main data collection points are summarised in Table 3. Each patient's management modality (conservative vs. surgery), along with the outcomes and complications, was documented. Complications reported were the same as those already listed in Table 1. Radiological measurements of medial and superior clear spaces to assess the presence

Table 2 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
All patients with closed, isolated lateral malleolar ankle fractures at the level of the syndesmosis	Skeletal immaturity Open fractures
Danis–Weber type-B ankle fractures	Pilon fractures Bimalleolar fractures Trimalleolar fractures Associated ipsilateral foot and/or ankle injuries

Table 3 Main data collection points

Performance of stability X-rays within 2 weeks of injury
Comment on ankle stability at virtual fracture clinic or outpatients
Time period between initial presentation and first follow-up appointment
Date of final follow-up appointment
Total number of face-to-face appointments before discharge

of instability were carried via the local hospital's imaging software—SECTRA PACS®.

The guidelines audited against were the BOAST guidelines on the Management of Ankle Fractures, which state that where there is uncertainty of stability in a fracture pattern, weight-bearing views must be achieved within at least 2 weeks of the injury to confirm the position remains acceptable [21]. After local presentation of the first audit cycle, a stability-based ankle fracture management guideline was introduced (Fig. 1). Departmental education was implemented, and posters of the management guideline were created to stress the importance of achieving stress views of the ankle within 2 weeks of injury. Awareness was raised particularly amongst the consultants, registrars, senior house officers, and nurse practitioners. The poster was designed by the orthopaedic consultant lead on this project and approved by the orthopaedic department following discussion and debate. This was displayed immediately after the presentation of the first audit cycle data and results around various parts of the hospital, including the minors' section of the emergency department, the trauma assessment unit, inpatient radiology rooms, as well as virtual and face-to-face fracture orthopaedic clinics.

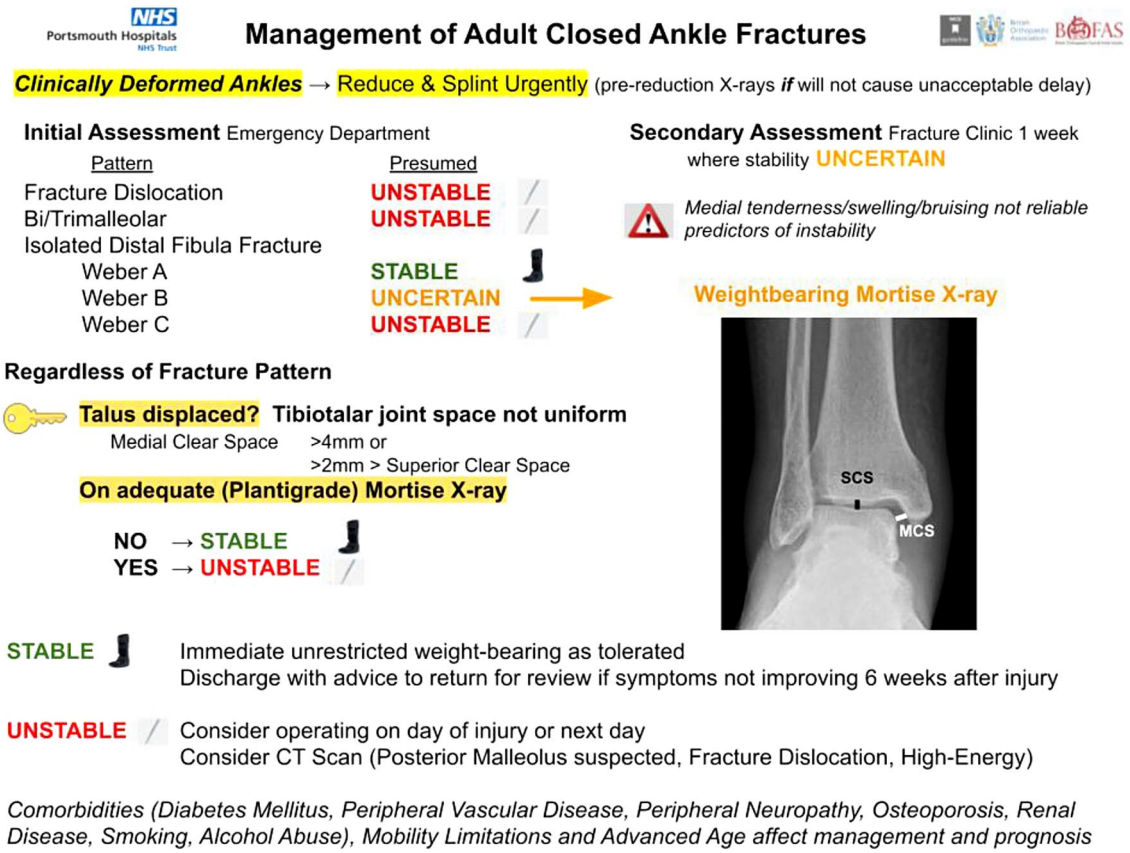

Fig. 1 Local management guideline: management of adult closed ankle fractures

Continuous variables are presented as means with standard deviations or ranges and were compared using Student's *t* test. Categorical variables are shown as absolute numbers and percentages and were compared using the *z* test for equal proportions or the Chi-squared test. Subgroup analyses were performed according to the presence or absence of a stability X-ray within 14 days of injury and the used modality of treatment. The relative risk was used to measure the strength treatment, and that between surgical management and developing complications. Statistical significance was defined as $p < 0.05$. All analyses were performed using Microsoft Excel 16.45.

Results

A total of 241 ankle fractures presented in two different 16-week periods. Of these, 93 were classified as isolated Weber B fractures, and after exclusion, 75 total ankles were included. The first group, representing the initial audit cycle, comprised 40 ankles, and the second group had 35. There was no difference in age or gender between the two groups (Table 4). Interestingly, we found that during the initial cycle, the majority of Weber B fractures had stability X-rays on initial presentation in A/E as opposed to the re-audit (Table 4). Conversely, we saw an improvement in performing stability X-rays on follow-up appointments in fracture clinic: 70% in the first group vs. 85.7% in the second ($p = 0.05$). Considering all stability X-rays done either on initial assessment or within 2 weeks of injury, there was an improvement in compliance to guidance from 82.5% in group 1 to 94.2% in group 2 ($p = 0.058$). We saw a significant improvement in documentation in fracture clinic appointments on the stability of the fracture pattern following weight-bearing assessment.

Of the 40 patients in group 1, 35 (87.5%) were managed conservatively versus 33 out of 35 (94.2%) in the second group, with no statistically significant difference between them (Table 4). Similarly, there was no difference in the overall complications between the two groups when both conservatively and surgically managed ankles were taken into consideration ($p = 0.58$). However, there was a significant difference in complications between those who underwent surgery against those managed conservatively (Table 5). The complications in the conservative group included one DVT and two had delayed union. In contrast, the operative group suffered from stiffness of the ankle joint requiring more physiotherapy. It was also found that those who did not receive a stability X-ray within 14 days of injury were 18.3 times more likely to undergo ORIF ($p < 0.0001$). As for those treated surgically, they were 12.9 times more likely to develop complications than their counterparts who were managed conservatively ($p < 0.0001$). There was a moderate correlation between surgical fixation and the development of complications ($r = 0.581$). None of the patients who underwent ORIF required re-intervention. Four patients who were conservatively managed (two in group 1 vs. two in group 2) did not have weight-bearing views; one was an elderly patient with multiple co-morbidities and was

Table 4 Demonstrating differences between initial (group 1) and re-audit (group 2) cycles

	Group 1 $N = 40$	Group 2 $N = 35$	*p* value
Age (range)	47.9 years (24–89)	51.2 years (15–83)	0.45
Male gender	14 (35%)	11 (31.4%)	0.63
Weight-bearing X-rays			
First presentation	27 (67.5%)	20 (57.1%)	0.82
Follow-up	28 (70%)	30 (85.7%)	0.05
Total	33 (82.5%)	33 (94.2%)	0.06
Stability comment			
First presentation	17 (42.5%)	13 (37.1%)	0.68
Follow-up	16 (40%)	28 (80%)	0.0002
Total	27 (67.5%)	30 (85.7%)	0.03
Management modality			0.16
Conservative	35 (87.5%)	33 (94.2%)	
ORIF	5 (12.5%)	2 (5.7%)	
Complications			0.58
Yes	4 (10%)	3 (8.5%)	
No	36 (90%)	32 (91.4%)	
Median number of follow-up appointments (range)	2.5 (0–4)	2 (0–6)	0.04
Median duration of follow-up (range)	42 (0–245)	27 (0–210)	0.17

Table 5 Demonstrating differences between conservatively versus surgically managed patients

	Conservative $N=68$	ORIF $N=7$	p value
Stability X-ray within 14 days			< 0.0001
Yes	64 (94.1%)	1 (14.3%)	
No	4 (5.9%)	6 (85.7%)	
Complications			< 0.0001
Yes	3 (4.4%)	4 (57.1%)	
No	65 (95.5%)	3 (42.8%)	
Median number of follow-up appointments (range)	2 (0–6)	3 (2–4)	0.006
Median duration of follow-up (range)	29.5 (0–197)	85 (28–245)	0.05

admitted whilst additional social support was arranged and deemed unfit for surgery, two were out-of-area patients who did not attend follow-up, and one who was discharged from the service with no documented complications.

In the first group, patients required a median of 2.5 (1–4) face-to-face clinical appointment over a median of 42 (0–245) days of follow-up, while the second group only required a median of 2 (0–6) appointments ($P=0.04$) over a median of 27 (0–210) days ($p=0.25$). Similarly, the median number of follow-up days increased from 2 (0–6) in the conservative group to 3 (2–4) in the operative group ($p=0.006$). Conservatively managed ankles were followed up over a median of 39.5 (0–197) days versus 85 (28–245) days for those who underwent fixation ($p=0.05$).

Discussion

Stability assessments through weight-bearing radiographs are crucial in guiding the management of ankle fractures where stability is uncertain. Our data demonstrated an improvement in compliance with guidelines reflecting improved provision of quality healthcare to patients. In both audit cycles, there were comparable numbers between operated and non-operated ankles. Only one of the operated ankle fractures in the first had undergone weight-bearing X-rays. This was influenced by the fact that two of the surgically managed ankles (28.5%) had obvious medial space widening and lateral talar displacement on initial X-rays, so they did not require weight-bearing views to ensure instability. However, we question whether there was potential for avoiding surgery had these X-rays been performed for the other operated ankles. Due to the trapezoidal shape of the talus, an AP or mortice radiograph of the ankle in anything but a neutral, plantigrade position can give the appearances of a widened medial clear space and indicate operative intervention, potentially, erroneously. Obtaining weight-bearing radiographs, by necessity, will result in a plantigrade positioning for radiographs. Although there were comparable numbers of patients undergoing fixation in both groups, there was relative certainty of instability in all but one in the second group. The complication rate was significantly higher in surgically fixed ankles, in accordance with literature[8]. The most commonly encountered complications in our cohort were stiffness and a reduced range of motion affecting functional outcomes and lifestyle; therefore, it is prudent that stability assessments be performed to provide the patient and the surgeon a possibility of conservative management. Although no cost analysis was performed in this study, it showed the potential to reduce the cost of management of ankle fractures. One could estimate cost differences between conservatively and surgically fixed ankles as patients in the latter not only underwent an operation, but also had longer hospital inpatient stays (one patient who was managed conservatively had to be admitted for social reasons), more imaging performed including intra-operative image intensifier, and more face-to-face appointments over a longer duration of outpatient follow-up.

This study argues the importance of stability assessments in ankle fractures when the certainty of stability is not immediately apparent. It stresses the significance of weight-bearing views in dictating the management of closed, isolated lateral malleolar fractures at the level of the syndesmosis. The guidelines (established from BOAST and NICE) implemented across the Trust aimed to guide healthcare professionals in recognising and appropriately investigating such fracture patterns. This may ultimately reduce the risk of complications and patient distress and achieve better clinical and functional outcomes.

Limitations of this study include the cyclical nature of data collection for audit purposes. As stability-based ankle fracture management becomes more engrained, with further cycles of the audit process, better adherence could be demonstrated in the future representing further improvements in practice. Although the number of ankles included was a true representation of their incidence in the general population, the sample size may be too small to draw conclusions. A larger-scale multicentre audit to look at the rate of stability assessments,

management, and subsequent complications of closed, isolated Weber B-type fractures in skeletally mature bone could add to the literature and help inform national guidelines.

In conclusion, introduction of a stability-based management guideline for ankle fractures allowed improved adherence to national guidelines with regard to stability assessment in isolated lateral malleolar fractures at the level of the tibiofibular syndesmosis, thereby reducing operative interventions in potentially stable ankle fractures and consequently no/less complication, inpatient stay and attendances at clinic.

Declarations

Conflict of Interest Zeid Morcos, Ali Yousaf, Luke Duggleby and Togay Koç declares that they have no conflicts of interest.

Ethical Approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent Informed consent was obtained from all patients for being included in the study.

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