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Fixation of ankle fractures – a major trauma centre's experience in improving quality

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ABSTRACT

BACKGROUND Ankle fracture malreduction has been shown to result in poor long-term functional outcomes. Varying methods can be used to change practice and thereby outcomes. We present over four years' worth of results with the effects of different techniques for change.

METHODS Two audit cycles were performed incorporating three audit data collections; an initial standard setting audit in 2013, with re-audits in 2015 and 2017. Between the first and second audit was a period of education and reflection. Between the second and third audit there was a change in process in ankle fracture management supported by education. Image intensifier films were reviewed on the hospital picture archiving and communication system, by at least two blinded observers in each cycle. These were scored based on the criteria published by Pettrone *et al*.

RESULTS In the initial audit in 2013, there were 94 patients, with a malreduction rate of 33%. In the second audit in 2015, there were 68 patients, with an increase in malreduction rate to 43.8%. In the third audit in 2017, there were 205 patients, with a significant decrease in malreduction rate to 2.4%. The final major complication rate was 0.98%. The rate of deep infection was 0.5%.

CONCLUSIONS By recognising and addressing the need to improve the quality of ankle fracture fixation, we have made significant improvements in radiological outcomes. Education alone, without system change, was not successful in our department in achieving improved outcomes.

KEYWORDS

Ankle fracture – Malreduction – Education – System change

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Introduction

Ankle fractures are one of the most common injuries presenting to trauma departments.[1] If the ankle injury is found to be unstable on presentation, orthogonal fixation is the standard treatment. Owing to the frequency of presentation, all trauma surgeons who practise general orthopaedic trauma will undertake ankle fracture fixation operations. A huge body of evidence is available to guide surgical management with the aim of ensuring the best possible outcome for the patient. Nevertheless, outcomes from ankle fractures are often not optimal. We present a series of three successive audit cycles from a major trauma centre, assessing the quality of ankle fracture fixation. We also explore aspects of learning and behaviour that impact on the implementation of clinical guidance and the management of patients.

Methods

We undertook two audit cycles, incorporating three audit data collections over a four-year period. All data collection was retrospective. All patients included in the study had unstable operatively treated ankle fractures. Exclusion criteria included paediatric fractures, isolated medial malleolar fractures and classic Pilon fractures. Trauma and orthopaedic consultants were present in theatre for all cases across the three audits. Re-audits in 2015 and 2017 used the same criteria for inclusion and data collection as the initial audit in 2015. The fracture pattern was classified using the AO classification system. Between the first and second audit was a period of education and reflection. Between the second and third audit there was a change in process in ankle fracture management supported by education.

The initial standard setting audit in 2013 included 94 patients attending the department between 1 January 2009 and 31 December 2009. The delay between patient presentation and audit allowed for mid-term patient reported outcome measures to be obtained. The first re-audit in 2015 included 68 patients presenting to the department from 1 January 2014 and 31 August 2014. The second re-audit in 2017 included 205 patients treated from 1 January 2015 and 30 September 2016.

The quality of anatomical reduction was recorded from the immediate postoperative radiographs using the lateral, anteroposterior and mortise views. The quality of anatomical reduction was assessed using the criteria described by Pettrone *et al*.[2] To classify the fixation as satisfactory, the following four criteria had to be met: fracture separation of medial and lateral malleolus to be ≤ 1 mm and ≤ 2 mm, respectively; to ensure deltoid ligament integrity, a medial clear space ≤ 3 mm; and to ensure the restoration of the syndesmosis, there was a tibiofibular space ≤ 5 mm, or tibiofibular overlap of ≥ 10 mm on anteroposterior or ≥ 1 mm on Mortise view. The measurements were accomplished using the graphics package present on the hospital's picture archiving and communication system (Carestream Vue PACS®). The quality of fixation was recorded in addition to original criteria set out by Pettrone.[2]

Results

There was a total of 363 patients included in the three audit data collections. The overall average age was 47.8 years (range 16–91 years) with a male to female ratio of 0.8 to 1. A summary of patient demographics is included in Table 1. There was no significant difference in patient demographics across the three groups using analysis of variance (ANOVA). Using the AO classification, there were 288 type B (79.2%) fractures, with 75 B1 fractures, 116 B2 fractures and 96 B3 fractures. The remaining 76 injuries were C type (20.8%) fractures, with 24 C1 type, 39 C2 type and 13 C3 type fractures. There was no statistically significant difference in percentage of fractures in each type on the AO classification across the three audits.

Using Pettrone's criteria to assess malreduction,[2] defining a malreduction with a Pettrone score of 1 or greater, the initial audit in 2013 found a 33.0% (31 of 94) malreduction rate. In the second audit in 2015, after a period of education and reflection, the rate had worsened, with a malreduction rate of 43.8% (28 of 64). The third audit, in 2017, following system change in the treatment of ankle fractures (including employment of a foot and ankle trauma lead and introduction of algorithms for certain ankle fracture types), found a significant reduction in malreduction rate to 2.4% (5 of 205). This was statistically significant on ANOVA.

In the initial audit in 2013, the overall major complication rate was 8.5% (eight patients). Only one complication occurred in the cohort of patients with appropriately reduced fractures. The complications included an ankle fusion for failure of fixation, a failure of fixation leading to deep infection and ultimately below knee amputation, two further deep infections and four revision fixations. There were five non-unions and eight further operations (four arthroscopies and four removal of metalwork). There were five deaths for unrelated causes.

In the second audit in 2015, there was a 10.9% (seven patients) major complication rate. This included six revision fixations, all occurring in the malreduced cohort and one ankle fusion. There was one non-union and four further operations (three arthroscopies and one removal of metal). There were three unrelated deaths in this audit. In the final audit in 2017, there was a major complication rate of 0.98% (two patients). These included one deep infection and one below-knee amputation in a polytrauma patient with a lower limb vascular injury. There were five further procedures performed, four removal of metal works and one arthroscopy.

Comparing the foot and ankle surgeon input throughout the audits has shown an increase from 41.5% of cases in 2013 and 32.8% in 2015 to 57.5% in 2017. The case mix has also changed, with the more complex fractures (44-B3 to 44-C3) being completed by foot and ankle surgeons. In 2017, 76.4% (91 of 106 patients) of 44-B3 to 44-C3 fractures were completed by foot and ankle surgeons, compared with only 31.0% (13 of 42 patients) in 2013 and 34.2% (12 of 35 patients) in 2015. The distributions of operations throughout the audits are illustrated in Table 2. This difference was statistically significant.

Table 1 Demographics across the three audit data collections.

Audit	Year	Age (mean years)	Age range (years)	Sex (M : F)
1	2013	46.3	17–88	42:52
2	2015	48.8	19–82	30:34
3	2017	48.2	16–91	88:117

F, female; M, male.

Discussion

It is well established that fractures resulting in disruption and displacement of an articular surface should be anatomically reduced where possible, to maximise long-term outcomes. In the ankle joint, the saddle shape congruity of the talas and tibia results in significant increases in joint pressure with even small amounts of displacement. Papers by Ramsay and Hamilton[3] and Lloyd et al.[4] showed that 1-mm medial–lateral displacement decreases the joint contact area by over 40%. In posterior malleolar fractures, the joint remaining bears increased stress with a shift of the centre of stress anteriorly, loading cartilage that normally sees little load. It is therefore understandable that ankle fracture malreductions have a high reported rate of osteoarthritis[5,6] and poor functional outcomes.[7] Worse patient-reported outcome measures have also been reported with unreduced syndesmotic disruption.[8] The results of our study are therefore significant, with an improvement in malreduction by greater than 30%. This improvement was not possible, however, without substantial departmental system change. These initial high malreduction rates are not specific to our institution, with similar rates being reported at other high-volume centres.[9,10]

Following the initial audit in 2013, education was provided that emphasised the poor results with non-anatomical reduction of ankle fractures and how best to achieve reduction. Common themes for suboptimal results during this

Table 2 Distribution of operations undertaken by lower limb trauma specialists (LLTS) compared with general orthopaedic surgeons throughout the three audits.

AO classification	Audit 2013		Audit 2015		Audit 2017	
	LLTS	Other	LLTS	Other	LLTS	Other
B1	9	16	1	9	8	32
B2	17	19	8	12	30	30
B3	5	12	4	12	54	9
C1	1	4	2	1	5	11
C2	3	3	6	7	16	4
C3	4	1	0	2	5	1
Total	39	55	21	43	118	87

period included metalwork malpositioning (such as screws in the syndesmosis, plates too long or screws in the ankle joint), cases of fibula fractures fixed in a shortened or rotated position, unfixed syndesmosis instability and ultimately the severity or difficulty of the fracture not being appreciated. Re-audit in 2015 unfortunately showed worsening results. Following the re-audit in 2015, system changes were implemented in the department in addition to further educational efforts. A designated foot and ankle trauma lead was established, as well as dedicated foot and ankle trauma clinics and lists. The definition of what constituted complex fractures was circulated and these injuries were to be discussed with lower-limb trauma specialists. We identified that patients with posterior malleolus fractures had persistently poorer outcomes, as mirrored in the literature.[11] We instituted algorithms for posterior malleolar fractures as well as obtaining computed tomography for any suspected plafond injury. This intervention aimed to ensure that the severity of all injuries was fully appreciated and that an appropriately experienced surgeon would be managing the patient. All intraoperative fluoroscopy images were to be reviewed at the trauma meeting the following day. The result of these changes has been a drop of malreduction to from 33% to 2.4%.

We know that educational activities improve knowledge but do not necessarily change behaviour in the healthcare profession.[12] Focusing on outcomes that are likely to be perceived as serious may increase the effectiveness of educational meetings.[13] Establishing new routines and priorities built around evidence-based practice may take months, even years, to develop.[12] What appears to help promote behaviour change is partly the way in which education is delivered and partly the follow-up strategies built around the education process.[14] Despite the abundance of guidelines available for clinicians, there are a variety of barriers to guideline adherence. These include lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, the inertia of previous practice and external barriers.[15] It is clear that these barriers must first be identified and addressed before any improvement in guideline adherence can be expected. As the barriers differ within guidelines, tailored and barrier-driven implementation strategies focusing on key recommendations are needed to improve adherence in clinical practice.[16] Behavioural change can be facilitated by attention to the different barriers.[17]

In addition to the intentional teaching of knowledge and skills by surgeons to their trainees (formal curriculum) is the unintended transmission of beliefs, attitudes and behaviours through a process called the hidden curriculum: 'what we don't know we are teaching'.[18] What we say we are doing is essentially the formal curriculum but what we actually do in practice can be thought of as the hidden curriculum. Unfortunately, these are commonly not aligned, resulting in an unawareness of practice that may not be optimal. Within a department, unintentional teaching can result in continued failures where anecdotal evidence and personal beliefs overwhelm evidence-based teaching. It is difficult to establish what surgeons 'learn' as opposed to what they are formally 'taught' but to establish a learning culture it is essential to aim to align the formal and hidden curriculum, to have an openness to new learning and to identify and address barriers to these changes.

It was apparent from the worsening malreduction rate of the re-audit of 2015 that educational efforts had not been successful. We recognised that education alone would not result in the department achieving better outcomes and that the quality of our ankle fracture fixation needed to improve. We analysed the systems in place and identified possible boundaries to optimal management. We considered that more attention to detail was needed and, as a result, patients with ankle fractures were reviewed more thoroughly in dedicated foot and ankle trauma clinics. If there was a complex fracture pattern, a posterior malleolus fragment or any suspicion of a plafond injury, computed tomography would be obtained and would be reviewed by a lower-limb trauma specialist. The cases were planned and assigned to appropriate trauma lists where possible, enabling complex cases to be dealt with on dedicated foot and ankle trauma lists. The whole department was involved and, if appropriate, ankle fracture fixation cases would be listed on a 'non-foot and ankle' trauma list.

The data from the 2017 audit showed an overall malreduction rate of 2.4% from 205 cases. 'Non-lower limb trauma specialists' carried out 88 of these cases with no significant difference in malreduction rates between that group and the group operated on by lower-limb trauma specialists. Analysis of the 2.4% where malreduction was noted revealed that there were 'avoidable' malreductions, such as failing to test or adequately fix a disrupted syndesmosis. Unavoidable malreductions occurred in cases with very poor bone quality and frequently complex fracture patterns. In these cases, we stressed the importance of adhering to the principles of reducing ankle fractures by prioritising joint line reduction, ensuring that the fibula is out to the correct length and rotation and checking the medial clear space is reduced. The system changes we introduced brought about real change in the quality of ankle fracture fixation in our department.

Conclusion

Education alone is insufficient in significantly altering quality of ankle fracture fixation. System changes are necessary to facilitate the recognition of the most complex cases and appropriate planning essential to obtain the best results. Thorough critique of ankle fracture fixation at the time of surgery to ensure adequate reduction and independent review the following day is essential to obtain the best outcome for the patient. The introduction of planned foot and ankle trauma lists for more complex fracture patterns, as well as algorithms for specific fracture types, has been shown to have a significant impact in our department. This model could be adopted in most departments and be of great benefit to many patients. The culture of it being 'just an ankle fracture' is no longer acceptable, but education without system change is unlikely to change outcomes in the long term.

The demonstrated system changes could be applied to many other specialities, both surgical and medical, to help improve outcomes in the ethos of 'getting it right first time'.

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