Pretibial lacerations: Experience from a lower limb trauma centre and systematic review

G.E. Glass, A. Jain

Kennedy Institute of Rheumatology, Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Roosevelt Drive, Oxford, OX3 7FY, UK

Department of Plastic and Reconstructive Surgery, Imperial College NHS Foundation Trust, Charing Cross Hospital, Fulham Palace Road, Hammersmith, London, W6 8RF, UK

Received 16 December 2013; accepted 5 August 2014

KEYWORDS
Pretibial laceration; Haematoma; Management; Dunkin classification; Elderly

Summary  Background: Pretibial lacerations are an important and neglected problem among the elderly. Poor management leads to prolonged hospitalisation and terminal decline. This study summarises our experience and evidence from the literature to ascertain an evidence-based rationale for referral and management.

Methods: Our data were obtained from review of a prospectively gathered database. Additionally, Pubmed, Embase, Medline, and the Cochrane Database of Systematic Reviews were searched through July 2013, with eligible studies evaluated using standard methodology.

Results: Seventy-three pretibial lacerations in 73 patients (63 females) were identified. Mean age was 78 ± 14, 1SD. Sixty patients were managed operatively with a mean length of stay of 11 ± 7 days, 1SD when uncomplicated by medical co-morbidity. Seven deaths occurred (4 in-hospital; 2 treated surgically and 2 treated conservatively) and 3 deaths occurred within 3 months of discharge; a death rate more than twice that of matched controls. Donor site "over-grafting" was performed in 19 cases and resulted in accelerated donor site healing (11 ± 9 days, 1SD vs. 29 ± 42 days, 1SD; P < 0.001). Negative pressure wound therapy delayed discharge (21 ± 23 days, 1SD vs. 15 ± 14 days, 1SD; P = 0.028). Microbiological sampling is unhelpful. Bed rest is unnecessary. "De-fatting" the flap is unproven.

Conclusion: Admissions expose the elderly to physical/functional decline and death. Our findings support a change of practice, minimising admissions for minor (Dunkin type I/II) injuries and rapid, protocol-driven surgical intervention and discharge for Dunkin type III/IV wounds.
Pretibial lacerations 1695

Introduction

Pretibial lacerations are painful and debilitating and occur as a consequence of age-related loss of dermal collagen, leaving thin, friable skin vulnerable to shear and friction.1 Tears are often associated with haematomas (exacerbated by a high incidence of warfarin use in this population2) which compromises the viability of adjacent tissue.3 Loss of skin durability is exacerbated by peripheral vascular disease, oedema, corticosteroids and diabetes mellitus by a final common pathway of oxidative stress and matrix metalloproteinase over-expression.4 Elderly women are most commonly affected.5 As these injuries often occur during falls or attempts to mount stairs loss of visual acuity and field may be predisposing factors with diminishing mobility both a cause and consequence. Moreover, nutritional deficiencies impair subsequent wound healing.6 With an ageing population, the current estimated incidence of 40–70 per 100,000 per year,7 accounting for around 0.5% of all emergency room attendances, is set to rise.8 The financial burden of these injuries is difficult to quantify but estimates report a mean expenditure of over £3000 ($5000) per acute admission.2 Often managed in the community, these injuries also find their way to hospital tissue viability clinics. Consequently, patients are admitted for debridement and skin grafting. Negative pressure wound therapy has been used to manage these cases. It is of vital importance to prevent unnecessary surgery, bed rest, in-hospital stay and antibiotic therapy, all of which can have a detrimental effect on the elderly and vulnerable.9 However, much of the evidence is based on small, retrospective case series. Our prospectively gathered database of lower limb trauma includes all pretibial lacerations encountered in our clinical practice since 2010. The aim of this article is to evaluate our experience and to review the existing literature systematically to propose a rationale for referral and management of this important, but much neglected problem.

Methods

Our practice

Since January 2010, our prospectively gathered database of lower limb trauma referrals has included pretibial lacerations. Data from our series were extracted from our database; between January 2010 and July 2013 (accessed 2nd August 2013). Additional information was obtained, where necessary, via retrospective case note review.

Systematic review

The systematic review was performed in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.10

Data sources and searches

We searched Pubmed (no date limit), EMBASE (OvidSP), Medline (OvidSP), The Cochrane Database of Systematic Reviews and the Cochrane Central Register of Controlled Trials (searched 20th July 2013) using the MeSH terms "lacerations" and "leg injuries" and combining the search terms "laceration" OR "hematoma/haematoma" OR "degloving" AND "leg" OR "lower extremity" with "fragility" OR "steroid" OR "warfarin" OR "aspirin" OR "mobilisation" OR "anaesth$" OR "classif$" OR "surgery" OR "dress$" OR "VAC" OR "negative pressure wound therapy" OR "topical negative pressure" OR "refer$" OR "antibiotic" OR "micro$". An abstract review was conducted of all articles identified and this formed the basis for selection. References of all articles included were cross-checked for further articles of relevance. Additionally, the online trials register ClinicalTrials.gov and the national research register (NRR) were scrutinised for completed, discontinued and ongoing trials relating to the management of pretibial lacerations.

Study selection

Studies were included if they reported on the referral or management of human pretibial lacerations, haematomas or lower limb degloving.

Data extraction and quality assessment

Extracted data were subdivided into "primary outcomes" and "secondary outcomes". Primary outcomes included demographic data and interventions and protocols. Demographic data included: age, gender, aetiology, comorbidities and medications. Mediation data of interest included aspirin, clopidogrel, dipyramide, warfarin and corticosteroids. Interventions and protocols included management, outcomes and any published algorithms. Outcome data included length of in-hospital stay and mortality. Data on mobility and function and pre-operative nutritional status were also sought but no studies addressing these issues were found. Secondary outcome data included existing classification systems and wound geometry, interventional approaches, method of anaesthesia, mobilisation, "over-grafting" of donor sites, negative pressure wound therapy and antibiotics and microbiological sampling. Data were extracted by the two investigators independently (GG and AJ) and discrepancies solved by consensus.
Data synthesis and analysis
Studies included for qualitative synthesis were evaluated using standard methodology. The 3 randomised controlled trials were assessed for risk of bias using the Cochrane Collaborators tool.11 Owing to poor quality of the source studies and the incompatible data sets, quantitative synthesis (meta-analysis) was not performed. The study search strategy is summarised in Figure 1.

Results

Part 1: our experience

Patient population
Seventy-three patients with 73 pretibial lacerations presented to Imperial College NHS Trust (ICNHST) between January 2010 and July 2013. Fifty-nine patients were referred acutely, 10 patients were referred following trialled conservative management in the community and 4 patients were referred with non-healing or infected wounds following failed conservative management. The mean delay between injury and admission was 3 ± 3 days, 1SD (acute referral), 20 ± 5 days, 1SD (trialled conservative management) and 51 ± 19 days, 1SD (failed conservative management). The mean age was 78 years (±14 years, 1SD). Sixty-three patients were female. Over half of all patients lived alone. Two-thirds of cases were caused by falls/trips. A haematoma was present in over 40% of cases. Evaluation of medical history revealed cardiac disease in around one-half of cases, with chronic respiratory and/or neurological disease (including dementia) in around one-fifth. Over 40% of patients took antiplatelet medication routinely; around one-fifth took warfarin. A summary of the patient characteristics is shown in Table 1.

Management
Pretibial lacerations were managed by dressings only, steristrips or debridement and split-thickness skin grafting as appropriate, following review by a consultant, associate specialist or lower limb trauma fellow. If skin grafts were performed, patients were mobilised from day 1 if possible, depending on pre-operative mobility. Evacuations of haematoma were followed by application of NPWT to the overlying skin (if it appeared viable) or debridement and grafting if it did not. Infected lacerations or haematomas were debrided, followed by the application of NPWT, with skin grafting performed when the wound bed was deemed suitable. The use of NPWT was at the discretion of the consultant in charge. The practice of "de-fatting" the flap and applying as a "donor-free" skin graft was not performed. Local, regional or general anaesthesia was used, depending on surgical feasibility, at the discretion of the anaesthetic team and the patients’ wishes. Sixty of 73 patients were managed surgically (debridement and grafting). All 60 patients managed surgically were classified as Dunkin grade III or IV. The remaining 13 patients were managed conservatively, of which 12 were classified as Dunkin II. The remaining patient was classified as Dunkin III but was not deemed fit for any operation. For those managed surgically, the mean delay between admission and surgery was 2 ± 2 days, 1SD. Fifty-one patients managed surgically and 10
patients managed conservatively had an uncomplicated in-hospital stay and were discharged. For these cases, hospital stay was $11/7/6$ days, $1SD$ versus $5/4/6$ days, $1SD$; $P < 0.002$, (one way ANOVA, Mann–Whitney). Nine patients managed surgically had co-existing medical pathology delaying discharge. Two died in hospital (day 37 and day 76 post-admission, respectively) and the remaining 7 patients were eventually discharged. Cause of death was cardiac arrest secondary to IHD and arrhythmia in one patient and gastrointestinal bleed and sepsis in the other. Three patients managed conservatively had co-existing medical pathology delaying discharge. Two died in hospital (day 9 and day 67 post-admission, respectively) and the other was discharged at day 47 post-admission. Cause of death was secondary to congestive cardiac failure in one patient and hospital acquired (pseudomonas) pneumonia in the other. Hence, the pretibial laceration was probably a direct contributory cause in 2 deaths. Out-patient follow-up data revealed that 3 additional patients died within 3 months of discharge from factors unrelated to their pretibial laceration.

Among those who underwent debridement and grafting, donor site “over-grafting” was performed in 19 (non-blinded, non-randomised) cases. Over-grafting resulted in significantly faster healing ($11/9/6$ days, $1SD$ vs. $29/42$ days, $1SD$; $P < 0.001$) compared with no donor over-grafting. Forty patients had NPWT applied to the wound bed, graft or both. These patients had a prolonged in-hospital stay compared with those who had surgical intervention but not NPWT ($21/3/6$ days, $1SD$ vs. $15/14$ days, $1SD$; $P = 0.028$). There was no significant difference noted in graft take between those who did and those who did not have NPWT applied to the graft.

Wound or tissue microbiology cultures were obtained in 58 of 73 cases yielding *staph. aureus* in 16 cases (of which 6 were MRSA) and *coagulase negative staphlococcus* in 6 cases. There were, in addition, 2 cases each of *pseudo-monas aeruginosa*, *enterococcus* and *bacillus* species. In 3 cases, a mixed growth pattern was observed. No growth was observed in 27 cases. While 14 of 73 cases presented with, or subsequently developed cellulitis (19%), the observed flora attributed to the cellulitis was *staph. aureus* (4), *pseudo-monas* (1), *bacillus* (1) and mixed flora (2). No growth was observed in the remaining 6 cases. Hence, presumptive microbiological sampling neither guided prophylaxis nor predicted infection. Similar findings have previously been described in relation to high energy lower limb trauma.12

### Part 2: evidence from the literature

Literature review identified 3 randomised controlled trials on pretibial lacerations. Two of the trials evaluated

<table>
<thead>
<tr>
<th>Demographic data:</th>
<th>Imperial College NHS Trust</th>
<th>Rees et al.16</th>
<th>Laing et al.15</th>
<th>Kennedy &amp; Kerse25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>73</td>
<td>109</td>
<td>75</td>
<td>120</td>
</tr>
<tr>
<td>Age</td>
<td>78 ($±14$, 1SD)</td>
<td>85.5 (median)</td>
<td>80</td>
<td>80 ($±7$, 1SD)</td>
</tr>
<tr>
<td>Range</td>
<td>40–97</td>
<td>51–95</td>
<td>73–93</td>
<td>65–94</td>
</tr>
<tr>
<td>F:M ratio</td>
<td>63:10</td>
<td>100:9</td>
<td>67:8</td>
<td>93:27</td>
</tr>
<tr>
<td>Lives alone (%)</td>
<td>42 (58)</td>
<td>N/R</td>
<td>34 (45)</td>
<td>N/R</td>
</tr>
<tr>
<td>Aetiology:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall/trip/slip (%)</td>
<td>47 (64)</td>
<td>N/R</td>
<td>53 (71)</td>
<td>N/R</td>
</tr>
<tr>
<td>Contact (%)</td>
<td>17 (23)</td>
<td>N/R</td>
<td>14 (19)</td>
<td>N/R</td>
</tr>
<tr>
<td>Other (%)</td>
<td>9 (12)</td>
<td>N/R</td>
<td>8 (10)</td>
<td>N/R</td>
</tr>
<tr>
<td>Haematoma (%)</td>
<td>31 (42)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>32 (±5, 1SD)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Co-morbidities:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac (%)</td>
<td>36 (49)</td>
<td>(51)</td>
<td>32 (43)</td>
<td>N/R</td>
</tr>
<tr>
<td>Respiratory (%)</td>
<td>16 (22)</td>
<td>(25)</td>
<td>24 (32)</td>
<td>N/R</td>
</tr>
<tr>
<td>Neurological (%)</td>
<td>14 (19)</td>
<td>(13)</td>
<td>15 (20)</td>
<td>N/R</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>7 (10)</td>
<td>N/R</td>
<td>5 (7)</td>
<td>N/R</td>
</tr>
<tr>
<td>Medications:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin/clopidogrel (%)</td>
<td>32 (44)</td>
<td>(32)</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Warfarin (%)</td>
<td>15 (21)</td>
<td>(10)</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>(INR)</td>
<td>2.8 ($±1.4$, 1SD)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Corticosteroids (%)</td>
<td>16 (22)</td>
<td>(29)</td>
<td>18 (24)</td>
<td>N/R</td>
</tr>
<tr>
<td>Management:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservative/dressings</td>
<td>9 (12)</td>
<td>10 (9)</td>
<td>11 (15)</td>
<td>N/R</td>
</tr>
<tr>
<td>Primary closure/steristrips</td>
<td>4 (6)</td>
<td>5 (5)</td>
<td>2 (3)</td>
<td>N/R</td>
</tr>
<tr>
<td>Debridement and grafting</td>
<td>60 (82)</td>
<td>94 (86)</td>
<td>61 (81)</td>
<td>N/R</td>
</tr>
<tr>
<td>Outcomes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>18 ($±20$, 1SD)</td>
<td>9 (1–31 days)</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>7 (10) @ 3 months</td>
<td>12 (11) @ 6 months</td>
<td>N/R</td>
<td>N/R</td>
</tr>
</tbody>
</table>
Table 2: Published classification systems for pretibial lacerations.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Payne &amp; Martin</th>
<th>Dunkin et al.</th>
<th>Lo et al.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Skin tear without loss</td>
<td>Laceration</td>
<td>Linear laceration without skin loss</td>
<td></td>
</tr>
<tr>
<td>a: linear type</td>
<td>a: linear type</td>
<td>-Manage conservatively</td>
<td></td>
</tr>
<tr>
<td>b: flat type</td>
<td>b: flat type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II: Flap with skin loss</td>
<td>Laceration or flap with minimal haematoma and/or skin edge necrosis</td>
<td>Flap laceration (viable)</td>
<td></td>
</tr>
<tr>
<td>a: &lt;25% of flap</td>
<td>a: &lt;25% of flap</td>
<td>-Steristrip in emergency room</td>
<td></td>
</tr>
<tr>
<td>b: &gt;25% of flap</td>
<td>b: &gt;25% of flap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III: Flap with 100% skin loss</td>
<td>Laceration or flap with moderate to severe haematoma and/or necrosis</td>
<td>Flap laceration (non-viable)</td>
<td></td>
</tr>
<tr>
<td>IV: Major degloving injury</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

mobilisation versus bed rest following excision and grafting.13,14 The remaining trial evaluated formal excision and grafting with "de-fatting" and replacing the skin flap. The overall quality of the evidence was poor. These trials, together with the remainder which included case series and technical innovations are described according to the outcomes evaluated as follows:

**Primary outcomes**

Evaluations of the primary outcomes were as follows:

1) Demographic data

Three papers were found containing demographic data in pretibial lacerations, with a total of 377 cases (Table 1). Mean age was 81 years. The female to male ratio was 6:1. Cardiac pathology (including ischaemic heart disease, arrhythmias and failure) was encountered in around one half of all cases with respiratory pathology in around one third and neurological pathology (including dementia), in around one-fifth. These findings were similar to our series. In the only study to report medications, antiplatelet use was noted in one third of cases. Additionally, warfarin use, reported at 10% in Rees et al. was less than in our series but corticosteroid use at 24%–29%, was similar. In the only series to report on aetiology, falls, trips and slips accounted for the majority of cases with contact injuries from household and garden furniture accounting for the remainder. The aetiological findings were similar to our series. Observations on the geometry of the wounds were made by Tandon & Sutherland, who reported that the majority of skin flaps were triangular and proximally based.5 Laing et al. reported that a proximally based flap involving the middle or distal third of the pretibial region and a laterally based flap to the middle third occur most commonly.15 These observations have not been verified elsewhere.

2) Outcome data

A mean in-hospital stay of 9 days was reported by one study,16 which was less than the mean length of stay in our series. A study of 109 patients reported that at 6 months, only 78% of patients admitted for management of a pretibial laceration and who were living independently at home prior to the injury had returned to independent living.16 To date, no objective functional assessments have been reported. Mortality of around 10% at 6 months has been reported.16

**Secondary outcomes**

Evaluations of the secondary outcomes were as follows:

3) Classification systems and intervention algorithms

Three classification systems have been published to date. These are compared in Table 2. The later classifications were developed in order to guide clinical management and address the complicating presence of haematoma, neither of which were addressed in the original classification.17 The descriptive system by Dunkin et al. is both easy to learn and apply and may be used to guide management at all levels of experience.18 The four grades of injury are shown in Figure 2. The modification by Lo et al. is stratified on the basis of need for surgical intervention, assuming prior experience in managing these injuries and is thus open to interpretation.19 Nonetheless Lo et al. suggest review of all such wounds at a consultant level, rather than at a junior level, to allow experienced clinical decision-making to minimise operative intervention. Thus, this classification is intended for use by surgeons who manage these injuries. Objective evaluation of the classification systems with respect to inter-observer variability has not been undertaken. Algorithmic approaches have been advocated by Dunkin et al.,16 Beldon20 and Lo et al.19 The approach advocated by Dunkin et al. favours conservative management for grade I and II injuries, with debridement and skin grafting for grade III and IV injuries (general anaesthetic was recommended for grade IV). They proposed a modification for infected wounds, using antibiotics, povidone-iodine dressings and delayed definitive closure. Lo et al. endorsed the approach of Dunkin et al., but stressed their preference for local anaesthetic intervention on a planned theatre list. The algorithm by Beldon is based on the Payne
& Martin classification and is intended for use by tissue viability nurses. Referral is advocated for type II injuries and above, depending on the skills and experience of the nurse.

4) Approaches to management

Crawford & Gipson advocated a conservative, ambulant approach where possible.31 Jones & Sanders24 and Sutton & Pritty23 advocated the use of steristrips in preference to sutures in managing viable flap lacerations. Silk reported success with a novel method of suturing through steristrips placed parallel to the laceration.24 Kennedy & Kerse reported healing times of $37 \pm 26$ days, 1SD for 120 pretibial lacerations treated by conservative methods.25 For those requiring an operative approach, Tandon & Sutherland advocated early surgical debridement and split-thickness skin grafting.5 By contrast, Foroughi & Nouri26 and later Grant27 reported "De-fatting" and fenestrating the flap and applying as a skin graft with the aim of avoiding donor site morbidity. Three randomised controlled trials have been published to date but neither selection bias, performance bias nor detection bias was adequately addressed by these studies, reflecting poor quality methodology in the field overall.13,14,28 Haiart et al. randomised 25 patients to formal excision and grafting or "defatting" the flap and applying it as a graft.28 They reported significantly faster healing in the excision and grafting group ($13.2 \pm 7.2$ days, 1SD) at the cost of delayed healing of one donor site. The NIHR UK clinical trials gateway reports one completed randomised controlled trial of debridement and grafting vs. "defatting" the flap vs. closure with steristrips in the management of pretibial lacerations but no data have been published to date.29

5) Method of anaesthesia

Budny et al. reported that the method of anaesthesia (general versus local anaesthesia) made no difference to a quantitative estimate of graft take.13 Ramnani & Weston reported the feasibility of debridement and grafting under regional nerve block.30 Hence, the limited evidence available suggests that the method of anaesthesia chosen has no bearing on outcome.

6) Mobilisation

Early mobilisation after skin grafting of the lower extremity was first advocated by Bodenham & Watson in 1971.31 Sharpe et al. and Shankar and Khoo successfully applied this approach to the management of pretibial lacerations, using meshed grafts.32,33 Both Budny et al. and Wood & Lees prospectively randomised patients to early mobilisation or bed rest following grafting for pretibial lacerations. Budny et al. observed no significant difference in estimated quantitative graft take at 1 and 3 weeks post op whether the patient was mobilised at day 1 or day 7 post op.13 Similarly, Wood & Lees observed no significant difference in estimated quantitative graft take at day 7, 10 and 14, whether the patient was mobilised at day 1 or day 10 post op.14

7) "Over-grafting" the donor site

In 1984 Fatah and Ward introduced the concept of applying meshed graft to the donor site to improve donor site morbidity and accelerate re-epithelialisation in elderly patients following skin graft harvest.34 While our experience suggested favourable healing there are no further data in the literature to support this practice.

8) The use of negative pressure wound therapy (NPWT)

The commitment to the use of NPWT has implications for length of stay that must be evaluated in the wider context of an integrated plan of management. While NPWT remains a popular method of both wound bed preparation and skin
graft bolstering, and has been shown to improve healing over draining haematomas, no studies have been published to address the use of NPWT in the management of pretibial lacerations.

9) Antibiotics and microbiological sampling

There are no published series reporting microbiological findings in these injuries.

Discussion

This paper evaluates the experience of a single lower limb reconstructive centre in the management of pretibial lacerations referred over a period of 30 months and summarises the relevant literature. We found that our patient population was broadly consistent with that described in the literature. Typically, these patients are elderly females with significant co-morbidities and the mechanism of injury is usually a simple fall or stumble. One notable exception was a series of 129 degloving injuries of the lower extremity in 102 patients with a mean age of 32.5 years. As these injuries were largely high energy injuries in young patients, this series was excluded for our analyses. The literature highlighted the variations in practice that exist, reflecting both a lack of a descriptive standardisation and an evidenced-based intervention algorithm. Moreover, our review highlighted the fact that most of the evidence available to guide practice is derived from small retrospective case series, revealing the need for robust, adequately controlled prospective trials. This is important because the limited data available revealed 19 deaths in 182 patients (with a mean age of 81 years) over a 3–6 month follow-up period. The Office for National Statistics (England and Wales) reported an all-cause mortality for females aged 81 years of 47 per 1000 in 2012, and an all-cause mortality for females aged between 80 and 84 of 53.3 per 1000 in 2013; less than half the rate for the whole year that the pretibial laceration population achieved at 3–6 months (data are only available at 3–6 months as prolonged follow-up is not routine in these cases). It is unclear whether minor limb trauma precipitates a decline in those with minimal physiological reserve or whether physical decline leads to falls hence limb trauma. In all likelihood, decline and death are multi-factorial, with injury being both a cause and consequence. Data from our series supports this assertion, for while most delayed discharges were as a result of pre-existing medical pathology, at least 2 deaths were directly attributable to the limb injury. Conversely, the data supports the notion, however, that there may be much to be gained by optimising the management of these patients, avoiding death and loss of independence.

A mean delay between admission and surgery of 2 days was observed in our series. It has been reported that surgical and anaesthetic cancellations, together with delays in referral, admission and discharge are common features of the management of these injuries. Moreover, unnecessary transfers (i.e. those treated conservatively after being referred for surgical intervention), repeated starvation, immobilisation, nosocomial infections and the absence of pre-emptive discharge planning all serve to undermine the benefits of a surgical approach. In our series, 12 of 73 patients were classified as Dunkin II and managed conservatively. An additional 1 patient had a Dunkin III wound but was deemed unfit for any operation. These patients should have been managed in the community. The decision-making errors in these cases has a multi-factorial basis and includes senior review after (but not before) admission, cross-cover of surgical specialties by junior staff at night and physical and social decline manifest as a pretibial laceration. In addition, 40 of 73 patients were managed using NPWT which did not improve graft take but did delay discharge. In the light of these data we now apply NPWT to the following wounds: 1) wounds with a high transudative output in nutritionally-deficient patients not suitable for grafting; 2) traumatised skin following evacuation of large haematomas; 3) debrided, infected pretibial lacerations pending resolution of infection. The findings of our study may allow us to change our practice directly in two ways. Firstly, admissions for minor (Dunkin Type I and II) pretibial wounds (accounting for 16% of our series) may be reduced. Secondly, delayed discharge and prolonged hospital inpatient stay (55% cases in our series) may be minimised by the avoidance of NPWT except in selected cases. Avoiding unnecessary admissions, delayed discharge and prolonged stay minimises hospital-associated morbidity and institutionalisation.

These findings favour a simple, algorithmic approach aimed at minimising in-patient intervention. An algorithmic, evidence-based multi-disciplinary management protocol, similar to the one developed by the British Orthopaedic Association (BOA) and the British Association of Plastic, Reconstructive and Aesthetic Surgeons (BAPRAS) for the management of lower limb trauma is some way from being realised for this uniquely complex problem, not least because the quality of the evidence is poor. However, should a number of specific questions be answered, the framework for developing such an approach can begin to take shape. Firstly, can these injuries be evaluated in a standardised manner, usable by all medical professionals, to permit comparative data evaluation? Further, can a standardised means of reporting pre-morbid status be agreed upon, permitting evaluation of the wound in the context of the overall condition of the patient? Thirdly, can thresholds for referral and surgical intervention be agreed upon? Fourthly, can the role of practices such as donor site over-grafting and negative pressure wound therapy be clarified? Fifthly, can a standardised functional end point be obtained and reported? Further studies aimed at making a meaningful contribution to the management of this problem are vital. For the time being, the areas of uncertainty are likely to remain.

The findings of this paper are applicable to both hospital and community practice as the injuries managed in each setting lie along a spectrum of (overlapping) clinical severity. This is clear from the fact that in our series, some patients were managed conservatively while most were managed surgically, but this does not imply that the most severe injuries occur more frequently. Moreover, this suggests a note of caution when utilising a classification system much as the one endorsed in this review, as severity may be considered in the context of the ability to manage the problem. Some primary and community care settings may
be comfortable with managing injuries that others may wish to refer on.

One limitation to this study is that the quality of the evidence to guide practice is poor, or in some cases non-existent. A number of reasons for this are proposed. As previously stated, these injuries present on a wide spectrum of severity, hence general practitioners and practice nurses, community and tissue viability nurses, emergency, medical and care-of-the-elderly physicians and general, trauma and plastic surgeons are all called upon to manage these injuries, depending on local availability and experience. Thus a standardised, comprehensive dataset has yet to be published. While the addition of our own case series is the most comprehensive dataset, it is, like others, subject to the section bias. Additionally (and regrettably), these injuries seldom fall within the sphere of interest of the team required to manage them, hence the results of such management are unlikely to be scrutinised or published. Yet such diverse specialty input may yet prove to be an asset. Owing to the scale and expense of the problem, the scope for the problem to get worse as the population ages, and competing claims for the limited resources available to manage these patients, strategic, multi-disciplinary thinking is vital if improvements in patient care are to be made.

While the review process was conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses, and the search executed using the Cochrane Library reference guide we cannot exclude the possibility that some trials were missed as we discovered that many terms are used in the literature to describe what we have called pretibial lacerations. Certainly, the total number of trials identified was small. The likelihood is, however, that the data does not exist.

Conclusion

Pretibial lacerations, typically resulting from minor extremity trauma to elderly women with medical comorbidities, lead to loss of independence and are implicated in 6-monthly mortality in excess of twice that predicted from age and gender-matched controls. The mainstay of management should be in the community, with surgical intervention restricted to Dunkin types III and IV. Application of the grading system, together with a senior review (using telemedicine if necessary) refines the referral pathway, facilitating prompt, definitive management at first consultation and preventing unnecessary admissions. If surgical intervention is planned, every effort should be made to minimise starvation time and mitigate the risk of cancellation. In-hospital stay should be minimised, aided by pre-emptive discharge planning. Early mobilisation is not detrimental to graft take and may prevent institutionalisation. The use of NPWT should never delay mobilisation and discharge. Prolonged antibiotic courses are not supported by evidence. Over-grafting donor sites may improve healing times. Local referral algorithms must reflect the availability of local services and be usable by primary care and emergency services. Outcome and mortality data are needed so that performance can be audited and improvements made in the care pathway of these complex patients.

Importantly, randomised controlled trials are needed to clarify the details of this management pathway.

Conflict of interest statement

None.

Funding and declarations

GG is in receipt of a grant from the Academy of Medical Sciences for work unrelated to this study. AJ is in receipt of HEFCE clinical senior lecturer award.

Declaration

This work was presented at the European Society of Plastic Surgeons (ESPRAS) meeting 9th July 2014.

References

29. http://www.ukctg.nihr.ac.uk/trialdetails/ISRCTN48457322 [accessed 02.05.13].