Pretibial lacerations

Pretibial lacerations are an increasingly common condition with an estimated incidence of 40–70 per 100 000 per year (Laing and Tan, 2009). They account for up to 5.2 per 1000 emergency department presentations in the UK (Davis et al, 2004). Pretibial lacerations typically occur in the elderly, and are much more common in women (*Table 1*).

As an individual ages, the skin becomes thinner and more fragile as a result of decreased collagen concentration (Shuster et al, 1975). The number of capillaries decreases, leading to less oxygen and nutrients being delivered to the skin. The ageing skin becomes drier and there is an increased likelihood of the epidermis peeling away from the dermis. In addition, the very subcutaneous location of the tibia means that minor blunt forces in this region, commonly resulting from a fall, can result in large skin tears with potentially major soft tissue loss.

When inappropriately managed, pretibial lacerations frequently become chronic wounds. Pretibial lacerations can precipitate a decrease in mobility and independence and are also associated with increased mortality (Cahill et al, 2015).

This article provides an overview of the assessment of pretibial lacerations and an evidence-based approach to their management.

Table 1. Predisposing factors to pretibial lacerations

Increasing age
Female
Systemic steroid use
Poor mobility or balance
Poor vision
Very thin flaps
Distally-based flaps
Haematoma beneath the flap

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History

Patients usually present with an acute laceration which might be isolated or associated with concomitant injuries. Salient points to highlight in the history include the mechanism of injury, with particular focus on whether the fall was mechanical or precipitated by a medical event, other injuries sustained, any comorbidities and the patient's social background (*Table 2*). Patients on anticoagulants are at higher risk of developing an associated pretibial haematoma. Patients on long-term steroids have thinner and more fragile skin, so lacerations tend to be more extensive. Furthermore, patients on steroids or who are immunocompromised in any other way, including diabetic patients, will take longer to heal and are at higher risk of wound infection.

Table 2. Points to highlight in the clinical history

Mechanism and time of injury
Precipitating factors
Other associated injuries
Medical comorbidities
Drug history – especially steroids, anticoagulants
Social history – place of residence, social support
Independence and mobility status

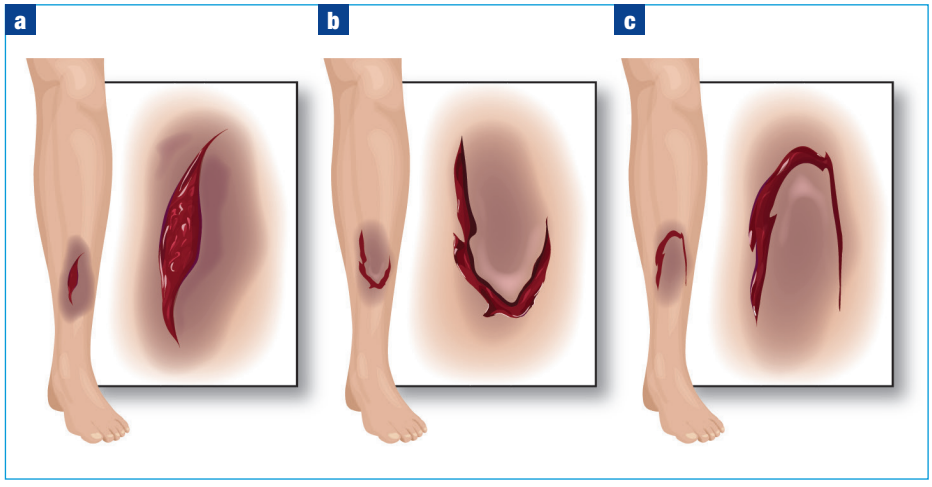
The clinical examination should start with a generalized assessment based on Advanced Trauma Life Support (ATLS) principles to exclude and manage associated life-threatening and then limb-threatening injuries. A focused assessment of the injured limb including its neurovascular status and the wound itself should ensue. Details to note on wound assessment are summarized in *Table 3*. The pretibial laceration can be linear (*Figure 1a*) or more commonly a flap (*Figure 1b*) with a variable degree of skin necrosis (factors increasing the likelihood of skin necrosis include very thin flaps, distally-based flaps and haematoma beneath flap). Flap lacerations can be proximally or distally based (*Figure 1c*). Associated haematomas are common (*Figure 2*).

Thorough irrigation of the wound with warm 0.9% sodium chloride will allow more accurate assessment of the wound as well as removing any debris. Irrigation also reduces the bacterial load within the wound. Devascularized tags of fat and skin should be gently trimmed. Significant haematoma within the wound will provide a culture medium for bacteria and may also cause tension on the overlying skin, increasing the risk of necrosis. Evacuation of haematomas is therefore recommended. This should be

Table 3. Wound assessment

Morphology of laceration (linear, flap, jagged)
Dimensions of wound
Depth of wound (epidermis, dermis, fascia, muscle, bone)
Active bleeding
Haematoma
Signs of infection
Viability of skin edges and skin flap. This can usually be determined by colour – a dark flap or one with a dusky blue edge is likely to be unviable
Skin quality

Figure 1. **a.** A linear pretibial laceration. **b.** A flap laceration. **c.** A distally-based laceration.



performed using a gloved finger and wall suction. Any tense haematomas present beneath unbroken skin can be evacuated by making a small skin incision with a scalpel over the haematoma. This should be carried out cautiously, as dislodging the haematoma could precipitate further bleeding, particularly in the anticoagulated patient. Debridement of the wound, especially if it involves evacuation of a haematoma, may necessitate local anaesthetic infiltration or mild sedation. Inhaled nitrous oxide is usually a good alternative to local anaesthetic.

Photographs of the wound are useful to monitor progress.

Investigations should include plain radiographs of the injured leg (anteroposterior and lateral views) to exclude fractures and radio-opaque foreign bodies. The presence of an open fracture will significantly alter management. Open fractures should be managed as per British Association of Plastic, Reconstructive and Aesthetic Surgeons/ British Orthopaedic Association (Nanchahal et al, 2009) and National Institute for Health and Care Excellence (2016) guidelines. If the patient is on anticoagulants, a clotting screen is indicated. A more detailed preoperative assessment based on the individual patient's risk may be necessary.

Classification

A number of classifications have been proposed to describe pretibial lacerations and guide their management, including those described by Payne and Martin (1990) and Dunkin et al (2003).

Lo et al (2012) proposed a more practical modification of the Dunkin classification (*Table 4*), which places greater emphasis on the degree of viability of the residual skin flap. Lo et al (2012) use their classification as the basis of an algorithm to guide which lacerations will require surgical management (*Table 4*).

Non-operative management

Following initial wound irrigation, a decision can be made as to whether operative or non-operative management is indicated. Crawford and Gipson (1977) demonstrated in that even severe lacerations can heal with non-operative management. In their 48-patient series, the mean time to healing was 65 days with a range of 41–100 days. All 48 patients healed without the need for hospital admission, bed rest or secondary grafting. Indications for non-operative management include:

Figure 2. Pretibial haematoma with overlying necrotic skin.

- Laceration with no skin loss or necrosis
- Clean wound
- Smaller wounds.

Wound closure should be attempted only if the wound is clean and if it is possible to do so without undue tension on the skin. Approximating the wound edges with adhesive paper strips (Steri-strips) is superior to suturing the wound in terms of faster healing times and lower rates of skin necrosis. A prospective randomized trial by Sutton and Pritty (1985) showed that sutured wounds were twice as likely to suffer from skin necrosis.

If sterile closure strips are used, these should be applied without placing tension and with space between the tapes to allow for drainage of exudate and blood.

Dressings

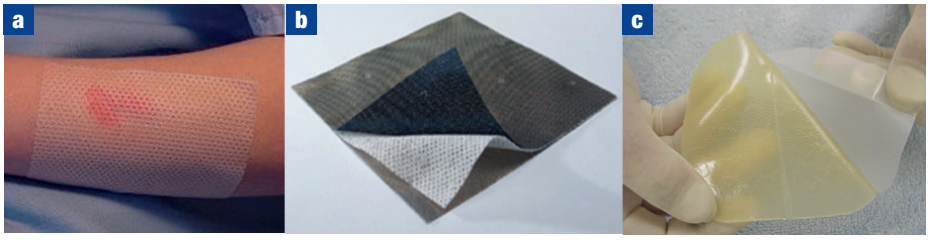
A wide array of dressings have been described for pretibial wound coverage. Dressings in common use include sterile paraffin tulle gras dressing made from open weave

Table 4. Classification and management of pretibial lacerations

Classification		Management
Type I	Linear laceration without skin loss	Manage non-operatively
Type II	Flap laceration viable	Steri-strip in emergency department and manage non-operatively
Type III	Flap laceration non-viable	A small non-viable flap may be excised and managed conservatively with dressings. Larger skin flaps can be primarily excised and skin grafted under local anaesthetic
Type IV	Skin loss	Manage conservatively if less than 1% total body surface area. If fails to heal within 2–3 months consider delayed primary skin graft under local anaesthetic. Alternatively, if local circumstances allow, primary skin graft can be performed under local anaesthetic
Type V	Laceration with haematoma	Will often require surgery. Evacuate haematoma and graft

From Lo et al (2012)

Figure 3. **a.** Silicone-based, **(b)** silver and **(c)** hydrocolloid dressings.



gauze (Jelonet), silicone-based, silver and hydrocolloid dressings (*Figure 3*). At present, no studies have demonstrated one specific dressing to be superior to others in pretibial lacerations.

Silicone-based dressings (e.g. Mepitel) are non-adherent to the wound bed but gently adherent to surrounding skin and are atraumatic on removal. For patients presenting with haematoma or necrotic skin edges, the application of moist wound dressings such as hydrogels, in gel or sheet form, can promote autolytic debridement of non-viable tissue without traumatizing the wound bed. Often the flap sloughs off with non-operative management (*Figure 4*).

In the non-operatively managed patient, gentle normal daily activity should be encouraged. However, the patient should also be advised to elevate the limb when seated to minimize oedema which can delay wound healing.

Operative management

Despite the frequency of pretibial lacerations, their management varies widely within and across hospitals. Even for the more severe lacerations which require tertiary referral, there is conflicting evidence whether to manage these operatively or non-operatively.

Figure 4. A conservatively managed pretibial laceration at 5 weeks post injury – the necrotic skin sloughed off leaving a granulating wound bed. A small area of necrotic tissue remains centrally.

Bearing in mind that Crawford and Gipson (1977) showed that all pretibial lacerations can potentially heal without surgery, the indications to operate need to be carefully considered, especially in view of the fact that the patient is likely to be frail, with multiple comorbidities. There are no objective criteria on which one can base the decision to operate, as no robust studies have been performed in this regard. Indications for surgical management represent expert opinion, but will also be guided by the individual surgeon's preference (*Table 5*).

The decision-making process should take into account the existing and future mobility of the patient, the potential for retaining independence and the effect that treatment may have on existing comorbidities. Hospitalization for surgery in patients with multiple comorbidities may result in deterioration of their general health and independence. If the patient is able to remain at home and continue mobilizing with a good quality of life, conservative management may be preferable. On the other hand, a medically fit, ambulant and independent patient may benefit more from surgery, as several weeks, or even months, in dressings may lead to loss of function and decreased quality of life.

The choice between operative and non-operative management should be made by a senior surgeon and involve the patient. The pros and cons of both treatment options, as well as the likely time to healing, should be discussed with the patient to allow him/her to make an informed decision.

Table 5. Indications for surgery

Lacerations with large necrotic skin flaps
Large area of skin loss (>1% total body surface area)
Major haematoma
Gross wound contamination or infection
Failure of conservative management after 2–3 months

From Lo et al (2012)

Anaesthesia

Excision and grafting of pretibial lacerations has been shown to be as effective (in terms of graft take) when performed under local anaesthesia as when general anaesthesia is used (Budny et al, 1993). When feasible, it is therefore advisable to use local anaesthesia.

The surgical procedure

The wound is debrided, any residual debris and haematoma removed, and copious irrigation with warm 0.9% sodium chloride solution performed. All necrotic tissue should be excised. In most cases, adequate debridement will leave a graftable wound bed. If there is ongoing infection or severe contamination, grafting may be delayed until the wound is clean, and microbiological sensitivities confirmed. If the injury was very severe with resultant exposure of bone or tendons, more advanced reconstructive options, such as free tissue transfer, may be required.

Non-viable skin flaps should be managed by excision and primary split skin grafting, rather than defatting of the flap and replacement over the wound bed to act as a full thickness graft. Split skin grafting involves excising an area of epidermis and variable thickness of underlying dermis from a donor site. The harvested skin, which is completely detached from its blood supply, is placed over the surgically prepared wound bed, from which it will derive nutrients. Within 72 hours, new vascular connections will start forming between the graft and underlying wound bed and the graft will eventually adhere to the wound – a process known as 'take'. Factors which commonly interfere with graft take include infection, sheer and haematoma formation which lifts the graft off the underlying wound.

The graft is usually harvested from the antero-lateral thigh using a Zimmer dermatome (*Figure 5*) or Watson knife (*Figure 6*). It is typically meshed (*Figure 7*) to allow drainage of blood and exudate, applied to the wound bed and secured with tissue glue, absorbable sutures or staples. A robust dressing which does not allow sheering of the graft is then applied. This usually involves a non-adherent dressing directly overlying the

graft (e.g. Mepitel or Jelonet), followed by gauze, wool and crepe bandage. If the graft is directly overlying a joint surface, a splint may be used.

Topical negative pressure dressings can be used as an alternative to simple dressings for securing the graft (*Figure 8*). Although negative pressure dressings are an effective method for 'bolstering' the graft, there is some evidence that their use can lead to increased length of hospital stay (Glass and Jain, 2014).

Timing of surgery

Delay to surgery has a significant effect on outcome. In a 4-year review of patients with pretibial lacerations, Tobuko-Metzger et al (2014) found that patients whose laceration was debrided and skin grafted within 7 days of injury had an average healing time of 55 days *vs* 110 days if surgery was delayed by 8 days or more.

Figure 5. A Zimmer dermatome.

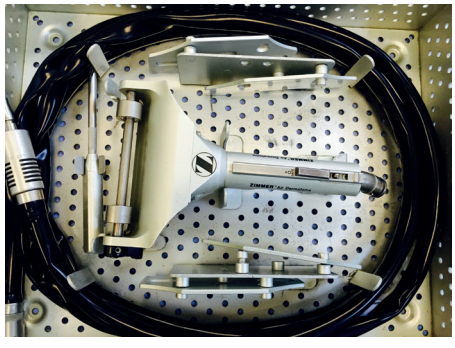
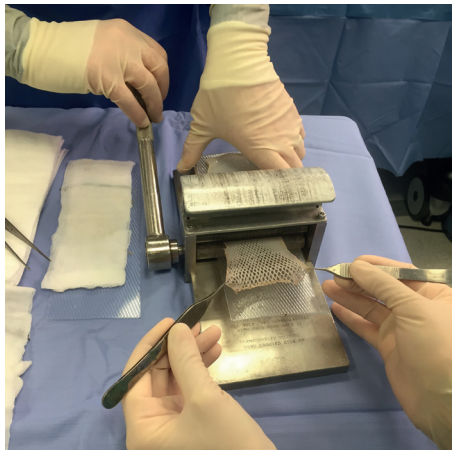


Figure 6. A Watson knife.

Figure 7. Meshing the graft.



> There is clear evidence that early mobilization is more appropriate than bed rest in patients with grafted pretibial lacerations.

Postoperative care

Wound care

The grafted site is typically left undisturbed for 5–7 days. At this point, neovascularization of the graft should have commenced and the dressing change is less likely to disturb the wound. If a splint was used to prevent graft sheer, this can be usually be discarded at the time of the first graft check.

Admission or outpatient care? Bed rest or early mobilization?

There is clear evidence that early mobilization is more appropriate than bed rest in patients with grafted pretibial lacerations. A prospective randomized trial by Budny et al (1993) compared mobilization to bed rest in 61 patients with pretibial lacerations. The study found no statistical difference in percentage graft take between patients who were mobilized immediately and discharged *vs* those who were confined to bed rest for 7 days. They also noted that bed rest hampered the return to mobility in one third of patients.

Figure 8. A topical negative pressure dressing.

Apart from reducing risks related to hospitalization, such as nosocomial infections, early discharge and mobilization also have socioeconomic implications related to reduced bed occupancy. A meta-analysis by Southwell-Keely and Vandervord (2012) confirmed that there is no difference in the healing of split skin grafts to pretibial lacerations in patients managed with early mobilization compared to patients managed with postoperative bed rest. Early mobilization was not associated with an increased incidence of haematoma, bleeding complications, infection or delayed donor site healing.

Antibiotics

Prophylactic antibiotics are not routinely recommended in patients with pretibial lacerations. Teece and Crawford (2004) did not find sufficient evidence to adequately support or reject their use in pretibial haematomas. Furthermore, cohort studies suggest that final wound healing outcomes are not altered by the presence of confirmed infection (Warren et al, 1991).

Complications

Common complications related to pretibial lacerations include wound infections and delayed wound healing (*Table 6*).

If the wound exhibits clinical signs of infection at any point, e.g. cellulitis, increased pain, change in exudate colour or production of purulent fluid, systemic

Table 6. Complications related to pretibial lacerations

Wound infection
Skin necrosis
Delayed wound healing
Complications related to debridement and grafting (bleeding, infection, graft failure, donor site morbidity, adverse scars, contour deformity)
Decline in mobility
Death

KEY POINTS

- Pretibial lacerations are common injuries occurring most frequently in elderly women.
- A thorough assessment of the patient, including mechanism of injury, as well as medical and social history, is essential when reviewing patients with pretibial lacerations.
- As there are no defined guidelines for managing pretibial lacerations, the benefits and risks of operative *vs* non-operative management need to be weighed carefully, taking into account the potential healing time and the patient's comorbidities, mobility and preferences.
- Operative management usually involves wound excision and split skin grafting.
- Long periods of bed rest and inpatient admission should be avoided whenever possible.

antibiotic therapy should be commenced. Intravenous antibiotics and surgical debridement should be considered if infection is severe or the patient is septic. Wound swabs should be obtained when a wound appears clinically infected to determine the causative organism and relevant antibiotic sensitivities.

Warren et al (1991) showed that *Staphylococcus aureus* was the most common pathogen in pretibial wounds. Glass and Jain (2014) also showed that staphylococci were the most commonly prevalent organisms in both non-infected and infected pretibial wounds. Therefore, a good empirical antibiotic for infected pretibial lacerations would be one with good Gram-positive cover such as flucloxacillin or clindamycin, although local antimicrobial prescribing guidelines should be followed.

Despite the close proximity of the tibia to the skin surface, a correlation between pretibial lacerations and osteomyelitis has not yet been documented in the literature. Increased mortality has also been documented as a complication of pretibial lacerations. Cahill et al (2015) showed that up to 6% of patients suffering pretibial lacerations die within the first month after injury, and 26% die within a year of the injury. The mean age of this cohort, which included patients treated both operatively (33.3%) and non-operatively, was 87.9 years and 11% of them had been too medically unfit to have surgery. These figures indicate that the deaths were at least in part attributable to the patients' pre-morbid state as opposed to directly the result of the pretibial injury.

Table 7. Measures to prevent skin lacerations

Patient factors	Use emollient
	Wear long sleeves or stocking
	Apply bandages as a precautionary measure
Environmental factors	Provide adequate lighting
	Look out for small furniture (night table, chair) in the immediate surroundings
	Upholster sharp borders of furniture or bed surroundings with soft material

Prevention

Prevention is an essential component in the management of pretibial lacerations. A study by Bank and Nix (2006) showed that simple interventions such as staff education and padding of side rails can halve the incidence of skin lacerations in a nursing home setting. Other preventative measures are listed in *Table 7*.

Conclusions

Although pretibial lacerations may appear to be simple injuries, they can be associated with high morbidity and mortality. A sound approach to managing pretibial lacerations not only optimizes wound outcomes, but also safeguards the general health of the patient, who tend to be elderly and vulnerable. BJHM

Conflict of interest: none.

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