Foot and Ankle Surgery 20 (2014) 40–43

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Effectiveness of 'in-cast' pneumatic intermittent pedal compression for the pre-operative management of closed ankle fractures: A clinical audit

M.K. Dodds FRCS*, A. Daly BA, K. Ryan MRCS, L. D'Souza FRCS

Department of Orthopaedic Trauma Surgery, The Mid-Western Regional Hospital, Limerick, Ireland

ARTICLE INFO

Article history:
Received 8 September 2013
Accepted 27 September 2013

Keywords:
Ankle fracture
AV compression pump
Soft-tissue condition
Timing of surgery

ABSTRACT

Background: Timing of surgery for ankle fractures is largely dependent on the condition of the surrounding soft-tissues. This study aimed to determine the clinical effectiveness of a pre-operative in-cast artero-venous (AV) impulse device in the management of closed ankle fractures requiring surgery.
Methods: A consecutive series of 64 closed ankle fractures were managed using the AV impulse system prior to surgery. Patients were compared to 73 consecutive closed ankle fractures managed surgically in the same unit immediately prior to the implementation of the AV impulse device study. Outcomes measured were time to surgery, length of hospital stay and surgical site infections.
Results: Median length of time to surgery, hospital stay duration and surgical site infections were all significantly reduced in the study group as compared to the control group.
Conclusions: In-cast intermittent AV compression foot pumps in the pre-operative management of closed ankle fractures were associated with earlier surgery, earlier discharge and reduced complications.

1. Introduction

The optimum timing of surgery for ankle fractures is largely dependent on the condition of the surrounding soft-tissue envelope. The presence of extensive oedema, ecchymosis and fracture blisters are each relative contraindications to surgery and may result in deferment of surgery for several days. Surgery performed within 8 h of injury has been associated with lower rates of wound necrosis and infection than compared to delay of 5 days or more of elevation and immobilization [1,2].

Delay in surgery impacts the patient in the short-term but also increases the burden on an orthopaedic in-patient trauma unit by prolonging the pre-operative interval and total hospital stay.

Numerous interventions have been developed to control soft-tissue swelling including elevation, compressive dressings and splint immobilization. More recently, cryotherapy and pulsatile compressive devices have been employed. Several studies have shown each of these to be effective in reducing oedema faster than simple elevation and immobilization [3–7].

The use of in-cast AV impulse devices has previously been shown to reduce oedema by means of measurement of ankle and toe girths [3–7]. To our knowledge, there has been only one study examining the clinical advantage of these devices [8], though this study had significant limitations.

The purpose of this study was to determine whether the use of an in-cast AV impulse device reduced time to surgery in ankle fractures. We also examined the total hospital length of stay, the frequency of surgical site infection and performed a cost analysis comparison.

2. Patients and methods

2.1. Control group

The authors retrospectively reviewed a consecutive series of closed ankle fractures admitted for surgical management between 1st January 2007 and 31st December 2007. During that period, the standard preoperative management consisted of early relocation of the ankle in the emergency department, application of a back-slab splint, analgesia, cryotherapy with ice-packs and elevation.

Inclusion criteria were all closed ankle fractures or fracture-dislocations in adults aged 16 yrs or older requiring surgery. Patients were excluded with open fractures, fractures of the tibial plafond (not posterior malleolus fractures) or concurrent ipsilateral lower limb DVT. Patients with diabetes or peripheral vascular disease were not excluded. Patients were identified from the operating theatre register. Data was obtained from individual medical records on patient demographics, date of admission, date of surgery, date of discharge, surgical site complications.

* Corresponding author. Tel.: +353 877955050.
E-mail address: Michaeldodds200@gmail.com (M.K. Dodds).

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http://dx.doi.org/10.1016/j.fas.2013.09.004

Pre-operative radiographs and operation notes were reviewed to determine fracture type.

For the purpose of audit, we performed a literature review of alternative therapies and based on this chose to implement the 'In-cast AV impulse system' pre-operatively for all closed ankle fractures. This formed the basis for the study group.

2.2. Study group

A consecutive series of patients was prospectively studied between November 2008 and October 2009. Data was obtained in the same fashion as for the retrospective review group. The same inclusion/exclusion criteria were applied.

The AV impulse device (low-profile under cast pad, Covidien AG, Mansfield, MA, USA) was applied to the patient's foot between a single layer of wool and stockinette and a backslab (Fig. 1). Radiographs were performed to confirm satisfactory reduction of the ankle mortice. After 1 h, the AV impulse pad was connected to the pump and intermittent compression therapy was commenced at 1 s impulses of 120 mm Hg at a rate of 3 pulses per minute. This was continued until the patient was brought to surgery. Prior to the study, education and training sessions were arranged for orthopaedic staff, emergency department nurses and doctors and plaster nurses, who were to apply the device. In situations where ankles were immobilized in backslabs without AV pumps, or inadequately reduced, the backslab would be changed in the emergency department and a pump applied. Compression therapy would usually commence in the emergency department and be continued on the ward until the time of surgery.

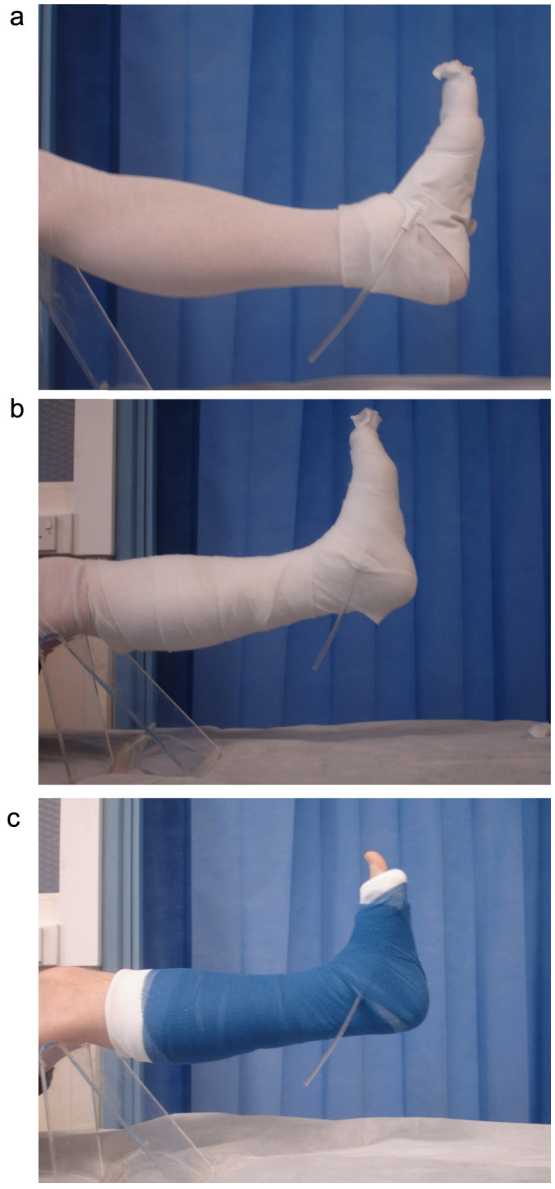

Fig. 1. (a) Application of in-cast pad over stockinette and single layer of wool. (b) Wool applied in a standard fashion. (c) Completed backslab with insufflation tube available for attachment to pneumatic pump.

2.3. Perioperative management

The trauma unit where the study was performed runs a theatre list every day of the week, though at weekends, shares theatre resources with other surgical specialties. For both the control and study groups, patients were brought to theatre on the next operating list provided the soft-tissue envelope was deemed satisfactory by the operating surgeon. This decision was based upon visual inspection typically utilizing the wrinkle sign, or pinch test on the skin. Thigh tourniquets were routinely used. Surgical drains were not. All patients received a per-operative dose of cefuroxime 1.5 g intravenously prior to tourniquet inflation, and 2 post-operative doses of cefuroxime 750 mg intravenously at 8 and 16 h unless there was a history of penicillin allergy, in which case an alternative antibiotic was prescribed. Clexane 40 mg subcutaneous injection once daily was prescribed throughout the in-hospital stay until discharge. Patients were discharged post-operatively when medically fit to do so and when deemed safe for discharge by the orthopaedic physiotherapy service. Surgical site infections (SSI) were defined as those with increased wound oedema and cellulitis requiring oral or intravenous antibiotic therapy as documented in the clinical records. Culture swab results were not used to define SSI as the false positive rate from commensal organisms would be misleading.

2.4. Statistical analysis

The two groups were compared in terms of patient demographics of age, sex and fracture type. We calculated the median length of time to surgery, total hospital length of stay and recorded episodes of surgical site complications. The median length of stay was chosen as it is more robust against potential skewing from outlying data. We also calculated the mean length of stay for patients' length of stay. Differences between the two groups were tested for statistical significance using the Mann–Whitney *U* test. A post hoc power analysis was performed. In order to detect a real difference between the two groups of one day or more, with a power of 0.9 a total of 46 patients would be required in the study (23 in each group).

3. Results

There were 73 patients in the standard practice group and 64 patients in the AV impulse study group. Patient and fracture demographics are shown in Table 1.

All patients in the study group complied with the AV therapy pre-operatively and no patients were excluded for non- or poor compliance.

The median values (range) for pre-operative length of stay for the control and the study groups were 2 days (0–10 days) and 1 day (1–3 days), respectively. The distribution in the two groups differed significantly (Mann–Whitney $U = 1696$; $N_{control} = 73$; $N_{study} = 64$; $P = 0.0025$ (2-tailed)). The distributions and ranges for individual values of the two groups are shown in Fig. 2.