

# A systematic review of compression treatment for venous leg ulcers

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## Abstract

**Objective:** To estimate the clinical and cost effectiveness of compression systems for treating venous leg ulcers.

**Methods:** Systematic review of research. Search of 19 electronic databases including Medline, CINAHL, and Embase. Relevant journals and conference proceedings were hand searched and experts were consulted.

**Main outcome measures:** Rate of healing and proportion of ulcers healed within a time period.

**Study selection:** Randomised controlled trials, published or unpublished, with no restriction on date or language, that evaluated compression as a treatment for venous leg ulcers.

**Results:** 24 randomised controlled trials were included in the review. The research evidence was quite weak: many trials had inadequate sample size and generally poor methodology. Compression seems to increase healing rates. Various high compression regimens are more effective than low compression. Few trials have compared the effectiveness of different high compression systems.

**Conclusions:** Compression systems improve the healing of venous leg ulcers and should be used routinely in uncomplicated venous ulcers. Insufficient reliable evidence exists to indicate which system is the most effective. More good quality randomised controlled trials in association with economic evaluations are needed, to ascertain the most cost effective system for treating venous leg ulcers.

## Introduction

Leg ulceration, usually of venous origin,<sup>1</sup> is a common chronic recurring condition usually managed in primary care, and it is expensive to treat.<sup>2,3</sup> Compression treatment, in the form of bandaging or hosiery, is regarded as the first line of treatment when venous leg ulceration occurs in the absence of clinically important arterial disease (table 1).

Considerable uncertainty remains, however, about the most effective treatment, and methods vary widely. A systematic review was therefore commissioned by the NHS health technology assessment programme to examine the effectiveness of compression systems for the treatment of venous leg ulcers.

## Methods

We conducted a systematic review using structured guidelines.<sup>4</sup> We undertook an electronic search of 19 specialist databases including Medline, CINAHL, and EMBASE and supplemented our search with hand searching, scrutiny of citations, and contact with relevant manufacturers and original authors (appendix). Details of search terms are available in the Cochrane Library database.

All randomised controlled trials examining the effect of compression on the healing of venous leg ulcers were considered, with no restrictions on publication status, date, or language. Decisions over inclusion of studies were made on the basis of a series of predetermined validity criteria, which, along with data extraction, were checked by a second reviewer.

**Table 1** Compression systems commonly used in management of venous leg ulcers\*

Type of compression	Examples	Performance characteristics
High elastic compression	Tensopress† (Smith and Nephew); Setopress† (Seton); Surepress† (Convatec)	Sustained compression; can be worn continuously for up to 1 week; can be washed and reused
Light compression or light support	Elastocrepe† (Smith and Nephew)	Low pressures obtained; used alone it gives only light support; a single wash reduces pressures obtained by about 20%
Light support only	Crepe† (many manufacturers)	For holding dressings in place, as a layer within a multilayer bandage, for light support of minor strains and sprains; pressures from crepe alone are too low to be effective in management of venous ulcers; 40-60% of pressure lost in first 20 minutes after application
Cohesive bandages	Tensoplus Forte† (Smith and Nephew); Coban† (3M)	Self adherent, so it prevents slippage; useful over non-adhesive bandages such as Elastocrepe and paste bandages; compression well sustained
Multilayer high compression	"Charing Cross" four layer bandage comprising orthopaedic padding, crepe, Elset, and Coban; other multilayer systems are in use (eg orthopaedic padding, Tensopress, shaped tubular bandage)	Designed to apply 40 mm Hg pressure at the ankle, graduating to 17 mm Hg at the knee, sustainable for a week
Inelastic compression	Short stretch bandage—eg Comprilan (Beiersdorf)	Principal bandage in mainland Europe; reusable with slight stretch, giving low resting pressure but high pressure during activity
	Unna's boot	Non-compliant, plaster-type dressing used in United States
Compression stockings	Class I—light support	Used to treat varicose veins
	Class II—medium support	Used to treat more severe varicosities and to prevent venous ulcers in patients with thin legs
	Class III—strong support	For treatment of severe chronic venous hypertension and severe varicose veins and to prevent ulcers in patients with large diameter legs

\*Adapted from Morison.<sup>27</sup>

†Often used as component of multilayer system.

The results of trials making similar comparisons, in which the results were homogeneous, were pooled by using a fixed effects (Peto) method, which weights each study by the inverse of its variance.<sup>5</sup>

## Results

We identified 24 relevant randomised controlled trials, of which six are unpublished (Colgan et al, Gould et al, Kralj et al, London et al, Morrell et al, Taylor et al).<sup>6-23</sup> Details of all these trials will be available in *Effective Health Care*<sup>24</sup> and in the Cochrane Library database.

### Compression v no compression (six trials)

Three trials compared the use of compression (provided by Unna's boot) with the use of dressings alone (fig 1). Two of these found a higher proportion of healed ulcers when compression was used. The third, small study showed a non-significant increase in healing with Unna's boot.

Three other studies that compared different forms of compression (short stretch, two layer, and four layer bandages respectively) with treatments using no compression showed that healing improved with compression (fig 1).

### Elastic multilayer high compression bandages v inelastic compression (six trials)

Three studies compared elastic, high compression, three layer bandages with low compression. The results of these studies were pooled (test for heterogeneity  $\chi^2 = 0.93$ ,  $df = 2$ ,  $P > 0.7$ ) and showed an overall significant increase in the odds of healing at 3 months with high compression bandages (odds ratio = 2.26; 95% confidence interval 1.4 to 3.7) (fig 2).

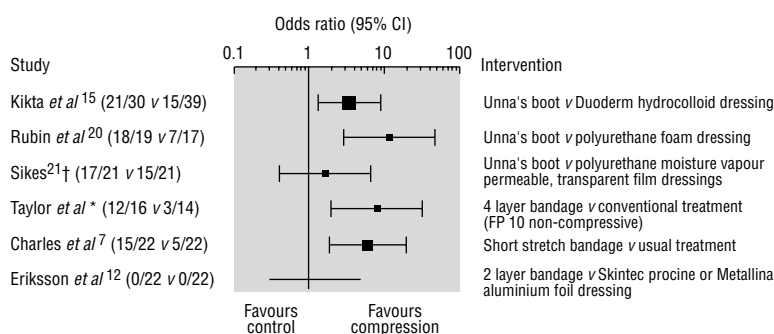
Three small studies found no difference between multilayer high compression (four layer bandages) and two forms of inelastic compression (Unna's boot and short stretch bandage) (fig 3). Both four layer and short stretch bandages resulted in higher healing rates than a paste bandage plus outer support (44%, 40%, and 23% of cases respectively healed at 3 months).

### Multilayer high compression systems v single layer systems (four trials)

Figure 4 shows the results of these trials. Four layer bandages were shown to increase the percentage of ulcers healed at 24 weeks and 12 weeks in two trials when compared with single layer compression bandages (Setopress or Granuflex). Two similar but much smaller studies found no difference in healing between four layer or three layer bandages and self adhesive single layer bandages. Pooling the studies (test for heterogeneity  $\chi^2 = 2.24$ ,  $df = 2$ ,  $P < 0.01$ ) showed that multilayer high compression bandages were associated with a higher rate of complete healing than single layer bandages (fig 4) (odds ratio = 2.2; 95% confidence interval 1.3 to 3.5).

### Comparisons between different medium and high compression systems (four trials)

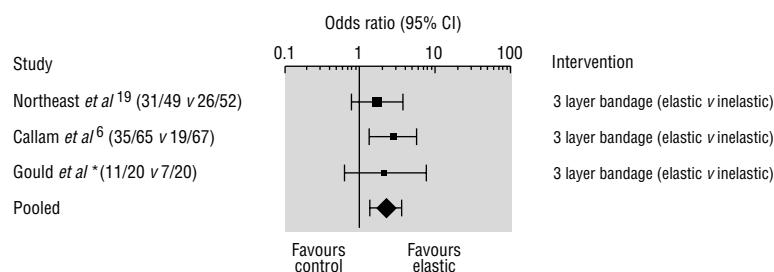
The original "Charing Cross" four layer bandage has been compared with a kit that provides all the constituents to make up a four layer bandage<sup>11</sup> and with a regimen adapted to achieve similar levels of compression by using materials available on prescription.<sup>23</sup> No



\* Unpublished.

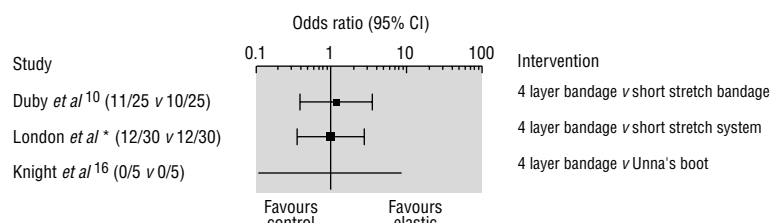
† Analysis based on multiple ulcers rather than patients, so analysis is inappropriate.

**Fig 1** Estimate of effect of compression treatment versus no compression (complete healing, after varying lengths of treatment)



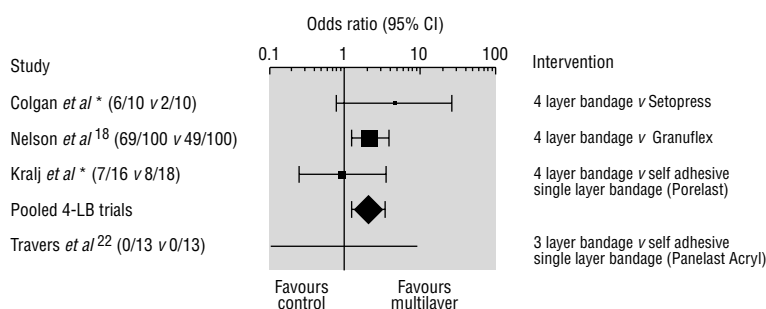
\* Unpublished.

**Fig 2** Estimate of effect of elastic multilayer high compression versus inelastic multilayer compression (complete healing, after varying lengths of treatment)



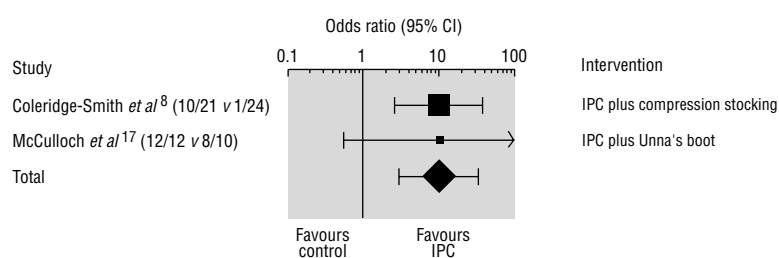
\* Unpublished.

**Fig 3** Estimate of effect of elastic multilayer high compression versus inelastic compression (complete healing, after varying lengths of treatment)



\* Unpublished.

**Fig 4** Estimate of effect of multilayer elastic high compression versus single bandage (complete healing, after varying lengths of treatment)



**Fig 5** Intermittent pneumatic compression (IPC) versus no intermittent pneumatic compression (complete healing, after varying lengths of treatment)

significant difference in outcome was found in either study, although the second trial was very small. Another small study found no difference in the number of ulcers healed at 12 weeks between four layer bandages (6/10) and a combination of three

bandages plus class II compression stockings (7/10) (Colgan *et al*).

A trial of only 30 patients comparing Unna's boot with moderate compression provided by a single bandage (Coban) found no difference in healing at 12 weeks.<sup>9</sup>

A trial directly comparing four layer and three layer bandages is in progress at St Thomas's Hospital, London.

**Compression hosiery v compression bandaging (two trials)**

A trial of 50 patients found that 84% of ulcers treated with a combination of two compression stockings (Thrombo and Sigvaris 503) healed completely at 3 months compared with 52% of those treated with a short stretch bandage (odds ratio 4.9; 95% confidence interval 1.3 to 18.3).<sup>14</sup> A small, poor quality trial found

**Table 2** Quality of randomised controlled trials of compression treatment for venous leg ulcers

Trial	Inclusion and exclusion criteria	Sample size (arms)	A priori sample size calculation	Method of randomisation	Baseline comparability of treatment groups	Blinded outcome assessment	Appropriate outcome measures	Intention to treat analysis
Callam <i>et al</i> <sup>6</sup>	Yes	132 (2)	Not stated	Not stated	Yes	Not stated	Yes	Not stated
Charles <sup>7</sup>	No	53 (2)	Not stated	Not stated	Not clear	No	Yes	No
Coleridge-Smith <i>et al</i> <sup>8</sup>	Yes	45 (2) 58 ulcers	Not stated	Coin toss	No	Not stated	Yes	NA
Colgan <i>et al</i>	Yes	30 (3)	No	Sealed envelope	Median initial ulcer size larger in Setopress group median ulcer duration higher in UB group	No	Yes	Yes
Cordts <i>et al</i> <sup>9</sup>	Yes	43 (2)	No	Not stated	Yes	Not stated	Yes	No
Duby <i>et al</i> <sup>10</sup>	No	67 (3) patients, 76 legs	Not stated	Not stated	Yes (except longer mean ulcer duration in paste group)	Not stated	Yes	No
Eriksson <sup>12</sup>	Yes	44 (3)	Not stated	Not stated	Yes	Not stated	Yes	Not stated
Gould <i>et al</i>	Yes	38 (2) patients, 48 legs	Not stated	Not stated	Yes	Yes	Yes	No
Hendricks <i>et al</i> <sup>13</sup>	No	21 (2)	No	Not stated	Not stated	Unclear	Yes	No
Horakova <i>et al</i>	No	59 (2)	Not stated	Surname (quasi-random)	No, stocking group contained larger ulcers of longer duration	Not stated	Yes	No
Kikta <i>et al</i> <sup>15</sup>	Yes	45 (2) patients, 58 ulcers	Not stated	Coin toss	Yes	Not stated	Yes	No
Knight <i>et al</i> <sup>16</sup>	No	10 (2)	Not stated	Not stated	Not stated	Not stated	No	Not stated
Krajc <i>et al</i>	Yes	40 (2)	Not stated	Sealed envelope	Yes	Not stated	Yes	Not stated
London <i>et al</i>	Yes	30 (2) (stratified ulcer size)	No	Sealed envelope	Yes	No	Yes	Yes (at 3 months but not at one year)
McCullum <i>et al</i> <sup>11</sup>	Yes	232 (2)	Yes	Not stated	Yes	No	Yes	Yes
McCulloch <i>et al</i> <sup>17</sup>	No	22 (2)	Not stated	Medical record number	Yes	Not stated	Yes	NA
Morrell <i>et al</i>	Yes	233 (2)	Yes	Sealed envelope	Yes	No	Yes	Yes
Nelson <i>et al</i> <sup>18</sup>	Yes	200 (2)	Yes	Sealed envelope	No	No	Yes	Yes
Northeast <i>et al</i> <sup>19</sup>	Yes	106 (2)	No	By computer	Yes	Yes	Yes	Not stated
Rubin <i>et al</i> <sup>20</sup>	No	22 (2)	Not stated	Medical record number	Yes	Not stated	Yes	No
Sikes <sup>21</sup>	No	13 (2)	Not stated	Alternate allocation	Mean ulcer duration longer in OpSite group	Not stated	Yes	NA
Taylor <i>et al</i>	No	36 (2)	Not stated	Minimisation	Yes	Not stated	No	Yes
Travers <i>et al</i> <sup>22</sup>	No	27 (2)	Not stated	Not stated	No	Not stated	Yes	NA
Wilkinson <i>et al</i> <sup>23</sup>	Yes	29 (2) patients, 35 legs	Not stated	Not stated	Yes	No	Yes	Yes

Trials without a reference were unpublished.

no difference between compression stockings and Unna's boot.<sup>13</sup>

### Intermittent pneumatic compression treatment (two trials)

Two small studies evaluated the benefit of adding intermittent pneumatic compression to compression stockings or Unna's boot (fig 5). A pooled estimate (test for heterogeneity  $\chi^2 = 0$ ,  $df = 1$ ) shows that the overall odds of healing increased with intermittent pneumatic compression (odds ratio = 10.0; 95% confidence interval 3.0 to 33.8).

## Discussion

The results suggest that the healing of venous ulcers is improved when compression is applied as bandages or hosiery. High compression delivered in three or four layers performs better than systems giving low compression and possibly better than single layer systems. The few small studies that have compared different high compression systems—for example, multilayer and short stretch bandages and Unna's boot—have shown no difference in effectiveness. Intermittent pneumatic compression when added to compression treatment seems to confer a significant benefit.

When clinics have specifically promoted the delivery of four layer high compression treatment their healing rates have improved compared with results for the usual care given by community nurses (Morrell et al, Taylor et al).<sup>25</sup> It is not easy, however, to disentangle the effects of the model of care, the associated training, and the type of bandaging used.<sup>26</sup>

The quality of research in this area is generally poor: trials are often too small, follow up is short, recurrence of ulcers is rarely considered, and sometimes multiple ulcers are incorrectly regarded as independent ulcers (table 2). Several papers do not report the method of bandage application, the experience of staff, other aspects of bandaging, and patients' mobility, which all affect healing. The same system applied by different staff under different circumstances may result in the attainment of widely differing pressures, making interpretation difficult.

It is not clear which of the high compression systems is the most cost effective. Rather than advocate one particular system it would seem more sensible to promote the increased use of any correctly applied high compression treatment in patients with uncomplicated venous disease. Well designed randomised controlled trials incorporating economic evaluations are needed to help determine the optimal strategy.

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Conflicts of interest: None.

## Key messages

- Compression treatment increases the healing of ulcers compared with no compression
- High compression is more effective than low compression but should only be used in the absence of significant arterial disease
- No clear differences in the effectiveness of different types of compression systems (multilayer and short stretch bandages and Unna's boot) have been shown
- Intermittent pneumatic compression appears to be a useful adjunct to bandaging
- Rather than advocate one particular system, the increased use of any correctly applied high compression treatment should be promoted

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## Appendix

### Databases searched

ISI Science Citation Index (on BIDS); BIOSIS (on Silver Platter); British Diabetic Association Database; CINAHL (on

OID CD ROM); CISCOM, the database of the Research Council for Complementary Medicine; Cochrane Database of Systematic Reviews (CDSR); Cochrane Wounds Group register of trials; Current Research in Britain (CRIB); Database of Abstracts of Reviews of Effectiveness (DARE); Dissertation Abstracts; DHSS Data (on Knight-Ridder Datastar); EconLit; Embase (on Knight-Ridder Datastar); Index to Scientific and Technical Proceedings (searched on BIDS); Medline (on OVID CD ROM); National Research Register (to locate ongoing research in NHS); NHS Economic Evaluation Database (NHS Centre for Reviews and Dissemination); Royal College of Nursing Database (CD ROM); System for Information on Grey Literature in Europe (SIGLE, on Blaise Line).

# The beefburger injury: a retrospective survey

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Injuries to the hand in the home are common and form a substantial proportion of hand injuries seen in accident departments.<sup>1-3</sup> Two of us (AFSF and JS) recognised an increasing number of cases of a characteristic and preventable injury, caused by the person trying to separate stacked frozen food items with a sharp knife. We therefore reviewed the case notes of patients at three hospitals and also examined the Department of Trade's home accident surveillance system database for similar injuries.

## Methods and results

Between February 1992 and July 1995 we identified 27 patients at four hospitals (Sunderland District General; Shotley Bridge; Withington, Manchester; and St Andrew's, Billericay). Cases were identified by alerted surgeons and by a review of the notes of patients with knife wounds, supplemented where necessary by telephone interview with the patient.

Three patients were treated in the accident and emergency department and the remainder admitted and treated by hand surgeons. All the patients injured their non-dominant hands. Eleven patients injured their palm and 16 their fingers. The injured structures varied from skin only to all structures on the palmar surface of a digit. There were 16 nerve injuries, nine tendon lacerations, and one volar plate injury. Two patients required revascularisation. Two patients ruptured their flexor tendon repairs: one was successfully re-repaired, the other needed tendon grafting. Two patients needed nerve grafting, one after infection, the other because of poor regrowth. Only six patients had skin lacerations alone.

Data from the home accident surveillance database for 1991 showed 32 patients with accidental injuries of a cutting or piercing type involving frozen articles. There were many similarities with our cases. In both our series and the database, beefburgers were the food most commonly responsible for the accidents (17 and 13 cases respectively), but chops, sausages, crumpets, and pastry featured in both series. The sex ratio (22 and 25 women respectively) and age profile (both mean age of 33 years) were also similar.

## Comment

We probably missed some cases in our hospitals because the notes do not always record how injuries occur. Nevertheless, we have identified a substantial number of cases of hand injury caused by trying to separate frozen foods, and the data from the home accident surveillance system suggest the injury is common. Some 14-21% of the 3.5 million patients who attend hospitals or general practitioners for trauma have hand injuries.<sup>1-3</sup> The time off work after hand injury averages three weeks,<sup>4</sup> though after tendon injury it may be as long as three months. Hands with nerve injuries rarely recover their previous level of function. The cost of hand injury is high,<sup>4</sup> and poor treatment will prolong recovery times and costs. Even trivial hand injuries can leave the injured hand stiff and painful<sup>3</sup> if treated incorrectly, so referral to experienced hand surgeons is important.

An understanding of the mechanisms of hand injury is important in injury prevention. The role of hand surgeons in preventing accidents has been emphasised.<sup>5</sup> We have tried here to draw attention to a type of hand injury that can cause severe morbidity, yet is avoidable. Although the injured person may be mainly at fault in such accidents, manufacturers could mitigate the possibility of injury. Freezing items individually using non-adherent film between the items of food would probably prevent these injuries. We believe that packets of such frozen foods should at least carry a prominent warning of the risk of this injury and instructions on how best to separate frozen foods.

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Conflict of interest: None.

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