Negative pressure wound therapy as an adjunct to compression for healing chronic venous ulcers

- **Objective:** To determine the efficacy of negative pressure wound therapy (NPWT), when used in combination with compression bandaging, for healing chronic resistant venous ulcers.
- **Method:** In this pilot study, seven patients (with a total of 12 chronic resistant venous ulcers) received adjunctive NPWT and compression bandaging for 4 weeks. Their wounds were monitored for a total of 12 weeks.
- **Results:** Dormant ulcers were seen to rapidly develop into healthy wounds, with a granulating base.
- **Conclusion:** This regimen may have a role in stimulating chronic venous ulcers into healing wounds, or in preparing them for skin grafting.

**Materials and method**

Patients were recruited from a community wound clinic. Inclusion criteria were patients with venous ulcers that had failed to heal despite >12 weeks of 40mmHg compression therapy, an ulcer surface area at least 2cm² and less than 10% reduction in ulcer area during a 2-week observation period immediately before the study began. Exclusion criteria were concomitant peripheral arterial disease (ABPI<0.8) and atypical ulcers (e.g. vasculitic ulcers).

Ethics approval was provided by the regional ethics committee.

Patients received adjunctive NPWT, placed under multilayered elastic compression bandages. Compression therapy was maintained at 40mmHg. This treatment regimen was continued for 4 weeks, with dressings changed three times per week, as 4 weeks was considered sufficient time to allow for a clinically significant change in the state of wounds.

NPWT was achieved using the VAC freedom device, which was set to continuous suction applied at 40mmHg. This treatment regimen was continued for 4 weeks, with dressings changed three times per week, as 4 weeks was considered sufficient time to allow for a clinically significant change in the state of wounds.

At each dressing change, ulcer surface area was measured using acetate tracings. The nature of the...
ulcer base was assessed semi-quantitatively, using visual percentile estimations of granulation tissue at the wound bed. A single observer estimated the granulation tissue percentage of all wounds.

**Statistical analysis**

Statistical analysis of the granulation tissue percentage and the surface area of ulcers was conducted using the Wilcoxon signed rank test. All tests were two-tailed and significance was set at p<0.05. Results compared day n with day 0. Some patients had more than one ulcer, so two separate analysis was performed; one on a per patient basis and the other on an ulcer basis.

**Results**

Seven patients were included in the study with a median age of 75 (range 56–82) years and a male to female ratio of 1:1.3. Twelve refractory ulcers had been present in these patients for a median duration of 23 months (range: 9–62).

Combined NPWT/compression was generally well tolerated. One patient (with two ulcers) needed white foam due to pain at dressing change with black foam. Infection was confirmed in one patient (with four ulcers) 10 days after the cessation of NPWT.

NPWT appeared to stimulate rapid development of granulation tissue in the ulcer bed of all patients. By the first dressing change there was a statistically significant (p<0.05) increase in granulation tissue. Within 2 days (one dressing change) of initiating NPWT, the mean percentage of granulation tissue increased from 30.8% (±38.6%) to 100%, and remained at or close to 100% throughout the NPWT phase of the study. This amount of granulation tissue slowly reduced following cessation of the NPWT therapy. Fig 1 demonstrates the mean change in granulation tissue per patient against time.

There were statistically significant reductions in ulcer surface area during the first week of NPWT therapy. However, this reduction was not sustained and by the time NPWT therapy finished there were no significant differences in ulcer area. While there appeared to be a reduction in ulcer surface areas during management with compression alone, this was not statistically significant. Fig 2 displays a chart of the mean (± standard error of the mean [SEM]) changes in ulcer surface area against time (weeks).

Continued compression therapy for 2 weeks beyond our study period achieved complete ulcer healing in two patients (two ulcers).

**Discussion**

In this case series, NPWT appeared to rapidly convert the wound bed into the granulation phase of healing and removed overlying slough from the ulcer bed by the first dressing change. However, early reductions in surface area were not maintained throughout the study period, and following cessation of NPWT therapy reductions in ulcer surface area did not reach statistical significance.

This pilot study suggests that NPWT therapy may have a role to play in preparing the bed of refractory wounds by rapidly stimulating the development of granulation tissue as a substrate for subsequent ulcer healing. This increase in granulation tissue may result in more rapid healing, but further investigation is required.

The small number of participants in this pilot pre-
cluded the use of independent controls. Patients served as their own controls; by extrapolating prior wound changes, it was suggested that they would have remained in a static state throughout the study period had the intervention not been applied. Prior to enrolment, some participants were having dressing changes once weekly, while was increased to three times weekly during the study. It is not clear if this played a role in the stimulation of healing.

Granulation tissue formation was semi-quantitatively assessed by examining the wound surface. While the same investigator conducted all measurements, this semi-quantitative approach is prone to bias. Future studies should aim to definitively measure this factor and perhaps also assess other variables, such as wound re-epithelisation.

Generally, black foam was well tolerated, although one participant required a white foam substitute due to pain at dressing change. The patient was given topical 1% lignocaine, infused through the black foam, but this was ineffective and merely prolonged the consultation. White foam was ultimately well tolerated in this case.

Ten days following the cessation of NPWT, the presence of wound infection was confirmed in all four ulcers in one patient (patient 6). This appears to have been a sporadic infection as there is no known association between NPWT and infection. Following this, all four ulcers increased in surface area, which may account for the lack of statistical significance when considering the observed trend towards a reduction in surface area post-NPWT therapy.

Statistical analysis was performed on 12 ulcers rather than 7 patients. This was because some patients had NPWT on both lower limbs and it was felt that analysis on a patient basis would not account for the variation in limb healing. However, two or more ulcers on the same patient are themselves not independent and may affect these results.

Our results suggest that NPWT could act as a preparatory apparatus for resistant ulcers. A proposed mechanism would be that NPWT initiates granulation tissue formation in the dormant ulcer, following which the wound is primed for continued wound bed epithelial growth and stimulated to progressively heal.

The lack of reduction in total ulcer surface area during the study period suggests that the sustained use of NPWT (beyond the period required to develop granulation tissue) may, in fact, counteract healing due to the recurrent wound trauma at dressing change. Two patients’ ulcers healed completely 2 weeks after the study end.

This is the first published trial of the use of NPWT in the treatment of chronic resistant venous ulcers. However, global results on the efficacy of NPWT for a multitude of different wound types suggest it has a role to play in the treatment of venous ulcers.

This study displays a potential use of NPWT, in combination with compression therapy, in stimulating the healing of chronic resistant venous ulcers or in preparing them for further treatments, such as skin grafting.

However, this treatment is both labour intensive and costly. Furthermore, patients have to cope with a bulky and potentially uncomfortable device. Therefore, while this study offers promise in the field of venous ulcers and vascular surgery, it must be emphasised that this is a pilot study and that further research is required.

References
8 Kaplan, M. Negative pressure wound therapy in the management of abdominal compartment syndrome. Ostomy Wound Manage. 2004; 50: (Suppl. 11A), 20–25.