Role of Negative Pressure Wound Therapy in Plastic Surgery-Its Basics, Indications and Contraindications

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Abstract—Negative pressure wound therapy (NPWT) is one of the most advanced technologies in wound treatment. It enhances wound healing by multiple mechanisms related to wound-host interactions. It can be utilized in a wide range of acute and chronic conditions, with reduced need for hospitalization and early recovery in complicated cases. Every new technology has its science behind it, so this article shall review the basics behind NPWT, indications and contraindications for its usage.

Keywords — Negative pressure-assisted wound therapy (NPWT).

I. THE BASICS OF NPWT

NPWT enhances wound healing by multiple mechanisms related to wound-host interactions. There are multiple physical effects of negative pressure suction forces, topical pressure and shearing forces. These mechanisms have to be understood before its usage in various clinical indications.

II. NEGATIVE PRESSURE SUCTION FORCES

These suction forces have been reported to reverse lymphatic flow, reduce bacterial count, evacuate wound fluids, decompress tissue oedema and induce granulation tissue formation.

III. REVERSAL OF LYMPHATIC FLOW

A distortion from the regular elliptical pattern of lymphatic flow away from the wound, towards regional lymph nodes was demonstrated by the application of NPWT to the wound. Dye injected in close proximity to the wound’s margins demonstrated a reverse flow pattern with a shift towards the wound, indicating a reversal of lymphatic flow from the surroundings of the wound towards the low pressure source. The reversal of lymphatic flow is of clinical significance since it aids in bacterial clearance from the wound, hence reduced need for hospitalization, antibiotic treatment and early recovery.

IV. INDUCTION OF GRANULATION TISSUE FORMATION

NPWT was reported to induce and accelerate granulation tissue formation in porcine and rabbit wound models. Studies examining the rate of granulation tissue formation in swine wounds showed that the 125 mmHg pressure treated wounds filled with granulation tissue significantly faster than 25 mmHg and 500 mmHg treated wounds. NPWT may induce granulation tissue to cover exposed bones and tendons, enabling coverage with skin grafts.

V. REDUCTION OF TISSUE OEDEMA

Crush injuries, complex fractures and burns have increased soft tissue oedema and interstitial pressure. The integrity of the capillary basement membrane of blood vessels is damaged during wounding, leading to increased permeability of capillaries and oedema, followed by decreased peripheral perfusion and ischaemia. Chen et al. reported restoration of the integrity of the basement membrane and narrowing of the endothelial spaces following NPWT.

VI. TOPICAL PRESSURE

Application of sub-atmospheric pressure to the wound was shown, by laser Doppler measurements, to result in an immediate increase in tissue perfusion and was claimed to be an important factor accounting for the favorable effects of NPWT. This increase in blood flow has been challenged by various studies and it is said that excessive topical pressure with hard non-compressible tubing may lead, in extreme cases, to ischaemia and necrosis. Kairinos et al. have also challenged previous reports claiming increased blood flow by NPWT based on Doppler measurements. They suggest that the application of negative pressure to the wound may, initially, partially occlude the underlying compressible vessels with the compensating increase in blood velocity in the wound’s capillaries, misinterpreted by laser Doppler readings as “increased perfusion”. Kairinos et al. therefore suggested that laser Doppler is unsuitable for measurements of tissue perfusion. Either ankle blood pressure measurements or Doppler monitoring, while recognizing their limitations, should

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The main indications and contraindications for use of negative pressure therapy are as below.

**TABLE I**

<table>
<thead>
<tr>
<th>Indications</th>
<th>Contraindications</th>
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<tr>
<td>1) Chronic wounds in case of diabetic and peripheral vascular disease.</td>
<td>1) Acute uncontrollable bleeding after major trauma. A meticulous hemostasis should be established prior to the application and it should be ensured that there are no exposed blood vessels, nerves, or internal organs in direct contact with the vacuum system.</td>
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<tr>
<td>2) Neuropathic and post-irradiation wound areas</td>
<td>2) Patient on anticoagulants.</td>
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<td>3) Deep pressure sores</td>
<td>3) Osteomyelitis</td>
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**REFERENCES**


VII. SHEARING FORCES

Intermittent operation of NPWT was reported to improve wound healing and blood flow in animal studies, as well as in clinical applications, by stimulating angiogenesis and granulation tissue.3,8,9 Chin et al. demonstrated, in a mouse model, the effect of a servo-controlled skin stretching device inducing predetermined cyclical stretching forces on skin growth.10 It was demonstrated that the application of cyclical tensile force generated transient, alternating hypoxia and reperfusion that led to accelerated tissue growth and enhances wound healing.

VIII. RECOMMENDED RNPT OPERATIONAL MODES, VACUUM PRESSURE LEVEL RANGE, SPAN, FREQUENCY OF DRESSING CHANGES

Vacuum pressure in NPWT should be tailored to each specific wound and adjusted according to the clinical condition and no such ideal pressure of 125 mmHg as previously considered holds true. Greater negative pressure should be strictly avoided during the early stage of trauma treatment as it may lead to acute uncontrolled bleeding.1 Excessive topical pressure may lead to compromised blood circulation and impairment of wound healing together with greater risk of bleeding. Moris Topaz has reported applying lower negative pressure in the range of 60–80 mmHg in the intermittent mode, for routine treatment of diabetic foot and PVD-induced limb ulcerations.1 Patients with an ankle-brachial ratio less than 0.5 should be treated with the lowest effective negative pressure and should be closely monitored for distal perfusion impairment. When higher levels of negative pressure (deeper vacuum) are needed for the initial treatment of heavily contaminated wounds, tissue ischaemia can be managed and tolerated by short-term higher negative pressure values applied in an intermittent mode.

4) Major trauma with crush injury, extensive tissue loss and infection
5) Postoperative wound dehiscence and infections
6) Failed sternal closures
4) In major burns as treatment of large areas may lead to extensive extracelluar fluid loss, electrolyte imbalance and may be acute bleeding by the applied negative pressure suction forces.

8) Enhancement of skin graft and flap survival.