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REVIEW ARTICLE

Value of incisional negative pressure wound therapy in orthopaedic surgery

Matthias H Brem, Hermann J Bail & Roland Biber

Department of Trauma and Orthopaedic Surgery, Teaching hospital of Friedrich-Alexander University Erlangen-Nuernberg, Nuernberg, Germany

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Correspondence to
Dr MH Brem, MHBA
Department of Trauma and Orthopaedic Surgery
Klinikum Nuernberg
Breslauer Straße 201
90471 Nuernberg
Germany
E-mail:
Matthias.Brem@klinikum-nuernberg.de

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Abstract

Soft tissue and wound treatment after orthopaedic interventions (especially after trauma) is still an enormously challenging situation for every surgeon. Since development of negative pressure wound therapy (NPWT), new indications have been consistently added to the original field of application. Recently, NPWT has been applied directly over high-risk closed surgical incisions. Review of the literature indicates that this therapy has shown positive effects on incisions after total ankle replacement or calcaneal fractures, preventing haematoma and wound dehiscence. In those cases reduced swelling, decreased pain and healing time of the wound were seen. Additionally, NPWT applied on incisions after acetabular fractures showed a decreased rate of infection and wound healing problems compared with published infection rates. Even after total hip arthroplasty, incisional NPWT reduced incidence of postoperative seroma and improved wound healing. In patients with tibial plateau, pilon or calcaneus fractures requiring surgical stabilisation after blunt trauma, reduced risk of developing acute and chronic wound dehiscence and infection was observed when using incisional NPWT. To conclude, incisional NPWT can help to reduce risk of delayed wound healing and infection after severe trauma and orthopaedic interventions.

Introduction

Since the introduction of negative pressure wound therapy (NPWT; V.A.C® Therapy, KCI, San Antonio, TX), indications have expanded constantly. In early years, traumatic wounds were seen as the main area of application (1). Then, development of indications moved on to include chronic wounds (2,3), wounds in plastic surgery before and after reconstructive surgery (4,5) and many other surgical fields. A further expansion of the application of NPWT was achieved by the addition of instillation to NPWT to treat wounds with infection (6–9). Another development was the use of NPWT over closed surgical incisions (10,11). The principle of NPWT on closed surgical wounds is easy to explain. A foam dressing is applied over a non-adherent layer to the clean incision after surgical closure in the operating room. The dressing is sealed with a self-adhesive plastic membrane and continuous negative pressure is applied by tubing connected to the therapy unit.

Literature review

Different studies have evaluated the use of NPWT on closed surgical incisions in orthopaedic and trauma surgery. The main field of interest for studies on the value of NPWT on closed surgical incisions was high-risk wounds with limited soft tissue coverage over bony structures and after fractures. Stannard *et al.* showed in a prospective randomised study with two different evaluations that NPWT applied to draining wounds after trauma and consecutive surgical intervention reduced draining time and rate of wound infection (10). The first evaluation was performed in a group of 44 patients that had haematomas with prolonged draining time (≥5 days). The patients were randomised either to NPWT or a pressure dressing group. The time

Key Messages

- this brief literature review reports favourable results from the use of negative pressure wound therapy (NPWT) over closed surgical incisions in a variety of wound types
- application of NPWT over closed surgical incisions in the operating room has resulted in decreased rates of infection and other wound complications in patients with total ankle replacement, total hip arthroplasty, and acetabular, tibial plateau, pilon and calcaneus fractures

of drainage was compared between these two groups. A significant reduction in mean drainage time was found in the NPWT group (NPWT, 1·6 days versus control, 3·1 days, $P = 0{\cdot}03$). The second part of the study also included 44 patients after trauma with high-risk wounds such as lower extremity fractures and pelvic fractures. Again, drainage time was compared between NPWT and standard postoperative dry wound dressings (control) and again a significant reduction of drainage was found (NPWT, 1·8 days versus control, 4·8 days, $P = 0{\cdot}02$; 10).

DeCarbo described a beneficial effect of NPWT on wounds after total ankle replacement or calcaneus fractures. He believes that NPWT as an adjunct to wound closure can decrease pain and swelling, and might even decrease the risk of infection and the time required to achieve complete healing in such wounds (12).

In a prospective randomised multicentre clinical trial, 249 patients with 263 fractures were enrolled in a study evaluating the use of NPWT after calcaneus, pilon or tibial plateau fractures. Fractures were randomly assigned to the control group ($n = 122$; standard postoperative dry wound dressings) or the NPWT group ($n = 141$). A significant reduction of infection was found in the NPWT group ($P = 0{\cdot}049$; 13).

Reddix *et al.* analysed retrospectively the value of incisional NPWT in extremely obese patients (BMI > 40) who suffered an acetabular fracture and required surgical stabilisation. In 19 patients they did not find any wound complications (14). Another retrospective study by Reddix *et al.* also showed positive effects of incisional NPWT on wounds after open reduction and internal fixation of acetabular fractures. They evaluated retrospectively the medical records of 235 patients who had surgery after acetabular fractures and an NPWT device placed on the incision. The NPWT group was compared with 66 consecutive patients preceding the time when their institution started NPWT as a standard treatment. The NPWT group showed reduced rates of deep wound infection (1·27% versus 6·06%) and wound dehiscence (0·426% versus 3·03%; 15). The institution's wound infection rate after initiation of incisional NPWT (1·27%) was significantly lower than the infection rate (6·15%) prior to the use of incisional NPWT ($P = 0{\cdot}0414$; 15).

All studies cited above were performed on patients with incisions that were at risk for developing wound healing complications (e.g. pilon, calcaneus and tibial plateau fractures with limited soft tissue coverage). Such incisions appear to be the major area of application up to now.

A different approach was used in a prospective, randomised clinical study. Wounds of patients after total hip arthroplasty were examined with ultrasound. All patients were randomised into two groups. In one group incisions were treated with NPWT; in the other they received the standard wound dressing of the institution. After 5 and 10 days, an ultrasound examination of the wound area was performed to evaluate for a potential seroma, as a seroma can be seen as a possible risk factor for wound infection. In the NPWT group, a significant reduction of the seroma size was found, in comparison with the standard wound dressing cohort (1·97 ml versus 5·08 ml, respectively; $P = 0{\cdot}021$; 11). This study showed that even in wounds with good soft tissue coverage, incisional NPWT showed positive effects on wound healing and complication rates.

At this time no algorithm has been established for the regular use of NPWT on closed surgical incisions. The existing data are very promising for further use of incisional NPWT. In the future, treatment algorithms should be developed, evaluated and introduced into clinical pathways after surgery.

Conclusion

Further studies are required to evaluate the effects of incisional NPWT on wound healing, healing time and economic perspective. According to the literature, incisional NPWT can help to reduce the risk of delayed wound healing and infection after trauma and orthopaedic interventions. Additionally, incisional NPWT can reduce the occurrence of postoperative seroma in the wound area after surgical interventions. Further prospective randomised clinical trials are required to evaluate the mechanisms of action of incisional NPWT.

Conflicts of Interest

MHB presented as a faculty member during the 2013 International Surgical Wound Forum (ISWF), an annual educational event sponsored by Kinetic Concepts, Inc. (KCI). His article is part of a KCI-funded educational supplement based on faculty presentations at the 2013 ISWF session related to wound care strategies using NPWT over closed surgical incisions and negative pressure therapy to treat the open abdomen. KCI provided editorial assistance.

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