Using Low Pressure, Negative Pressure Wound Therapy for Wound Preparation and the Management of Split-Thickness Skin Grafts in Three Patients with Complex Wounds

Cheryl Nease, PT

Abstract

The use of negative pressure wound therapy (NPWT) is well established in the management of hard-to-heal wounds. One institution, familiar with NPWT’s capabilities as well as its shortcomings (eg, pain at dressing changes and pain with the maximum recommended setting of 125 mm Hg), sought a viable alternative. A low pressure, negative pressure wound therapy (LP-NPWT) system, using subatmospheric pressure levels of 75 mm Hg and a low-adherence dressing, was evaluated to prepare the wound bed for split-thickness skin graft (STSG) on three patients. One patient was a healthy 23-year-old man with extensive trauma-related soft tissue wounds. The two women — 54 and 47 years old — had multiple comorbidities. One had a lower extremity fasciotomy wound and the other had a dehisced surgical wound with a history of irradiation. Wound area was reduced >60% in all three wounds in 3 to 6 weeks as new granulation tissue developed. The average pain reported was moderate (4 to 5 on a Visual Analogue Scale), ranging from 2 to 10 during dressing changes; pain levels reported tended to decrease as therapy progressed. Little or no trauma on dressing removal and no signs of infection were noted. In all cases, STSGs, followed by 4 days of LP-NPWT were applied and all wounds healed. The results from these three cases suggest that the LP-NPWT system is a useful healing adjunct for complex wound bed preparation and graft management. Clinical studies to quantify the effects of LP-NPWT technology and compare its safety and efficacy to other negative pressure systems are needed.

Key Words: case series, traumatic wounds, skin grafts, low-pressure negative pressure therapy

Potential Conflicts of Interest: The author discloses she is a consultant for and/or receives speaker honoraria from ConvaTec, Inc., Skillman, NJ, and Boehringer Wound Systems, Norristown, PA. ConvaTec Inc. provided editorial assistance during the preparation of the final revisions of the manuscript.

The use of negative pressure wound therapy (NPWT) has been well established and documented in the successful management of hard-to-heal wounds. From as far back as 1947 when the use of suction drainage was recorded for clearing postoperative accumulation of blood, bile, or exudate, the use of NPWT has been a valuable addition to the clinician’s armamentarium of products and strategies.1

Understanding of clinical wound management and the mechanisms of NPWT action has expanded, as have NPWT system, dressing, and material technologies. A recent review2 of the published literature concluded that the benefits of NPWT may include reduction of wound volume/size, faster wound healing, enhancement of the rate of graft take, reduction of complications, and reduction of nursing time and costs.

The reported benefits of NPWT include the creation of a moist wound environment, physical stimulation of a biologic response, removal of exudate and reduction of edema, alteration of wound fluid composition, assistance in granulation tissue formation, and control of bacterial burden.2,3 One key element in the mechanism of action as described in the literature is “… the application of mechanical force [cellular strain] to wounds induces tissue deformation at the level of individual cells, leading to cell stretch, thereby providing a

Ms. Nease is a physical therapist, Memorial Health University Medical Center, Savannah, GA. Please address correspondence to: Cheryl Nease, PT, Memorial Health University Medical Center, 4700 Waters Avenue, Savannah, GA 31403; email: cnease1987@aol.com.
Memorial Health University Medical Center (MHUMC), the author’s institution, a 553-bed, level I trauma center and teaching hospital, lacks a standard protocol for the management of complex and/or large wounds. The goal is to select a dressing that supports healing and minimizes complications. NPWT often is chosen because the institution’s clinicians have found it can rapidly decrease the depth and size of the wound, facilitating a faster change to topical therapy as opposed to advanced wound care dressings. Because the NPWT system used at the institution was associated with a number of clinical performance and economic concerns — pain and tissue trauma at dressing changes when using the black foam dressing and pain potentially associated with the recommended operating pressure level of the current system (125 mm Hg) — an alternative was sought.

The author became aware of low pressure negative pressure wound therapy (LP-NPWT) and initiated a literature search of articles that found eight case study/case series, all poster presentations describing the use of a LP-NPWT system on a variety of wound etiologies. Three (one case study each of a pressure ulcer, puncture wound, and a diabetic foot ulcer) described decreases in wound volume of >80%, 92%, and 95%, respectively, achieved with LP-NPWT following 5 to 6 weeks of therapy. Two poster presentations were case series on radiation burns and full-thickness wounds of various etiologies. Each included three patients. The radiation cases included patients with radiation burns on the chest following mastectomy and demonstrated a decrease in wound volume >80% following 4 to 5 weeks of LP-NPWT. In the full-thickness wounds (patients ages 47 to 57 years with multiple comorbidities), wound volume measured in two of the three patients (postsurgical dehiscence and full-thickness inflammatory wound) decreased 94% by week 4 and 91% by week 3, respectively. A six-patient case study that included pressure ulcers, postsurgical dehiscence, and surgical wounds found that four out of six patients experienced wound volume decreases of 76% to 100% after 3 to 9 weeks of LP-NPWT.

An open-label, noncomparative study investigated pain outcomes (at application, during use, and at dressing changes) and changes in wound volume following use of the LP-NPWT system. In this case series of seven patients undergoing 113 dressing changes, 85% of patients reported pain levels as none to mild, 71% reported dressing adherence as none to mild, and 86% reported bleeding at dressing changes as none to mild in their chronic or surgical wounds.

The purpose of this case study was to evaluate use of the LP-NPWT system within the management and preparation of complex surgical and traumatic wounds for split-thickness skin grafting (STSG). Based on prior experience with an NPWT system, the authors were particularly concerned with clinical outcomes (exudate management, rate of healing, quality of healing) without the usual negative pressure dressing-related pain, bleeding, trauma, and disruption of the granulation bed at dressing changes.

### Key Points
- The most commonly used and reported negative pressure wound therapy (NPWT) system involves the use of a foam dressing and high (125 mm Hg) pressure.
- Concerned about observed limitations to standard NPWT, including pain, the author used low (75 mm Hg) NPWT and a nonadherent dressing on three patients with complicated wounds.
- No adverse events were observed and all wounds were successfully grafted.
- The author concludes that controlled clinical studies to compare the effects of this system to high-pressure NPWT are warranted.

### Procedure

**The LP-NPWT system.** The LP-NPWT system evaluated (Engenex®, Boehringer Technologies, LP, Norristown, PA) consists of a pump, specialized dressings, and other associated hardware (see Figure 1). According to the manufacturer, the dressing incorporates Bio-dome™ Technology (BDT, Boehringer Technologies, LP), which is comprised of nonwoven polyester layers joined by a silicone elastomer. The polyester dressing is designed to optimize cellular strain at the surface of the wound while providing unobstructed tissue growth with less dressing integration into the wound. Dressings that incorporate this technology are designed for optimal performance at 75 mm Hg. The BDT EasyRelease™ dressing was used in all three cases.

The LP-NPWT system also tracks Compliant Hours™ — the total time the system is delivering effective negative pressure. Visual indicators and audible alarms signal the occurrence of any interruptions in the delivery of negative pressure. This feature facilitated tracking of overall patient adherence to the therapy.

To trial the LP-NPWT device, three wound types with complex etiologies were selected: 1) bilateral, traumatic lower extremity wounds from a motor vehicle accident, 2) fasciotomy due to compartment syndrome of the left lower extremity (LLE), and 3) surgical wound dehiscence due to vascular incompentence with skin previously compromised by radiation treatment. These patients presented themselves and met the criteria of having complex wounds. The goal was to test the therapy on wounds with different etiologies in patients with different comorbidities to ascertain the system’s effectiveness.

Each patient’s status and history were recorded. Data were collected at the initiation of LP-NPWT and at each dressing change and later transferred onto data collection sheets and entered into Microsoft Excel Spreadsheet Software (Microsoft®
Corporation, Redmond, WA). The program was used to calculate the mean pain scores and to graph volume changes.

Outcomes. Data collected during each assessment included wound measurements (length, width, and depth), percent nonviable tissue, percent granulation tissue (percentage of nonviable tissue and percent granulation tissue were determined by visual analysis of the wound), exudate amount (descriptive: heavy, medium, low, scant), presence of bleeding or trauma upon dressing removal (yes/no), use of systemic or topical drugs/agents (yes/no, frequency, amount), and any qualitative observations. Wound area was calculated by multiplying the measured length at longest point times width at widest point at a perpendicular angle and volume was calculated by multiplying length times width (as described for area) times depth at deepest point. Percent change was the percentage difference in depth or area between assessments.

Infection. Presence of infection was assessed based on clinical judgment including the following criteria: excessive drainage, increased white blood cell count, periwound erythema, and increased pain. No laboratory tests were conducted to confirm infection. The author performed assessments and collected data for all cases.

Pain. Pain assessments were obtained using a Visual Analog Scale with scores ranging from 0 (no pain) to 10 (worst pain possible). Pain was assessed at dressing application (the patient was asked to rate pain after the dressing was applied); during wear (the patient was asked to rate pain since the last dressing application); and at dressing removal (the patient was asked to rate their pain immediately after the dressing was removed). In some cases, assessments could not be completed because some dressing changes were conducted in the OR under general anesthesia.

In all instances, institutional policies for conducting clinical trials and product assessments were followed, including obtaining signed, informed patient consent forms.

Case 1: Bilateral Trauma Wounds of the Thighs
Twenty-three-year-old Mr. C was admitted to MHUMC on June 5, 2007 after sustaining multiple injuries in a motorcycle accident. Initial injury assessment included left shoulder avulsion, open wounds with significant neurological and vascular deficits, open wound and fractures of the left elbow, large soft tissue wounds of the lateral aspects of each thigh, and left pneumothorax. Initial plastic surgery intervention of the bilateral thigh wounds involved multiple operating room irrigations and debridements with removal of nonviable muscle and fat, fascia, and foreign material. The wounds were packed with gauze rolls soaked in a mild disinfecting solution.

Following stabilization and completion of the required interventions in the operating room (by day 8), the hydrotherapy team was integrated into Mr. C’s ongoing management team; they focused on the avulsion soft tissue thigh wounds. Patient-controlled analgesia (PCA) morphine with bolus was prescribed throughout the course of therapy to manage pain. The following information addresses the massive bilateral thigh wounds, the therapy rendered, and outcomes.

Right thigh.
Wound management and preparation for STSG. Wound assessment on day 10 (June 15) revealed mild odor, copious exudate, approximately 20% nonviable tissue, and minimal external contamination (quantitative bioburden assessments were not made). Contamination was assessed based on presence of environmental debris in the wound (eg, grass, asphalt, pieces of guard rail). The wound measured 26 cm x 18 cm x 3 cm, yielding a wound area of 468.0 cm² and wound volume of 1,404 cm³. Undermining measuring 9.7 cm x 3 cm was observed in the proximal area (see Figure 2a).

LP-NPWT was initiated and maintained for 10 consecutive days with dressing changes on days 1, 3, 4, and 7 using the specially designed polyester dressing. The undermined area was
LOW PRESSURE NEGATIVE PRESSURE WOUND THERAPY

managed with a polyester dressing and a silver-impregnated dressing (Acticoat®, Smith & Nephew, Largo, FL) — ie, the silver dressing was placed between the polyester dressing and the wound bed, a method investigated in previous research and found to be compatible with the LP-NPWT system. The silver dressing was used prophylactically to minimize the risk of infection. Subatmospheric pressure of 75 mm Hg was applied continuously 24 hours/day.

Average pain levels during the first 3 days of LP-NPWT were 8 during application, 4 when in place, and 9 after removal. Figure 2b depicts the wound at LP-NPWT day 4 with the dressing in place. Figure 2c depicts the wound following 7 days of therapy. During the 7-day application of LP-NPWT, the wound decreased from 1,404 cm³ to 523.8 cm³ (63%) in volume and from 468 cm² to 348.8 cm² (25%) in area (523.8 cm² and 348.8 cm², respectively). The wound bed was well perfused and contained healthy neo-granulation tissue with approximately 5% nonviable tissue. The wound margins were clean and the undermined area was clean and smaller (not quantified). No clinical signs of infection were noted. Wound exudate was approximately 4,100 cc over the 10-day period until STSG was applied on day 11 (410 cc/day). No edema was evident.

The pain score later in the therapy period (days 7 through 11) averaged 2.5 between dressing changes. Pain assessment at dressing application and following removal was not obtained because these procedures occurred in the OR under general anesthesia.

Application and management of STSG. On Day 11, it was decided that the undermined area could be closed and an STSG and NPWT were applied under general anesthesia (see Figure 2d) using a combination of the polyester dressing and prophylactic antimicrobial dressing. Four days after surgery, the dressings were removed and a nearly 100% take of the STSG was observed (see Figure 2e). During the 4 days after surgery, an additional 200 cc of exudate was evacuated and LP-NPWT was discontinued. The wound continued to heal and 33 days post-STSG was completely re-epithelialized (see Figure 2f).

Left thigh.

Wound management and preparation for STSG. Assessment on the day of initiation of LP-NPWT (day 0, June 13, 2007) revealed a strong odor, thick exudate, a wound bed containing approximately 15% to 20% nonviable tissue, and visible external contamination. The clinical signs suggested infection; however, wound cultures were not obtained. The wound measured 17.5 cm x 9 cm x 2 cm, yielding a wound area of 157.5 cm² and wound volume of 315 cm³. Undermining was observed in the proximal area and measured 8.3 cm x 7.0 cm (see Figure 3a). Interventions before LP-NPWT initiation included pulse-lavage irrigation, surgical debridement of necrotic tissue, and disinfectant dressings
LP-NPW T was initiated using the polyester dressing. This therapy was maintained for seven consecutive days with dressing changes on days 1, 4, and 5. The undermined area was treated with the polyester dressing and a silver dressing as described previously. Subatmospheric pressure of 75 mm Hg was applied continuously 24 hours/day. Initial pain ratings (days 0 through 2) averaged 8 at dressing application, 4 between dressing changes, and 9 following dressing removal.

By day 5 of therapy, the wound decreased in area from 157.5 cm² to 110.5 cm² (30%) and in volume from 315 cm³ to 110.5 cm³ (65%) (see Figure 3b). The wound bed exhibited healthy neo-granulation tissue with <5% nonviable tissue, the wound margins were clean with evidence of early epithelial cell formation, and the undermined area was clean and smaller (not quantified). No clinical signs of infection were noted. Wound exudate totaled approximately 2,500 cc over the 4-day period (625 cc/day) and pain levels between dressing changes remained unchanged (averaged 4). Pain scores during application and following removal were not available because these procedures were performed in the OR under general anesthesia.

Application and management of STSG. On day 6, it was determined that the wound was sufficiently resolved — the undermined area could be closed primarily and the wound could successfully support a STSG (see Figure 3c). LP-NPWT was applied immediately postoperatively with a polyester and a silver dressing. On postsurgery day 3, the dressings were removed. Graft take was 100% (see Figure 3d) and LP-NPWT was discontinued. The wound continued to heal and 36 days post-STSG was completely re-epithelialized (see Figure 3e).

Summary. In this case, the management of the massive bilateral full-thickness thigh wounds using the LP-NPWT enabled the successful preparation for and application of STSGs. The ability to graft was due in large part to the rapid development of new granulation tissue in each wound and the resulting reduction of wound volume (~65%) within 7 days.

The LP-NPWT system efficiently cleared wound exudate and reduced edema. The neo-granulation tissue within the wound bed was noted to have a budding appearance coincident with the contoured design of the contact layer of the dressing. The rapid formation of granulation tissue did not lead to hypergranulation tissue; rather, it provided a viable foundation for the successful application of the STSG with near 100% take. Additionally, despite the rapid growth of new tissue, the dressing material showed no evidence of incorporation into the wound bed. Tissue disruption during dressing changes was minimal with only minor areas of bleeding/ooze and disruption of the granulation tissue bed.

The dressing conformed to the wound and was easily placed in the proximal sinus tract. Pain was an issue for Mr. C and because of the extent of the injuries and his overall discomfort, PCA morphine with bolus PRN was administered throughout the therapy period. Overall, wound pain scores ranged from low to moderate when no interventions were conducted to high during dressing changes. This was consistent with all procedures during the period. The average pain ratings for the right thigh wound were 9.3 at application, 3.5
during wear, and 10 following removal. Similarly for the left thigh wound, average pain scores were 8.3 at application, 3.3 during wear, and 9.5 following removal. These wounds were extremely large and difficult to manage. Based on clinician experience, the fact that the patient was able to adhere to the therapy was a positive sign because in this case extreme pain would be expected with any therapy.

Case 2: Fasciotomy Wound of LLE

Ms. D, 54 years old, presented with acute onset of a cold, painful left foot. She had undergone lower extremity revascularization surgery earlier in the year at another facility and already had one occlusion event, which was reversed. Other surgical procedures included lymph node resection to bilateral groins. Ms. D is a relatively heavy smoker with history of congestive heart failure, myocardial infarction with stent placement, deep vein thrombosis, and arterial insufficiency.

At the time of presentation July 16, 2007, 55 days before initiation of consistent LP-NPWT, Ms. D underwent successful angioplasty with stent placement and was discharged to home care. On August 10, 31 days before initiation of consistent LP-NPWT, she developed acute severe ischemia of the same leg with significant loss of motor and sensory function and was readmitted to the hospital. Between August 11 and August 22, she underwent multiple procedures including a thrombectomy, balloon angioplasty, and thrombolysis in an attempt to restore blood flow (see Figure 4a). She developed compartment syndrome and underwent an anterolateral fasciotomy.

Approximately 20% to 30% of the muscle in the anterior compartment was necrotic. Despite multiple surgical debridements, this increased to approximately 50%. A series of complications developed including post-op bleeding, hematomas, and necrosis of the anterior compartment
muscles. Her risk of limb loss was very high and the possibility of above-knee amputation was discussed.

On August 24, 17 days before STSG, Ms. D underwent bypass surgery of the left femoral to below-knee popliteal artery to provide the best opportunity for long-term limb salvage. Following revascularization surgery, Ms. D was surgically debrided twice to remove the remaining nonviable muscle in the anterior compartment. Clinicians were concerned that the combination of vascular surgery of the LLE and the conditions described would limit the opportunity to employ NPWT, particularly for systems that operate at the typical range of 125 mm Hg; because Ms. D’s arterial blood supply was so tenuous, the author was concerned the pressure could cause tissue damage/necrosis at the wound edge. Therefore, to try to avoid further complications, the LP-NPWT system with lower settings (75 mm Hg) and the polyester dressing were used.

LP-NPWT was utilized inconsistently for 17 days before STSG because of frequent surgeries and dressing application in the OR, which included LP-NPWT or wet-to-dry gauze dressing; however, throughout this period, granulation tissue formation increased. After a 1-week stay in rehabilitation, Ms. D was discharged home with LP-NPWT. On August 31 (see Figure 4b), she had palpable distal pulses and the wound was adequately perfused and contained approximately 15% nonviable tissue.

Wound management and preparation for STSG. At the time of Ms. D’s outpatient evaluation by the Hydrotherapy Department on September 10, 2007, the wound measured 30 cm x 8 cm x 3 cm (720 cm³); 10% of the wound area comprised nonviable tissue, including a segment of exposed bone (tibia). Oral pain medication (Percocet, Endo Pharmaceuticals, Inc., Chadds Ford, PA) was ordered to manage postsurgical pain and was continued throughout the therapy period. LP-NPWT was initiated on this visit (see Figure 4c) and continued for 31 days (see Figure 4d,e). Evaluations were included from this point forward; Ms. D now was consistently using the LP-NPWT system and in the author’s care, facilitating appropriate assessments.

Ms. D was highly cooperative; the system operated approximately 23 to 24 hours/day at a constant pressure of 75 mm Hg. On average, the LP-NPWT system cleared 187 cc of exudate per day. No clinical signs of infection were noted.

In the 4 weeks of consistent LP-NPWT, granulation tissue formation was rapid, achieving a 95% reduction in wound volume and a 21% reduction in wound area. Nonviable tissue was reduced from 10% to 3%. Initial pain ratings averaged 3 at dressing application, 2 between dressing changes, and 3.5 following dressing removal.

Application and management of STSG. After 31 days of LP-NPWT, Ms. D received a STSG, successfully applied after
excision of a small, focused area of necrotic tissue. LP-NPWT at 75 mm Hg was continued immediately postoperatively using a combination of the polyester dressing and prophylactic antimicrobial dressing to help ensure the graft did not migrate and assist in the evacuation of fluid between the wound bed and STSG.

Dressings were changed 4 days post-graft, revealing a viable graft with >90% take (see Figure 4f). The only area of STSG nonadherence (and not medically concerning) was in a deep section in the area of the tibia. This area rapidly filled in with granulation tissue and healed uneventfully. Pain scores at this later point in the therapy averaged 1 at application, 1 during wear, and 2 following dressing removal.

Forty-five days after its initiation (14 days post graft), LP-NPWT was discontinued and a combination of an antimicrobial dressing (Acticoat®), a nonadherent dressing, and an elastic wrap were applied. The LLE and wound have been monitored continually to ensure the health of the affected area (Figures 4g, 4h).

Summary. STSG was successfully applied and the clinician reported “little to no” disturbance of the granulation bed due to dressing adherence and “little to no” bleeding following dressing removal. Throughout therapy, no tissue growth into the dressing or attachment to the dressing was observed. The average pain scores were all in the low range: 2.1 at dressing application, 1.5 during wear, and 2.5 following dressing removal.

Case 3: Dehiscence of Surgical Wound

Prior surgical interventions/NPWT. Ms. E was a 47-year-old woman with a medical history that included anal cancer, hypertension, anxiety disorder, hypothyroidism, and relatively heavy smoking. Her anal cancer was diagnosed in 1997 and recurred in 2003. After the recurrence, she underwent radiation therapy (doses and duration unknown) and an abdominoperineal resection. The surgical wound was complicated by poor and delayed healing for which NPWT, using a higher-pressure system, was attempted.

Ms. E was unable to tolerate the dressing changes with NPWT due to significant pain. She also reported feeling continuously uncomfortable (pain levels were not quantified) while the system was operating and refused to continue with this therapy. The NPWT was discontinued and her wound eventually healed by secondary intention.

Two weeks before presentation of the current wound, Ms. E underwent extensive iliofemoral thromboendarterectomy secondary to acute ischemic changes to her left foot. Her neurologic deficit (paresthesia) resolved and she was discharged home. She returned to her physician 1 week later with mild erythema at the wound edges. She was placed on an oral antibiotic; the surgical staples were left in place. When she returned to the physician’s office 1 week later, her wound had dehisced, exposing ischemic-appearing subcutaneous fat.

At presentation 4 days before initiating LP-NPWT, Ms. E’s wound appeared infected at the wound edge and underlying necrotic fatty tissue was visible. The wound measured 6.4 cm
therapy period, granulation tissue formation was rapid, re-

gression and assist in removing fluid between the wound bed 

prophylactic antimicrobial dressing to help prevent graft m -

and the STSG. 

STSG was applied and LP-NPW T was continued im-

mediately following dressing removal. (see Figure 5 e). Pain ratings later in therapy (days 46 through 49) averaged 3 at dressing application, 2 during wear, and 3 following dressing removal. 

Application and management of STSG. On Day 49, a STSG was applied and LP-NPW T was continued immediately postoperatively with a combination of polyester dressing and prophylactic antimicrobial dressing to help prevent graft migration and assist in removing fluid between the wound bed and the STSG. 

The dressings were changed on the fourth day post-STSG and the graft was viable with >95% take (see Figure 5f). LP-NPWT was discontinued at that time. On the seventh day post-STSG, the graft healed and was left open to the air (see Figure 5g). 

Summary. Based on the difficulties encountered with a prior, irradiated wound, a change in wound management protocol for Ms. E was necessary. During the 6-week LP-NPWT therapy period, granulation tissue formation was rapid, resulting in an 86% reduction in wound volume. The wound area increased by 18% as nonviable tissue was reduced from 30% to 5%. The inability of the wound to epithelialize, likely due to the effects of previous radiation therapy, was anticipated and the primary reason for managing this wound for preparation of a STSG. 

Although Ms. E experienced initial pain and discomfort, likely the result of the initial intervention and debridement, the pain level quickly reduced to a low-to-moderate range that was well tolerated. Throughout her therapy, Ms. E continued to have moderate levels of pain and anxiety with the dressing changes, although over time she tolerated them less anxiously. Her average pain scores were 4.8 during dressing application, 2.7 during wear, and 5.7 following dressing removal. The tissue did not grow into or attach to the dressing during the therapy period. At the time of dressing removal, there was “little to no” disturbance of the granulation bed due to dressing adherence and “little to no” bleeding on dressing removal. At one instance (day 23), the pain score spiked; the authors believe this was due to Ms. E’s extreme anxiety and fear not related to the therapy. The continuation of therapy resulted in the successful application of a STSG. 

Discussion 

The cases presented demonstrated a decrease in wound volume and an increase in development of healthy granulation tissue with good progression toward wound healing following incorporation of LP-NPW T into the wound management protocol. Figure 6 depicts a close-up of the wound reviewed in Case 2 and represents the typical appearance of granulation tissue in the wound bed following LP-NPW T. 

Other important outcomes relevant to the LP-NPW T technology used were noted. Throughout the therapy, no clinical signs of infection were found and the percentage of nonviable tissue decreased. Clinicians observed that this dressing was well tolerated, all reported “little to no” bleeding or trauma on dressing removal, and no tissue growth into the dressing. 

Pain is a commonly reported issue with NPWT. A consensus report from the V.A.C.® Therapy Canadian Consensus Group 16 recommended the use of low pressure (50 mm Hg to 75 mm Hg) in continuous negative pressure mode to manage pressure-associated pain. They recommend moistening the dressing sponge, instilling local anesthetic, or using a nonadherent dressing to manage pain associated with dressing removal. The wound pain reported at dressing changes with NPWT is thought to be associated with a disruption of granulation tissue in the wound bed due to the granulation tissue sticking to, or growing into, the dressing. 6 

In these three patients, the average pain ratings were 4.8 (± 2.71) at dressing application, 2.43 (± 1.20) between dressing changes, and 5.13 (± 2.80) following dressing removal. All patients were able to successfully adhere to and complete their therapy. Furthermore, the pain levels seemed to decrease as the wounds improved; from early to late in the therapy, average pain levels decreased by 67% at dressing application, 37.5% during wear, and 67.9% following removal. Pain levels may be related to the observations of no tissue growth into the dressing, leading to the low incidence of bleeding and disruption of the wound bed. The author believes these outcomes were associated with the low adherence and design of the polyester dressing. Because this is a noncomparative study, it
is inappropriate to make comparisons with results from other commercially available systems. The purpose of this study was to define the clinical experiences of this LP-NPWT device.

Overall, the LP-NPWT system met the needs of clinicians at the author’s facility and optimal patient outcomes, successfully prepared wounds for skin graft application and protection of grafts following surgery with 90% to 100% graft take.

The clinical observations from this assessment support the hypothesis that use of a NPWT system operated at a low pressure in combination with a nonadherent special dressing can help prepare the wound bed for STSG in complex trauma wounds. In fact, the relatively consistent shape of the curves on wound volume reduction (see Figure 7) may suggest a predictable pattern of the rate of granulation tissue formation, regardless of wound size. The directional contraction that the polyester dressing is designed to achieve appears to enable the formation of a sound, granulation tissue foundation. This may contribute to the relatively rapid formation of the granulation base and successful graft take.

Although only three cases were studied (and not compared to other products), the results were sufficiently convincing for facility clinicians to continue to employ this LP-NPWT device with other wounds. Further studies are needed in specific wound etiologies and clinical scenarios to fully demonstrate the potential benefits of this LP-NPWT system in current wound management.

**Conclusion**

Based on the three case reports presented, the LP-NPWT system may represent an advance in NPWT technology and wound and patient outcomes. The acceptable levels of observed pain, exudate management, minimal bleeding, and wound bed disruption are important for the management of this population of patients with complex wounds that need STSG. The use of LP-NPWT in conjunction with the polyester dressing technology seems to have contributed to the rapid formation of granulation tissue in these various wound types. Controlled clinical trials quantifying the differential effects of the LP-NPWT technology and comparing its safety, efficacy, and cost to other NPWT systems are needed.

**References**


