

Negative Pressure Wound Therapy Applied to a Meshed Split-Thickness Skin Graft

Dong-Hun Lee, Yu-Jin Kim*

Department of Plastic and Reconstructive Surgery, Gachon University Gil Medical Center, Incheon, Korea

Received April 24, 2016
Revised July 22, 2016
Accepted July 28, 2016

*Correspondence to: Yu-Jin Kim
Department of Plastic and Reconstructive Surgery, Gachon University Gil Medical Center, 21 Namdong-daero 774beon-gil, Namdong-gu, Incheon 21565, Korea
Tel: +82-1577-2299
Fax: +82-32-461-2774
E-mail: pseugene@gilhospital.com
ORCID: <http://orcid.org/0000-0003-1333-4977>

Financial support: None.
Conflict of interest: None.

Purpose: Skin grafting is used for the transfer of cutaneous tissue from one site of the body to another. To improve graft survival, close contact between the graft and the wound bed is essential for vessels to grow across the gap. Here, we introduce an easy and efficient dressing method to improve graft survival.

Materials and Methods: A retrospective chart review was performed to identify patients who underwent split thickness skin graft and negative pressure wound therapy (NPWT) or conventional treatment between January 2007 and April 2015. Overall, 25 consecutive patients were included in the NPWT group and 49 were included in the conventional dressing group to compare the outcome of the procedure. The data were obtained from medical records, including age, sex, cause of the skin defect, size of graft, time for healing, wound preparation time, and complications.

Results: Of the NPWT group, the average wound size was $147.04 \pm 146.74 \text{ cm}^2$ (range, 9~900 cm^2). With the exception of one patient, all wounds healed without the need for further procedure. The average duration of time required for the NPWT group, which was defined as removal of stitches (or staples) and no need for additional active dressing, was 6.4 ± 1.97 days (range, 5~15 days). The average time for the conventional dressing group was 10.78 ± 2.38 days (range, 5~15 days).

Conclusion: NPWT can be used to cover regions in which wound healing does not occur fully or when neither tie-over nor compressive dressings are applicable. This treatment also reduced wound healing time and allowed earlier patient mobilization and hospital discharge.

Key Words: Skin transplantation, Wound healing, Negative-pressure wound therapy

INTRODUCTION

Skin defects caused by burns, trauma, infections, and chronic ulcers, such as venous ulcers and diabetic foot ulcers, are commonly presented to plastic and reconstructive surgeon in clinical practice. There are several therapeutic methods of the skin and soft tissue defect: inducing secondary healing from the wound dressing to the skin graft or flap surgery. Skin

grafting is the most frequently used procedure in the area of reconstructive surgery, defined as a technique for the transfer of cutaneous tissue from one site (donor site) of the body to another (recipient site). Each step of the skin grafting procedure is important, as is postoperative care. Many studies have been published about the three phases of skin graft success: serum imbibition, revascularization, and maturation. To improve graft survival, close contact between the graft and the wound bed is

critical for 1) vessels to grow across the gap, 2) elimination of graft movement during the immediate postoperative period, and 3) prevention of fluid accumulation. Conventional cotton bolster and tie-over dressings are useful for securing the graft site. However, when sealing off was done, recompression and fixation were difficult. Irregular and uneven wounds have a higher risk of fluid accumulation and graft tenting, resulting in partial or total graft loss. In contrast to traditional dressings, negative pressure wound therapy (NPWT) enhances wound healing via induction of growth factors, evacuation of fluid, bacterial clearance, and improved microcirculation.¹

In the early 1990s, Argenta and Morykwas² encountered many complex wounds. They designed several devices to draw the edges of the wound together to facilitate wound healing. An open-pore polyurethane foam was placed in the wound, covered by a semi-occlusive dressing, and connected by a tube to a vacuum source. They called this method NPWT.³ The device that Argenta and Morykwas² described has revolutionized the treatment of complex wounds, and it has become widely adopted over the last 10 years with over 1,000 peer-reviewed publications describing its use. We focused on its application to skin grafting and reported its outcomes.

Here, we introduce an easy and efficient dressing method with NPWT to improve outcomes of skin graft surgery to complicated cases observed in Gachon University Gil Medical Center compared to previously described procedures.

MATERIALS AND METHODS

Patient characteristics

A retrospective chart review was performed to identify patients who underwent split-thickness skin grafting and NPWT dressing for reconstruction of skin defect between January 2007 and April 2015. Twenty-five consecutive patients were included in this study. To compare the outcome of graft survival, we reviewed the 49 patients that were treated with skin graft and conventional bolster dressing in the same period. The data were obtained from the medical records, including age, sex, cause of the skin defect, graft size, removal timing of stitches or staples, wound preparing duration (if delayed reconstruction was performed), and complications. Wound preparing duration was defined period from the initial occurred wound time to the performing skin graft. Wound preparation was performed with

conservative treatment, such as saline soaking dressing, until healthy granulation tissue formation.

Outcome evaluation

The wound size measurement was performed by multiplying the perpendicular width and length of the wound with flexible ruler placed on it. Graft survival assessment was determined by the gross morphology of skin graft such as color, texture, capillary refill time and epithelization of wound margin and slit incision. These factors were performed by same study primary therapist.

Operative technique

All patients were treated with the same procedure. We harvested split-thickness skin graft at a thickness of 0.02794 cm from the patient's own thigh using an air-powered dermatome (Zimmer[®], Air Dermatome; Zimmer Surgical Inc., Warsaw, IN, USA) and harvested skin graft was meshed 1.0:1.5 with an EXPANDER (Meshgraft[™] II; Zimmer Surgical Inc.). The potential for fluid collection beneath the graft is reduced by meshed graft. Recipient site was covered with meshed split-thickness skin graft and we sutured the laid split-thickness skin graft to the defect margin and to the wound bed for fixing the graft. Then, we applied antibiotic ointment (Teramycin[®]; Pfizer, New York, NY, USA) and non-adherent single layer of medicated paraffin gauze containing 0.5% chlorhexidine acetate (Bactigras[®]; Smith&Nephew, Mississauga, ON, Canada), as an antibacterial dressing, to laid skin grafts. Because a thin, porous barrier (medicated paraffin gauze) is then placed between the graft and open-cell polyurethane foam, we prevented the adherence of the foam to the transplanted skin graft. An Open-cell polyurethane foam (Curavac[®]; CGBio, Seongnam, Korea) that was trimmed to the size and geometric dimension of the uneven wound contour. Then trimmed open-cell polyurethane foam and poly vinyl chloride (PVC) suction tube was added and wound was sealed with transparent film (Ioban[™]; 3M[™], Maplewood, MN, USA) to allow a negative pressure environment at the dressing site. PVC suction tube is brought out in an area where pressure will not be applied for preventing another injury, as pressure ulcer. PVC suction tube is then connected to a computerized suction pump that provides 80 mmHg of continuous negative pressure. The dressing was maintained for about 3 days, at which time most

grafts are well adhered to the recipient bed. On the first opening of the dressing, all grafts were opened and negative pressure therapy was stopped. After the negative suction dressing was carefully removed, the dressing was then changed every other day for the remainder of the hospitalization stay. Cleansing and applications of antibiotic ointment (Teramycin®; Pfizer), cotton ball molding, and mild compressive dressing were subsequently performed.

Conventional bolster dressing was an wet cotton ball applying instead of open-cell polyurethane foam. And mild compressive secondary dressing was following instead of applying the negative pressure therapy. Consecutively following dressing was same with NPWT group.

RESULTS

Patient demographics are shown in Table 1, 2. Of the NPWT applying group, the mean patient age was 48.15 ± 25.49 years (range, 4~83 years). The average wound size was 147.04 ± 146.74 cm² (range, 9~450 cm²). Wound defects were located various areas of the upper/lower limbs and trunk. Immediate skin graft reconstruction was performed to six patients and delayed reconstruction patients were nineteen. Wound preparing average duration for delayed skin graft reconstruction is 40 ± 2.19 days (range, 9~88 days). All patients were healed without having revision surgery except one patient (patient 1). The average duration of taken time was 6.4 ± 1.97 days (range, 5~15 days).

Table 1. Patient demographics and operative results (negative pressure wound therapy group)

Patient No.	Sex	Age (yr)	Mechanism	Underlying disease	Total grafted area (cm ²)	Location	Taken time (d)	Wound preparing duration (d)
1	Female	83	Traumatic defect	None	450.0	Thigh	5	44
2	Male	76	Onconlogic surgery	HTN	70.0	Forearm	7	Immediate reconstruction
3	Male	45	Necrotizing fasciitis	None	400.0	Trunk	5	75
4	Female	50	RT-induced sarcoma	None	141.0	Chest wall	15	Immediate reconstruction
5	Male	4	Scar	None	35.0	Foot	7	Immediate reconstruction
6	Male	69	Burn	DM	250.0	Lower leg	7	16
7	Male	79	Ischemic ulcer	HTN	50.0	Lower leg	5	84
8	Male	63	Venous ulcer	HTN, PV, CVA, PVD	25.0	Buttock	7	12
9	Female	50	After PBSC release	None	54.0	Upper arm	6	Immediate reconstruction
10	Male	64	After PBSC release	HTN	165.0	Lower leg	6	Immediate reconstruction
11	Male	42	Traumatic defect	None	75.0	Thigh	5	88
12	Female	75	Traumatic defect	DM, HTN, CVA	30.0	Lower leg	5	33
13	Male	50	Onconlogic surgery	None	25.0	Foot	7	Immediate reconstruction
14	Female	63	Traumatic defect	None	42.0	Foot	7	10
15	Female	57	Traumatic defect	HTN	9.0	Foot	7	39
16	Female	27	Traumatic defect	None	100.0	Thigh	6	80
17	Male	71	Traumatic defect	HTN, DM	285.0	Thigh, lower leg	7	36
18	Male	6	Traumatic defect	None	181.0	Thigh, forearm	6	34
19	Male	50	Traumatic defect	None	84.0	Forearm	6	19
20	Male	53	Traumatic defect	HTN	312.0	Foot	5	55
21	Female	29	Traumatic defect	None	390.0	Lower leg	6	21
22	Male	58	DM foot	HTN, DM, CKD	22.5	Foot	6	13
23	Male	44	Traumatic defect	DM	176.0	Foot	5	42
24	Male	81	Traumatic defect	None	9.0	Thigh	7	9
25	Female	83	Traumatic defect	HTN	22.5	Lower leg	5	50

RT: radiotherapy, PBSC: postburn scar contracture, DM: diabetes mellitus, HTN: hypertension, PV: polycythemia vera, CVA: cardiovascular accident, PVD: peripheral vessel disease, CKD: chronic kidney disease.

Table 2. Patient demographics and operative results (conventional dressing group)

Patient No.	Sex	Age (yr)	Mechanism	Underlying disease	Total grafted area (cm ²)	Location	Taken time (d)	Wound preparing duration (d)
1	Female	52	Burn	None	211.00	Thigh	14	40
2	Male	46	Chronic ulcer	None	141.00	Abdomen	12	49
3	Female	33	Traumatic defect	None	1.50	Face (cheek)	13	6
4	Male	37	Traumatic defect	None	1.50	Face (cheek)	6	Immediate reconstruction
5	Male	34	Traumatic defect	None	10.50	Face (nose)	12	10
6	Male	76	Traumatic defect	HTN	10.00	Face (forehead)	12	14
7	Male	56	Ischemic ulcer	Burger's disease	70.00	Foot	13	118
8	Female	44	Burn	None	42.25	Foot	12	22
9	Female	38	Burn	None	2.00	Foot	9	19
10	Female	23	Burn	None	32.00	Foot	7	16
11	Male	30	Burn	None	99.00	Foot	13	15
12	Male	75	Burn	None	60.00	Foot	8	20
13	Female	50	Burns	None	150.00	Foot	14	21
14	Female	59	Burns	HTN, DM	42.00	Foot	12	31
15	Female	21	Traumatic defect	None	48.00	Foot	13	18
16	Male	12	Traumatic defect	None	60.00	Foot	10	19
17	Male	25	Traumatic defect	None	6.00	Heel	9	17
18	Male	63	Ischemic ulcer	None	6.00	Heel	10	26
19	Male	48	Burn	None	30.00	Hand	8	34
20	Male	6	Burn	None	2.00	Hand	8	21
21	Male	31	Burn	None	7.00	Hand	9	25
22	Male	48	Burn	None	2.00	Hand	10	28
23	Male	30	Burn	None	15.00	Hand (2nd~5th fingers)	13	15
24	Male	10	Burn	None	1.40	Hand (2nd finger)	7	20
25	Male	60	Traumatic defect	None	400.00	Thigh	12	53
26	Female	38	Burn	None	16.00	Ankle	10	19
27	Female	60	Burn	None	4.50	Ankle	8	19
28	Female	71	Traumatic defect	None	50.00	Ankle	11	28
29	Male	13	Traumatic defect	None	9.00	Ankle	9	25
30	Male	9	Burn	None	12.00	Knee	10	30
31	Male	48	Burn	None	180.00	Lower leg	9	35
32	Female	70	Burn	HTN, CAOD	21.00	Lower leg	12	Immediate reconstruction
33	Female	73	Traumatic defect	Adrenal insufficiency	11.25	Lower leg	12	14
34	Female	43	Burn	None	55.00	Lower leg	11	20
35	Female	42	Burn	None	10.00	Lower leg	9	23
36	Female	80	Onconlogic surgery	DM	9.00	Lower leg	8	Immediate reconstruction
37	Female	31	Traumatic defect	SLE	12.00	Lower leg	10	12
38	Male	65	Traumatic defect	None	202.50	Thigh	13	103
39	Male	56	Fournier's gangrene	HTN, DM	120.00	Perineum	14	47
40	Female	28	Burns	None	24.50	Lower leg	14	30
41	Female	59	Traumatic defect	None	0.75	Scalp	7	10
42	Male	53	Fournier's gangrene	None	617.00	Scrotum	15	23
43	Male	51	Traumatic defect	None	77.00	Scrotum	14	19
44	Female	32	Burn	None	162.00	Thigh	15	25
45	Male	13	Burns	None	10.00	Thigh	10	18
46	Male	50	Traumatic defect	None	65.00	Elbow	11	56
47	Male	21	Burn	None	35.00	Forearm	9	24
48	Female	46	Burn	None	84.50	Forearm	8	25
49	Male	42	Burn	None	42.00	Wrist	13	18

HTN: hypertension, DM: diabetes mellitus, CAOD: coronary artery occlusive disease, SLE: systemic lupus erythematosus.

Of the conventional bolster dressing group, the mean patient age was 42.88 ± 19.34 years (range, 6~80 years). The average wound size was $66.94 \pm 109.94 \text{ cm}^2$ (range, $0.75 \sim 617.00 \text{ cm}^2$). Wound defects were located various areas same as NPWT group, except but facial wound. Delayed skin graft reconstruction patients were forty six and immediate reconstruction patients were three. Wound preparing average duration for delayed skin graft reconstruction is 27.56 ± 20.92 days (range, 6~118 days). In fourteen patients (28.6%), fluid accumulation such as hematoma or seroma formation occurred and partial graft loss occurred in 8 patients (16.3%). The average duration of taken time was 10.78 ± 2.38 days (range, 6~15 days).

Case 1

Patient 1 had an avulsion injury on the left thigh due to traffic accident with a very large and uneven wound bed surface. An artificial dermis (Matriderm®; MedSkin Solutions Dr. Suwelack, Billerbeck, Germany) was used as a skin graft to prevent joint stiffness because the location of the wound defect involved the knee joint (Fig. 1, 2). After 5 days of surgery, most of transplanted skin graft was well taken. But there still remain a few defects on grafted area. Cultured allogenic keratinocyte (Kaloderma®; Tego Science, Seoul, Korea) was onlaid over remnant defect. After 11 days of first skin graft surgery, we did revision surgery again (total re-grafted defect size was about 46 cm^2).

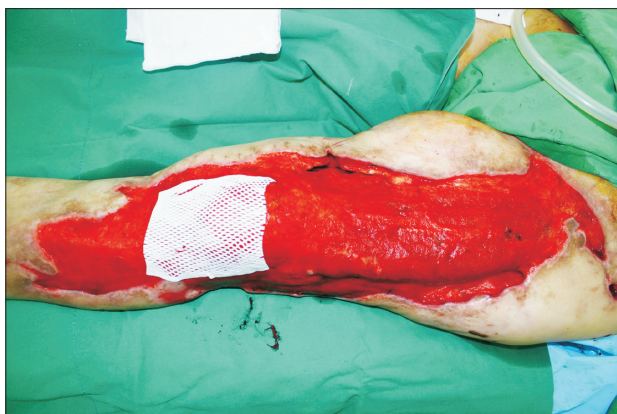


Fig. 1. Patient 1; Intraoperative clinical photo. An acellular dermal substitute (Matriderm®, MedSkin Solutions Dr. Suwelack, Germany) was used as a skin graft to prevent joint stiffness because the location of the wound defect involved the knee joint.

Case 2

Patient 2 had a squamous cell carcinoma on his wrist, and we widely excised the skin cancer using a safety margin of 10 mm. After that, we elevated the local flap (reverse flow distal forearm island flap) and treated the skin graft for coverage of the flap donor site. After excision of the cancer, the patient had a defect that had an irregular contour and poor vascular bed, including exposure of the paratenon. After 7 days of surgery, most of skin graft was well taken without any wound discharge (Fig. 3).

Case 3

Patient 3 had extensive skin loss in the abdominal region and right side that was not suitable for a compression dressing; severe kyphosis made it difficult for the patient to move after surgery. NPWT was identified as a suitable dressing to maintain even pressure distribution across the large wound bed (Fig. 4). All stitches (staples) were removed on postoperative day 5 and all transplanted skin graft was well epithelization and taken.

Case 4

Patient 4 had radiotherapy-induced sarcoma on the left chest wall and underwent wide excision and reconstruction with a free transverse rectus abdominis myocutaneous flap, but the flap had to be detached due to a thrombus at the anastomosed site. The subsequent defect on the chest wall was treated using a left gastroepiploic artery-pedicled omental flap and a mesh split thickness skin graft over the flap with NPWT application. NPWT effectively allows drainage of exudates from the



Fig. 2. Patient 1; Postoperative 5-day clinical photo. The graft was well taken and staples were completely removed, although focal raw surfaces requiring an additional surgery were seen.



Fig. 3. Patient 2; Postoperative 11-day clinical photo. He did not need a splint for immobilization of the graft area on his wrist, which prevented stiffness in his hand and wrist.

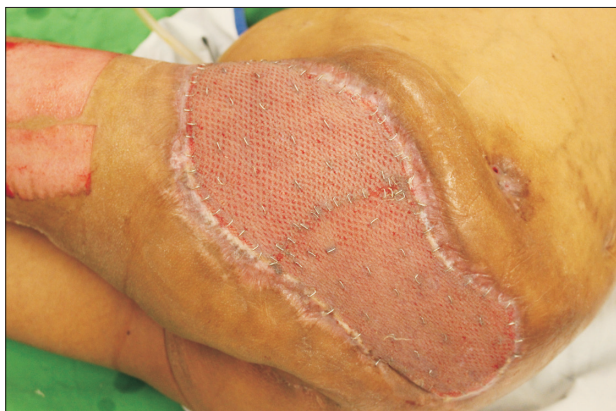


Fig. 4. Patient 3; Postoperative 3-day clinical photo. Patient 3 had extensive skin loss in the abdominal region and right side that was not suitable for a compression dressing; severe kyphosis made it difficult for the patient to move after surgery. Negative pressure wound therapy was identified as a suitable dressing to maintain even pressure distribution across the large wound bed.

omentum, reducing seroma or hematoma formation as well as lessening the chance of inflammation or infection (Fig. 5). The graft site was completely healed on postoperative 15 days and there was not required any dressing except but applying ointment for keeping graft moisture.

Case 5

Patient 5 (5-year-old boy) had a hypertrophic scar on his ankle that was treated with scar excision; the resulting defect was covered by a mesh skin graft and application of NPWT over the grafted skin. He did not need a splint to immobilize the graft area on his ankle, which permitted full mobility of the



Fig. 5. Patient 4; Postoperative 2-day clinical photo. Negative pressure wound therapy effectively allows drainage of exudates from the omental flap with onlaid skin graft, reducing seroma or hematoma formation as well as lessening the chance of inflammation or infection.



Fig. 6. Patient 5; Postoperative 6-day clinical photo. Non-compliant children was good candidate of applying negative pressure wound therapy for securing skin graft. He did not need a splint to immobilize the graft area on his ankle, which permitted full mobility of the lower limb.

lower limb (Fig. 6).

As mentioned above, identical surgical techniques and postoperative management were done on all of the patients, yielding good aesthetic results without significant complications throughout the follow-up period.

DISCUSSION

A healthy wound bed, the prevention of fluid drainage between the wound bed and the graft, and the prevention of shearing forces from disrupting the graft are all critical for prompt graft success. Conventional tie-over or compressive

molding dressings are sufficient for simple wounds, but for the complicated cases observed in our hospital, such methods do not suffice.

In our study, NPWT group shows more desirable clinical outcomes in aspects of graft taken or healing time and complication such as hematoma, seroma and partial graft loss. Through many studies, expected split-thickness skin graft failure rate of 15% to 30% when using traditional dressing was reported.^{4,6} Comparing previous reports, our data suggest that conventional dressing group showed similar results of graft loss (16.3%) but a negative-pressure wound therapy over a split-thickness skin graft site may enhance overall graft survival (4%). Even graft taken or healing was required a shorter period at NPWT group (6.4±1.97 days) than conventional dressing group (10.78±2.38 days).

Several studies announce why NPWT may enhance graft survival.^{2,7} First, an important aspect to increase graft survival rate is maintaining study pressure to contact between the transplanted graft and the recipient wound surface.^{2,8} In our study, patient 2 and 3 were not suitable for a compression dressing to graft area because we were concerned about chocking the flap pedicle and compressing his trunk lead to respiration difficulty. In cases when compression dressing cannot be applied, compression of the graft was achieved without putting pressure on the surrounded structure using NPWT. After extensive three-dimensional skin grafting, it can be difficult to apply pressure effectively; however, NPWT evenly distributes pressure and secures transplanted skin firmly against the defect wound.

Second, accumulation of fluid (hematoma or seroma) beneath the graft has an adverse effect on graft survival. The use of NPWT contributes continuous evacuation immediately, which prevents the fluid accumulation and the graft site remains clean, thus limiting the chance of infection. Also the NPWT has been associated with lower bacterial counts at wound site,³ and this reduction in the local bacterial flora may enhance graft survival. In our study, patient 4 was treated using a left gastroepiploic artery-pedicled omental flap and a mesh split thickness skin graft over the flap with NPWT application. NPWT effectively allows drainage of exudates from the omentum, reducing fluid collection as well as lessening the chance of inflammation or infection. Severe drainage from the wound can cause a hematoma under the graft or an infection at

the surgical site; however, fluid collection and infection can be prevented using negative pressure. It is critical to note that mesh or fenestrated grafts are likely to produce the best outcomes, as these maximize fluid removal and prevent accumulation of fluid.⁹ When applying NPWT, a slit incision is used to prevent fluid accumulation and better coaptation of the grafted skin. An incision using an expander without over-spreading the grafted skin is critical for both effectively removing fluid and producing better aesthetic outcomes at the same time. This will also reduce healing time.

As many studies suggest, NPWT yields better results for noncompliant children than do conventional methods. Major advantages of NPWT for pediatric patients are the superb success rates of the skin grafts and early mobilization. In age groups where compliance issue are highly expected, like in babies, toddlers and unteachable child, a firm and secure fixation of the skin grafts and high mobility of the patients are of utmost importance for the overall treatment outcome.¹⁰

We used a somewhat lower negative suction pressure (80 mmHg) than conventional pressure (125 mmHg). High pressure is not required for taken graft, but continuous firm contact between recipient bed and transplanted skin is important. As mentioned in previous studies, many surgeons are limited to a single vendor for NPWT. Therefore, the traditional approach of using 125 mmHg pressure and a polyurethane foam dressing was the only treatment described in the literature and taught to them for complex wounds. Pressure selection was based on classical swine studies conducted at Wake Forrest University. Argenta and Morykwas² reported that local tissue perfusion was optimized at 125 mmHg. Recently, Borgquist et al.¹¹ re-created the swine study and reported that pressures up to 80 mmHg increased local perfusion and higher pressures reduced perfusion.

Although no controlled studies have been performed, we have found this technique of dressing graft to be excellent for circumstances in which a skin graft must be placed over an uneven wound bed surface.

CONCLUSION

We suggest using NPWT under the following circumstances:

1. Presence of a very large and uneven wound bed surface (except a circumferential wound bed)

2. In an area that requires a non-compressible dressing (beside flap)
3. For use over the dermal substitute and skin graft
4. In non-compliant children
5. In cases of a poor vascular bed, paratenon, over the scar tissue.

NPWT can be used to cover wounds in which healing does not occur fully or when tie-over and compressive dressings are not applicable. The use of NPWT further contributes to reduced wound healing time and allows earlier patient mobilization and hospital discharge.

REFERENCES

1. Webb LX, Pape HC. Current thought regarding the mechanism of action of negative pressure wound therapy with reticulated open cell foam. *J Orthop Trauma* 2008;22:S135-7.
2. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. *Ann Plast Surg* 1997;38:563-76; discussion 577.
3. Morykwas MJ, Argenta LC, Shelton-Brown EI, McGuirt W. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. *Ann Plast Surg* 1997;38:553-62.
4. Brandes SB. *Urethral reconstructive surgery*. New Jersey: Humana Press, Springer Science & Business Media; 2008.
5. Thourani VH, Ingram WL, Feliciano DV. Factors affecting success of split-thickness skin grafts in the modern burn unit. *J Trauma* 2003;54:562-8.
6. Henderson NJ, Fancourt M, Gilkison W, Kyle S, Mosquera D. Skin grafts: a rural general surgical perspective. *ANZ J Surg* 2009;79:362-6.
7. Deva AK, Buckland GH, Fisher E, Liew SC, Merten S, McGlynn M, et al. Topical negative pressure in wound management. *Med J Aust* 2000;173:128-31.
8. Molnar JA, DeFranzo AJ, Marks MW. Single-stage approach to skin grafting the exposed skull. *Plast Reconstr Surg* 2000;105:174-7.
9. Avery CM, Pereira J, Brown AE. Suprafascial dissection of the radial forearm flap and donor site morbidity. *Int J Oral Maxillofac Surg* 2001;30:37-41.
10. Hoeller M, Schintler MV, Pfurttscheller K, Kamolz LP, Tripolt N, Trop M. A retrospective analysis of securing autologous split-thickness skin grafts with negative pressure wound therapy in paediatric burn patients. *Burns* 2014;40:1116-20.
11. Borgquist O, Ingemansson R, Malmsjö M. The influence of low and high pressure levels during negative-pressure wound therapy on wound contraction and fluid evacuation. *Plast Reconstr Surg* 2011;127:551-9.