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Vacuum-assisted Closure: A Reliable Method to Secure Skin Graft

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Abstract

Background: **The success of skin grafting procedure requires many factors and the most important ones are avoidance of fluid collection under the graft and immobilization to prevent shearing force between the graft itself and the recipient bed. Blood, serum, and purulent material collection under the graft will separate the skin graft from its wound bed, prevent vascularization, and thus cause loss of the graft.**

Objectives: **To determine the effectiveness of the application of a vacuum-assisted closure (VAC) over the skin graft to obtain a secure skin graft immobilization and to prevent fluid collection under the graft.**

Materials and Methods: **Prospective studies of VAC were done on 17 wounds of 14 consecutive patients, ages ranged from 2 to 74 years. A local made collapsible foam was sterilized and used to cover the wound and a non-collapsible nasogastric tube was used for suction of the air from the wound. The other end of the nasogastric tube was connected to the wall suction pump that provided 100-125 mmHg of continuous negative pressure, for a period of 4-7 days, without external immobilization with cast or K-wire fixation. The wound was observed for another two weeks after the VAC dressing had been removed.**

Results: **Ninety to 100% of graft take was observed in all wounds in the first week and 100% of the wound completely healed in the third week.**

Conclusions: **The technique of VAC with the skin grafting procedure is a simple and reliable method to secure the skin graft on the wound bed and to prevent fluid collection under the graft.**

Introduction

A skin grafting procedure is a simple method for covering a wound which can not be closed by direct suture. Critical factor for the survival of the graft is to provide appropriate contact between the dermal layer of the graft and the recipient bed. It is necessary to secure a graft in place during the period of inosculation and capillary in-growth that usually takes 2-5 days. However, in some areas such as irregular surface, exudative surface, or the surface subjecting to repeated motion, successful grafting procedure is much more difficult because the collection of hematoma and exudate or moving bed from shearing force over the joint area can result in failure or complete loss of the graft. A tie-over bolster dressing is frequently cumbersome and fails to distribute pressure evenly to the grafts over irregular beds.

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A simple VAC for securing skin graft on the wound bed and preventing fluid collection under the graft was used. We used cheap, local made foam and a non-collapsible nasogastric tube to obtain a continuous sub-atmospheric pressure at 100-125 mmHg. This technique will ensure a good surface contact between the graft and recipient bed while under negative pressure.

Materials and Methods

Prospective studies were carried out in 14 consecutive patients (17 wounds), ages ranged from 2 to 74 years. The intermediate split-thickness skin grafts were harvested and multiple holes were made by a surgical blade or 1.5:1 skin graft meshing device. The graft was then transplanted on the recipient site either immediately in the operating room and tacked with staples, sutures or delayed at the ward as an open technique without tacking.

A sterilized sponge, local-made foam, was cut slightly larger than the size of graft to fit the appropriate contour of the wound defect. The nasogastric tube was inserted through the center of the foam to suck air from the wound. A thin, porous barrier was placed between the sponge and the graft to prevent the adherence of the sponge to the transplanted skin. One adhesive film was applied to cover the whole sponge and the intact skin edges around the graft, allowing the negative pressure to be created under the entire dressing. Additional adhesive film might be necessary to cover the leakage area if the sponge would not collapse.

The outside end of the tube was connected to a wall suction pump that provided 100-125 mmHg of continuous negative pressure. This would make the dressing airtight and create the vacuum effect. If there were no leaks in the dressing, the sponge would fold in on itself and put an even amount of pressure over the entire graft (Figure 1) and the sponge would contour the graft to the wound bed. The complete surface contact between the graft and the recipient bed was created. Any fluid collection on the wound would be sucked into the closed reservoir of the pump, so no

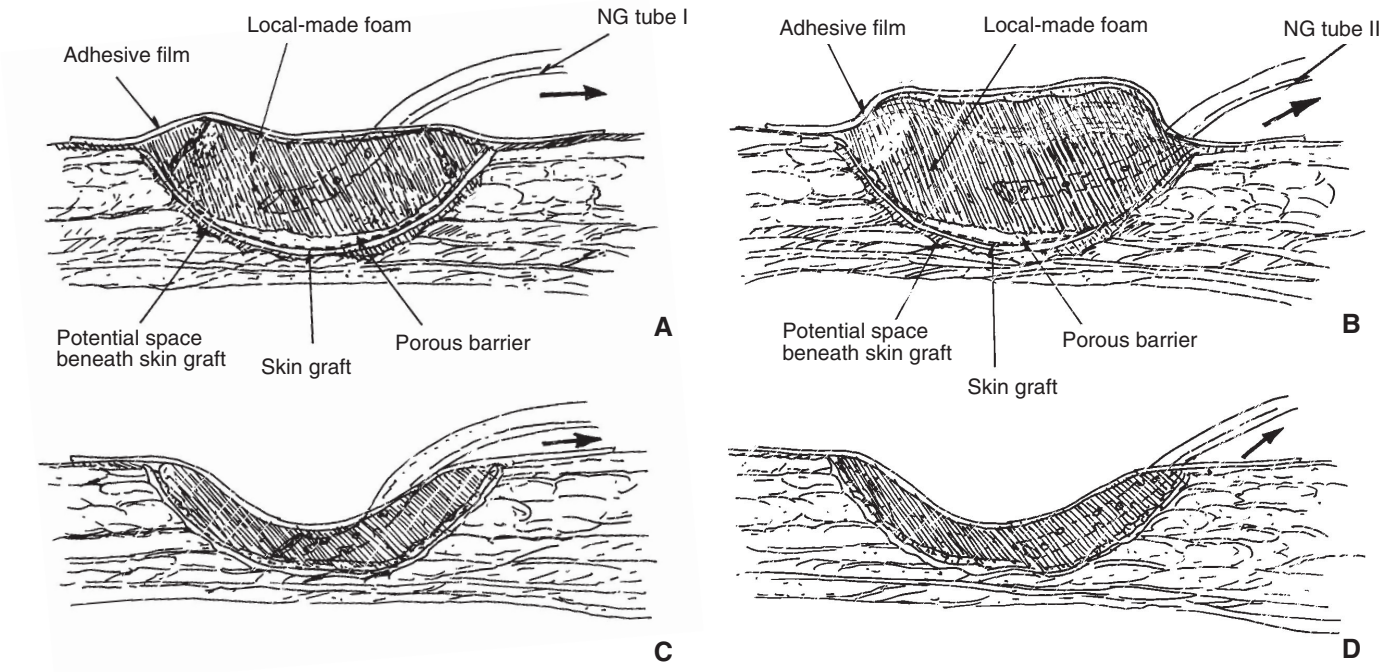

Fig. 1 The NG tube can be inserted through the local-made foam either on its top surface (A) or its side wall (B). It is imperative that the tip of the NG tube must stay within the foam. The adhesive film completely covers the whole wound. When the wall suction pump is working effectively without any air leakage, the foam must abruptly and completely be collapsed by continous negative pressure and distributes the pressure evenly on the skin graft (C, D). The blood, serum, and purulent material collection under the graft will be aspirated through the foam and via the NG tube to the drainage bottle. The whole skin graft will be secured and immobilized in good contact without shearing force on the wound bed.

fluid collection either below or above the graft was left. The VAC dressing also helped to immobilize the graft on the wound bed.

The VAC dressing was applied to the graft for a period of 4-7 days without using any additional materials to immobilize the joint area as it had usually been done in a traditional skin grafting procedure. The graft area and its survival areas were measured in all wounds. Later, simple dry dressing was applied and the wound was examined every week till the third week after surgery.

Table 1 Patient's data

No.	Age	Sex	Underlying disease	Cause of skin loss
1	42	M	Scald burn	Burn
2	51	M	DM	Necrotizing fasciitis
3	65	M	None	SCC
4	66	F	None	Plastocytoma
5	50	F	CA breast	Flap necrosis
6	62	M	DM	Necrotizing fasciitis
7	42	M	Scald burn	Burn
8*	68	M	Leprosy	Chronic wound
9	62	M	IHD s/p CABG	Sternal wound dehiscence
10	45	F	Burn scar contracture	Releasing
11	44	F	None	Avulsion wound
12	74	M	None	Chronic wound
13	28	F	None	Avulsion wound
14	2	M	Scald burn	Burn

**The patient was properly treated 10 years ago with no active infection*

Results

During the 5-month period, this method was used to secure the skin grafting procedure in 17 wounds (14 patients). The graft sites included the lower extremity (11), the trunk (3), and the upper extremity (3). There were 7 chronic wounds, 7 acute wounds, and 3 burn wounds (Table 1). The sizes of the wounds measured between 15 cm^2 to 300 cm^2. Ninety - 100% of the grafted areas survived in all wounds in the first week and all wounds completely healed (100%) in the third week. No complication was detected. (Table 2)

Case Reports

Case 1 (Patient No. 5)

A 56-year-old female patient underwent modified radical mastectomy. Unfortunately, a skin flap necrosis

Table 2 Outcome of 17 wounds

Patient No.	Wound type	Location	Area of defect (cm^3)	Days of V.A.C. Application	Percentage of Graft Take	Additional procedure
1	Burn	Rt. thigh, leg	250	4	100%	-
		Lt. thigh, leg	280	4	100%	
2*	Chronic	Rt. thigh, leg	300	4	90%	STSG
3	Acute	Lt. foot	40	7	100%	-
4	Acute	Rt. thigh,	168	6	100%	-
5	Chronic	Lt. chest	90	6	100%	-
6	Chronic	Rt. leg	20	4	100%	-
		Lt. leg	88	4	100%	-
		Lt. foot	31	4	100%	-
7	Burn	Lt. hand	31	4	100%	-
8	Chronic	Lt. foot	15	7	100%	-
9**	Acute	Chest	97	4	95%	-
10	Acute	Rt. hand	44	4	100%	-
11	Chronic	Lt. leg	50	7	100%	-
12	Acute	Rt. forearm	90	4	100%	-
13	Chronic	Lt. leg,	150	4	100%	-
14	Burn	Back	140	7	100%	-

** Graft loss was 30 cm^2 and split-thickness skin graft (STSG) was used for coverage of the defect again with VAC dressing till day 7.*
***STSG was covered on a muscle flap with VAC dressing.*

Fig. 2 A The wound before coverage with STSG.
B During the application of VAC dressing over the graft (day 1-6).
C Complete take of the graft (day 14).

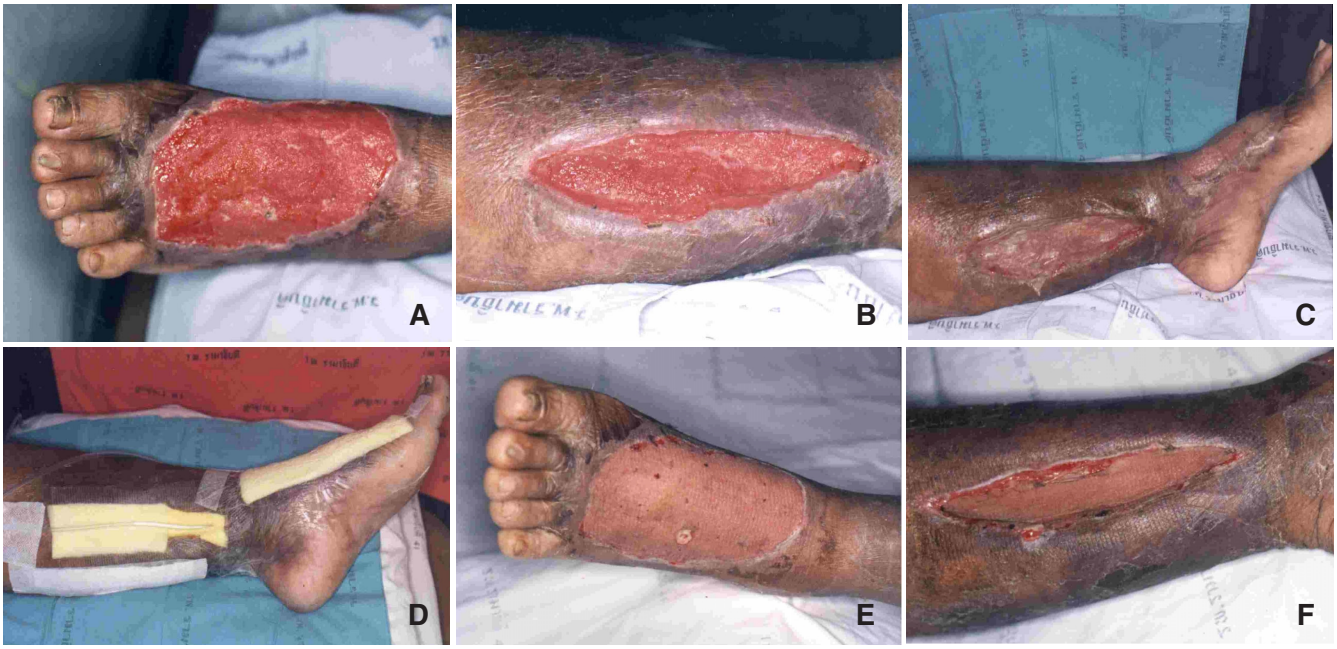

Fig. 3 A, B The healthy granulating wounds before skin coverage.
C The wounds were covered with STSG before VAC dressing were applied to secure the skin graft.
D During the application of VAC dressings over the grafts (day 1-4).
E, F Demonstrating 100% take of skin grafts at both sites.

developed. The necrotic tissue was debrided and wet-to-dry dressing was applied for 2 weeks before coverage with split-thickness skin graft (STSG). The grafts healed completely (Figure 2 A-C).

Case 2 (Patient No. 6)

A 62-year-old male, diabetic patient suffered from a necrotizing fasciitis on his left leg. The wound was radically debrided and some tendons were exposed. The VAC dressing was applied for 4 weeks before the skin coverage. Two skin defects were left at the medial aspect of the left leg and the dorsum of the left foot (Figure 3 A-F).

Case 3 (Patient No. 7)

A 42-year-old man sustained scald burn at the dorsum of his right hand. Burn wound care including serial tangential escharectomy was done regularly for

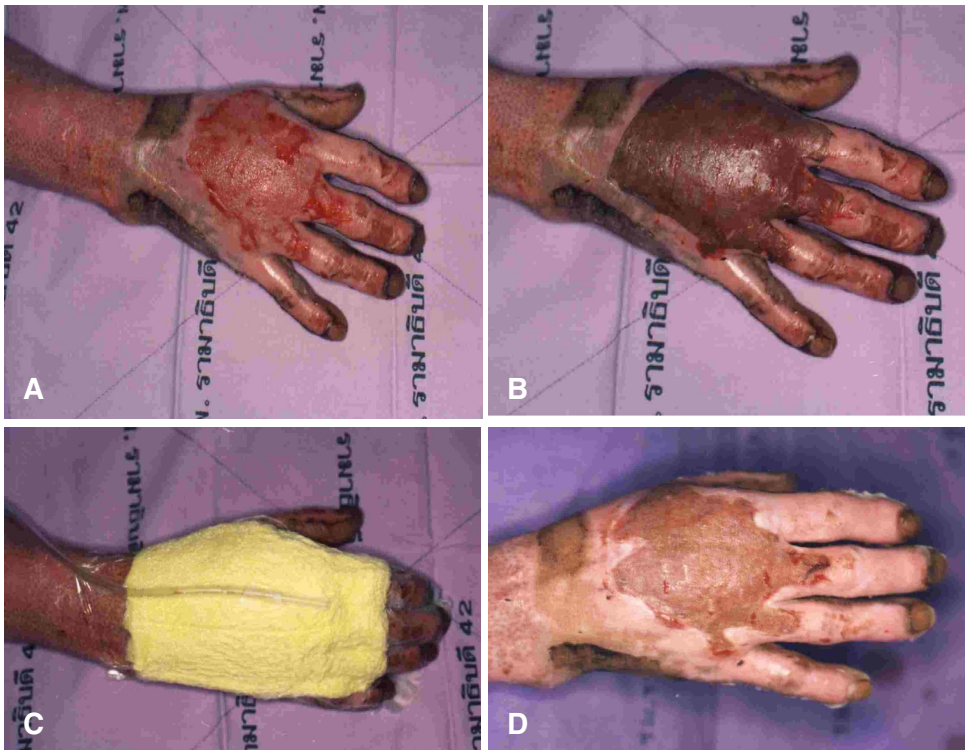

Fig. 4 A Before coverage with STSG.
B The area of granulating wound was covered with STSG before application VAC dressing to secure the skin graft.
C During application of VAC dressing over the graft (day 1-4).
D Complete take of the graft (day 7).

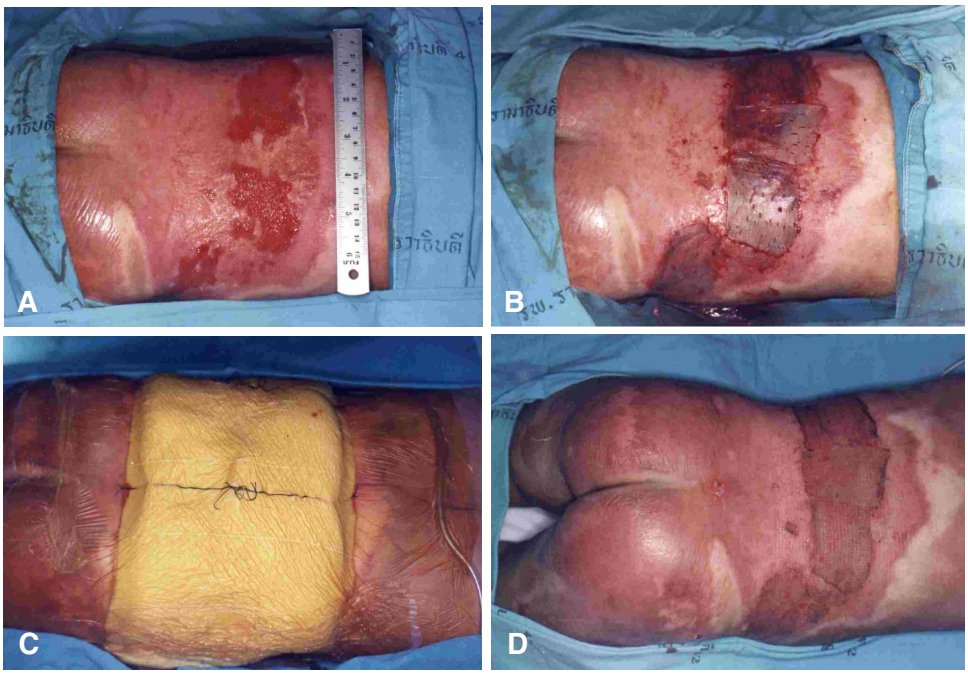

Fig. 5 A The healthy granulating wound 3 weeks before skin coverage.
B The wound was covered with STSG before application with VAC dressing.
C During VAC dressing over the graft (day 1-7).
D Complete take of the graft (day 14).

two weeks. Some superficial burn area healed by epithelialization but the granulating wound on the dorsum of the hand needed skin coverage rather than healing by secondary intention which could lead to hypertrophic scar formation and extensor scar contracture (Figure 4 A-D).

Case 4 (Patient No. 14)

A 2-year-old boy sustained scald burn at back. Burn wound care was done regularly and at three weeks after the injury, there still were some granulating wounds which needed skin grafting. Skin grafts were then applied and secured with the VAC dressing. At day 14, the grafts healed completely (Figure 5 A-D).

Discussion

For centuries, skin grafting has been a simple procedure for wound coverage. The classical method of graft fixation consists of a tie-over bolster dressing maintaining in situ for approximately 5-7 days.[1] Bolster dressing has been successful in the majority of patients, however, inadequate graft bed, hematoma, seroma, fluid collection, movement, infection and technical error can contribute to graft loss.[1-3] In these situations, the conventional skin graft stabilization techniques are problematic and ineffective.

In 1997, Argenta[4] reported VAC, an innovative technique using negative pressure, for closure of chronic wound. This technique leads to enhanced granulation tissue formation and consequently more rapid re-epithelialization of wound compared with conventional packing with saline-moistened gauze. Experimental studies[5] demonstrated increased oxygen tension, decreased bacterial counts and increased granulation tissue formation with this technique. With this concept, we have been using the VAC dressing for securing the skin graft since October 2000. In 1998, Blackburn[6] reported 3 cases using this technique for securing the skin graft. In his study, the graft survived greater than 95%. Schneider[7] used this technique in more than 100 wounds without any graft loss. In 1999, Meara[8] reported VAC in the treatment of degloving injury in 5 patients with 60%-100% graft survival. Molnar[9] reported 4 patients using this technique for single stage approach of skin grafting over the exposed skull, the graft survived more than 95%.

In our report, we studied this technique prospectively in different wounds (acute, chronic, burn, or muscle flap) and different areas (trunk, lower extremity, upper extremity). Our results showed greater than 90% graft survival in all wounds with no complications. This technique is extremely efficacious, with increased graft take due to total immobilization of the graft with complete contact of the skin graft and the recipient bed, thereby limiting shearing forces, eliminating fluid collection, bridging of the graft (in mesh graft) and decreasing bacterial contamination. Moreover, they can be easily, and quickly applied (some wounds were applied at ward, with no sutures). We also noted that this technique could be applied over the muscle flap (patient no. 9) and could be applied easily in a 2- year-old boy (patient no. 14) without complications.

The only disadvantage is that the patient could not get out of bed when the VAC dressing was applied, because the wall suction system for negative pressure was used. However, temporary disconnection from the wall suction system can be made and the patient can leave the bed.

Summary

We conclude that the VAC dressing over the skin graft is a simple and reliable method to secure the skin graft in good contact with the recipient bed. This dressing technique is an alternative treatment to secure the graft, especially to the difficult recipient beds. As all local-made materials used for this technique are readily available in any hospitals, this simple technique is convenient and cheap as well as effective. It should be recommended for the treatment of difficult wounds and also in the skin grafting procedures.

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