Original Article

Application of Negative-pressure Wound Therapy after Radical Excision of Soft Tissue Malignancy: To Obtain a Better Esthetic Result with a Less Invasive Reconstructive Technique

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ABSTRACT

Background: The applications of negative-pressure wound therapy (NPWT) have been well documented. Nowadays, NPWT can be used to treat extensive tissue loss after complete resection of soft tissue malignancy, such as invasive skin cancer or sarcoma. **Materials and methods:** Information on demographics, total days of therapy, complications, recurrence of malignancy, presence of a concave wound, and slough formation was collected from five patients who had been treated with NPWT after resection of invasive skin cancer or sarcoma between April 2018 and March 2019.

Results: The patients comprised three men and two women with a median age of 51.4 (range, 30–70) years. Four patients had sarcoma, and one had deep subcutaneous skin cancer. After treatment with NPWT or NPWT i-d (instillation of saline with a 10-min dwell time, followed by NPWT) for an average of 12.6 (range, 6–28) days, none of the patients had a concave wound or slough, and good granulation tissue covered the tendons and vessels in all cases. No recurrences of malignancy were observed during 12–19 months of follow-up.

Conclusion: NPWT is extremely effective for complicated wounds after surgery for deep cutaneous malignancy and has a favorable esthetic outcome because of accelerated wound healing.

Key words : complicated wound, esthetic result, negative-pressure wound therapy, progressive malignancy

Introduction

The applications of negative-pressure wound therapy (NPWT) have been well documented. Over time, there have been an increasing number of reports on NPWT, with sudden increases in the number of publications when technological improvements are made. Randomized controlled trials and retrospective cohort studies of NPWT have reported reduced wound volumes, accelerated granulation tissue formation, and reduced rate of postoperative complications¹⁻⁴⁾. The clinical applications of NPWT include exposed bone or joints, deep sternal wounds, open abdominal or intra-abdominal infections,

deep pressure ulcers, and diabetic foot⁵⁻⁹⁾.

Significant tissue defects after wide resection of invasive skin cancer or sarcoma with the exposure of the tendons, bones, joints, and vessels generally require reconstructive procedures that include good-quality vascularized tissue and rapid healing. Pedicled flaps are used most commonly to cover such defects, and free flaps have gained popularity because of their rapid healing¹⁰⁾. However, not all patients are candidates for reconstructive surgery. In the past, such patients were treated using a dermal matrix, followed later by a skin graft to cover the defect. Although a dermal matrix can be effective, the amount of granulation tissue generated to cover the exposed bone, joint, or tendon at the site of the defect is limited¹¹⁾,

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Fig. 1. Leiomyosarcoma on the lateral chest wall in a 62-year-old man who was not treated with negative-pressure wound therapy.

- a: Deep surgical wound after tumor resection, including the resected muscle.
- b: Twenty-six days after conservative treatment using artificial dermis.
- c: Intraoperative image after split-thickness skin graft.
- d: Appearance of the wound at 12 months after skin graft.

meaning that slough forms in the granulation tissue with dimpling and a conspicuous wound site persists after the skin graft as our case, a 62-year-old male patient with leiomyosarcoma treated by artificial dermis, shows (Fig. 1). Presently, NPWT is considered for extensive tissue loss following resection of cutaneous malignancy, such as invasive skin cancer or sarcoma.

The application of NPWT to the surgical wound site after resection of a malignancy has generally been contraindicated after a report suggesting that moderate intermittent negative pressure causes malignant cells to become more invasive¹²⁾. However, if complete resection of the malignancy is confirmed pathologically, the application of NPWT may be considered. NPWT is increasingly being used for surgical site defects following resection of malignancy^{13, 14)} and is particularly effective for deep complicated surgical wounds. In the past, an unsatisfactory cosmetic outcome after tumor resection was accepted because the focus was on the tumor to preserve life. Nowadays, there is more interest in using NPWT to accelerate wound healing and improve the esthetic outcome.

In this article, we describe five patients with significant tissue defects after surgical resection of deep subcutaneous malignancy who were treated with NPWT and discuss the use of this treatment modality to accelerate wound healing and obtain a better cosmetic result.

Patients and methods

A retrospective review of the medical records at Hokkaido University Hospital identified five patients who had received NPWT after resection of invasive skin cancer or sarcoma between April 2018 and March 2019. In all cases, NPWT was implemented until the next skin graft operation after pathologically complete resection of the malignancy was confirmed. Information on demographics, total duration of NPWT, complications, and recurrence of malignancy as well as the effectiveness of accelerated wound healing, as indicated by whether or not the wound was concave and the slough was formed, was collected.

The study was approved by the institutional ethics committee and conducted in accordance with the ethical principles of the Declaration of Helsinki. All patients provided written informed consent.

Results

Patient characteristics and results are summarized in Table 1. There were three men and two women with a median age of 51.4 (range 30–70) years. Four patients had sarcoma, and one had deep subcutaneous skin cancer. The malignancies were located on the posterior aspect of the neck (n=1), sole of the foot (n=1), popliteal area (n=1), buttock region (n=1), and

Table 1. Characteristics of patients and negative pressure wound therapy

Case	Age (years)/sex	Disease	Region	Comorbidities	NPWT mode	Interval from resection to skin graft, days	Total days NPWT	Concave wound	Slough	Recurrence follow-up interval
1	48, female	Leiomyosarcoma	Right sole	Connective tissue disease	Continuous NPWT (-50 mmHg)	49	28	None	None	None (18 months)
2	30, female	Myxofibrosarcoma	Posterior neck		Intermittent NPWT (-50 mmHg to -125 mmHg)	31	15	None	None	None (19 months)
3	70, male	Squamous cell carcinoma	Right popliteal area	Coronary artery disease	NPWT i-d	28	8	None	None	None (12 months)
4	53, male	Dermatofibrosarcoma protuberans	Buttocks	Hypertension	10-min dwell time, 3.5-h NPWT (-125 mmHg) NPWT i-d	31	6	None	None	None (12 months)
5	56, male	Myxofibrosarcoma	Occipital		10-min dwell time, 3.5-h NPWT (-125 mmHg) NPWT i-d	24	6	None	None	None (12 months)
					10-min dwell time, 3.5-h NPWT (-125 mmHg)					

NPWT: negative-pressure wound therapy, NPWT i-d: negative-pressure wound therapy with instillation and dwell time

occipital region (n=1). One patient received intermittent NPWT (−125 mmHg for 5 min alternating with −50 mmHg for 2 min), one received continuous NPWT (−50 mmHg), and three received NPWT i-d (instillation of saline with a 10-min dwell time, followed by 3.5 h of NPWT at −125 mmHg). After an average of 12.6 (range, 6–28) days of NPWT or NPWT i-d, none of the patients had a concave wound or slough within the wound. All patients went on to receive a skin graft, and no recurrences of malignancy were noted during 12–19 months of follow-up.

Two representative cases

Case 1

The patient was a 48-year-old woman who presented with a subcutaneous nodule measuring 2.5×3.5 cm on the sole of her right foot. Radiographic examination of the right foot demonstrated no bony abnormality or invasion into the bone. Magnetic resonance imaging examination revealed an irregularly shaped mass with an approximately clear border but invading to the surrounding muscle tissue. We performed incisional biopsy to obtain a diagnosis because the mass was suspected to be malignant. No evidence of metastasis was found on enhanced computed tomography (CT) and positron emission tomography (PET)-CT scans. The histopathological findings were consistent with a diagnosis of soft tissue sarcoma. The differential diagnosis included fibrosarcoma, rhabdomyosarcoma, and poorly differentiated leiomyosarcoma. We performed a 2-cm-wide local excision of the tumor with resection of the surrounding muscles (flexor digitorum brevis, abductor hallucis, flexor hallucis longus, and part of the flexor hallucis brevis). The defect, in which the tendon of the flexor digitorum longus, plantar quadratus muscle, and periosteum of the first metatarsal bone were exposed (Fig. 2a), was covered with artificial dermis. The final pathological diagnosis was leiomyosarcoma with a free margin. After confirming complete sarcoma resection, continuous NPWT (−50 mmHg) was initiated and continued for 28 days. The exposed tendon, muscle, and periosteum were covered with flat granulation tissue without slough formation (Fig. 2b). Skin graft was performed 49 days after the first operation (Fig. 2c). The postoperative course was uneventful, and no recurrence was noted during 18 months of follow-up (Fig. 2d).

Case 2

The patient was a 70-year-old man who presented with an ulcerating mass in the right popliteal region. The mass measured 2.5×3.5 cm. An incisional biopsy revealed squamous cell carcinoma. No evidence of tumor spread was noted on enhanced CT and PET-CT scans. We performed a wide local excision with a 1-cm lateral margin and sentinel lymph node biopsy. The defect, in which the tendon of the biceps femoris muscle and common peroneal nerve were exposed (Fig. 3a), was covered with artificial dermis. Pathological evaluation

confirmed a free tumor margin without ductal invasion. The sentinel lymph node biopsy was negative. After confirming complete tumor resection, NPWT i-d was initiated and continued for 6 days, after which the exposed tendon was almost covered with good granulation tissue without slough formation (Fig. 3b). Skin graft was performed 24 days after the first operation (Fig. 3c). The postoperative course was uneventful, and no disease recurrence was noted at the 1-year follow-up (Fig. 3d).

Discussion

The goal of treatment of the primary tissue defect after resection of a skin malignancy is to reconstruct the excised tissue and secure wound healing. Although the recent guidelines have gradually shifted to accept narrower margins, the defect after tumor resection tends to be large and deep. Significant tissue defects arising from wide resection of invasive skin cancers and sarcomas, with the exposure of the tendons, bones, joints, and vessels, generally require flap reconstruction. However, for a variety of reasons, not all patients are candidates for reconstructive surgery. The acceleration of granulation by NPWT is useful in such cases, especially in terms of the coverage of the tendon and periosteum. The tissue remaining after tumor resection still has a good blood supply and responds well to NPWT, accelerating wound healing and achieving a favorable esthetic outcome. In our series, even after just a few days of NPWT, the quality of the granulation was good, and no slough was noted. Furthermore, there was no recurrence during follow-up after tumor resection. Our experience is that NPWT achieves flat and good granulation, leaving no slough and covering the tendons, bones, and vessels.

There is one caveat to the use of NPWT after resection of malignancy. This type of surgical wound has been considered a contraindication to NPWT because the application of negative pressure has been reported to cause changes that establish a local pro-malignant environment¹²⁾. However, this is only a concern in the event of residual tumor cells. Therefore, NPWT need not be contraindicated for a surgical wound after pathologically confirmed complete resection of malignancy. NPWT is now being used more frequently to treat these wounds^{13, 14)}. An earlier case series validated the use of NPWT and concluded that its application results in improved quality of life and earlier discharge to home¹⁵⁾.

This study has some limitations that stem mainly from its retrospective non-comparative design, small number of cases, and missing data in some instances. However, our experience in this limited case series at least raises the possibility of using NPWT to treat significant tissue defects with the exposure of the tendons, bone, joints, and vessels after wide resection of invasive skin cancer or sarcoma. Finally, the patients in our series were only followed up for 12–19 months, which is not

Fig. 2. Leiomyosarcoma on the sole of the right foot in a 48-year-old woman who received negative-pressure wound therapy (NPWT).

- a: Deep wound after sarcoma resection, showing the tendon tissue, periosteum, and vessels.
- b: Twenty-eight days after treatment with continuous NPWT.
- c: Intraoperative image after split-thickness skin graft.
- d: Appearance of the wound at 18 months after skin graft.

Fig. 3. Squamous cell carcinoma in the right popliteal area in a 70-year-old man.

- a: Deep wound after skin cancer resection, showing the tendon tissue and common peroneal nerve.
- b: Eight days after instillation of saline with a 10-min dwell time, followed by negative-pressure wound therapy.
- c: Intraoperative image after split-thickness skin graft.
- d: Appearance of the wound 1 year after skin graft.

long enough to exclude the possibility of an increased risk of recurrence. Multicenter prospective studies with a longer follow-up duration are needed to confirm our preliminary findings.

In conclusion, NPWT accelerates healing of complicated surgical wounds after resection of deep cutaneous malignancy and achieves a favorable esthetic outcome.

Sources of funding

None.

Conflicts of interest

None.

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