

ORIGINAL ARTICLE

Application of skin traction for surgical treatment of grade IV pressure sore: a clinical report of 160 cases

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Study design: Retrospective clinical study.

Objective: To assess the method of primary surgical closure of pressure sores developed by the Ruixin Hospital for burns.

Setting: Nanjing, China.

Methods: The study included 235 grade IV pressure sores of 160 patients, M:F = 119:41. Their age ranged from 19 to 93 years (mean = 47.4, s.d. ± 15.7). The primary disease was spinal cord injury in 141 patients (88.1%). The location of sore spread over ischial, sacrococcygeal and trochanteric regions. The largest pressure sore measured 15 × 25 cm². The time from onset of sore to admission ranged from 3 months to 22 years (mean = 35.5 months, s.d. ± 55.8). Local preoperative preparation included external skin traction using adhesive tapes, wound cleaning and change of dressing. General condition was checked and improved by supportive measures. Operation procedures included thorough debridement, excision of hidden minor scars, mobilizing opposing skin flaps and meticulous haemostasis before closure. Skin traction continued after the operation until the wound was healed.

Results: All but 10 sores healed primarily. These 10 sores healed after a revision. The length of stay in hospital ranged from 20 to 140 days (mean = 45.1 days, s.d. ± 21.1). Follow-up period was 2–51 months (mean = 22 months, s.d. ± 12.5). Two ischial sores recurred owing to long sitting. They were cured with the same method. Three illustrative cases are presented.

Conclusion: The method is simple and enjoys a high success rate with a short stay in hospital and hence is cost effective. The recurrence is rare.

Spinal Cord (2011) 49, 76–80; doi:10.1038/sc.2010.83; published online 20 July 2010

Keywords: grade IV pressure sores; skin traction; primary surgical closure

Introduction

The treatment of pressure sores remains a challenge worldwide, especially the IV-degree pressure sores accompanied by large-area necrosis and loss of skin and other soft tissues. Severe infection of bone and joint and bone necrosis further deteriorate the condition. Some patients eventually die of septicaemia as a result. At present, myocutaneous flap is often adopted to cure the sore. The donor sites are predominately gluteus maximus, gluteus medius or tensor fascia lata. Transferring myocutaneous flap leaves a large wound behind and compromises blood supply of normal tissues around it, thus involving a high risk of failure. As a result, the use of flap can be limited. It is not desirable for patients with a large area of loss of soft tissues, paraplegia with severe spasticity and poor physical condition, and for the elderly.¹ Our hospital has developed a new method of surgical

treatment supplemented by skin traction and stretching. It was used successfully for IV-degree pressure sores.

Patients and methods

Patients

From January 2005 to February 2009, our hospital treated 160 patients with 235 pressure sores. There were 119 male and 41 female patients. The age ranged from 19 to 93 years, with a mean of 47.4 (s.d. ± 15.7). There were 141 patients with spinal cord injury (88.1%). Twenty (12.5%) of them were over 65 years of age (Table 1). The location of pressure sore is presented in Table 2. The largest pressure sore measured 15 × 25 cm². The time from the onset of pressure sore to admission ranged from 3 months to 22 years, with a mean of 35.5 months (s.d. ± 55.8).

Methods

Preoperative preparation. External skin traction was used to bring skin edges closer. Specially prepared plasters of rubberized fabrics (FuJiNing, Shanghai Medical Instrument

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Received 13 January 2010; revised 19 May 2010; accepted 24 May 2010; published online 20 July 2010

Table 1 Diagnosis of primary lesion and age range

Diagnosis of primary lesion	Age (years)		Total number of patients
	0–65	65+	
Traumatic SCI	117	7	124
Spinal cord lesions	14	1	17
Brain trauma and lesion	6	9	15
Other	3	3	4
Total number of patients	140	20	160

Abbreviation: SCI, spinal cord injury.

Table 2 Location of pressure sores

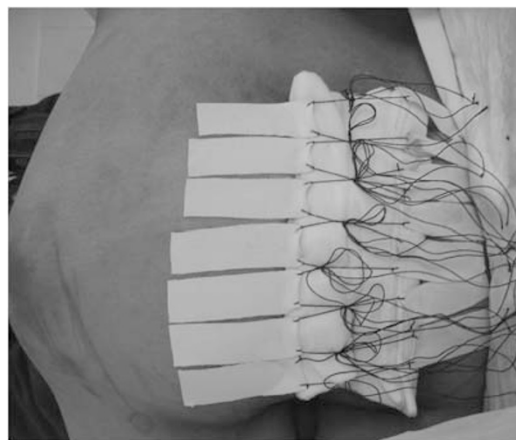
Location	Patients (n)	%
Sacroccygeal	72	30.6
Greater trochanter of femur	39	16.6
Ischial tuberosity	112	47.7
Other	12	5.1
Total	235	100%

(Group) Co., Ltd) about 2 cm wide and 5 cm long were stuck to the skin of the opposing sides of the wound (Figure 1). The brand was chosen from a large variety of commercially available plasters for its least irritation and lack of report of allergy. Strips of plasters were placed in a parallel way close together to bring the skin edges closer without causing them to slip off. No. 7 surgical threads were sutured into the free edge of the plasters for further use. After the wound had been cleaned and dressed, the sutures of opposing sides were tied and knotted over the dressing with slight tension so that the dressing was secured in position and the opposing skin edges were approximated. When re-dressing was necessary, the knots were undone and redone after completion. After every dressing, the traction force was increased by making tighter knots to bring the skin edges even closer. Allergic skin is contraindicated for the use of plasters.

All patients received skin external traction. Of these patients, 170 sores received traction, whereas 65 did not. Sixty-three patients (39%) received traction for no more than 10 days. Thirty-three patients (21%) received traction for 11–15 days, whereas 64 (40%) received it for more than 15 days.

The wound was cleaned everyday by irrigating with a syringe or a continuous drip of normal saline for 2–3 days. In case of dirty wounds, iodine or chlorhexidine was added. Antibiotics were used locally in case of culture sensitivity. Systemic use of antibiotic was applied only when there was systemic infection.

Most patients with multiple and large sores were poorly nourished. All patients were physically less than fit and involved one or more risk factors (Table 3). Old age exacerbated the situation even further. Preparation of patient's physical condition with supportive and corrective measures was essential. Operation was not carried out until haemoglobin and blood albumin had reached 10 and 30 g, respectively.

**Figure 1** Dressing over a sore wound with adhesive tapes in place.**Table 3** Risk factors for sore surgery

Risk factor	Patients (n)	%
Severe infection	24	15
Anaemia and hypoproteinaemia	65	38.8
Diabetes	15	9.4
Spasticity	48	31
Osteomyelitis	51	30

Method of operations. Thorough debridement of the wound was essential for the success of the operation. It was carried out delicately with plastic surgery instruments. In order to distinguish dead or less viable tissues from fully viable ones, methylene blue was applied to the wound surface. The tissues stained blue were totally removed. The necrotic bone or the outstanding part of the bone that might cause excessive pressure and difficulty in closure were excised and the bony surface smoothed. After thorough debridement and also as a result of the long-standing retraction of muscles, the wound might not have enough muscle to cover the deep tissues. This part of the wound was closed with skin and subcutaneous tissues and left without muscle layer closure.

The entire wound was examined thoroughly with the surgeon's index finger to locate any scar under the surface. It was resected to mobilize the skin fully for better approximation. If this was not enough, dissection at the base of the skin flap on both sides of the wound could be carried out to further mobilize the flaps. After such careful debridement, the skin used to close the wound appeared normal and was felt so on touch. Thorough haemostasis with electric coagulation was carried out to minimize blood collection under the to-be-sutured skin flaps. In case of doubt, suction drainage was used.

Postoperative treatment. The skin traction was applied continuously after operations to release the tension of edges of the skin flaps. The tied threads pressed the dressing down to minimize the possible dead space under the flaps. A large



Figure 2 Case 1: sacrococcygeal pressure sores, a 52-year-old man, paraplegic, with a sore (Figure 1) measuring $7 \times 8 \text{ cm}^2$. Preoperative traction for 15 days, wound healed 13 days after operation, follow-up 35 months and no recurrence. Left: before operation; middle: after debridement; right: healed wound.



Figure 3 Case 2: bilateral trochanteric sores (Figure 2), a 28-year-old man, paraplegic, with one sore measuring $7 \times 8 \text{ cm}^2$ and the other $6 \times 7 \text{ cm}^2$. Preoperative traction for 10 days, wound healed 14 days after surgery and no recurrence after 50 months. Left: right trochanteric sore before operation; middle: during debridement; and right: healed wound.



Figure 4 Case 3: ischial sore, male, 34-year-old, paraplegic. The depth of the sinus was 10cm (Figure 4). Preoperative traction for 14 days, wound healed 13 days after operation, follow-up 50 months and no relapse. Left: left ischial sore with sinus; middle: healed wound; and right: sinography.

dosage of antibiotics of at least relatively high sensitivity was used to prevent wound infection.

Results

No allergy to the plasters was observed in all patients, but after use for longer than 2 weeks, some minor rashes were seen. They did not cause special discomfort to the patients or hamper treatment. All sores but those of 10 patients healed primarily. Two of the 10 patients had sacral and coccygeal sores, in which the wound cavity and the tissue loss were too extensive to achieve complete closure during the first operation. The minor wound left behind was healed with split-thickness skin graft. The other eight cases had sores of ischial tuberosity, in which collection of blood in the wound cavity required a second extended debridement and closure.

The length of stay in hospital ranged from 20 to 140 days, with a mean of 45.1 days (s.d. ± 21.1). The follow-up period

ranged from 2 to 51 months, with a mean of 22 months (s.d. ± 12.5). Of the 160 patients, two patients had their ischial sores recurring as a result of prolonged sitting. Their sores healed with a treatment similar to that mentioned above.

Illustrative cases

Three illustrative cases are shown in Figures 2, 3 and 4

Discussion

The treatment of deep pressure sores remains a challenge, because they suffer extensive loss of skin and underlying soft tissues, poor blood circulation and fibrosis. Deep infection of bone and joint further complicates the treatment. Many surgeons, particularly plastic surgeons, adopt transfer of myocutaneous flap to cover the wound. The common donor sites are gluteus maximus, gluteus medius and the tensor fascia lata. However, as a myocutaneous flap demands a

suture with no tensile forces, even a small wound needs a flap several times the size of wound for rotation and coverage. As a result, tissue disassociation affects a huge area, which inevitably destroys the blood circulation of tissues surrounding the sore. In addition, the intrinsic blood supply of the dissociated flap is poorer than that of healthy tissues; so there is a certain risk that the flap may not survive; the circulation will be further reduced even after healing and the skin may feel coarse and tough on touch; and the scar on the edges may be highly hypertrophic. The flap is less resistant to shear force and friction, and hence is liable to breakdown. Furthermore, the donor area is covered with skin from other areas with poor cosmetic effect. Paraplegic and senile patients who tend to have pressure sores cannot endure the massive surgical trauma of myocutaneous flap owing to their poor general condition. On the other hand, the conservative method takes very long for a sore to heal and is hardly successful for large and deep sores.

In summary, it was the following key ingredients that made our simple method of treating grade IV sores successful, thus avoiding the shortcomings of the lengthy conservative method and flap surgery:

1. Daily thorough cleansing of wound.
2. Bringing skin and its underlying tissues closer within a period of time, normally less than 2 weeks, by continuous external skin traction without undue tension.
3. Using methylene blue to identify the cleavage between viable and non-viable tissues before debridement.
4. Meticulous debridement including excision of dead bone.
5. Excision of all visible and hidden scars to free the movement of the skin.
6. Skin traction after the operation to maintain the skin in position without due tension and to eliminate dead space below the skin by applying pressure on the dressing through tightening the threads.

Most wounds, with a diameter no longer than 10 cm for trochanteric and 12 cm for sacroischial sores, respectively, can be cured successfully with this method.

The research into skin stretching could be traced back to 1976, when Barrer *et al.*² introduced the retention bridging device. The ends of the device were attached to the skin edges on both sides of the soft tissue defect. When the device is tightened over the wound, the skin edges are brought closer together until they meet and heal, thus facilitating healing without tension. In a literature review, Takei *et al.*³ revealed that external stretching had multiple benefits for wound healing. They included upregulating the level of growth factors, extracellular matrix and genes to enhance cell proliferation. Tension can promote cell division and multiplication. Histologically, external tension can stimulate the skin to increase its number of layers and elongate its rete pegs. Basal cells grow into columns vertically. Spinous and granular cells proliferate. The density of the collagen and elastic fibres, capillaries and fibroblasts increases. Takei also reported that the traction forces along the outer surface of the skin could enable cells to divide and multiply under the influence of many factors. Knight *et al.*⁴ confirmed that

expansion of skin could stimulate and accelerate mitosis of fibroblasts, as well as enhance synthesis of collagenous fibres. Leighten *et al.*⁵ proved that external force could stimulate and increase vascularization. During expansion of skin, the subcutaneous blood vessels, nerves and other tissues are also stretched. The quality of the expanded skin is superior to that of the unexpanded one. This is an effect similar to that of a delayed skin flap. However, it does not have the drawback of fibrosis under the myocutaneous flap. The advantage of stretching is that it does not cause hyperplasia of fibrous tissues between the deep fascia and the myocutaneous flap, as a result of surgical dissection to mobilize the flap. Viscosity and elasticity are the basis for skin to expand.^{6,7} Many reports indicate that local revascularization takes place as a result of skin expansion.⁸⁻¹¹ This could be associated with transient local hypoxia that triggers a self-regulatory mechanism of capillaries.¹²⁻¹⁵ Consequently, more capillaries become open as seen in a delayed skin flap.¹⁶ Preoperative traction of skin can considerably reduce tension during stitching.¹⁷⁻¹⁹ This offers unique technical advantage in surgical practice.²⁰⁻²¹

The technology of expanding the skin to create a larger area for wound closure was introduced by Neumann in 1957 by using a progressively distended subcutaneous balloon.²² Later, various devices have been introduced to ease closure of either fresh or chronic wounds.¹⁷⁻²⁷ They either penetrate (Kirshner's wires) or are hooked to the skin. They could not be applied with ease and might inflict more trauma to the patient. It is also more difficult to use for wounds of uneven surface or irregular shape. We modified the technique of traction by using non-invasive plasters stuck to the skin surface for chronic or even infected wounds and achieved primary repair of deep pressure sores. Despite oedema and rigidity of the edges of the wound, such traction can still effectively expand the skin and help close the wounds. It is much less traumatic and painful for the patient, and is easy and convenient to use.

Even in case of minor loss of skin after the operation, external skin traction is used as seen in illustrative case no. 3. In this case, after excision of non-viable tissues, a huge space was left behind. Postoperative skin traction was applied to approximate the opposing skin flaps and undermine them under light pressure dressing into the wound to fill the space.

Tissues with poor blood supply should be radically excised with maximum preservation of viable tissues, which can be used to cover the wound. Local application of methylene blue helps in identifying viable from non-viable tissues. The surface of the wound should be smoothed. If the wound is too large for closure, mobilization of the skin on both sides of the wound at their bases might be necessary. The plane of dissection should be between the deep fascia and the subcutaneous layer.

The method is indicated for paraplegic and senile patients. The surgery needs only a short hospitalization and leaves behind a small scar and a low recurrence rate. In addition, this method is also effective with difficult types of wounds with uneven surface or irregular shape. The fine texture and good cosmetics of the skin after the surgery are appealing. This method can be recommended for wider application.

The follow-up of 22 months is relatively short for a lesion that tends to recur many years after the operation. A longer follow-up study needs to be conducted in the future.

Conflict of interest

The authors declare no conflict of interest.

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