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1

Abstract

2 According to the treatment of open fracture, the resurfacing of bone-exposing complex
3 wounds of Gustilo-Anderson III B and C fracture remains challenging. To treat
4 bone-exposing wounds, artificial dermis has been effective. We evaluated the
5 outcome of adapting artificial dermis the resurfacing bone-exposing complex wounds
6 of Gustilo-Anderson III B and C fracture clinically. Seven patients who had sustained
7 Gustilo-Anderson III B and C fracture of the legs underwent open reduction and Ilizarov
8 external fixation. The bone-exposing wounds were covered with slit artificial dermis,
9 and a basic fibroblast growth factor was sprayed every day. Wounds in all patients
10 showed insufficient granulation on the bone. Four patients developed osteomyelitis.
11 Consequently, all cases required a local flap for resurfacing the wounds. Although the
12 artificial dermis allows wounds to heal earlier, it is impossible to prepare a favorable
13 wound bed on the bone when the fracture is classified as Gustilo-Anderson III B and C.
14 We concluded that artificial dermis is not a recommendable resurfacing option for
15 patients with Gustilo-Anderson III B and C fracture because the poor circulation of
16 bone may result in osteomyelitis.

17 Key words: artificial dermis, Gustilo-Anderson III fracture, bone-exposing wounds, open

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fracture, osteomyelitis

1 Sir:

2 We read the article of Chen X. et al. (Management of wounds with exposed bone
3 structures using an artificial dermis and skin grafting technique. J Plast Reconstr
4 Aesthet Surg. 2010 Jun;63(6):e512-8. Epub 2009 Dec 9.), and would like to
5 congratulate the authors on their interesting study ¹⁾. They presented 5 patients with
6 fresh open fractures using an artificial dermis and skin grafting technique. Among
7 them, the bone-exposing wounds of 4 patients healed successfully.

8 Artificial dermis is beneficial for the reconstruction of wounds with exposed tendons or
9 bone ²⁾. The unique characteristic of artificial dermis, promoting granular regeneration
10 even on bare bone, may allow resurfacing with a free skin graft instead of flap surgery for
11 the treatment of several bone-exposing wounds including deep burns, post-abrasion of
12 neoplasms and skin defects due to trauma. ³⁾ However, we feel that it is impossible to
13 prepare a favorable wound bed on the bone when the open fracture is too severe and
14 complex, such as those classified as Gustilo-Anderson III B and C. We present the
15 outcomes of resurfacing Gustilo-Anderson III B and C bone-exposing wounds, which
16 had been treated with artificial dermis.

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Patients and Methods

1 A total of 7 patients with Gustilo-Anderson III B (5 cases) and C (2 cases) open fracture
2 were treated in the National Organization Nagasaki Medical Center in 2011 and 2012
3 (Table). All patients underwent open reduction and Ilizarov external fixation. According
4 to bone-exposing wound resurfacing, slit artificial dermis (Terudermis®,
5 Orimpas-Terumo Co., Ltd., Tokyo, Japan) was applied to the wounds, and
6 oiment-impregnated gauze was applied to the wounds. A basic fibroblast growth factor
7 (bFGF) (trafermin, Fiblast Spray®, Kaken Pharmaceutical Co., Ltd., Tokyo, Japan) was
8 sprayed every day.

9 **Results**

10 In all 7 cases, abundant granulation tissue did not develop on the bone-exposing wound
11 surface during 2 to 5 weeks after adapting the artificial dermis to the bone (Figure).
12 Four patients developed osteomyelitis and required continuous irrigation. Among them,
13 2 underwent sequestration. Consequently, all cases required local flap transfer to
14 resurface the bone-exposing wound. Two patients showed shortening of the tibia
15 because of sequestration; thus, they underwent bone distraction. One patient
16 developed malunion, and required bone grafting. These patients with complications
17 required a longer period for the complete union of bones, which caused prolonging of the
18 fixation period (11-18 months).

1 Five patients could walk after removal of the external fixation, and 2 still require fixation.

2 Discussion

3 Now, artificial dermis is used for the reconstruction of wounds with exposed tendons or
4 bone, because it promotes the early infiltration of mononuclear cells and fibroblasts and
5 better growth of connective tissue strands and epithelium ⁴⁾. It is widely known that
6 several growth factors allow ulcers to heal more rapidly ⁵⁾. Combination treatment with
7 bFGF and artificial dermis promotes the proliferation and recruitment of fibroblasts,
8 neovascularization, and synthesis of collagen fibers. Consequently, this method
9 improves complex wounds and quickly prepares a favorable wound bed ²⁾. However,
10 bone-exposing wounds in our patients with Gustilo-Anderson III B and C fracture had not
11 improved with this combination treatment, and required conventional flap surgery.

12 The main problem is total absence or extreme deficiency of blood flow to bone
13 fragment or fractured stumps, which leads to sequestration and osteomyelitis,
14 necessitating prolongation of the period of external fixation. Although the wounds may
15 not develop infection, a favorable wound bed cannot develop with poor vascularity. On
16 the other hand, some bone-exposing wounds due to causes such as deep burns and
17 post-abrasion of neoplasms may be appropriate for artificial dermis usage, because
18 these bones maintain sufficient circulation without non-vascular fragments. We

1 conclude that artificial dermis is not a recommendable resurfacing option for patients with
2 Gustilo-Anderson III B and C fracture because the poor circulation of the bone may result
3 in osteomyelitis.

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5 Conflict of Interest:none

6 Funding:none

7

8 **Ethical considerations**

9 The procedures followed were in accordance with the ethical standards of our institutional
10 committee on human experimentation and with the Helsinki Declaration of 1975, as revised in
11 1983.

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References

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1) Chen X, Chen H, Zhang G. Management of wounds with exposed bone structures using an artificial dermis and skin grafting technique. *J Plast Reconstr Aesthet Surg.*

3

4

2010;63(6):e512-8.

5

2) Fujioka Masaki, Combination treatment with basic fibroblast growth factor and

6

artificial dermis improves complex wounds caused by collagen diseases with steroid

7

use. *Dermatologic Surgery* 2009;35 (9): 1422-5.

8

3) Fujioka Masaki. Artificial dermis: A new material for wound treatment. *J wound*

9

technology 2009;4:13-9.

10

4) Hom DB, Manivel JC. Promoting healing with recombinant human platelet-derived

11

growth factor--BB in a previously irradiated problem wound. *Laryngoscope.* 2003;

12

113: 1566-71.

13

5) Akita S, Akino K, Imaizumi T, et al. The quality of pediatric burn scars is improved by

14

early administration of basic fibroblast growth factor. *J Burn Care Res.* 2006;27:333-8.

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1 **Legends**

2 Table: Patients who sustained Gustilo-Anderson IIIB and C fracture and underwent
3 bone-exposing wound resurfacing with artificial dermis.

4 Figure: A 58-year-old man sustained Gustilo-Anderson IIIB fracture to the right leg.
5 After reduction and external fixation, the tibia bone-exposing wound was
6 resurfaced with artificial dermis and sprayed with bFGF every day. Three
7 weeks later, most of the wound was covered with favorable granulation, but
8 not the surface of the tibia (arrow).

Table

	Age	Site of open fracture	Gustilo-Anderson classification	Complicatio n	Surgical resurfacing (post injury period, weeks)	Additional surgery	Prognosis/ External fixation period
1	74 M	Rt. Tibia and fibula	IIIC (PTA reconstruction)	-	Local flap (5 W)	-	Walk/ 4 months
2	58 M	Rt. Tibia and fibula	IIIB	-	Local flap (3 W)	-	Walk/ 6 months
3	32M	Rt. Tibia and fibula	IIIB	Osteomyelitis	Sequestration (2 W) , Local flap (5 W)	Bone elongation	Walk/ 13 months
4	68M	Rt. Tibia and fibula	IIIB	Osteomyelitis	Local flap (3 W)	Bone grafting	Walk/ 11 months
5	44M	Rt. Tibia and fibula	IIIB	Osteomyelitis	Sequestration, Local flap(2 W)	Bone elongation	Walk/ 18 months
6	56 M	Rt. Tibia	IIIC (PTA reconstruction)	Osteomyelitis	Local flap (4 W)	-	On external fixation
7	74M	Rt. Tibia and fibula	IIIB	-	Local flap (2 W)	-	On external fixation

PTA:;Posterior tibial artery, FSG: Free skin grafting

Figure

