Artificial dermis is not effective for resurfacing bone-exposing wounds of Gustilo-Anderson III fracture

Masaki Fujioka, M.D., Ph.D.

Kenji Hayashida, M.D.

Chikako Murakami, M.D.

Dr. Fujioka is the Clinical Professor of the Department of Plastic and Reconstructive Surgery, Nagasaki University, Nagasaki, Japan and Director of the Department of Plastic and Reconstructive Surgery, Clinical Research Center, National Hospital Organization Nagasaki Medical Center, Nagasaki, Japan.

Drs. Murakami and Hayashida are staff surgeons of the Department of Plastic and Reconstructive Surgery, National Hospital Organization Nagasaki Medical Center, Nagasaki, Japan.

Address correspondence to:  Fujioka Masaki, M.D., Ph.D.

Department of Plastic and Reconstructive Surgery,

National Hospital Organization Nagasaki Medical Center.

1001-1 Kubara 2 Ohmura City, Japan, postal code 856-8562
tel. 0957-52-3121  fax. 0957-54-0292
Artificial dermis is not effective for complex bone-exposing wounds

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

Key words: artificial dermis, Gustilo-Anderson III fracture, bone-exposing wounds, open fracture, osteomyelitis
Artificial dermis is not effective for complex bone-exposing wounds

Sir:

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

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

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

**Results**

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

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

Discussion

Now, artificial dermis is used for the reconstruction of wounds with exposed tendons or bone, because it promotes the early infiltration of mononuclear cells and fibroblasts and better growth of connective tissue strands and epithelium. It is widely known that several growth factors allow ulcers to heal more rapidly. Combination treatment with bFGF and artificial dermis promotes the proliferation and recruitment of fibroblasts, neovascularization, and synthesis of collagen fibers. Consequently, this method improves complex wounds and quickly prepares a favorable wound bed. However, bone-exposing wounds in our patients with Gustilo-Anderson III B and C fracture had not improved with this combination treatment, and required conventional flap surgery. The main problem is total absence or extreme deficiency of blood flow to bone fragment or fractured stumps, which leads to sequestration and osteomyelitis, necessitating prolongation of the period of external fixation. Although the wounds may not develop infection, a favorable wound bed cannot develop with poor vascularity. On the other hand, some bone-exposing wounds due to causes such as deep burns and post-abrasion of neoplasms may be appropriate for artificial dermis usage, because these bones maintain sufficient circulation without non-vascular fragments. We
conclude that artificial dermis is not a recommendable resurfacing option for patients with Gustilo-Anderson III B and C fracture because the poor circulation of the bone may result in osteomyelitis.

Conflict of Interest: none

Funding: none

Ethical considerations

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


2) Fujioka Masaki, Combination treatment with basic fibroblast growth factor and artificial dermis improves complex wounds caused by collagen diseases with steroid use. Dermatologic Surgery 2009;35 (9): 1422-5.


Artificial dermis is not effective for complex bone-exposing wounds

1  **Legends**

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

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

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

PTA: Posterior tibial artery, FSG: Free skin grafting