1. The Usage of Artificial Skin

1. Burn
   • Third degree burn [fig 1b]

2. Diabetic Ulcer
   • Patients with diabetes will have difficulties in wound healing
   • Inflammation will occur
   • Chronic Wound will be formed

2. Introduction of Skin Autograft

• Transplantation of skin from a donor site to a receiver site in the same individual
• Skin graft harvest sites are usually lower abdomen and lower legs [fig 2]

4. Working Principle

There are two methods to produce artificial skin. Both of them use fibroblasts to make it.[fig 4]

Method 1: Mesh Scaffolding Method

1. Fibroblasts are thawed and expanded
2. Fibroblasts are put in the roller bottle to undergo rolling process for 3-4 weeks
3. Cells are transferred to a culture system (consists of bioreactors and biodegradable mesh scaffolds)
4. New skin is created by the cells under the culture system

Method 2: Collagen Method

1. Cells are transferred to a culture system
2. Small amount of cold collagen and nutrients such as glucose and hormones is added
3. New skin cells grow when heating the collagen and allow fibroblasts to stick on it
4. Keratinocytes are added and seeded onto the new dermal skin two weeks later
5. Epidermal layers are formed by keratinocytes. New skin is created and stored in sterile containers

5. Comparison between Autograft and Artificial Skin

<table>
<thead>
<tr>
<th>Artificial Skin Grafting</th>
<th>Autograft</th>
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<tbody>
<tr>
<td>Fast implanting speed to avoid bacterial infection to patients</td>
<td>Lower chance of rejection after implantation</td>
</tr>
<tr>
<td>Can be used for patients with wound area greater than 50% of their bodies</td>
<td>Presence of skin characteristics such as hair, sweat gland because the source is real skin</td>
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<tr>
<td>Life-saving approach towards patients with severe injuries</td>
<td>Skin age is matched</td>
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<tr>
<td>Not require a donor site</td>
<td>Can be used in wounds in easily observable areas such as face</td>
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<tr>
<td>Smoother and more regular because of thick layer of granular layer, spinous layer and stratum corneum</td>
<td>Limitation to the size of injured area</td>
</tr>
<tr>
<td>Absence of some characteristics of skin such as hair, sweat gland</td>
<td>Growing speed is usually slow</td>
</tr>
<tr>
<td>The pigmentation of skin may not be the same as the patients' skin</td>
<td>Another wound is made</td>
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</tbody>
</table>
In the production of skin substitutes, no natural materials are used. It is used because it can be produced cheaply and reduce the risk of disease. It is used to support the 3D structures under special conditions through a lot of peptides that assemble into a network that polymerizes upon contact. The surface layer causes it to polymerize and the surface layer of the artificial skin can integrate into the human body fully and consistently. The artificial skin is mimicking human skin. The artificial skin can be used for burn therapy and the artificial skin can reduce the risk of disease. The artificial skin has the ability to integrate into the human body fully and consistently. The artificial skin can be used for burn therapy and the artificial skin can reduce the risk of disease. The artificial skin is mimicking human skin.

**Wound Preparation**

- Fig 7a: Removing necrotic tissue (Fig 5a)
- Fig 7b: 2. Elastic epidermis and a porous collagen-chondroitin-6-sulfate fibrillar dermis (Fig 5b)
- Fig 7c: 3. After healing process and the donor site is ready the elastic epidermis is peeled (Fig 5c)
- Fig 7d: 4. Showing the thin Nectoderm (Fig 5d)

**Real case Analysis**

- Fig 7e: Showing biopsy after one week of artificial skin grafting
- Fig 7f: Showing biopsy after five weeks

**Considerations of the surgery**

- Need to match the texture, pigmentation and thickness of the skin.
- These might be skin cancer onset on the donor site.
- It is more advisable to harvest skin bilaterally to maintain facial symmetry.
- Failure of skin grafting are often caused by providing non optimal physiological conditions for the graft.
- Usually used for burn.

**8. Future Development in Dermal Substitutes**

**Hydrogels (self-assembling peptides) [SAP]**

This technology allows for optimal control over the scaffold structure and composition. It uses peptides that assemble into 3D structures automatically into 3D structures under special conditions through a lot of noncovalent bonds. The resulting hydrogels then present a fibrous nanoenvironment to the cells that is similar to the skin. It is used because it can be produced cheaply and reduce the risk of disease transmission as no natural materials are used.

**Self Healing Artificial Skin**

A material is created with a microvascular network which is capable of pumping self-healing polymers to repair sites of skin by Microvascular Autonomic Composites Initiative. [4]

**6. CLINICAL USAGE OF THE SKIN SUBSTITUTES**

- **ICX-SKN – Mimicking nature**
  - The artificial skin can integrate into the human body fully and consistently.
  - The artificial skin is mimicking human skin.

**7. Recent Advances**

**From Hair Root**

Artificial Skin is grown from hair roots-Fraunhofer - Osaka (2008, January 4). Artificial skin can also grown from patients’ hair roots-

**Imaginary Skin – For Artificial Limbs, robots**

Over ridge National Laborartory’s Nanomaterials Synthesis And Protocols Group is developing flexible, multifunctional skin. Carbon Nanotubes (Fig 6b) is used because it behaves a temperature and pressure sensor as part of a material with thermal and mechanical properties similar to human skin.

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