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Healos® Bone Graft Replacement
Healos® is an osteoconductive matrix produced by DePuy Spine, Inc. comprised of cross-linked bovine Type I collagen fibers fully coated with hydroxyapatite. When combined with autogenous bone marrow aspirate, Healos® provides an environment for osteoprogenitor cell attachment, proliferation and differentiation. It is reported to have similar structure and remodeling characteristics to endogenous bone.

Infuse® Bone Graft
Infuse® Bone Graft is produced by Medtronic Sofamor Danek and consists of an absorbable bovine-derived Type I collagen sponge carrier combined with rhBMP-2 (recombinant human morphogenetic protein-2). The Infuse® Bone Graft must be used in conjunction with the LT-CAGE® Lumbar Tapered Fusion Device and is indicated for interbody spinal fusion in patients with degenerative disc disease.

CuffPatch™ Surgical Mesh
CuffPatch™ Surgical Mesh is a resorbable matrix produced by Arthrotek, Inc. composed of porcine collagen. CuffPatch™ is intended for use as an implantation device during rotator cuff surgery. It is limited to the supraspinatus to reinforce soft tissues repaired by suture or suture anchors.

Neomem™ Membrane
Neomem™ membrane is a Type I bovine collagen matrix produced by Citagenix, Inc. indicated for use in guided tissue and bone regeneration procedures and to aid in post-surgical wound healing associated with bone defects, dental implants and ridge augmentation.
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Adequate preclinical, and clinical testing of xenotransplantation devices must be performed along with patient follow-up.

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Informed consent should be obtained and must cover the risks of using xenotransplantation devices.

Recipients should be provided with updated information, especially if relevant to their clinical course.

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The two photomicrographs on the left show the Restore SIS-regenerated tendon midsubstance as a dense, longitudinally-oriented, sparsely cellular, and mostly avascular collagenous tissue typical of tendons.

The two photomicrographs on the right show that the Restore SIS-regenerated tendon-bone interface is similar to that of native tendons, with Sharpey's fibers anchoring the tendon to the adjacent cortical bone.
Bio-Oss®/Orthoss® Natural Bone Mineral

Bio-Oss® is an osteoconductive bone graft substitute produced by Geistlich Biomaterials composed of natural hydroxyapatite crystals obtained from deproteinized bovine bone. Bio-oss® shows similarity to human bone and is used for bone regeneration applications. Orthoss® is a similar bovine-derived bone graft product used as an alternative bone replacement material that when combined with autogenous bone or bone marrow aspirate, provides additional osteogenic potential.

Bio-Gide®/Chondro-Gide® Resorbable Membrane

Bio-Gide® is a resorbable membrane produced by Geistlich Biomaterials composed of porcine Type I and III collagen. The bilayer structure consists of a compact, smooth, cell-occlusive layer and a loose, porous layer that favors cell invasion. Bio-Gide® is indicated for use in guided bone regeneration and wound healing. Chondro-Gide® is a similar porcine-derived collagen membrane indicated for use during autologous chondrocyte transplantation procedures to cover and hold cultivated autogenous chondrocytes in articular cartilage defects.

Restore® Orthobiologic Implant

Restore® Orthobiologic Implant is a resorbable scaffold derived from porcine small intestine submucosa produced by DePuy, Inc. The Restore® implant can be used to reinforce soft tissues involving the supraspinatus previously repaired by sutures or anchors during rotator cuff injury repair.

Collagraft® Strip Bone Graft Matrix

Collagraft® Strip (also called Neu-Graft® Strip) is a bone graft substitute produced by NeuColl, Inc. consisting of a combination of Type I bovine dermal fibrillar collagen, hydroxyapatite and tricalcium phosphate. Collagraft® provides an osteoconductive environment for new bone formation. The addition of autogenous bone marrow also provides Collagraft® with osteoinductive and osteogenic properties and is indicated for use in acute long bone fractures, traumatic osseous defects and bony voids.
There has been a significant increase in the use of commercially available xenografts as alternatives for bone, cartilage and tendon repair. Materials involving xenografts vary from collagen components derived from bovine and porcine sources to deproteinated bone which can be combined with various polymers, ceramics and autogenous tissues.

Xenografts offer several promising alternatives for regenerative applications involving both clinical and basic research in orthopaedics.

Concerns of xenograft products are the transmission of pathogens, viruses and the immunological response elicited, especially in immunocompromised patients.

Future research must include a thorough understanding of the immunological responses to xenografts for use in orthopaedic applications. Additionally, new strategies for disease detection and prevention must be developed.

All xenotransplantation products should follow the guidance of industry established by the Food and Drug Administration.

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Further information and requirements for the use of xenotransplantation devices and concerns can be found at www.fda.gov/cber/guidelines.htm.
**Choices of Xenogeneic Tissues for Applications in Orthopaedic Surgery**

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**Summary of Currently Available Xenografts for Musculoskeletal Regeneration**

There are various companies currently manufacturing xenografts. Below are some of the available products used for musculoskeletal regeneration.

<table>
<thead>
<tr>
<th>Company</th>
<th>Product *</th>
<th>Collagen</th>
<th>HAP</th>
<th>TCP</th>
<th>BMP</th>
<th>Abx</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neucoll, Inc.</td>
<td>Collagraft®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Long bone fracture &amp; bony void filler</td>
</tr>
<tr>
<td>Medtronic SD</td>
<td>Infuse®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Interbody spinal fusion</td>
</tr>
<tr>
<td>Arthrotek, Inc.</td>
<td>CuffPatch™</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Soft tissue repair reinforcement</td>
</tr>
<tr>
<td>Geistlich</td>
<td>Bio-Gide®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Autologous chondrocyte transplantation</td>
</tr>
<tr>
<td>Biomaterials</td>
<td>Bio-Oss®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>DePuy, Inc.</td>
<td>Healos®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Citagenix, Inc.</td>
<td>Neomem™</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Guided bone and tissue repair &amp; wound healing</td>
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<tr>
<td>Biomet Merck</td>
<td>Collapat® II</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Bone lesion repair</td>
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<tr>
<td>Group</td>
<td>Endobon®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Bone lesion repair</td>
</tr>
<tr>
<td></td>
<td>Targobone®</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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* Product Composition: Hydroxyapatite (HAP), Tricalcium Phosphate (TCP), Bone Morphogenetic Protein (BMP), Antibiotic (Abx)

**Take Home Messages**

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ROSEMARIE T. SUGNIA, P.H.A., STEVE F. RAPHAEL, B.S., M.D., N.D.
and B. R. YAN, M.D., P.H.A.

逃避 ENGINEERING
Volume 8, Number 1, 2002

ABSTRACT
A cell-free biomaterial derived from porcine small intestinal submucosa (SIS) has been used successfully in many models as a xenogeneic scaffold material without generating immune-mediated inflammatory reactions. We investigated whether this absence of inflammation is due to the presence of porcine transforming growth factor β (TGF-β) activity found in SIS that may have immunosuppressive properties on helper T (Th) cell subset activation and differentiation. We used in vitro models for the generation of human Th1 and Th2 cells to investigate the influence of SIS. We found that SIS partially suppressed Th1 cell expansion and secretion of interleukin 12 (IL-12) and interferon γ (IFN-γ) in a TGF-β-dependent manner, but Th1 cell expansion and IFN-γ secretion could be fully overcome by addition of recombinant IL-12. The suppression by SIS of Th cell activation also involved the induction of Th cell apoptosis. In addition, SIS completely abolished the generation of Th2 cells in vitro, but this effect of SIS was not reversed by neutralizing TGF-β antibodies. Our results indicate the presence in SIS of factors that can suppress Th cell activation through both the inhibition of IL-12 secretion and the induction of Th cell apoptosis. We established further that these factors include TGF-β and at least one other factor.

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