

Bone Graft Materials in Veterinary Dentistry



The Bone Graft Experts

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A variety of bone graft materials can be utilized in veterinary dentistry. Some of the more common applications for these products include placement in certain extraction sites to help prevent alveolar ridge loss, during surgical periodontal therapy, for fracture repair and to help stabilize near-fractures caused by dental disease. Because of the high degree of hype and misinformation surrounding these materials, I will provide references for some of my comments.

A number of terms have been used in a confusing and overlapping fashion to describe and promote the use of some of these materials. Would you rather buy "sand" or a "bi-phasic ceramic bone allograft"? Me too. Some of these terms, along with their (simplified) definitions include:

1. **Sintering** - a manufacturing process by which different powdered materials are fused into a single solid substrate by heating them to a temperature below their melting points.
2. **Ceramic** - an inorganic non-metallic solid material produced by heating and then cooling.
3. **Bioglass** - A material comprised of silicon, sodium, calcium and phosphorous oxides. When implanted, they form a layer of hydroxyapatite-type material on their surface, conducive to osteoblast attachment. Most of these materials have little or no long-term resorption in the body.
4. **Hydroxyapatite (HA)** - a crystalline material that is made up primarily of calcium and phosphorous. HA can be produced artificially, is biologically stable and is not resorbed over time. Normal bone consists of approximately 50% HA.
5. **Tricalcium Phosphate (TCP)**- A ceramic material made of calcium and phosphorous. TCP has been used as a bone graft material alone or mixed with a variety of other products, such as HA, Bioglass or real bone. When used alone it has poor mechanical stability in the graft site. It is thought to contribute calcium and phosphorous ions for new bone production and some forms of TCP have been shown to have osteo-inductive capabilities.
6. **Bone Morphogenic proteins (BMP)** - a class of proteins that induce mesenchymal cells to become osteoblasts and even form bone in non-bony sites. BMP activity is highly desirable in graft materials and is present in demineralized freeze-dried bone.

Until recently, a relatively limited selection of materials were available for the veterinary marketplace, many of which were adapted from the human side and priced prohibitively. Some exciting new products have been introduced recently for veterinary patients. This article will cover the spectrum of

materials reasonably available for veterinary patients. Please recognize that dozens of other products are available on the human side, but tend to be cost prohibitive for our patients.

Graft materials can have different modes of action, described as follows:

1. **Osteoconductive (aka-osteopromotive)** - all materials show at least this level of activity, implying they provide a friendly environment for osteoblasts to proliferate and form new bone as they are "conducted" across the graft material. This is the lowest level of activity in graft materials. Bio-glass products provide this level of action. Artificial graft materials are termed Alloplastic products.
2. **Osteoinductive** - this level of activity means that the product is capable of stimulating undifferentiated mesenchymal cells, present in all tissues, to differentiate into osteoblasts capable of new bone production. Some products do this via Bone Morphogenic Protein (BMP) activity. This activity is present in Demineralized Freeze-dried Bone Graft (DFBG). The process of demineralization is thought to unmask proteins present in bone collagen that possess BMP activity. Pure BMP is available experimentally, but is presently cost prohibitive for routine clinical use in veterinary patients. There are also problems with using purified BMP, not the least of which is figuring out how to keep the molecule where you place it. This has led to some unfortunate human fatalities when these materials were utilized for cervical spinal surgery. Fortunately, DFBG does not exhibit the problem of migration and uncontrolled new bone growth. This class of materials has exciting possibilities for future treatment of veterinary patients, such as regenerating bone in furcation defects. More recent evidence has shown that some alloplastic (artificial) graft materials also possess some degree of osteoinduction.¹ The mechanisms of osteo-induction in calcium/phosphate ceramics is thought to be different from DFBG and is enhanced when the material has a rough surface, a micro-porous structure and when surrounded by high levels of calcium and phosphorous ions. The osteo-inductive pathways of these products result in intra-membranous bone formation, while the BMP pathway leads to endochondral ossification.
3. **Osteogenic** - These products are capable of producing bone, which means they contain live osteoblasts. Auto-grafts harvested from the patient while being treated are an example of this class. While live bone can be harvested from a patient being treated, the cost of the harvesting equipment and/or the morbidity involved have limited it's use in veterinary medicine. For that reason, this paper will focus on Osteoconductive and Osteoinductive materials.

Veterinary products available in the veterinary marketplace

Consil (Nutramax) is a synthetic alloplastic material made of Bioglass. The human equivalent is sold as "Perioglas". It comes in a granular and putty form. The putty form is easier to handle but is a little more expensive. After implantation this material forms a hydroxyapatite-like layer on the surface that facilitates osteoblast attachment. Figure 1 shows the structure of a typical Bioglass, which has a very smooth surface. Bone and fibrous tissue gradually fills in the spaces in between the particles of Bioglass and the material has not been shown to resorb over time. (Figure 2) The bone that fills in the defect consists largely of the original glass particles. The quality of bone and rate at which the bone is produced around a bioglass has been shown to be highly variable.² Historically this material has been used in extraction sites to help maintain the level of the alveolar bony ridge bone post-extraction and also in periodontal surgery. Bioglasses were introduced in 1967, and for many years were one of the only bone void fillers.

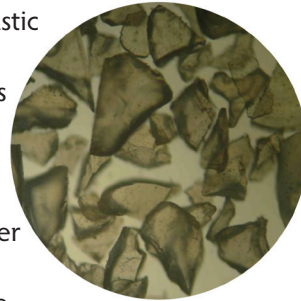


Figure 1. Structure of a typical Bioglass, showing the particles.

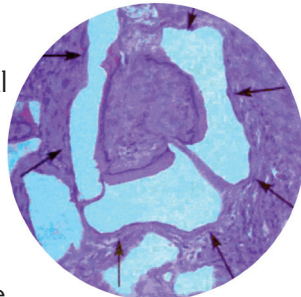


Figure 2. Bioglass after healing. The white areas are the bioglass material and the surrounding tissue in this slide is primarily connective tissue.

Synergy (By Veterinary Transplant Services;) is a recently introduced product for the veterinary marketplace. It is a next generation alloplastic (synthetic) ceramic graft material consisting of sintered HA and TCP. The sintering process joins the two materials into biphasic particles that are rough and porous (Figure 3). The rough surface and porosity of the product have been shown to confer osteoinductive properties in similar products. Bone has been shown to fill into the rough surfaces and pores in the product (Figure 4). Synergy is primarily formed of TCP, which eventually dissolves away, gradually opening up more pores in the material for bone to fill into. The HA provides dimensional stability for the product as the TCP is resorbed and eventually the graft site will consist of 85% normal bone and 15% HA particles. The HA particles in the product are only very slowly resorbed. The dissolving TCP is also thought to directly contribute calcium and phosphorous ions for mineralizing new bone.³ This material would be appropriate for placement in extraction sites when indicated.

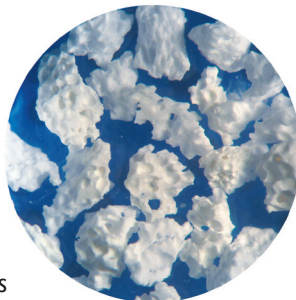


Figure 3. Microscopic structure of Synergy. Note the rough surface concavities and pores in the structure.

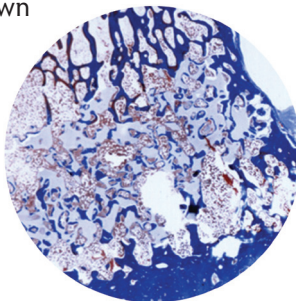
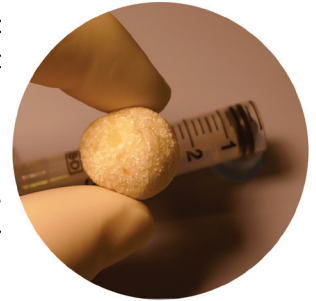


Figure 4. Shows new bone formation (Dark Blue) around Biphasic (Light Blue) at 12 weeks.

Fusion (VTS) has also been introduced recently into the veterinary marketplace. It is a mixture of Synergy (see above) and demineralized freeze-dried bone graft (see below). While not as expensive as pure demineralized bone allograft, the addition of some real bone to the product should provide some BMP activity. This combination can provide osteoinduction via two unique pathways. It comes in a putty form and is more expensive than Synergy and less expensive than pure DFBG. This material would be appropriate for a higher quality graft material for extraction sites (especially in older patients) or as a lower cost alternative to pure DFBG for use in fractures, near-fractures and surgical periodontal therapy.



Fusion bone graft material

Periomix (from VTS) is demineralized freeze-dried bone graft (DFBG), available in canine and feline origins. This is the gold standard for pre-packaged bone graft materials in veterinary patients and should be utilized whenever new bone growth is critical. The author uses this material in fracture sites that have bony defects, for near-fractures secondary to dental disease and when performing surgical periodontal therapy (open root planing).



Hopefully this will help clear up some of the confusion that exists around these products and help guide rational use of dental bone graft products in your practice.



For a brief review of currently available graft materials in veterinary dentistry, scan this code

REFERENCES

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