NanoBone®

The innovative formula for spinal surgery

Information on the synthetic bone grafting material NanoBone®
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The evolution in bone formation with NanoBone® technology

Previous technology - sintered ceramics

For years, hydroxyapatites (HA) have been considered as the most important components for bone formation. The HAs used so far, however, are sintered materials. Production technologies based on high temperatures create ceramics, characterized by small internal surface area which decelerate or impede cellular degradation by osteoclasts.

The large internal surface area is decisive for protein adhesion and the biological functionality

The internal surface area (m²/g) has been measured using mercury porosimetry and BET. Extend of inner surface area is one of the characteristics determining the resorption rate of bone grafts.
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The new generation of bone grafting

The main component of autologous bones is hydroxyapatite. In order to support the natural process of bone formation, nature should serve as role model. The revolution of NanoBone® is its nanostructure: Nano crystalline hydroxylapatite (HA) is embedded in a silica gel matrix.


New technology - NanoBone® technology

HA crystallites

- size as in natural bone on the nanometer scale
- No bonding between crystallites - unsintered
- Physiological proteins adsorb to the NanoBone® crystallites

Silica gel matrix

- large internal surface area, strong attraction and adhesion of autologous molecules - high biocompatibility
- Release of SiO₂
- quick vascularization
- accelerated wound healing
- Matrix change = biologisation of synthetic material (pre-condition for the remodelling process)

The large internal surface area is decisive for protein adhesion and the biological functionality

3 | Transmission electron microscope image (TEM): HA crystallites as large as in natural bones

4 | Transmission electron microscope image in scanning mode (STEM): HA crystallites embedded in a silica gel matrix
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Natural processes - complete reconstruction

Bone grafting due to remodeling processes

1 | Quick vascularisation*: Immunohistological illustration of the vessels (vWF)
2 | Beginning degradation with osteoclasts (TRAP)*
3 | Enrichment of endogenous BMP-2*: Immunohistological illustration

The graphic shows the matrix change: Within 10 days, the SiO₂ matrix is substituted by a matrix made of organic autologous structures. This is biologisation.


Organics in - SiO₂ out**

Organics

SiO₂
Controlled osteoinductivity

In addition to osteoconductivity, NanoBone® has osteoinductive properties. The osteoinductive activity is limited to the implantation area where natural bone with all the properties of skeletal bone is formed. It is subject to the biological processes of remodeling, and will be resorbed if not functionally strained.

4 | Intramuscular osteoinduction shown in a sheep model: Within 26 weeks, a functional bone block is formed which is locally limited to the implantation area (see micro CT). The granulate is degraded by Osteoclasts; new bone formation started by Osteoblasts.

5 | Intramuscular tissue formation similar to the healing process of bone defects. Histological image, decalcified cut. HE staining, 12 weeks after intramuscular implantation.

6 | Micro CT of the intramuscularly formed bone after 26 weeks with typical structures of cancellous and cortical bone.

7 | Proof of the BMP-2 enrichment (brown) in granulate. Immunohistology, decalcified cut, 12 weeks intramuscular in sheep.

* Helms et al.: Comparison of the osteoinductive properties of nanocrystalline bone substitute material on hydroxyapatite basis (NanoBone® S) with a porous hydroxyapatite ceramics (Cerabone) in ectopic implantation in a sheep, EF11-1448, DKOU 2010


NanoBone® for spondylodesis

The results of a prospective CT-controlled clinical study on intercorporal fusion showed a 90% fusion (27 of 30 segments) after 9 months. The clinical score Oswestry Disability Index (ODI) improved by 28% for the whole study population, and the value of the Visual Analog Scores (VAS) even improved by 47%.

Conclusion: In a heterogeneous patient population with different indications, ages and co-morbidity, NanoBone® is a very good supportive option to achieve a quick and reliable fusion for a very high number of patients.

Study confirms effectiveness

* Hebecker et al: A new nanostructured bone substitute for the use in neurosurgery - results of a prospective study in lumbar fusion and further applications, Poster, DGNC 2008
Simple handling

1 Mixing with blood

- NanoBone® must be mixed with the patient’s blood about 10 minutes before the application
- the material is extremely hydrophilic and quickly absorbs blood

2 Fibrin clotting

- due to the extremely large surface area of NanoBone® the autologous proteins immediately attach to the nanopores, and fibrin is quickly formed

3 Filled cage

- when mixed with blood, the material takes on a paste-like consistency and can be filled easily into the cage
- due to the quick formation of fibrin, the material can be locally applied
For questions with regard to application, product and/or the ordering of NanoBone® please do not hesitate to contact us!