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Hydroxylapatite deposition induces graft alterations in CHD patients

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Objectives. Calcification-dependent graft failure often causes repeated operations in patients with congenital heart disease. However, the underlying patho-mechanisms are still poorly understood. Therefore, we analyzed the chemical composition of depositions in explanted tissue samples and compared them with serum levels of different ions. We aimed at developing prognostic parameters predicting graft longevity.

Methods. Different grafts explanted during pediatric cardiac redo procedures 10.69±8.65 years after initial implantation were examined. These included Contegra® grafts (n=3), homografts (n=2), one pericardial valve and one GORE-TEX® graft. Perioperative patient data and serum levels of potassium, sodium, calcium and phosphate were collected.
Micro X-Ray Fluorescence (μXRF) was used to detect the spatial distribution of different elements. Thin sections (10 μm) were prepared on silica slides and documented by light microscopy. An instrument equipped with a Rh X-ray tube (50kV, 30W) was operated with a spatial resolution of 25 μm. Five to ten cycles with a measuring time of 10 ms per point were performed and the spectra as well as spatial resolved images were created with the corresponding software.
For X-ray powder diffraction (Stoe StadiP, CuKα1 radiation, 60h counting time), highly crystallized areas were separated, washed with doubly-destilled water and dried in a vacuum desiccator. The dried samples were finely ground and filled into 0.3 mm glass capillaries.

Results. Severe macroscopic calcification was evident in all samples. Calcium and phosphorus were the main components of appositions encountered. Although the term calcification usually refers to calcium carbonate apposition, we could identify calcium phosphates instead.
The X-ray powder patterns revealed hydroxylapatite ($Ca_5(PO_4)_3OH$), which is well-known as major component in dentin, tooth enamel and bone material. Calcium phosphates like alpha- and beta-$Ca_3(PO_4)_2$ could be excluded.
Correlations of graft degeneration and clinical data, especially serum calcium levels, could not be proven at the time of reoperation.

Conclusion. Graft material is prone to hydroxylapatite deposition. Chemically, a similarity to bone matter and its degree of hardness could be shown. Whether medical treatment with chelating agents can improve graft longevity remains a question to answer. In this preliminary study, serum levels of ionized calcium did not correlate with the timing of graft failure.