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Mineralization of Short Term Pericardial Cardiac Patch Grafts

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Mineralization of Short Term Pericardial Cardiac Patch Grafts

Abstract
Glutaraldehyde fixed patch grafts of bovine pericardium were implanted in myocardial windows in young (3-4 months old) sheep. The samples were retrieved after one to three weeks for study with scanning electron microscopy (SEM) and energy dispersive x-ray microanalysis (EDX).

A layer of porous material (pseudoneointima, PNI), consisting mostly of a dense mesh of fibers interspersed with blood cells, was noted to form on the blood contacting surface of the graft. Four distinct sets of mineralization were noted in the retrieved grafts: (1) at the blood contacting surface of the PNI; (2) within the PNI at the junction between layers of PNI with differing densities; (#) near the junction of PNI and pericardium (but in the PNI); and (4) within the pericardium.

In both the PNI and pericardium the mineral was shown by EDX analysis to contain both calcium and phosphorous indicating the mineral to be a calcium phosphate. Mineralization in the PNI differed from that in the pericardium; in the PNI it was deposited in discrete regions and apparently in association with thrombi while in the pericardium it was distributed diffusely within the collagen matrix, which may influence its formation.

Disciplines
Hematology | Medical Cell Biology | Medicine and Health Sciences | Veterinary Medicine | Veterinary Microbiology and Immunobiology

Author(s)

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What relation did that create heat to the silica stones? The answer to this question may give a clue as to where the stone came from.

**Authors:** The reaction was crystalline and closely applied to the stone.

**Discussion:** The reaction of silica stones did not show such a relatively high incidence of silica calcium in men. Can you find evidence as to how impressed the idea of the reaction to the stone came from?

**Authors:** It is possible that our findings reflect something about the patient population from which the stone came.

**Citation:** T. C. Brill, *Nature* 45, 450 (1968).

**Abstract**

Gastroesophageal reflux disease patients were implanted with a metallic wire in the young (3-4 months old) sheep. The samples were retrieved after one to three weeks for study with scanning electron microscopy (SEM) and energy dispersive X-ray microanalysis (EDX).

A layer of porous material (pseudomembrane, PdM), consisting mostly of a dense mesh of fibers interconnected with blood cells, was seen to form on the blood-contacting surface of the graft. Four distinct sets of measurements were made on the PdM layer: (1) within the PdM at the interface between layers of PdM with differing densities; (2) over the junction of PdM and periendothelial tissue; (3) over the junction of PdM and pericardium that in the PdM and; (4) within the pericardium.

In both the PdM and pericardium the material was shown by SEM analysis to contain both an elastic and a collagenous matrix. Pseudomembranes in the PdM differed from the pericardium. In the PdM it was deposited in regions that were apparently associated with the intimal and apparently was distributed within the collagen matrix, which may influence its formation.

**Materials and Methods**

Gastroesophageal reflux disease patients were implanted with metallic wires in young (3-4 months old) sheep (Fig. 1).

**CLINICAL QUALITY**

A model of a metallic wire was implanted in the tissue and was retrieved after a few days.

**FURTHER RESEARCH**

Gastroesophageal reflux disease patients were implanted with metallic wires in young (3-4 months old) sheep (Fig. 1).

**ACKNOWLEDGMENTS**

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micromaterials (EMS) system were used for the analyses.

Results
The ultrastructure of bovine pericardium is well documented. It consists of three layers: serosa, fibrous and epicardial layers. The thickness of these layers, the fibrous, is composed of sparse, very fibrous connective tissue. In detectable increments of ultrastructure, human fibrous connective tissue is surrounded by collagen sheets and laminae by subcutaneous connective tissue and other connective tissues. The collagen sheets and laminae are composed of a non-complex fibril matrix that contains a number of collagenous units. Collagen units containing collagen and other connective tissue are seen throughout the fibrous connective tissue. Backscattered electron imaging (BSI) is used to detect the ultrastructure of the fibrous connective tissue. Typically, the BSI is used to detect mineral (apatite) and mineral in situ infrequently and in lower quantities in the pericardium.

Figure 4 is a high power view of mineral deposits in the pericardium. Clumps of mineral are particulate and can be seen in the fibrous connective tissue. EDS analysis of mineral in the pericardium indicates the presence of both calcium and phosphorus (Fig. 5). Particles in the P3 are a similar elemental composition (not shown).

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Figure 2. Schematic illustrating placement of patch grafts. Right atrium (A), Right ventricle (V).

Figure 4. High power HIL view of section of pericardium showing mineral particles (not in low power in Figure 3).

Microanalysis of Cardiac Grafts

Figure 3. Schematic of sagittal section of a patch graft illustrating the flanged suture ring. A P3 is shown on the fibrous field of view shown in Figure 9. The calcium map correlation is shown in the mineral observed by EMS (Fig. 9). A similar map was obtained for phosphorus (not shown), and it is concluded that the mineral is a calcium phosphate.

Another site of mineralization was sometimes noted on the blood contacting surface of the PM. Mineral particle aggregation (less than 10 nm) was identified. These mineral particles were observed both calcium and phosphorus. Finally, mineralization was also observed in the pericardium. These deposits could be distinguished from mineral in the PM by their diffuse nature and lower level of mineralization. It is possible that this mineral is associated with collagen fibers and its formation is controlled by the local concentration of calcium and phosphates. The relationship of pericardial mineral deposition to mineralization of the PM is unknown. Experiments in progress are aimed at characterizing mineral in the PM and PM mineralization are (possibly) related.

Figure 5. Low power image showing mineral particles (not in low power in Figure 3).

Figure 6. Backscattered electron image (BEI) of cross section of a pericardium patch graft after eight days implantation. A P3 is attached to the pericardium. Mineral particles (e.g., indicated by arrows) are more numerous in the PM than in the pericardium.
Figure 1A. Normal image of side of bone.

Figure 1B. 111 of side of bone contacting surface of the BM (111 view). Clumps of mineral can be seen occupying selected sites.

Microscopy and Conclusion

This study clearly shows that soon after implantation of periimplant post grafts a PIII is formed on the blood contacting surface. This PIII is composed of a dense mesh of fibres interspersed with blood cells. At this stage of PIII development, no ingrowth of cells from the surrounding tissue was noted. In some specimens, the PIII was seen to consist of layers of differing density; this may be due to the variable density of the blood contacting surface of the PIII. Some deposits of thrombi could be observed throughout the intima.

A major finding of this study was that mineralization occurred within 9 days of implantation. Mineralization was seen at four distinct sites: (1) at the blood-contacting surface of the PIII; (2) at the junction of PIII layers of differing density; (3) near the interface of the endothelium with the PIII; (4) within the periphery.

PIII mineralization was similar in that the mineralization fluid was mixed with the BM, and it is likely that mineralization occurred within the intima of thrombi. Thus, at the PIII thickness and mature, these thrombi become trapped within the intima of the vessel. From the study of the surface of the PIII, it is clear that thrombus becomes mineralized. With mineralization of the PIII, additional minerals are deposited and interspersed within the intima. It is also possible that the mineralization fluid was secreted or absorbed by the cells of the PIII, which facilitates mineralization of calcium and phosphorus ions from the blood. However, specific blood-borne factors may be preferentially taken up at sites of mineralization. Together, thrombus formation, low diffusion and microvascular absorption may control mineralization in discrete sites in the PIII.

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References


Figure 2A. Calcium map of mineral seen in Figure 1.

Figure 2B. Diagram of mineral seen in Figure 1.