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Scanning Electron Microscopy Examination and Elemental Analysis of Atherosclerotic Calcifications in a Human Carotid Plaque

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Atherosclerosis is a chronic progressive inflammatory disease of the arterial wall, in which calcification is a critical determinant of plaque stability and has major consequences for the overall clinical burden of the atherosclerotic process.[1] Calcification of the vascular wall occurs through osteoblast-mediated ectopic mineral deposition, resembling the process of orthotopic (skeletal) osteogenesis.[2,3]

Energy dispersive x-ray spectroscopy (EDAX) is a potent analytical tool that allows the elemental analysis and characterization of biological specimens.[4] Coupling EDAX to scanning electron microscopy (SEM) makes it possible to establish a precise correspondence between morphology of the specimens and identification of chemical elements.

Figure 1 shows the SEM (Philips XL30 SEM-FEG) image of a section of carotid endarterectomy specimen obtained from a 68-year-old man through surgical thromboendarterectomy. The mineralized material is clearly surrounded by several layers of collagen fibers. Figure 2 shows another section of the plaque: Detached endothelial cells can be observed all around and above an evident intraluminal protrusion of the plaque, containing a solid core that in turn expands largely throughout the intima with voluminous calcifications. Disordered intimal collagen bundles surround the plaque. A lesion is present on the cap of the plaque, through which the solid inner core can be easily observed. EDAX analysis of this core clearly shows the presence of calcium and phosphorus, which is highly suggestive for the deposition of hydroxyapatite. On the other hand, no carbon is present at this level (Figure 3). Carotid endarterectomy specimens are valuable sources for the ex vivo study of the atherosclerotic process, and in this context SEM coupled with EDAX may prove to be a powerful analytical tool.

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Disclosures

None.

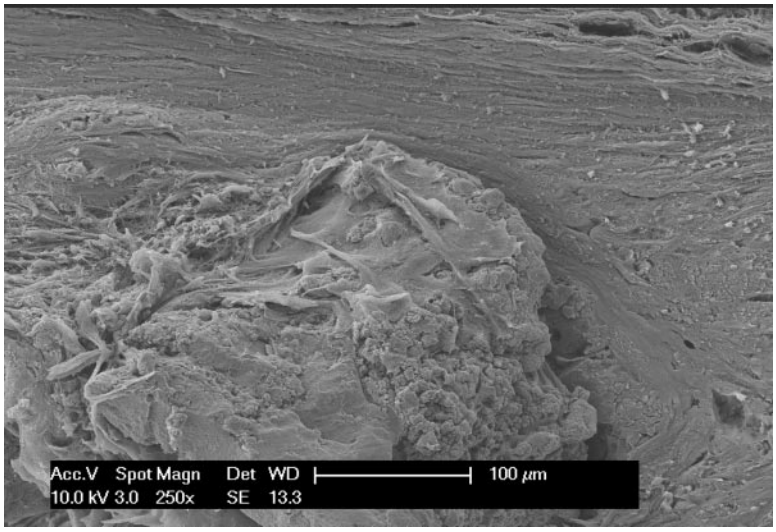

Figure 1. SEM image of a section of carotid plaque. The mineralized material is clearly surrounded by several layers of collagen fibers.

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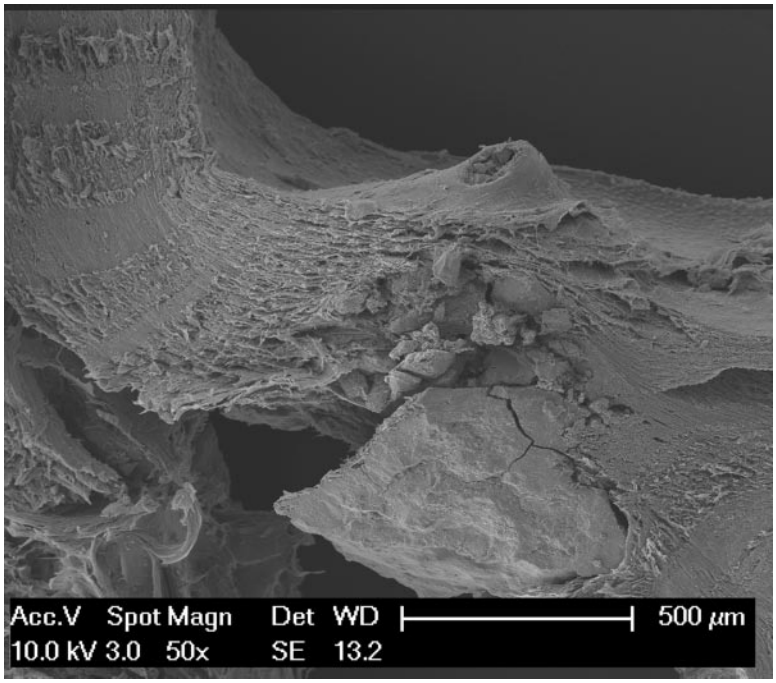

Figure 2. SEM image of a section of carotid plaque with an evident intraluminal protrusion containing a solid core. Detachment of endothelial cells and exposure of basal lamina can be observed. Note abundant collagen bundles of intima above and around several voluminous calcifications.

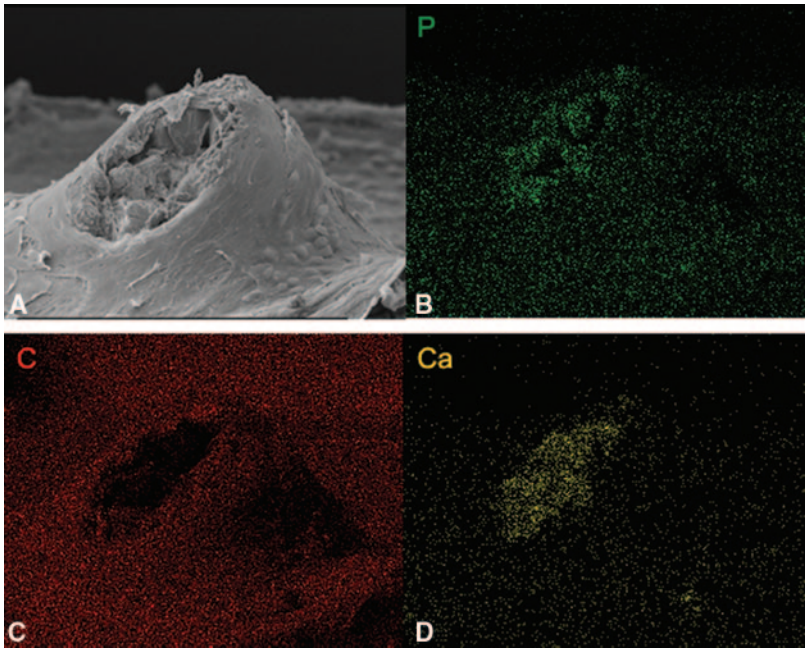

Figure 3. Magnification of the intraluminal protrusion of the plaque (A) and EDAX maps of its inner core, showing results of elemental analysis for the presence of phoshorus (B), carbon (C), and calcium (D).