A Histological “Fly-Through” of a Diseased Coronary Artery

Nico Bruining, PhD; Michiel Knaapen, PhD; Sebastiaan de Winter, BSc; Glenn Van Langenhove, MD, PhD; Patrick W. Serruys, MD, PhD; Ronald Hamers, PhD; Pim. J. de Feijter, MD, PhD; Stefan Verheye, MD, PhD

To evaluate the feasibility and accuracy of quantitative invasive (applying intravascular ultrasound) and noninvasive (applying multislice computed tomography) coronary plaque compositional imaging methods, an ex vivo validation study was performed.1,2 Quantitative volumetric histopathology analysis was applied as a reference method. A left anterior descending coronary artery was excised 24 hours postmortem and fixed in 4% formaldehyde before imaging. After imaging with intravascular ultrasound and multislice computed tomography, the artery was prepared for histological sectioning. The specimen was subsampled at 5 different locations, at 5-mm intervals3 (Figure 1). From each location, 15 consecutive histology slides with a distance of 100 μm apart were sectioned, thus representing histological information over a length of 1.5 mm for all 5 subsegments. All sections were stained for Trichrome Masson analysis, allowing identification of the following tissue components: smooth muscle cells (purple), collagen (blue), lipids (colorless), and calcified or necrotic tissue components (open spaces; Figure 2). Subsequently, from all sections the volumetric fractions of all histological components were estimated. The volume fractions were correlated to information using above-described imaging purposes.1

To get a comprehensive overview of the histology analysis, we decided to create a computer-simulated “fly-through” movie by “gluing” together the 15 consecutive individual histology sections of each subsegment. To produce a “smooth” movie, dedicated software was used that added interpolated images in between the original, 100-μm derived sections.

In this article, we present 2 of these movies, which indicate how heterogeneously the coronary plaque composition is distributed on even such short distances of only 1.5 mm. Furthermore, they also show the large dimensional changes of the coronary vessel for both the lumen and the outer vessel border at these small intervals (Figure 3 and Movie 1). In addition to the first movie, the second movie shows the offspring of 2 small side-branches (Figure 4 and Movie 2). Volumetric histopathology allows quantification of the various tissue components, provides detailed information into coronary plaque morphology, and serves as a reference method to match cross-sections obtained from various imaging modalities.

Disclosures

None.

References


Figure 2. Magnification of a histology section showing the different layers of tissue components of the diseased coronary artery. Starting from the lumen outwards to the outer vessel border, we can identify the following: P, plaque; ei, elastica interna; M, media; ee, elastica externa; and A, adventitia.

Figure 3. A. First frame of Movie 1. During the movie, both the lumen and the vessel will change dramatically in shape, components, and dimensions over the 1.5-mm length, as can be observed in the last frame (B) of Movie 1.

Figure 4. A, First frame of Movie 2. B, Last frame of Movie 2. SB indicates side branch.
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Movie 1

The movies are produced similarly, as if an intravascular imaging catheter is pulled back, as is custom for by example intravascular ultrasound. The relative rapid changes in both plaque composition as well as the dimensional changes of the coronary vessel can be nicely appreciated.

Recommended viewing application: Windows media player.

Movie 2

This movie shows the offspring of two small side-branches.

Recommended viewing application: Windows media player.