Calculation of the Translesional Pressure Gradients on Coronary Stenosis by Combining Three-dimensional Coronary Angiography Parameters with Frame Count Data

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Background: Fractional flow reserve (FFR) is the ratio of the intracoronary pressure distally to the stenosis divided by the proximal pressure during vasodilatation. It has great clinical importance in cases of intermediate coronary artery stenosis.

Aim: Determining the tranlesional pressure gradients, based on the data calculated from the 3D coronary angiography and the frame count method using classic fluid dynamic equations and to compare them with the measured values.

Methods: FFR measurements were performed on 15 coronary segments of 10 patients by PressureWire Certus and RadiAnalyser equipment. 3D reconstructions of the same segments were performed by the IC30 software of the Axiom Artis (Siemens) X-ray machine, and the cross-sectional area stenosis (AS) (%), the length of the lesion (L) (mm), the minimal lumen area (MLA) (mm2), the plaque volume (PV) (%) and the distal reference area (dRefA) (mm2) were determined. The flow velocity (mm/s) was assessed by the frame count on the coronary angiography after administration of 6 ml contrast material (Scanlux) with 3ml/s rate by ACIST Injection System. Vessel length was determined on the 3D reconstruction.

Pressure gradients (Hgmm) were calculated on the basis of the fluid dynamic equations: dP= Q(Rp+QRt), where Rp= 0,75 x L / MLA2 and Rt= 3,76x (1/MLA - 1/dRef A)2, Q(volumetric flow)(ml/s) = flow velocity x dRefA.

Results: Regression analysis demonstrated significant relationship between the calculated and measured resting distal/proximal pressure ratio (r=0.66; p=0.007). Tight correlation was found between the calculated and measured FFR (assuming twofold volumetric flow during vasodilatation) (r=0.88; $p<0.001$). Among the 3D parameters only the AS and the PV showed significant correlation with the FFR (r=0.62 and 0.71; p=0.013 and 0.003, respectively).

Conclusions: The calculation of pressure gradients by fluid dynamic equations using 3D coronary angiography and frame count data can predict the functional flow consequence of a stenosis.