

CASE REPORT

Functional assessment of coronary artery disease by intravascular ultrasound and computational fluid dynamics simulation



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KEYWORDS

Coronary artery disease;
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Computer simulation

Abstract Clinical trials have shown that functional assessment of coronary stenosis by fractional flow reserve (FFR) improves clinical outcomes. Intravascular ultrasound (IVUS) complements conventional angiography, and is a powerful tool to assess atherosclerotic plaques and to guide percutaneous coronary intervention (PCI). Computational fluid dynamics (CFD) simulation represents a novel method for the functional assessment of coronary flow. A CFD simulation can be calculated from the data normally acquired by IVUS images. A case of coronary heart disease studied with FFR and IVUS, before and after PCI, is presented. A three-dimensional model was constructed based on IVUS images, to which CFD was applied. A discussion of the literature concerning the clinical utility of CFD simulation is provided.

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PALAVRAS-CHAVE

Doença cardíaca coronária;
Reserva fracionada de fluxo miocárdico;
Ultra-sonografia intravascular;

Avaliação funcional da doença arterial coronária com ultra-som intravascular e simulação computadorizada de dinâmica de fluidos

Resumo Estudos clínicos demonstraram que a avaliação funcional da doença coronária com fio de pressão e determinação da reserva fracionada de fluxo (fractional flow reserve - FFR) melhora a evolução clínica. O estudo por ultra-som intravascular (IVUS) complementa a angiografia convencional, e é uma ferramenta poderosa para a avaliação das placas ateroscleróticas

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Dinâmica de fluidos; Simulação computorizada

orientando a intervenção coronária percutânea (ICP). A simulação computadorizada da dinâmica de fluidos (CFD), representa um novo método que permite avaliar funcionalmente o fluxo coronário. A CFD pode ser calculada a partir dos dados normalmente obtidos por IVUS. É apresentado um caso de doença coronária estudada com FFR e IVUS, antes e após a ICP. Foi construído um modelo tridimensional com base nas imagens obtidas por IVUS e avaliado com a técnica de CFD. É apresentada uma discussão bibliográfica sobre a utilidade clínica da simulação com CFD.

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Introduction

Randomized studies have shown that functional assessment of coronary stenosis by fractional flow reserve (FFR) improves clinical outcomes and reduces unnecessary revascularizations.^{1,2} Intravascular ultrasound (IVUS) has been in daily use in catheterization laboratories for several years. IVUS complements conventional angiography, and is the gold standard for assessment of atherosclerotic plaques. It also provides live information on the size

of the healthy vessel and lesion characteristics, which increases the accuracy of endoluminal treatment, thereby improving the outcomes of percutaneous coronary intervention (PCI).³ However, the relationship between anatomic data from IVUS and functional assessment of ischemia is the subject of debate.⁴ Computational fluid dynamics (CFD) simulation is a novel method for the prediction of blood flow, pressure gradients and functional assessment of specific coronary lesions.⁵ These techniques can be applied to functional assessment of coronary flow from the data

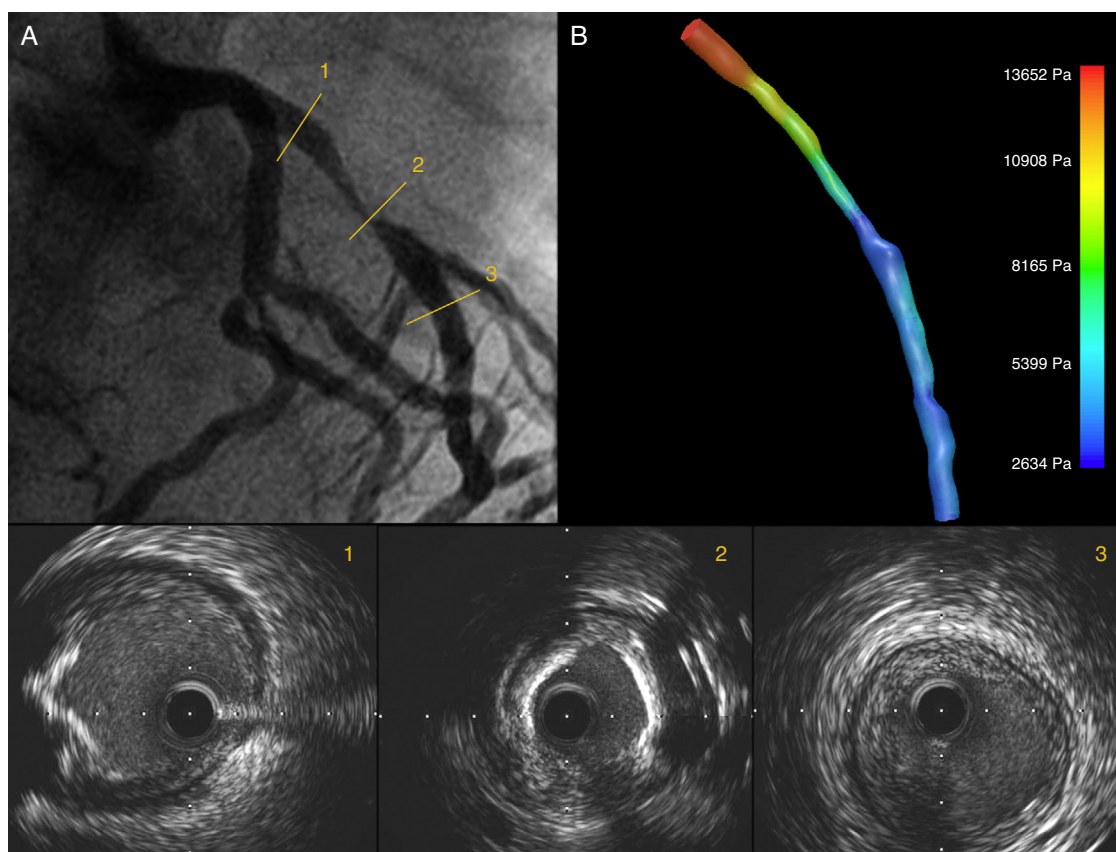


Figure 1 Coronary angiography showing a significant lesion in the proximal left anterior descending (LAD) artery (A). IVUS images show the LAD ostium without significant lumen involvement and an eccentric calcified lesion (1); in the mid segment a concentric lesion with severe calcification is visible (2), and the distal segment has a fibrous, concentric, non-significant plaque (3); (B) 3D IVUS reconstruction of the LAD with pressure gradients obtained through CFD.

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