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Research letter

Invasive evaluation of coronary artery compliance modification after intracoronary lithotripsy

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To the Editor

Coronary artery compliance (CACom) can be evaluated invasively using intravascular ultrasound (IVUS) by measuring changes in the vessel lumen area (ΔA) caused by systolic–diastolic pressure changes (ΔP).[1–3] Even if most of the blood flow occurs in diastole, systolic expansion of epicardial vessels occurs, regardless of the presence of fibrotic or calcific plaques.[3] Intravascular lithotripsy (IVL) has recently emerged as an effective treatment for heavy calcified coronary stenosis.[4] In this context, some researchers have hypothesized that IVL might enhance CACom and improve stent outcomes.[4] However, this hypothesis has not been directly confirmed yet. Thus, the present study aims to invasively evaluate the CACom of severely calcified vessels before and after IVL treatment.

Method

Patients who underwent IVL (Shockwave Medical, Santa Clara, California) in de novo lesions were retrospectively enrolled from our institutional registry. Demographic, clinical and procedural data were collected from the hospital electronic records. Studies having IVUS performed immediately before the first IVL therapy and promptly after its completion were eligible for inclusion. CACom was evaluated as follows: $\Delta A/\Delta P \times 100$.[1] ΔA was evaluated using IVUS, with the smallest luminal area identified at peak diastole and the largest luminal area determined at peak systole, all within a single cardiac cycle.[5] ΔP, measured at the tip of the guiding catheter, was assessed by examining the hemodynamic data at the time IVUS was performed. CACom measurement was carried out in the most calcified part encompassed by the IVL balloon's coverage. Angiographic and IVUS images were evaluated by two independent expert operators. The local ethical committee approved the retrospective analysis of clinically collected data. Statistical analysis was performed with SPSS version 25.0 (IBM, Armonk, New York, USA).

Results

Thirty-three patients (age 72.9 ± 9.8 years, 24.2% women) were included. Most target lesions (48.5%) were located in the left anterior descending artery. The IVL device's overall success rate, defined as successful IVL balloon delivery to the target lesion and therapy administration without serious complications, was 93.9%. There were no intraprocedural patient deaths. Rotational atherectomy was used in 18.2% of the cases. On IVUS, calcium fractures were observed in 63.6% of the cases. The median maximum calcium angle recorded was 360° (360°–360°). Prior to PCI, the minimum vessel area measured was 3.9 ± 1.5 mm^2. Following PCI, the minimum stent area (MLA) expanded to 10.6 ± 2.1 mm^2, reflecting an MLA expansion rate of 77.1 ± 11.1%. Before IVL treatment, the median CACom was 0.24 (0.14–0.51). Following IVL, the median CACom increased to 0.61 (0.37–1.12) (Fig. 1, panel a). The Mann–Whitney U test revealed a statistically significant difference in CACom before and after IVL treatment ($U = 240$; P-value < 0.0001).

Comments

Thus, herewith provided an in-vivo demonstration of the improvement of CACom in calcific lesions after IVL. Compared with noncalcified plaques, calcified coronary lesions have been associated with reduced CACom.[1] Given our selection of severely calcified vessels, it is not surprising that the compliance values observed in our study were even lower than those reported in the literature.[1] Importantly, improved CACom might reduce the need for aggressive high-pressure balloon dilatation prior to stent placement, thereby lowering the risk of vessel dissections or perforations. Notably, drugs affecting vascular media tone, such as nitroglycerin, might have impacted measurement accuracy.

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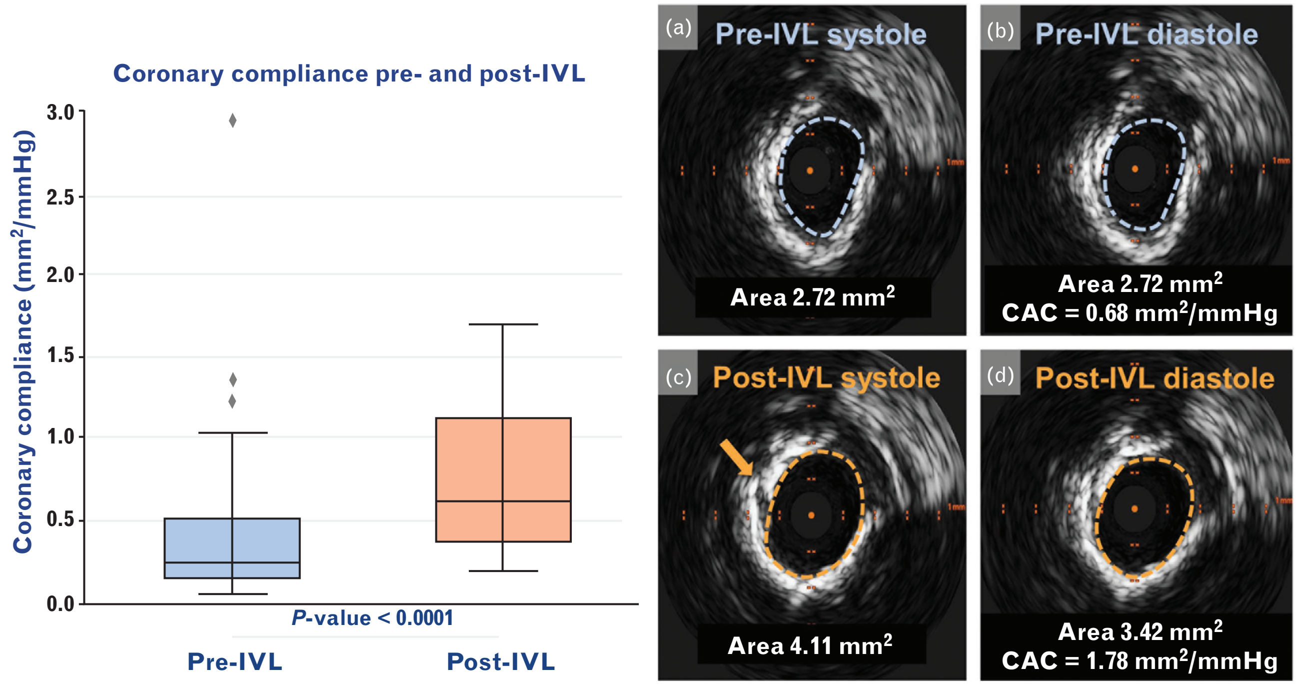
Fig. 1



(Panel a) Box plots illustrating coronary compliance preintravascular lithotripsy and postintravascular lithotripsy. (Panel b) Intravascular ultrasound images of a severely calcified vessel, displaying frames pre-IVL in systole (a) and diastole (b), and post-IVL in systole (c) and diastole (d). IVL, intravascular lithotripsy.

However, prior studies indicate that the dynamic changes in vessel dimensions are similar in patients receiving intravenous nitroglycerin compared to those without.[3] The high rate of calcium fractures observed in our study might be linked to the significant difference found in our results (Fig. 1, panel b). In this regard, Reddy *et al.*[2] have previously emphasized that plaque fractures after coronary angioplasty led to increased vessel distensibility.

Despite limitations (retrospective design, potential measurement errors, and lack of a control group), our study highlights the role of IVL in improving CACom, potentially clarifying the mechanism behind its well recognized high rate of stent implantation success.[4]

Conflicts of interest

The Department of Cardiology of the Leiden University Medical Center received unrestricted research grants from Abbott Vascular, Bayer, Biotronik, Boston Scientific, Edwards Lifesciences, GE Healthcare, and Medtronic. F.v.d.K. received consultancy fees from Edwards Lifesciences and Abbott Vascular. J.M.M. received a research grant from Shockwave Medical and speaker fees from Abiomed, Boston Scientific, and Penumbra Inc. The remaining authors have no conflicts of interest to declare.

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