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Discrepancies in vessel sizing between angiography and intravascular ultrasound varies according to the vessel evaluated

Kensuke Takagi [a,b,c], Joanne Shannon [a,b,d], Sandeep Basavarajaiah [a,b], Azeem Latib [a,b], Rasha Al-Lamee [a,b,d], Tasuku Hasegawa [a,b], Cosmo Godino [a,b], Massimo Ferraro [b], Filippo Figini [a,b], Mauro Carlino [a], Matteo Montorfano [a], Alaide Chieffo [a], Antonio Colombo [a,b,*]

[a] Interventional Cardiology Unit, San Raffaele Scientific Institute, Milan, Italy
[b] Interventional Cardiology Unit, EMO-GVM Centro Cuore Columbus, Milan, Italy
[c] Interventional Cardiology Unit, New Tokyo Hospital, Chiba, Japan
[d] Imperial College Healthcare NHS Trust, London, United Kingdom

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ABSTRACT

Background/objectives: Quantitative coronary analysis (QCA) of the coronary artery and stent size may be influenced by anatomical location in relation to both calibration point and the X-ray tube. The impact of this phenomenon on lesion assessment is undetermined.

Methods: In total, 427 consecutive patients who underwent PCI with intravascular ultrasound (IVUS)-guidance were enrolled. The minimum stent diameter (MSD) was measured using QCA (MSD_{QCA}) and IVUS (MSD_{IVUS}) analysis. We used reference objects positioned at a different height from the X-ray source to validate our approach.

Results: A statistically positive moderate correlation was observed between MSD_{QCA} and MSD_{IVUS} ($r = 0.649$, $p = 0.001$). The mean MSD_{QCA} and MSD_{IVUS} were 3.04 ± 0.49 mm and 2.68 ± 0.47 mm respectively. The difference between MSD_{QCA} and MSD_{IVUS} of > 0.75 mm was more frequently observed in the LCx rather than in the LAD (7.4% in the LAD vs. 24.3% in the LCx, $p = 0.001$). The discrepancy between the MSD_{QCA} and MSD_{IVUS} for the LCx was larger than for the LAD, and tended to be larger than for the RCA (13.3% vs. 18.5%, $p = 0.05$ and 18.5% vs. 14.5%, $p = 0.17$). A discrepancy >20% was more frequently observed in the small (≤2.5 mm) than in the large MSD_{IVUS} group (52.7% vs. 25.1%, $p = 0.001$). This discrepancy was more common in the LCx than in the LAD or RCA (48.6% vs. 30.9% vs. 31.2%, $p = 0.03$).

Conclusions: Assessment of the MSD_{QCA} is more likely to overestimate in the LCx than in the LAD, particularly when the MSD_{IVUS} is <2.5 mm. Therefore, we should be less aggressive in oversizing balloons and stents based on QCA for the LCx or small vessel intervention.

1. Introduction

Traditionally, quantitative coronary analysis (QCA) has been used, not only to assess the severity and progression of coronary artery disease (CAD) [1–5], but also to optimize device selection and to assess the immediate and longer term results [6,7]. However, QCA is subjected to the limitations of 2-dimensional imaging, such that it can underestimate disease severity [8–11], particularly when positive remodeling has occurred [12]. Intravascular ultrasound (IVUS) has now emerged as a more sensitive tool for the assessment of plaque severity, morphology and procedural results compared with QCA [13–15].

Furthermore, it is known that the ability to accurately assess the size of the coronary arterial tree by visual estimation might be influenced by the anatomical location of major branches, and their relation to the X-ray tube. However, there is little available clinical data regarding this issue. Based on our own experience, and following informal discussion with other centers, we have realized that, at certain anatomical points, the internal lumen of a coronary artery [in particular the left circumflex artery (LCx)] can be over-estimated angiographically. This could potentially result in the selection of larger devices (stents and balloons) that may cause coronary dissection and/or rupture. However, the impact of anatomical location on lesion assessment and real world angioplasty has not been determined. In this study, we directly compared minimum stent diameter using QCA (MSD_{QCA}) and MSD using IVUS (MSD_{IVUS}) following stent implantation in order to evaluate the effect of lesion location on the accuracy of MSD_{QCA}.

* Corresponding author at: EMO-GVM Centro Cuore Columbus, 48 Via M. Buonarroti, 20145 Milan, Italy. Tel.: +39 024812920; fax: +39 0248193433.
E-mail address: info@emocolumbus.it (A. Colombo).

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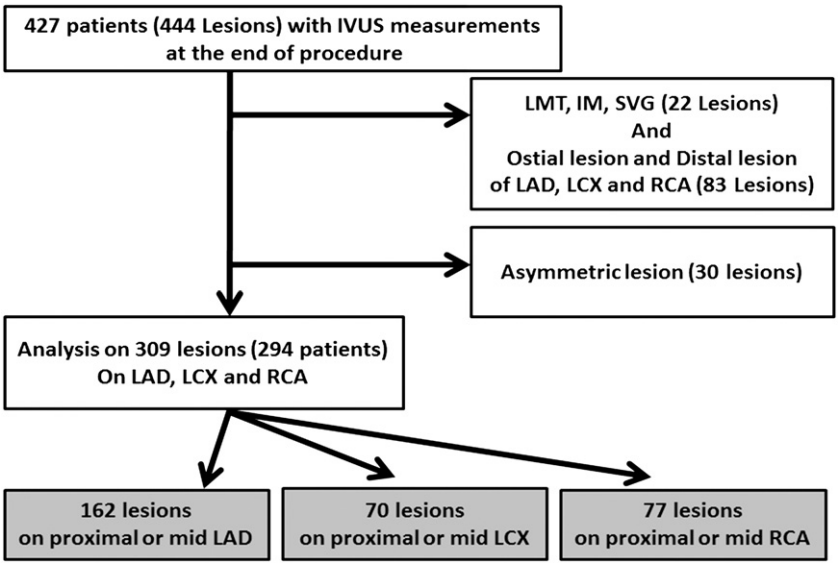

Fig. 1. Study population.

2. Materials and methods

Between April 2007 and April 2010, consecutive patients who underwent stent implantation using IVUS-guided optimization were included in this retrospective cohort analysis, which aimed to determine whether the anatomical location of a lesion affected the assessment of vessel size when performed by QCA and IVUS. The MSD at the end of each procedure was compared using QCA with IVUS as the gold standard, and was then correlated directly with the vessel treated. The study profile is shown in Fig. 1.

2.1. Angiographic procedure

Meticulous care was taken to ensure identical conditions during the angiographic examinations (catheters, contrast media, projections, recordings). In particular, intracoronary nitroglycerin (150 μg) was administered into each coronary artery before angiographic injection. The segments of interest were visualized in multiple transverse and sagittal views to clearly separate stenosis from branches, minimize foreshortening, and obtain views as perpendicular as possible to the long axis of the segments to be analyzed.

2.2. Quantitative coronary analysis

All coronary angiograms were performed and QCA data analyzed at the EMO Centro Cuore Columbus Hospital by means of the Clinical Measurements Solutions system (QCA-CMS, version 5.1; MEDIS Imaging Systems, Leiden, the Netherlands). The QCA was calculated using, as far as possible, the same anatomical view for the corresponding vessel in order to ensure standardization: the right anterior oblique caudal 30°/20° was used for the LCx; the right anterior oblique cranial was used for the LAD and the left anterior oblique cranial view was used for the RCA in each case. The methods of QCA analysis have been detailed in previous studies [16]. The QCA analysis was performed by experienced technicians supervised by an expert physician with identical angulations that best showed the stenosis at its most severe degree with minimal foreshortening and branch overlap. Computer software automatically calculates the MSD. The QCA and IVUS analysis were performed independently by experts who had not taken part in the original interventional procedure and hence had no knowledge on the procedural outcomes. The experts who performed the QCA analysis were blinded of the IVUS analysis and vice versa.

2.3. IVUS image acquisition

IVUS studies were performed following stent implantation using 30-MHz IVUS catheters (iLab®, Boston Scientific, Natick, Mass). Intracoronary nitroglycerin (150 μg) was administered before the IVUS examination in all cases. The methods of image acquisition using IVUS have been detailed previously [16]. In all cases, the transducer was pulled back automatically at a speed of 0.5 mm/s up to the guiding catheter with the use of a validated motorized device.

2.4. Definitions for IVUS and QCA

Using both QCA and IVUS, the MSD was calculated (MSD_{QCA} and MSD_{IVUS}). This was defined as the minimum diameter inside the stent, which was determined automatically by the QCA software, and by offline analysis of individual segments in

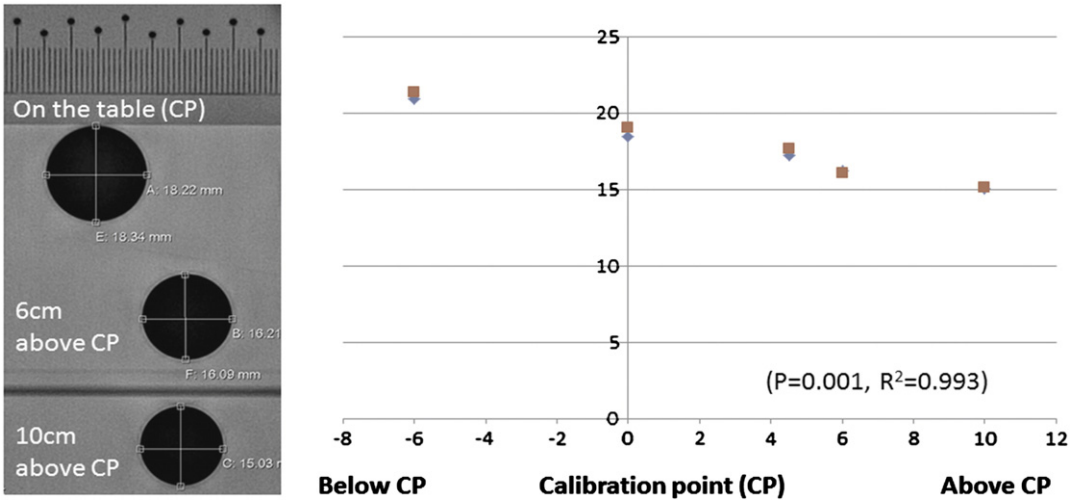

Fig. 2. The projected size of the coin according to the distance between calibration point and subjects. The 2 cent coin was assessed using the 2-axis diameter in different positions. Calibrated position was fixed on the 6 mm height above the board. The coin located on different heights was assessed. This figure showed correlation of the distances between the coin and the calibrated point and the projected coin 2-axis diameter. There is strong correlation between these figures. ($p = 0.001$, $R^2 = 0.993$).