Comparative cath-lab assessment of coronary stenosis by radiology technician, junior and senior interventional cardiologist in patients treated with coronary angioplasty

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Abstract: Background: Exact quantification of plaque extension during coronary angioplasty (PCI) usually falls on interventional cardiologist (IC). Quantitative coronary stenosis assessment (QCA) may be possibly committed to the radiology technician (RT), who usually supports cath-lab nurse and IC during PCI. We therefore sought to investigate the reliability of QCA performed by RT in comparison with IC. Methods: Forty-four consecutive patients with acute coronary syndrome underwent PCI; target coronary vessel size beneath target coronary lesion (S) and target coronary lesion length (L) were assessed by the RT, junior IC (JIC), and senior IC (SIC) and then compared. SIC evaluation, which determined the final stent selection for coronary stenting, was considered as a reference benchmark. Results: RT performance with QCA support in assessing target vessel size and target lesion length was not significantly different from SIC (%r = 0.46, p < 0.01; %r = 0.64, p < 0.001, respectively) as well as JIC (%r = 0.79, r = 0.75, p < 0.001, respectively). JIC performance was significantly better than RT in assessing target vessel size (p < 0.05), while not significant when assessing target lesion length. Conclusions: RT may reliably assess target lesion by using adequate QCA software in the cath-lab in case of PCI; RT performance does not differ from SIC.

Keywords: quantitative coronary angiography, radiology technician, coronary angioplasty

Background

Exact quantification of coronary size and plaque extension is crucial for the successful treatment of coronary atherosclerosis with coronary angioplasty (PCI). This task usually falls on interventional cardiologist (IC) who performs PCI. Coronary angiography is currently the gold standard for evaluating coronary artery disease [1]. Modern computerized software systems available for coronary radioscopic imaging analysis may be of help for quantitative coronary stenosis assessment (QCA) [2]. The use of QCA software is not limited to IC but may also be committed to the radiology technician (RT), who usually supports cath-lab nurse and IC when performing PCI.

We therefore sought to investigate the reliability of QCA performed by RT in comparison with IC, in order to determine whether RT may possibly relieve the IC of this task.

Methods

In 44 consecutive patients with acute coronary syndrome who underwent PCI, target coronary vessel size beneath target coronary lesion (S) and target coronary lesion length (L), both needed for choosing the appropriate coronary stent, were assessed by a) RT, b) junior IC (JIC), and c) senior IC (SIC) and then compared. SIC evaluation, which determined final stent selec-
Radiology technician in cath-lab assessment

tion for coronary stenting, was considered as reference benchmark. SIC assessment was not based on QCA support.

SIC is a skilled IC with more than 10-year experience in interventional cardiology and more than 150 primary coronary angioplasties per year; JIC was a post graduate in cardiology performing his training in interventional cardiology in our University Hospital, with less than 2-year experience.

Angiographic analysis by RT and JIC was performed with QCA software by General Electric (Fairfield, USA) support.

Angiographic cine images were acquired at 15 frames per second. Two-dimensional QCA was performed offline. Automated distance calibration was used to determine pixel size. All analyses were performed during the ECG-gated end-diastolic frame. Angiographic views with the least foreshortening and yielding the best depiction of the stenoses were used. Edge detection correction was performed if required.

RT, JIC and SIC were blinded to each other measurements; data were analysed by a blinded investigator.

Patients with primary PCI or emergency PCI were excluded from the study. Complicated coronary angioplasties (edge dissection) were excluded from the study. Nitrates were infused in 4 cases, when required by SIC: measurements were therefore performed in such cases even by JIC and RT after nitrate infusion.

This is an observational study approved by local ethical committee complying with Helsinki Declaration. The investigators were not involved in the clinical management of the patients enrolled in the study.

Statistical Analysis

All results are expressed as mean ± standard deviation for continuous variables and compared with Student \( t \)-test, as percentage for dichotomic variables and compared with \( \chi^2 \) test.

Variable normality was analysed with Kolmogorov–Smirnov test. Measurements were compared with Pearson’s or Spearman’s test as required, and reported on Bland–Altman plots; regression coefficients were compared with \( z \)-statistic test. RT vs. JIC performance comparison was reported as mountain plots.

A \( p \) value < 0.05 was considered as statistically significant.

Results

Patients’ characteristics are given in Table I. In 45% of cases, admission diagnosis to cath-lab was ST-elevation acute myocardial infarction, in 54% unstable angina-non-ST-elevation acute myocardial infarction.

RT performance with QCA support in assessing target vessel size and target lesion length was not significantly different from SIC (\( r = 0.46, p < 0.01; r = 0.64, p < 0.001 \), respectively) (Figs 1 and 2).

JIC performance with QCA support in assessing target vessel size and target lesion length was not significantly different from SIC (\( r = 0.79, p < 0.001; r = 0.75, p < 0.001 \), respectively) (Figs 1 and 2).

JIC performance was significantly better than RT in assessing target vessel size (correlation coefficient 0.79 vs. 0.46, \( p < 0.05 \)), while not significant when assessing target lesion length size (correlation coefficient 0.75 vs. 0.64, \( p \) n.s.) (Fig. 3).

Discussion

In the present study we showed as RT with QCA analysis may yield results similar to SIC in quantifying target vessel size and target lesion length in cath-lab during PCI.

As previously reported, coronary angiography is currently the benchmark in assessing coronary stenosis in case of suspected coronary artery disease.

However, subjective evaluation of angiographically apparent coronary artery disease is inadequate due to high degrees of intra-observer and inter-observer variability [3]. The reported average standard deviation for estimation of any segmental stenosis by any single

### Table I - Demographic and physical characteristics

| Variable                        | Mean | Std. Dev. | Median | Quartile |
|--------------------------------|------|-----------|--------|----------|
| Age                            | 64.2 | 9.5       | 63.5   | 15.0     |
| Target vessel size assessed by RT | 2.9  | 0.6       | 3.0    | 0.8      |
| Target lesion length assessed by RT | 17.2 | 6.3       | 15.9   | 7.5      |
| Target vessel size assessed by JIC | 2.9  | 0.4       | 2.8    | 0.3      |
| Target lesion length assessed by JIC | 19.9 | 5.9       | 18.0   | 8.0      |
| Target vessel size assessed by SIC | 2.9  | 0.4       | 2.8    | 0.3      |
| Target lesion length assessed by SIC | 20.4 | 6.6       | 18.0   | 8.0      |
| LVEF                            | 49   | 9         | 50     | 10       |

RT = radiology technician; JIC = junior interventional cardiologist; SIC = senior interventional cardiologist
Fig. 1. Bland–Altman plot (as percent) comparing coronary size assessed by radiology technician vs. senior interventional cardiologist (upper, \( p < 0.01 \)) and junior interventional cardiologist vs. senior interventional cardiologist (lower, \( p < 0.001 \))

Fig. 2. Bland–Altman plot (as percent) comparing target lesion length assessed by radiology technician vs. senior interventional cardiologist (upper, \( p < 0.001 \)) and junior interventional cardiologist vs. senior interventional cardiologist (lower, \( p < 0.001 \))
reader was 18%, while disagreement about the number of major vessels with a 70% stenosis occurred 31% of the time. Discrepancies were most likely to occur in analysing distal arterial segments, in reading non-opacified segments, and during analysis of films showing more severe disease or having poorer technical quality. Recent experience in reading arteriograms seemed to be the most important characteristic in determining the accuracy of a reader.

Thus, methods and algorithms for quantitative coronary angiography (QCA) have been developed in order to objectively quantify the extent of CAD [4].
Several generations of QCA systems have been developed based on edge detection algorithms to improve measurement accuracy. First-generation algorithms improved the reliability of coronary measurements [5]; however, these first generation systems tended to overestimate the diameters of small vessels [6]. Second generation systems corrected for overestimation of small vessel sizes (diameter approximation 1.2 mm) and produced more reliable results at the low end of the spectrum of vessel size [7]. Further improvements were made in third generation systems which took advantage of images from new digital flat-panel detectors instead of the conventional image intensifier systems. This latest system is better able to determine smaller diameter vessels [8] and analyze complex lesion morphology with irregular contours [9].

Despite a widely showed reliability of QCA software, there is discrepancy between visual estimation and computer-assisted measurement of lesion severity [10].

The visual analysis overestimated disease severity in arteries with greater than or equal to 50% diameter stenosis and underestimated severity in all arteries with less than 50% diameter stenosis [11]. In only 62% of the cases did visual and quantitative methods agree on the presence of severe disease; visual estimates diagnosed significantly more three-vessel disease. Visual interpretation significantly overestimates initial lesion severity.

On the other hand, several studies found that visual estimates of lesion severity are consistently and significantly higher than quantitative measurements [12].

Less is known, however, on who may benefit from QCA software support. While SIC normally has the final responsibility of choosing the opportune coronary stent after a careful assessment of coronary lesion and coronary vessel characteristics, RT support may be of help to IC in relieving of this task. We found that RT performance in assessing culprit plaque is actually similar to SIC. These findings may support a more active role for RT in management of the patient with coronary artery disease treated with PCI, with particular regards to emergency contexts (primary PCI), in which a strict collaboration among cath-lab staff members is crucial for the best and most effective performance.

Conclusions

RT may reliably assess target vessel S and target lesion L by using adequate QCA software. RT Results are not significantly different from SIC.

Limitations

Principal limitation of the study is the small sample size; these preliminary data need to be confirmed in larger studies enrolling larger number of subjects even in emergency setting.

SIC analysis was not based on QCA assessment: when QCA assessment was required by SIC or first SIC assessment was not confirmed at the end of the procedure, requiring final post-dilatations and significant increase in coronary stent size, the subject was excluded from the study.

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Conflict of interest: The authors declare no conflict of interest.

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