Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Quantitative Coronary Angiography versus OCT in assessing Intermediate Left Main Coronary Artery Lesions: A Comparative Study

Sneha Garg[1], Pramod Kumar Pareek[2]*, Rakesh Mahla[3], Anand Ram[1], Dhiraj Daga[4]

[1]*Senior Resident, Department of Cardiology, JLN Medical College, Ajmer*

[2]*Assistant Professor, Department of Cardiology, JLN Medical College, Ajmer*

[3]*Professor, Department of Cardiology, JLN Medical College, Ajmer*

[4]*Assistant Professor, Department of Radiation Oncology, JLN Medical College, Ajmer*

Corresponding Author :- Dr Pramod Kumar Pareek,

dr.pramodpareek@gmail.com

ABSTRACT

Aim: This study aims to compare visually non-significant Left Main (LM) Coronary Artery Lesions using Quantitative Coronary Angiography (QCA) and Optical Coherence Tomography (OCT) for assessing a better modality in countries where OCT is not widely available

Materials & Methods: It is a comparative study conducted at a tertiary care centre in Northwest India from the period January 2022 to June 2023. 52 patients with visually non-significant LM lesions underwent OCT and QCA analysis out of which 47 adequate results were statistically analyzed. Inclusion Criteria-Age >18 years, visually non-significant LM lesions (defined by stenosis <50%),History of acute coronary syndrome. Exclusion Criteria-History of PCI or CABG, Known LM disease

Results: Mean age of patients was 60.9±8.2 with 31 males. 59% presented with Acute MI, 33% with USA and 7% with NSTEMI. Minimum Lumen Diameter by QCA is 3.02±0.77mm and by OCT is 3.22±0.65mm. Reference Diameter Calculated by QCA is 4.04±0.61mm and by OCT is 4.34±0.66mm. Minimum lumen diameter of QCA was weakly correlated to that of OCT (r=0.25, p=0.12). Reference lumen diameter of QCA has good correlation with that of OCT (r=0.59, p=0.001). The average diameter stenosis is QCA and in OCT were 26.5 ± 10% and 40 ± 8% respectively, with statistically significant difference between the two (p= 0.02) with QCA underestimating the stenosis. The average area stenosis is QCA and in OCT were 25.7±11.3% and 37.1±21.1% respectively, with statistically significant difference between the two (p<0.05) with QCA underestimating the stenosis. 29.6% of patients had significant LM stenosis and were advised intervention accordingly. OCT lesion characterization showed White mural thrombus in 7%, Fibrocalcific plaque in 33%, Fibrous plaque in 33% and fibroatheroma and mixture lesions in rest.

Conclusions: Area stenosis is significantly underestimated by QCA than OCT resulting in missing out on significant LM lesions. There is a good correlation and agreement between QCA and OCT for measurement of reference diameters. However, the MLD was underestimated by QCA. OCT is a better modality for assessing LM artery lesion severity and thus, guiding intervention.

Keywords: Quantitative Coronary Angiography, Optical Coherence Tomography, Myocardial Infarction

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Introduction

Accurate diagnosis of left main coronary artery disease is crucial, as it significantly contributes to cardiovascular morbidity and mortality and should not be overlooked. Growingly, percutaneous coronary intervention (PCI) is considered a viable treatment option for notable atherosclerotic disease in the left main coronary artery (LMCA), specifically in carefully chosen patient cohorts. Furthermore, there is an escalating recognition of the importance of precise evaluation and assessment of the actual impact of LMCA lesions, especially when they appear moderately or equivocally during angiography. Traditional angiography is still the main stay in diagnosis of Left Main coronary artery disease worldwide. The safety of postponing revascularization in individuals with stable left main (LM) disease is not as thoroughly established, yet prevailing clinical practice guidelines strongly advocate revascularization for all patients with LM stenosis of ≥50%.(1) The dependence of our existing clinical practice guidelines on the severity of angiographic lesions as the exclusive factor influencing risk and as the default threshold for deciding on LM PCI or CABG surgery is obsolete in today's age of well-established noninvasive and invasive methods for assessing the functional and prognostic importance of challenging coronary lesions seen in angiography. Specifically, the visual assessment of intermediate left main (LM) stenoses (30-50%) from coronary angiography displays notable inconsistencies between different observers.On the contrary, the angiographic evaluation of LM stenosis ≥70% demonstrates outstanding accuracy and reproducibility.(2), (3)

Around 35 years ago, Brown and colleagues pioneered Quantitative Coronary Angiography (QCA). Their method involved enlarging 35-mm cine-angiograms acquired from different angles and manually tracing the arterial boundaries on a sizable screen. Subsequently, computer-assisted adjustments were made to account for pincushion distortion, enhancing the accuracy of the measurements. Left Main is a short and comparatively straight vessel thus making the QCA measurements more reliable. The process for analyzing a standard, linear vessel segment is relatively uncomplicated, but achieving robust arterial contours that demand minimal manual adjustments necessitates the use of sophisticated and extensively validated software.(3)

Optical coherence tomography (OCT) is a cutting-edge real-time, tomographic imaging technique capable of evaluating and presenting vascular architecture at an extremely high level of detail (axial resolution ranging from 10 to 15 μm), offering a close association with pathological features. Unlike intravascular ultrasound (IVUS), optical coherence tomography (OCT) provides higher spatial resolution (15 μm compared to 100 μm) but sacrifices tissue penetration capability (2.0 mm versus 10 mm). Earlier ostial LM lesions was considered a limitation for OCT assessment but that is manageable now. OCT provides precise evaluation for intermediate LM stenosis.

Thus, our study is aimed to evaluate visually non-significant LM artery lesions by both QCA and OCT and compare the two modalities in this setting.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Material and Methods

Study Population

This was a cross-sectional, single centre, comparative, observational study conducted from January 2022 to June 2023. Total 52 patients with visually non-significant LM lesions underwent OCT and QCA analysis. Out of which 47 adequate results with adequate QCA and OCT frames were statistically analysed.

Inclusion Criteria was Age >18 years, visually non-significant LM lesions (defined by stenosis <50%), History of acute coronary syndrome. Exclusion Criteria-History of PCI or CABG, Known LM disease, hemodynamic instability, renal insufficiency, and anatomical characteristics suchas extreme vessel tortuosity and severe calcification that might prevent the advancement of the OCT catheter..(1)

Methods

Coronary angiogram was performed using 5F diagnostic catheter and traditional 6 to 8 views were taken for left coronary system analysis. Patients fitting the inclusion criteria were selected. QCA analysis was conducted on angiographic images acquired at a rate of 15 frames per second, utilizing specialized QCA software packages. The analysis focused on selecting angiographic views that exhibited minimal foreshortening and provided the most accurate representation of the stenotic coronary segments. Measurements takenby QCA was Reference vessel diameter, Minimum Lumen Diameter and Area stenosis. The minimum lumen diameter (MLD) was obtained by averaging measurements from two orthogonal projections without foreshortening.

The patients which had intermediate LM coronary artery stenosis on coronary angiogram irrespective of disease present in other vessel were taken for OCT analysis after consent.The OCT imaging system was utilized. An OCT image catheter was advanced towards the target lesion by guiding it distally over a standard 0.014-inch angioplasty guidewire. Once the catheter was properly positioned, a contrast media solution was manually flushed through the 6F guiding catheter at a rate of 3 to 4 ml/s for approximately 3 to 4 seconds. The imaging core was then automatically pulled back over a longitudinal distance of up to 54 mm, at a speed of 20 mm/s, until a blood-free image was observed. The resulting OCT images were digitally stored for subsequent analysis. By visually examining all consecutive frames, three potential frames were chosen for measuring the minimum lumen area (MLA). The MLA represents the smallest lumen area among these selected frames. The Minimum lumen diameter (MLD) was defined as the average diameter of the lumen at the location of the MLA site. Reference Vessel Diameter and area stenosis was also acquired. Further, LM lumen and vessel characteristics were evaluated for the nature of plaque, presence of thrombus etc.

Statistical analysis

The data was tabulated and analysed using Microsoft Excel software. Categorical variables were displayed as percentages.Continuous variables were reported as mean ± standard

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

deviation (SD) and were compared using the paired t-test. A significance level of $p < 0.05$ was considered indicative of statistical significance. The associations between the measurements (OCT vs. QCA) were examined using a simple regression analysis.

Results

Total 52 patients with visually non-significant LM lesions were enrolled in the study. Satisfactory OCT pullbacks with good LM delineation were obtained in 47 patients. These were further evaluated. Patient characteristics are tabulated in table 1.

Table 1. Study Population Characteristics

Characteristic	**Value**
Age	60.9 ± 8.2
Male	66% (31)
Female	33% (16)
CAD Risk Factor	
1- Dyslipedimia	52% (38)
2- Diabetes Mellitus	44% (20)
3- Hypertension	38% (18)
4- Family History	33% (16)
5- Smoker	55% (26)
Presentation	
1- Unstable Angina	33% (16)
2- NSTEMI	7% (4)
3- Acute MI	59% (27)
Associated Lesion	
1- LAD	55% (26)
2- LCX	15% (7)
3- RCA	30% (14)

59% presented with Acute MI, 33% with USA and 7% with NSTEMI. Coronary Artery Disease risk factors were present in 82% of the patients which were dyslipidemia (52%), diabetes mellitus(44%), hypertension(38%),family history(33%) and smoking(55%).

Minimum Lumen Diameter, reference lumen diameter and area stenosis were evaluated by the softwares. The data was analysed and correlation was taken out of the values calculated by QCA and OCT. Results are tabulated in Table 2.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Minimum Lumen Diameter by QCA is 3.02±0.77mm and by OCT is 3.22±0.65mm. Mean difference of 0.20mm with MLD by OCT being greater. Reference Diameter Calculated by QCA is 4.04±0.61mm and by OCT is 4.34±0.66mm. Mean difference of 0.34mm with OCT being greater. Minimum lumen diameter of QCA was weakly correlated to that of OCT (r=0.25, p=0.12). Reference lumen diameter of QCA has good correlation with that of OCT (r=0.59, p=0.001).The average diameter stenosis is QCA and in OCT were 26.5 ±10% and 40 ± 8% respectively, with statistically significant difference between the two (p= 0.02) with QCA underestimating the stenosis. The average area stenosis is QCA and in OCT were 25.7±11.3% and 37.1±21.1% respectively, with statistically significant difference between the two (p<0.05) with QCA underestimating the stenosis. 29.6% of patients had significant LM stenosis and were advised intervention accordingly. OCT lesion characterization showed White mural thrombus in 7%, Fibrocalcific plaque in 33%, Fibrous plaque in 33% and fibroatheroma and mixture lesions in rest.

Table 2- Characteristics of Left Main Coronary Artery

Characteristics	**QCA**	**OCT**	**Significance**
Minimum Lumen Diameter	3.02±0.77mm	3.22±0.65mm	(r=0.25, p=0.12)
Reference Lumen Diameter	4.04±0.61mm	4.34±0.66mm	(r=0.59, p=0.001)
Diameter Stenosis	26.5±10%	40±8%	P=0.002
Area Stenosis	25.7±11.3%	37.1±21.1%	p <0.05

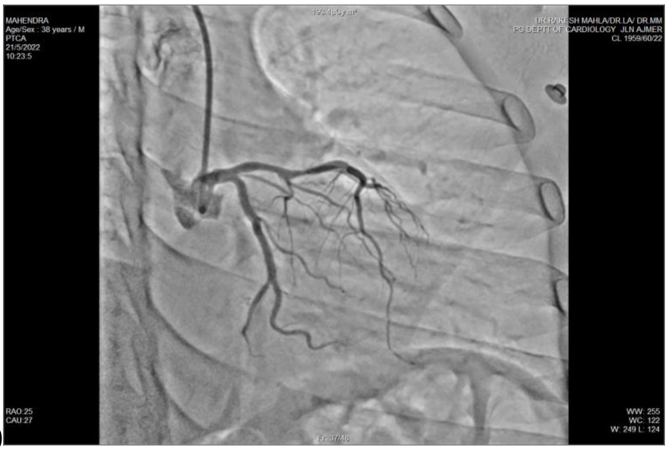
Table 3- Left Main Coronary Artery Lesion Characteristics by OCT

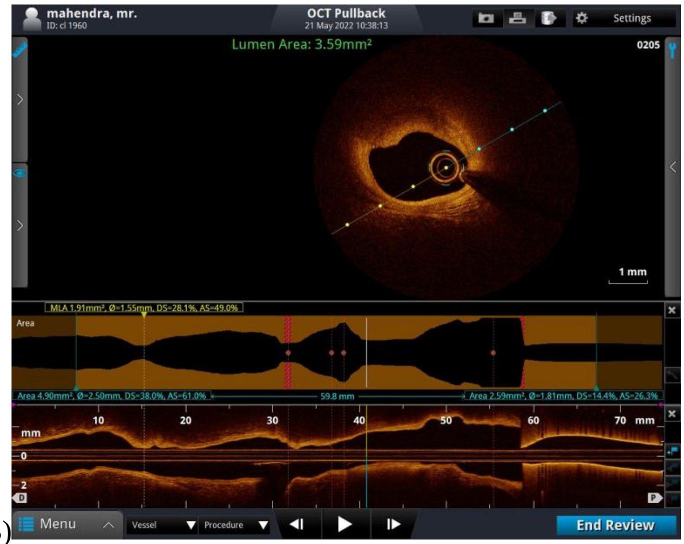
Characteristics	Value
Segment with Significant Left Main Disease	
1- Proximal	8%
2- Mid	40%
3- Distal	42%
LM morphology	
1- White mural thrombus	7%
2- Fibrous Plaque	33%
3- Fibroatheroma Plaque	33%
4- Fibrocalcific Plaque	10%
5- Mixture Lesions	17%

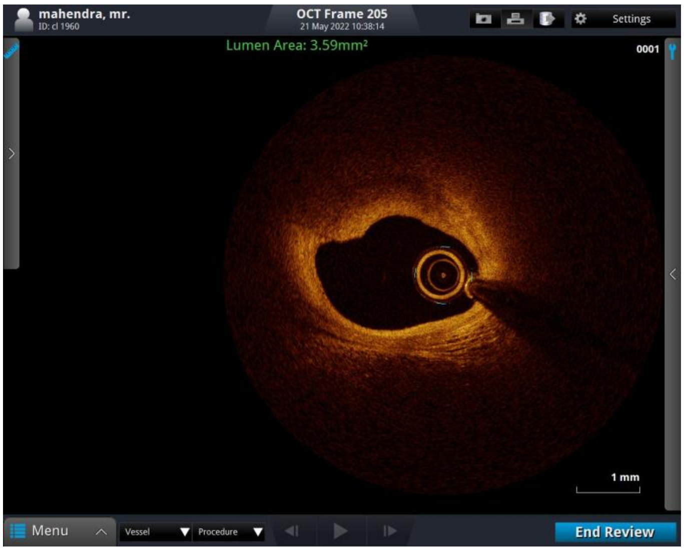
29.6% of patients had significant LM stenosis and were advised intervention accordingly. OCT lesion characterization showed White mural thrombus in 7%, Fibrocalcific plaque in 33%, Fibrous plaque in 33% and fibroatheroma and mixture lesions in rest.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Image 1- A)RAO Caudal view of Left Coronary Artery System, B)OCT pullback, C) LM Cross-section

A)


B)


C)


ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Image 2- White Mural Thrombus in Left Main Artery in OCT

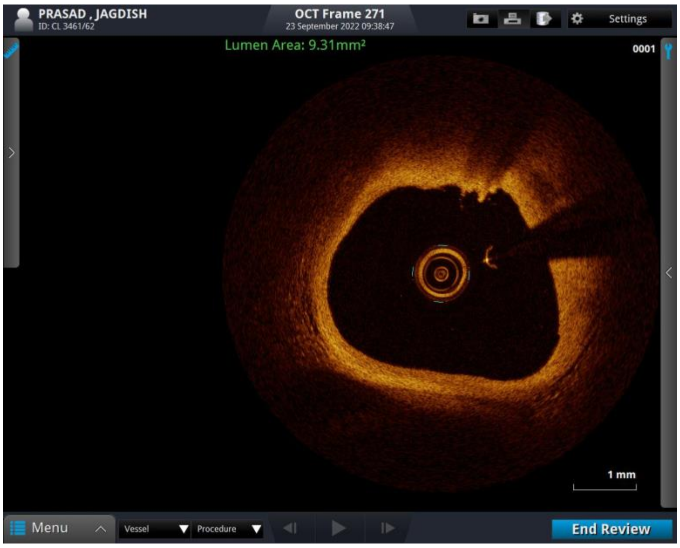


Image 3- A)AP CAUDAL VIEW ,B)Significant distal LM Stenosis in OCT Pullback, C) Lesion Characterictic

A)


C)


B)


Discussion

The main finding of this study was that Minimum Lumen diameter and reference lumen diameter by QCA was underestimated than OCT with results which were statistically significant for the reference lumen diameter. Thus, the total diameter stenosis and area

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

stenosis were underestimated by QCA leading to missing out on the significant LM coronary artery stenosis.Due to its high resolution and strong contrast between the lumen and vessel wall, OCT is expected to yield accurate luminal measurements. However, some prior studies have presented conflicting results regarding OCT morphometry. Several phantom models have demonstrated precise measurements using OCT. For instance, Sawada et al. showed that OCT measurements of diameter and area in phantom models matched the actual values when the image wire was positioned at the center of the lumen. (4)Similarly, Tsuchida et al. revealed a strong correlation between OCT measurements and the actual lumen dimensions in a plexiglass phantom with a precision of 10mm (relative SD 1.8%, r = 1.000, intercept 0.01, slope 1.02).(5) In a single-laboratory pilot study, Tahara et al. found that OCT measurements exhibited excellent correlations with the actual phantom dimensions (concordance correlation coefficient ≥ 0.9958).(6) The study by further by supported the accuracy of OCT measurements compared to IVUS, aligning with previous phantom investigations that demonstrated OCT's closer proximity to the actual phantom dimensions.(7)

Both OCT and QCA have been previously compared individually to FFR for non-left main disease, as presented in Gonzalo et al. found a moderate correlation, at best, between OCT & FFR based on their assessment using linear and quadratic regression models. The diagnostic accuracy of OCT-derived dimensional variables, particularly MLA and MLD, in identifying hemodynamically significant coronary stenoses was determined to be moderate.(8) Moreover, Shiono et al. evaluated intermediate to significant stenoses, with a higher-diameter stenosis and FFR values that were predominantly lower than the ischemic threshold (set at 0.75 in that particular study).(9)

No study to the best of our knowledge has yet compared QCA and OCT in a Left Main coronary artery disease.

Conclusion

With advancements in the cardiac catheterisation laboratory setups, QCA software is easily available. But in low and medium economy countries OCT is still a expensive and patients have affordability issues. Thus, we compared both entities in LM evaluation. Traditional visual angiography has limitations in assessing significant LM artery disease. As we concluded in our study that 29.6% of patients with visually non-significant LM stenosis had significant LM artery disease requiring intervention.

Minimum Lumen Diameter of the LM artery didn’t have a statistically significant difference between the two groups, thus according to our study OCT didn’t offer an advantage in the same. But , the reference diameter was significantly underestimated by the QCA thus affecting the diameter and area stenosis. Area stenosis is significantly underestimated by QCA than OCT resulting in missing out on significant LM lesions.

Moreover, OCT has added advantage of evaluation of the vessel morphology, bifurcation disease, bifurcation angle and plaque characterisation. These can be of great importance in choosing the modality of revascularisation.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

Traditional visual coronary angiography can't be relied upon totally in Left Main Coronary Artery assessment as it tends to miss out significant lesions in 20-50% visual stenosis group. Among QCA and OCT, OCT is a better modality for assessing LM artery lesion severity and thus, guiding intervention.

References

1. Lawton JS, Tamis-Holland JE, Bangalore S, Bates ER, Beckie TM, Bischoff JM, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022 Jan 18;145(3):e18–114.

2. Fisher LD, Judkins MP, Lesperance J, Cameron A, Swaye P, Ryan T, Maynard C, Bourassa M, Kennedy JW, Gosselin A, Kemp H. Reproducibility of coronary arteriographic reading in the coronary artery surgery study (CASS). Catheterization and cardiovascular diagnosis. 1982;8(6):565-75.

3. Ramadan R, Boden WE, Kinlay S. Management of Left Main Coronary Artery Disease. J Am Heart Assoc. 7(7):e008151.

4. Reiber JHC, Tu S, Tuinenburg JC, Koning G, Janssen JP, Dijkstra J. QCA, IVUS and OCT in interventional cardiology in 2011. Cardiovasc Diagn Ther. 2011 Dec;1(1):57–70.

5. Sawada T, Shite J, Negi N, Shinke T, Tanino Y, Ogasawara D, et al. Factors that influence measurements and accurate evaluation of stent apposition by optical coherence tomography. Assessment using a phantom model. Circ J Off J Jpn Circ Soc. 2009 Oct;73(10):1841–7.

6. Tsuchida K, van der Giessen WJ, Patterson M, Tanimoto S, García-García HM, Regar E, et al. In vivo validation of a novel three-dimensional quantitative coronary angiography system (CardiOp-B): comparison with a conventional two-dimensional system (CAAS II) and with special reference to optical coherence tomography. EuroIntervention J Eur Collab Work Group Interv Cardiol Eur Soc Cardiol. 2007 May;3(1):100–8.

7. Tahara S, Bezerra HG, Baibars M, Kyono H, Wang W, Pokras S, et al. In vitro validation of new Fourier-domain optical coherence tomography. EuroIntervention J Eur Collab Work Group Interv Cardiol Eur Soc Cardiol. 2011 Feb;6(7):875–82.

8. Kubo T, Akasaka T, Shite J, Suzuki T, Uemura S, Yu B, et al. OCT Compared With IVUS in a Coronary Lesion Assessment. JACC Cardiovasc Imaging. 2013 Oct;6(10):1095–104.

9. Gonzalo N, Escaned J, Alfonso F, Nolte C, Rodriguez V, Jimenez-Quevedo P, et al. Morphometric assessment of coronary stenosis relevance with optical coherence tomography: a comparison with fractional flow reserve and intravascular ultrasound. J Am Coll Cardiol. 2012 Mar 20;59(12):1080–9.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 07, 2023

10. Shiono Y, Kitabata H, Kubo T, Masuno T, Ohta S, Ozaki Y, et al. Optical coherence tomography-derived anatomical criteria for functionally significant coronary stenosis assessed by fractional flow reserve. Circ J Off J Jpn Circ Soc. 2012;76(9):2218–25.