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RESEARCH ARTICLE

ANATOMICAL AND RADIOLOGICAL STUDY OF CORONARY OSTIA IN ADULT HUMAN HEARTS

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Abstract

The annual number of deaths from cardiovascular diseases (CVD) in India jumped from 2.26 million (1990) to 4.77 million (2020). With the uptrend of CVD cases, the procedures related to coronary arteries also have tremendously increased. Accurate knowledge of the diameter of the coronary artery is needed to facilitate the various cardiac interventions for diagnostics and therapeutical purposes. Therefore, this study was aimed to measure and compare the diameter of the coronary artery from cadaveric hearts, and from living persons by quantitative coronary angiography and intravascular ultrasound. The present descriptive cross-sectional study was carried out on 40 embalmed hearts from the department of anatomy, P.D.U. Government medical college Rajkot, Gujarat; 131 angiograms by QCA and 131 luminogram by IVUS technique from the department of cardiology, Synergy Superspeciality Hospital, Rajkot, Gujarat, after approval from the institutional ethical committee. The collected data by all three methods were compared and analyzed by standard statistical methods using Epi info software version 7.2. The mean diameter of RCA= 2.73mm, LCA=3.6mm, LAD=2.55mm and LCX=2.57mm measured from cadaveric hearts. The diameter measured by QCA were RCA=3.69±0.58mm, LCA=4.12±0.56mm, LAD=3.29±0.39mm, LCX=3.18±0.4mm; and by IVUS RCA=4.78±0.59mm, LCA=5.72±0.59mm, LAD=4.49±0.5mm, LCX=4.47±0.53mm. The Pertinent finding of our study is that the diameter of LCA is greater than the RCA (p value<0.001) measured by all three methods; the diameter of coronary arteries measured by IVUS is considerably larger than those measured by QCA. IVUS is a pivotal adjunct of QCA and has been increasingly used in clinical and research applications.

Introduction:-

Coronary heart disease prevalence rates have ranged from 1.6% to 7.4% in rural populations and from 1% to 13.2% in urban populations over the past several decades in India [1]. The annual number of deaths from cardiovascular diseases (CVD) in India was projected to rise from 2.26 million (1990) to 4.77 million (2020) [2]. With the uptrend of CVD cases, the number of cardiac procedures has been rising as well. From the National interventional council

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data for the year 2018-India, numbers of percutaneous coronary intervention (PCI) had risen from 2,16,817 in 2013 to 4,38,351 in 2018 [3].

Coronary ostia serve as the origin of the right coronary artery (RCA) and left coronary artery (LCA) from the anterior aortic sinus and left posterior aortic sinus respectively. After arising from the coronary ostium, the left coronary artery divides into two main branches left anterior descending (LAD) artery and the left circumflex (LCX) artery [4]. The difference in the diameter may affect the amount of coronary blood flow [5].

There are several methods to measure the diameter of coronary arteries such as Quantitative Coronary Angiography (QCA), Magnetic Resonance Angiography, Intravascular Ultrasound (IVUS) etc.

QCA is a two-dimensional imaging modality that represents a complex lesion of coronary arteries in a simple 2-dimensional luminogram. Whereas, IVUS is a pivotal adjunct of coronary angiography that allows visualization of coronary artery and ostia in three dimension [6].

In the past decades, imaging modalities related to the coronary arteries have been increasingly used in clinical and research applications. Therefore, this study is aimed to measure and compare the diameter of the coronary artery from cadaveric hearts, and from living persons by QCA and IVUS.

Material and Methods:-

The present descriptive cross-sectional study was carried out on 40 embalmed hearts from the department of anatomy, P.D.U. Government medical college Rajkot, Gujarat; 131 angiograms by QCA and 131 luminogram by IVUS technique from department of cardiology, Synergy Superspeciality hospital, Rajkot, Gujarat after approval from the institutional ethical committee.

The heart specimens were collected from the dissection of embalmed human cadaver during undergraduate teaching. The cadaveric heart with gross anomaly was excluded from the study. Each heart was dissected at the aortic root to open and identify the origin of RCA and LCA [7]. The main branches of LCA which are LAD and LCX were identified. The maximum diameters of the arteries were measured at the commencement by a digital millimeter vernier caliper (Image 1).

The coronary diameter at the origin of RCA, LCA, LAD and LCX arteries were measured on angiograms by QCA. Standard quality control analysis software with a digital acquisition system and electronic calipers was used for the measurement (IGS 320 Cath Lab, GE Healthcare) (Image 2). Largest diameter was measured electronically at origin of contrast filled coronary arteries. Unclear coronary angiograms were omitted as well.

The coronary diameter of coronary arteries on luminogram by IVUS included in the study were measured using from the cross sectional images obtained during IVUS procedure (Opticross IVUS catheter, Boston Scientific) (Image 3).

A double check of the diameter by all three methods was done by the two individual observers. The collected data by all three methods was compared and analyzed by standard statistical methods using Epi info software version 7.2.

Result:-

The mean diameter of RCA, LCA, LAD and LCX at commencement was measured from the cadaveric heart, angiogram by QCA, and luminogram by IVUS, and are as in Table no. 1 with standard deviation and its statistical significance (p-value<0.0001).

The mean diameter of LCA is greater than the RCA by all three methods. The mean diameters measured from IVUS were greater than the mean diameters measured from the cadaveric heart and QCA.

Discussion:-

The Pertinent finding of our study is that the diameter of coronary arteries measured by IVUS is considerably larger than those measured by QCA. Similar findings have been noted by Sreenivas et al [8] and Pravin et al[9] (Tables 3 & 4). Additionally, the diameter measured from cadaveric hearts was also lower than IVUS.

In the present study, the mean diameter of RCA was 2.73 mm and LCA was 3.6 mm. These values were lower than results reported by Jyothi and Dakshayani [10] (RCA=3.43mm, LCA=4.27mm); Agrawal [11] (RCA=3.09mm, LCA=4.26mm); and Jeshika et al.[12](RCA=3.29mm, LCA=3.87mm) in the cadaveric heart as shown in the Table 2.

The diameter measured by QCA in our study (RCA=3.69±0.58, LCA=4.12±0.56, LAD=3.29±0.39, LCX=3.18±0.4) is in concordance with the studies by Sreenivas et al.[8] (RCA=3.27±0.56, LCA=4.50±0.79, LAD=3.45±0.63, LCX=3.16±0.47), Theodore et al.[13] (RCA=3.9±0.6, LCA=4.5±0.5, LAD=3.6±0.5, LCx=3.4±0.5) and Pravin et al.[9] (LCA=3.89±0.25, LAD=3.36±0.28, LCX=2.85±0.27) as per in the table-3.

The results by Sreenivas et al. [8] (RCA=3.85±0.62, LCA=4.60±0.69, LAD=3.71±0.60, LCX=3.55±0.56) and Pravin et al. [9] (LCA=4.33±0.32, LAD=3.61±0.21, LCx=3.31±0.16) by IVUS were lower than the results of this study (RCA=4.78±0.59, LCA=5.72±0.59, LAD=4.49±0.5, LCX=4.47±0.53) mentioned in the table-4.

Critical analysis of the various studies shows that the diameter of LCA is greater than the RCA [8-13]. The present study delineates the same analysis (p value<0.001) by all the methods.

As the Numbers of the PCI tremendously increased, accurate knowledge of the diameter of coronary arteries is needed to facilitate the various cardiac interventions for diagnostics and therapeutic purposes.

Limitations of QCA, which can lead to data variability including inconsistencies in image acquisition (e.g., vessel foreshortening, different imaging planes or magnification), frame selection and differences in vessel tone among measurements. The significant discrepancy in distances from the x-ray generator to the calibration device (i.e., catheter) and to the coronary vessel also leads to underestimation or overestimation of measurements. Disparities have also been noted between coronary angiograms and post-mortem examination [14]. The IVUS produces real-time, cross-sectional images that give better assimilation of the dimensions that can results in a larger diameter in comparison to QCA and cadaveric specimen.

As this is the kind of distinct study describing diameters of coronary arteries by QCA and IVUS along with cadaveric hearts in the Gujarat region, the further large-scale study will provide more accurate data and that will be beneficial to interventional cardiologists and radiologists.

Tables

Table 1:- Mean diameter of various Coronary arteries.

Coronary arteries	**Cadaveric Heart**		**QCA**		**IVUS**		**F value**	**p value***
	n	**(Mean±SD) mm**	**n**	**(Mean±SD) mm**	**n**	**(Mean±SD) mm**		
RCA	40	2.73±0.92	36	3.69±0.58	37	4.78±0.59	67.2	<0.001
LCA	40	3.6±0.83	83	4.12±0.56	81	5.72±0.59	123.6	<0.001
LAD	40	2.55±0.91	79	3.29±0.39	79	4.49±0.5	107.2	<0.001
LCX	40	2.57±0.68	20	3.18±0.4	19	4..47±0.53	57	<0.001
*One way ANOVA								

Table 2:- Studies showing diameter of coronary arteries of cadaveric heart.

Diameter (mm) of arteries in cadaveric heart					
Studies	**n**	**RCA**	**LCA**	**LAD**	**LCx**
Jyothi and Dakshayani [10] (2017)	49	3.43±0.87	4.27±0.72		
Agrawal [11] (2018)	50	3.09	4.26		
Jeshika et al. [12] (2018)	50	3.29	3.87		
Present study (2022)	40	2.73±0.92	3.6±0.83	2.55±0.91	2.57±0.68

Table 3:- Studies showing diameter of coronary arteries, measured from QCA.

Diameter (mm) of arteries by QCA				
Studies	**RCA (n)**	**LCA (n)**	**LAD (n)**	**LCX (n)**
Sreenivas et al.[8] (2019)	3.27±0.56 (62)	4.50±0.79 (221)	3.45±0.63 (164)	3.16±0.47 (45)

Theodore et al.[13] (2020)	3.9±0.6 (20)	4.5±0.5 (18)	3.6±0.5 (20)	3.4±0.5 (20)
Pravin et al.[9] (2021)		3.89±0.25 (186)	3.36±0.28 (177)	2.85±0.27 (44)
Present study (2022)	3.69±0.58 (36)	4.12±0.56 (83)	3.29±0.39 (79)	3.18±0.4 (20)

Table 4:- Studies showing diameter of coronary arteries, measured from luminogram by IVUS.

Diameter (mm) of arteries by IVUS				
Studies	**RCA (n)**	**LCA (n)**	**LAD (n)**	**LCX (n)**
Sreenivas et al.[8] (2019)	3.85±0.62 (62)	4.60±0.69 (221)	3.71±0.60 (164)	3.55±0.56 (45)
Pravin et al.[9] (2021)	-	4.33±0.32 (186)	3.61±0.21 (177)	3.31±0.16 (44)
Present study (2022)	4.78±0.59 (37)	5.72±0.59 (81)	4.49±0.5 (79)	4..47±0.53 (19)

Image 1:- showing mesurment of diameter of right coronary artery by digital verniear calipre [PT= pulmonary trunk, RCA= Right coronary artery]

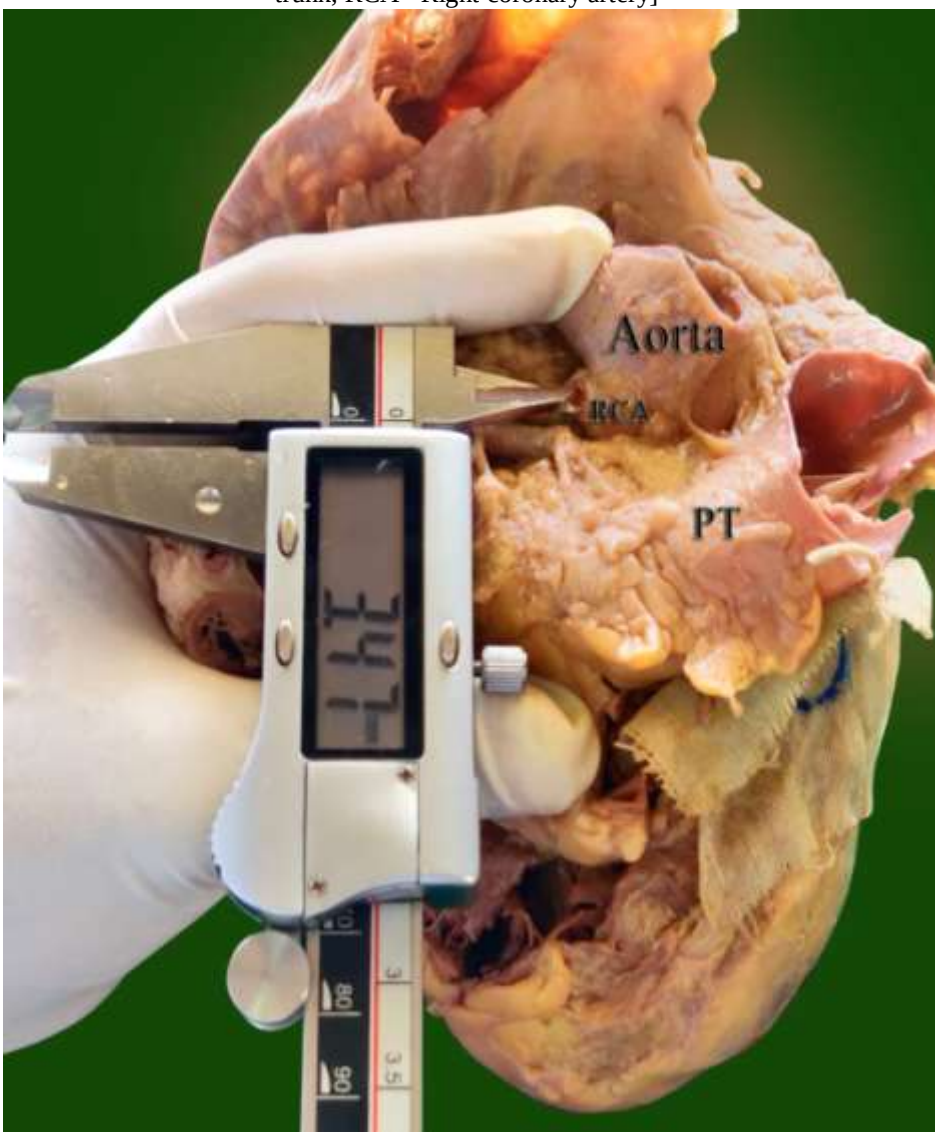


Image 2:- Quatitative coronary angiogram of the left coronary artery [Left main = left coronary artery]

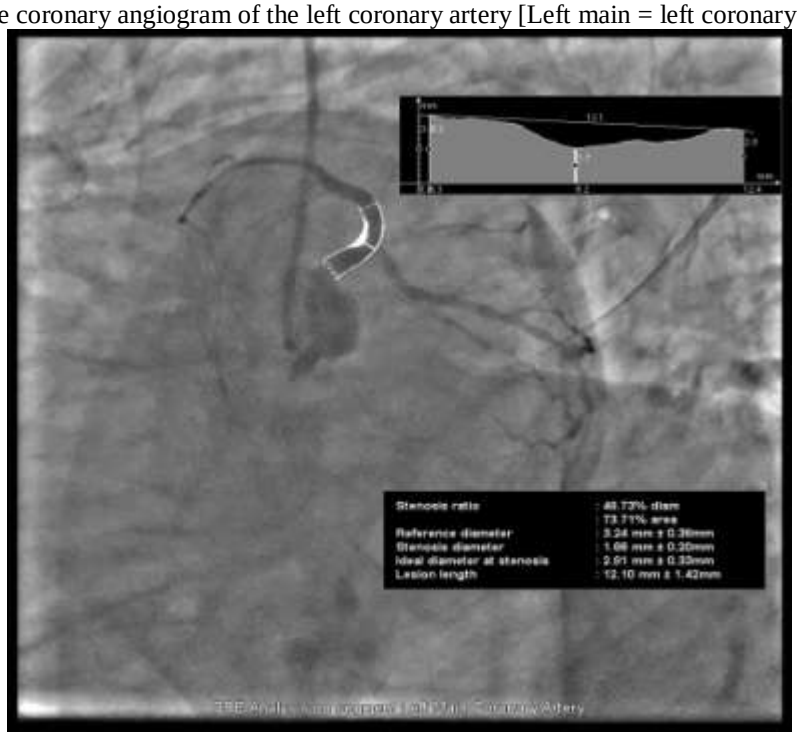
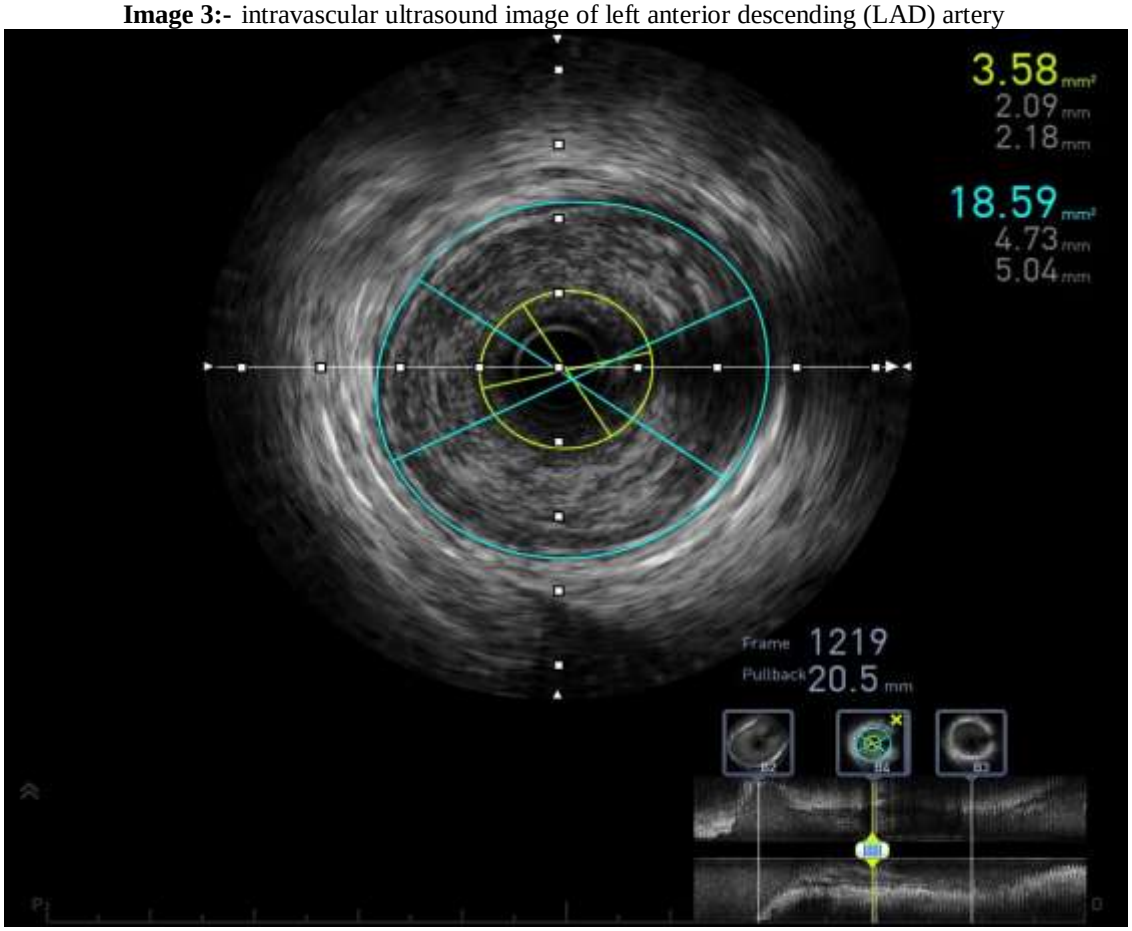


Image 3:- intravascular ultrasound image of left anterior descending (LAD) artery



Declarations
Ethical Approval
Ethical approval of study:
This study was conducted after approval of the study proposal by the Pandit DeenDayal Medical College, Rajkot, India.(Institutional Ethical Committee (Registered number : ECR/635/INST/GJ 2014/RR-20), Outward no : PDUMC/IEC/73/2021

Consent to participate :
All the participants were consented.

Consent for publish :
All co-authors agreed for the submission of research article in the journal where out article is submitted, They also consent for the order of the ownership

Competing interests
Nil.

Conflict of interest :
Nil.

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Nil.

Availability of data and materials
The data that support the findings of this study are available from the corresponding author, [P.A], upon reasonable request.

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