Diagnostic Accuracy of Coronary Artery CT Imaging as a Pre-ICA Test in Low-Risk Patients with Chest Pain: A Study at Queen Alia Heart Institute

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ABSTRACT

Background/Aim: Over the last years, coronary CT Angiography has been utilized as a diagnostic test for patients with chest pain and suspected coronary artery disease. Our primary aim in this study was to compare the performances of anatomically related diagnostic procedures in predicting the candidacy for Invasive Intervention over Pharmacotherapy Interventions.

Methods: A retrospective study was conducted for adult and elderly patients who presented with clinical concerns for coronary artery diseases' symptoms between January 1st 2020, to January 1st 2021. Only patients who were intervened with the dual diagnostic procedures by coronary CT angiography and invasive coronary angiography were included in our study. The differences in the degree of coronary narrowing were used to categorize eligible patients into 3 groups which were analyzed via One-Way ANOVA test. The propensity of invasive interventions over medical therapy was investigated via Receiver Operating Characteristic and Sensitivity tests.

Results: The optimal operating cutoff points to prognosticate the propensity of Invasive Intervention over Pharmacotherapy Interventions were [47.5% vs 55%, 42.5% vs 47.5%, and 15% vs 45%, respectively**].** All Invasive Coronary Angiography related diagnostic procedures had higher specificity, negative predictive value, and accuracy indices than CT Angiography based diagnostic procedures for Left Anterior Descending, Right Coronary, and Circumflex arteries [(98.47% vs 67.35%, 96.94% vs 90.31%, 98.98% vs 73.47%), (88.13% vs 78.11%, 70.90% vs 66.04%, and 68.55% vs 65.45%), and (91.42% vs 70.12%, 75.15% vs 67.46%, 73.08% vs 62.13%), respectively].

Conclusion: Although coronary CTA could not substitute for ICA, however, it is considered to be a very good tool for initial assessm 10.12816/0061745ent of patients with suspected coronary artery disease.

Keywords: coronary computed tomography, invasive coronary angiography, coronary artery disease.

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INTRODUCTION

Although diagnostic cardiac catheterization or Invasive Coronary Procedure (ICP) carries a relatively small but not negligible risk of major complications, there has been much effort put forward trying to track affected obstructive coronary artery disease (CAD) patients to accurately allocate them for ICP in the era of global shortages in medical facilities and persistent uptrending in CAD related cases. [1-3]

Practically, patients who presented with clinical concerns for CAD to Cardiology clinics, are commonly undergone non-invasive diagnostic tests including myocardial perfusion imaging (MPI). Patients with positive diagnostic tests are typically scheduled for ICP. Of importance, elective ICPs have an overall limited diagnostic yield which further exhaust our overloaded specialized cardiac institution.

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On the other aspect, there are limited correlations between anatomical and functional evaluations which put us on further load to early and appropriately prognosticating the candidacy for ICP and the candidacy for invasive revascularization procedures over medical treatment. [4-6]

While traditional physical, biochemical, and imaging diagnostic tests have an established valid approach, questions remain whether accuracy can be improved for appropriately triaging and consequently scheduling affected CAD patients for ICPs. Over the last years, Coronary Computed Tomography Angiography (CTA) imaging has gained more popularity as a diagnostic test for patients with chest pain and suspected coronary artery disease. In addition to its non-invasive nature, it has shown considerable accuracy approaching 96% in comparison to ICA in patients with stable ischemic heart disease. Another considerable advantage is the high negative predictive value, hence the high value of utilizing it as a screening tool. Although it has been demonstrated to show accurate results, however functional assessment is lacking, so other diagnostic modalities like stress testing may be needed. [7-12]

Therefore, in this study we primarily aimed to compare the performance of anatomically related diagnostic procedures, CTA vs ICP, in predicting the candidacy for Invasive Intervention over Pharmacotherapy Interventions, and to explore whether using CTA as adjunctive strategy to traditional diagnostic strategies may be as a gatekeeper to ICA procedures in an attempt to minimize the overall professional and cost expenditures while optimizing dual patient safety and diagnostic accuracy.

MATERIAL AND METHODS

A single-center, non-funded and non-sponsored retrospective study was conducted for patients who presented with clinical concerns for CAD to QAHI's Cardiology clinics, RMS, Amman, Jordan, between January 1st 2020 till January 1st 2021. Only patients who were intervened with the dual diagnostic procedures of coronary CTA and ICA were included in our study. The study was conducted in compliance with the Declaration of Helsinki as well as HIPAA and institutional regulations. An informed consent form was waived owing to the study's retrospective design nature and the ethical approval was signed by our Institutional Review Board (Ref #24, 1/2022).

Patients aged 20–80 who were independently scheduled to undergo a clinically indicated ICA after having suspected stable CAD, as manifested by historical and dated clinical signs/symptoms and electrocardiograms, were included in our study after excluding patients with prior coronary artery bypass grafting, serum creatinine >2.0 mg/dl, potential pregnancy status, and prior reaction to iodinated contrast material. A total of 1996 eligible patients underwent coronary CTA prior to ICA. 1621 patients (81.2%) were only had undergone cCTA without subsequently referring to ICA [579 Female (35.7%) and 1042 Male (64.3%)]. 36 patients (1.8%) had invalid coronary CTA results and were consequently referred to ICA [10 Female (27.78%) and 26 Male (72.2%)]. Finally, 339 patients (16.98%) underwent coronary CTA and were subsequently referred to ICA [82 Female (24.19%) and 257 Male (75.81%)]. Figure1 summarizes the inclusion and exclusion criteria.

We initially investigated the grade of coronary occlusion (%o) on the 4 pre-defined anatomical cardiac sites by coronary CTA followed by ICA. The subtracting value (-100% to +100%) of %o ICA and %o CTA (Δ%(o ICA-o CTA) was used to categorize all eligible studied patients into 3 comparative groups; patients whose Δ%(o ICA-o CTA)<0 cohort [Group I or Overestimated Cohort], patients whose Δ%(o ICA-o CTA)=0 cohort [Group II or Matched Cohort], patients whose Δ%(o ICA-o CTA)>0 cohort [Group III or Underestimated Cohort]. In Overestimated Cohort, the %o CTA, was higher than it was actually detected by ICA and vice versa in Underestimated Cohort. All gathered data were from our Institutional Electronic Medical Record (EMR). Demographics included were: age, gender, hypertension, diabetes mellitus, and smoking statuses, were anatomically based analyzed and compared across the 3 aforementioned categorized cohorts by Chi Square and One-Way ANOVA testes for categorical and non-categorical data, respectively.

Non-parametric and parametric data results were expressed as Mean±SD and Number (Percentage), respectively.

According to our institutional revascularization protocol, PCI for LMA, LADA, RCA, and CxA is indicated over ACB in stable CAD's patient whose stenosis percentage is ≥60% in ≥1 arteries including LMA but <4 arteries or ≥2 arteries not including LMA but <4 arteries. In stable CAD 's patients who have stenosis percentage≥60% in the 4 arteries, or <4 arteries but had recurrent symptoms despite 2 separate (percutaneous interventions) PCIs are eligible for aorto-coronary bypass (ACB) procedure. Otherwise, asymptomatic and symptomatic stable CAD's attended patients are treated medically, including anti-platelets, β-Blockers, Statins. In this study, the tested patients' incidences of undergoing invasive procedures over pharmacotherapy were plotted against the %o of the 8 tested non-invasive and invasive angiographical procedures to construct Receiver Operating Characteristics (ROC) curves. ROC test was conducted to explore the 8 related Area under ROCs. Thereafter a sensitivity analyses was conducted the optimal cut-off points, sensitivities, specificities, positive and negative predictive values, Youden and accuracy indices, and the negative likelihood ratios of the AUROCs related significant tested non-invasive and invasive angiography procedural occlusion percentages. Statistical analysis was performed using Statistical Package for Social Science (SPSS) software version 23.0. Statistical significance was set at 5%.

RESULTS

All eligible studied patients were anatomically categorized into 3 comparative groups as previously mentioned. Anatomically based tested cardiac sites were LMA, LADA, RCA, and CxA. Based on the Δ%**o**ICA-**o**CTA, Overestimated Cohort (Δ%**o**ICA-**o**CTA<0), Matched Cohort (Δ%**o**ICA-**o**CTA=0), and Underestimated Cohort (Δ%**o**ICA-**o**CTA>0) were independently compared for the 4 cardiac tested sites. Eligible tested patients were randomly distributed across the 3 categorized cohorts (Overestimated, Matched, and Underestimated) among the 4 tested arteries (LMA, LADA, RCA, and CxA) with Count (%) of [150 (44.25%), 106 (31.27%), and 83 (24.48%) vs 150 (44.25%), 106 (31.27%), and 83 (24.48%) vs 90 (26.55%), 180 (53.10%), and 69 (20.35%) vs 78 (23.10%), 203 (59.88%), and 58 (17.11%), respectively].

Age was only significantly distributed across Group I-III in RCA and CxA arteries with an overall Mean±SD of [51.94±10.70 years and 51.91±10.72 years, p-Value=0.001 and 0.005, respectively]. Gender distributions among LMA, LADA, and RCA were Stastically insignificant. Overall Female: Male distributions in CxA were [83 (24.5%) vs 256 (75.5%), 5.49: 1, p-Value=0.009]. Regarding co-morbidities and smoking status, there were also variabilities in distribution among the 4 tested arteries. For example, in contrast to significantly distributed in LMA and CxA regarding HTN statuse [186 (54.9%) vs 153 (45.1%) and 186 (54.9%) vs 153 (45.1%), p-Value=0.032 and 0.016, respectively], DM status was only significantly distributed in RCA and CxA [249 (73.5%) vs 90 (26.5%) and 249 (73.5%) vs 90 (26.5%), p-value=0.001 and 0.011, respectively]. While smoking status was insignificantly distributed across the categorized cohorts among the 4 investigated arteries.

Primarily, recruited data from CTA and ICA diagnostic procedures were related to stenosis or occlusion percentages in the individual 4 assessed coronary territories. Statistically, these %**o** were parametrically analyzed and compared across the 3 categorized cohorts by One-Way ANOVA test. The Means±SDs of the 8 %**o** were significantly in all investigated arteries except LMA [43.2%±29.6% vs 36.7%±36.8%, 21.3%±28.9% vs 20.9%±33.03%, and 15.98%±25.3% vs 16.43%±30.2%, p-value=0.000, respectively]. Also, the operating dependent variable [Δ%(oICA-oCTA)] had statistically differences across the comparative cohorts among LADA, RCA, and CxA [-6.55%±28.32%, -0.24%±27.40%, and

0.45%±28.15%, p-Value=0.00, respectively]. Both the 4 arteries related %o and Δ%(oICA-oCTA) were also non-parametrically analyzed by categorizing the defined ranges [0%-100% and -100% to +100%, respectively] into sub-categories.

The primary dependent variable that was used in our study to explore the anatomically related CTA based Non-Invasive Strategy (Strategy I) with ICA based Invasive Strategy (Strategy II) in predicting the candidacy for Invasive Intervention (PCI or ACB) over Pharmacotherapy Interventions, was significantly distributed across the 3 comparative groups among the 4 cardiac sites with Count (%) of [197 (58.1%), 119 (35.1%), and 23 (6.8%) vs 197 (58.1%), 119 (35.1%), and 23 (6.8%) vs 197 (58.1%), 119 (35.1%), and 23 (6.8%) vs 197 (58.1%), 119 (35.1%), and 23 (6.8%), p-Value=0.000, respectively]. Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA among the 4 studied cardiac arteries were fully presented in Tables I-IX.

Receiver Operating Characteristic (ROC) test was conducted to explore the Area under ROC curves (AUROCs) of the 8 tested non-invasive and invasive angiographical procedures for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021. As illustrated in Figure 2, the AUROCs were significant for both non-invasive coronary CT scan angiography (CTA) and invasive coronary angiography (ICA) of Left Anterior Descending Artery (LADA), Right Coronary Artery (RCA), and Circumflex Artery (CxA) with Area±SEM of 0.774±0.026 (95% CI; 0.722-0.826), 0.624±0.032 (95% CI; 0.561-0.686), and 0.613±0.032 (95% CI; 0.552-0.675) versus 0.911±0.019 (95% CI; 0.873-0.949), 0.702±0.031 (95% CI; 0.642-0.762), and 0.672±0.031 (95% CI; 0.611-0.733), respectively. Oppositely, both the dual diagnostic procedures of CTA and ICA on the Left Main Artery (LMA) had insignificant AUCROCs of 0.529±0.032 (95 %CI; 0.466-0.592) and 0.549±0.032 (95% CI; 0.486-0.612), respectively.

Once the ROC analysis was constructed against the propensity for either Percutaneous Invasive (PCI) or Aorto-Coronary Bypass (ACB) Invasive Strategy (1) versus Non-Invasive Strategy (0). Sensitivity analysis was thereafter processed on a total of 1996 processed cases for which 142-case were processed as positive actual state and 196-case were processed as a negative actual state [1658 patients who undergone only CTA were dealt with as missing data. higher values of the test result variable(s) indicate stronger evidence for a positive actual state. The positive actual state is the patients who undergone invasive procedures of PCI or ACB]. The conduction of sensitivity analysis was aimed to track the optimal cut-off points, sensitivities (TPR), specificities (TNR), positive and negative predictive values (PPV and NPV), Youden and accuracy indices (YI and AI), and the negative likelihood ratios (NLR) of the 6 significant tested non-invasive and invasive angiography procedural occlusion percentages [%oLADA_CTA vs %oLADA_ICA, %oRCA_CTA vs %oRCA_ICA, and %oCxA_CTA vs %oCxA_ICA]. The optimal operating cutoff points to prognosticate the propensity of Strategy I over Strategy II were [47.5% vs 55%, 42.5% vs 47.5%, and 15% vs 45%, respectively]. All ICA related diagnostic procedures had higher TNVs, NPVs, and AIs than CTA based diagnostic procedures for LADA, RCA, and CxA [(98.47% vs 67.35%, 96.94% vs 90.31%, 98.98% vs 73.47%), (88.13% vs 78.11%, 70.90% vs 66.04%, and 68.55% vs 65.45%), and (91.42% vs 70.12%, 75.15% vs 67.46%, 73.08% vs 62.13%), respectively]. All Sensitivity results were fully summarized on Table 9.

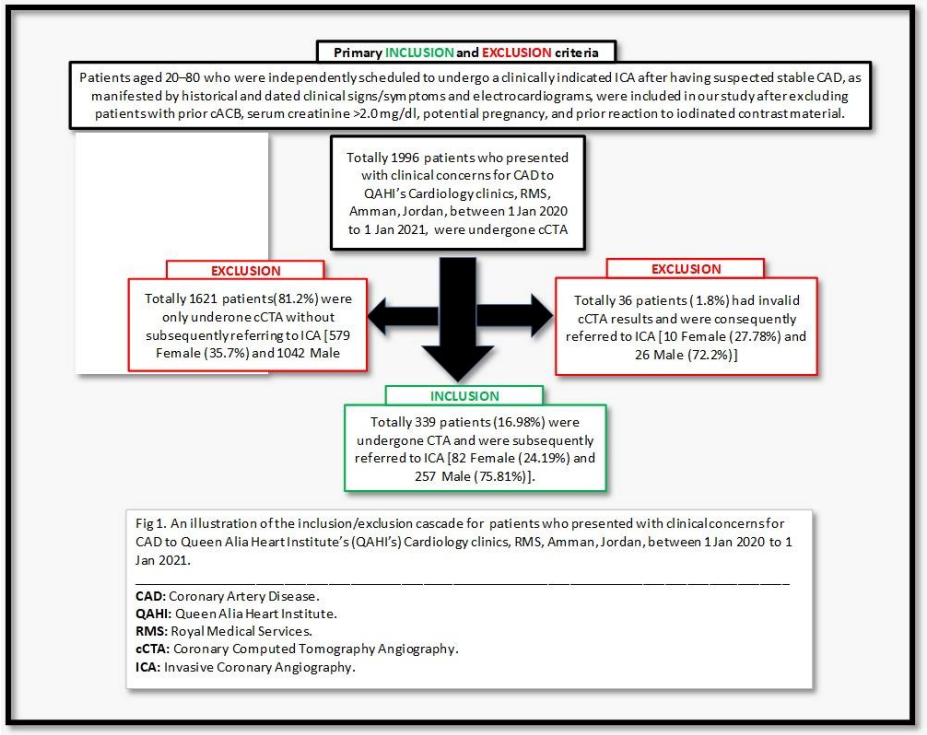

Fig 1. An illustration of the inclusion/exclusion cascade for patients who presented with clinical concerns for CAD to Queen Alia Heart Institute's (QAHI's) Cardiology clinics, RMS, Amman, Jordan, between 1 Jan 2020 to 1 Jan 2021.

CAD: Coronary Artery Disease.
QAHI: Queen Alia Heart Institute.
RMS: Royal Medical Services.
cCTA: Coronary Computed Tomography Angiography.
ICA: Invasive Coronary Angiography.

Table I. Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the LMA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=24, 44.25%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=303, 31.27%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=12, 24.48%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Age (Yrs)		52.13±10.58	50.57±10.73	53.36±10.79	51.94±10.70	0.196
Gender	F	3 (12.5%)	77 (25.4%)	2 (16.7%)	82 (24.2%)	0.300
	M	21 (87.5%)	226 (74.6%)	10 (83.3%)	257 (75.8%)	
	M: F	7: 1	2.94: 1	5: 1	3.13: 1	
HTN Status	Negative	7 (29.2%)	172 (56.8%)	7 (58.3%)	186 (54.9%)	0.032
	Positive	17 (70.8%)	131 (43.2%)	5 (41.7%	153 (45.1%)	
DM Status	Negative	15 (62.5%)	225 (74.3%)	9 (75.0%)	249 (73.5%)	0.451
	Positive	9 (37.5%)	78 (25.7%)	3 (25.0%)	90 (26.5%)	
SMOKing Status	Negative	10) 41.7% (	162 (53.5% (	7 (58.3% (	179) 52.8% (	0.498
	Positive	14 (58.3% (	141 (46.5% (	5 (41.7% (	160 (47.2% (	
%oLMA_CTA		3.23%±11.25%	3.58%±14.75%	3.73%±12.47%	3.47%±12.69%	0.340
	≥0% to <20%	2) 8.3% (	299 (98.7% (	8 (66 .7% (	309 (91.2% (	0.000
	≥20% to <50%	18 (75.0% (	2 (0.7% (	2 (16.7% (	22 (6.5% (	
	≥50% to <80%	4 (16.7% (	0 (0.0% (	2 (16.7% (	6 (1.8% (	

≥80%	0 (0.0% (	2(0.7% (	0 (0.0% (	2 (0.6% (	
%oLMA_ICA	1.80%±9.77%	4.15%±16.95%	3.86%±15.76%	3.04%±13.89%	0.953
≥0% to <20%	2 (8.3%)	70 (23.1%)	2 (16.7%)	74 (21.8%)	0.087
≥20% to <50%	5 (20.8%)	90 (29.7%)	1 (8.3%)	96 (28.3%)	
≥50% to <80%	13 (54.2%)	105 (34.7%)	5 (41.7%)	123 (36.3%)	
≥80%	4 (16.7%)	38 (12.5%)	4 (33.3%)	46 (13.6%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **F:** Female.
- **M:** Male.
- **M: F:** Male to Female ratio.
- **QAHI:** Queen Alia Heart Institute
- **HTN:** Hypertension.
- **DM:** Diabetes Mellitus.
- **SMOK:** Smoking
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **LMA:** Left Main Coronary Artery.

TableII. (Continued) Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the LMA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=150, 44.25%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=106, 31.27%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=83, 24.48%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Δ%(oICA-oCTA) _LMA		-1.43%±10.30%	0.57%±10.94%	0.12%±12.74%	-0.43%±11.14%	0.323
	≥-100% to <-80%	1 (4.2%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0.000
	≥-80% to <-50%	3 (12.5%)	8 (2.6%)	0 (0.0%)	11 (3.2%)	
	≥-50% to <-20%	8 (33.3%)	74 (24.4%)	2 (16.7%)	84 (24.8%)	
	≥-20% to <-0%	2 (8.3%)	50 (16.5%)	2 (16.7%)	54 (15.9%)	
	≥0% to <20%	7 (29.2%)	127 (41.9%)	4 (33.3%)	138 (40.7%)	
	≥20% to <50%	2 (8.3%)	30 (9.9%)	2 (16.7%)	34 (10.0%)	
	≥50% to <80%	1 (4.2%)	14 (4.6%)	1 (8.3%)	16 (4.7%)	
	≥80%	0 (0.0%)	0 (0.0%)	1 (8.3%)	1 (0.3%)	
INTERV	**Medical Therapy**	14 (58.3% (	181 (59.7% (	2 (16.7% (	197 (58.1%)	0.000
	PCI	7 (29.2% (	109 (36.0% (	3 (25.0% (	119 (35.1%)	
	ACB	3 (12.5% (	13 (4.3% (	7 (58.3% (	23 (6.8%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **QAHI:** Queen Alia Heart Institute
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **LMA:** Left Main Coronary Artery.
- **PCI:** Percutaneous coronary intervention
- **ACB:** Aortocoronary bypass
- **INTERV:** Intervention

Table III. Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the LADA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=150, 44.25%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=106, 31.27%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=83, 24.48%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Age (Yrs)		52.13±10.58	50.57±10.73	53.36±10.79	51.94±10.69	0.196
Gender	F	35 (23.3%)	28 (26.4%)	19 (22.9%)	82 (24.2%)	0.810
	M	115 (76.7%)	78 (73.6%)	64 (77.1%)	257 (75.8%)	
	M: F	3.29: 1	2.79: 1	3.367: 1	3.13: 1	
HTN Status	Negative	85 (56.7%)	52 (49.1%)	49 (59.0%)	186 (54.9%)	0.329
	Positive	65 (43.3%)	54 (50.9%)	34 (41.0%)	153 (45.1%)	
DM Status	Negative	107 (71.3%)	79 (74.5%)	63 (75.9%)	249 (73.5%)	0.717
	Positive	43 (28.7%)	27 (25.5%)	20 (24.1%)	90 (26.5%)	
SMOK Status	Negative	88 (58.7%)	51 (48.1%)	40 (48.2%)	179 (52.8%)	0.156
	Positive	62 (41.3%)	55 (51.9%)	43 (51.8%)	160 (47.2%)	
%oLADA_CTA		50.69%±19.78%	31.55%±39.72%	44.63%±24.58%	43.2%±29.6%	0.000
	≥0% to <20%	2 (1.3%)	59 (55.7%)	13 (15.7%)	74 (21.8%)	0.000
	≥20% to <50%	63 (42.0%)	11 (10.4%)	22 (26.5%)	96 (28.3%)	
	≥50% to <80%	69 (46.0%)	12 (11.3%)	42 (50.6%)	123 (36.3%)	
	≥80%	16 (10.7%)	24 (22.6%)	6 (7.2%)	46 (13.6%)	
%oLADA_ICA		19.73%±25.44%	31.55%±39.717%	73.81%±20.37%	36.7%±36.8%	0.000
	≥0% to <20%	79 (52.7%)	59 (55.7%)	0 (0.0%)	138 (40.8%)	0.000
	≥20% to <50%	53 (35.3%)	11 (10.4%)	11 (13.4%)	75 (22.2%)	
	≥50% to <80%	6 (4.0%)	12 (11.3%)	26 (31.7%)	44 (13.0%)	
	≥80%	12 (8.0%)	24 (22.6%)	45 (54.9%)	81 (24.0%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

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- **M: F:** Male to Female ratio.
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- **HTN:** Hypertension.
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- **SMOK:** Smoking
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **LADA:** Left anterior descending artery.

Table IV. (Continued) Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the LADA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=150, 44.25%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=106, 31.27%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=83, 24.48%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Δ%(oICA-oCTA) _LADA		-30.95%±16.87%	0.00%±0.00%	29.18%±18.78%	-6.55%±28.32%	0.000
	≥-100% to <-80%	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0.000
	≥-80% to <-50%	11 (7.3% (	0 (0.0% (	0 (0.0% (	11) 3.2% (	
	≥-50% to <-20%	84 (56.0% (	0 (0.0% (	0 (0.0% (	84) 24.8% (	
	≥-20% to <-0%	54 (36.0% (	0 (0.0% (	0 (0.0% (	54 (15.9% (	
	≥0% to <20%	0 (0.0% (	106 (100.0% (	32 (38.6% (	138 (40.7% (	
	≥20% to <50%	0 (0.0% (	0 (0.0% (	34 (41.0% (	34(10.0% (	
	≥50% to <80%	0 (0.0% (	0 (0.0% (	16 (19.3% (	16 (4.7% (	
	≥80%	0 (0.0% (	0 (0.0% (	1 (1.2% (	1 (0.3%)	
INTERV	Medical Therapy	120 (80.0%)	64 (60.4%)	13 (15.7%)	197 (58.1%)	0.000
	PCI	26 (17.3%)	34 (32.1%)	59 (71.1%)	119 (35.1%)	
	ACB	4 (2.7%)	8 (7.5%)	11 (13.3%)	23 (6.8%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **QAHI:** Queen Alia Heart Institute
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **LADA:** Left anterior descending artery.
- **PCI:** Percutaneous coronary intervention
- **ACB:** Aortocoronary bypass
- **INTERV:** Intervention

Table V. Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the RCA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=90, 26.55%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=180, 53.10 %) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=69, 20.35%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Age (Yrs)		53.13±10.01	50.04±10.95	55.36±9.94	51.94±10.70	0.001
Gender	F	20 (22.2%)	49 (27.2%)	13 (18.8%)	82 (24.2%)	0.338
	M	70 (77.8%)	131 (72.8%)	56 (81.2%)	257 (75.8%)	
	M: F	3.5: 1	2.67: 1	4.31: 1	3.13: 1	
HTN Status	Negative	42 (46.7%)	105 (58.3%)	39 (56.5%)	186 (54.9%)	0.183
	Positive	48 (53.3%)	75 (41.7%)	30 (43.5%)	153 (45.1%)	
DM Status	Negative	55 (61.1%)	147 (81.7%)	47 (68.1%)	249 (73.5%)	0.001
	Positive	35 (38.9%)	33 (18.3%)	22 (31.9%)	90 (26.5%)	
SMOK Status	Negative	49 (54.4%)	97 (53.9%)	33 (47.8%)	179 (52.8%)	0.832
	Positive	41 (45.6%)	83 (46.1%)	36 (52.2%)	160 (47.2%)	
%oRCA_CTA		43.54%±19.56%	9.22%±26.34%	23.55%±28.01%	21.3%±28.9%	0.000
	≥0% to <20%	3 (3.3%)	157 (87.2%)	36 (52.2%)	196 (57.8%)	0.000
	≥20% to <50%	51 (56.7%)	7 (3.9%)	16 (23.2%)	74 (21.8%)	
	≥50% to <80%	29 (32.2%)	4 (2.2%)	14 (20.3%)	47 (13.9%)	
	≥80%	7 (7.8%)	12 (6.7%)	3 (4.3%)	22 (6.5%)	
%oRCA_ICA		13.17%±22.96%	9.17%±26.27%	62.00%±27.52%	20.9%±33.03%	0.000
	≥0% to <20%	62 (68.9%)	157 (87.2%)	1 (1.4%)	220 (64.9%)	0.000
	≥20% to <50%	18 (20.0%)	7 (3.9%)	24 (34.8%)	49 (14.5%)	
	≥50% to <80%	6 (6.7%)	4 (2.2%)	16 (23.2%)	26 (7.7%)	
	≥80%	4 (4.4%)	12 (6.7%)	28 (40.6%)	44 (13.0%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **F:** Female.
- **M:** Male.
- **M: F:** Male to Female ratio.
- **QAHI:** Queen Alia Heart Institute
- **HTN:** Hypertension.
- **DM:** Diabetes Mellitus.
- **SMOK:** Smoking

- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **RCA:** Right coronary artery.

Table VI. (Continued) Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the RCA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=90, 26.55%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=180, 53.10 %) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=69, 20.35%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
	≥-100% to <-80%	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.000
	≥-80% to <-50%	9 (10.0%)	0 (0.0%)	0 (0.0%)	9 (2.7%)	
	≥-50% to <-20%	45 (50.0%)	0 (0.0%)	0 (0.0%)	45 (13.3%)	
	≥-20% to <-0%	36 (40.0%)	0 (0.0%)	0 (0.0%)	36 (10.6%)	
	≥0% to <20%	0 (0.0%)	180 (100.0%)	16 (23.2%)	196 (57.8%)	
	≥20% to <50%	0 (0.0%)	0 (0.0%)	31 (44.9%)	31 (9.1%)	
	≥50% to <80%	0 (0.0%)	0 (0.0%)	14 (20.3%)	14 (4.1%)	
	≥80%	0 (0.0%)	0 (0.0%)	8 (11.6%)	8 (2.4%)	
INTERV	Medical Therapy	61 (67.8%)	117 (65.0%)	19 (27.5%)	197 (58.1%)	0.338
	PCI	24 (26.7%)	55 (30.6%)	40 (58.0%)	119 (35.1%)	
	ACB	5 (5.6%)	8 (4.4%)	10 (14.5%)	23 (6.8%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **QAHI:** Queen Alia Heart Institute
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **RCA:** Right coronary artery.
- **PCI:** Percutaneous coronary intervention
- **ACB:** Aortocoronary bypass
- **INTERV:** Intervention

Table VII. Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the CxA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=78, 23.01%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=203, 59.88%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=58, 17.11%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Age (Yrs)		54.45± 8.68	50.36±10.93	53.91±11.60	51.91±10.72	0.005
Gender	F	22 (28.2%)	56 (27.6%)	5 (8.6%)	83 (24.5%)	0.009
	M	56 (71.8%)	147 (72.4%)	53 (91.4%)	256 (75.5%)	
	M: F	2.55:1	2.63: 1	10.6: 1	5.49: 1	
HTN Status	Negative	32 (41.0%)	122 (60.1%)	32 (55.2%	186 (54.9%)	0.016
	Positive	46 (59.0%)	81 (39.9%	26 (44.8%)	153 (45.1%)	
DM Status	Negative	47 (60.3%)	157 (77.3%)	45 (77.6%)	249 (73.5%)	0.011
	Positive	31 (39.7%)	46 (22.7%)	13 (22.4%)	90 (26.5%)	
SMOK Status	Negative	44 (56.4%)	106 (52.2%)	30 (51.7%)	180 (53.1%)	0.798
	Positive	34 (43.6%)	97 (47.8%)	28 (48.3%)	159 (46.9%)	
%oCxA_CTA		42.12%±22.34%	5.10%±18.35%	18.71%±23.74%	15.98%±25.3%	0.000
	≥0% to <20%	4 (5.1%)	185 (91.1%)	32 (55.2%)	221 (65.2%)	0.000
	≥20% to <50%	45 (57.7%)	8 (3.9%)	16 (27.6%)	69 (20.4%)	
	≥50% to <80%	22 (28.2%)	4 (2.0%)	9 (15.5%)	35 (10.3%)	
	≥80%	7 (9.0%)	6 (3.0%)	1 (1.7%)	14 (4.1%)	
%oCxA_ICA		10.06%±22.74%	5.10%±18.35%	64.47%±25.67%	16.43%±30.2%	0.000
	≥0% to <20%	61 (78.2%)	185 (91.1%)	1 (1.8%)	247 (73.1%)	0.000
	≥20% to <50%	11 (14.1%)	8 (3.9%)	18 (31.6%)	37 (10.9%)	
	≥50% to <80%	2 (2.6%)	4 (2.0%)	14 (24.6%)	20 (5.9%)	
	≥80%	4 (5.1%)	6 (3.0%)	24 (42.1%)	34 (10.1%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **F:** Female.
- **M:** Male.
- **M: F:** Male to Female ratio.
- **QAHI:** Queen Alia Heart Institute
- **HTN:** Hypertension.
- **DM:** Diabetes Mellitus.
- **SMOK:** Smoking
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **RCA:** Right coronary artery.

Table VIII. (Continued) Comparatively studied variables for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021, and were intervened with the dual diagnostic procedures of CTA and ICA on the CxA, across the 3 categorized groups.

Studied Comparative Variables		Group I (N=78, 23.01%) Δ%(oICA-oCTA) <0 CTA Overestimation Status	Group II (N=203, 59.88%) Δ%(oICA-oCTA) =0 CTA Matching Status	Group III (N=58, 17.11%) Δ%(oICA-oCTA) >0 CTA Underestimation Status	Total (339)	P-Value
Δ%(oICA-oCTA) _CxA		-32.05%±17.64%	0.00%±0.00%	45.76%±27.27%	0.45%±28.15%	0.000
	≥-100% to <-80%	2 (2.6%)	0 (0.0%)	0 (0.0%)	2 (0.6%)	0.000
	≥-80% to <-50%	5 (6.4%)	0 (0.0%)	0 (0.0%)	5 (1.5%)	
	≥-50% to <-20%	45 (57.7%)	0 (0.0%)	0 (0.0%)	45 (13.3%)	
	≥-20% to <-0%	26 (33.3%)	0 (0.0%)	0 (0.0%)	26 (7.7%)	
	≥0% to <20%	0 (0.0%)	203 (100.0%)	8 (13.8%)	211 (62.2%)	
	≥20% to <50%	0 (0.0%)	0 (0.0%)	27 (46.6%)	27 (8.0%)	
	≥50% to <80%	0 (0.0%)	0 (0.0%)	12 (20.7%)	12 (3.5%)	
	≥80%	0 (0.0%)	0 (0.0%)	11 (19.0%)	11 (3.2%)	
INTERV	**Medical Therapy**	47 (60.3%)	136 (67.0%)	14 (24.1%)	197 (58.1%)	0.000
	PCI	25 (32.1%)	63 (31.0%)	31 (53.4%)	119 (35.1%)	
	ACB	6 (7.7%)	4 (2.0%)	13 (22.4%)	23 (6.8%)	

The non-categorical parametric data of the comparative variables across Group I-III were statistically analyzed via One-Way ANOVA Test, and expressed as Mean±SD (p-value< 0.0). While the categorical non-parametric data were statistically analyzed by Chi Square Test (at p-value< 0.05) and expressed as Number (Percentage).

- **Group I:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion exceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) <0.
- **Group II:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion equaled which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) =0.
- **Group III:** Attended QAHI's Cardiology clinics patients with a chief complaint of chest pain whose assessed CTA's percentage of occlusion subceeded which it was investigated by ICA procedure as mathematically defined as Δ%(oICA-oCTA) >0.

- **QAHI:** Queen Alia Heart Institute
- **CTA:** Coronary Computed Tomography Angiography
- **ICA:** Invasive Cardiac Angiography
- **RCA:** Right coronary artery.
- **PCI:** Percutaneous coronary intervention
- **ACB:** Aortocoronary bypass
- **INTERV:** Intervention

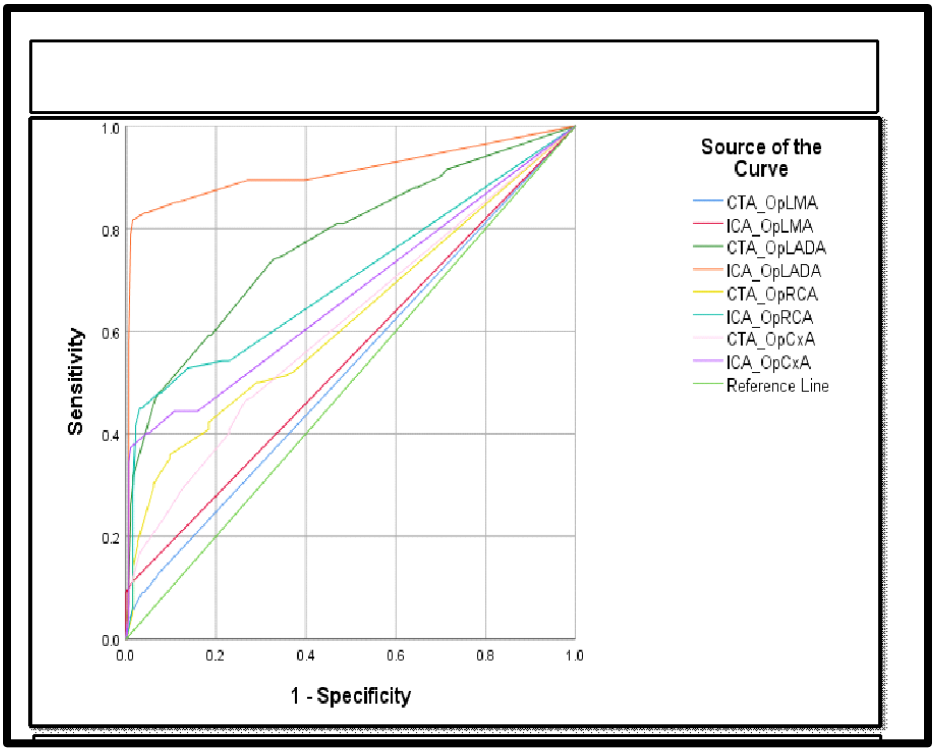

Table IX. The optimal cut-off points, sensitivities, specificities, positive and negative predictive values, Youden and accuracy indices, and the negative likelihood ratios of the 6 significant tested non-invasive and invasive angiography procedural occlusion percentages for patients who presented with chest pain to QAHI's Cardiology clinics, RMS, Amman, Jordan between 1 Jan 2020 to 1 Jan 2021.

Prognostic Indicator	Cutoff	TPR	FPR	YI	TNR	PPV	NPV	NLR	AI
%oLADA_CTA	47.5%	73.90%	32.70%	41.29%	67.35%	62.13%	78.11%	38.69%	70.12%
%oLADA_ICA	55%	81.70%	1.50%	80.16%	98.47%	97.48%	88.13%	18.59%	91.42%
%oRCA_CTA	42.5%	35.90%	9.70%	26.22%	90.31%	72.86%	66.04%	70.96%	67.46%
%oRCA_ICA	47.5%	45.10%	3.10%	42.01%	96.94%	91.43%	70.90%	56.66%	75.15%
%oCxA_CTA	15%	46.50%	26.50%	19.95%	73.47%	55.93%	65.45%	72.85%	62.13%
%oCxA_ICA	45%	37.30%	1.00%	36.30%	98.98%	96.36%	68.55%	63.32%	73.08%

- The area under the receiver operating characteristic (ROC) analysis was constructed against the propensity for either Percutaneous Invasive (PCI) or Aorto-Coronary Bypass (ACB) **Invasive Strategy (1)** versus **Non-Invasive Strategy (0)**. Sensitivity analysis was thereafter processed on a total of 1996 processed cases, 142-case were processed as positive actual state, and 196-case were processed as a negative actual state. 1658 patients who undergone only CTA were dealt with as missing data. higher values of the test result variable(s) indicate stronger evidence for a positive actual state. The positive actual state is the patients who undergone invasive procedures of PCI or ACB.

TPR: True positive rate (sensitivity).
FPR: False positive rate.
YI: Youden index.
TNR: True negative ratio (specificity).
PPV: Positive predictive value.
NPV: Negative predictive value.
NLR: Negative likelihood ratio.
AI: Accuracy index.

LADA: Left Anterior Descending Artery.
RCA: Right Coronary Artery.
CxA: Circumflex artery.
CTA: Coronary Angiography.
ICA: Invasive Coronary Angiography.

Discussion

It is increasingly being recognized that there may not be an ideal diagnostic testing, including ICP, for prognosticating candidacy of PCI or ACB invasive management modalities over pharmacotherapeutic interventions. Additionally, the relatively low prevalence of diagnosed obstructive CAD after pursuing ICA even after positive clinical, biochemical, and imaging traditional diagnostic tests will actually decreases the overall picking opportunities for revascularization appropriateness. While recent appropriateness criteria consider CTA an optimal pre-ICA procedure in patients with diagnostically ambiguous traditional diagnostic tests, most studies that investigated the diagnostic utilities of CTA versus ICA were largely limited to retrospective studies that ambiguously differentiated the diagnostic performances of CTA and ICA and their sensitivity indices for invasive over medical treatment propensities.

The uniqueness of our study was its multidimensional investigated approaches. First, we included all patients already referred for ICA after CTA based on positive and ambiguous traditional diagnostic tests which gave this study a generalizability advantage. Second, owing to moderately functional and anatomical correlations, we categorized the stenosis percentages on 4 anatomical cardiac sites to explore the diagnostic capabilities and to differentiate between CTA vs ICA across 3 compared categorized groups among these 4 studied arteries. Third, in addition to NPVs and TPRs, we presented other sensitivity indices in this study, especially TNRs, AIs, PPVs, NLRs, and YIs. Fourth, most previous studies dichotomized stenosis ranges into 2 primarily levels, ≥50% or <50%. In this study, we divided the occlusion percentage ranges into 4 levels, 2 levels <50% and 2 levels ≥50%. Dichotomizing ≥50% range into ≥50%-80% and ≥80% ranges may have a clinical role in prioritizing eligible revascularization patients in over exhausted situations. Fifth, in our study we explored the operating diagnostic cutoff points of occlusion percentages for the 3 investigated cardiac arteries and for the 2 studied diagnostic procedures to prognosticate the propensity of invasive revascularization strategy over non-invasive medical treatment.

Given the clinical importance of early discrimination obstructive CAD from other non-CAD similar presentation symptoms, several studies have investigated CTA after positive traditional diagnostic tests in different groups. For example, the Advanced Cardiovascular Imaging Consortium (ACIC) registry included 3,623 patients with positive diagnostic test results but reported significant composite cardiac vascular stenosis (>50%) in only 19.7% of studied patients. **[13-14]** In our study, we explored a much higher average incidences of stenosis percentages (≥50%-80% and ≥80%) as assessed by the sequential tested diagnostic procedures (CTA and ICA) in LADA, RCA, and CxA with counts (%) of {[123 (36.3%) and 46 (13.6%) vs 44 (13.0%) and 81 (24.0%)], [47 (13.9%) and 22 (6.5%) vs 26 (7.7%) and 44 (13.0%)], and [35 (10.3%) and 14 (4.1%) vs 20 (5.9%) and 34 (10.1%)]}. The higher findings in this study compared to the aforementioned study may be owing to higher prevalence of CADs in our country and due to a more risky attended patients to our specialized cardiac institute.

Other previous studies have had inconsistencies regarding the diagnostic performance of CTA versus ICA. For example, a subgroup of 621 patients, according to ACIC registry, who underwent both CCTA and ICA after stress testing had substantially lower values for TPR, TNR, PPV and NPV of 93.7%, 37.9%, 70.6% and 79.1% respectively. **[15-18]** In our study, we assessed a substantially different sensitivity indices compared to results of ACIC registry. The TPRs, TNRs, PPVs, NPVs for patients who presented with chest pain to QAHI's Cardiology clinics, and were intervened with the dual diagnostic procedures of CTA and ICA on the LADA, RCA, CxA were [(73.90%, 67.35%, 62.13%, and 78.11%) vs (81.70%, 98.47%, 97.48%, and 88.13%) vs (35.90%, 90.31%, 72.86%, and 66.04%) vs (45.10%, 96.94%, 91.43%, and 70.90%) vs (46.50%, 73.47%, 55.93%, and 65.45%) vs (37.30%, 98.98%, 96.36%, and 68.55%)].

Low-dose CTA was found to have an acceptable comparable sensitivity to ICT in our study and is universally suggested as an alternative to ICT for triaging patients with suspected coronary artery disease. **[19-20]** More recently, ultra-high-resolution CT scan devices yielded excellent correlation between CT and ICA

results. Further research is underway comparing ultra-high-resolution CT scan. Finally, this study show that coronary CTA results showed good concordance with ICA findings, and that it is specifically useful in ruling out cases with no stenosis, supporting the role of coronary CTA as a diagnostic test in suspected coronary artery disease.

Strength and limitations of the study:

This study is limited by its retrospective design, using single-center data. Nonetheless, our specialized cardiac center is an experienced and high-volume unit, so our data may be useful in other centers. A larger, multisite, and prospective study is needed to control for multiple confounders.

CONCLUSION

Despite the limitations of coronary CTA being a diagnostic test compared to ICA where interventional treatment could be performed, CTA based diagnostic procedure may have practically a unique early diagnostic and prognostic value in patients who presented with chest pain with variable sensitivity analysis indices in the era of global over and ever-shrinking in medical teams and facilities to make sure optimum resource provision and implement swift management protocols.

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