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CORRELATION BETWEEN CORONARY INJURIES DIAGNOSED BY MULTISLICE CT CORONARY ANGIOGRAPHY AND DIAGNOSED BY VISIBLE CORONARY CINEANGIOGRAPHY METHOD

CORRELAÇÃO ENTRE AS LESÕES CORONARIANAS DIAGNOSTICADAS PELA ANGIOTOMOGRAFIA E AS DIAGNOSTICADAS PELO MÉTODO VISUAL DA CINEANGIOCORONARIOGRAFIA

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ABSTRACT

Objective: To evaluate the diagnostic efficacy of multislice CT coronary angiotomography compared with coronary cineangiography. Material and Methods: We retrospectively evaluated 146 patients submitted to MSCT and CA with quantitative coronary angiography (QCA), with a mean interval of one month between the exams. The study was carried out at the Costantini Cardiology Hospital. The risk factors for the sample, the location of the lesions and the degree of severity of the coronary obstruction in the large vessels (LCT, AD, CX and RC).The results of the diagnostic methods were compared using Pearson correlation coefficient. From the positive findings, a correlation evaluation was performed between the methods for the severity of the lesions. Results: The sample consisted predominantly of men (73.97%), and hypertension (SAH) (71.91%) was the most frequent risk factor. The most affected artery was AD. Regarding the degree of severity of the lesions, the results were as follows in the comparison between MSCT and CA: mild lesions with correlation r = 0.23, moderate with r = 0.53 and severe with r = 0.70. In the comparison between MSCT and QCA: mild lesions with correlation r = 0.45, moderate with r = 0.70 and severe with r = 0.67. Conclusion: MSCT showed moderate correlation with QCA and CA in moderate and severe lesions, and a strong correlation in the absence of lesions when compared with QCA.

Keywords: Angiograpy; Angiography, Digital Subtraction; Coronary Angiograpy; Magnetic Resonance Angiograpy; Computed Tomography Angiography.

RESUMO

Objetivo: Avaliar a eficácia diagnóstica da angiotomografia coronariana (AC) comparada com a cineangiocoronariografia (CAT). Material e Métodos: Foram avaliados retrospectivamente 146 pacientes submetidos a AC e CAT com angiografia coronariana quantitativa (ACQ), com intervalo médio de um mês entre os exames. O estudo foi realizado no Hospital Cardiológico Costantini. Foram avaliados os fatores de risco da amostra, a localização das lesões e o grau de severidade da obstrução coronariana nos grandes vasos (TCE, DA, CX e CD). Os resultados dos métodos diagnósticos foram comparados pelo coeficiente de correlação de Pearson. A partir dos achados positivos foi realizada a avaliação de correlação entre os métodos perante a severidade das lesões. Resultados: A amostra foi composta predominantemente por homens (73,97%), sendo a hipertensão arterial (HAS) (71,91%) o fator de risco mais frequente. A artéria mais acometida foi a DA. Quanto ao grau de severidade das lesões, os resultados foram os seguintes na comparação entre AC e CAT: lesões discretas com correlação r = 0,23; moderadas com r = 0,53 e severas com r = 0,70. Na comparação entre AC e ACQ: lesões discretas com correlação r = 0,45; moderadas com r = 0,70 e severas com r = 0,67. Conclusão: A AC apresentou moderada com ACQ e CAT em lesões moderadas e severas, e forte correlação na ausência de lesões quando comparada com ACQ.

Descritores: *Angiografia; Angiografia Digital; Angiografia Coronária; Angiografia por Ressonância Magnética; Angiografia por Tomografia Computadorizada.*

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INTRODUCTION

According to the World Health Organization (WHO), cardiovascular diseases are the leading cause of death worldwide.[1] In the United States (USA) and other western countries coronary artery disease (CAD) is primarily responsible for this morbid and incapacitating scenario.[2] The diagnosis of CAD is confirmed by coronary angiography, which is indicated when coronary stenosis is suspected in patients with risk factors and/or who show signs of myocardial ischemia on functional examinations.[2] An invasive exam with a low incidence of complications, which may nevertheless occur. Among the most frequent complications are acute myocardial infarction (AMI) and cerebrovascular accident (CVA).[2]

In order to minimize complications that may occur during diagnosis, coronary angiography is a noninvasive alternative for detection and or exclusion of CAD. Unlike functional methods, it is able to visualize coronary arteries similarly to coronary angiography.[3]

However, the first published studies with coronary angiography obtained with four-, eight- and 16-detector CT scans showed important limitations of the method due to the low sharpness of the acquired images and difficulties in the analysis of distal coronary segments, especially in coronary branches with a diameter of at least 2 mm.[4] Improvement in spatial and temporal resolution, generating 40 slices per rotation and covering the entire heart volume in 8 to 9 seconds,[5] obtained with the advent of 40-detector tomography, allowed for further analysis. of the entire coronary territory, including the middle and distal coronary segments. This advance in image resolution has driven the use of the exam in clinical practice.

Coronary angiography (CA) with 16-detector demonstrates accurate identification of significant coronary lesions (> 50% stenosis) in vessels of 1.5 to 2 mm, with reported sensitivities and specificities ranging from 82% to 95% and 82% to 98%, respectively.[6] The observations by Raff et al.[7] show that CA of 40 detectors accurately delineates the presence or absence of significant lesions within the entire coronary arteries in a broad spectrum of patients. According to SCOT-HEART,[8] CA increased the identification of obstructive and nonobstructive atherosclerotic lesions, providing changes in preventive treatments, suggesting a tendency for reduction in coronary events.

However, motion artifacts and severe coronary calcifications are still considered limitations for the reliable evaluation of all coronary segments. Calcium deposits found may be responsible for false negatives and false positives,[9] or even inappropriately classify the lesion according to its severity. In addition, patients with calcium scores greater than 400, body mass index greater than 30 kg/m^2, and heart rate greater than 70 beats per minute remained a diagnostic challenge.

Thus, the objective of this study is to compare and/or correlate the results obtained by CA with those of coronary angiography, a method considered gold standard for diagnosis of CAD, regarding the severity of the lesions.

GENERAL PURPOSE

To evaluate the correlation between the lesions diagnosed by Coronary Angiography (CA) and those diagnosed by the visual method of coronary angiography (CAT).

SPECIFIC PURPOSE

To evaluate the correlation between the lesions diagnosed by coronary angiography (CA) and those diagnosed by the Quantitative Coronary Angiography (QCA) method.

MATERIALS AND METHODS

Retrospective study, patients treated by the Coronary Angiotomography service of Hospital Cardíaco Costantini (HCC) from January to December 2014 who underwent coronary angiography and coronary angiography, in this order, with a maximum interval between examinations of four months.

In this study, CA examination was performed on the Philips CT Brillance 64-channel device with prospective acquisition coupled with the electrocardiogram (ECG), with HR kept below 65 bpm during the exam. Metoprolol tartrate was used to control HR at doses of 5-50 mg (1 to 10 ampoules). The helical technique was used before and during the peripheral intravenous infusion of 110 ml of non-ionic, water-soluble iodinated contrast, with multiplanar and three-dimensional reconstructions of the images obtained with 64 detectors.

The diagnosed lesions were classified according to their severity as mild (obstruction degree between 1 to 30%), moderate (obstruction degree between 31% and 69%) and severe (obstruction degree ≥70%). In this study, only the lesions found in the main vessels were considered: LCT (Left Coronary Trunk), RC (Right Coronary), Cx (Circumflex) and RC (Right Coronary).

Coronary cineangiography was performed by insertion of catheters via the femoral (used in this study), radial or brachial artery which were guided to the heart by an X-ray machine. In this study coronary angiography was performed by the Philips Xper Allura FD10 device. During the exam iodinated contrast injections were performed through catheter, which allowed the visualization of the coronary arteries.

Coronary lesions diagnosed were visually classified according to their severity, as mild (obstruction degree 1 to 30%), moderate (obstruction degree 31% to 69%) and severe (obstruction degree ≥70%). In this study, only the lesions found in the main vessels were considered: LCT (Left Coronary Trunk), AD (Anterior Descending), Cx (Circumflex) and RC (Right Coronary).

Quantitative Coronary Angiography (QCA) was used to quantify the area of obstructive lesion after coronary angiography. Image analyzes were interpreted by observers of the hemodynamics team using a specific program for quantifying coronary obstructive lesion (CASS version 5.7.4 from Pie Medical Imaging B.V., The Netherlands).

In all cases the images were obtained in different projections, always seeking the best view of the lesion and the proximal and distal portions of the artery. Thus, it was possible to establish the mean vessel reference diameter, the extent of the lesion, the minimum luminal diameter and the percentage of stenosis diameter (reference diameter - minimum luminal diameter/reference diameter x 100) pre and post procedure. The calibration standard was established by the outer diameter of the contrast-filled catheter.[10]

For all lesions diagnosed in the main vessels: LCT (left coronary trunk), AD (anterior descending), Cx (Circumflex) and RCA (right coronary artery), quantitative coronary angiography (QCA) calculations were performed to quantify the severity

of the coronary artery lesion in: mild (obstruction degree 1 to 30%), moderate (obstruction degree 31 to 69%) and severe (obstruction degree ≥70%).

The information was extracted from EPACS system and TASY system of Hospital Cardíaco Constantini (HCC). To evaluate the frequencies, a simple percentage assessment was performed and to evaluate the correlation between the positive findings of the methods, the Pearson correlation test was performed. Pearson's coefficient measures the degree of correlation and the direction of this correlation. If positive or negative between the variables, the values range from -1 to +1, where p = 1 means the perfect correlation between them and p = -1 perfect negative correlation. Among the values of p, positive or negative, p from 0 to 0.3 indicates negligible correlation, p from 0.3 to 0.5 weak correlation, p from 0.5 to 0.7 moderate correlation, p from 0.7 a 0.9 strong correlation and p> 0.9 indicates a very strong correlation.

RESULTS

A total of 146 patients were evaluated, who underwent CA and CAT examinations, respectively, with a mean ΔT of 30.95 days, respectively. Of these, 108 (73.97%) were male and 38 (26.03%) female. The mean age was 64.21 (± 11.26) years, and 64.38% of the sample (n = 94) were aged ≥ 60 years, and 105 (71.91%) were hypertensive (SAH), 97 (66.43%) dyslipidemic and 31 (21.23%) smokers. The other risk factors were shown in Table 1.

Table 2 presents the distribution of the number of lesions and their frequencies obtained by the CA/CAT/QCA methods, according to the coronary obstructions severity classification.

Among the coronary arteries diagnosed with lesion, the most frequent in both methods (CT angiography vs. coronary angiography) was the Anterior Descending (AD), followed by the Right Coronary (RC) and Circumflex (Cx). Some patients had lesions in more than one artery, as shown in Table 3.

Figure 1 shows in blue the number of lesions diagnosed according to their degree of severity by the CA method. In orange the description of the number of lesions according to severity diagnosed by CAT. In green, the number of concordant lesions in both exams according to the degree of obstruction. The lesions found in the LCT, AD, Cx and RC were considered.

Figure 2 shows in blue the number of diagnostic lesions according to their degree of severity by the CA method. In

Table 1. Referring to sample risk factor description.

Patients profile	
Male	108 (73.97%)
Age ≥ 60 years	94 (64.38%)
DM	35 (23.97%)
Obesity	12 (8.21%)
Sedentarism	25 (17.12%)
DSLP	97 (66.43%)
TAB	31 (21.23%)
SAH	105 (71.91%)
FH	27 (18.49%)

DM= Diabetes *Mellitus*; DSLP= Dyslipidemia; TAB= Smoking; FH= Family History; SAH= Systemic Arterial Hypertension.

Table 2. Results of CA/CAT/QCA exams regarding the number of lesions diagnosed per patient and their severity in the segments analyzed by the different methods.

CA lesions Segments	Absent	Discrete	Moderate	Severe
LCT	100 (68,49%)	27 (18,49%)	15 (10,27%)	4 (2,73%)
AD	21 (14,38%)	10 (6,84%)	50 (34,24%)	65 (44,52%)
Cx	56 (38,35%)	15 (10,27%)	44 (30,13%)	31 (21.23%)
RC	52 (35,61%)	10 (6,84%)	45 (30,82%)	39 (26,71%)
CAT lesions Segments	**Absent**	**Discrete**	**Moderate**	**Severe**
LCT	125 (85,61%)	9 (6,16%)	8 (5,47%)	4 (2,73%)
AD	30 (20,54%)	22 (15,06%)	35 (23,97%)	59 (40,41%)
Cx	81 (55,47%)	8 (5,47%)	26 (17,80%)	31 (21,23%)
RC	64 (43,83%)	10 (6,84%)	35 (23,97%)	37 (25,34%)
QCA Lesions Segments	**Absent**	**Discrete**	**Moderate**	**Severe**
LCT	121(82,87%)	1 (0,68%)	7 (4,79%)	17 (11,64%)
AD	33 (22,60%)	18 (12,32%)	49 (33,56%)	46 (31,50%)
Cx	77 (52,73%)	11 (7,53%)	33 (22,60%)	25 (17,12%)
RC	61 (41,78%)	18 (12,32%)	42 (28,76%)	25 (17,12%)

Where: LCT= Left Coronary Trunk; AD= Anterior Descending; Cx=Circumflex; RC=Right Coronary; CA= Coronary Angiotomograpjy; CAT= Cineangiocoronariography and QCA= Quantitative Coronary Angiography.

Table 3. Referring to vessels affected by lesions.

Vessels affected by lesions	CA (n)	CAT (n)
LCT	46	21
AD	125	116
Cx	90	65
RC	94	82
Uniarterial	21	39
Biarterial	51	45
Triarterial or Mores	69	50

LCT= Left Coronary Trunk; AD= Anterior Descending; Cx=Circumflex; RC=Right Coronary; CA= Coronary Angiotomograpjy; CAT= Cineangiocoronariography.

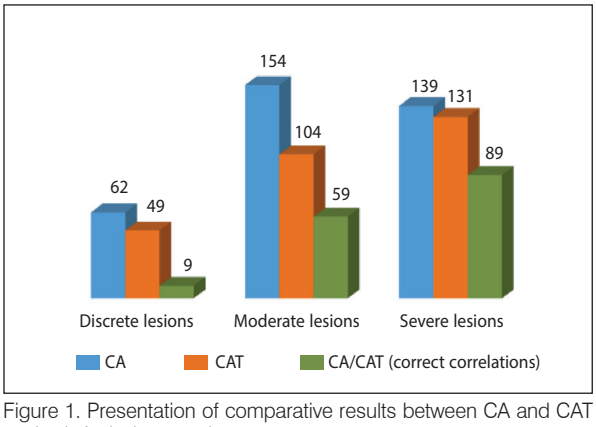

Figure 1. Presentation of comparative results between CA and CAT methods for lesion severity assessment.

burgundy the description of the number of lesions according to the degree of severity diagnosed by the QCA. In green, the number of concordant lesions in both exams according to the degree of obstruction and anatomical position. The lesions found in the LCT, AD, Cx and RC were considered.

To evaluate the correlation between the correct findings of the diagnostic methods CA and CAT and CA and QCA in relation to the severity of the lesions and their respective anatomical position (vessel), Pearson's correlation test (r) was performed.

There is a negligible correlation between discrete lesions, being weak in LCT when compared to CA with CAT, moderate correlation for moderate injuries in LCT and moderate correlation of all arteries when compared to severe lesions. Figure 3 shows the correlations between CA and CAT.

Figure 4 presents the correlations obtained between the CA and QCA methods. There is a strong correlation in severe injuries in LCT and moderate in AD, Cx and RC. In moderate lesions the correlation was moderate in LCT and AD and strong in Cx and RC.

The large vessels (LCT, DA, Cx and RC) were analyzed together comparing the results of CA vs CAT, and a moderate correlation was found between the severe lesions (r = 0.70). When comparing the CA vs QCA results, a moderate correlation (r = 0.70) was found between the moderate lesions, as shown in Figure 5.

In addition to these analyzes, the results found between the methods in the absence of lesions were correlated, as shown in Table 4, which reaffirms the high negative predictive value of the CA method for CAT.

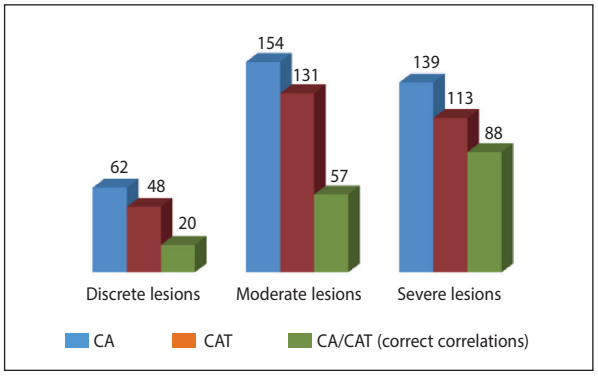

Figure 2. Presentation of comparative results between the CA and QCA methods regarding the assessment of lesion severity.

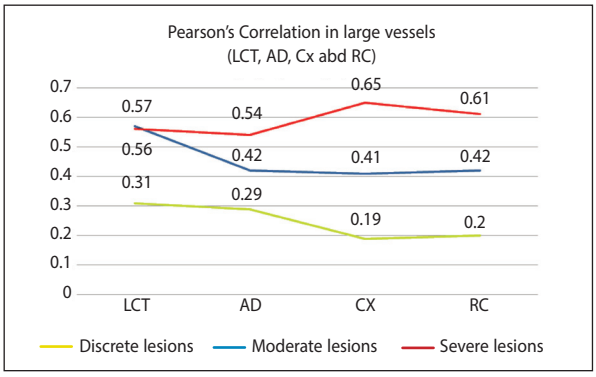

Figure 3. Graph referring to Pearson Correlation Coefficient values according to the severity of the lesions and their anatomical position / vessels (CA vs CAT).

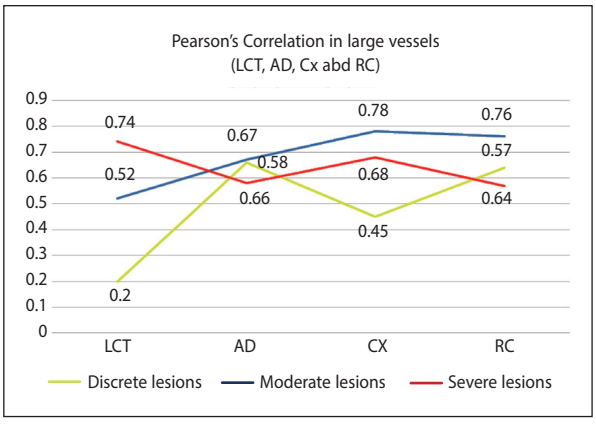

Figure 4. Graph related to Pearson Correlation Coefficient values according to the severity of the lesions and their anatomical position / vessels (CA vs QCA).

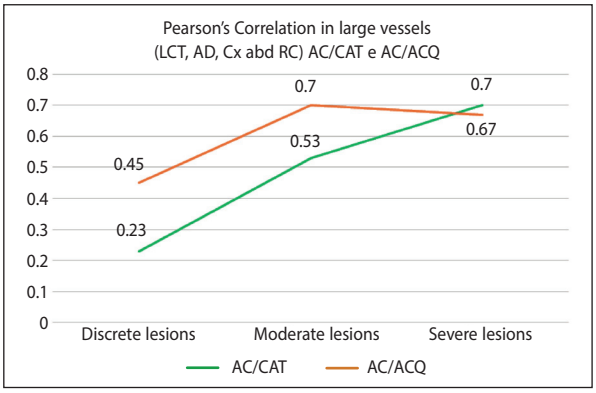

Figure 5. Large vessels (LCT, AD, Cx and RC) analyzed together (CA vs CAT and CA vs QVA).

Table 4. Pearson coefficients values in correlated methods.

Segment	CA/QCA Pearson Correlation Coefficient for No Lesion
LCT	r =0.64
AD	r =0.71
Cx	r =0.84
RC	r =0.84
LCT/AD/Cx/RC	r =0.81

LCT= Left Coronary Trunk; AD= Anterior Descending; Cx=Circumflex; RC=Right Coronary;.

DISCUSSION

In this study, CA had a moderate diagnostic performance for coronary artery disease compared to QCA in moderate and severe lesions. In addition, it demonstrated a high correlation in the absence of lesions, confirming its high negative predictive value (> 90%),[11,12] establishing itself as a reliable method for excluding coronary artery disease.

Studies show that the detection of significant obstructive coronary disease (luminal reduction > 50%) by CA shows good accuracy with high sensitivity (82% - 99%) and specificity (94% - 98%) when compared to CAT. These studies highlight the high Negative Predictive Value (NPV) of the method (95% -99%), which is useful in ruling out obstructive

coronary disease, making CA an excellent tool for noninvasive coronary artery assessment.[13,14]

Also in this study, CA showed a weak correlation with QCA in discrete coronary lesions, and a moderate correlation with moderate and severe lesions, the same findings were found when comparing CA/CAT results, except for discrete lesions where the correlation it was despicable. Despite being a noninvasive and lower risk test, which may represent an advantage in the indication when compared to CAT, the results of this study show that doubts may arise regarding the effectiveness of the method to diagnose discrete lesions.

Evaluation of atherosclerotic arterial disease by cardiac catheterization is a method that may have certain limitations. Among them because it is a method of evaluation of the vessel luminogram, it is not possible to visualize the arterial wall. When we seek the onset of atherosclerotic disease, we have shown with Glagov et al.,[15] that the onset of atherosclerosis is caused by a dilation of the outer elastic membrane, with a positive remodeling of plaque growth without compromising the arterial lumen. When a mass increase of over 40% is reached, then a luminal impairment that can be detected by coronary angiography begins. For this reason, shallow vulnerable plaques can often develop acute coronary events due to plaque rupture or erosion not detected on coronary angiography. Coronary angiotomography is a method that allows an assessment of the arterial lumen of the vessel wall. Therefore, lesions classified as mild in CA may have a low correlation with CAT, since this method only evaluates the arterial lumen and does not visualize positive plaque remodeling in the early phase of atherosclerotic disease.

In moderate coronary lesions, when the great vessels were analyzed separately through the CA/CAT comparison, they showed a weak correlation, except for the TBI where the correlation was moderate, and through the CA/QCA comparison they presented a moderate correlation in the LCT and AD and strong correlation. on Cx and RC. When we analyzed the moderate lesions in the great vessels together, there was a moderate correlation in the comparison between both methods.

The method presented its best correlation within the sample of severe lesions when the great vessels were compared. CA/CAT analyzed together or separately, as reported in the literature, where current studies show that the results of this technique have excellent correlation with coronary angiography when obstructive lesion is> 50%, with sensitivity> 80% and specificity> 90%.[11,12] The same group of lesions was analyzed through the CA/QCA comparison showing moderate correlation together or alone except for LCT where the correlation was strong.

In addition, when assessing the highest incidence artery, the prevalence of the AD artery was noted, a factor that may be justified as being less affected by movement artifacts,[16] and also generally presenting a larger caliber (> 2.5 mm), being more easily measured in angiographic images. The sample consisted predominantly of men, with hypertension being the most frequent risk factor.

STUDY LIMITATIONS

Coronary angiotomography evaluation and its classification regarding the severity of the lesions performed by more than one observer. Only the results obtained in larger vessels were evaluated.

CONCLUSION

CA showed a weak correlation with QCA in mild coronary lesions, and a moderate correlation with moderate and severe lesions. When comparing CA with CAT results, a negligible correlation was observed in mild and moderate lesions in moderate and severe lesions.

CONFLICTS OF INTEREST

The author declares that he has no conflicts of interest in this work.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of the manuscript. MAMS and MFS were the main contributors in the writing of the manuscript. MAMS, MD, followed patients and gathered clinical data. MRI and COC evaluated the data of the statistical analysis. CRC, DZ and ST conducted bibliographic research, manuscript revision and contributed to the intellectual concept of the study.

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