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# Effect of Aortic Diameter and Systole Blood Pressure on Determination of CTA Coronary Pre-Delay Scan Bolus Trcking Technique

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A R T I C L E I N F O

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A B S T R A C T

The variation in the pre-delay scan time of each individual on the CTA Caronaria check bolus tracking will contribute to the total acquisition time and vary the total amount of contrast and copy that must be provided during the acquisition. This study aims to determine the effect of aortic diameter and systole blood pressure on pre-delay scan time. This research method is observational analytic with a retrospective crossectional approach measuring independent variables of aortic diameter and systole blood pressure. The result are the R Square value is 0.364. The regression coefficient value of systole blood pressure (X1) is 0.043, the T value that was determined is 3. 102, and the significance value is 0.003. In addition, the computed T value is 3.597, the regression coefficient value of aortic diameter (X2) is 0.256 and then we founded F value of regression model was 22.072. As conclusion are Pre-delay scan duration is positively and significantly impacted by aorta diameter, systolic blood pressure has a positive and significant effect on pre-delay scan time and The two variables together have a positive and substantial effect on the pre-delay delay time. Additionally, this study discovered that other parameters controlled 63.6% of the deleye time of contrast material administration, with the remaining 36.4% being influenced by aortic diameter and systole blood pressure

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## INTRODUCTION

CT Scan of the heart is a non-invasive imaging of the heart organ whose use has become very routine for cardiologists as well as echo cardiology devices. Heart scan using CT Scan can see the morphology of the heart in general, looking for thrombus in the intra heart (Pasteur-Rousseau & Sebag, 2020). ESC 2019 recommendations, where cardiac CT Scan is highly recommended for chronic coronary syndrome patients at low to moderate levels (Neumann et al., 2020).

CTA Coronary uses contrast media injection, one of which is used is bolus tracking technique. Bolus Tracking is a technique used in computed tomography imaging that shows real time monitoring (direct appearance) of media contrast display in one intended scan area after a while the contrast media is injected into the blood vessels (Utami et al., 2022). This tracking bolus has the ability to detect, analyze the threshold value reached during contrast and instruct the CT scan tool to take pictures (acquisition). Bolus tracking on each Caronaria CTA examination often varies the length of time the pre-delay scan reaches a threshold for each individual, the length of time a pre-delay scan reaches this threshold will contribute to the total acquisition time which is closely related to the total amount of contrast and copy that must be provided during acquisition.

There are many software that can be used to estimate the amount of contrast volume of media to be injected based on weight, whereas in the actual process of tracking bolus, there are variations in the length of time the threshold is reached. The length of time the threshold is reached greatly affects the total amount of contrast media that must be injected, of course this is very problematic when the initial estimate of the amount of contrast volume is wrong. Inaccuracy in determining the estimated amount of volume contrast media occurs because there are too many and too few amounts of contrast media to be injected, if too much then what happens is that the acquisition takes place accompanied by contrast media injection is still in progress so that the amount of contrast media in the superior vena cava is still large and will provide artifacts graffiti in the initial scanning area, this is very disruptive to the tracker process, which is a repeated acquisition process and is accompanied by gradual analysis until the threshold value is reached and provides information to the system to make CTA Coronaria acquisition, while if it is too little, the potential value of the degree of whiteness (opacity) at the end (distal) of the distal coronarian artery of the coronarian artery decreases drastically, so it greatly affects the visualization of coronary arteries sum.

One of the difficulties in CTA Coronary examination is the difficulty in determining how long the scan delay time is on CTA Coronaria examination. Many factors influence it including aortic diameter and systole pressure. And this study tried to determine the influence of the diameter of the aorta and systole determination on the determination of the pre-delay scan of contrast injection CTA Coronary examination media.

## LITERATURE REVIEW

Multi Slice Computer Tomography (MSCT) CTA Coronaria

MSCT is an examination tool using radiation that utilizes a computer to reconstruct data obtained from several detector circuits that receive X-ray beams that are subjected to absorption of a weakened amount of energy (Bontrager, 2014). MSCT is able to obtain smooth axial cross-sectional images, with better spatial resolution, and can be reconstructed into three-dimensional images, so that they can be viewed from various projections (Shinbane et al., 2016).

The heart's MSCT technology uses the technique of collecting data simultaneously from very thin collimated slices with short scan times of up to 0.5 seconds and even faster. Can enable good isotropic scanning with high spatial, temporal, and contrast resolution. The use of isotropic voxel data allows the acquisition of sagittal and coronal images with the same spatial resolution as axial images. The fine volume data obtained through scanning with MSCT can produce three-dimensional images that can be used in a variety of reconstruction methods. MSCTs with fast tube turnaround times and simultaneous data acquisition combined with electrocardiography (ECG) can be used in the examination of mobile organs that require high spatial and temporal resolution, such as coronary arteries and the heart (Marchal et al., 2005).

The heart is a rapidly moving, continuous organ that introduces artifacts into the MSCT image. Throughout the cardiac cycle, there are peaks and troughs in the heart's action during diastole and diastole. As a result, it's critical to coordinate data gathering with the cardiac cycle. To create a volumetric data set, data from multiple gantry rotations must be combined, which requires determining the data collecting time. ECG signal observation can be used to determine data retrieval time. The R-R interval (time interval between successive ECG R waves, heart rate from 1000 ms to 60 bpm) measures the interval between two consecutive heartbeats. When heart movement is at its lowest during the diastolic part of the cardiac cycle, scanning and data gathering are typically chosen utilizing an absolute delay of 300–500 ms or a relative delay of 40–60% before the following R wave (Boushra & Muntazar, 2006).

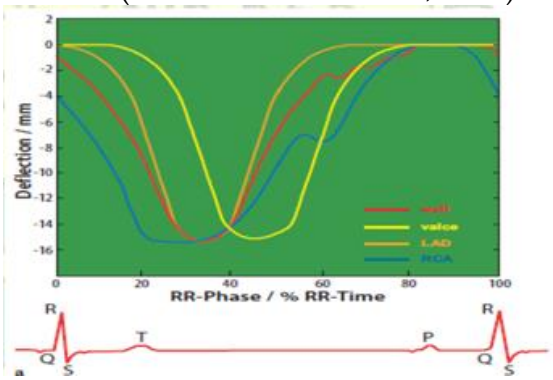


Figure 1. Graph Of ECG Waves in the R-R Phase (14)

Data acquisition techniques for cardiac MSCT examination based on ECG waves are divided into two techniques, namely prospective ECG-gated MSCT and retrospective gated MSCT techniques (Flohr et al., 2007).

Prospectif ECG Triggering MSCT

Potential ECG measurement is a method of synchronizing the scanning process using a partial scanning technique with heart movements to obtain data about a specific phase of the cardiac cycle. Usually, an acquisition scan is performed during the diastolic phase, when movement of the heart is minimal. ECG potential measurement is often used to analyze calcium scores.

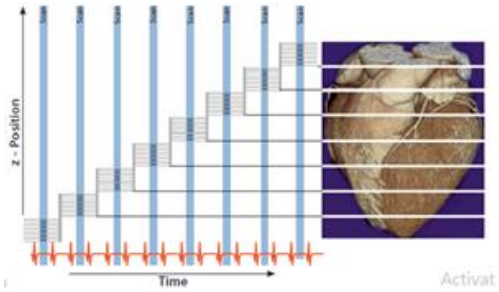


Figure 2. Prospective ECG Triggering MSCT Data Acquisition Process (14)

Retrospektif ECG Gating MSCT

Retrospective ECG gatting is an attempt to synchronize the reconstruction of a continuous spiral scan with heart movement using simultaneously recorded ECG traces. The scan data obtained are selected for reconstruction based on a predetermined phase of motion of the heart with a specific time relationship starting from the beginning of the R wave as the starting point of the data used for image reproduction. Retrospective ECG measurements are often used in coronary artery examination.

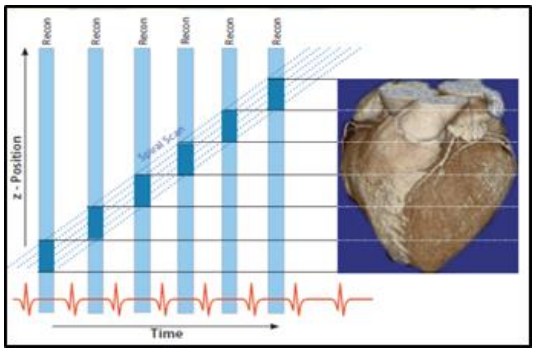


Figure 3. Retrospective Method of ECG Gating MSCT Data Acquisition Process (14)

Contrast Injection Technique

There are two different methods in determining how long it takes for the threshold to be reached in CTA Coronaria, the first is called the bolus test where before the examination takes place a test or test a number of contrast injections and repeated scanning for a certain time, then the resulting data is analyzed with an application to see the profile of the threshold increase during contrast injection and simultaneous repeated scanning, What is obtained is the length of time delay in the occurrence of peak treshold values in aortic desendence. The second is bolus tracking, the bolus tracking technique is carried out in a series of examination procedures where the tracking process with repeated scanning until a certain threshold value is reached followed directly by the acquisition of CTA

coronaria (Utami et al., 2022). The bolus test is a method that is a repeated acquisition with a certain time lag and a certain amount of acquisition accompanied by the injection of contrast media into the patient's body with a certain volume, injection speed (ml / second) and pressure of injection simultaneously. The results of the acquisition data will be analyzed to get the right time to get the peak threshold value (Nainggolan, n.d.).

Diameter Aorta

The biggest and strongest artery in the human body is the aorta. These are blood arteries pushed by the heart via the lungs with oxygenated blood. The aorta transports blood throughout the body. Three walls build up the aorta. There is a thinner outer layer called Kerak, a thicker middle layer called middle, and a thin inner layer called intima that make up the wall (Saladin & Porth, 2010) (Goldstein et al., 2015). Diameter according to the dictionary Indonesian means a straight line through the midpoint of a circle (Ernawati Waridah, 2017). The diameter of the aorta is a straight line through the midpoint of the aortic blood vessel circle. The CTA Cardiac procedure allows us to take measurements with CT scan modality features very well when the locator procedure is performed.

Systole Blood Pressure

One of the clinical factors that is most frequently examined is systole blood pressure, and treatment decisions are heavily influenced by blood pressure values. It is not always simple to determine the physiological relevance of blood pressure in specific patients, though. This measurement explores the physical foundation and physiological factors of blood pressure, as well as the link between blood pressure and tissue perfusion. Previous blood pressure checks addressed a few of these concerns (Magder, 2014).

## METHODOLOGY

This type of quantitative analytical research with a crossectional design measures independent and dependent variables (pre-delay scan time) carried out simultaneously and is momentary and observed at current conditions, and each object is observed once. This is done to describe the time the pre-delay scan reached the threshold in CTA Coronaria which is associated with aortic diameter and systole blood pressure. And to find out the pattern of the relationship between the causal variable (independent) with the effect variable (outcome or dependent) and find out the confonding factor, the relationship of these variables is analyzed quantitatively to find out a fit and simple model to find out the estimated time of pre-delay scan to reach treshold on CTA Coronaria.

Multiple regression analysis is employed. The amount of influence that exists between the independent and dependent variables is measured using regression analysis. Simple linear regression is used when there is only one independent variable and one dependent variable (Juliandi & Manurung, 2014). On the other hand, multiple linear regression refers to the process of analyzing data involving numerous independent or dependent variables. A regression model that includes more than one independent variable is called multiple linear regression. To ascertain the direction and degree of the independent variable's influence on the dependent variable, multiple linear regression analysis is used

(Ghozali, 2018). Various fields, including engineering, physics, economics, management, biology, and agriculture, can benefit from using the techniques of regression analysis (Efendi et al., 2020).

## RESULTS AND *DISCUSSION*

From a field observation, data on aortic diameter, systole pressure and coronary CTA pre-scan delay time were obtained from 80 patients who performed CTA Coronary examination. Then the data is processed using SPSS software and analyzed using multiple regression analysis.

1.Descriptive Analysis

Using the maximum, minimum, average, and standard deviation of a set of data, descriptive statistical analysis can be used to describe the data. (Wahyuni, 2020) from variable systole pressure (X1), aortic diameter (X2), and pre delay scan (Y).

Table 1. Descriptive Data

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Sistol pressure | 80 | 100 | 193 | 137.90 | 21.914 |
| Diameter Aorta | 80 | 26 | 43 | 33.52 | 4.316 |
| Pro Delay Scan | 80 | 14 | 30 | 20.00 | 2.946 |
| Valid N (listwise) | 80 | | | | |

Systole pressure (X1) has a minimum value of 100 and a maximum value of 193, as shown in table 1 above. Systole pressure (X1) for the average value is 137.90, with a standard deviation of 21.914. Aortic Diameter (X2) has a minimum value of 26 and a maximum value of 43. The aorta's mean diameter (X2) is 33.52, with a 4.316 standard deviation. Pre Delay Scan (Y) has a minimum value of 14 and a maximum value of 30. Pre Delay Scan (Y) average is 20, standard deviation is 2.946.

2. Classical Assumption Test

A. Normality Assumption Test

B.The Kolomogrov-Smirnov evaluation was utilized in this investigation to assess the normalcy versus residuals, with a significance threshold of $\alpha = 0.05$. The normalcy assumption is met if the probability $p >= 0.05$ (2018). Using SPSS software to process statistical analysis data, the following information was obtained:

Table 2. Normality Test

| | | Unstandardized Residual |
|---|---|---|
| N | | 80 |
| Normal Parameters[a,b] | Mean | .0000000 |
| | Std. Deviation | 2.34854545 |
| Most Extreme Differences | Absolute | .110 |
| | Positive | .110 |
| | Negative | -.044 |
| Test Statistic | | .110 |
| Asymp. Sig. (2-tailed) | | .018[c] |
| Exact Sig. (2-tailed) | | .268 |
| Point Probability | | .000 |

From Table 2 above, the Exact Sig 0.268 or p value is smaller when compared to the significance of 0.05 so that it means assuming normality is met.

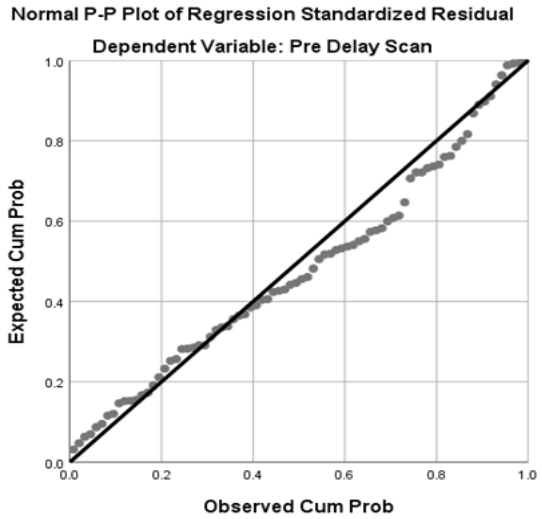


Figure 4. Test Normality With Normal Probability Plot Approach

Based on Figure 4 above, the normality test results using the normal probability plot demonstrate that the point distribution tends to approach the diagonal line, indicating that the normality assumption has been met by the data (2018).

C. Multicollinearity Test

Regression models can be used to determine whether there is a high or perfect correlation between independent variables by using the Multicollinearity Test (Janir, 2012). To check whether multicollinearity occurs or not can be noticed from the value of Variance Inflamation Factor (VIF). If the VIF value is greater than 10, the data is multicollinear.

Table 3. Multicollinearity Test

| Model | | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| 1 | (Constant) | | |
| | Tekanan Sistol | .759 | 1.317 |
| | Diameter Aorta | .759 | 1.317 |

Based on table 3 above, the VIF Ratio of Systole Pressure (X1) is 1.317 and the VIF Value of Aortic Diameter (X2) is 1.317. The VIF value <10 It can be considered that multicollinearity is not present in the data.

D. Heteroscedacity Test

The heteroscedasticity test is used to determine if the residual variance inequality between observations in a regression model is fixed, hence the name heteroscedasticity (Santoso, 2000). Detection of heterokedasticity can be done using the Glejser Test (Janir, 2012).

Table 4. Hasil Uji Glejser

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 1.907 | 1.486 | | 1.283 | .203 |
| | Tekanan Sistol | .007 | .009 | .104 | .802 | .425 |
| | Diameter Aorta | -.036 | .047 | -.099 | -.760 | .450 |

It can be inferred that heteroscedasticity does not occur based on Table 4's Glejser Test results, where the significance values for X1 and X2 are both greater than 0.05 at 0.425 and 0.450, respectively.

E. Autocoralation Test

The aims of Autocoralation Test is to show the correlation of observation members sorted by time or space (Ajija et al., 2011). The Durbin-Watson Test was used in this study's autocorrelation analysis. From processed data statistically obtained:

Table 5. Durbin-Watson Test Results

| Model | Durbin-Watson |
|---|---|
| 1 | 1.586 |

Durbin-Watson test statistical values larger than 3 or less than 1 are indicative of autocorrelation (Sitepu, 2021). according to Table 5. Given that the Durbin-Watson test result above produced a value of 1,586 that is larger than 1 and less than 3, it is reasonable to believe that the data exhibit autocorrelation symptoms.

**2. Regression Analysis**

With the assumption that there is a linear straight line between the dependent variable and each of its predictors, multiple linear regression looks at the impact of two or more independent variables (explanatory) on a single dependent variable (Janir, 2012). Statistical processed data are obtained as follows:

Table 6. Multiple Regression Analysis Table

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .604[a] | .364 | .348 | 2.379 | .586 |

a. Predictors: (Constant), Diameter Aorta, Tekanan Sistol

b. Dependent Variable: Pre Delay Scan

Table 6 above provides the regression equation, which is:

$$\mathbf{Y = 5.419 + 0.43\ X1 + 0.256\ X2}$$

It can be interpreted that:
1. The constant value has a positive value of 5.419. When there is a positive sign, the influence between the independent and dependent variables is one-way. This indicates that the Deleye time value is 5.419 if all independent variables, such as Systole Blood Pressure (X1) and Aortic Diameter (X2), are at zero percent or remain constant.
2. The Systole Blood Pressure variable (X1) shows a positive regression coefficient value of 0.43. This means that, provided all other independent factors remain constant, a 1% rise in Systole blood pressure will result in a 0.43 increase in Deleye time. When there is a positive sign, the influence between the independent and dependent variables is one-way.
3. The regression coefficient value for the Aortic Diameter variable (X2) has a positive value of 0.256. This means that, if all other independent variables remain constant, an increase of 1% in the aortic diameter will result in an increase of 0.256 in the Deleye time. When there is a positive sign, the influence between the independent and dependent variables is one-way.

According to table 6 above, the R Square value is 0.364, which indicates that other factors influence the remaining 63.6% of the deleye injection time of contrast material, with the Aortic Diameter and Systole Blood Pressure having a 36.4% effect.

Table 7. Partial Effect Significance Test Results (T-Test)

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 5.419 | 2.230 | | 2.430 | .017 |
| | Tekanan Sistol | .043 | .014 | .323 | 3.102 | .003 |
| | Diameter Aorta | .256 | .071 | .375 | 3.597 | .001 |

As can be seen from Table 7 above, X1's regression coefficient value is 0.043, which is positive. This indicates that Y is positively impacted by systole pressure. The effect is significant if the significance value of 0.003 is less than 0.05 and the T count is 3.102 more than the T Table (1.991). in order to get the conclusion that the Systole Blood Pressure influences the Time Delay of Injection Contrast CTA Coronary Exam in a Positive and Significant Way partially.

According to Table 7 above, X2's regression coefficient value is 0.256, which is a positive number. This indicates that Y is positively impacted by systole pressure. The effect is significant because the known T count is 3.597 more than the T Table (1.991) and the significance value is 0.001 less than 0.05. Thus, it can be said that the Aortic Diameter influences the Time Delay of Injection Contrast CTA Coronary Exam in a Positive and Significant Way partially.

Table 8. Results of the Simultaneous Effect Significance Test (Test F)

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 249.803 | 2 | 124.902 | 22.072 | .000[b] |
| | Residual | 435.738 | 77 | 5.659 | | |
| | Total | 685.541 | 79 | | | |

It can be concluded from Table 8 above that systole blood pressure and aortic diameter significantly influence pre-time delay scan contrast injection on CTA coronary examination simultaneously because the systole blood pressure calculation's F value is 22.072 greater than the F table value (3.115) and the significance value of 0.000 is smaller than 0.05.

The delay time of the contrast injection CTA Coronary examination is positively and partially significantly impacted by the statistical analysis results pertaining to the relationship between the aortic diameter and the pre-delay scan of CTA Coronary contrast injection media. This is consistent with other studies that found that the lengthier the delay scan time on a CTA coronaria evaluation, the larger the TCD (Tranversal Cardiac Diameter) (Tang et al., 2011).

## CONCLUSIONS AND RECOMMENDATIONS

The diameter of the aorta has a positive and significant on the pre-delay scan time, meaning that the longer the diameter of the aorta, the longer the delay scan time. Systole blood pressure has a positive and significant on the pre-delay scan time, meaning that the higher the systole blood pressure, the longer the scan delay time. Both variables together have a positive and significant on the pre-delay delay time, which means that the longer the diameter of the aorta and the higher the cytol blood pressure, the longer the scan delay time. This study also found that the effect of Aortic Diameter and Systole Blood Pressure on the time of deleye injection of contrast material by 36.4% and Other variables influenced the remaining 63.6%.

## FURTHER STUDY

This study concluded that the effect of Aortic Diameter and Systole Blood Pressure on the time of injection of contrast material was only 36.4% and there were still 63.6% more influenced by other factors. So it is highly recommended for further development to use other factors in exploring the cause of the long delay scan CTA Coronary. Other variables can also be used such as ureal creatinine content or kidney function test results (GFR), Body Mass Index (BMI), age, heart rate (HR) and others.

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