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Evaluation of optimal contrast -enhanced CT scan for Pulmonary Angiography in Palestinian Health System

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Evaluation of optimal contrast -enhanced CT scan for Pulmonary Angiography in Palestinian Health System

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Dedication

To the woman who taught me that any dream, no matter how small, is worth fighting for. To my Mother Nihad

To the man who held my hand in front of tank canons and armed soldiers, and taught me that nothing should stop me from going to school. To my Father Fathi

To the world's best siblings Ali , Mohamad , Rawan , Razan , Amena and dena .

To my lifetime best-friend, the one who never got tired of listening to my complaints, to my fiancé Maryam .

Thank you, God, my prayer and gratitude to you. You are the one who gave me the power to work hard and continue, despite the obstacles, until I reached this high and great status.

Ahmad Alyan

Declaration

I certify that this thesis was submitted for the degree of masters. It is the result of my own research, except where otherwise is acknowledged. I also certify that this thesis (or any part of the same) has not been submitted for any other university or institution.

Name: Ahmad Fathi Ali Alyan

Signed *Ahmad Alyan*

Date: 3 / 04 /2024

Acknowledgments

Praise be to the Lord of the Worlds, as it should be, for His majesty and authority, may blessings and peace be upon the Seal of all Messengers and Prophets, our Master Muhammad, my God bless him and grant him peace. great gratitude goes to Dr. Mohammad Hjuj, for patient supervision and guidance, Dr. Maysara Ruman for unconditional support and fruitful advice, Dr. Sawsan Abu Sharkh for her generous attendance and comments.

I extend my thanks and gratitude to all my distinguished professors at the College of Medical Imaging Technology, Faculty of Medicine, in Al-Quds University.

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List of abbreviations

PE: Pulmonary Embolism

PT: Patient

NO: Number

PA: Pulmonary Angiography

CT: Computed Tomography

CAT: Computed Axial Tomography

MDCT: Multi-Detector Computed Tomography

HU: Hounsfield Unite

PU: Pulmonary Artery

RTP: Right Pulmonary

LTP: Left pulmonary

AC: Ascending Aorta

DC: Descending Aorta

SVC: Superior Vena Cave

SUB: Subclavian Artery

DVT: Deep Vein Thrombosis

CTPA: Computed Tomography Pulmonary Angiography

PACS: Picture Archiving and Communication System

SPSS: Statistical Package for Social Sciences

SD: Standard Deviation

Abstract:

Introduction:

Computed tomography (CT) technology became one of the gold standard diagnostic modalities all around the world. During the last decade, many advances reveal to new angiographic procedures in CT in shorter exam time and higher image quality. Adequate timing in CT angiography of the Pulmonary Arteries considered vital to the accuracy of the diagnosis of pulmonary embolism.

Purpose:

The overall aim of this research is to assess the optimal contrast -enhanced CT scan for Pulmonary Angiography in Palestinian Health System

The main objectives of this research are:

- Determine the optimal contrast media enhancement of the pulmonary trunk and descending aorta according to the hospital examined, the gender, and the age of the patient.
- To determine the accuracy of scanning the pulmonary trunk and descending aorta according to the hospital examined, the gender, and the age of the patient.

Methodology

A retrospective cross-sectional study was performed to evaluate the optimal contrast enhanced Computed tomography of pulmonary angiography of 285 patients who underwent the exam to role out pulmonary emboli. Data was collected using the picture archiving and communication system from all eight governmental hospitals in the West Bank. SPSS Statistical Package for Social Sciences was used to analyse the collected data according to gender, age group, optimal enhancing, and image accuracy in addition to hypothesis testing.

Results

Data analysis reveals that optimal enhancement percentage was consistently observed at 75%, encompassing 214 patients. In contrast, 7% of cases, representing 21 patients, were rendered unsuitable for evaluation due to suboptimal enhancement. Notably, a significant proportion, 62% of patients, demonstrated high diagnostic accuracy, with 11% yielding lower accuracy.

The pronounced variation in the performance of these hospitals, with Jenin Hospital emerging as the standout contender in both timing enhancement and diagnostic accuracy.

A remarkable 19.3% of cases within Jenin Hospital achieved optimal enhancement, showcasing an extraordinary 17.5% high accuracy rate, significantly outperforming other departments. This achievement at Jenin Hospital could be attributed to a fine-tuned protocol of optimal enhancement and high accuracy through the meticulous use of time bolus tracking.

In our study of contrast media volume. Through our investigation, we revealed that the use of contrast media at Jericho Hospital had the highest recorded contrast volume of 110 cc. Alia Hospital reported the smallest contrast media volume, weighing in at a mere 50 cc. This contrast in the volume of contrast media used highlights the significant variability in approaches to pulmonary artery CT angiography across these medical institutions.

Analyzing the flow rate of contrast media (cc/sec), the data clearly depicted that Salfit and Ramallah Hospitals, with their adoption of a flow rate of 5 cc/sec, reigned supreme in this domain. This was a stark contrast to Jenin Hospital, where the flow rate dipped to 3 cc/sec, emerging as the lowest among all the hospitals under examination.

Conclusion

The current study's research emphasizes the critical role played by contrast media enhancement ratios, CM volume, injection rate, and timing protocols in the accuracy and effectiveness of pulmonary artery CTPA in Palestinian government hospitals. The wide variation in results between these hospitals suggests that there is room for further standardization and improvement in the use of alternative medicine. Our findings not only advance knowledge in this field, but also provide valuable insights for clinicians and medical practitioners, ultimately benefiting patient care and treatment outcomes.

Chapter One:

Introduction:

1.1Problem statement

Achieving optimal enhancement in the pulmonary arteries, based on contrast agent protocols, is essential to aid in diagnosis and identify specific pathological areas in CTPA. The precise timing of post-contrast administration for image acquisition is essential to increase diagnostic accuracy and effectiveness of the screening process.

1.2 Research objectives

1. To evaluate the amount of contrast media volume used in the exam and flow rate assessment.
2. To determine the optimal enhancement of the contrast media within the pulmonary trunk and descending aorta according to hospitals, age, and gender.
3. To determine the enhancement accuracy of the contrast media within the pulmonary trunk and descending aorta according to hospitals, age, and gender.

1.3Hypotheses

1) Due to gender age and region There is no significant correlation between HU DC AORTA - PA TRUNCK To examine at the level $\alpha \leq 0.05$.
2) The percentages of HU(PA) There is no significant correlation between HU DC AORTA - PA TRUNCK To examine at the level $\alpha \leq 0.05$.

1.4 Significance of the Work

The purpose of this research is to assess the optimal and accuracy of contrast -enhanced CT scan for Pulmonary Angiography in Palestinian Health System .

1.5 Research questions

1. Which hospital has the highest optimal percentage and compliance to standards?
2. Which hospital has the highest enhancement accuracy percentage and compliance to standards?
3. Wich hospital has the highest number of examination within the sample?

1.6 Justifications

- The absence of comparable studies on this topic raises the need to establish a standard protocol for Palestinian Hospitals.
- Existing literature indicates instances of acute renal failure (ARF) following CTPA due to excessive contrast media (CM) usage.
- However, certain protocols prove more accurate, preventing misdiagnosis of pulmonary embolism (PE) in some cases.
- Implementing these protocols in Palestinian hospitals can mitigate contrast-induced ARF and enhance the accurate diagnosis of PE cases.

Chapter 2:

Theoretical Background & Literature Review:

1.1 Background of study

2.1.1 Computed Tomography (CT)

Non-invasive diagnostic imaging commonly known as a CT scan or CAT scan, uses both computer and X ray technology to produce axial (horizontal) images called slices of the organs inside human bodies. This advanced imaging process allows all aspects of the body to be clearly and precisely seen--arteries, blood vessels; nerves; bones, muscles; fat or organs. One especially notable aspect of this is that CT scans are far more accurate and detailed than standard X-rays, revealing a complete three-dimensional view inside the human body. (Muhogora WE, et al 2009).

The 1970s saw the introduction of computed tomography. Its technique uses rotating X-ray tubes with detectors that are connected to a computer so that it can process and create an image of every tissue in the body. It may cover a sizable portion of the patient's body and generates radiographs of superior quality to X-rays in terms of contrast resolution and spatial resolution (Tsalafoutas, I. A. & Koukourakis, 2010).

MDCT is a major step forward in the field of CT imaging, and it has direct applications in many systems, with the cardiovascular system being one example. Among the advantages MDCT has to offer are an enhanced rate of scanning, greater coverage in terms of area and extent, and better resolution. To keep the maximum benefits and lowest risk ratio, optimization of technical parameters or clinical rationale is required (Burrill J, et al 2007).

2 .1.2 Pulmonary Angiography

Pulmonary embolism (PE) is a condition in which blood clot cuts off an artery in the lung, stopping most or all of that part. Known as deep vein thrombosis (DVT), these blood clots form in the legs and generally flow through into the right side of the heart before settling down hold up there. Among diagnostic methods, the most effective is computed tomography pulmonary angiography (CTPA). An intravenous contrast medium is injected for this CT scan, which travels to the pulmonary arteries. Its bright, white color on the scan images increases arterial visibility. This operation is often combined with fixed scan delays and the use of a test bolus as well as tracking how this spreads. Thus it has become popular for its effectiveness in deciding when to begin treatment, especially so much the better for patients with right heart failure or pulmonary hypertension.

Standard protocol of optimal timing in CTPA

1. Bolus Tracking:

   During the injection of contrast, sequential axial slices are taken at a predefined region of interest; once it reaches a threshold enhancement level (T > 100 Hounsfield Units), we begin diagnostic scanning with a volume of 60ml, and use contrast concentration that is above or equal to an arbitrarily selected density difference between water-based saline solution

2. Test Bolus:

   Some minor 'test' amount of contrast is mixed in. Sequential axial slices at a predetermined region of interest are recorded to determine when the peak enhancement occurs. This information is then employed to determine the best scanning delay, with a test bolus of 20 ml contrast and 10 mL saline at rate of flow --4.5/-yon; Tonji Hospital Nuclear Medicine Research Center (NJHCMRC), p.369 Nowakowski et al., The Brain in Color EDITIONS 60 ml of contrast and 100ml saline are injected at the same rate in terms of volume for the succeeding diagnostic scan.

3. Fixed Delay Timing:

   Once the contrast media are introduced, a timer begins running-with fixed scan delays. Which exacting bolus-tracking method achieves the most accurate timing determination still remains an open question. As for the reported benefits it offers patients with right heart failure or pulmonary hypertension, this hasn't been shown scientifically. The thresholds for pulmonary artery enhancement that result in diagnostic scanning (i.e., mean transit time) or the time delay required for scanning following a trigger event are set by experience without any formal validation. Also, there is little information about the time -enhancement property of pulmonary arteries and on what delay should be used to best see through them. These gaps in understanding naturally demand further analytical studies. (Chang Hyun Lee, et al 2007).

In patients suspected of having pulmonary embolism, the value of a procedure called pulmonary angiography extends further to examination at subsegmental arteries. Methods of quicker scanning and the thin collimation utilization all clearly point to one conclusionthe determination of an optimum time for pulmonary artery angiography has become a vital issue. The timing of this procedure is now considered to be one of the most important variables for obtaining a complete portrayal of the peripheral pulmonary artery. (Chang Hyun Lee, et al 2007). A blood clot became lodged in a lung artery, blocking the passage of blood to some part of that lung. Such an event is termed pulmonary embolism (PE). The thrombi are usually born in the legs and make their way through to the right side of heart, into lungs--the medical name for this is deep vein thrombosis (DVT). The modality of choice for PE is computed tomography (CT). (Jeffrey L. Carson, et al 1992).

2.1.3 Indications for CT pulmonary angiography

It is a diagnostic test commonly performed to rule out pulmonary embolism (PE). The radiology department will use a somewhat different strategy: diagnostic density of the main pulmonary artery and its branches. We use the contrast agent intravenously as it travels to the pulmonary artery because the pulmonary artery has blood and the HU is close to the tissue. We use a contrast agent to distinguish it from other nearby tissues and arteries. In order for the contrast agent to fulfill this function, we need an ideal time to get there.

2.2 Diagnosis of pulmonary embolism with CT pulmonary angiography: a systematic review

A study published in 2006. Journal title The Emergency Medicine by KHogg, et al. conducted on Medline, EMBASE, and gray literature were systematically searched by two researchers. They used Any study which compared CT pulmonary angiography to an acceptable reference standard or prospectively followed up a cohort of patients with a normal CT pulmonary angiogram. The Conclusion: Diagnostic studies give conflicting results for the diagnostic accuracy of CT pulmonary angiography. Follow-up studies show that CT pulmonary angiography can be used in combination with an investigation for deep vein thrombosis to exclude pulmonary embolism. The Results: Thirteen diagnostic and 11 follow-up studies were identified. Studies varied in the prevalence of pulmonary embolism (19-79%), patient groups, and method quality. Few studies recruited unselected emergency department patients. There was heterogeneity in the analysis of sensitivity (53 to 100%), specificity (79 to 100%), and false negative rate (1.0 to 10.7%). The pooled false negative rate of combined negative CT pulmonary angiography and negative deep vein thrombosis testing was 1.5% (95% CI 1.0 to 1.9%) (KHogg, et al, 2006).

2.3 Determination of Optimal Timing Window for Pulmonary Artery MDCT Angiography

A study published in the American Journal of Roentgenology 2007 by Chang Hyun Lee, et al, was conducted on patients consisting of 61 women and 89 men who were 31-94 years old (mean age, 55.2 years; mean weight, 62.4 kg). We prospectively studied 150 patients. Routine chest CT scans were acquired using 1.3 mL/kg of contrast medium (370 mg I/mL) that was injected at a fixed injection duration of 30 seconds, followed by a 10-second saline chase. The conclusion of the study protocol of a 30-second injection and 10-second normal saline flush was that the optimal temporal window to achieve pulmonary artery enhancement greater than 200 HU was from 16 seconds to 41 seconds after the injection. The result times to reach 100 HU and 200 HU at the pulmonary artery were 11 ± 2.5 (SD) seconds and 16 ± 3.0 seconds, respectively. Pulmonary artery enhancement duration greater than 200 HU was 25 ± 2.7 seconds (only obtained in group C). The mean time to peak enhancement (335 ± 62 HU) at the pulmonary artery was 37 seconds. M ean enhancement measured on the diagnostic scan was 294 ± 43 HU, group A; 208 ± 48 HU, group B; and 157 ± 15 HU, group C for the pulmonary artery, and 240 ± 42 HU, group A; 277 ± 49 HU, group B; and 172 ± 29 HU, group C for the aorta ($p < 0.01$) (Chang Hyun Lee, et al 2007).

2.4 CT Angiography of Pulmonary Arteries to Detect Pulmonary Embolism with Low Kilovoltage Settings

An article published in 2006 by Claudia Schueller-Weidekamm, et al, conducted on 38 male and 24 female patients (mean age 61 years; range 17–86 years). We retrospectively study compare a low kilovoltage scanning protocol with a reduced radiation dose with a standard high kilovoltage, the conclusion reduces radiation exposure, low kilovoltage scanning increases the percentage of central and peripheral pulmonary arteries that can be evaluated with CT angiography without a substantial decrease in image quality. was a significantly higher average CT number in the main pulmonary artery (379 HU ± 95) for the 100-kVp protocol than for the 140-kVp protocol (268 HU ± 63, $P < .001$, two-sided ttest). Maximum CT numbers in peripheral pulmonary arteries at the level of the aortic arch and lung bases, respectively, were 290 HU ± 91 and 279 HU ± 100 for 100 kVp and 185 HU ± 65 and 144 HU ± 63 for 140 kVp ($P < .001$). The mean percentage of subsegmental arteries considered analyzable per patient was higher for 100 kVp than for 140 kVp (Claudia Schueller-Weidekamm, et al 2006).

2.5 Peripheral Pulmonary Arteries How Far in the Lung Does Multidetector Row Spiral CT Allow Analysis

An article published in 2001 by Benoit Ghaye, et al conducted to analyze the influence of multi-detector row spiral computed tomography (CT) on the identification of peripheral pulmonary arteries, The conclusion of the study Multi–detector row CT with reconstructed scans of 1.25-mm-thick sections enables accurate analysis of peripheral pulmonary arteries down to the fifth order on spiral CT angiograms. Multi–detector row CT with reconstructed scans of 1.25-mm-thick sections (group 1) allowed (*a*) analysis of a significantly higher percentage of subsegmental arteries (94% in group 1 vs 82% in group 2; $P < .001$) and (*b*) a significantly higher percentage of fifth- and sixth-order arteries, respectively, identified in 74% and 35% of cases in group 1 and 47% and 16% in group 2 ($P < .001$). The causes for inadequate depiction of subsegmental branches in group 1 were partial volume effect (43%), anatomic variants (39%), and cardiac (17%) and respiratory (1%) motion artifacts. Peripheral pulmonary arteries were analyzed on optimally opacified contrast material–enhanced spiral CT angiograms in 30 patients devoid of pleuroparenchymal disease who underwent scanning with multi–detector row CT (collimation, 4 × 1 mm; pitch, 1.7–2.0; scanning time, 0.5 second). Two series of scans were systematically generated from each data set, 1.25-mm-thick (group 1) and 3-mmthick (group 2) sections, leading to the analysis of 600 segmental (20 arteries per patient), 1,200 subsegmental (40 arteries per patient), 2,400 fifth-order (80 arteries per patient), and 4,800 sixth-order (160 arteries per patient) pulmonary arteries in each group (Benoit Ghaye, et al 2001).

2.6 Analysis of contrast time-enhancement curves to optimize CT pulmonary angiography

This study was by Zhu J et al in 2017, this study was designed to analyze the contrast enhancement pattern in the pulmonary artery and develop an optimal strategy for pulmonary artery CT scan timing. They concluded peak enhancement of PA occurred, on average, right after the completion of contrast injection for 20 seconds. The fixed scan delay of 19 seconds or circulation-adjusted delay with the bolus threshold of 150 HU and diagnostic delay of 10 seconds appear optimal. The study population consisted of 30 women and 70 men who had ages between (24–75 years). Body weight of the patients was (range, 30–83 kg). The volume of contrast medium adjusted for body weight was (range, 30–83 ml). The mean contrast medium injection rate was 2.98±0.47 ml/s. The results of this study showed that the mean degree of peak PA enhancements was 431.4±65.2HU (range, 263.8 -- 575.3HU). The mean time to peak enhancement was 22.4±3.1 seconds (range, 11–27 seconds). From potential fixed delays ranging 11–27 seconds, 19 seconds showed the highest enhancement quality. For the circulation-adjusted delays, the combination of 150 HU bolus-track threshold with diagnostic delay of 10 seconds had the highest enhancement quality materials and methods that were used , One hundred consecutive patients referred for contrast-enhanced chest CT were prospectively studied ,multiple images of low radiation were acquired at different intervals after the start of the injection and time-enhancement data were measured over the PA.

2.7 CT pulmonary angiography and CT venography: factors associated with vessel enhancement

A study published in the American Journal of Roentgenology July 2007 by Arakawa H, et al, was conducted on 242 cases (83 men and 159 women; mean age, 63 years; age range, 21-92 years) underwent CT pulmonary angiography they using a bolus-tracking technique; They made two groups and two different amounts of nonionic iodine contrast medium were administered: patients weighing > 50 kg who were undergoing both CT pulmonary angiography and CT venography received 450 mg I (group B), whereas all whereas all other patients received 300 mg I (group A). at 3 minutes after the start of the contrast injection.

Multiple regression analyses were performed with attenuation as the dependent variable and patient age, sex, and weight; amount of contrast medium; scanning delay; and presence of embolism as the independent variables.

The Conclusion: The bolus-tracking technique showed relatively small variations in the scanning delay time. Patient age, body weight, and the amount of contrast medium were the important factors associated with vessel enhancement in combined CT pulmonary angiography and CT venography. The **Results:** The scanning delay for CT pulmonary angiography ranged from 10 to 31 seconds (mean, 19 seconds; SD, 3.3). Subjective estimates of enhancement quality on CT venography were significantly better for group B than for group A ($p < 0.001$). Multiple regression analyses revealed that body weight and age were the only significant and consistent independent variables associated with enhancement of the pulmonary arteries. The amount of contrast medium, body weight, and scanning delay were the independent variables that were consistently associated with enhancement of the deep veins.

2.8 CT of deep venous thrombosis and pulmonary embolism: does isoosmolar contrast agent improve vascular opacification?

A study published in Department of Radiology, Medical College of Wisconsin, 9200 W Wisconsin Ave, Milwaukee, WI 53226-3596, USA by Lawrence R Goodman et al. Radiology. 2005 Mar conducted on 51 consecutive patients who underwent computed tomography pulmonary angiography. They received a similar iodine load with iohexol 300 and were studied with a similar technique. Section thickness was 1.25 mm for pulmonary emboli and 5 mm for deep venous thrombosis. The characteristics of the test and control group (that is, gender, age, and weight) were not significantly different ($P > .05$). In addition, in test patients who had undergone CT pulmonary angiography and CT venography within the past 2 years, current and previously obtained images (that is, paired studies) were compared and regions of interest were measured in four pulmonary artery and four sites lower extremity veins by two independent observers. The result of this study Iodixanol increased average attenuation by 7 HU ($P < .05$) in the lower extremities and decreased average attenuation by 42 HU ($P < .05$) in the pulmonary arteries. In the 11 paired studies, similar results were obtained. Conclusion: Iodixanol caused a modest but statistically significant improvement in venous attenuation and a decrease in arterial attenuation. The diagnostic importance of this small increase in venous attenuation is not clear.

2.9Computed tomography pulmonary angiography using a 20% reduction in contrast medium dose delivered in a multiphasic injection

This study to Chen M et al, published 2017 MAR ,it was in Berlin and Munich, Germanyin and it utilized a lower dose (60 mL) of contrast agent compared to the normal dose (75 mL) currently used in clinical practice for computed tomography pulmonary angiography (CTPA) CTPA protocol Scans were performed on a 128-slice CT scanner, acquired radiation dose of 120 kV and a tube output of a minimum of 666 mAs/80 Kw for 5 s, used a bolus tracking method to control the scan initiation (Upon reaching a threshold of 100 Hounsfield units (HU) in the main pulmonary artery, the scan was initiated) this study demonstrated that using a reduced dose of contrast medium (60 mL vs 75 mL) is clinically feasible without adversely affecting the image quality and diagnostic value of CTPA for PE. They propose the lower contrast dose of 60 mL should be used as standard practice in all patients undergoing CTPA, population There are two groups (control and study) In the control group, there were 32 male and 38 female patients, whose age's range (34-93). In the study group, there were 23 male and 34 female patients, whose age's range (16-92) results They found no significant difference between the two groups , axial images from the 60 and 75 mL groups showing the good opacification of the main pulmonary arteries so they concluded that lower dose of iodine contrast at 60 mL can be feasibly used in CTPA without resulting in a higher number of sub optimally opacified scans.

2.10 Optimizing computed tomography pulmonary angiography using right atrium bolus monitoring combined with spontaneous respiration

This study to Min Wang et al. Eur Radiol. 2015 Sep, it was in Department of Computed Tomography, Jining No. 1 People's Hospital, No. 6, Jiankang Road, Jining City, ShanDong Province, 272011, People's Republic of China. This study was designed to test the utility of right atrium (RA) monitoring in ensuring optimal timing of CTPA acquisition. Was conducted Sixty patients referred for CTPA were divided into two groups. Group A (n = 30): CTPA was performed using bolus triggering from the pulmonary trunk, suspended respiration and 70 ml of contrast agent (CA). Group B (n = 30): CTPA image acquisition was triggered using RA monitoring with spontaneous respiration and 40 ml of CA. Image quality was compared. The Result is Subjective image quality, average CT values of pulmonary arteries and density difference between artery and vein pairs were significantly higher whereas CT values of pulmonary veins were significantly lower in group B (all $P < 0.05$). There was no significant difference between the groups in the proportion of subjects where sixth grade pulmonary arteries were opacified ($P > 0.05$). Conclusions: RA monitoring combined with spontaneous respiration to trigger image acquisition in CTPA produces optimal contrast enhancement in pulmonary arterial structures with minimal venous filling even with reduced doses of CA.

2.11 CTA contrast enhancement of the aorta and pulmonary artery: the effect of saline chase injected at two different rates in a canine experimental model

A study published in Investigative Radiology, July 2007 by Chang Hyun Lee, et al was conducted on Three injection protocols they used; contrast injection (24 mL, 0.8 mL/s) without saline chase (protocol A), contrast injection with saline chase injected at the same rate as the contrast medium (protocol B), and contrast injection with saline chase injected at half the rate (0.4 mL/s) of the contrast medium (protocol C). In the 3 dogs used in the study, each of the protocols was applied twice for every dog resulting in a total of 18 sessions of monitoring scans. CT images were acquired every second at the fixed level of the aorta and pulmonary artery (PA). The duration of plateau, plateau deviation, and peak arterial enhancement were computed and compared using the Kruskall-Wallis and MannWhitney U test. The Conclusions: Saline chase prolongs the duration of plateau and delays peak enhancement of the pulmonary artery and aorta. Saline chase injected at half the rate of contrast medium injection allowed more uniform and prolonged plateau contrast enhancement than other protocols. The Results: peak contrast enhancements were significantly more delayed with protocol B than with protocol A in both the PA (B: 48 seconds, A: 30 seconds, P=0.024) and aorta (B: 46 seconds, A: 38 seconds, P=0.024). The duration of enhancement plateau was longer with protocol B than with protocol A in PA (B: 14.8 seconds, A: 9.0 seconds, P=0.002) and in aorta (B: 16.2 seconds, A: 11.6 seconds, P=0.004). Protocol C had the longest duration of plateau in both PA (34.5 seconds, P=0.002) and aorta (33.8 seconds, P=0.004) with uniform plateau enhancement. The peak enhancement values of protocol C, however, were substantially lower than that of protocol A and B in both the PA (A: 262 HU, B: 239 HU, C: 191 HU, P=0.001) and aorta (A: 263 HU, B: 268 HU, C: 210 HU).

Chapter Three:

Study Methodology

3.1 Introduction

This chapter covered the sampling method, sample size, inclusion criteria, exclusion criteria as well as the study methodology, which includes the design, instruments for data collection, and statistical analysis, as well as the research's ethical issues.

3.2 Research setting

This study was conducted in eight governmental hospitals in Palestine which include: Palestine Medical Complex , Jenin governmental hospital , Jericho governmental hospital , Beit Jala governmental hospital , Martyr Yasser Arfat governmental hospital , Darwish nazal hospital , Alia governmental hospital , Abu AL-Hasn governmental hospital.

To achieve the goal of this study the researcher quantified the number of patients who underwent CT examination of Pulmonary Angiography which are the following:

Table (3.1) CT examination of Pulmonary Angiography

Hospital	Location
Palestine Medical Complex	Ramallah
Jenin governmental hospital	Jenin
Jericho governmental hospital	Jericho
Beit Jala governmental hospital	Bethlehem
Martyr Yasser Arfat governmental hospital	Salfit
Darwish nazal hospital	Qalqilya
Alia governmental hospital	Hebron

Abu AL-Hasn governmental hospital	Hebron/Yatta

3.3 Population and sampling

The study was conducted on all patients who underwent pulmonary angiography for suspected (PE) in governmental hospitals in Palestine.

3.3.1 Sampling Method

Data collected retrospectively through the hospital's archiving system (PACS), and were asked the radiographer the following:

1. What is the volume of contrast used?
2. What is the volume rate injection used?
3. What type of optimization(reject and suboptimal and optimal) is used?
4. What type of accuracy (high , medium, low) is used?

3.3.1.1 research definitions

Optimization:

1.Optimal: Measurement of contrast enhancement within the PA is >300 HU.

2. Suboptimal: Measurement of contrast enhancement within the PA 200-300 HU.

3.Reject: Measurement of contrast enhancement within the PA is <200 HU. (Roggenland et.al 2008)

Optimal enhancement

Accuracy:

High: Contrast enhancement >300 HU in PA and <200 HU in DA

Medium: Contrast enhancement >300 HU in PA and DA

Low: Contrast enhancement <200 HU in PA and >300 HU in DA(M.chen et.al 2017)

Standard Computed Tomography pulmonary artery protocol and acquisition timing methods:

The patient is positioned supine, feet first. The injector is connected to the cannula, and the patient's arms are lifted above their head. The center of the line position is placed at the glabella. The side effects of the contrast and the breath holding technique are explained to the patient. We choose the CTPA protocol starting with a PA The CT localizer radiograph (scanogram) from half the orbits to mid liver, which is optional. we start the scan with three sequences. The first one is centered at

The main scan begins at the apex of both lungs until mid liver. The second scan begins at the same time as the injection of the contrast begins. The software begins measuring the HU of the pulmonary tract when it reaches the required threshold. The third scan begins. Only the third scan requires the patient to perform a breathing technique.

The researcher will employ both methods, asking different CT technologists and personal monitoring pathways, to observe the contrast agent protocol in each CT scan unit.

4.3.2 Data collection time

Data was collected retrospectively by all the computed tomography angiography of pulmonary embolism from (1/1 -30/5) in the year 2023.

4.3.3 Sample size

All PE patients population who underwent Chest CT for PE, CTPA, with CM (285 patients)

4.3.4 Inclusion Criteria

In our study, no specific age, all patients underwent a pulmonary angiography examination was included.

4.3.5 Exclusion Criteria

Any patient has allergy from iodine, patient who refuses to share his medical information.

3.4 Research design

Quantitative retrospective study design was used in this study.

3.5 Research instrument

Patient medical files, Hospital information system and PACS system.

3.6 Data Analysis

The collected data was analyzed by using the Statistical Package for Social Sciences (SPSS) Version (28). Data entry will be performed and double-checking for outliers or errors. Descriptive data analysis done. Regarding descriptive statistics, frequency, percentages, mean score and Standard Deviation (SD) will be measured to describe the study variables .

3.7 Ethical consideration

Al-Quds University institutional review board (IRB) was obtained, ethical approval from the Palestinian Ministry of Health was obtained, and anonymity and confidentiality will be protected all the time.

Chapter Four:

Reslut And Discussion:

4.1 Introduction

In this chapter, demographic frequencies and hypothesis testing results will be included.

4.2 Demographic Frequencies

4.2.1 Sample Distribution

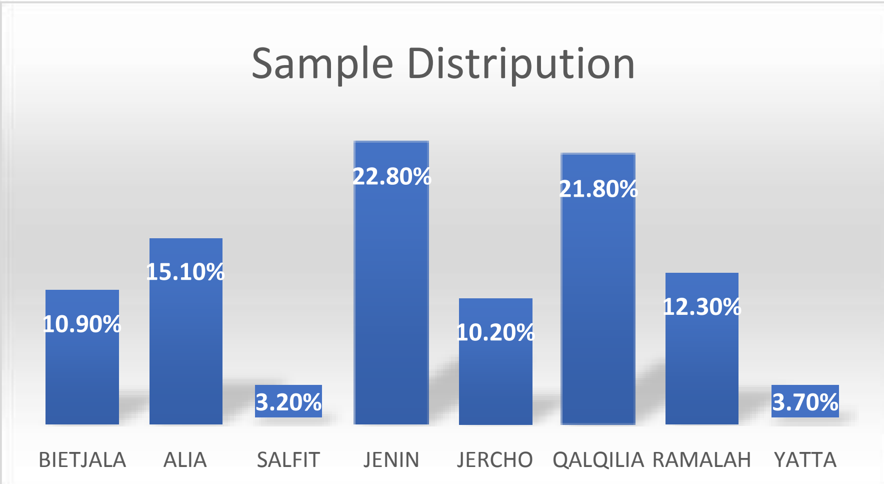

Figure 4.1: the sample distribution among hospitals, and shows that about 22.8% (n=65) of the sample was from Jenin hospital, while the smallest data was from Salfit hospital 3.2% (n=9).

4.2.2 Gender Distribution

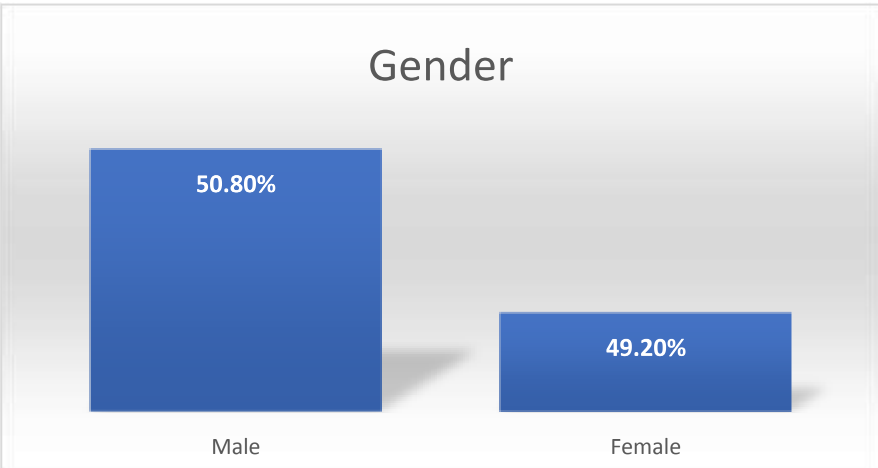

Figure 4.2: The sample distribution according to gender, that showed that the percentages of both males and females are nearly the same

4.2.3 Age Group

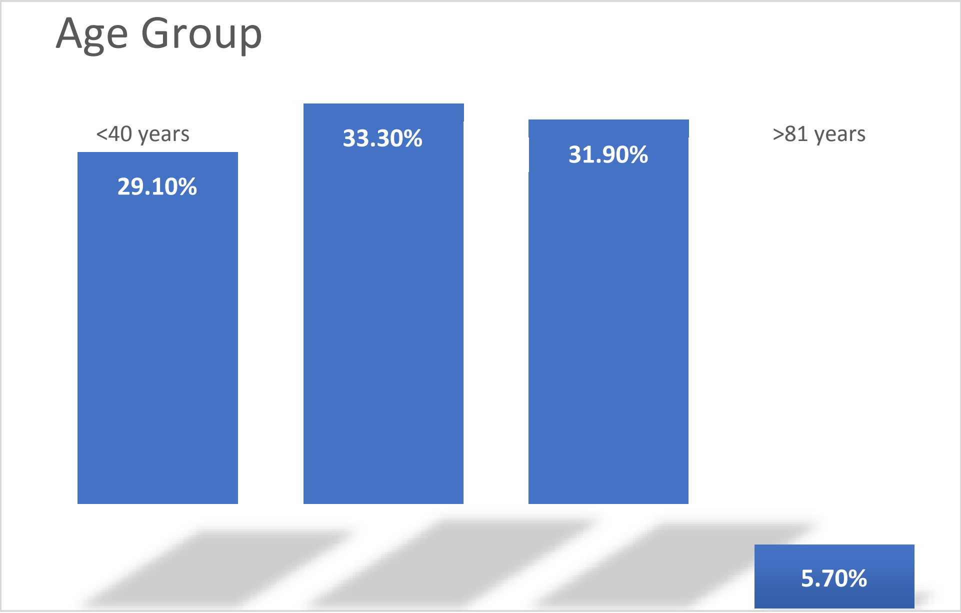

Figure 4.3: The sample distribution according to age group, and shows that about 33.3% (n=95) of the sample was between the 40-60 years, while the smallest data was from up of 81 year 5.7% (n=16).

4.3 Operational Frequencies

4.3.1 Hounsfield Value for the Pulmonary Trunk

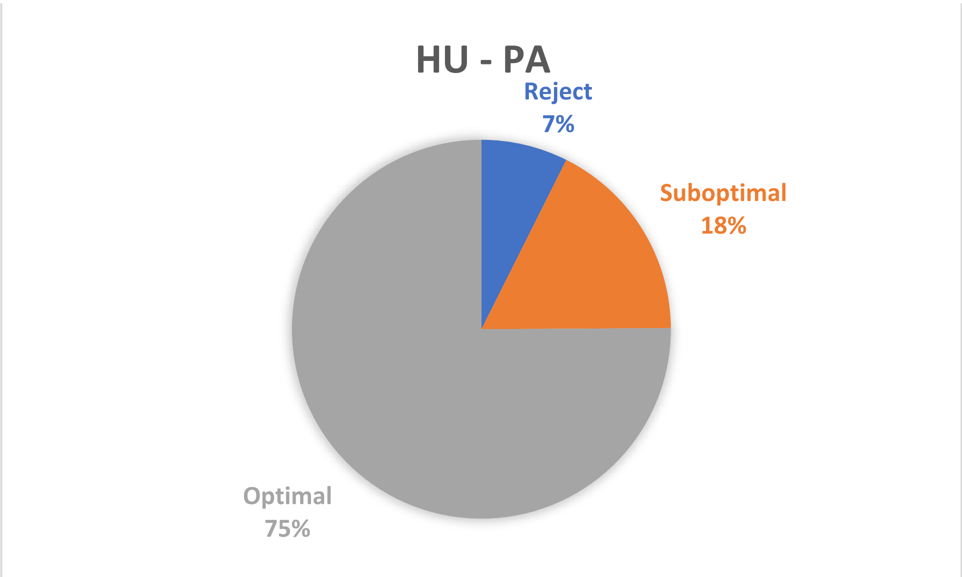

Figure 4.5**:** The sample distribution of the Hounsfield pulmonary trunk, and shows that about optimal 75% (n=214) of the sample , while the reject data was 7% (n=21).

4.3.2 Enhancing Accuracy

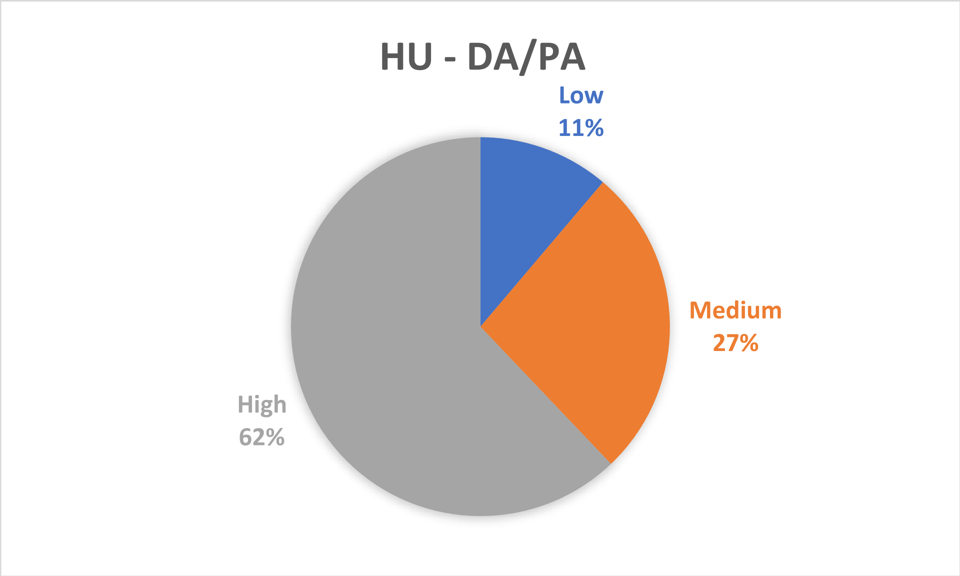

Figure 4.6: The sample distribution of Huon's field of pulmonary trunk and descending aorta , shows that the high is 62% (n=177) of the sample, while the low accuracy was 11% (n=32).

4.3.3 Contrast Media Volume in CC

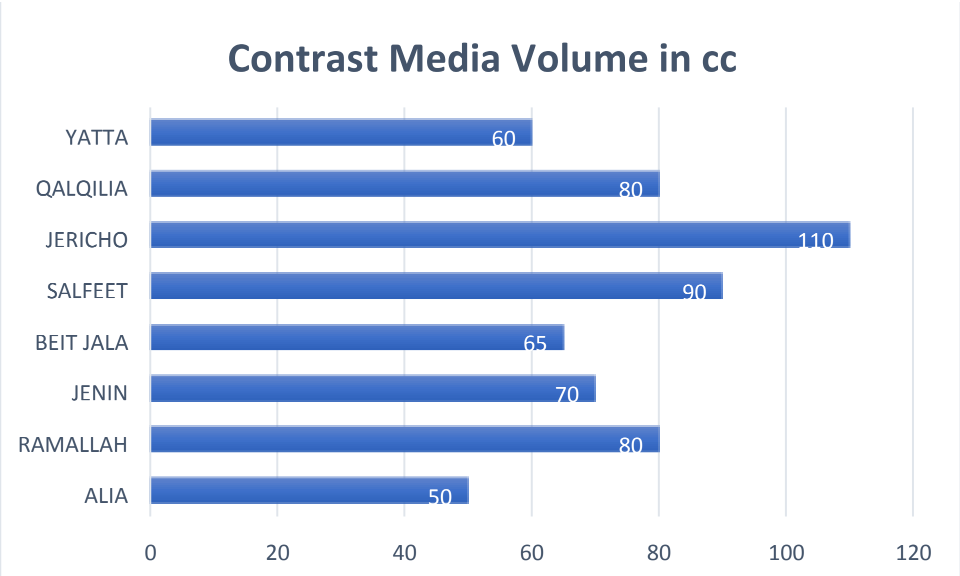

Figure 4.7: The sample distribution among of contrast media volume , and shows that about the highest contrast is 110 cc in from Jericho hospital, while the smallest contrast media was from alia hospital is 50 cc.

4.3.4 Contrast Media Flow Rate cc/sec

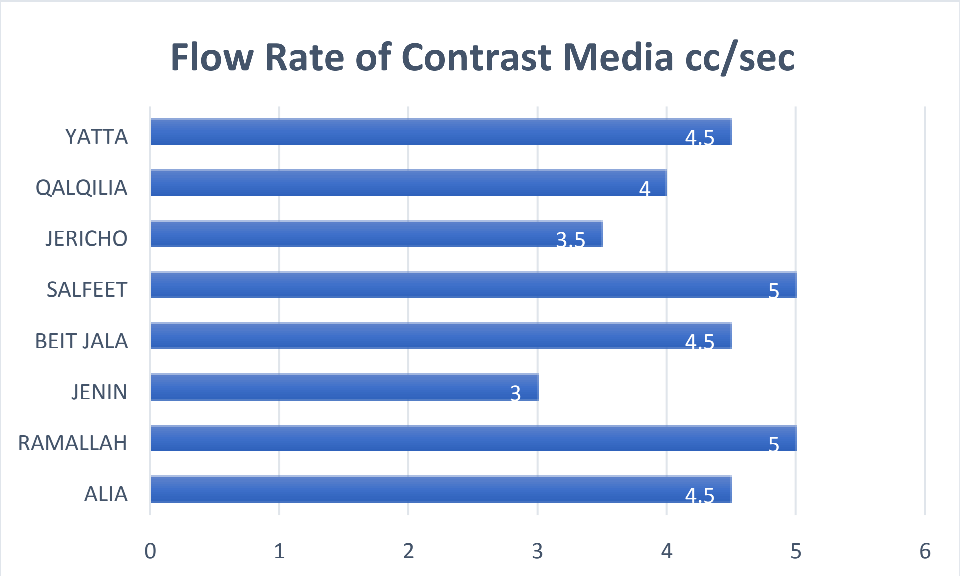

Figure 4.8: The sample distribution among of flow rate contrast media cc/ sec, and shows that the highest flow rate is 5 cc/sec from Salfit and Ramallah hospitals, while the smallest flow rate from Jenin Hospital is 3 cc/sec

4.4 Hypothesis Testing

4.4.1 Hypothesis One

There is no significant correlation at the level of significant α≤0.05 between region and HU(PA)

To examine the hypothesis chi-square test used

Table (4.1) : The results of Chi-square to test the correlation at the level of significant α≤0.05 between region and HU(PA)

Crosstab						
			HU_PA			Total
			reject	suboptimal	optimal	
region	BIETJALA	Count	4	4	23	31
		% of Total	1.4%	1.4%	8.1%	10.9%
	ALIA	Count	9	10	24	43
		% of Total	3.2%	3.5%	8.4%	15.1%
	SALFIT	Count	0	3	6	9
		% of Total	0.0%	1.1%	2.1%	3.2%

	JENIN	Count	2	8	55	65
		% of Total	0.7%	2.8%	19.3%	22.8%
	JERCHO	Count	0	4	25	29
		% of Total	0.0%	1.4%	8.8%	10.2%
	QALQILIA	Count	2	15	45	62
		% of Total	0.7%	5.3%	15.8%	21.8%
	RAMALAH	Count	3	5	27	35
		% of Total	1.1%	1.8%	9.5%	12.3%
	YATTA	Count	1	1	9	11
		% of Total	0.4%	0.4%	3.2%	3.9%
Total		Count	21	50	214	285
		% of Total	7.4%	17.5%	75.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.551[a]	14	.016
Likelihood Ratio	27.286	14	.018
Linear-by-Linear Association	4.622	1	.032
N of Valid Cases	285		

There is a significant correlation at the level of significant $\alpha \leq 0.05$ between region and HU(PA) since p-value is 0.016 less than 0.05 reject the null hypotheses

Hypothesis number two:

There is no significant correlation at the level of significant $\alpha \leq 0.05$ between region and HU DC AORTA - PA TRUNCK

To examine the hypothesis chi-square test used

Table (4.2): The results of Chi-square to test the correlation at the level of significant α≤0.05 between region and HU DC AORTA - PA TRUNCK.

Crosstab

			HU DC AORTA - PA TRUNCK			
			low	mid	high	Total
region	BIETJALA	Count	1	11	19	31
		% of Total	0.4%	3.9%	6.7%	10.9%
	ALIA	Count	10	9	24	43
		% of Total	3.5%	3.2%	8.4%	15.1%
	SALFIT	Count	1	5	3	9
		% of Total	0.4%	1.8%	1.1%	3.2%
	JENIN	Count	4	11	50	65
		% of Total	1.4%	3.9%	17.5%	22.8%
	JERCHO	Count	2	14	13	29
		% of Total	0.7%	4.9%	4.6%	10.2%
	QALQILIA	Count	11	18	33	62
		% of Total	3.9%	6.3%	11.6%	21.8%
	RAMALAH	Count	1	5	29	35
		% of Total	0.4%	1.8%	10.2%	12.3%
	YATTA	Count	2	3	6	11
		% of Total	0.7%	1.1%	2.1%	3.9%
Total		Count	32	76	177	285
		% of Total	11.2%	26.7%	62.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	36.556[a]	14	.001
Likelihood Ratio	35.914	14	.001
Linear-by-Linear Association	.300	1	.584
N of Valid Cases	285		

There is a significant correlation at the level of significant α≤0.05 between region and HU DC AORTA - PA TRUNCK since p-value is 0.001 less than 0.05 reject the null hypotheses

Hypothesis number three:

There is no significant correlation at the level of significant α≤0.05 between gender and HU(PA)

To examine the hypothesis chi-square test used

Table (4.3) : The results of Chi-square to test the correlation at the level of significant α≤0.05 between gender and HU(PA)

Crosstab

			HU_PA			Total
			reject	suboptimal	optimal	
gender	male	Count	11	26	106	143
		% of Total	3.9%	9.1%	37.2%	50.2%
	female	Count	10	24	108	142
		% of Total	3.5%	8.4%	37.9%	49.8%
Total		Count	21	50	214	285
		% of Total	7.4%	17.5%	75.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	.143[a]	2	.931
Likelihood Ratio	.143	2	.931
Linear-by-Linear Association	.129	1	.719
N of Valid Cases	285		

There is no significant correlation at the level of significant $\alpha \leq 0.05$ between gender and HU(PA) since p-value is 0.931 more than 0.05 accept the null hypotheses

Hypothesis number four:

There is no significant correlation at the level of significant $\alpha \leq 0.05$ between gender and HU DC AORTA - PA TRUNCK

To examine the hypothesis chi-square test used

Table (4.4): **The results of Chi-square to test the correlation at the level of significant $\alpha \leq 0.05$ between gender and HU DC AORTA - PA TRUNCK**

Crosstab

			HU DC AORTA - PA TRUNCK			Total
			low	Mid	high	
gender	male	Count	15	38	90	143
		% of Total	5.3%	13.3%	31.6%	50.2%
	female	Count	17	38	87	142
		% of Total	6.0%	13.3%	30.5%	49.8%
Total		Count	32	76	177	285
		% of Total	11.2%	26.7%	62.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.172[a]	2	.917
Likelihood Ratio	.172	2	.917
Linear-by-Linear Association	.149	1	.700
N of Valid Cases	285		

There is no significant correlation at the level of significant α≤0.05 between gender and HU DC AORTA - PA TRUNCK since p-value is 0.917 more than 0.05 accept the null hypotheses

Hypothesis number five:

There is no significant correlation at the level of significant α≤0.05 between age and HU(PA)

To examine the hypothesis chi-square test used

Table (4.5) : The results of Chi-square to test the correlation at the level of significant α≤0.05 between age and HU(PA)

Crosstab						
			HU_PA			Total
			reject	suboptimal	optimal	
age	less tha 40	Count	9	21	53	83
		% of Total	3.2%	7.4%	18.6%	29.1%
	40-60	Count	7	17	71	95
		% of Total	2.5%	6.0%	24.9%	33.3%
	61-80	Count	5	12	74	91
		% of Total	1.8%	4.2%	26.0%	31.9%
	more than 81	Count	0	0	16	16

		% of Total	0.0%	0.0%	5.6%	5.6%
Total		Count	21	50	214	285
		% of Total	7.4%	17.5%	75.1%	100.0%

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.807[a]	6	.046
Likelihood Ratio	16.346	6	.012
Linear-by-Linear Association	10.484	1	.001
N of Valid Cases	285		

There is a significant correlation at the level of significant α≤0.05 between age and HU(PA) since p-value is 0.046 less than 0.05 reject the null hypotheses Hypothesis number six:

There is no significant correlation at the level of significant α≤0.05 between age and HU DC AORTA - PA TRUNCK

To examine the hypothesis chi-square test used

Table (4.6) : The results of Chi-square to test the correlation at the level of significant α≤0.05 between age and HU DC AORTA - PA TRUNCK

Crosstab						
			HU DC AORTA - PA TRUNCK			Total
			low	mid	high	
age	less tha 40	Count	10	23	50	83
		% of Total	3.5%	8.1%	17.5%	29.1%
	40-60	Count	11	23	61	95
		% of Total	3.9%	8.1%	21.4%	33.3%

	61-80	Count	9	25	57	91
		% of Total	3.2%	8.8%	20.0%	31.9%
	more than 81	Count	2	5	9	16
		% of Total	0.7%	1.8%	3.2%	5.6%
Total		Count	32	76	177	285
		% of Total	11.2%	26.7%	62.1%	100.0%

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.832[a]	6	.991
Likelihood Ratio	.838	6	.991
Linear-by-Linear Association	.025	1	.875
N of Valid Cases	285		

There is no significant correlation at the level of significant α≤0.05 between age and HU DC AORTA - PA TRUNCK since p-value is 0.991 more than 0.05 accept the null hypotheses

Hypothesis number seven:

There is no significant correlation at the level of significant α≤0.05 between HU(PA) and HU DC AORTA - PA TRUNCK

To examine the hypothesis chi-square test used

Table (4.7) : The results of Chi-square to test the correlation at the level of significant α≤0.05 between HU(PA) and HU DC AORTA - PA TRUNCK

HU_AP * HU DC AORTA - PA TRUNCK Crosstabulation						
			HU DC AORTA - PA TRUNCK			Total
			low	mid	high	
HU_AP	reject	Count	5	5	11	21
		% of Total	1.8%	1.8%	3.9%	7.4%

	suboptimal	Count	13	24	13	50
		% of Total	4.6%	8.4%	4.6%	17.5%
	optimal	Count	14	47	153	214
		% of Total	4.9%	16.5%	53.7%	75.1%
Total		Count	32	76	177	285
		% of Total	11.2%	26.7%	62.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	41.089[a]	4	.000
Likelihood Ratio	39.761	4	.000
Linear-by-Linear Association	24.395	1	.000
N of Valid Cases	285		

There is a significant correlation at the level of significant α≤0.05 between HU(PA) and HU(PA) since p-value is 0.000 less than 0.05 reject the null hypotheses

4.5 Answers of research questions:

1. Wich hospital has the highest number of examinations within the sample?

   Jenin governmental hospital 22.8%.

2. Which hospital has the highest optimal percentage and compliance to standards?

   Jenin governmental hospital 19.3%.

3. Which hospital has the highest enhancement accuracy percentage and compliance to standards?

   Jenin governmental hospital 17.5%.

In the scope of our research, we embarked on an extensive study conducted across eight Palestinian governmental hospitals, enrolling a cohort of 285 patients. Our central focus revolved around the use of the Hounsfield unit as a pivotal tool for determining the optimal contrast enhancement window for pulmonary artery CT angiography. This investigation also probed the relationship between contrast dosage and enhancement outcomes, aiming to contribute valuable insights to the medical community.

The overarching findings from our research unequivocally indicated that the choice of contrast enhancement percentage played a pivotal role in the diagnostic accuracy achieved in these medical facilities. Across all the hospitals under scrutiny, the optimal enhancement percentage was consistently observed at 75%, encompassing 214 patients. In contrast, 7% of cases, representing 21 patients, were rendered unsuitable for evaluation due to suboptimal enhancement. Notably, a significant proportion, 62% of patients, demonstrated high diagnostic accuracy, with 11% yielding lower accuracy.

The pronounced variation in the performance of these hospitals, with Jenin Hospital emerging as the standout contender in both timing enhancement and diagnostic accuracy. A remarkable 19.3% of cases within Jenin Hospital achieved optimal enhancement, showcasing an extraordinary 17.5% high accuracy rate, significantly outperforming other departments. This achievement at Jenin Hospital could be attributed to a fine-tuned protocol of optimal enhancement and high accuracy through the meticulous use of time bolus tracking.

In our study of contrast media volume. Through our investigation, we revealed that the use of Analyzing the flow rate of contrast media (cc/sec), the data clearly depicted that Salfit and Ramallah Hospitals, with their adoption of a flow rate of 5 cc/sec, reigned supreme in this domain. This was a stark contrast to Jenin Hospital, where the flow rate dipped to 3 cc/sec, emerging as the lowest among all the hospitals under examination.

It is of paramount importance to emphasize the potential consequences of hospitals employing a high contrast volume in their protocols. Our findings strongly suggest that such an approach might inadvertently expose patients to a higher risk of side effects. According to established medical literature, pulmonary angiography typically prescribes an injection volume of 60 ml of contrast, coupled with 100 ml of saline, administered at a rate of 4.5/5 mL/s. The investigation unveiled that a high volume of contrast is associated with side effects, primarily due to different mechanisms that, in some cases, remain either poorly understood or subject to ongoing debate. Nonetheless, certain influencing factors have been identified, underlining the complexity of this facet of medical practice.

Our research also delved into the distribution of patient samples across age groups. The data we meticulously collected and analyzed revealed some intriguing patterns. The most substantial cohort, 33.3% (95 patients), fell within the age group of 40 to 60 years, while the smallest segment comprised patients aged 81 and older, accounting for a mere 5.6% (16 patients). These age distribution trends provide essential insights for clinicians and medical practitioners, aiding in the development of more targeted and effective diagnostic and treatment strategies.

Drawing comparisons with existing research is a hallmark of a comprehensive study, and in this vein, we observed a study by Chang Lee in 2007. Lee's work involved a prospective investigation of three distinct injection protocols: Protocol A (24 ml, 0.8 mL/s without saline), Protocol B (administering contrast medium at the same rate as saline), and Protocol C (employing half the rate, 0.4 mL/s of contrast, with saline). The outcome of this study was significant, revealing that peak contrast enhancements in Protocol B were noticeably delayed compared to Protocol A. Moreover, Protocol C yielded lower peak enhancement values compared to both Protocol A and Protocol B. These insights from Lee's work underscore the vital role that contrast injection protocols play in achieving optimal enhancement and, consequently, accurate diagnostic outcomes.

While Chang Lee's study delved into specific protocols, our research took a more comprehensive approach. We compared and assessed the protocols adopted by eight Palestinian public hospitals, all aimed at improving pulmonary embolism examination. The range of injected volumes observed across these institutions was considerable, spanning from 50 to 120 ml. Injecting rates, measured in ml/sec, were equally diverse, with rates fluctuating between 2.5 and 5. This variation in approach highlights the complexities surrounding standardization in medical practice.

Furthermore, our study emphasized the relevance of the electrical charge of the contrast media used in these procedures. The side effects experienced by patients were more frequent and pronounced when contrast media exhibited an increase in osmolality, protein binding, and lipophilicity. Conversely, hydrophilicity of the contrast media acted as a mitigating factor, reducing the risk of side effects. Moreover, we recognized that patients with renal failure might be at higher risk of experiencing side effects, underlining the importance of considering patient-specific factors in designing contrast protocols.

Chapter Five:

Conclusion And Recommendation:

5.2 Conclusion:

our research underscores the critical role that contrast enhancement percentages, contrast media volume, and injection protocols play in the accuracy and efficacy of pulmonary artery CT angiography in Palestinian governmental hospitals. The wide variation in results among these hospitals suggests that there is room for further standardization and optimization in the use of contrast media. Our findings not only contribute to the body of knowledge in this field but also provide valuable insights for clinicians and medical practitioners, ultimately benefiting patient care and treatment outcomes.

5.2 Recommendation:

1. We recommend unifying the contrast media volume in the pulmonary angio protocol in Palestine health system.
2. We recommend to standardization the injection rate in the pulmonary angio protocol in Palestine health system.
3. We recommend to do courses to medical imaging teqnolgist to do the optimal enhancement for the real time.

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دراسة تقييم التباين الأمثل للأشعة المقطعية المحسنة لتصوير الأوعية الرئوية في النظام الصحي الفلسطيني

اعداد :احمد فتحي علي عليان

اشراف : د. محمد حجوج

ملخص الدراسة

المقدمه :

أصبحت تقنية التصوير المقطعي المحوسب إحدى طرق التشخيص القياسية الذهبية في جميع أنحاء العالم. خلال العقد الماضي، كشفت العديد من التطورات عن إجراءات تصوير الأوعية الدموية الجديدة في التصوير المقطعي المحوسب في وقت اختبار أقصر وجودة صورة أعلى. يعتبر التوقيت المناسب في تصوير الأوعية المقطعية للشرايين الرئوية أمرًا حيويًا لدقة تشخيص الانسداد الرئوي.

الغاية:

الهدف العام من هذا البحث هو تقييم التصوير المقطعي المحوسب بالتباين الأمثل لتصوير الأوعية الرئوية في النظام الصحي الفلسطينية

الأهداف الرئيسية لهذا البحث هي:

1. تحديد التعزيز الأمثل باستخدام وسائط التباين لشريان الرئوي والشريان الأبهر النازل وفقًا للمستشفى الذي تم فحصه وجنس وعمر المريض.

2. تحديد دقة مسح الشريان الرئوي والشريان الأبهر النازل حسب المستشفى الذي تم فحصه وجنس وعمر المريض.

المنهجية:

تم إجراء دراسة مقطعية بأثر رجعي لتقييم التباين الأمثل للتصوير المقطعي المحوسب لتصوير الأوعية الرئوية لـ 285 مريضًا خضعوا للفحص لاكتشاف الصمات الرئوية. تم جمع البيانات باستخدام نظام أرشفة الصور والاتصال من جميع المستشفيات الحكومية الثمانية في الضفة الغربية. تم استخدام الحزمة الإحصائية للعلوم الاجتماعية لتحليل البيانات المجمعة حسب الجنس والفئة العمرية والتحسين الأمثل ودقة الصورة بالإضافة إلى اختبار الفرضيات.

النتائج:

ويكشف تحليل البيانات أن نسبة التحسين الأمثل تمت ملاحظتها باستمرار عند 75%، وتشمل 214 مريضًا. في المقابل، أصبحت 7% من الحالات، التي تمثل 21 مريضًا، غير مناسبة للتقييم بسبب التعزيز دون المستوى الأمثل. ومن الجدير بالذكر أن نسبة كبيرة، 62% من المرضى، أظهرت دقة تشخيصية عالية، مع 11% أقل دقة.

التباين الواضح في أداء هذه المستشفيات، حيث ظهر مستشفى جنين كمنافس بارز في تحسين التوقيت ودقة التشخيص. حققت 19.3% من الحالات داخل مستشفى جنين تحسينًا مثاليًا، حيث أظهرت معدل دقة عاليًا بنسبة 17.5%، متفوقة بشكل كبير على الأقسام الأخرى. يمكن أن يعزى هذا الإنجاز في مستشفى جنين إلى البروتوكول الدقيق للتحسين الأمثل والدقة العالية من خلال الاستخدام الدقيق لتتبع الجرعة الزمنية.

في دراستنا لحجم وسائط التباين. من خلال التحقيق الذي أجريناه، كشفنا أن استخدام وسائط التباين في مستشفى أريحا كان له أعلى حجم تباين مسجل قدره 110 سم مكعب.

أعلن مستشفى عالية عن أصغر حجم لوسائل التباين، حيث بلغ وزنها 50 سم مكعب فقط. يسلط هذا التباين في حجم وسائط التباين المستخدمة الضوء على التباين الكبير في طرق تصوير الأوعية المقطعية للشريان الرئوي عبر هذه المؤسسات الطبية.

الخاتمة:

يؤكد بحث الدراسة الحالية على الدور الحاسم الذي تلعبه نسب تعزيز وسائط التباين، وحجم وسائط التباين، ومعدل الحقن، وبروتوكولات التوقيت في دقة وفعالية تصوير الأوعية الدموية بالتصوير المقطعي للشريان الرئوي في المستشفيات الحكومية الفلسطينية. يشير التباين الكبير في النتائج بين هذه المستشفيات إلى أن هناك مجالًا لمزيد من التوحيد والتحسين في استخدام الطب البديل. ولا تعمل النتائج التي توصلنا إليها على تعزيز المعرفة في هذا المجال فحسب، بل توفر أيضًا رؤى قيمة للأطباء والممارسين الطبيين، مما يفيد في نهاية المطاف رعاية المرضى ونتائج العلاج.