COMPARISON OF CHEST RADIOGRAPH AND CT PULMONARY ANGIOGRAPHY FINDINGS AMONG ADULTS WITH SUSPECTED PULMONARY EMBOLISM AT MTRH, ELDORET, KENYA

BY

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A Research thesis Submitted to Moi University School of Medicine in Partial fulfillment of the award of the degree of Master of Medicine in Radiology and Imaging.

COMPARISON OF CHEST RADIOGRAPH AND CT PULMONARY ANGIOGRAPHY FINDINGS AMONG ADULTS WITH SUSPECTED PULMONARY EMBOLISM AT MTRH, ELDORET, KENYA

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DECLARATION

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DEDICATION

This work is dedicated to my parents Mr. Abdinasir Adan Mohamed and Mrs. Halima Ibrahim Ali whose love and support has been my strength all through my life

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ABSTRACT

Background: Pulmonary embolism (PE) is the third leading cause of mortality in cardiovascular disease, after myocardial Infarction and cerebrovascular stroke. Diagnosis of PE is based on computed tomographic pulmonary angiography (CTPA), which is the gold standard. Other tests include clinical, D-dimer test, Chest Radiograph, Ventilation/perfusion studies, Echocardiography and lower limb Doppler ultrasound. PE poses a diagnostic challenge due to non-specific clinical presentation and non-availability of gold standard diagnostic tests especially in resource limited settings including Kenya, as well as variability in common Chest Radiograph findings in PE hence the justification for this study.

Objective: To describe and compare chest radiograph and CTPA findings among adults suspected to have pulmonary embolism at Moi Teaching and Referral Hospital (MTRH)

Methods: This was a cross-sectional descriptive study conducted at the Radiology department, MTRH between September 2017 and August 2018. Seventy Five (75) consecutive patients aged ≥18 years with clinically suspected PE were enrolled after consenting. Socio-demographic data was recorded using a questionnaire. Study participants done Chest Radiograph were further subjected to CTPA examination as per current MTRH Protocol. All chest radiographs and CTPA were reviewed and findings documented on standard reporting form. Data was analyzed using STATA software version 13.0. Descriptive statistics was summarized by percentage, whereas categorical data was analyzed using Chi-square and Fishers exact test. *P* value <0.05 was considered statistically significant. Cohen Kappa statistics was used to compare findings between Chest Radiograph and CTPA.

Results: Mean age of the study participants was 46.5 years (SD ±18.7), with females being the majority at 64 %(48). The chest radiograph was interpreted as abnormal in 65.52% (19) of the participants with PE. The common chest radiograph abnormalities associated with PE were cardiomegaly at 45 %(13) pleural effusion at 38% (11), atelectasis 24% (7), and Hampton hump at 21% (6). CTPA prevalence of PE was 38.7% (29) and the right pulmonary artery was the most predominant location for PE. Common parenchymal and pleural abnormalities associated with PE detected on CTPA were Pleural effusion accounting for 62% (18), atelectasis at 35% (10), Hampton hump at 31.3% (9), consolidation 17%(5) and Westermark's sign at 14%.(4).The presence of Hampton hump on Chest Radiograph was significantly associated with PE ($p = 0.012$) and there was fair agreement between chest radiograph and CTPA in the diagnosis of PE at 60% with Cohen Kappa statistics of 0.21.

Conclusions: 1. Majority (65.5%) of the patients with PE had Cardiomegaly, pleural effusion, atelectasis and Hampton hump as the common abnormal Chest Radiograph findings 2.There was fair agreement between chest radiograph and CTPA in identifying pulmonary embolism.

Recommendations: 1. High index of suspicion for PE in patients with Hampton hump, Cardiomegaly, pleural effusion and atelectasis on chest Radiograph

2. Chest radiograph can be used for investigating patients with suspected pulmonary embolism in resource constrained settings.

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DEFINITION OF TERMS

Pulmonary Embolism is defined as partial or total occlusion of pulmonary arteries or its branches by thrombi that originate typically in the large veins of the lower extremities or pelvis

Thrombus: Formation of a blood clot (platelets and/or fibrin) within the vascular system. A thrombus becomes an embolism if it breaks away and blocks a blood vessel.

LIST OF ABBREVIATIONS

AO	Ascending Aorta
CTPA	Computed Tomographic pulmonary angiography
DVT	Deep Venous Thrombosis
HU	Hounsfield Units
LPA	Left pulmonary artery
MDCT-PA	Multidetector Computed Tomographic Pulmonary Angiography
MPA	Main Pulmonary Artery
MTRH	Moi Teaching and Referral Hospital
PA	Postero-anterior
PE	Pulmonary Embolism
RA	Right atrium
RPA	Right pulmonary artery
RV	Right ventricle
V/Q	Ventilation Perfusion radionuclide scanning
VTE	Venous thrombo-embolism

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND INFORMATION

Pulmonary embolism (PE) is defined as partial or total occlusion of pulmonary arteries or its branches by thrombi that originate typically in the large veins of the lower extremities or pelvis (Kasper et al., 2005)

PE is the third most common acute cardiovascular pathology after myocardial infarction and stroke, resulting in thousands of deaths each year globally. It is a fatal disorder for which if diagnosed early, anticoagulation therapy improves its outcome. Untreated PE has 30% mortality rate but if treated the mortality rate is reduced to 2.5 to 8% (Daniel F. Worsley and Abass Alavi 2003)

The challenge is that the disease is difficult to identify often because the symptoms are non-specific and diagnosis strongly relies on noninvasive imaging techniques.

According to Kenya National guidelines for Cardiovascular disease Management (2018) and American College of Radiology, CT Pulmonary angiography is the gold standard for diagnosis of PE because it has high sensitivity and specificity and low inconclusive results, however it's not available in most health facilities in developing countries Kenya included and it is expensive (Lomamba et al 2017)

The chest radiograph is the initial test in the assessment of cardiopulmonary diseases and has the advantage of being non-invasive, available and cheap.

Controversy exists in literature on the role of Chest Radiograph in the diagnosis of PE, some authors saying it's only useful in the diagnosis that mimic PE while others say Chest Radiograph may provide clues.

This study was conducted to compare and describe chest radiograph and CT pulmonary angiography findings in patients with suspected pulmonary embolism.at MTRH

1.2 Problem Statement

PE is a life-threatening condition if not diagnosed early. The overall mortality rate in untreated patients is 30%, with approximately 10% of patients dying within one hour of the event. (Raksha Ramlakhan et al 2017)

The challenge is that the disease is difficult to diagnose often because the symptoms are non-specific

American college of Radiology (ACR) 2016, recommends CTPA as the standard care test for detection of PE, however the challenge there is non-availability of CT scans and personnel with expertise in most health facilities in Kenya and its relatively expensive

The Chest radiograph is relatively cheap and available and first imaging study to evaluate cardiopulmonary diseases and rarely health care workers look for evidence of pulmonary embolism therefore looking for features of PE may enhance early diagnosis

No study on comparison of chest radiography and CT Pulmonary angiography findings was done in our local set up

The purpose of this study was to describe CT Pulmonary angiography and chest radiograph common findings among patients with clinically suspected pulmonary embolism with the aim enhancing early diagnosis

1.3 Justification

Pulmonary embolism remains largely under diagnosed and under treated clinical problem amongst hospitalized patients especially in poor resource centers due to non-availability of gold standard test which is CT Pulmonary angiography(Lomamba et al 2017)

There is Variability in common chest radiograph findings in patients with pulmonary embolism for instance Zubairi et al (2007) and Elliot CG et al. (2000) reported cardiomegaly to be the most common finding while Worsley DF et al (1995) and Stein PD et al (1991) found that atelectasis and/or pulmonary parenchymal abnormalities to be the most common

Chest radiograph is the initial investigation done to patients suspected to have pulmonary embolism, relatively cheap and available and therefore describing the findings in our set up and comparing with the gold standard may enhance early diagnosis

Data that describe chest radiographic findings associated with the diagnosis of acute pulmonary embolism are limited

No study has described the comparison between chest radiograph and CT Pulmonary angiography findings among patients with suspected pulmonary embolism in our local set up

Pulmonary Embolism (PE) is an important cause of morbidity leading to thousands of deaths each year globally. If diagnosed early with the most available and non-invasive diagnostic tool, morbidity and mortality can be significantly reduced.

1.4 Research Question

What are the comparison of chest radiograph and CTPA findings among adult suspected to have pulmonary embolism at MTRH?

1.5 Objectives

1.5.1 Broad objective

To describe and compare chest radiograph and CTPA findings among adult patients suspected to have pulmonary embolism at MTRH

1.5.2 Specific Objectives

1. To describe common chest radiograph findings among adult patients with suspected pulmonary embolism at MTRH
2. To describe radiological findings on CTPA in suspected pulmonary embolism patients at MTRH
3. To compare chest radiograph and CTPA findings among adult patients with suspected pulmonary embolism at MTRH

CHAPTER TWO

LITERATURE REVIEW

Pulmonary embolus (PE) refers to obstruction of the pulmonary artery or one of its branches by material (e.g., thrombus, tumor, air, or fat) that originated elsewhere in the body(Kasper et al., 2005)

2.1 Epidemiology of Pulmonary Embolism

The overall incidence of venous thromboembolism worldwide is 0.75-2.69/1000 individuals in the populations (Raskob, G. E et al 2014)

Globally the incidence of PE is estimated to be approximately 60 to 70 per 100,000, according to a community based study done in western France.(Bělohlávek, Dytrych, & Linhart, 2013). 1 in 4 deaths globally is due to venous thromboembolism and it occurs in 60% of hospitalized patients (Otellini PS 2011)

In Europe, the annual incidence rates of venous thrombosis and PE was found to be approximately 5 to 10 per 10000 inhabitants. (Bělohlávek et al., 2013)

. Incidence of PE in the United States of America is 10 per 10,000 annually and is responsible for 5% to 10% of all hospital deaths.(Anderson et al., 2007)

According to a systematic review by Danwang Celestin et al (2017), wide-range prevalence of PE was reported in Africa among medical patients (0.14% and 61.5%), with a mortality rate of PE between 40% and 69.5%

CTPA prevalence of PE was reported to be 32.4% in sub-Saharan Africa (Tambe J et al 2012) and an autopsy study done by Ogengo et al. **(2011)** in KNH described an incidence rate of 0.032% over a five-year period in black Africans at a tertiary hospital in Kenya, PE is a frequent cause of cardiovascular mortality in Kenya accounting for 14.21% of deaths.

Pastakia SD et al (2010) in Eldoret reported major indication for anticoagulation in Western Kenya to be pulmonary thromboembolism at 59%

However true incidence of PE is unknown because 80% of patients with an identified PE at autopsy are unsuspected or undiagnosed before death (Stein et al., 2006)

2.2 Pathophysiology, Risk factors and Clinical Presentation

Venostasis, hypercoagulability and vessel wall injury (Virchow triad) are the known key triggers of venous thrombosis and risk factors for PE (Preto et al 2010)

Since about 50-60% of patients with DVT develop PE, together they are termed as venous thromboembolic disease. (Kostadima & Zakynthinos, 2007)

Risk factors for pulmonary embolism, include advanced age, prolonged immobility, surgery, trauma, malignancy, pregnancy, estrogen therapy, congestive heart failure and inherited or acquired defects in blood coagulation factors. These factors can occur in is isolation or in combination (Preto et al., 2010). However, in 30% of patients with PE there is identifiable risk factor (Bělohlávek et al., 2013) and in ENDORSE-Africa study, 70.6% of patients with venous thromboembolism had no risk factors(Kingue et al., 2014)

Although non-specific, symptoms of PE in the Prospective Investigation of Pulmonary

Embolism Diagnosis (PIOPED) study include dyspnea (73%), chest pain (66%), cough (37%), and hemoptysis (13%).

2.3 Diagnosis of Pulmonary Embolism

Diagnosis of PE is challenging because of its non-specific clinical presentation and if missed can lead to serious effects including mortality and if over diagnosed may warrant unnecessary initiation of anticoagulation (Hamad et al 2011)

2.4 Noninvasive Imaging Modalities

2.4.1 Chest Radiograph

According to American college of Radiology PE appropriateness criteria (2016) chest radiograph is first line Radiological investigation in evaluating suspected PE patients because its inexpensive, fast and easy to perform and in addition may reveal substitute diagnosis explaining the symptoms such as pneumonia, pneumothorax and pleural effusion (Elliot et al 2000)

Majority (88%) of patients with PE show abnormal chest Radiograph findings according to the international cooperative study of the PE registry reported (Elliot et al 2000). In another study, chest radiograph was found to have no role in the diagnosis of PE as such, but useful in identifying differential diagnosis like pneumonia, pulmonary edema, or pneumothorax (Moore et al., 2018) (Worsley et al., 1993)

The sensitivity of chest radiograph in the diagnosis of pulmonary embolism was found to be 52% to 88% while the specificity was 31% to 80%. The false-positive and false-negative ratios were, 21% and 41%. respectively (Greenspan, Ravin, Polansky, & McLOUD, 1981)

Chest Radiograph findings in patients with PE may vary over time, initially it may be normal or may show features of pulmonary oligemia(Westermark sign).Over time, features of atelectasis, pleural effusion, infiltrates and an elevated hemidiaphragm will appear. Late finding include Hampton hump, and enlargement of right descending pulmonary artery (Pallas sign) (Preto et al., 2010) (Abbas et a al 2013)

There are wide variations on common Chest Radiograph findings among patients with PE; Zubairi et al (2007) in Pakistan and C. Gregory Elliott et al (2000) USA reported cardiomegaly to be the most common Chest Radiograph finding while Worsley DF et al (1993) and Stein PD et al (1991) USA found that atelectasis and/or pulmonary parenchymal abnormalities to be the most common abnormality

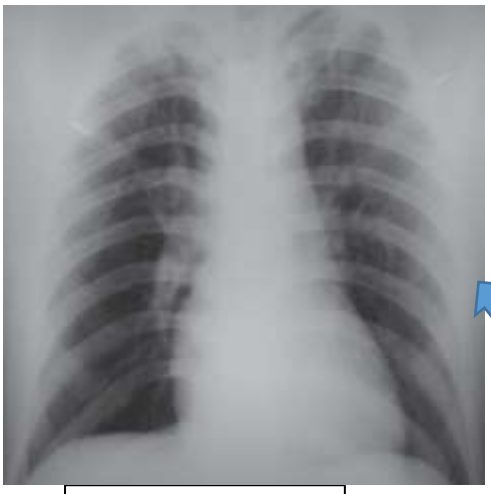


Figure 1A

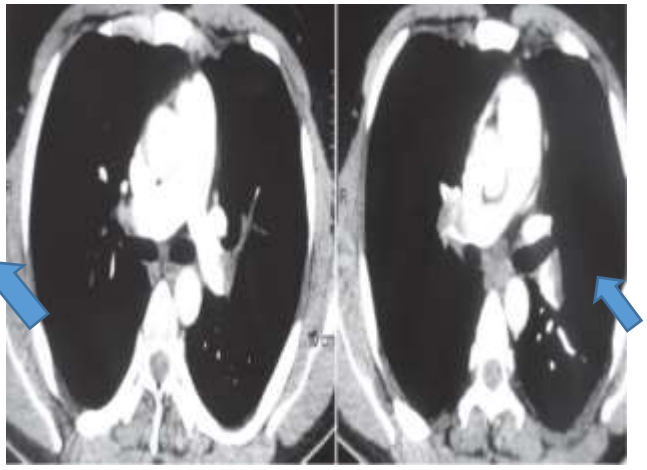
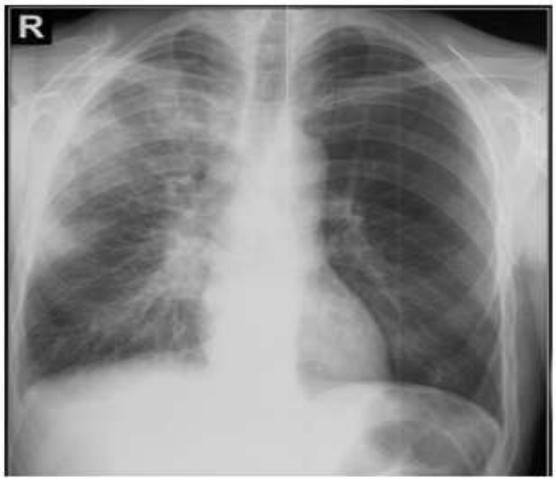


Figure 1B and 1C

Figure 1A PA Chest X-ray shows prominent right descending pulmonary artery with oligemic lung fields Figures 1B and 1C: CTPA shows intraluminal filling defect in both pulmonary arteries (arrows)

Source:Muthaiah, B., & Menon, V. B. (2017). Recurrent pulmonary embolism associated with oral hormonal contraceptive use. *International Journal of Health & Allied Sciences*, *6*(3), 180**.**



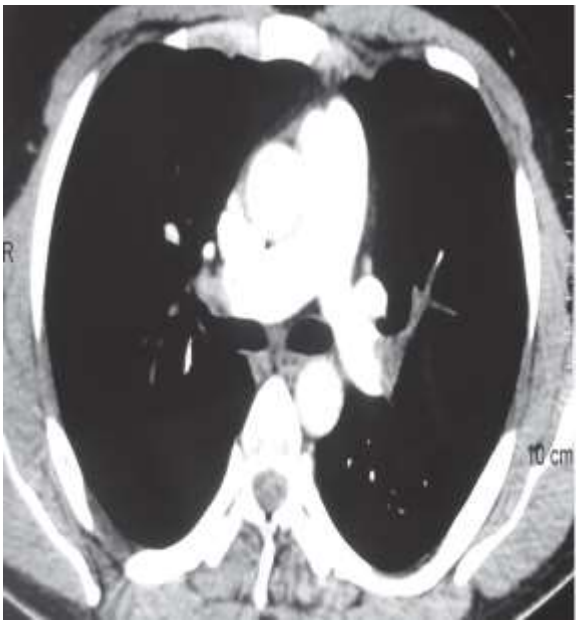


Figure 2: A postero-anterior chest radiograph of a 53 years old male patient with acute pulmonary thromboembolism and right lung cancer reveals multiple heterogeneous opacities, with irregular borders and subcostal intensity in upper 2/3 of the right lung; enlargement of right hilum. CTPA confirmed acute thrombus

Source: Mazilu, L., Adam, T., Suceveanu, A., Baz, R., & Tofolean, D. (2015). *Medica Tomitana*, *21*(2), 67-74.

Figure 2

Chest Radiograph plays an important role in investigating patients with suspected PE due to fair overall agreement for interpreting it consistent with or not with PE (Nicola Sverzellati et al 2012)

2.4.2 CT Pulmonary Angiography (CTPA)

British Thoracic Society guidelines for the management of suspected acute pulmonary embolism 2003 and Kenya National guidelines for cardiovascular disease Management (2018) recommend CTPA as the first line imaging modality for suspected pulmonary embolism because of its high sensitivity and specificity

CTPA has the advantage of being available and faster as the thorax can be scanned in few seconds and it's not user dependent.(Riedel, 2004)

Another advantage of CTPA is that it can determine the severity of PE by assessing presence or absence of right ventricular strain unlike conventional Pulmonary angiography(Riedel, 2004)

CTPA has good inter-observer agreement Compared to scintigraphy and has the advantage of offering alternative diagnosis such as, pulmonary mass, pneumonia, emphysema, pleural effusion, and Mediastinal adenopathy(Riedel, 2004)

CTPA has shortcoming of delivering high doses of ionizing radiation (10 to 70 millisievert]) which is risky to pregnant women, children and adolescents patients who are two to three times more likely to develop radiation-induced cancer therefore V/Q scan preferred because of less radiation dose (1.5Msv)

In a study done in the western cape of South Africa, CTPA prevalence of PE was found to be 26% and the commonest location of PE patient is in the right middle lobe.(Ramlakhan, Andronikou, & Rajkumar, 2017)

Spiral CT Scan can assess main, lobar, and segmental pulmonary emboli with a sensitivity of greater than 90% and detect emboli as small as 2 mm , however has poor sensitivity in identifying small sub segmental emboli. In addition, an alternate diagnosis can be made in up to 57% of the patients (Mazilu et al 2015)

Simultaneous CT venography of iliac veins and inferior vena cava can be performed after CTPA to detect DVT especially when caval filter insertion is desired, however this increases radiation to reproductive organs (Riedel, 2004) (Hamad et al 2011)

CTPA features of PE are eccentric intravascular filling defect within the lumen of the vessel, complete occlusion of the vessel and sometimes filling defect forming an obtuse angle with the vessel wall indicating chronicity. CTPA parenchymal findings of PE include oligemia, peripheral wedge shaped opacity and ground glass opacification(Mazilu, Adam, Suceveanu, Baz, & Tofolean, 2015; Wittram et al., 2004)

Recently CTPA use has increased significantly leading to detection of clinically insignificant PE (Schissler et al 2013)

Factors that contribute to misdiagnosis of PE are patient related factors, technical factors, anatomical factors and pathological factors(Wittram et al., 2004)

Patient related factors include Respiratory motion artifacts visualized as “seagull” appearance on lung window and change in position of pulmonary artery on different images. It can be avoided by use of Multidetector CT scan which uses short time (Schoepf & Costello, 2005; Wittram et al., 2004)

Poor window width and window level setting is a key technical factor that can cause over diagnosis or under diagnosis of PE and especially my miss a small emboli. Specific setting for PE is 700 and 100HU (Window width and level respectively). Streak artifact, lung a logarithm artifact, partial volume artifact on an enlarged lymph node need to be considered. (Wittram et al., 2004)

Some pathological conditions that may mimic PE include mucus plug, localized increase in vascular resistance, pulmonary artery stump in situ thrombosis and primary pulmonary artery sarcoma(Wittram et al., 2004)

Poor contrast enhancement, image reconstruction, and patient cooperation are the factors that can cause difficulties in PE diagnosis. Opacification of the superior vena cava can more than the pulmonary artery may cause beam-hardening artifacts to obscure the pulmonary arteries in the medial right upper lobe. On the other hand, a poor bolus is a limitation often difficult to overcome, as contrast differences between an embolus and vessel lumen are difficult to detect..(Schoepf & Costello, 2005)

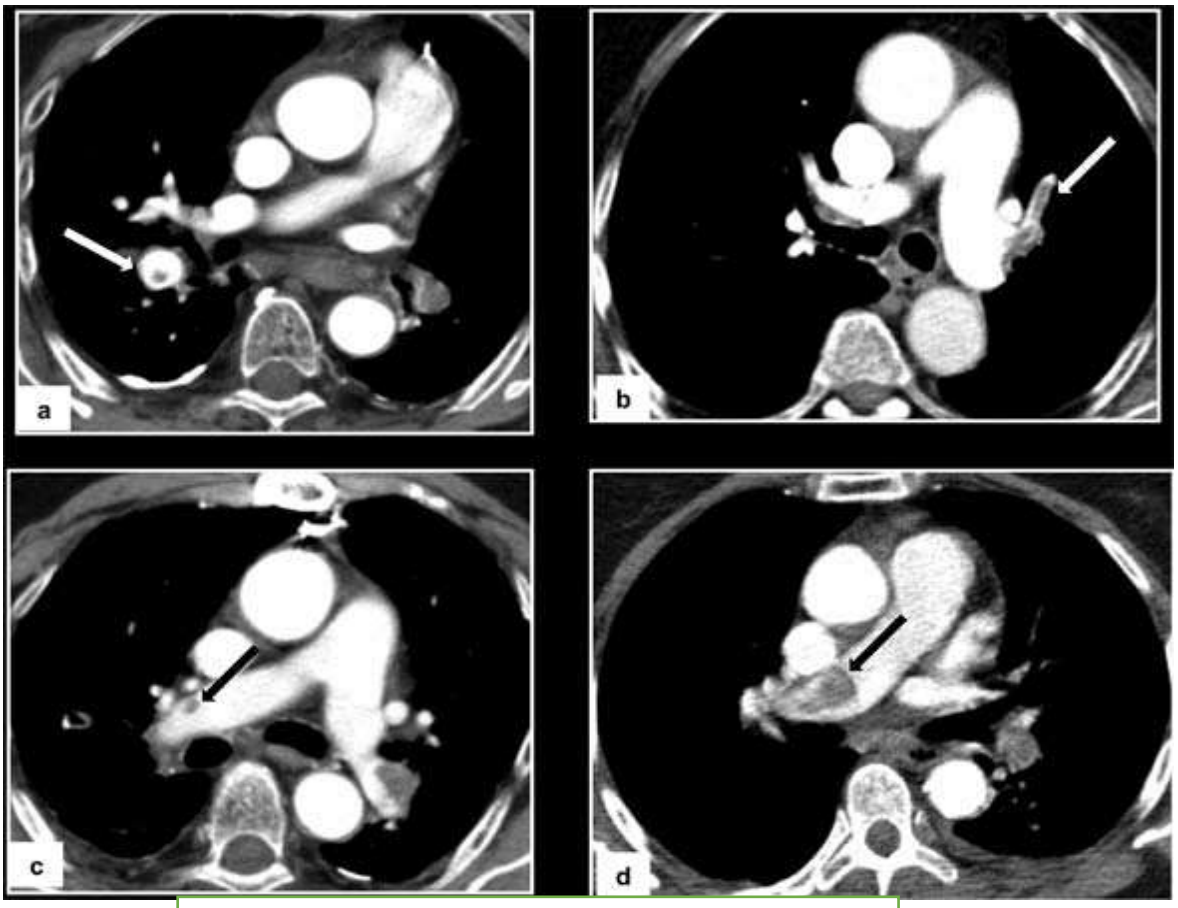


Figure 3

Figure 3: CTPA signs of acute PE. Partial obstruction. All images are axial slices of 3 different patients. Images 3a and 3c are from the same patient – 60 years. Man who had right knee replacement 2 weeks previously. Image a shows the transversal image of a central clot ("doughnut sign"). Image 3b is from a 75 y. bedridden woman after a stroke. See the longitudinal aspect of a central clot ("railway track sign"). 3c and 3d images show central clots which draw an acute angle with the vessel wall.

Source:(Preto, Rocha, Campos, Carneiro, & Gonçalves, 2010)

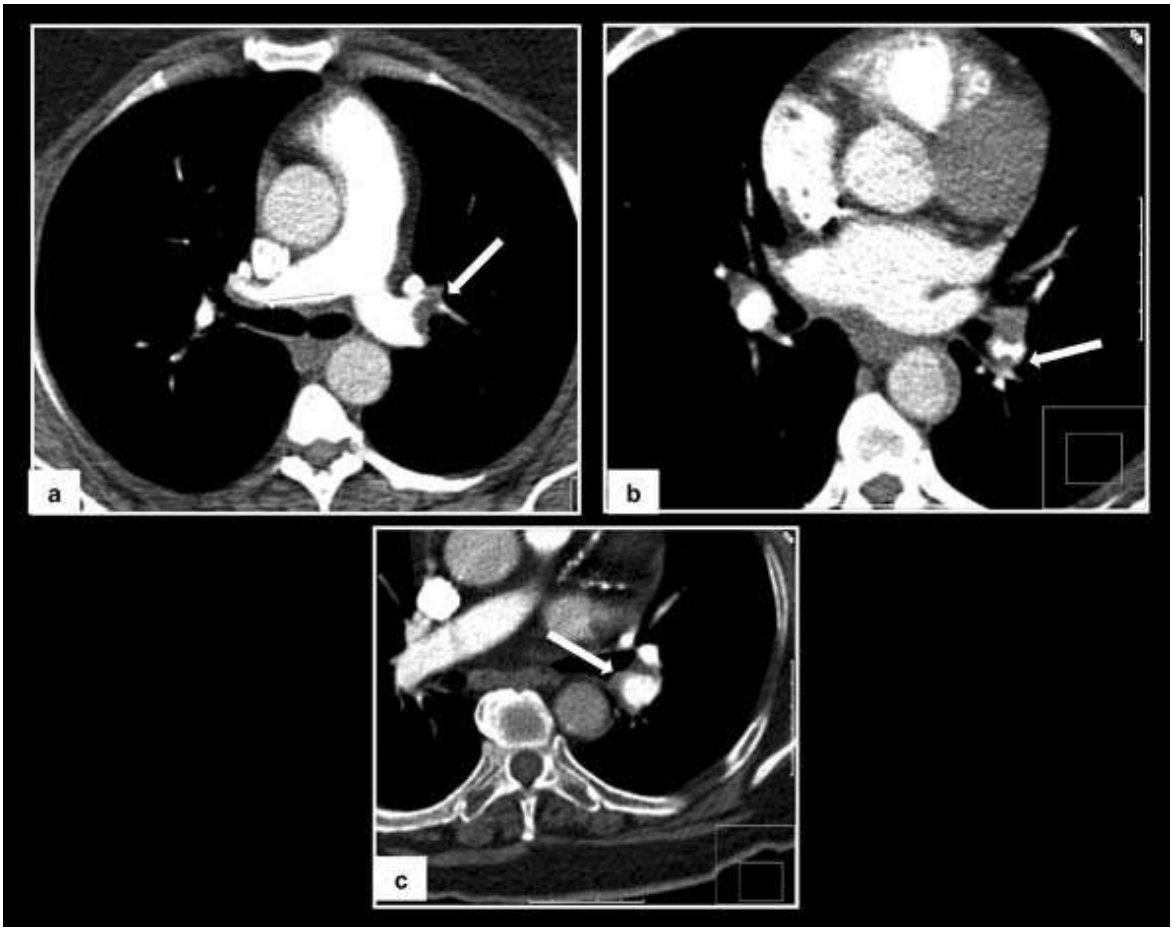


Figure 4

Figure 4: CTPA signs of chronic PE. Incomplete obstruction– different aspects. Image a shows organized thrombus (arrows) as cause of intimal irregularities. It looks like the vessel walls are "thicker" than they should in the longitudinal view. Image 4b shows intimal irregularity of chronic PE as a broad-based, smooth, margined abnormality that can affect one or both sides of the vessel. It forms obtuse angles with vessel wall. On 4c we observe eccentric chronic thrombus, an usual aspect of this entity on the axial plane. This eccentric filling defect forms obtuse angles with vessel wall (arrow)

Source:(Preto et al., 2010)

2.4.3 The Quantitative Plasma D-dimer Enzyme-Linked Immunosorbent Assay (ELISA)

D-dimer is degradation product of fibrin and found to have high sensitivity for the diagnosis of DVT and PE. However it's more useful in situations where PE is unlikely clinically because of high negative predictive value **(**Preto et al., 2010)

The D-dimer test has low specificity (40%) therefore myocardial infarction, pneumonia, sepsis, cancer, the postoperative state, pregnancy and systemic illness can cause false positive outcome (Preto et al., 2010)

2.4.4 Compression Ultrasonography – Ultrasonography of the deep venous system of the lower limbs relies upon loss of vein compressibility as the primary criterion for DVT. Because duplex venous ultrasound is a relatively easy study to perform and interpret, some authors have advocated bilateral lower extremity studies early in the algorithm for the work-up of PE. The rationale is that deep venous thrombosis (DVT) and PE are treated in essentially the same manner and that a positive result would thus obviate the need for further imaging. It should be noted, however, as a limitation of this strategy, that failure to diagnose PE in the setting of venous thromboembolism may result in incorrect (over)diagnosis of PE recurrence during follow-up, particularly with the use of V/Q scintigraphy. (Schoepf & Costello, 2005)

2.4.5 V/Q Scintigraphy (ventilation/Perfusion scan)

Commonly used in patients whom intravenous contrast is contraindicated and in pregnant patients with suspected PE because of low ionizing radiation.

It involves two aspects: perfusion study which entails use of macro-aggregated albumin labeled with a gamma-emitting radionuclide which are injected intravenously and trapped in the pulmonary capillary bed and ventilation study obtained with radiolabeled (99mTc) inhaled gases such as xenon or krypton,

PE appears as perfusion scan defect with normal ventilation. (Leung, A. N et al 2011) (Schoepf & Costello, 2005))

A normal chest Radiograph improves the diagnostic value of V/Q scan use in patients with suspected PE (P. Robin et al 2015)

2.4.6 MR Angiography- Disadvantages include poor spatial resolution, non-availability and long duration of examination despite being anon-radiation exam .(Preto et al., 2010)

MR Angiography has high sensitivity (77–87%) and specificity (95–98%) in detecting proximal PE but high inconclusive results and requires highly skillful technicians to perform.(PIOPED 111, .(Schoepf & Costello, 2005)

2.4.7 Elevated Cardiac Biomarkers Serum troponin levels and brain natriuretic peptide or pro-brain natriuretic increase in right ventricular infarct and are predictors of mortality and complications of PE.(Preto et al., 2010)

2.4.8 Electrocardiogram common abnormalities include, sinus tachycardia, S1 Q3 T3 sign: an S wave in lead I, Q wave in lead III, and inverted T wave in lead III. Above findings are relatively specific but insensitive. However the most frequent abnormality is the ST-wave inversion in leads V1 to V4.(Preto et al., 2010)

2.4.9 Echocardiography

Transthoracic echocardiography has low sensitivity and specificity for identifying PE. A negative echocardiogram cannot exclude a diagnosis of PE. However, it's useful in prognostication, treatment choice for example thrombolysis and monitoring response to treatment

2.5 Invasive Diagnostic Modalities

2.5.1 Conventional Catheter Pulmonary Angiography Chest CT with contrast has virtually replaced invasive pulmonary angiography as a diagnostic test. Invasive catheter based diagnostic testing is reserved for those in whom an interventional procedure such as catheter-directed thrombolysis or embolectomy is planned. A definitive diagnosis of PE depends upon visualization of an intraluminal filling-defect in more than one projection. (Preto et al., 2010)

CHAPTER THREE

Research Design and Methodology

3.1Study Design

The study was descriptive cross- sectional study that was carried out for a period of 12 months beginning on September 2017and ending on August 2018

This design has the advantages of measuring proportions of population with certain disease characteristics in this context pulmonary embolism, it's also relatively quick and easy to conduct and no loss to follow up.

3.2 Study Site

The research study was conducted at the Radiology and Imaging department (CT scan and general radiography units) at the Moi Teaching and Referral Hospital. The Hospital is located in Eldoret town, which is 350 Kilometers northwest of the Capital Nairobi .MTRH is a tertiary (level 6) health facility serving as a teaching hospital for Moi University School of Medicine, Public health and Dentistry. Others include Kenya Medical Training Collage (KMTC), Eldoret and University of Eastern Africa Baraton School of Nursing. MTRH is also a training center for medical, clinical and nursing officer interns. It is the referral hospital for the Western part of Kenya and North rift and has a catchment population of approximately 13 million people. The facility has several departments including Surgery, Pediatrics and Radiology and Imaging among others

3.3 Study Population

Adult patients suspected to have pulmonary embolism referred to radiology department for Computed tomographic pulmonary angiography

3.4 Eligibility Criteria

3.4.1 Inclusion Criteria

1 Adult patients 18 years and above

2 Clinically suspected to have pulmonary embolism, referred to radiology department for CTPA

3. Consented to participate in the study

3.4.2 Exclusion Criteria

1. Chest Radiograph not done or done outside facility for the purpose of standardization
2. Patient sent for follow up CT Pulmonary angiography
3. Declined to consent

3.5 Sampling and Sampling Procedures:

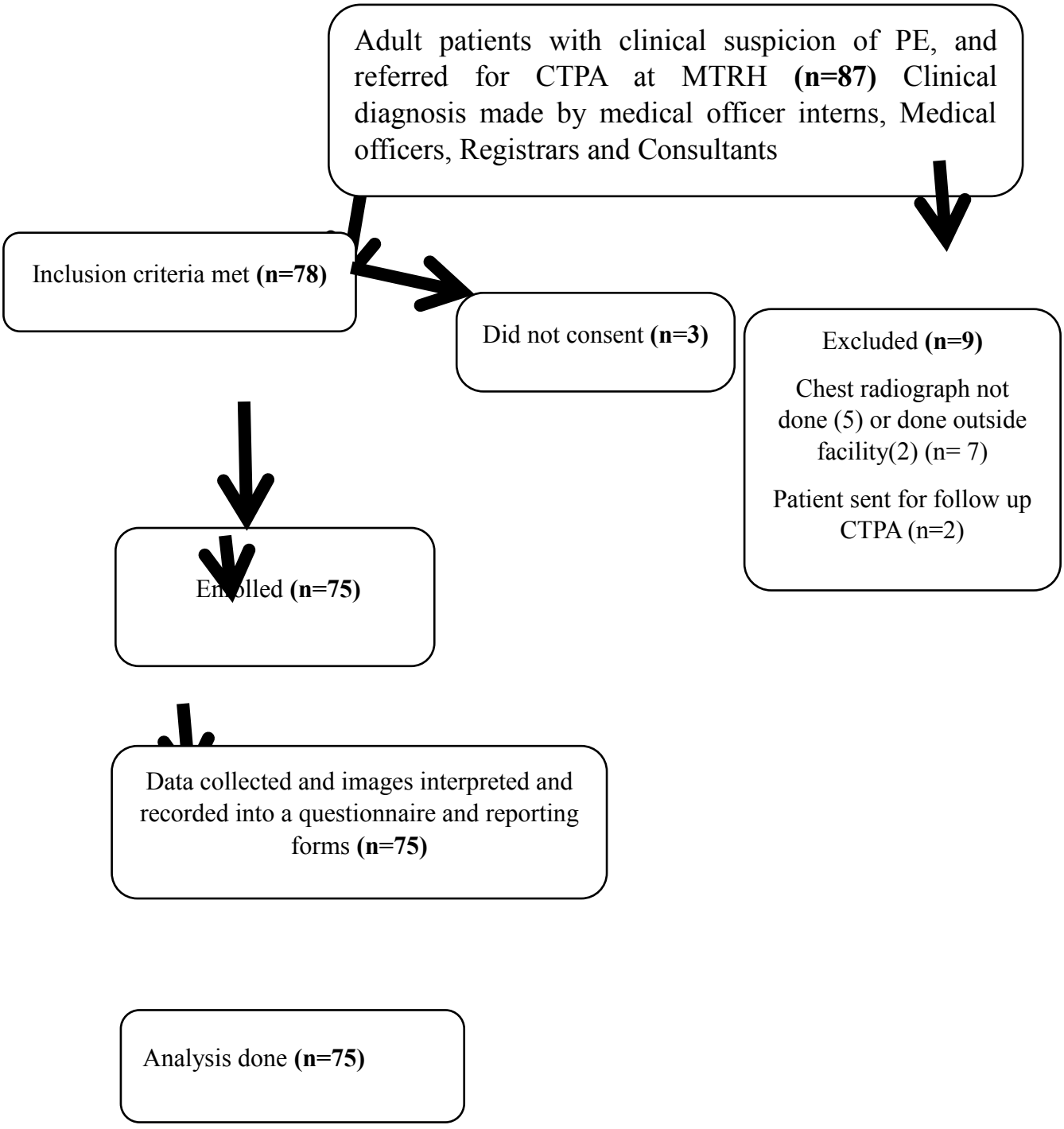
3.5.1 Sample Size determination

A census study was chosen because of the small number of patients referred for CT Pulmonary angiography at MTRH in the previous years (total 69 CTPAs done in the year 2016). A total of 75 study participants were recruited after giving consent

3.5.2 Sampling Method

Consecutive sampling technique was used in this study. Every patient suspected to have pulmonary embolism and referred for CTPA was recruited after obtaining consent .A total of 75 participants were recruited at the end of the study period and the study conducted for a period of 12 Months (Sept 2017 to August 2018).

Enrolment flow Chart



3. 6 Study Procedure

CT PULMONARY ANGIOGRAPHY PROCEDURE (Siemens somatom perspective, Germany)

The entry point for the study was at the CT scan room MTRH.

All scans were performed using a 32-slice Multidetector CT scanner).The scanning protocol included a bolus intravenous injection of 1mls/kg body weight iodinated contrast (omnipaque 350mg I/ml) at 5 mL/sec via an antecubital vein along with a saline wash out(half the volume of the contrast given).

Using a bolus-tracking technique (region of interest over the main pulmonary artery with a threshold of 100 Hounsfield units [HU]), the scan was triggered at the point of maximal pulmonary arterial enhancement (100 HU). A spiral CT scan of the thorax from the lung apices to the adrenal glands was acquired during this phase (kVp, 100–120; mAs 120; pitch, 0.9; rotation time, 0.5 seconds; collimation, 32 _ 0.6 mm).

Images were reconstructed at 2mm slice thicknesses: (a) for primary routine image interpretation, 5-mm axial slices were reformatted of the entire dataset; (b) in addition, for evaluation of the pulmonary arteries, contiguous thin (1.5 mm) slices of the thorax was be systematically reformatted. Images were displayed with three different gray scales for interpretation of lung window (window width/levels [HU] 1200/-600), Mediastinal window (350/50), and pulmonary embolism–specific windows (700/80 HU).

All images were archived electronically and evaluated by the principle investigator and two consultant radiologists.

CTPA Diagnostic criteria for acute pulmonary embolism (Conrad Wittram et al 2004**) either one of the following**

1. Intraluminal filling defect causing non-enhancement of the vessel
2. Incomplete filling defect encircled by contrast material, producing the "polo mint" or "railway track"
3. A marginal embolus that forms acute angle with the vessel wall

Diagnostic criteria for chronic pulmonary embolism (Conrad Wittram et al 2004**): one of the following**

(a) *Obstruction of a vessel by a thrombus that appears small in size compared to nearby vessels*

(b) A marginal embolus that forms an obtuse angle with the vessel wall

c) Thickened and small sized vessels with contrast passing through it due to recanalization

(d) A web within a contrast material–filled artery

Supportive signs include calcifications, collateral vessel formation especially bronchial arteries and mosaic lung parenchymal pattern

Interpretation of Chest Radiograph

- All the patient had PA Chest Radiograph done
- Chest Radiograph was first characterized as normal or abnormal
- If abnormal, one or more of the following indirect signs of PE on Chest Radiograph were looked for:-

❖ Cardiomegaly (cardio thoracic ratio > 0.5),

❖ Pleural effusion,

❖ Atelectasis (loss of lung volume),

❖ Enlargement of pulmonary artery (Fleischner's sign),

❖ Pulmonary parenchymal infiltrate/consolidation,

❖ Elevated hemi diaphragm,

❖ Focal oligemia (Westermark's sign) and

❖ A peripheral wedge-shaped opacity (Hampton's hump).

Above criteria were borrowed from studies done by Zubairi etal(2007), Miniati et al (2014), Nicola Sverzelleti et al(2012) and C.Greogory Elliot et al(2000)

3.7 Data Management

3.7.1 Data collection procedures

Data on the demographics of the study participants were collected using a questionnaire, which was administered to the participants during recruitment.

Data on chest radiograph and CTPA findings was captured using standard request/report forms.

3.7.2 Data entry:

Data was coded and entered using MS EXCEL. The collected data was checked for accuracy, correctness and completeness by the Principal Investigator or research assistant before interviewing the subsequent patient. Data was saved and backed up

into two different storage devices by the Principal investigator in order to avoid loss or damage.

3.7.3 Data Protection and Security

The data was protected using a password in the computer and confidentiality was maintained including removing identifiable parameters in case of sharing the information.

3.7.4 Data Analysis and Presentation Plan

The analysis was done using STATA/MP3

Descriptive statistics was applied initially where the data was summarized using mean, median, frequency, Standard deviation, and range.

Comparison between chest radiograph and CTPA was done using Cohen Kappa statistics.

Categorical data comparing the proportion of participants with confirmed pulmonary embolism with those without was analyzed by Chi-square and fisher's exact tests

Data presented using tables or pie charts. The significance of the variables was calculated using P-value. P-value less than 0.05 was considered significant at the 95 % confidence limits.

3.8 Ethical Considerations

Ethical approval was sought from and obtained from Institutional Research and Ethics Committee (IREC) Moi University and MTRH

Permission was also obtained from the departments of Radiology and Imaging MTRH

The participants were given detailed explanation of the study and an informed consent sought and obtained before enrollment into the study and those who declined to

participate were not discriminated against. They were informed about the procedures involved in the study and the possible benefits and harm

The participants were informed about the public health importance of the study since early diagnosis of pulmonary embolism reduces mortality and morbidity significantly Chest radiograph and CTPA results were explained to the patients

All the patients received medical attention regardless of whether they participated in the study or not and all the information obtained kept confidential.

Finally no incentives or coercion was used to convince patients to participate in the study.

3.9 Data Dissemination Plan

The findings of the research was presented to the department of Radiology and Imaging Moi University and MTRH Radiology department. It is due to be presented to School board Moi University. It will also be made available to the Moi University Library. The results of this research shall be availed for publication in a reputable journal of medicine for use in improving diagnosis and management of pulmonary embolism

CHAPTER FOUR

RESULTS

4.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

A total of 75 patients were included in the study after giving consent. The age of the patients ranged from 19 years to 88 years with a mean of 46.5(±SD 18.7) years.

The number of females were more constituting 64 %(48) giving Male to Female ratio of 1:1.79 and 29(38.7%) of study participants had PE on CTPA

Table 1: Age and gender distribution

VARIABLE	**PE NEGATIVE**	**PE POSITIVE**	**TOTAL**	**P VALUE**
Age(mean±SD)	43.43± 2.74	51.48±3.37		**0.069**
<36 years	21(75%)	7 (25%)	28(37.33%)	
36-45 years	9(56.3%)	7(43.7)	16 (21.33%)	
46-55 years	5 (55.6%)	4 (44.4%)	9 (12%)	
56-65 years	6 (54.5%)	5(45.5%)	11 (14.67%)	
>65 years	5 (45.5%)	6 (54.5%)	11 (14.67%)	
Total	46(61%)	29(39%)	75(100%)	
Gender				**0.434**
Male	18(66.7%)	9(33.3%)	27 (36%)	
Female	28(58.3%)	20(41.67%)	48 (64%)	

On average those who were diagnosed with pulmonary embolism were older with a mean age of 51.48, ±SD 3.37 and Majority of the participants who had pulmonary embolism were females accounting for 41.67 % (20), however the difference in age and gender were not statistically significant **(p>0.05).**

Table 2: CTPA OUTCOMES

	PE POSITIVE	**PE NEGATIVE**	**TOTAL**
Number	29	46	75
Percentage (%)	38.7	61.3	100

Table 3: Chest Radiograph findings among patients with PE on CTPA (n=29)

Chest Radiograph findings	Frequency	Percent
Normal	10	34.48
Abnormal	19	65.52
Total	**29**	**100**

Majority of the study participants with PE on CTPA (65.52% (19)) had an abnormal chest x-ray findings as depicted in table 3

Table 4: chest Radiograph findings in patients with PE on CTPA (n=29)

Chest Radiograph findings	**Frequency**	**Percentage (%)**
Cardiomegaly	13	44.8
Pleural effusion	11	37.9
Atelectasis	7	24.1
Hampton's hump	6	20.7
consolidation	5	17.2
Oligemia	3	10.3
Pulmonary artery enlargement	2	6.9
Elevated hemidiaphragm	1	3.4

Common chest radiograph findings in patients with pulmonary embolism were cardiomegaly accounting for 44.8 % (13), pleural effusion at 37.9% (11), atelectasis

24.1 %(7), Hampton hump 20.7 %(6) and consolidation at 17.2 %(5). Rare findings include oligemia 10.3 %(3), pulmonary artery enlargement 6.9% (2) and elevated diaphragm at 3.4%

Of note is 14 study participants had more than one Chest Radiograph findings and cardiomegaly and pleural effusion were the commonest associations occurring together

Table 5: Chest Radiograph diagnosis in patients negative for PE on CTPA (n=46)

Alternative diagnosis on Chest Radiograph	Frequency	Percent(%)
Normal	14	30.43
pulmonary edema	7	15.2
cardiomegaly	5	10.9
pleural effusion	9	19.6
pneumonia	6	13.0
Tuberculosis	2	4.3
Pneumothorax	3	6.5
Others (COPD, Interstitial lung disease and Hilar mass	3	6.5

In patients with no pulmonary embolism, 30.4 %(14) had normal chest radiograph diagnosis, while 19.6 %(9) had pleural effusion. However features of pulmonary edema, cardiomegaly and pneumonia were present in15.2%, 10.9% and 13.0% of the participants respectively.

Total percentage is more than 100% because 18 patients had more than one Chest Radiograph diagnosis.

Table 6: CTPA outcomes

	Variable	**Frequency**	**Percentage**
Conclusion	Normal	3	4.00
	Pulmonary embolism	16	21.3
	PE +Additional diagnosis	13	17.3
	Alternative diagnosis	43	57.3
	Total	75	100%

Majority (57.3 %) of the participants had an alternative diagnosis, while 38.7% (29) had PE, however 3 patients (4%) showed normal CTPA examination as shown in table 6. Alternative diagnosis means other diagnosis in patients who were negative for Pulmonary embolism on CTPA

Table 7: Location of pulmonary embolism

Variable	**Category**	**Frequency**	**Percentage**
Right lung	Right pulmonary artery	17	58.6
	Right lobar artery	15	51.7
	Right segmental /sub segmental arteries	1	3.4
Left lung	Left pulmonary artery	11	37.9
	Left lobar artery	11	37.9
	Left segmental/ sub segmental arteries	1	3.4
	Main pulmonary artery	3	10.3

As depicted in table 8, pulmonary embolus was more commonly found in the right pulmonary artery accounting for 58.6%, followed by right lobar/segmental arteries at 51.7%, subsequently by left pulmonary artery and left lobar/segmental arteries

accounting for 11(37.9%) each. However the least was found at segmental/sub-segmental arteries and main pulmonary artery accounting for 3.4% and 10.3% respectively.

Of note is that the percentages add up to more than 100%, this is because an individual may have PE in more than one location.

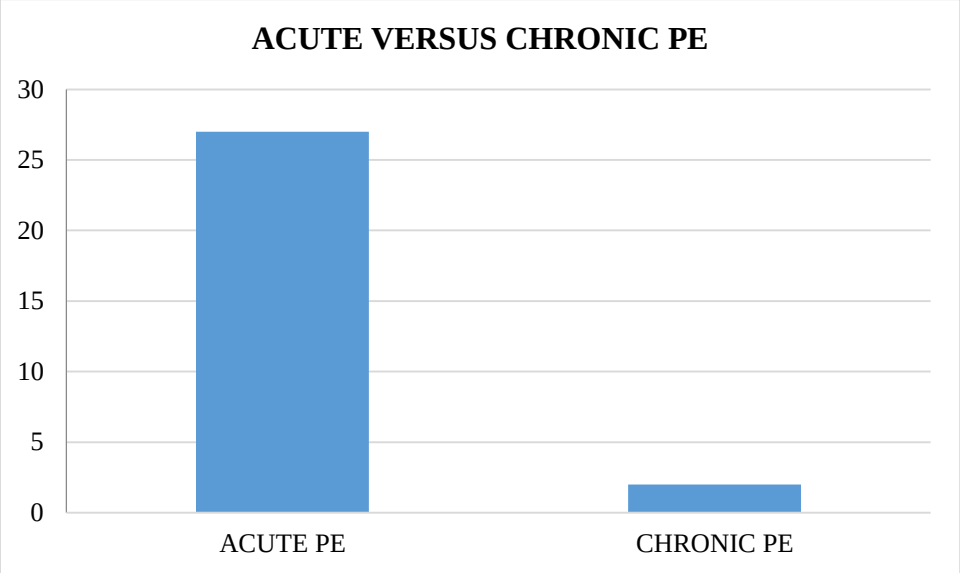


Figure 5: A cute versus chronic pulmonary embolism

Majority of the participants had evidence of acute pulmonary embolism 27(93%) while 7% (4) showed features of chronic pulmonary embolism as showed in figure 4

Table 8: MPA/Ascending aorta diameters and Right ventricle/Left ventricle diameters ratios (n=75)

Variables	Category	CT findings		Total	p-value
		No embolism	Embolism		
MPA diameter / AO diameter	<1	27	7	34	0.003
	≥1	19	22	41	
Total		46	29	75	
Right ventricle diameter / Lt Ventricle Diameter	<1	43	14	57	<0.001
	≥1	3	15	18	
Total		46	29	75	

A ratio of Main pulmonary artery diameter to ascending aorta ≥1 was found in 75.87 %(22) of study participants with pulmonary embolism, this associations is statistically significant with a P Value of 0.003

Right ventricle diameter/left ventricle ratio of ≥1 which is a marker of right ventricular dysfunction was present in 51.7 %of patients with pulmonary embolism and this association is statistically significant (P Value of <0.05)

Table 9: Pleural and Parenchymal findings in PE positive on CTPA

	PE Positive		PE Negative	
variables	Frequency	percent	Frequency	percent
Pleural effusion	18	62.1	25	54.3
Atelectasis	10	34.5	13	28.3
Hampton hump	9	31.0	1	2.2
consolidation	5	17.2	11	23.9
Westermark sign	4	13.8	2	4.3

Pleural effusion, atelectasis and Hampton hump were the commonest parenchymal and pleural abnormalities in patients with pulmonary embolism as shown in table 10 constituting 62.1 %(18), 34.5%(10) and 31%(9) correspondingly.

Table 10: Additional diagnosis in patients with pulmonary embolism

Diagnosis(n=13)	**Frequency**	**Percentage**
pulmonary arterial hypertension	4	30.8
Bronchiectasis	3	23.08
Chronic obstructive pulmonary disease	2	15.38
Thyroid mass	1	7.69
pleural thickening	1	7.69
Metastatic lung disease	2	15.38
Lung mass	**2**	**15.38**
Interstitial lung disease	1	7.69
Emphysema	3	23.08

On top of pulmonary embolism, 13 patients had additional diagnosis of which pulmonary arterial hypertension and bronchiectasis were the commonest as shown in table 10.

Table 11: CTPA diagnosis in patients who are <u>negative</u> for pulmonary embolism (alternative diagnosis n=43)

Diagnosis	**frequency**	**percent**
Pleural effusion	12	26.0
Congestive heart failure	10	21.7
pneumonia	8	17.4
COPD	4	8.7
Pulmonary arterial hypertension	4	8.7
pneumothorax	3	6.5
Metastatic lung disease	3	6.5
Pleural thickening	2	4.3
Acute respiratory distress syndrome	2	4.3
Interstitial lung disease	2	4.3
Pulmonary Tuberculosis	2	4.3
Others-pulmonary lymphoma, pericardial effusion and atelectasis	3	6.5

In patients who were negative for pulmonary embolism, pleural effusion, congestive heart failure and pneumonia were the most common CT diagnosis made accounting for 26%(12), 21.7% (10) and17.4% (8) respectively

Table 12: comparison of chest Radiograph and CTPA findings in patient with suspected PE (n=75)

	CTPA findings			
Chest Radiograph findings	**No embolism (n=46)**	**Embolism (n=29)**	**Total**	**p-value**
Cardiomegaly	16	13	29	0.384
Hampton's hump	1	6	7	0.012*
Oligemia	1	3	4	0.292*
Pleural effusion	17	11	28	0.932
Pulmonary artery enlargement	1	2	3	0.555*
Atelectasis	6	7	13	0.216
consolidation	11	5	16	0.492
Elevated hemidiaphragm	7	1	8	0.141*

NB * means Fishers exact test was used

In comparing Chest Radiograph and CTPA, peripheral wedge shaped opacity (Hampton's hump) was significantly associated with Pulmonary embolism (P = 0.012) as shown in table 13

Table 13: level of agreement between Chest Radiograph and CTPA in the diagnosis of PE

Chest Radiograph findings	CTPA findings		Total
	embolism	No embolism	
Embolism	19	20	39 (**52%**)
No embolism	10	26	36(**48%**)
Total	29(**38.7%**)	46(**61.3%**)	75(**100%**)

Kappa = **(**Percent agreement observed**)** __ (Percent agreement expected by chance)

100% - (Percent agreement expected by chance alone)

Percentage of observed agreement = 19 + 26 ÷ 75 **= 60%**

Percent agreement expected by chance alone = 15.08 + 22.08 ÷ 75 **= 49.55%**

Kappa = 60-49.55 ÷ 100-49.55 **= 0.21**

Table 14 Kappa index stratified by Viera and Garret 2005	
< 0	poor
0.01 – 0.20	Slight
0.21 – 0.40	**Fair**
0.41 – 0.60	Moderate
0.61-0.80	substantial
0.81-0.99	perfect

There was fair agreement between Chest Radiograph and CTPA in identifying PE as shown in the above table indicating Chest Radiograph can be used for targeting patient in poor resource settings for subsequent confirmatory test.

IMAGE ILLUSTRATIONS

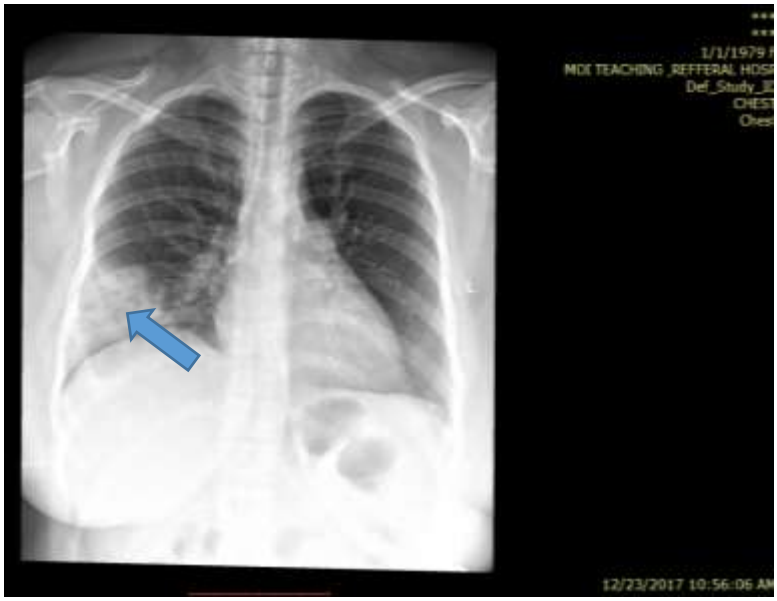


Figure 6(a)

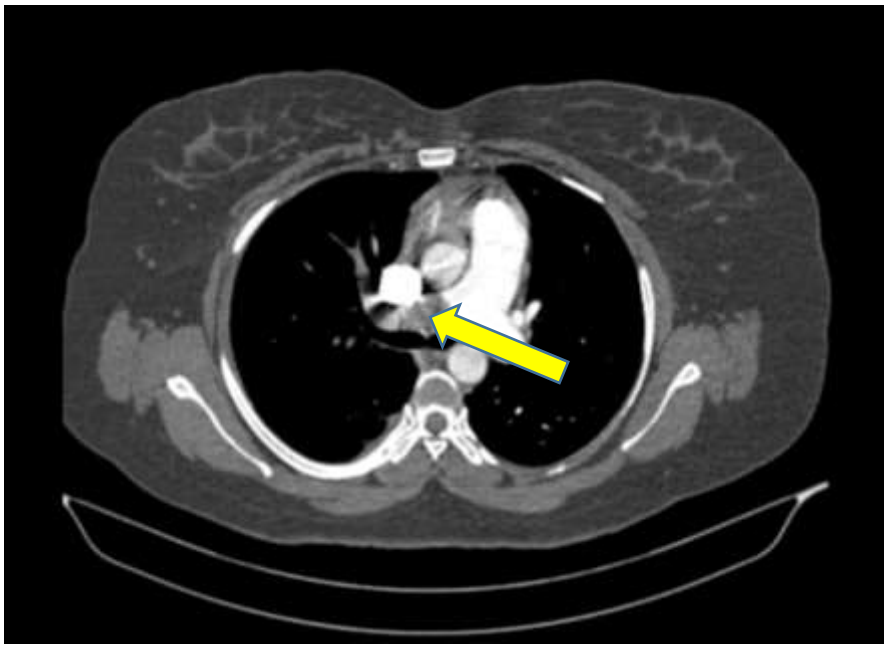


Figure 6 b

Figure 6a and 6b -A 41 year old female, PA Chest radiograph showing right sided pleural based wedge shaped opacity (hampton hump-Blue arrow). Axial CT Pulmonary angiography demonstrating Right pulmonary artery thrombus(Yellow arrow)

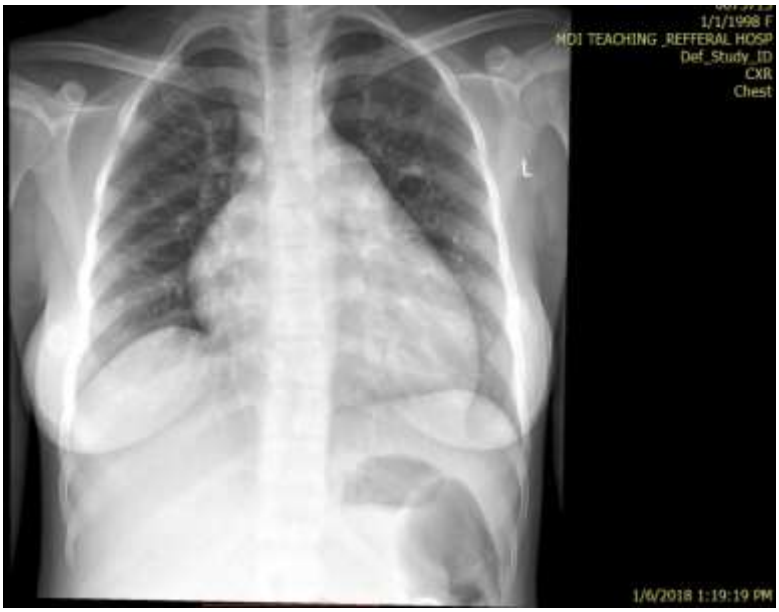


Figure 7a

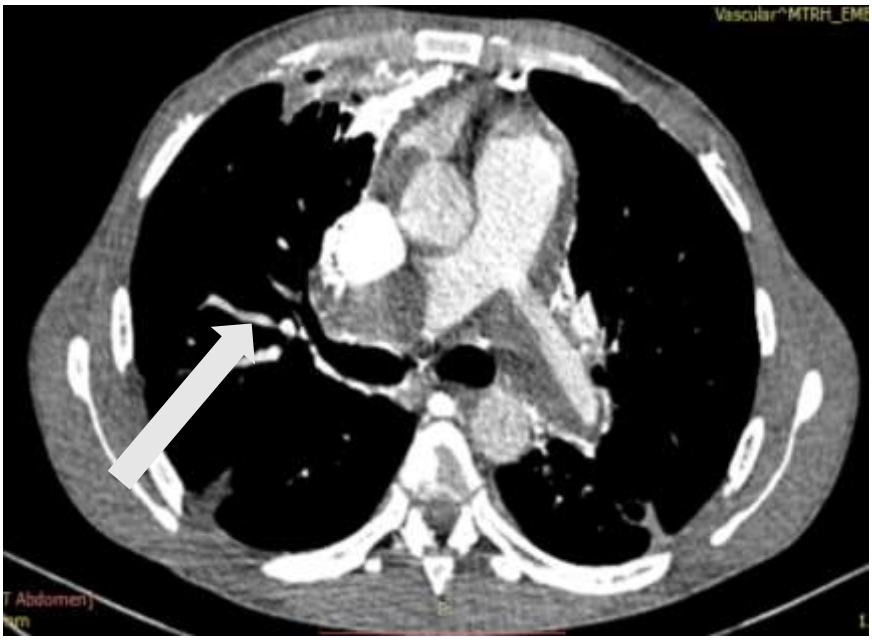


Figure 7b

Figure 7a and 7b A 39 year old female, PA chest radiograph demonstrating cardiomegaly (CTR=58%), subsequent CT Pulmonary angiography done revealed a thrombus on the Right and left pulmonary arteries (white arrow)

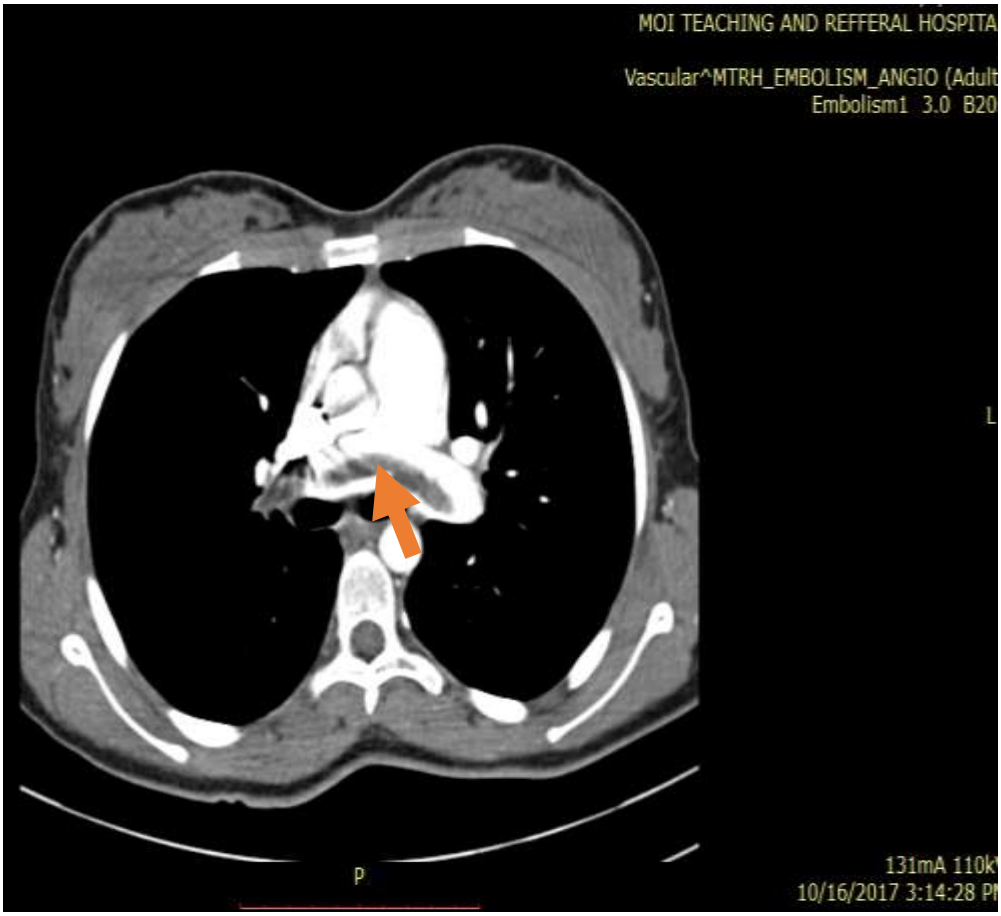


Figure 8

Figure 8: CT Pulmonary angiography axial cut of a 19 year old female showing a large intraluminal filling defect (saddle thrombus-orange arrow) at the pulmonary artery bifurcation extending into the main pulmonary arteries partially occluding their lumen

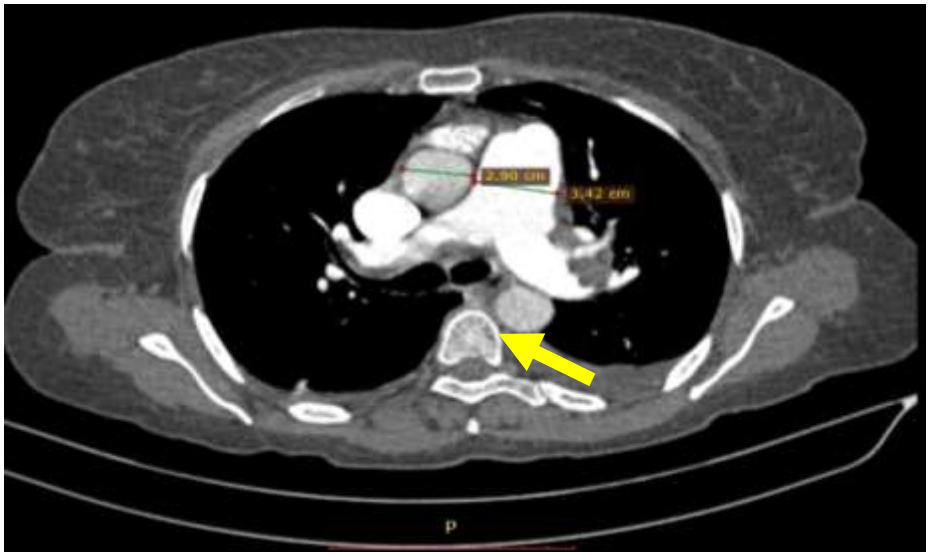


Figure 9 a

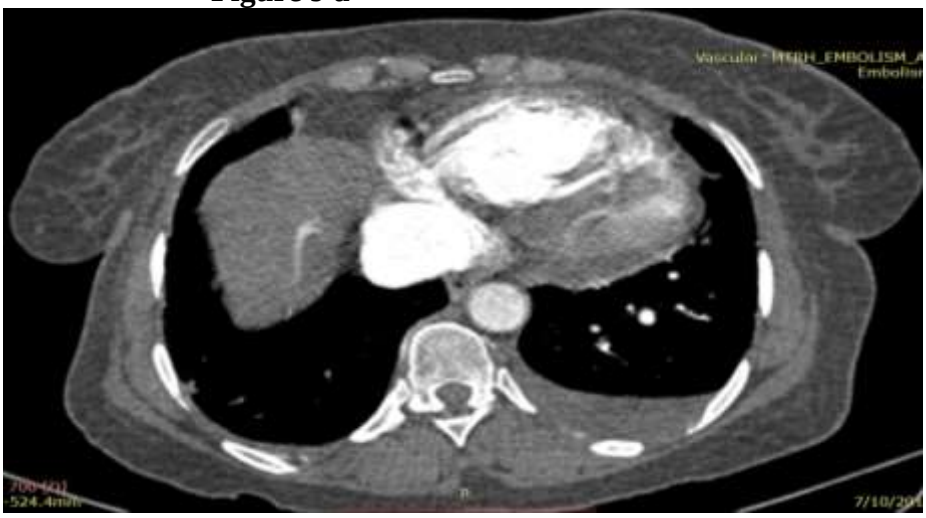


Figure 9b

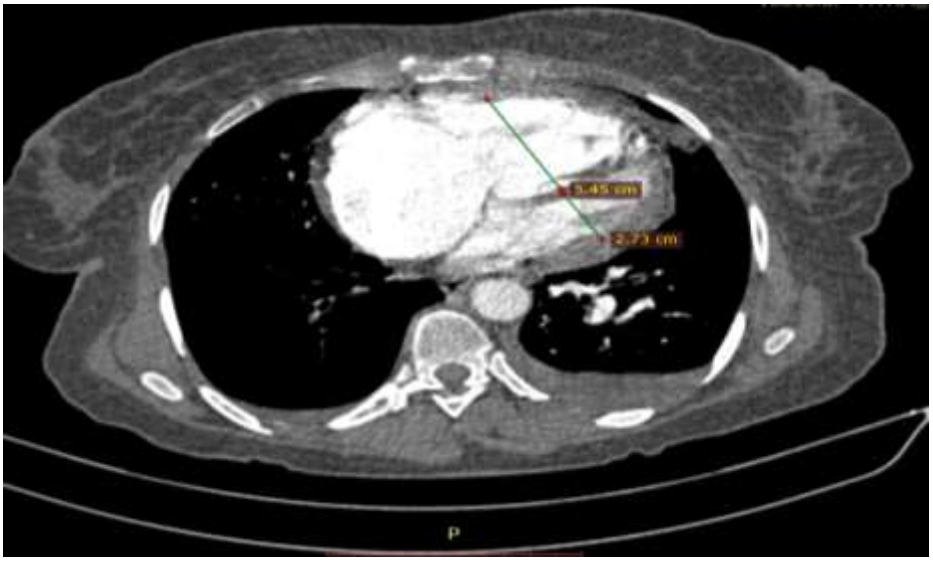


Figure 9c

Figure 9:52 year old Patient with chronic thromboembolic pulmonary arterial hypertension (CTEV): figure 8a demonstrate markedly dilated main pulmonary artery (MPA diameter=34.2mm) and a thrombus on the left pulmonary artery(yellow arrow), figure 8b reveals reflux of contrast into inferior Vena Cava and flattened intraventricular indicating right heart strain and figure. 9c shows markedly dilated right atrium, right ventricular enlargement and displacement of intraventricular septum to the right suggesting right cardiac strain

CHAPTER FIVE

DISCUSSION

A total of 75 consecutive patients with clinically suspected pulmonary embolism were enrolled into the study after giving consent. Mean age of the study participants was 46.5(±SD 18.7) years and ranged from 19 years to 88 years

On average those who were diagnosed with pulmonary embolism were older with a mean age of 51.48 ±SD3.37 years than those with no pulmonary embolism (mean age 43.43± SD2.74). Comparable outcome was reported by Lumumba et al in Democratic Republic of Congo (2017) – whereby he reported mean age of 64.1 ± SD13.8 years old in those with PE and a lower mean age of 52.2 ± SD14.6 years old in those with no PE Similar finding was also described by Tambe et al (2012) in a study done in Cameroon. Likewise Raksha Ramlakhan et al (2017) reported **s**imilar mean age in patients with PE

Majority of the patient with pulmonary embolism were females constituting 41.67 %, however the association between pulmonary embolism, age and gender was not statistically significant (p>0.05). A study done by Ogeng'o JA et al (2011) in Kenyatta National Hospital reported that pulmonary embolism has no gender predilection, this is in agreement with our study.

5.1 Chest radiograph findings among adult patients with suspected pulmonary embolism

Majority (65.52%) of the patients with pulmonary embolism on CTPA had an abnormal chest Radiograph findings. The most common chest radiographic abnormality in patients with PE was cardiomegaly accounting for 44.8% (13), others included pleural effusion at 37.9% (11), atelectasis 24.1%(7), pleural based opacity (Hampton hump) 20.7%(6) consolidation 17.2%(5) , while enlarged pulmonary

artery, focal oligemia and elevated diaphragm accounted for 6.9%(2),10.3% (3) and 3.4%(1) respectively This was in keeping with a study done by Zubairi et al (2007) in Pakistan that reported 82% of patients with pulmonary embolism had abnormal chest radiograph and the commonest finding was cardiomegaly (38%) similarly a study by Elliot CG et al. (2000) where he found out that 78% of patients with pulmonary embolism had an abnormal chest radiograph finding and the most common abnormality was cardiomegaly accounting for 27 %

In contrast Worsley DF et al (1995) on prospective investigation on pulmonary embolism diagnosis (PIOPED) and Stein PD et al (1991) USA found that atelectasis and/or pulmonary parenchymal abnormalities to be the most common finding reported. The difference could be explained by selection bias since they have excluded patients with prior cardiopulmonary disorders and it was a prospective and multi-institutional study and conducted in a different location

In patients with **no** pulmonary embolism**,** 30.43 %(14) had normal chest radiograph diagnosis, while 19.57 %(9) had pleural effusion. However features of pulmonary edema, cardiomegaly and pneumonia were present in15.21%, 10.87% and 13.04% of the participants respectively. This indicate that not only that does a chest radiograph provide clue to the diagnosis pulmonary embolism but it also valuable in the diagnosis of other common cardio-respiratory diseases, which mimic Pulmonary embolism

A study by Zubairi et al (2007) in Pakistan indicated that chest Radiograph is a non-invasive diagnostic tool for PE by excluding diseases whose differential diagnosis is PE

Comparable conclusion was made by C.Gregory et al (2000) that chest radiograph is essential test for the assessment of cardiopulmonary disease and provide guidance on what additional diagnostic investigation to perform for PE

5.2 Prevalence of PE in CTPA Population

CTPA prevalence of pulmonary embolism was found to be 38.7 %(29) therefore realizing CTPA advantage of visualizing embolus and confirming the final diagnosis. This is comparable to a study done by Tambe et al (2012) that reported a prevalence of 32.4%, in sub-Saharan Africa.

Similarly Karabulut and Kiroglu (2008) in Turkey obtained CTPA prevalence of 38%

Low occurrence of PE in Sub-Sahara Africa previously reported in PIOPED 11(Prospective Investigation of Pulmonary Embolism Diagnosis) study at 23.3% may be explained by the long standing lack of suitable diagnostic tools that are expensive and absence of trained personnel in sub-Saharan Africa (Tambe et al (2012))

Ramlakhn et al (2017) in South Africa and Lomamba et al in Democratic Republic of Congo (2017) a lower prevalence of 26.2% and 26%, respectively however both studies used a different methodology-retrospective study design

5.3 Acute versus chronic PE

The exact prevalence of chronic pulmonary embolism remains obscured and to an extent significantly underestimated (Eva Castaner et al-2009) but this study revealed the prevalence to be 7 %(2). Similar findings were reported by Farid Rashidi et al (2017 and Tapson VF and Humbert M (2006) which reported a prevalence of 9.9% and 4% respectively.

Differentiating chronic from acute pulmonary embolism is key since chronic pulmonary embolism is potentially curable with pulmonary thromboendarterectomy and early recognition improves the outcome (Eva Castaner et al-2009)

5.4 Anatomical location of Pulmonary Embolism

With respect to distribution of PE, right pulmonary artery was the most predominant site, accounting for 58.6% (17), followed by right lobar arteries 15(51.7%), subsequently by left pulmonary artery and left lobar artery accounting for 11(37.9%) each. However main pulmonary artery and segmental and sub-segmental arteries were the least common site accounting for 10.3% and 7.2% respectively

Why the Right pulmonary artery was the most predominant location for Pulmonary embolism (58.6%in my study) could be explained probably majority up to 70-90% in some studies, the source of the embolus is deep venous thrombosis which goes first to right side of the heart and subsequently the main and right pulmonary artery

RaniaRefaat and Maha A.El-Shinnawy(2013) reported lobar arteries to be the commonest anatomical site for pulmonary embolism(40%) and Main pulmonary artery and its branches to be the least site (10%) however this study was comparing distribution in oncology and non-oncology patients. similar finding was stated by Oser RF etal (1996)

At the level of the bifurcation of the Main pulmonary artery, it is conventional that the ascending aorta is larger in diameter than the MPA in normal persons since it's easy to define this structures anatomically and easily measured and reproducible. Thus, a ratio of greater than 1 is often used to suggest pathology Quyn A. Truong (2012)

A ratio of Main pulmonary artery diameter to ascending aorta ≥1 was found in 75.87 %(22) of study participants with pulmonary embolism, this associations is statistically significant with a P Value of <0.05.

Main pulmonary artery diameter/ascending aorta diameter ≥1 is a predictor of occurrence of pulmonary hypertension attributable to pulmonary embolism as reported by Sanas S etal (2006**)**

CT scan Right Ventricle diameter /Left ventricle diameter ratio of ≥1 is an indicator of Right ventricular dysfunction attributed to pulmonary embolism.

It is a reliable and accurate method of identifying pulmonary embolism patients at risk as indicated by Yvonne M. Ende-Verhaa etal (2017)

In this study Right ventricle diameter/left ventricle ratio of ≥1 was present in 51.7 %(15) of patients with pulmonary embolism as opposed to those with no pulmonary embolism (48.3%) and this association is statistically significant (P Value of <0.05)

Kumamaru KK etal reported that RV/LV ratio is sufficient to exclude RV strain or PE-related short-term death

Majority of the participants 57.3 %(43) had an alternative diagnosis, while 38.7 %(29) were found to have pulmonary embolism with 13(17.3%) having additional diagnosis, however 3 patients showed normal CTPA outcome as depicted in table 6 thus CTPA provided additional information that suggested or confirmed an alternative or additional diagnosis, this is in agreement with a study done by Kun-Il Kim (1999)

5.5 Pleural and Parenchymal findings on CTPA in PE

Pleural effusion 62 %(18), atelectasis 34.5 %(10), Hampton's hump 31.3% (9) and consolidation 17.24% (5) were the common pleural and parenchymal findings in patients with PE

Pleural effusion in PE is explained by the fact that it obstructs blood flow and causes ischemia distal to the embolus leading to an increase in lung interstitial fluid thereby traversing the visceral pleura into the pleural space

Similar findings were reported by Karabulut N and Kiroğlu Y (2008) in Turkey and Shah et al USA (1999). However Ramlakhan R et al (2017) S.Africa described consolidation to be the most parenchymal abnormality associated with PE

5.6 Comparison of Chest Radiograph and CTPA findings

20.7% (6) of patients with PE had peripheral wedge shaped opacity (Hampton hump) on Chest Radiograph, this was significantly associated with PE occurrence (P value=0.012). Hamptom humb is one of the specific chest Radiograph signs of PE with specificity of 82%(Worsley et al., 1993)

This was in agreement with studies done by Raksha Ramlakhan (2017) South Africa and C.Gregory Elliot *(2000). In* Contrast Findik S (2008) in Turkey described a high percentage of 36%, however he only studied patients with massive PE and who were hemodynamically unstable

5.7 Level of agreement between Chest Radiograph and CTPA in the diagnosis of PE

As shown in tables 14and 15, the level of agreement between chest radiograph and CT Pulmonary angiography in the diagnosis of pulmonary embolism was 60% with a Kappa statistics of **0.21** indicating a fair agreement between the two modalities and therefore the chest Radiograph can be used for identifying patients with suspected pulmonary embolism especially in a resource poor setting and for subsequent confirmatory investigation, in this case CT Pulmonary angiography.

The Cohen kappa coefficient is often used in assessing the level and extent of agreement between two tests whereby a value of >0.81 indicates perfect agreement, whereas a kappa of 0 indicates agreement was by chance (Viera and Garrett 2005)

Similar finding was reported in a study by Sverzellati, Nicola et al (2014) italy where he found out that the level of agreement for the interpretation of the chest

radiograph as consistent or not with PE was fair **(k= 0.24)** and therefore recommended that chest radiograph could be reliably used for identifying patients with suspected PE for different subsequent diagnostic investigations.

Chest Radiograph is important in guiding the clinician on deciding the probability that pulmonary embolism could be cause cardiopulmonary symptoms and influences the choice to perform further confirmatory investigation

However there are limited studies that compare Chest radiograph and CTPA findings

5.8 Study Limitation

Time interval between when Chest Radiograph was done and patient refereed for CTPA may have affected Chest Radiograph findings

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1Conclusions

- Majority (65.5%) of the patients with PE had Cardiomegaly, pleural effusion, atelectasis and Hampton hump as the common abnormal Chest Radiograph findings.
- CTPA prevalence for PE was 38.7%, and right pulmonary artery was the most predominant location.
- Chest Radiograph findings and CT Pulmonary angiography had a fair agreement (60%) (K= 0.21) with regards to diagnosis of pulmonary embolism. In addition, Hampton humb was associated with occurrence of pulmonary embolism (p= 0.012)

6.2 Recommendations

- High index of suspicion for pulmonary embolism in patients with Hampton hump, Cardiomegaly, pleural effusion and atelectasis on chest Radiograph.
- Chest radiograph can be used for investigating patients with suspected pulmonary embolism in resource constrained settings for a subsequent confirmatory test.

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APPENDICES

Appendix I: Consent Form

English Version

My name is Dr. Ibrahim Abdinasir Adan

I am pursuing Masters of Medicine degree in the department of Diagnostic Radiology and Imaging at Moi University.

I am doing my research study on matters related to imaging of patients with suspected Pulmonary embolism who have done chest radiograph and referred for Multi-detector Computed Tomographic Pulmonary Angiography to either confirm or rule out pulmonary embolism.

I am requesting to use your data and findings for the purposes of improving the management of patients with similar problems

No name is required and your information will be treated as confidential. I will ask you few questions and the chest radiograph and CTPA numbers will be used. Your investigative imaging findings shall be utilized only for the purpose of research. There will be no other chargeable repeat investigations performed for the purpose of research.

All information obtained in this study will be treated with utmost confidentiality and shall not be divulged to any unauthorized person

Please note that your participation is voluntary and you have the right to decline or withdraw from the study.

Participant's signature _____Date _____

I certify that the patient has understood and consented to participate in this study.

Dr. Adan Ibrahim Abdinasir

Signature _____

Date _____

FOMU YA RIDHAA (RUHUSA) YA MGONJWA

Jina langu ni Daktari Ibrahim A. Adan

Ninasoma shahada ya uzamili katika idara ya uchunguzi wa magonjwa kwa mionzi (Radiolojia)

katika chuo kikuu cha Moi

Ninafanya utafiti katika eneo la shida ya kuziba kwa mishipa ya damu ya mapafu, haswa upigaji

picha kutumia xray ya kifua na CTPA na matatizo yanayoweza kuambatana.

Ninaomba ridhaa/ruhusa yako, niweze kupata na kutumia taarifa zako katika utafiti wangu,ili

hatimaye maoni ya utafiti wangu yafaidi katika matibabu ya magonjwa ya namna hii. Tafadhali

fahamu ya kuwa taarifa zako ni za siri. Nitatumia nambari ya hospitali tu ili kukutambulisha.

Hakutakuwepo na malipo ya ziada wala uchunguzi zaidi kwa minaajili ya utafiti. Matumizi ya

picha ni kwa minaajili ya utafiti pekee.

Uko na haki yakukubali au kukataa kushiriki au kujitoa katika zoezi zima bila kuathiri huduma

nyingine zitolewazo mahali hapa.

Sahihi ……

Tarehe ……

Nathibitisha ya kwamba mhusika ameelewa na ameridhia kushiriki katika utafiti huu.

Daktari Adan Ibrahim Abdinasir

Sahihi.. ……..……

Tarehe ……

Appendix 2: Questionnaire

1. PATIENT'S BIODATA

Serial No._____ Age _____ Gender Male _____ Female _____

2. CLINICAL HISTORY do you have the following symptoms (tick where applicable)

(a) Difficulty in breathing yes ☐ No ☐

(b) Chest pain yes ☐ No ☐

(c) Cough Yes ☐ No ☐

(d) Coughing out blood stained sputum Yes ☐ No ☐

(e) Others (specify) ----------

(f) None

3. RISK FACTORS (Tick where applicable and specify)

(a)Do you suffer a clot in your lower limbs vessels? Yes ☐ No ☐

(b)Have you ever suffered a clot in your lower limb vessels? Yes ☐ No ☐

(c) Have you been operated before? Yes ☐ No ☐

(d)Any history of trauma? Yes ☐ No ☐

(e)Have you ever remained immobile for 3 or more consecutive days? Yes ☐

No ☐

(f) Do you suffer from any cancer? yes ☐ No ☐

(g) Do you suffer from any blood clotting disorder? Yes ☐ No ☐

(g) Have you ever used birth control bills? yes ☐ No ☐

If yes specify----------

(i)Other(s) ----------

(j)None

Appendix 3: Chest Radiograph Reporting Form

1. PATIENT'S BIODATA

Serial No. _____ Chest radiograph number _____

Age_____

Gender Male _____ Female _____

1. **Projection (Tick appropriately)**

Posteroanterior ☐ **Antero-posterior** ☐

Lateral ☐

FINDINGS

Trachea-------- **----------**

Heart and Mediastinum----------

_____

_____

Hila region- size, shape and density----------

_____

_____

_____

Diaphragm:

_____

_____

Lungs and pleura

present Absent

1.Cardiomegaly

2.pleural effusion

3. Westermark sign(oligemia)

4.Atelectasis

5.Pulmonary artery enlargement

6.consolidation

7. Hampton humb

8. Elevated hemidiaphragm

Conclusion:

1. **Normal**
2. **Consistent with Pulmonary embolism**
3. **Alternative diagnosis**

Appendix 4: CT Pulmonary Angiography Report

Clinical information:
Findings:
Lungs and airways----------

Pleura----------

Heart and pericardium----------

Mediastinum and hila----------
Chest wall and lower neck ----------
Vessels
Aorta ----------
Pulmonary arteries

Pulmonary embolus (tick): present
Absent

If present, specify the location of pulmonary embolism**. (Tick and specify)**

Right Lung	**Right pulmonary artery**	**Lobar arteries**	**Segmental /Sub segmental arteries**
Left lung	**Left pulmonary artery**		
Main pulmonary artery			

Other site (specify**) ----------**
Evidence of acute pulmonary embolism? Tick

Yes

No

Evidence of chronic pulmonary embolism? Tick

Yes

No

Are there signs of right heart strain? Tick

Yes

No

State diameter in millimeters of:

MPA diameter/ AO diameter _____

Right ventricle diameter/left ventricle diameter _____

Other findings	**PRESENT**	**ABSENT**
1.Pulmonary artery enlargement		
2.Hampton hump		
3. Westermark sign(oligemia)		
4.Pleural effusion		
5.Atelectasis		
6.consolidation		
7. others specify		

Conclusion (i) Normal

(ii)No pulmonary embolism

(iii)Pulmonary Embolism

(iv)Additional diagnosis

(v)Alternate diagnosis

Appendix 5: Institutional Research and Ethics Committee Approval of Amendments

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference IREC/2017/120
Approval Number: 0001940

27th February, 2018

Dr. Ibrahim Abdinasir Adan,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
27 FEB 2018
APPROVED
P. O. Box 4606 - 30100 ELDORET

Dear Dr. Adan,

RE: APPROVAL OF AMENDMENT

The Institutional Research and Ethics Committee has reviewed the amendment made to your proposal titled:-

"Comparison of CT Pulmonary Angiograph and Chest Radiograph Findings among Adult Patient with Suspected Pulmonary Embolism at MTRH, Eldoret, Kenya".

We note that you are seeking to make amendments as follows:-

1. To change the title to above from "***Correlation between Chest Radiographic and CTPA Findings among Adults Patients with Suspected Pulmonary Embolism at MTRH, Eldoret, Kenya".***
2. To change the broad objectives to;
   - To describe chest computed tomographic pulmonary angiography and chest radiography findings among adult patients suspected to have pulmonary embolism and determine the comparison between them at MTRH.
3. Specific Objectives
   - To compare CT pulmonary angiography and chest radiograph findings among adult patients with pulmonary embolism at MTRH.

The amendments have been approved on 27th February, 2018 according to SOP's of IREC. You are therefore permitted to continue with your research.

You are required to submit progress(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change(s) or amendment(s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc: CEO - MTRH; Dean - SPH; Dean - SOM
Principal - CHS; Dean - SOD; Dean - SON

Appendix 6: Institutional Research and Ethics Committee Formal Approval

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET

Reference: IREC/2017/120
Approval Number: 0001940

8th September, 2017

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
08 SEP 2017
APPROVED
P.O. Box 4606-30100 ELDORET

Dr. Ibrahim Abdinasir Adan,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Adan,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Correlation between Chest Radiography and CTPA Findings among Adult Patients with Suspected Pulmonary Embolism at MTRH, Eldoret, Kenya".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1940*** on 8th September, 2017. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 7th September, 2018. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

Appendix 7: Moi Teaching and Referral Hospital Approval to Conduct Research

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: ceo@mtrh.go.ke
P. O. Box 3
ELDORET

Ref: ELD/MTRH/R&P/10/2/V.2/2010

18th September, 2017

Dr. Ibrahim Abdinasir Adan,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

"Correlation between Chest Radiography and CTPA Findings among Adult Patients with Suspected Pulmonary Embolism at MTRH, Eldoret, Kenya".

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

18/08/2017

DR. WILSON K. ARUASA
CHIEF EXECUTIVE OFFICER
MOI TEACHING AND REFERRAL HOSPITAL

CC - DCEO, (CS)
- Director of Nursing Services (DNS)
- HOD, HRISM