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Characterization of Pulmonary Embolism using MDCT in Sudanese Population

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Abstract: ***CT scan considered as one of the sensitive tools in investigation of pulmonary embolism PE, in this study a characterization of CT- PE of Sudanese population was evaluated and compared with the other communities. CT pulmonary angiography using MDCT was performed to the all patients which were already divided by the emergency department as low, medium, or high risk of pulmonary embolism. The subjects included in this study were 78 patients 33 (42.3%) males and 45 (57.7%) females, the frequency distribution of study-patients age showed that the higher probability of PE age group is patient over 71 years old, also the study found that the PE probability increased as age function increased with the followings data : in the age group from 21-30 there was 3.6% of research subjects having pulmonary embolism, for the age group of 31-40 there was 7.7% registered pulmonary embolism, while for the age group of 41-50 the collected patients with PE covered 11% of the total subjects, 51-60 years age group almost contain 19.2 % and for 61-70 age group there was 11.5% of the research patients with pulmonary embolism, while over-70 there was a 30.8% with pulmonary embolism and that was disagree with the document of García-Sanz etal.2014, The result of this study showed that, there were 48 patients (61.5%) of all research-subjects with family history and 30 patients (38.5%) without family history. , the result of this study showed that there were 36 (46.2%) in the right pulmonary artery, 17 (21.8%) left pulmonary artery and 25 (32.1%) bilateral in the right and left pulmonary artery, patients in the sub segmental PE group included 10 (45%) with single PE and 12 (55%) with multiple PE. for location of pulmonary embolism, there were 9 patients (11.5%) with pulmonary embolism located at the center of the pulmonary artery and 69 (88.5%) was peripherally and this was disagree with the study of García-Sanz et.al. 2014.***

Keywords: Pulmonary Embolism PE, MDCT

1. Introduction

British engineer Godfrey Hounsfield came up with an improvement on the 70-year-old technology its combined x-ray images with a computer; if you took many x-rays of the same area at slightly different angles, a computer could put the information from the x-rays together to create a cross-sectional image, Hounsfield called this technology a CT (computerized tomography) scan (1). Its less-invasive modern technologies have largely replaced invasive procedures such as angiography for imaging of the pulmonary arteries; these techniques have the advantage of short exposure times and the ability to create three-dimensional (3D) data sets that have greater diagnostic possibilities than do standard projection angiographic images, contrast material–enhanced spiral computed tomography (CT) provides these advantages. .(1 Computed tomography (CT) is increasingly being used as the main thoracic imaging technique in suspected pulmonary embolism.(2-3). Single-detector–row computed tomography (CT) has a low sensitivity for pulmonary embolism and must be combined with venous-compression ultrasonography of the lower limbs. as its shown in M.T. (4) study which discus Personal details like age, gender, active smoking and obesity (body mass index >30) properly, the female have a higher awareness of VTE disease, family history of VTE, or varicose veins was more commonly found in women, whereas cancer and chronic obstructive pulmonary disease (COPD) were more frequent in men. (5). before any other test was administered, patients underwent clinical evaluation in the emergency department by the physicians in charge with the use of the Geneva score. (6, 7, 8) The Geneva score is based on seven variables: age, previous deep venous thrombosis or pulmonary embolism, recent surgery, heart rate, the partial pressure of arterial oxygen, the partial pressure of arterial carbon dioxide, and the findings on chest radiography (e.g., band atelectasis or hemi diaphragm elevation). It allows the classification of patients into three categories of clinical probability of pulmonary embolism (low, intermediate, or high), corresponding to an increasing prevalence of pulmonary embolism.

Since its introduction in the early 1990s, spiral CT angiography of the pulmonary circulation has progressively gained widespread acceptance, enabling one not only to obtain uniform and nearly constant opacification of pulmonary vessels down to 2–3 mm in diameter, but also to analyze the peripheral pulmonary vasculature with more precise anatomic details than those available with conventional angiographic studies. . (1). Initial experience with single detector helical scanners showed high sensitivity for evaluation of the proximal pulmonary vascular tree (which includes the segmental branches) with sensitivities and specificities both well above 90%. However, the technique has been much less accurate for peripheral (subsegmental) branches, with sensitivities and specificities probably in the range of 60 to 70%. The advent of multi-detector CT (16 and 64-slice) scanners has provided increased spatial resolution with decreased scan time (decreasing motion artifact), as well the ability to perform multi-planar image reformation and image acquisition is routinely under 10 seconds for 64-MDCT, this technology has resulted in exquisitely detailed evaluation of the entire pulmonary vascular tree, with improved detection of peripheral pulmonary embolism. (1). Pulmonary artery is one of the two vessels which are formed

as terminal branches of the pulmonary trunk and convey un-aerated blood to the lungs; the two pulmonary arteries differ in length and anatomy, and the right pulmonary artery is the longer of the two it passes transversely across the midline in the upper chest and passes below the aortic arch to enter the hilum of the right lung as part of its root, the left pulmonary artery is the shorter of the two terminal branches of the pulmonary trunk, it pierces the pericardium (the sac around the heart) and enters the hilum of the left lung. (1). CT pulmonary angiography (CTPA) is a medical diagnostic test that employs computed tomography to obtain an image of the pulmonary arteries it was introduced in the 1990s as an alternative to ventilation/perfusion scanning, which relies on radionuclide imaging of the blood vessels of the lung, because of its minimally invasive nature and high sensitivity and specificity, CTPA has evolved into the first line imaging study for the evaluation of suspected pulmonary embolism, images are acquired using a breath hold technique during the pulmonary arterial enhancement phase following intravenous contrast material injection, with pulmonary embolism appearing as a filling defect in the otherwise densely opacified pulmonary artery. Pulmonary embolism (PE) is a blockage of the main artery of the lung or one of its branches by a substance that has travelled from elsewhere in the body through the bloodstream (embolism). PE most commonly results from deep vein thrombosis (a blood clot in the deep veins of the legs or pelvis) that breaks off and migrates to the lung, a process termed venous thromboembolism (VTE), small proportion of cases are caused by the embolization of air, fat, or talc in drugs of intravenous drug abusers or amniotic fluid. The obstruction of the blood flow through the lungs and the resultant pressure on the right ventricle of the heart lead to the symptoms and signs of PE. The risk of PE is increased in various situations, such as cancer or prolonged bed rest due to orthopedic surgery or Caesarean section. Symptoms of pulmonary embolism include difficulty breathing, chest pain on inspiration, and palpitations and the clinical signs include low blood oxygen saturation and cyanosis, rapid breathing, and a rapid heart rate, severe cases of PE can lead to collapse, abnormally low blood pressure, and sudden death. Diagnosis is based on these clinical findings in combination with laboratory tests (such as the D-dimer test) and imaging studies, usually CT pulmonary angiography, Pulmonary embolism can be diagnosed through the patient's history, a physical exam, and diagnostic tests including chest x ray, lung scan, pulmonary angiography, electrocardiography, arterial blood gas measurements, and leg vein ultrasonography or venography. (9). this study was aimed to describe the characteristic of pulmonary embolism with the features and common site in Sudanese population of different age group.

2. Materials and Method:

This is a descriptive retrospective cohort study designed to characterize the pulmonary embolism patients using MDCT, the study was carried out in the radiological departments in Khartoum state, Sudan during the period from Feb to Jun 2017. The instrument used in this study is MDCT (64slice) scanners fitted with Power automatic injector (stellate) imaging system interface module. The type of contrast media used in the study is a nonionic iodine contrast agent (Omnipaque) with concentration of 300 mg I/mL. The study include a group of patients who were referred to the Radiology department with a suspicion of pulmonary embolism after clinical investigation carried out and the patient have complaining of chest pain, low blood oxygen saturation and, abnormally low blood pressure. The study sample contains 78 patients (33 male and 45 female) with the average age of the 57 years for male and 42 years for the female.

2.1 Inclusion criteria

The study population consist males and females with an age ranging from 30to70 years, the patient should have a clinical examination and previous studies of chest x- ray and D-dimer test laboratory test should be performed, and the suspicion of PE examination was high and need CT scan to confirm and character the clinical question.

2.2 Exclusion criteria

A Childe, Pregnant female, subject below 30 year old and patient with low renal function profile are considered as a criterion to exclude the subject from this study.

The data of patients were obtained by using of the data collection sheet, the variables registered were: age, gender, Family History, postoperative, location of pulmonary embolism, and characterize of the emboli location (central and/or peripheral).

2.3 Methodology:

All patients were asked to continue adequate simple fluid intake up to 3 hours prior to examination to ensure adequate hydration, patients were taught how to hold breath during examination when requested, to ensure their cooperation and then underwent CT pulmonary angiography with a multi-detector row CT scanner the patients were positioned supine on the CT table in the “foot first” position with an 18-20 gauge cannula placed into a superficial vein within the antero-cubital fossa, a two scouts were acquired, anteroposterior and lateral, the examination was planned on these scouts from the level of mid of the neck till the upper abdomen and the patients were requested to hold their breath during the first 20 seconds of the acquisition.

The technical parameters will be sassed (kV, mAs tube rotation/s), the acquisition timing for optimum opacity is achieved by using automatic bolus tracking in region of interest placed on an artery the ROI is placed on the pulmonary artery just below the tracheal carina , the trigger level is set at 80 Hounsfield units.

Before dynamic CT was performed, high resolution CT (HRCT) images were obtained. One –mm- thick imaged were taken at 10-mm spacing from lung apexes to lung bases, with the patient breathing out fully for each image. Then 100 ml of iodinated contrast medium (Omnipaque 300 mg/ml) was intravenously injected with a power injector at rate 6 ml/sec.

The scanning was then performed from the lung apexes to the middle pole of the kidneys. Smart preparation technique-scanning delay was automatically determined with bolus tracking in the pulmonary trunk , and only after the contrast medium injection and subsequent waiting for density of in the pulmonary trunk to be over 80 Hu was the starting scan used. The region of interest (ROI) was placed in the in the pulmonary trunk. The scanning parameters were a collimation of 1.25 mm, a table speed of 34.375 mm/sec and a pitch of 1.375. Axial slices were reconstructed with a slice width of mm and a slice interval of 5.0 mm. Then, the 0.625 mm reconstructed raw data of the dynamic CT images were sent to the CT workstation.

CT angiography was interpreted and the arterial tree was always studied part by part, from the pulmonary trunk to the last peripheral arterioles, the degree of contrast enhancement in the pulmonary artery was also evaluated , also the mean Hounsfield units was measured at the level of pulmonary arteries bifurcation. Several tools were used at the workstation to display the data, and most often, MPR and MIP were used in this study. Rotations around and along any axis in real time were also used. The observers assessed the relationship of the lung lesions and adjacent pulmonary artery with multiple windows and levels simultaneously at CT workstations and recorded the relationships as encasement, penetration in the margin, and disconnection. The definition of encasement is a mass enveloping a pulmonary artery while decreasing the size of a pulmonary artery`s caliber. Displacement indicates a mass is causing deviation of a pulmonary artery away from the normal vascular course without a notch in the pulmonary artery penetration is when a pulmonary artery passes through the lesion without changing the vascular course or caliber of the pulmonary artery.

3. Result and Discussion

The subjects included in this study were 78 patients 33 (42.3%) males and 45 (57.7%) females, the percentage ratio of males to female is similar to the percent in the study of Ebadi et.al. 2010 (5) which shows the differences in clinical presentation of pulmonary embolism in women and men. I this study, the frequency distribution of study-patients age showed that the higher probability of PE age group is patient over 71 years old, also the study found that the PE probability increased as age function increased with the followings data : in the age group from 21-30 there was 3.6% of research subjects having pulmonary embolism, for the age group of 31-40 there was 7.7% registered pulmonary embolism, while for the age group of 41-50 the collected patients with PE covered 11% of the total subjects, 51-60 years age group almost contain 19.2 % and for 61-70 age group there was 11.5% of the research patients with pulmonary embolism, while over-70 there was a 30.8% with pulmonary embolism and that was disagree with the document of García-Sanz etal.2014 (4) revealing that the age of patients with subsegmental PE was lower than that of patients with central and segmental PE. The difference could be related to hyper coagulation and the changes in vascular endothelium that come with aging19: these could facilitate the extent of thrombi in older patients, especially considering that no age difference was found in the prevalence of risk factors for PE.

The result of this study showed that, there were 48 patients (61.5%) of all research-subjects with family history and 30 patients (38.5%) without family history. as its shown in M.T. García-Sanz etal.2014 (4) study which discus Personal details like age, gender, active smoking and obesity (body mass index >30) with the incidence of PE properly, the female have a higher awareness of VTE disease, family history of VTE, or varicose veins was more commonly found in women, whereas cancer and chronic obstructive pulmonary disease (COPD) were more frequent in men. Robert EbadI etal.2010 (5). Also the result showed that, from whole research subjects, 54 patients (69 %) have pulmonary embolism after an operational intervention history and 24 patients (31%) have pulmonary embolism without a previous operational intervention.

Table 1 shows the frequency distribution of patients under study according to location of pulmonary embolism, the result of this study showed that there were 36 (46.2%) in the right pulmonary artery, 17 (21.8%) left pulmonary artery and 25 (32.1%) bilateral in the right and left pulmonary artery, patients in the sub segmental PE group included 10 (45%) with single PE and 12 (55%) with multiple PE.

Table 1: shows the frequency and percentage of patients under study according to the detected location of pulmonary embolism by CT

Site	Frequency	Percentage
Right	36	46.2%
Left	17	21.8%
Bilateral	25	32.1%

Figure 1 shows the frequency character for location of pulmonary embolism, there were 9 patients (11.5%) with pulmonary embolism located at the center of the pulmonary artery and 69 (88.5%) was peripherally and this was disagree with the study of García-Sanz et.al. 2014 (4), which is properly due to sample size variation as his study was included 313 PE patients; 56% were women and the median age was 70 years, and his result found that the Central PE accounted for 68% of cases; segmental and subsegmental PE is 25% and 7% respectively, also the result of the study reported that the patients with subsegmental PE were always younger which had lower comorbidity and none of them presented proximal DVT.

Study was included 313 PE patients; 56% were women and the median age was 70 years (interquartile range 53-78 years). Central PE accounted for 68% of cases; segmental and subsegmental PE, for 25% and 7%. Patients with subsegmental PE were younger, had lower comorbidity and none of them presented proximal DVT

Patients with pulmonary embolism located peripherally at the pulmonary artery, the researcher result was agree with M.T. García-Sanz etal.2014.(4).

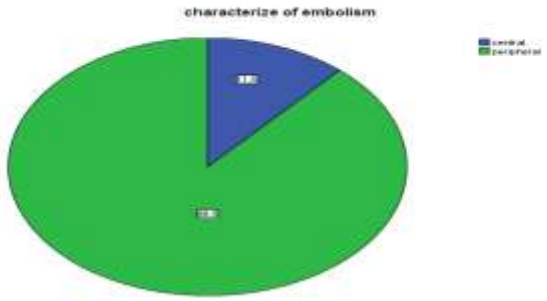

Figure 1: shows the frequency distribution of patients under study according to the character for location of pulmonary embolism detected by CT scan

4. Recommendations

A large sample size is needed for further characterization of the pulmonary embolism patients. Pulmonary CTA is a good stander modality in detection of pulmonary embolism but still need another investigation to support the diagnosis. Using a modified technique in pulmonary CTA by adding a delayed run to fill the small peripheral vassals to exclude sup-segmental embolism..the use of automatic triggering for contrast media to reach the optimum vascular enhancement is best practice. Use saline flush pre and post contrast media admission to avoid upper chest stick artifact (miss diagnosis for the upper pulmonary branches vassals. Pulmonary embolism is a live treating case so the diagnostical departments should reduce the cost of pulmonary CTA examination.

Appendix (1) represents the design of Data collection sheet

Characterization of pulmonary artery using CT angiography in Khartoum state

Data collection sheet

1- Demographic data:

- Patient number : ☐
- Gender : male ☐ female ☐
- Age : <20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61-70 ☐ >71 ☐

2- Postoperative:

Yes ☐ No ☐

3-Location of pulmonary embolism:

Right ☐ Left ☐ Bilateral ☐

4-Characterize of embolism:

Central ☐ Peripheral ☐

Figure 2: shows the example of questionnaire used for study data collection

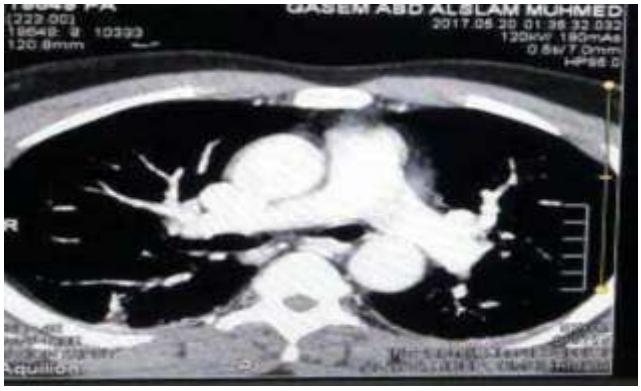

Figure 3: shows the example of detected PE with MDCT

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