IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 2 Ver. 14 February. (2018), PP 06-11
www.iosrjournals.org

Hounsfield's Unit (HU) value inthe detection of thrombus involving pulmonary trunk, right and left pulmonary arteries on plain CT chest images: A retrospective study.

Dr. Kishan A Bhgwat[1], Dr. Vijaya Mohana Reddy. R[2]
[1](Professor, Dept. of Radio diagnosis, SSIMS&RC, Davangere, India)
[2](Post Graduate, Dept. of Radio diagnosis, SSIMS&RC, Davangere, India)
Corresponding Author: Dr. Kishan A Bhgwat

Abstract: *Pulmonary embolism is one of the common diseases with high morbidity and mortality. It is the third most common cause of death after myocardial infarction and stroke. Because of its nonspecific clinical presentation, the condition is still difficult to diagnose clinically and is a major public health problem.Current practice of diagnosis of pulmonary thrombo embolism depends mainly on the computed tomography pulmonary angiography using iodinated contrast material. But in conditions of contraindications for usage of iodinated contrast material, the diagnostic efforts depend mainly on the conventional tools like conventional pulmonary angiography and lung perfusion scintigraphy (V/Q test). The aim of our study is to identify pulmonary embolism on Plain CT images itself using HU value difference between the pulmonary thrombus and the adjacent flowing blood. It is a retrospective study. A total of 39 cases of CTPA proven pulmonary thromboembolism (involving pulmonary trunk, its right and left branches) were included in the studywhich were done from June 2011 to June 2017 in S S Institute of medical sciences, Davangere, India.HU is assessed all along the length of pulmonary arteries using an uniform ROI of 0.3 sq.cm and observed for any sudden variation in the average HU value. On plain CT Images, there was a difference minimum of 15 HU noted between the thrombus and adjacent flowing blood in 27 out of 39 cases. Our study shows the possibility of diagnosis of pulmonary embolism in significant number of clinically suspected cases on plain* CT *imaging itself.*

Key words: *HU: Hounsfield's unit, CT: Computed tomography, CTPA: computed tomography pulmonary angiography, ROI: Region of Interest, RISPACS: radiological information system-Picture archiving and communication system, PE: pulmonary embolism.*

Date of Submission: 14-02-2018 Date of acceptance: 28-02-2018

I. Introduction

Pulmonary embolism is one of the common diseases with high morbidity and mortality. It is the third most common cause of death after myocardial infarction and stroke. Because of its nonspecific clinical presentation, the condition is still difficult to diagnose clinically and is a major public health problem. The condition is caused by partial or total occlusion of the pulmonary arteries by lumen occluding thrombus. The source of the thrombus is most commonly from the deep veins of the leg. In an ultrasound study, (Anderson et al., 1991)[1] deep vein thrombosis was detected in about 29 % of the cases of pulmonary embolism. The association can be still more, because the small thrombi or fresh emerging thrombi are difficult to visualize on the ultrasonography.Laennec[2] in 1819 was the first person to describe the term pulmonary embolism.Radiologically, the first description of pulmonary embolism was given by Wharton and Pierson[3] on a chest radiograph in 1922.

II. Materials and methods

This retrospective study was carried out on CTPA proven cases of pulmonary thromboembolism which were done from June 2012 to June 2017 in S S Institute of medical sciences, Davangere, India. From them, cases with thrombosis involving pulmonary trunk, its right and left branches were included in the study. Thrombosis involving rest of the pulmonary arterial tree was excluded to avoid the complexity. A total of 39 cases were taken into the study.

Study design: Retrospective study.

Study location: The study was carried out in Department of Radio diagnosis at S S Institute of medical sciences & research centre, located in Davangere district of Karnataka state, India. The centre is a tertiary care teaching hospital.

Study duration: June 2011 to June 2017

Sample size: 39 cases.

All the studies of CT pulmonary angiography which were performed in the department from June 2011 to June 2017 were retrieved from RISPACS. Then reports of all the cases are reviewed. Then the cases which were reported as positive for pulmonary embolism involving pulmonary trunk, right and left branches were included in the study. Rest are excluded from the study. A total of 39 cases were taken into the study.

Inclusion Criteria:
Pulmonary thromboembolism cases with thrombosis involving pulmonary trunk, its right and left braches were taken into the study.

Exclusion criteria:
1. Negative cases of pulmonary embolism.
2. Cases with thrombosis involving distal to the bifurcation of right and left pulmonary arteries.

Methodology / Technique:
At first, without the knowledge of exact location of thrombus in the pulmonary arteries, plain CT chest images were reviewed in standard mediastinal window settings. Using an ROI (region of interest) of about 0.3 sq cm, the average HU values were assessed all along the length of the pulmonary trunk, its right and left branches. The HU values were assessed upto the level of bifurcation of right and left pulmonary arteries. The serial HU values were observed for any sudden variation in the HU value between any two closely spaced regions of interest. Later, CT pulmonary angiography images were reviewed for all the 39 cases to identify exact location of the thrombus.

III. Results:

Out of total 39 cases, 27 cases show a minimum of 15 HU value difference between atleast two closely spaced regions of interest. The observed location, when viewed on CTPA images shows lumen filling thrombus in those 27 cases. The variation in the HU value is due to the attenuationdifferences between the clotted blood and the normal adjacent flowing blood. In rest of the 12 cases, the HU values did not show any significant variation and data from these cases was ignored.

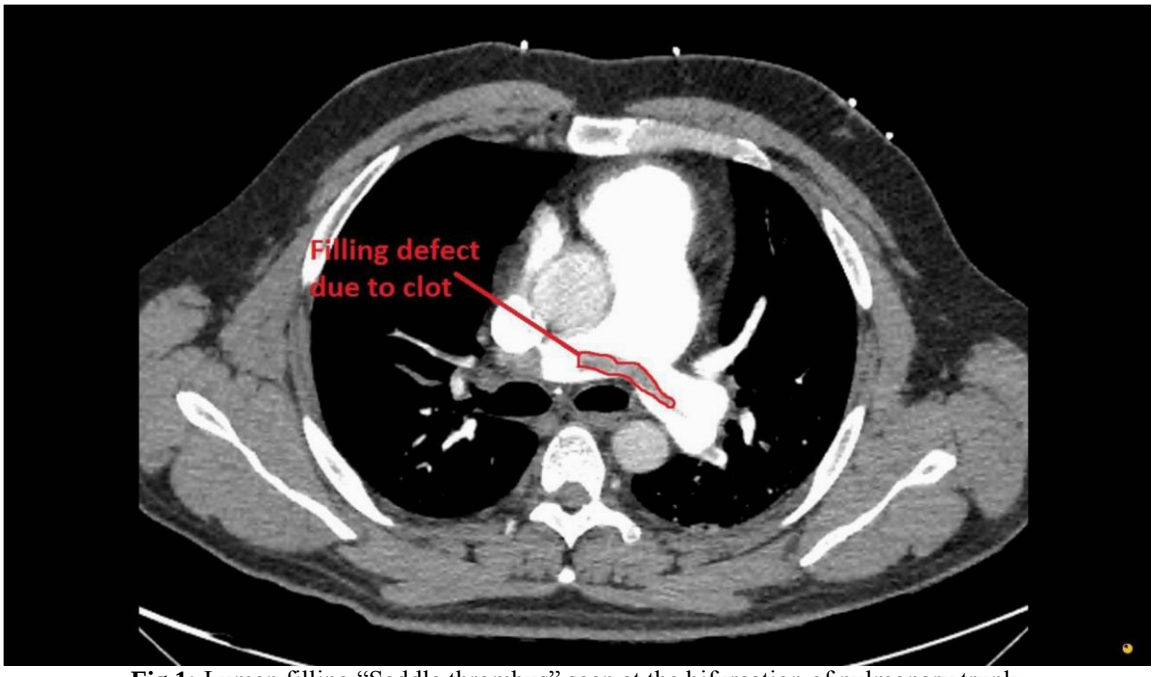
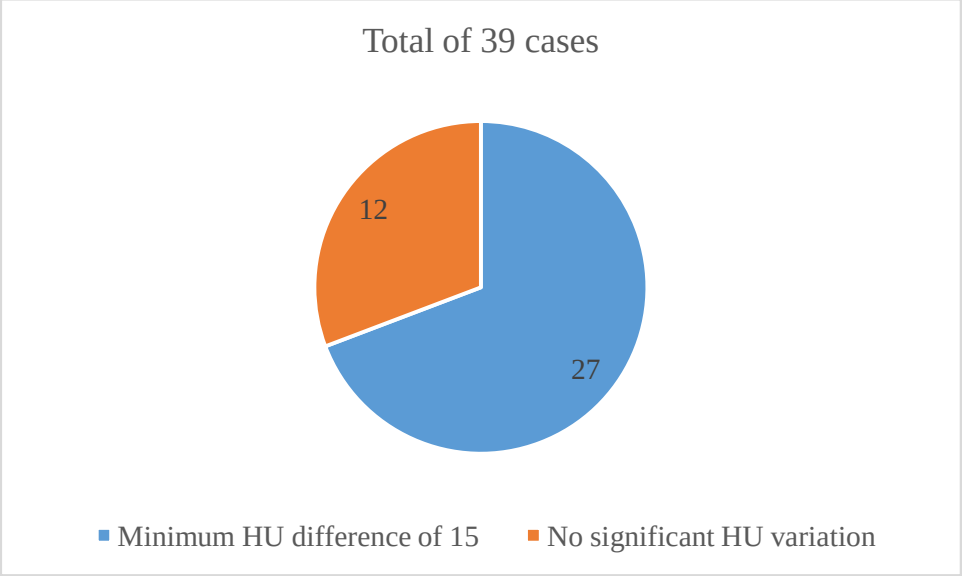
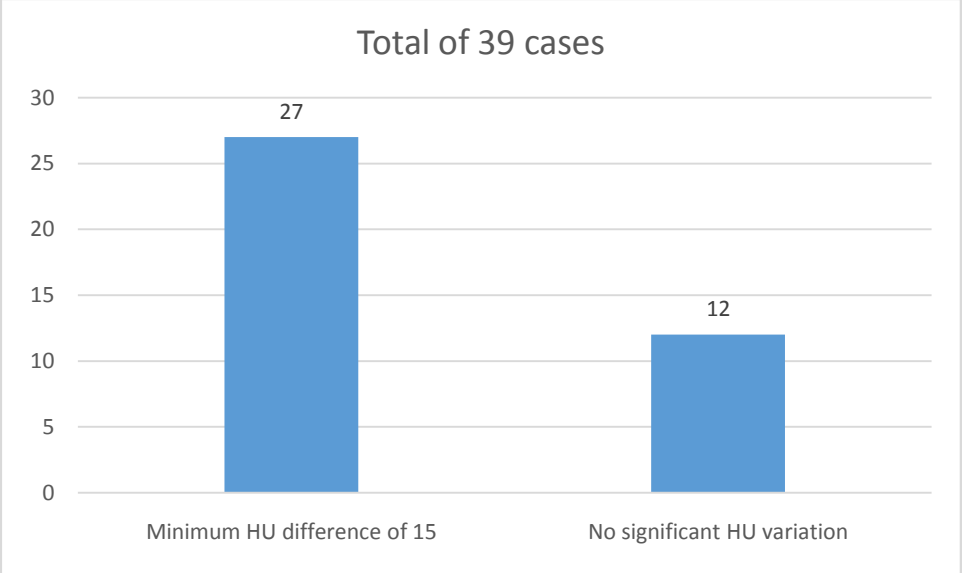


Fig.1: Lumen filling "Saddle thrombus" seen at the bifurcation of pulmonary trunk.



Pie chart showing proportion of cases with significant HU variation and without variation.



Bar diagram shwoing proportion of cases with significant HU variation and without variation

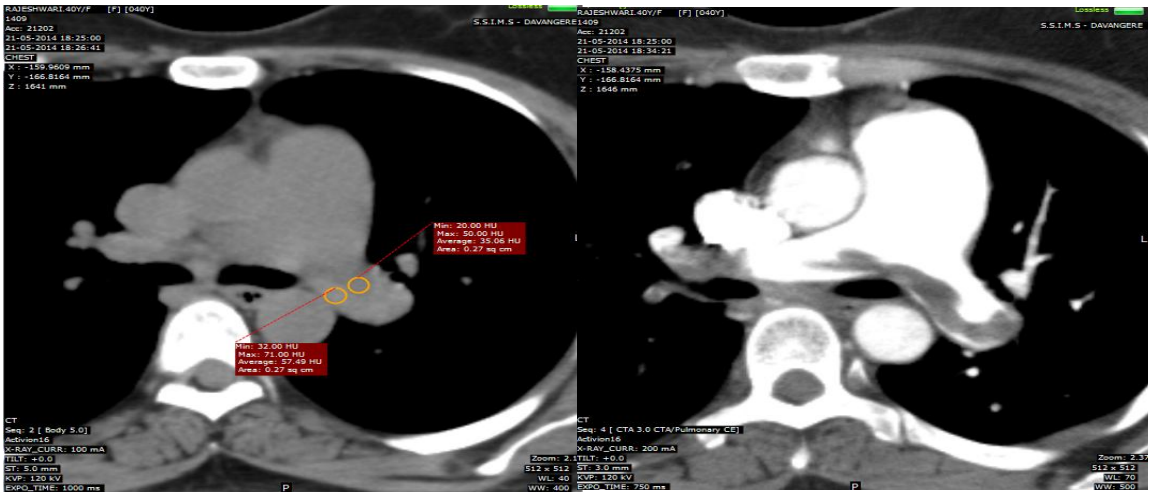


Fig 2:A. An HU difference of 22 seen involving two adjacent ROI in left pulmonary artery. **B.** the corresponding location on CTPA shows saddle thrombus extending to both right and left pulmonary arteries.

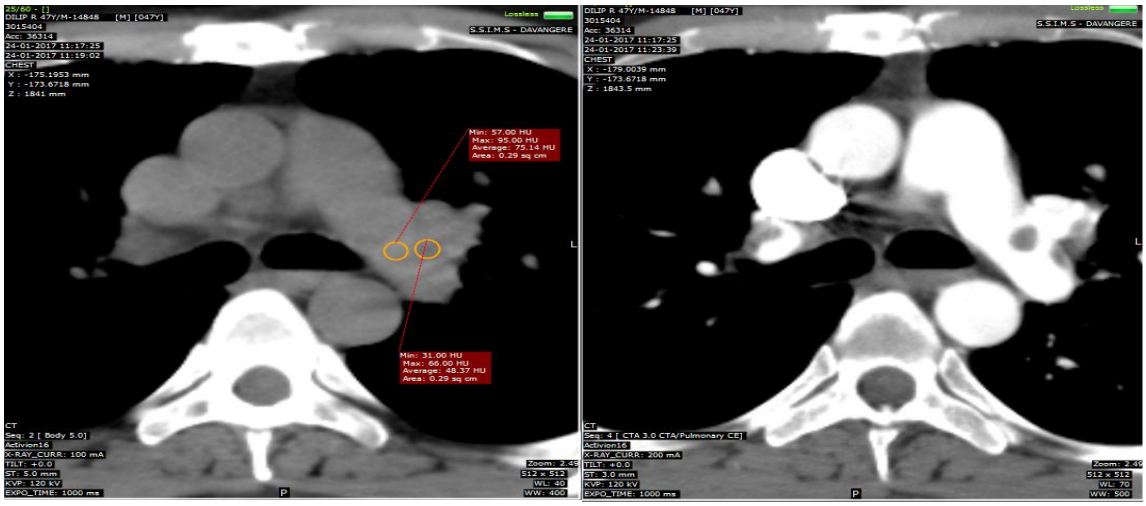


Fig 3: A.An HU difference of 27noted between two adjacentROI in left pulmonary artery. **B.** The location corresponds to small thrombus on CTPA images.

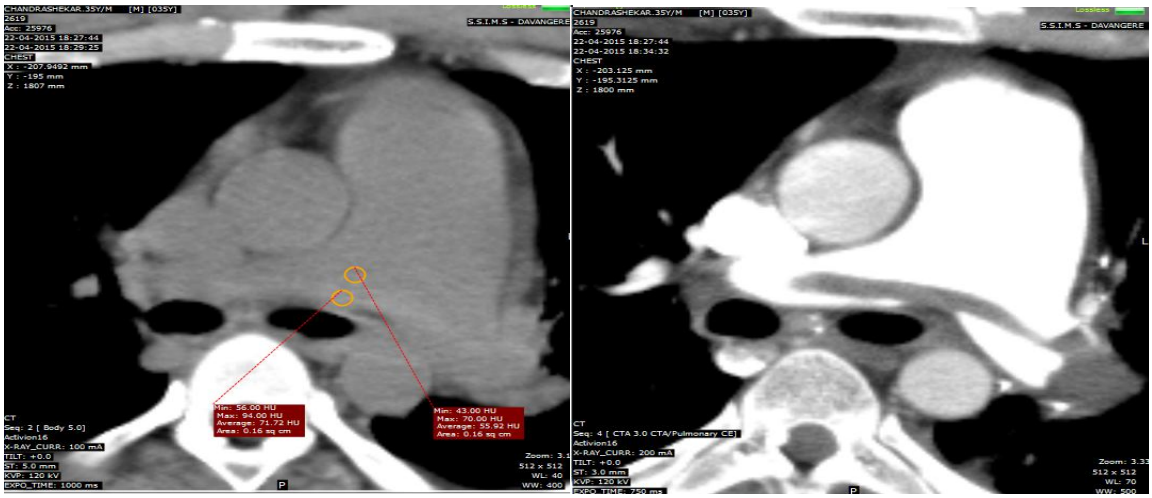


Fig 4:A. An HU difference of 16 noted between two adjacent regions of interest at the bifurcation of pulmonary trunk.**B.**corresponding location on CTPA images shows saddle thrombus.

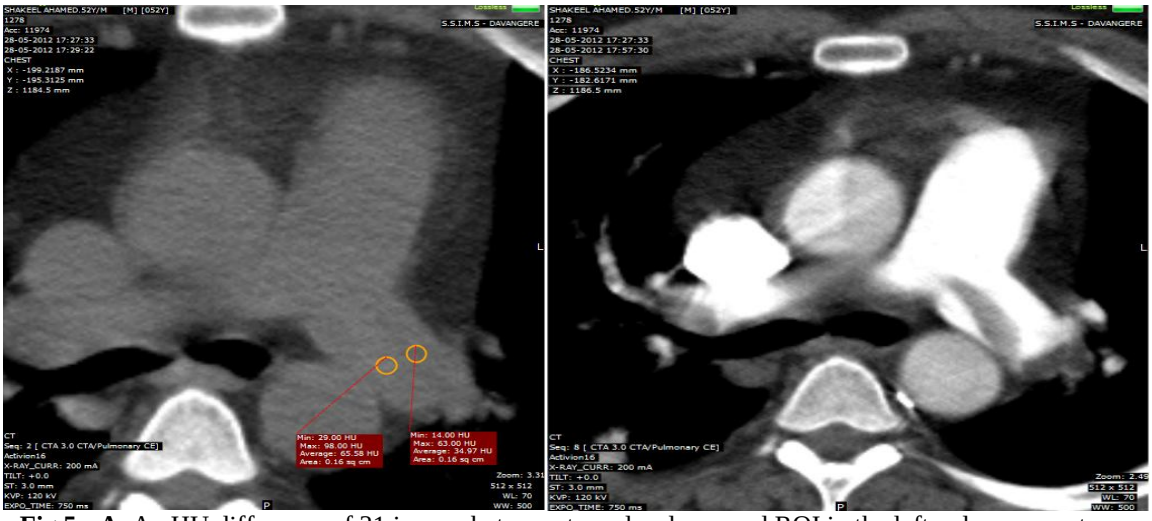


Fig 5 : A. An HU difference of 31 is seen between two closely spaced ROI in the left pulmonary artery. **B.** the location corresponds to thrombus on the CTPA image.

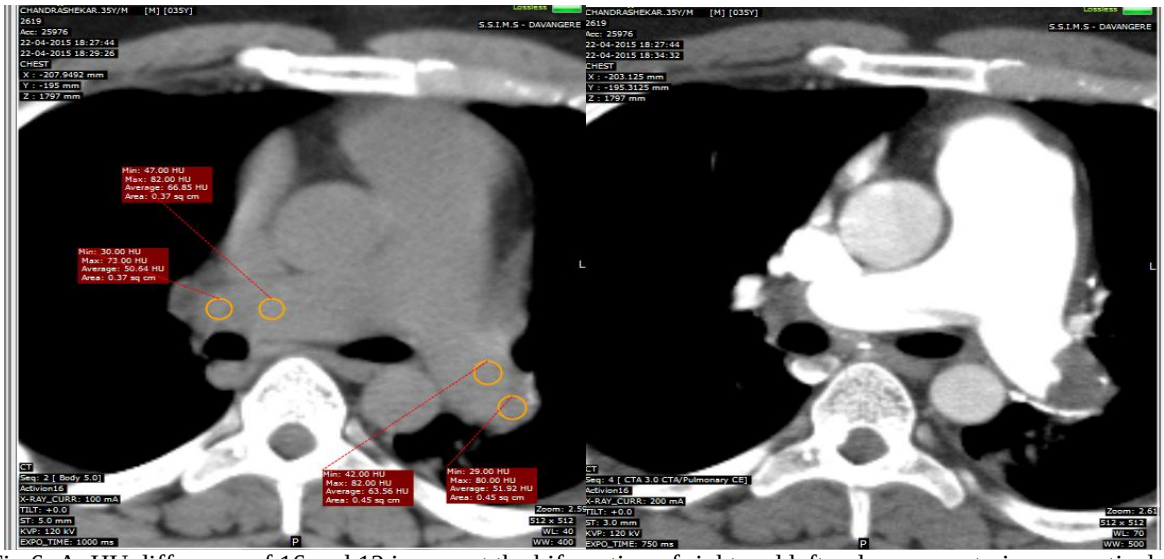


Fig 6: A. HU difference of 16 and 12 is seen at the bifurcation of right and left pulmonary arteries respectively. B. corresponding locations shows thrombi on CTPA.

IV. Discussion:

The diagnosis of PE is very important, because it is rapidly fatal and false positive or false negative results should always be avoided. The condition is difficult to assess clinically, because the differentials for the clinical symptoms includes a vast list like obstructive airway diseases, pneumonias, congestive cardiac failures etc. Because of its nonspecific presentation of PE, it remains a diagnostic challenge for both clinicians and radiologists.

In most individuals emboli arise from the deep veins of the legs but other sites, such as the upper limbs,[4] may be a source of emboli, particularly in patients with indwelling venous catheters.

Clinical history and physical examination were the primary diagnostic tools in the cases suspected of pulmonary embolism. Even after combining the findings of electrocardiogram, D dimer levels, arterial blood gas analysis and chest radiographs, the results were still inaccurate in confirming the pulmonary embolism. The results were far low in accuracy till the advent of accurate diagnostic tests.

Conventional pulmonary angiography[5] which was introduced in the 1960s was considered as the gold standard diagnostic tool for pulmonary embolism. The main disadvantage with conventional pulmonary angiography is, it is an invasive test though the complications reported were very less with the technique. It is seldom done now a days and is replaced by more accurate and non-invasive techniques now a days.

Another technique which was introduced in 1960s itself was lung perfusion scintigraphy (V/Q test). It was used extensively as a diagnostic tool for PE as it a non-invasive test. The advantage of the test was, it has high sensitivity and high negative predictive value. Unfortunately, the technique suffers from a large number of indeterminate studies in which the diagnosis of PE cannot be reliably confirmed or excluded.

Since 1990s, the diagnostic strategy for pulmonary embolism was changed. The main aim of the tests is to diagnose the cases who have PE, accurately and rapidly from the patients who do not have PE. Early diagnosis aids in early usage of anticoagulants / thrombolytics with early patient recovery.

It is during this period, computed tomography pulmonary angiography (CTPA) emerged as an alternative non-invasive technique. CTPA carries the advantages of a much lower rate of indeterminate study and the ability to diagnose alternate conditions for the patient's symptoms. Also, the binary interpretation ("positive" vs "negative") was much more acceptable to physicians rather than the complex probabilistic system of V/Q scintigraphy.CTPA has become the principal diagnostic tool worldwide for PE diagnosis. The earlier techniques are not used now a days unless CTPA is contraindicated / inconclusive / not available.

However, in some circumstances like renal disease, allergic reactions, severe dehydration, severe cardiac disease, or recent administration of large dose of contrast medium or on certain medications, use of iodinated contrast material is contra indicated. In such cases, these pulmonary embolism cases poses a major challenge for the clinicians for rapid diagnosis and treatment. In such cases, CTPA is contra indicated and the clinician has to dependonly on lab investigations and conventional imaging techniques.

In this study, we have investigated the usefulness of HU value (using an ROI) on plain CT chest images if it gives any clue to the diagnosis of pulmonary thrombo embolism. We found out that any sudden change in the HU value with a difference minimum of 15 HU between two closely spaced regions of interest increases the diagnostic possibility of pulmonary embolism.Using this technique, we found out retrospectively that, 27 out of 39 cases can be diagnosed of pulmonary embolism on plain CT images itself.The technique can

add to the confidence of radiologist and clinician if the clinical and other lab data is favouring the diagnosis.But as we are not directly visualising the thrombus, possibility of false positive and false negative results are more. Furthermore, the technique cannot rule out the pulmonary embolism as it is not performed for lobar, segmental and sub segmental pulmonary tree.

In 2016, Canellas *et al*[6]had published a study using HU value for the characterisation of portal vein thrombus (neoplastic versus bland). But, there was no literature found on this kind of study on pulmonary embolism previously.

There was no significant variation in the HU values when the thrombus is streak, irregular, incomplete and extending along the length of the involved artery. Also, the technique will not be useful when there is complete lumen occluding thrombus extending till the bifurcation of vessels. Another drawback of the study is, the HU difference can be due to the turbulence of blood in the arteries. In such cases, the technique may give false positive results.

Future prospects:

Like CT texture analysis software[7] which is an objective assessment of heterogeneity of the tissue microenvironment, this technique can open research in the development of a software for diagnosing the various conditions using the attenuation differences within the tissue which are below the level of subjective perception.

V. Conclusion

Significant number of cases can be diagnosed on plain CT chest images itself using the HU value. The study can open research in future prospects like CT texture analysis.

References

[1]. Anderson FA Jr, Brownell HB, Goldberg RJ, Hosmer DW, Nilima AP, Jovanovic B, Forcier A et al. A population-Based perspective of the hospital incidence and case fatality rates of deep vein thrombosis and pulmonary embolism: The Worcester DVT study. Arch Intern Med 1991; 151:933–938.

[2]. Laenaccl: Eisenmann B, Thiranos JC, Petit H, Kieny R.[Embolectomy in massive lung embolism]. Herz.1989 Jun; 14 (3) : 173-81.

[3]. Wharton LR, Pierson JW. The minor forms of pulmonary embolism after abdominal operations a clinical and roentgenographic study journal of the american medical association 79 (23): 1904-1910. doi : 10.1001 / jama. 1922. 02640230014006.

[4]. Shah MK, Burke DT, Shah SH. Upper extremity deep vein thrombosis. South Med J 2003;96:669–672.

[5]. Stein PD, Athanasoulis C, Alavi A, Greenspan RH, Hales CA, Saltzman HA et al. Complications and validity of pulmonary angiography in acute pulmonary embolus. Circulation 1992; 85:462–468.

[6]. Canellas R, Mehrkhani F, Patino M, Kambadakone A, Sahani D. Characterization of portal vein thrombosis (neoplastic versus bland) on CT images using software-based texture analysis and thrombus density (Hounsfield units). American Journal of Roentgenology. 2016 Nov;207(5):W81-7.

[7]. Summers RM. Texture analysis in radiology: Does the emperor have no clothes?. Abdominal Radiology. 2017 Feb 1;42(2):342-5

Dr. Kishan A Bhgwat "Hounsfield's Unit (HU) value inthe detection of thrombus involving pulmonary trunk, right and left pulmonary arteries on plain CT chest images: A retrospective study..". "IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), Volume 17, Issue 2 (2018), PP 06-11.