

**ROLE OF HRCT IN EARLY DETECTION OF EMPHYSEMA IN SMOKERS WITH NORMAL CHEST RADIOGRAPH**

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**ABSTRACT: INTRODUCTION:** Emphysema is defined by the American Thoracic Society through pathological criteria as "Abnormal permanent enlargement of airspaces distal to terminal bronchioles, accompanied by destruction of their walls and without obvious fibrosis." In the present scenario there is no diagnostic tool to detect the susceptible smoker. Hence a noninvasive tool that can detect the pathological changes early will be of immense value to guide the physician to alter the risk factors in asymptomatic patients as emphysema has its roots decades before the onset of symptoms. Recently High Resolution Computed Tomography Scan (HRCT) has established itself as a sensitive modality for the detection of early emphysema. **MATERIALS AND METHODS:** The study group consisted of 32 adult current smokers defined as those who have been smoking five or more cigarettes per day regularly for more than five years. The study group was chosen from attendants/healthy volunteers who attended the outpatient department, Government Fever Hospital, Guntur between January 2014 to march 2015. **RESULTS:** All the 32 subjects included in the study were males. Overall normal spirometer was observed in all the subjects. 17(53%) out of 32 subjects had CT evidence of emphysema. 5 of these 17 subjects with emphysema showed evidence of air trapping on expiratory scans only with normal inspiratory HRCT scan. 15 subjects (47%) had no evidence of emphysema on both inspiratory and expiratory HRCT scans. The incidence of emphysema increased with increasing age and pack years. **CONCLUSIONS:** The present study concludes that HRCT done in both inspiration and expiration is a good noninvasive modality to detect early emphysema in asymptomatic current smokers there by enabling the physician to implement preventive measures in susceptible subjects. The present study also emphasized the advantage of expiratory scan in detecting emphysema when inspiratory scan is normal. The HRCT of lung is also cost effective and minimizes radiation hazard if it is done with limited cuts.

**KEYWORDS:** Chest X-ray, COPD, Emphysema, HRCT, Smokers, Spirometry.

**INTRODUCTION:** Emphysema is defined by the American Thoracic Society through pathological criteria as "Abnormal permanent enlargement of airspaces distal to terminal bronchioles, accompanied by destruction of their walls and without obvious fibrosis." Emphysema and Chronic bronchitis together comprise the clinical syndrome of Chronic Obstructive Pulmonary Disease, which is the third leading cause of death world wide by 2030 as per the 2008 WHO World Health Report.<sup>(1)</sup> On CT scan emphysema is characterized by the presence of areas of abnormally low attenuation and disruption of vascular pattern. Precise clinical assessment of the presence and severity of emphysema during life has been confounded by the inconsistency with which clinical examination, pulmonary function tests and chest radiographic changes predict the pathological findings.<sup>(2,3)</sup> Only 10 to 15% of smokers who are susceptible develop emphysema.<sup>(4)</sup>

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In the present scenario there is no diagnostic tool to detect the susceptible smoker. Hence a noninvasive tool that can detect the pathological changes early will be of immense value to guide the physician to alter the risk factors in asymptomatic patients as emphysema has its roots decades before the onset of symptoms. Recently High Resolution Computed Tomography Scan (HRCT) has established itself as a sensitive modality for the detection of early emphysema.<sup>(5,6,7,8,9)</sup> The present study is done at Guntur where tobacco is grown and consumed in large quantities and the prevalence of emphysema is also high. The purpose of the present study is to determine the presence of early and asymptomatic emphysema in current smokers using inspiratory and expiratory HRCT scan which goes undetected on chest radiography and spirometry.

**MATERIALS AND METHODS: AIMS AND OBJECTIVES:** The present study aims at the detection of early emphysematous changes in asymptomatic smokers by high-resolution CT (HRCT). The primary objective of this study is to determine the role played by HRCT in detecting early emphysema in asymptomatic current smokers who have a normal chest radiograph and spirometry.

**STUDY DESIGN:** The study group consisted of 32 adult current smokers defined as those who have been smoking five or more cigarettes per day regularly for more than five years. The study group was chosen from attendants/healthy volunteers who attended the outpatient department, Government Fever Hospital, Guntur between January 2014 to march 2015. An informed consent was obtained from all the subjects to participate in the study.

**Inclusion Criteria:**

1. Asymptomatic current smokers as defined above.
2. 25-50 years of age group.
3. Any smoker - Beedi, Chutta, Cigarette.

**Exclusion Criteria:**

1. Obvious evidence of emphysema and any pulmonary disorder on standard chest radiography.
2. Previous history of recurrent respiratory tract infections.
3. Known asthmatics.
4. Patients on steroid or bronchodilator therapy.
5. Presence of skeletal abnormalities of the vertebral column like kyphosis, scoliosis, etc.
6. Coexistent cardiac, endocrine or renal disease.

**METHODOLOGY:** A detailed questionnaire regarding the symptoms related to chronic obstructive airway disease as well as coexisting disorders was taken from all the subjects followed by detailed clinical examination. Informed consent was taken from the subjects before subjecting them to investigations. Standard frontal and left lateral chest radiographs were obtained and reviewed for features of emphysema and other diseases. Presence of any abnormality suggestive of pathological process in any subject was not taken up for study. Pulmonary function tests including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC, FEF25-75 and peak expiratory flow rate (PEFR) were performed with VITALOGRAPH ALPHA. The functional definition of emphysema was taken as FEV1 <80% of predicted value and/or FEV1/FVC <80% of predicted value as per ATS 2006 guidelines.

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Patients with FVC or FEV<sub>1</sub> of <80% were eliminated from the study. High resolution computed tomography was done using a TOSHIBA ASTEION CT Scanner. Sections were obtained at 1 cm intervals using 2 mm collimation from lung apices to bases. The sections were taken at the end of full inspiration and in supine position. Expiratory scans were taken at 3 levels i.e. aortic arch, carina and lung bases. The radiographs and CT scans were assessed by two observers independently. The images were viewed with window level of -600 to -700H and window width of 1500 to 1700H. Lung superior to the carina was defined as the upper zone and lung inferior to the carina as the lower zone.

### **CT Criteria for Diagnosis of Emphysema were taken as follows:**

**Non-bullous Emphysema:** areas of decreased attenuation and disruption of the vascular pattern, usually lacking a well-defined wall.

**Bullous Emphysema:** Regions of emphysema with a well-defined wall 1 -2 mm in maximum thickness.

**Paraseptal Emphysema:** Sub pleural peripheral emphysematous 'lesions in a single layer usually less than 1cm.

**Air Trapping:** Failure of an area to increase in attenuation after full expiration, compared with the attenuation at full inspiration.

**RESULTS:** This study was conducted in Government Fever Hospital, Guntur from January 2010 to June 2011. 32 subjects who satisfied the inclusion criteria were taken up for the study. All the 32 subjects included in the study were males. There were no female subjects in the study. The mean age of subjects in this study was 38.41 years. The youngest patient was aged 27 years and oldest patient was aged 50 years. The following table gives the age distribution of the patients in this study. The distribution of smoking pattern in the subjects taken up for the study is summarized below (Table 2). Pack years are calculated from the number of packs of cigarettes/beedies smoked per day multiplied by number of years of smoking. On the 32 patients in the study group, 24 were cigarette smokers while 8 of them were habituated to both beedi and cigarette. All the subjects in the study had normal FVC, FEV<sub>1</sub> & FEV<sub>1</sub>/FVC. Overall normal spirometry was observed in all the subjects. 17(53%) out of 32 subjects had CT evidence of emphysema. 5 of these 17 subjects with emphysema showed evidence of air trapping on expiratory scans only with normal inspiratory HRCT scan. 15 subjects (47%) had no evidence of emphysema on both inspiratory and expiratory HRCT scans.

The incidence of emphysema increased with increasing age and pack years (Table 4 & 5). The youngest patient who had emphysema was aged 33 years. Emphysema was not detected before 30 years. A significant number of subjects with a smoking history of more than 10 pack years had emphysema. The incidence of air trapping increased with age and air trapping was not detected before 30 years of age (Table 6). Air trapping was seen more frequently in subjects with a smoking history of more than 10 pack years. However subject with smoking history of more than 30 pack years did not show air trapping on expiratory CT scan (Table 7). The most common finding on HRCT scans was air trapping (77%) followed by Bullous emphysema (59%) as shown in Table 8. Emphysematous changes were distributed in both zones in 12 patients (71%) while in 4 patients it was seen in upper lung zones (23%) lower zone predominance was seen in only 1 patient (6%) (Table 9).

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**DISCUSSION:** The study group consisted of 32 current asymptomatic smokers with a mean age of 38.4 years and mean pack years of 16.7. The present study used subjective method for detection of emphysema by HRCT and found that 17 out of 32 subjects (53%) had emphysema. This is comparable to the study by SASHIDHAR et al (2001) who studied 50 patients and found significant emphysema in 29(58%) patients. The present study also found that the incidence of emphysema increased with age and pack years. This is comparable to SASHIDHAR et al study. In the present study, the most common finding on HRCT was air trapping (77%) followed by bullous emphysema (59%), paraseptal emphysema (41%) and non-bullous emphysema (35%). REMY JARDIN et al performed only inspiratory scans and showed bullous emphysema (70%), non-bullous emphysema (90%) and paraseptal emphysema (75%).

The above variation is due to consideration of air trapping as a radiological feature of emphysema in the present study as described by KNUDSON et al (1991) and GEVENOIS et al (1996).<sup>(10,11)</sup> The present study showed emphysema in upper zones in 4 out of 13 subjects (23%), in lower zones in 1 subject (6%) and in both upper and lower zones in 8 out of 13 subjects (71%). REMY JARDIN et al showed 65% upper zone distribution and both upper and lower zone distribution in 35%. SASHIDHAR et al showed 44% upper lung zone distribution and both upper and lower zone distribution in 56%. The present study considered air trapping as emphysema and this might be a cause for a higher percentage of distribution in both zones.

Air trapping was identified on expiratory scans in 13 out of 32 subjects (41%) and the incidence of air trapping increased with age and pack years. This is comparable to the study by LEE et al (52%).<sup>(12)</sup> The present study found that air trapping was distributed in both zones in 62%, while LEE et al (2000) showed lower lobe predominance (84%) which is not comparable. In the present study expiratory scans showed air trapping in 8 out of 12 subjects (67%) with abnormal inspiratory scans and in 5 out of 20 (25%) with normal inspiratory scans there by' emphasizing the sensitivity of expiratory scans in the early detection of emphysema which is not comparable with NISHIMURA et al (1998) who stated that expiratory CT underestimates the degree of emphysema as compared with inspiratory CT scans.<sup>(13)</sup>

The present study is not strictly comparable to other studies as the present study was performed on current asymptomatic smokers and used both inspiratory and expiratory HRCT scans for detection of early emphysema. The CT reading was done by subjective method and objective quantification was not done. Pathological correlation was not done like REMY JARDIN (1993), BERGIN (1986), HAYHURST (1984), HRUBAN (1987) and GEVENOIS (1996). In the following table an attempt is made to compare the results of the present study with similar studies with subtle variations.<sup>(14,15)</sup> REMY JARDIN et al did not perform expiratory scans for detection of emphysema and hence the figures shown do not appear to correlate. If air trapping is not considered the present study correlates with REMY JARDIN study.

**CONCLUSIONS:** The present study concludes that HRCT done in both inspiration and expiration is a good noninvasive modality to detect early emphysema in asymptomatic current smokers there by enabling the physician to implement preventive measures in susceptible subjects. The present study also emphasized the advantage of expiratory scan in detecting emphysema when inspiratory scan is normal. The HRCT of lung is also cost effective and minimizes radiation hazard if it is done with limited cuts.

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Age Group	Number of Cases	%
25-30	04	12.5
31-40	17	53.13
41-50	11	34.38
<b>Total</b>	<b>32</b>	<b>100</b>

**Table 1: Age Distribution**

Pack Years	Number of Patients
1-10	09
11-20	14
21-30	06
31-40	01
41-50	01
>50	01
<b>Total</b>	<b>32</b>

**Table 2: Smoking Pattern**

Result	Number of subjects	Total number of subjects	%
Emphysema on inspiratory scans	12	32	37.5
Emphysema on expiratory scans only	5	32	15.63
<b>Emphysema in total</b>	<b>17</b>	<b>32</b>	<b>53.13</b>

**Table 3: Frequency Of Emphysema On HRCT**

Result	Number of Subjects	Total number of Subjects	%
25-30	0	04	-
31-40	09	17	52.94
41-50	08	11	72.73
<b>Total</b>	<b>17</b>	<b>32</b>	<b>53.13</b>

**TABLE 4: Frequency of Emphysema in Each Age Group**

Pack years	Number of subjects with emphysema	Total number of subjects	%
1-10	02	09	22.22
11-20	08	14	57.14
21-30	05	06	83.33
31-40	01	01	100
41-50	0	01	0
>50	01	01	100
<b>Total</b>	<b>17</b>	<b>32</b>	<b>53.13</b>

**Table 5: Frequency of Emphysema in Smokers in Relation to Pack Years**

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Age Group	Number of Subjects with air Trapping	Total number of Subjects	%
25-30	0	04	-
31-40	07	17	41.18
45-50	06	11	54.55
<b>Total</b>	<b>13</b>	<b>32</b>	<b>40.63</b>

**Table 6: Frequency of Air Trapping in Each Age Group**

Pack Year	Number of Subjects with air Trapping	Total number of Subjects	%
1-10	02	09	22.22
11-20	06	14	42.86
21-30	05	06	83.33
31-40	0	01	-
41-50	0	01	-
>50	0	01	-
<b>Total</b>	<b>13</b>	<b>32</b>	<b>4.63</b>

**Table 7: Frequency of Airtrapping in Smokers**

	Upper Zone	Lower Zone	Both Zones	Total
Bullous Emphysema	10	--	--	10(59%)
Non bullous Emphysema	03	--	03	06(35%)
Paraseptal Emphysema	05	--	02	07(41%)
Air trapping	03	02	08	13(77%)

**Table 8: HRCT Scan Findings in Smokers**

	Upper Zone	Lower Zone	Both Zones	Total
Emphysema on inspiratory scans	08	--	04	12
Emphysema on expiratory scn only	--	01	04	05
Emphysema in total	04 (23%)	01 (6%)	12(71%)	17

**Table 9: Distribution of Emphysema on HRCT**

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Author	Year of study	Number of patients	Mean age	Mean pack years	% of emphysema detected by CT	Upper zone	Lower zone	Both zones
GURNEY et al	1992	59	58	60	61%	58%	39%	-
REMY JARDIN et al	1993	98	33	12.8	20%	65%	-	35%
LEE et al	2000	82	45	-	52%	-	84%	16%
SASHIDHAR et al	2001	50	53.5	40.7	58%	48%	-	52%
Present Study	2014-15	32	38.4	16.7	53%	23%	6%	71%

Table 10

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