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Morophological variations of the domes of the Diaphgram: A study conducted at SGT Medical College, Gurugram (Haryana)

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Abstract
Background: Diaphragm is very important structure and landmark that separates thoracic and abdominal cavities in addition to its role in respiration. There is a lot of variations in the shape position, outline and heights of both the domes of the diaphragm. These can vary in patients having smoking history or having other pathologies like pulmonary collapse, pneumonias, infarction, rib fracture and pleurisy. These can lead to some wrong diagnosis which unwarranted and unnecessary treatments for the underlying pathologies which infect do not exist.
Material and Methods: Thirty nine subjects were studied with their chest x-rays of frontal and lateral views. This included 13 (33%) females and 26 male (67%).
Results: Right dome was raised in most of the cases barring those who fall in the smokers group. The height was more in the 46-60 years age group. The height of the domes was falling at the level of D10 and D11 levels.
Conclusion: The study confirms the change of level and height of the dome among smokers and nonsmokers and as per the different age groups.

Keywords: domes; diaphragm; smoking history; pathologies

Introduction
Diaphragm is a dome shaped structure separating the thoracic and abdominal cavities. The level of right cupola is normally at the anterior costal ridge of the sixth rib. This dome is half of the space higher than left side. This has got an aperture that permits the various structures to pass through that and is called as inferior thoracic aperture (Figure 1).

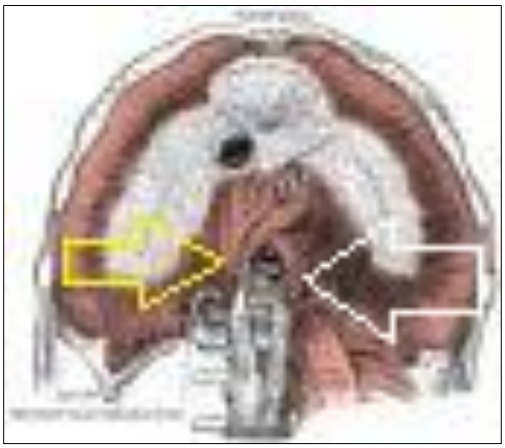

Fig 1: Abdominal side of the dome with right (yellow arrow) and left (white arrow) crus (borrowed diagram)

The development of the diaphragm can lead to various variations in the shape, outline, depth and margins of the dome. The insertion of both the domes is in the form of conjoined tendon. This can also be different on right as well as on left side.

Material and Methods
Thirty-nine subjects were studied prospectively from October 2019 to December 2019 as per their habits and socio-economical background. Both the sexes were included in the study with the

Distribution as 26 being male (67%) and 13 (33%) as female (Table 1 and Figure 2). Both the postero-anterior and lateral films are indispensable for the evaluation of the domes.

Table 1: The distribution of all the patients who were studied

S. NO	Patient name	Age & SEX	Weight of patient	Smoker/ Non smoker	Position of Domes of the Diaphragm on PA view		Height of right dome curvature of the diaphragm on lateral view
					LEFT	RIGHT	
1	Vivek	17yr/M	74kg	Non smoker	Midpoint of T11	Lower border T10	3.5cm
2	Raj Bahadur	17yr/M	68kg	Non smoker	Midpoint of T11	Lower border T11	3.5cm
3	Azad	20yr/M	58kg	Non smoker	T10	T10	5.3cm
4	Mithlesh	21yr/M	68kg	Smoker (1pack/day)	T8	IVD T8-T9	5.2cm
5	Brijesh	21yr/M	72kg	Smoker (4cig/day)	T10	T10	5.8cm
6	Karan	23yr/M	54kg	Non smoker	Upper border T11	Lower border T10	5.7cm
7	Lekhram	25yr/M	53kg	Non smoker	T11	T11	3.4cm
8	Rakesh	25yr/M	62kg	Non smoker	IVDisc T9-T10	T9	5.7cm
9	Satpal	27yr/M	65kg	Non smoker	Lower border T11	Upper border T11	6.5cm
10	Kavita	27yr/F	70kg	Non smoker	Lower border T7	T8	3.8cm
11	Poonam	27yr/F	68kg	Non smoker	T11	T10	6.5cm
12	Dharmender	27yr/M	62kg	Non smoker	T11	Upper border T11	6.4cm
13	Suman	29yr/F	52kg	Non smoker	T12	T11	2.9cm
14	Sanjay	29yr/M	74kg	Smoker (1pack/day)	T11	T10	6.4cm
15	Parveen	29yr/M	80kg	Non smoker	Upper border T11	T11	4.7cm
16	Lata	30yr/F	74kg	Non smoker	Lower border T10	Upper border T9	6.7cm
17	Deepak	30yr/M	67kg	Non smoker	Upper border T12	T11	4.8cm
18	Deepak	30yr/M	58kg	Smoker	IV disc T11-T12	T11	4.7cm
19	Parveen	32yr/M	80kg	1 ½ pack/day	T10	T9	4.7cm
20	Kaluram	33yr/M	82kg	½ pack/day	Upper border T10	T10	4.4cm
21	Suman	33yr/F	60kg	Non smoker	Upper border T11	T10	5.7cm
22	Manoj	34yr/M	84kg	Smoker 3cig./day	T11	T11	5.3cm
23	Jay kishan	34yr/M	67kg	Smoker ½ /day	T8	T8	4.3cm
24	Roopwati	35yr/F	70kg	Non smoker	T9	T8	3.2cm
25	Rajesh	35yr/F	84kg	Smoker 1pack/day	T10	T9	6.3cm
26	Pooja	36yr/M	68kg	Non smoker	Lower border T11	Upper border T12	4.6cm
27	Rekha	36yr/F	68kg	Non smoker	Upper border T12	T11	4.5cm
28	Pinki	36yr/F	70kg	Non smoker	T10	T10	4cm
29	Inderjeet	36yr/M	72kg	Smoker 1 pack/day	IVD T8-T9	T8	5.5cm
30	Ajeet	40yr/M	73kg	Smoker 1 pack/day	T9	T9	11cm
31	Inderjeet	42yr/M	80kg	Smoker 3cig./day	Upper border T10	Lower border T9	4.2cm
32	Anita	43yr/F	62kg	Non smoker	T11	T10	5.5cm
33	Kuldeep	45yr/M	58kg	Smoker	T9	T10	4cm
34	Karan	45yr/M	72kg	Smoker 2cig./day	Upper border T10	Lower border T9	4.4cm
35	Kuldeep	45yr/M	84kg	Smoker x10day	T10	T9	4cm
36	Pavitra	45yr/F	72kg	Non smoker	Lower border T11	Lower border T10	4.1cm
37	Sampuran	50yr/M	75kg	Smoker 1 ½ pack/day	Upper border T11	T10	2.5cm
38	Santra	58yr/F	80kg	Non smoker	IVD T11-T12	T11	6.4cm
39	Shyamwati	60yr/F	76kg	Non smoker	Upper border T11	T9	5.2cm

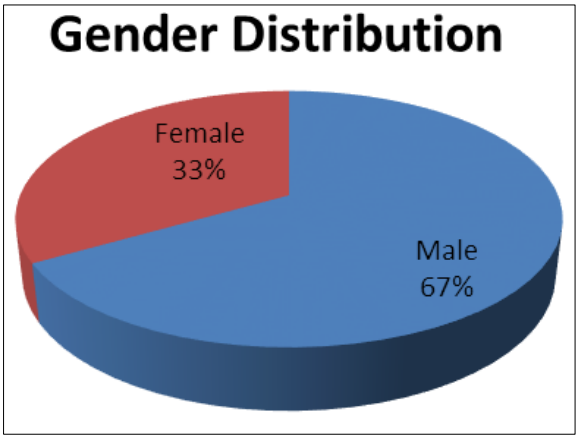

Fig 2: Distribution of thirty-nine subjects as per the gender

All the cases were further evaluated in three group categories as 15-30y, 31-45y and 46-60 y. The distribution for different sexes were also further categorized (Figure3).

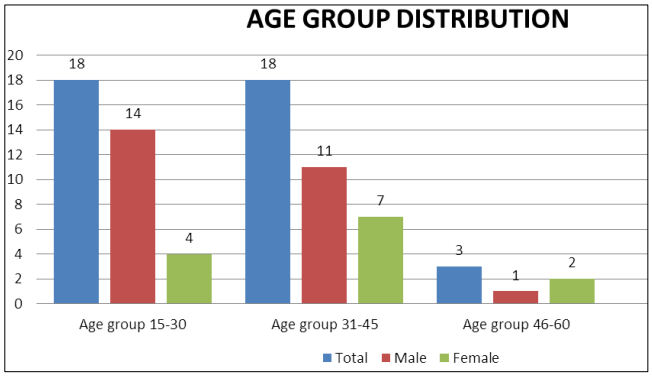

Fig 3: Age-wise distribution of the cases. The distribution had been done in three groups as 15-30 y, 31-45y and 45-60y as per the gender as shown in the diagram

All the persons were between the weight ranges of 52kg to 84kg with the average weight being 69.6kg (Figure 4).

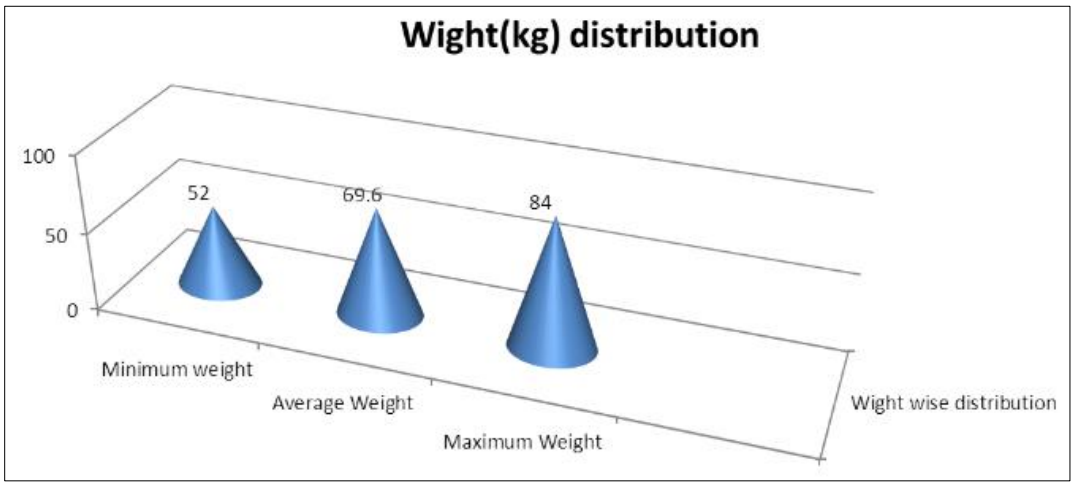

Fig 4: Distribution of the subjects as per the weight and mean being 69.6 kg

The trial group composed of two categories of smokers (41%) and non-smokers (59%) to compare the morphological characteristics of the domes (Figure 5)

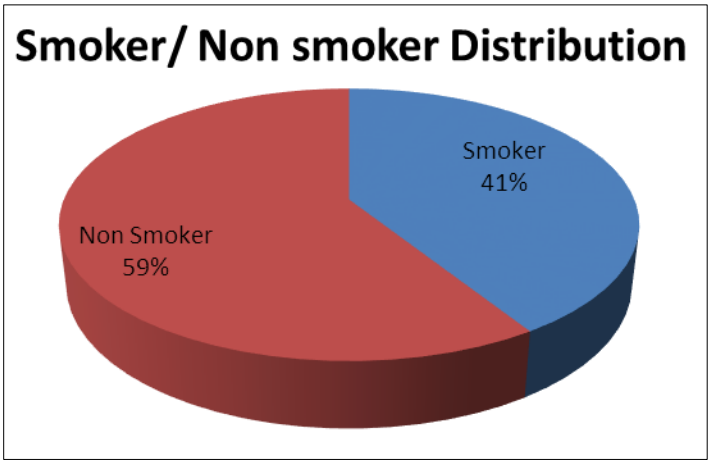

Fig 5: Distribution as per the smoker (41%) and non-smoker (59%) category

Results

The position of the domes varied on both the sides.The range of the position of the domes were from D8 level to D11.Ten (25.64%) of the cases were having higher position of the right dome at D10 vertebra as compared to six (15.38%) of left dome at the same position. In 5 cases (12.8%) the left dome was higher at D11 level (Figure 6).

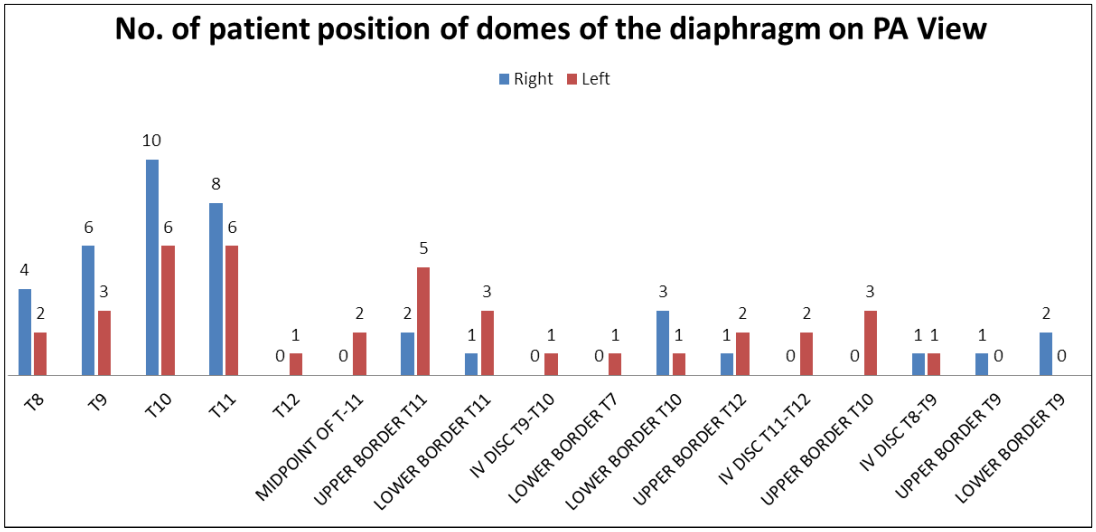

Fig 6: Bar chart shows the different level of the right as well as left dome. The majority of the dome positions were at D10 and D11 levels.

There was difference of heights of the right dome among smokers and non-smokers. Maximum height was noted among 53% among non-smokers as compared to 47% in smokers category (Figure 7 and Figure 8).

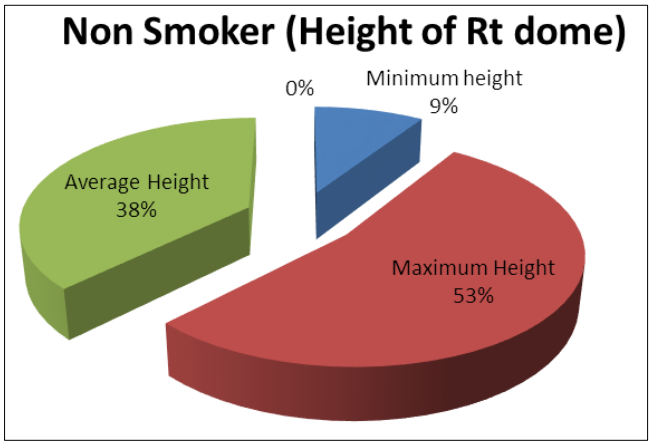

Fig 7: Distribution of the height of right dome among smokers

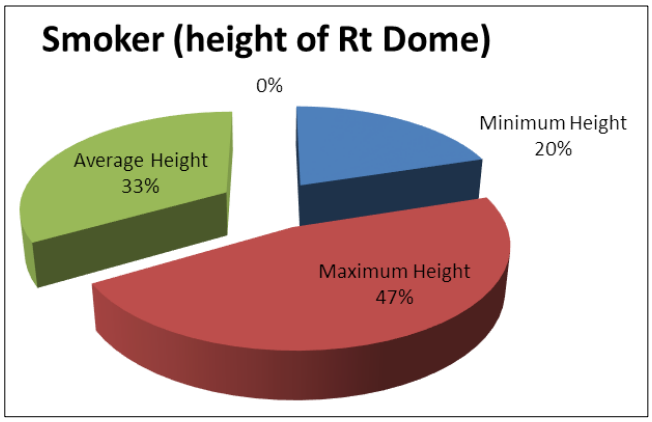

Fig 8: Distribution of the height of right dome among non-smokers

The maximum height of right dome was found to be 6.7 cm and was found to be in 45-60 years age group. The minimum height of right dome was 1.1 cm and the group was in 15-30 years group The height was taken as vertical line drawn on another line joining the anterior and posterior margins of the diaphragm (Figure 9 and 9a and Figure 10)).

Fig 9: Chest x-rays lateral and postero-anterior for the purpose of measurements

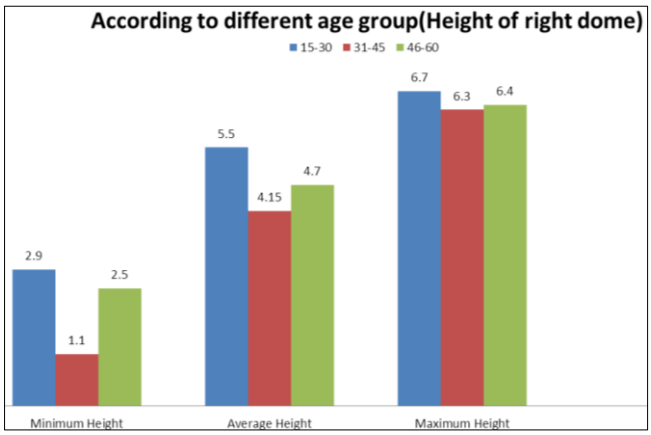

Fig 9(a): The distribution of the range of the height of the right dome on the lateral projection of chest

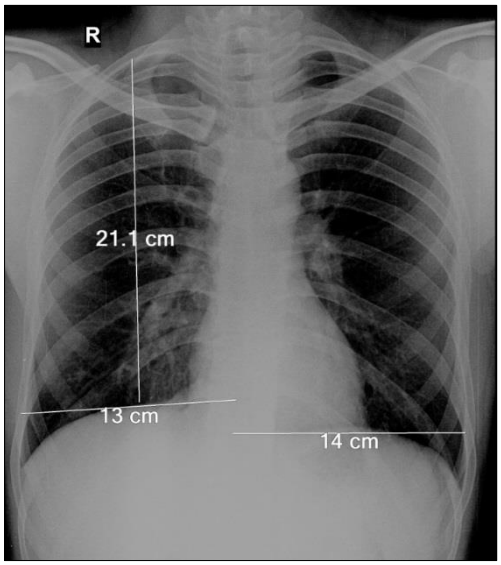

Fig 10: Chest radiograph show both the domes and their levels

Discussion

The attachment of the diaphragm is to the three parts as sterna, costal and lumbar. There are two medial and lateral arcuate ligaments, and two crura as right and left. Central tendon fuses with pericardium and the inferior vena cave aperture lies within this. Diaphragm varies in various individuals in many morphological ways [1, 2]. It is very important to understand the anatomy and variations in both the domes of the diaphragm in diagnostic as well as for the surgical point of views. The diaphragm on one side is attached to the lung by phrenocardiac and on other side to the liver by coronary and falciparum ligaments [3, 4]. There are three segments as sterna, costal and right and left diaphragmatic pillars. The main consideration is given on the following points in view of muscle slips, serrated appearance because of muscle slips, hump and accessory diaphragm:

a. contour of both the domes
b. outline of both the domes: bumps
c. depth or heights of the right dome
d. accessory diaphragm
e. inversion of the diaphragm

Scalloping are seen in the contour because of the small muscle fascicles at the insertion especially at the lower ribs. In a series of 540 case this finding was seen in 30 cases (5.5%).This was more common on right side than left and was found more common in asthenic individuals [5, 6. 7]. This also becomes more common among the individuals having emphysema or pneumothorax.Felson had noted raised dome in 2% on right side and 9% on left side in series of 500 normal chests. In 50% of the cases the left dome was raised due to the gaseous distension. Splenic flexure syndrome had been noticed in some cases having pain in left hypochondrium. The right dome may be raised due to the gas in the hepato-diaphragmtic interposition. This happens in Chiliaditi's syndrome. Bilateral raised dome may be seen in ascites, pregnancy, hepatosplenomegaly and large abdominal neoplasm or cyst [8]. The bump was more commonly seen on right side at anteromedial aspect near the cardiac shadow. This can also seen in post-surgical cases where the injury to the fibril of the phrenic nerve is the underlying reason. Accessory dome is the duplication and is always seen on the right side. The association with scimitar syndrome is well known. Inversion of the dome can be seen in any of the condition where a mass or collection is present in the thoracic cavity. Pendelluft theory had been explained for the movement of the dome during inspiration and expiration. This is because the air moves to the other lung in inspiration through the passage [9].

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Conflict of interest

Nil

Consent of the patients

Proper written consent was taken.

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