

**PULMONARY FUNCTION TESTS IN PLEURAL EFFUSION BEFORE AND AFTER COMPLETE THORACENTESIS**Sanjay Sahay<sup>1</sup>, Satish K. Ramteke<sup>2</sup>, Sharmila Ramteke<sup>3</sup>**HOW TO CITE THIS ARTICLE:**

Sanjay Sahay, Satish K. Ramteke, Sharmila Ramteke. "Pulmonary Function Tests in Pleural Effusion before and after Complete Thoracentesis". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 23, June 09; Page: 6314-6324, DOI: 10.14260/jemds/2014/2742

**ABSTRACT: OBJECTIVE:** Pleural effusion is accumulation of abnormal amount of fluid in pleural space. Thoracentesis is associated with subjective improvement in many patients. We aimed to assess the spirometric values before and after thoracentesis in pleural effusion. **MATERIAL AND METHOD:** The study comprised 44 patients admitted in SCB medical college and hospital Cuttack, Orissa in department of Tuberculosis & chest Disease. Pleural effusion was diagnosed clinically and by CXR. Pulmonary function was performed with computed spirometric analyzer. Spirometric measurements for FEV1, FVC, FEV1/FVC%, TV, VC were done before and after complete thoracentesis. 'P' value for each parameter is calculated using 'z' table. **RESULTS & CONCLUSION:** Lung function values showed inverse relation to the amount of pleural effusion. Pulmonary function tests established clearly that pleural effusion produced a restrictive pattern, which showed statistically significant improvement following thoracentesis.

**KEYWORDS:** PFT, Pleural effusion

**INTRODUCTION:** Pleural effusion is accumulation of fluid in pleural cavity. It is the most common manifestation of the disease of pleura. The clinical recognition of pleural effusion signals on abnormal pathophysiologic state that has resulted in a dysequilibrium between pleural fluid formation and removal. In patients with pleural effusion, the alteration in physiological states leading to restrictive pulmonary function and hypoxia have been recognized. Studies have shown improvement in lung function following thoracentesis.

**AIMS AND OBJECTIVES:**

1. Clinical and radiological studies of pleural effusion.
2. Pulmonary function tests before and after complete thoracentesis.
3. Correlation between clinico-radiological and pulmonary function status.

**MATERIAL AND METHOD:** The study comprised 44 patients admitted in SCB medical college and associated hospital Cuttack, Orissa in department of Tuberculosis & chest Disease. **Inclusion criteria:** (1) Patients aged 15yrs and above of both sexes with unilateral or Bilateral pleural effusion of recent onset. **Exclusion criteria:** (1) Pleural effusion with parenchymal disease. (2) Encysted pleural effusion. (3) Pleural effusion with pneumothorax and hydropneumothorax. (4) Patient of bronchial asthma and COPD. (5) Systemic diseases leading to pleural effusion like cardiovascular, renal, hepatic.

Patients were clinically examined and routine blood examination and sputum for AFB was done. Based on X-ray chest, patients were classified as minimal, moderate and massive type. Patients with pleural effusion level up to lower border of fourth rib anteriorly were classified as minimal

## ORIGINAL ARTICLE

effusion, up to lower border of second rib as moderate effusion and above second rib as massive pleural effusion. Pulmonary function test was done in all the patients using dry rolling seal spirometer of Morgan Transfer test Machine both before and following complete thoracentesis.

Lung function tests were carried out after gaining confidence of the patients and making them learn the correct procedure. Each patient was advised to sit over a stool for 5 minutes. After that he/she was asked to blow in the mouth piece through his mouth, keeping nasal opening close with nasal clip. Tidal volume, Vital capacity, Forced Vital Capacity (FVC), Forced expiratory volume in 1 sec. (FEV<sub>1</sub>), FEV<sub>1</sub>/FVC ratio calculated. All tests were repeated three times and mean value was calculated.

Lung volumes were corrected to body temperature and pressure standard (BTPS). Pulmonary function tests values were compared with predicted corresponding Indian values (kamal<sup>2</sup> et al) 1977, S.K. Jain<sup>3</sup> et al, (1967)

Finally all the values of different pulmonary function parameters are arranged in two groups. Before and after thoracentesis. 'p' value for each parameter is calculated using 'z' table, with this table we can know whether changes in pulmonary function parameters are significant statistically or not.

**OBSERVATION:** Total 44 cases were taken and the results of the study are as follow:

No. of cases	FVC before Thoracentesis in Ltre.	FVC after Thoracentesis in Ltre.	Predicted FVC in Ltre	Percentage of Predicted
1	1.5	1.6	2.1	76.10%
2	2.0	2.4	2.9	82.75%
3	1.1	1.4	1.9	73.68%
4	1.0	1.5	1.9	78.95%
5	1.5	2.0	2.6	76.92%
6	1.5	1.6	1.9	84.21%
7	1.6	2.1	2.7	77.77%
8	2.2	2.4	2.8	85.71%
9	1.1	1.4	1.8	77.77%
10	1.1	1.3	2.6	50.00%
11	1.1	1.5	1.9	78.94%
12	1.1	1.3	1.6	72.72%
13	1.2	1.7	2.4	70.83%
14	1.2	2.0	2.4	83.33%
15	1.1	1.4	2.0	70.00%
16	1.6	1.7	1.8	94.44%
17	1.5	1.6	2.4	66.66%
18	0.9	1.0	2.8	35.71%
19	1.5	1.6	1.8	88.88%
20	1.2	1.0	1.7	94.11%
21	0.9	1.2	1.3	92.30%
22	1.1	2.1	2.2	95.45%
23	1.7	1.0	1.4	71.42%
24	0.9	1.8	1.9	94.73%
25	1.6	2.0	2.1	74.07%
26	1.2	2.7	2.2	77.27%

## ORIGINAL ARTICLE

27	1.2	1.3	1.8	72.22%
28	1.1	1.5	2.8	53.57%
29	1.4	1.3	2.0	65.00%
30	1.1	1.4	1.8	77.77%
31	1.1	2.4	2.7	88.88%
32	2.4	2.4	2.5	94.77%
33	1.6	1.8	1.9	94.23%
34	1.2	1.8	2.4	75.00%
35	1.2	1.7	2.5	68.00%
36	1.5	1.6	3.3	68.66%
37	2.0	2.4	3.2	75.00%
38	1.1	1.4	2.1	66.66%
39	1.0	1.5	2.6	57.69%
40	1.5	2.0	2.8	71.42%
41	1.2	1.5	1.6	93.75%
42	2.1	2.2	2.6	84.61%
43	1.6	2.1	2.8	75.00%
44	1.1	1.4	1.7	64.70%
<b>Total = 44 Cases</b>				
<b>Mean</b>	<b>1.38</b>	<b>2.56</b>	<b>2.27</b>	<b>76.73%</b>
<b>S.D.</b>	<b>± 0.351</b>	<b>± 0.385</b>	<b>± 0.621</b>	<b>± 12.88%</b>
<b>Table 1: Forced Vital Capacity (FVC) of all the Patients before and after complete thoracentesis</b>				

The above table shows the Forced Vital Capacity all patients before and after complete thoracentesis. The mean value observed before aspiration was found 1.38 liters (S.D= ±0.351) and after aspiration the mean value was 2.56 Liters (S.D= ±0.385)

No. of cases	FEV <sub>1</sub> before Thoracentesis in Ltre.	FEV <sub>1</sub> after Thoracentesis in Ltre.	Predicted FEV <sub>1</sub> in Ltre	Percentage of Predicted
1	1.0	1.1	2.8	39.28%
2	1.4	1.6	2.1	76.19%
3	0.8	2.1	1.4	78.57%
4	0.5	1.0	1.5	66.66%
5	1.2	1.5	2.0	75.00%
6	1.0	1.1	1.5	73.33%
7	1.4	2.0	2.3	86.95%
8	2.1	2.2	2.5	88.00%
9	0.8	1.1	1.4	78.57%
10	0.9	0.9	2.8	32.14%
11	0.9	1.1	1.5	60.00%
12	0.9	1.1	1.4	68.79%
13	0.8	1.4	2.2	63.63%
14	1.0	1.5	1.7	88.23%
15	1.3	1.4	1.6	87.50%
16	1.8	1.1	1.5	73.33%
17	1.0	1.1	2.3	47.83%
18	0.7	0.8	2.1	38.02%

## ORIGINAL ARTICLE

19	1.0	1.1	1.8	57.89%
20	0.8	1.4	1.5	93.33%
21	0.9	1.1	1.2	91.66%
22	1.3	1.5	1.9	78.94%
23	0.7	0.8	1.6	50.00%
24	1.3	1.4	1.5	93.33%
25	1.0	1.5	1.7	88.23%
26	0.9	1.4	2.6	53.84%
27	0.9	1.1	1.5	73.33%
28	1.0	1.1	2.3	47.82%
29	0.9	0.9	1.4	64.28%
30	0.8	1.1	1.5	73.33%
31	2.1	2.2	2.4	91.66%
32	1.4	2.0	2.1	95.23%
33	1.1	1.4	1.7	82.35%
34	1.1	1.5	1.8	83.33%
35	0.8	1.4	1.8	76.77%
36	1.0	1.1	2.3	47.82%
37	1.4	1.6	1.8	88.88%
38	0.8	1.0	1.3	76.92%
39	0.5	1.0	1.8	27.77%
40	1.2	1.5	1.9	78.94%
41	1.0	1.1	1.2	91.66%
42	1.4	2.0	2.4	83.33%
43	1.4	1.9	2.1	90.44%
44	0.8	1.1	1.6	68.75%
<b>Total = 44</b>				
<b>Mean</b>	<b>1.025</b>	<b>1.31</b>	<b>1.8</b>	<b>96.79%</b>
<b>SD</b>	<b>±0.328</b>	<b>±0.366</b>	<b>±0.471</b>	<b>±34.69%</b>

**Table 2: FEV<sub>1</sub> of all patients before and after complete thoracentesis**

The above table shows the FEV<sub>1</sub> of all patients before and after complete thoracentesis. The mean value observed before aspiration was found 1.025 liters (S.D = ±0.328) and after aspiration the mean value was 1.31 Liters (S.D= ±0.366).

No. of cases	FEV <sub>1</sub> /FVC% before Thoracentesis	FEV <sub>1</sub> /FVC% after Thoracentesis	predicted FEV <sub>1</sub> /FVC% in Ltrs	Percentage Of Predicted
1	66%	68%	51.55%	131.91%
2	86%	83%	92.07%	90.21%
3	73%	78%	106.00%	73.58%
4	50%	66%	75.75%	87.12%
5	72%	75%	97.50%	76.91%
6	66%	68%	87.01%	78.14%
7	86%	95%	111.80%	84.97%
8	87%	91%	102.67%	89.63%
9	73%	78%	101.02%	77.21%

## ORIGINAL ARTICLE

10	81%	89%	64.28%	138.45%
11	81%	84%	76.00%	110.52%
12	81%	87%	72.00%	79.51%
13	66%	81%	81.26%	97.68%
14	83%	79%	105.88%	74.61%
15	81%	72%	125.00%	57.60%
16	73%	78%	77.64%	100.46%
17	66%	68%	71.75%	88.13%
18	77%	80%	133.94%	59.72%
19	66%	68%	65.13%	104.40%
20	66%	81%	99.17%	81.67%
21	81%	84%	99.30%	84.59%
22	76%	85%	103.65%	82.00%
23	77%	80%	70.00%	114.28%
24	81%	72%	98.52%	73.08%
25	83%	79%	118.11%	66.90%
26	66%	81%	69.67%	116.26%
27	81%	84%	101.53%	82.74%
28	78%	66%	89.26%	73.94%
29	81%	69%	80.09%	69.77%
30	73%	79%	94.29%	82.72%
31	87%	91%	103.12%	88.24%
32	86%	83%	100.48%	82.60%
33	78%	72%	86.93%	82.82%
34	83%	83%	111.10%	79.47%
35	66%	81%	14.36%	70.82%
36	66%	68%	69.64%	97.64%
37	86%	83%	133.33%	62.25%
38	73%	78%	115.39%	67.59%
39	50%	66%	48.13%	137.12%
40	72%	75%	110.52%	67.86%
41	66%	72%	97.77%	73.64%
42	65%	87%	98.48%	88.34%
43	87%	90%	126.26%	71.28%
44	73%	78%	106.26%	74.97%
<b>Total = 44cases</b>				
<b>Mean</b>	<b>74.44%</b>	<b>78.26%</b>	<b>92.91%</b>	<b>86.72%</b>
<b>S.D.</b>	<b>± 11.34%</b>	<b>± 19.29%</b>	<b>± 20.97%</b>	<b>± 21.30%</b>

**Table 3: FEV<sub>1</sub>/FVC ratio of all patients Before and after complete thoracentesis**

The above table shows the FEV<sub>1</sub>/FVC% of all patients before and after complete thoracentesis. The mean value observed before aspiration was found 74.74% (S.D= ±19.29%) and after aspiration the mean value was 78.26% (S.D= ±20.97%).

## ORIGINAL ARTICLE

Types of PFT	All patients		Minimal Effusion		Moderate Effusion		Massive Effusion	
	Before	After	Before	After	Before	After	Before	After
TV	0.751 (0.312)	0.085 (0.340)	0.74 (0.318)	0.78 (0.319)	0.72 (0.772)	0.75 (0.382)	0.69 (0.389)	0.72 (0.292)
VC	1.10 (0.318)	1.33 (0.345)	1.13 (0.371)	1.43 (0.327)	1.20 (0.361)	1.23 (0.384)	1.01 (0.269)	1.15 (0.284)
FVC	1.38 (0.351)	2.56 (0.385)	1.50 (0.397)	1.70 (0.416)	1.20 (0.370)	1.30 (0.392)	1.20 (0.292)	1.30 (0.367)
FEV <sub>1</sub>	1.025 (0.328)	1.31 (0.360)	1.08 (0.413)	1.40 (0.670)	1.10 (0.361)	1.20 (0.359)	1.20 (0.378)	1.30 (0.389)
FEV <sub>1</sub> /FVC%	74.74 (11.34)	78.26 (19.29)	75.50 (9.90)	81.80 (7.39)	72.12 (7.12)	74.94 (12.03)	48.71 (7.11)	58.74 (7.19)

**Table 4: Pulmonary function test According to the amount of effusion**

Table above shows PFT according to the amount of effusion in patients. This shows a significant improvement of all parameters following thoracentesis.

Age Group In years	No. of patients	TV in Ltre	VC In Ltre	FVC In Ltre	FEV1 in Ltre	FEV1/FVC%
15-25	2	0.65 (0.452)	0.83 (0.047)	1.08 (0.422)	1.17 (0.453)	61.75 (9.09)
26-35	8	0.87 (0.457)	1.14 (0.398)	1.16 (0.467)	1.21 (0.458)	60.11 (8.21)
36-50	13	0.82 (0.379)	1.10 (0.379)	1.23 (0.460)	1.16 (0.439)	76.77 (9.63)
>50	6	0.87 (0.472)	1.06 (0.362)	1.15 (0.441)	1.17 (0.457)	76.15 (10.64)

**Table 5: PFT in relationship to age group in male patients before thoracentesis**

The above table shows PFTs in different age groups before aspiration along with their S.D. values.

## ORIGINAL ARTICLE

Age Group in years	No. Of patients	TV in Ltre	VC in Ltre	FVC in Ltre	FEV1 in Ltre	FEV1/FVC%
15-25	2	0.80 (0.492)	1.51 (0.406)	2.01 (0.610)	1, 14 (0.412)	79.50 (11.5)
26-35	8	0.89 (0.467)	1.50 (0.468)	1.60 (0.520)	1.41 (0.337)	83.14 (8.13)
36-50	13	0.87 (0.402)	1.48 (0.418)	1.60 (0.492)	1.44 (0.463)	80.16 (8.69)
>50	6	0.92 (0.479)	1.49 (0.441)	1.46 (0.518)	1.45 (0.442)	80.66 (8.22)

**Table 6: PFT in relationship to age groups in Male patients after complete thoracentesis**

Similarly to previous table, present table shows different parameters of PFT in male patients after complete thoracentesis.

Age Group In years	No. Of patients	TV In Ltre	VC in Ltre	FVC in Ltre	FEV1 in Ltre	FEV1/FVC%
15-25	4	0.72 (0.412)	1.40 (0.413)	1.35 (0.377)	1.02 (1.161)	60.52 (1.810)
26-35	4	0.91 (0.397)	1.40 (0.409)	1.35 (0.372)	1.05 (0.211)	60.71 (1.161)
36-50	7	0.74 (0.419)	1.37 (0.410)	1.35 (0.366)	1.01 (0.192)	76.07 (3.40)
>50	6					

**Table 7: Pulmonary Function Test in relationship to age groups in female patients before thoracentesis**

PFT in female patients before thoracentesis with their S.D. changes in different age groups.

Age Group in years	No. Of patients	TV in Ltre	VC In Ltre	FVC In Ltre	FEV1 in Ltre	FEV1/FVC%
15-25	4	0.82 (0.417)	1.47 (0.411)	1.35 (0.377)	1.06 (0.124)	77.11 (5.78)
26-35	4	0.95 (0.399)	1.37 (0.392)	1.35 (0.372)	1.08 (0.209)	77.61 (5.65)
36-50	7	0.88 (0.412)	1.36 (0.382)	1.37 (0.366)	1.12 (0.186)	77.44 (5.35)
>50	6					

**Table 8: Pulmonary Function Test in relationship to age groups in female patients after complete thoracentesis**

Above table shows different parameters of PFT in female patients following thoracentesis. None of the patient is above 50 years of age. All parameters show improvement in their function after complete thoracentesis.

## ORIGINAL ARTICLE

PFT Parameter in Ltrs.	Before Thoracentesis	After Thoracentesis	'p' value
TV	0.75 (0.332)	0.885 (0.340)	<0.001
VC	1.10 (0.318)	1.33 (0.345)	<0.001
FVC	1.38 (0.351)	2.56 (0.385)	<0.001
FEV1	1.025 (0.328)	1.31 (0.366)	<0.001
FEV <sub>1</sub> /FVC%	74.74 (11.34)	78.26 (19.29)	<0.05

**Table 9: Pulmonary Function Test in all the cases of pleural effusion before and after complete thoracentesis**

'p' value is found out in all cases before and after complete thoracentesis using 'z' table. All the parameters have shown significant improvement except FEV<sub>1</sub>/FVC% which does not show much change.

**DISCUSSION:** Pulmonary function tests have been proved to be of definite value in diagnosis and guiding therapy. This has facilitated better understanding of respiratory disease especially among those patients in whom clinical examination and radiological studies reveal little or no abnormalities. Out of 44 cases, 65.91% were males and 34.09% were females. It shows major number of patients (45.47%) were in 36-50 years of age group. Next common age group was 26-35 years. Majority of the patients in all age groups were male.

Maximum number of the cases of either sex has pleural effusion on the right side (52.6%), left side had 45.47% of the cases of pleural effusion and only one case had bilateral pleural effusion in the present study. Moderate amount of effusion seen in 59.0% of the cases, next common minimal effusion with 22.73% and massive effusion with 18.18% respectively.

Average height of all the patients were 156.39cms and mean age of patients were 38.9 years. The range of the age was between 15 to 70 years. Similar study conducted by Rupak Singla<sup>1</sup> et al, has an average height of 1.60±0.08mts and mean age was 26.6 ± 11.0 with a range of 13-70 years. Tables related to PFT have shown different parameter of pulmonary function. This is also associated with predicted value of the specific parameter along with the percentage of predicted. This value is collected and conceited using the predicted formula as mentioned by Kamat<sup>2</sup> et al (1977) and Jain<sup>3</sup> SK et al (1967) for both male and females separately.

Table-4 shows pulmonary function tests with its different parameters according to amount of effusion. It has been divided into minimal, moderate and massive effusion depending upon X-ray chest. Lung function test performed before and after complete thoracentesis. It has been observed that the value in each parameter was comparatively decreased as the amount of effusion increased.

All the parameters have shown improved value following thoracentesis, showing that improvement in lung volumes are related to the amount of fluid aspirated, this study was at par with the work performed by Rupak Singla<sup>1</sup> (1995) who observed that pulmonary function tests in pleural effusion shows moderate restrictive abnormalities with mildly reduced diffusion capacity and this derangement of pulmonary function tests are proportional to the severity of pleural effusion. Relief of



## ORIGINAL ARTICLE

---

dyspnea following thoracentesis results primarily from reduction in the size of thoracic cage, which allow inspiratory muscles to operate in a more advantageous portion of their length tension curve.

N.R. Anthonisen Martin<sup>4</sup> (1977) measured the regional lung function in subject with small pleural effusion using Xenon-133 and suggested that pleural effusion and their antecedent changes in pleural surface pressure had no influence on regional lung expansion and did not increase airways closure. Table 5, 6, 7, & 8 shows pulmonary function tests in different age groups in male and female patients before and following complete aspiration. All the pulmonary parameters have shown a significant improvement. Similar results were observed by Falah A Deli et al.<sup>11</sup>

Table-9 shows different parameters of pulmonary function before and following thoracentesis with 'p' value. Tidal volume has shown improvement in pulmonary function after thoracentesis with a 'p' value of 0.001 which is significant statistically. Vital capacity shows a significant improvement with, p, value of <0.001. This result was comparable with the work done by Autio<sup>5</sup> V (1959) who indicated that moderate to massive pleural effusion lead to a large reduction of vital capacity. A pleural covering clearly demonstrate on chest film was associated with marked decreased of vital capacity to half of the normal value.

Among the studies reported from by Jain SK and Ramiah<sup>6</sup> mostly on vital capacity, it becomes abundantly clear that mean vital capacity and other lung function volumes in Indians as such are lower than their Western counterparts. However, work performed by Neil E. Brown<sup>7</sup> et al (1978) on pulmonary mechanics and gas exchange following thoracentesis did not found any change in vital capacity. Gilmartin<sup>8</sup> JJ et al (1985) had observed reduction in vital capacity of cases of pleural effusion.

Forceful maneuvers like forced vital capacity (FVC) and forced expiratory volume in 1 sec. (FEV<sub>1</sub>) have shown a significant improvement in their function with a 'p' value of 0.001 respectively. This study is comparable with the work done by Light RW<sup>9</sup> et al (1995) who concluded that improvement in FVC after thoracentesis is small in relation to amount of fluid withdrawn.

Wang JSet<sup>10</sup> et al has studied the change in pulmonary mechanics and gas exchange following thoracentesis in patients with inversion of diaphragm in pleural effusion concluded that there is small but significant improvement in FVC & FEV<sub>1</sub> = (p=0.001).

In our study the ratio of FEV<sub>1</sub>/FVC does not show significant change in 'p' value, showing this ratio does not alter in pleural effusion.

The present functional status of the lung have shown that there is a restrictive pattern seen which shows a significant improvement in both symptom and lung volumes following thoracentesis.

The study conducted by Rupak Singla<sup>1</sup> (1995) have shown the similar type of restrictive abnormalities in lung functions along with mildly reduced diffusion capacity, with mild hypoxemia, hypocapnia and respiratory alkalosis.

Among different factors determining lung volumes in a given individual nutritional factor and reported chest infection occurring in early childhood may leave behind a residual shut down of some of functioning lung tissues, which may not be evident clinically or radiologically but nevertheless affects the development and hence the capacity of adult lung (Jain SK & Ramjah)<sup>7</sup>

Gilmartin JJ<sup>9</sup> et al (1985) had also observed a restrictive ventilatory defect with reduction of vital capacity, functional residual capacity and total lung capacity.

## ORIGINAL ARTICLE

---

**CONCLUSION:** Lung function values showed inverse relation to the amount of pleural effusion. Pulmonary function tests established clearly that pleural effusion produces a restrictive pattern, which showed statistically significant improvement following thoracentesis.

### REFERENCES:

1. Rupak Singla (1995) - Pulmonary function tests in patients of tubercular pleural effusion before during and after chemotherapy. *Indian Jr. of Tuberculosis* 1995. 42, 33.
2. Kammat SR et al (1977) - Indian norms for pulmonary functions. *Jr. Asso. Phys. Ind.* 1977, 25, 531-539.
3. Jain SK & Ramiah TJ (1969) - Normal Standardisation of pulmonary function tests for healthy Indian Man 15-40 years old. Comparison of different regression equation. *Indian Jr. of Medical & Research.* 1969, 57, 8; 1453-61
4. N.R. Anthonisen & Martin (1977) Regional Lung Function in pl. Effusion. *Am. Rev. Resp. Dis.* 116, 1977, 201-207.
5. Autio V. (1959). Reduction of pul. Function of parenchymal & pleural lesions. Broncho-spirometric study of the pts. With unilateral involvement. *Acta. Tubere Scand.* 1959, 37, 112.
6. Jain SK and Ramiah (1969). Normal Standardization of pul. Function test for healthy Indian men age 15 to 40 yrs, *Ind. Jr. Medical & Research*, 1969, 57, 8: 1453-61.
7. Neil E Brown, Zamel, Arnold Aberman (1978). Changes in Pul. Mechanics and gas exchange following thoracentesis. *Chest*, 74:5, Nov 1978, 540-42.
8. Gilmartin JJ, Wright AJ, Gibson GJ (1985) - effect of pleural effusion pneumothorax on pulmonary function. *Thorax*, 1985, 40 (i) 60-5.
9. Light RW, Stansbury OW, Brown SE (1995) - Relationship between pleural pressure and changes in pulmonary function after therapeutic Thoracentesis. *Am. Rev. Resp. Dis.* 1986, 133(4) 650-61.
10. Wang jS et al (1995) - changes in pulmonary mechanics and gas exchange after thoracentesis in patients with inversion of a hemi-diaphragm secondary to large pleural effusion. *Chest* 1995, 107: 1610-14.
11. Falah A Deli, Haider Jabbar Kadum, Hasan Saleh, Spirometric and Heamodynamic changes after therapeutic thoracocentasis. *Medical Journal of Babylon-Vol.8 No. 1 -2011.*

**AUTHORS:**

1. Sanjay Sahay
2. Satish K. Ramteke
3. Sharmila Ramteke

**PARTICULARS OF CONTRIBUTORS:**

1. Assistant Professor, Department of Pulmonary Medicine, Chirayu Medical College and Hospital, Bhopal.
2. Associate Professor, Department of Medicine, Chirayu Medical College and Hospital, Bhopal.
3. Assistant Professor, Department of Paediatrics, Gandhi Medical College and Hamidia Hospital, Bhopal.

**NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:**

Dr. Satish K. Ramteke,  
Department of Medicine,  
Chirayu Medical College and Hospital,  
Bairagarh, Bhopal-462030, M. P.  
Email: satishh.ramteke@gmail.com

Date of Submission: 13/05/2014.  
Date of Peer Review: 14/05/2014.  
Date of Acceptance: 21/05/2014.  
Date of Publishing: 04/06/2014.