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Original Research Paper

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A STUDY OF SPIROMETRY IN PATIENTS OF PLEURAL EFFUSION BEFORE AND AFTER THORACENTESIS

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ABSTRACT Pleural effusion compromises lung functions and daily activity of patient.Removal of pleural fluid by thoracentesis cause relief of dyspnea and improves lung functions including improvement in FVC and FEV1.50 patients who came to OPD of L.G.Hospital between January 2019 to December 2019 and diagnosed to have unilateral pleural effusion on chest x-ray were enrolled for this study.Their spirometry parameters (FVC,FEV1 and ratio of FEV1/FVC) and dyspnea score(mMRC grade) were noted and analyzed before and after thoracentesis.Out of 50 patients with unilateral pleural effusion 35(70%) were male and 15(30%) were female with mean age±SD of 34±12.8 years.Majority 29(58%) had moderate amount of pleural effusion,12(24%) had minimal pleural effusion and 9(18%) had massive pleural effusion.After thoracentesis dyspnea has improved in these patients.Most 30(60%) patients had restrictive spirometry pattern before thoracentesis,which showed improvement and after thoracentesis 21(42%) patients had restrictive spirometry pattern.In all cases the difference in spirometry parameters FVC and FEV1 before and after thoracentesis came statistically significant,whereas difference in ratio of FEV1/FVC before and after thoracentesis came statistically non significant. Thoracentesis causes improvement in lung functions and decrease in dyspnea that helps patients to get better routine active life.

KEYWORDS: Pleural effusion, FEV1, FVC, Ratio of FEV1/FVC, Thoracentesis

Introduction :

Pleural effusion is a collection of abnormal amount of pleural fluid in pleural space due to disequilibrium between pleural fluid formation rate and rate of pleural fluid absorption, secondary to local or systemic disease.[1] Pleural effusion causes changes in respiratory mechanics, with a reduction in static and dynamic lung function.[2]This alteration in physiological states leads to restrictive pulmonary function and decreased lung compliance.[3]

Many diseases that cause pleural effusions, such as congestive heart failure, malignancy, pneumonia and pulmonary embolism, also affect the pulmonary parenchyma. Therefore, it is frequently difficult to determine what part of the pulmonary dysfunction is due to the pleural effusion and what part is due to the underlying disease.[4]

Removal of considerable amount of pleural fluid by therapeutic thoracentesis causes relief of dyspnea and improvement in the mechanical function of the chest, allowing patients to return to routine activities.With thoracentesis,a significant improvement in pulmonary functions, particularly in FVC and FEV 1 is seen.[5] Improvements in ventilatory capacity and lung volumes following pleural drainage can be checked by spirometry parameters before thoracentesis and 24 to 36 hour after thoracentesis.[6][7]

Aim :

- To study the effect on spirometry parameters before and after thoracentesis in patients of pleural effusion.

Objectives :

- To correlate the spirometry finding with grading of pleural effusion.
- To compare spirometry findings before and after thoracentesis.

Material and Method :

A prospective study was conducted in department of Respiratory Medicine, AMC MET Medical college, Sheth L.G hospital, Ahmedabad. 50 patients who came to OPD and diagnosed to have unilateral pleural effusion on chest x-ray(PA view) and who gave consent were enrolled in this study from January 2019 to December 2019.

Patient who fulfill following criteria were included in this study:

- Patients with unilateral pleural effusion who will require thoracentesis.
- Patients who will give consent.

Patients were excluded in the study who met following criteria:

- Patients having bilateral pleural effusion.
- Patients having loculated pleural effusion.
- Patients having recurrent pleural effusion.
- Patients having associated parenchymal lung disease.
- Patients of COPD or Asthma who have smoking history of more than 10 pack years.
- Pleural effusion with hydropneumothorax.
- Patients who were not cooperative for thoracentesis.
- Patients who had developed iatrogenic pneumothorax as a complication of thoracentesis.
- Patients who were not able to perform spirometry properly.

After taking consent, patients of pleural effusion were asked for detailed history and examination.Dyspnea (according to

Modified Medical Research Council (mMRC) grade) was noted and Routine investigations like Complete blood count,serum protein and ultrasonography of chest were done. Based on chest X-ray(PA view), patients were classified in 3 types.[8]

I. Minimal pleural effusion : Pleural effusion level up to lower border of fourth rib anteriorly
II. Moderate pleural effusion : Pleural effusion up to lower border of second rib
III. Massive pleural effusion : Pleural effusion above second rib

Then Spirometry parameters (FVC , FEV1 and ratio of FEV1/FVC) were performed before doing thoracentesis in these patients using ndd EasyOne Pro (SN: 500240) pulmonary function test machine and noted in Microsoft excel sheet 2010.

After spirometry, therapeutic thoracentesis was done by standard method till maximum up to 1.5 liter[9] or till the patient experienced discomfort with symptoms like coughing or chest pain or vagal manifestations (dizziness or nausea).In all patients with minimal effusion ultrasonography guided thoracentesis was done.

Pleural fluid was sent for investigations like routine-microscopic examination, culture sensitivity for pyogens, Adenosine deaminase(ADA) level, GenXpert, cytology for diagnosis.

After 24 to 36 hours of thoracentesis again chest x-ray was done.If fluid has been refilled or iatrogenic pneumothorax has occurred in any patient,they were excluded from further study.In other patients,after seeing improved chest x-ray post thoracentesis spirometry was performed and improvement in dyspnea score in each patients was noted.

According to spirometry parameters FVC,FEV1 and ratio of FEV1/FVC , we can categorized three spirometry pattern[10] : -

a. Obstructive : where ratio of FEV1/FVC < 0.7 with decreased FEV1 and normal/decreased FVC
b. Restrictive : where ratio of FEV1/FVC > 0.7 with decreased FVC and normal/decreased FEV1
c. Mixed : where ratio of FEV1/FVC < 0.7 with decreased FVC.

(FVC = Forced vital capacity, FEV1 = Forced expiratory volume in one second)

All the reports and data were compiled in Microsoft excel sheet 2010 and analyzed statistically using Paired T-test and McNemar test.

RESULT :

Total 50 patients of pleural effusion according to inclusion criteria, were enrolled for this study.

Out of 50 cases of pleural effusion, 35(70%) patients were males and 15 (30%) were females with male to female ratio 2.33 and mean age±SD of 34±12.8 years. Highest number of patients,29(58%) patients were in 21-40 years of age group having 19 (38%) male patients. Next common age group was 41-60 years having 12 (24%) patients includes 11(22%) male patients. Majority of the patients in all age groups were male. [Table-1]

Table-1 : Age and Gender wise distribution

Age group (Years)	Male(%)	Female(%)	Total
0-20	4 (8%)	4 (8%)	8 (16%)
21-40	19 (38%)	10 (20%)	29 (58%)
41-60	11 (22%)	1 (2%)	12 (24%)
>60	1 (2%)	0	1 (2%)
Total	35 (70%)	15 (30%)	50 (100%)

Amongst 50 cases of unilateral pleural effusion, 29 (58%) cases had right sided pleural effusion and 21 (42%) cases had left sided pleural effusion.

In this study 29(58%) patients were having moderate amount of effusion.12 (24%)patients had minimal pleural effusion and 9(18%) patients had massive pleural effusion.

Grades of dyspnea (mMRC grades) were higher before thoracentesis, after thoracentesis, number of patients with no complaint of dyspnea has increased from 19(38%) to 37(74%) patients. All 12 patients of minimal pleural effusion,19 out of 29 patients of moderate pleural effusion and 6 out of 9 patients of massive effusion had improved clinically and had no dyspnea after 24 to 36 hours following thoracentesis.

11(22%) patients had Grade 1 dyspnea, out of which 9 patients were of moderate effusion and 2 were of massive effusion after thoracentesis. Only 2 (4%) patients had Grade 2 dyspnea with one patient of massive effusion and one of moderate effusion. None had Grade 3 and Grade 4 dyspnea after thoracentesis. [Table-2]

Table-2 : Co-relation between amount of pleural effusion and dyspnea (according to mMRC grade) before and after thoracentesis

Amount of pleural effusion	No. of patients having dyspnea (according to mMRC grade)									
	Grade 0		Grade 1		Grade 2		Grade 3		Grade 4	
	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis
Minimal	10	12	2	0	0	0	0	0	0	0
Moderate	8	19	13	9	6	1	2	0	0	0
Massive	1	6	1	2	4	1	2	0	1	0
Total	19 (38%)	37 (74%)	16 (32%)	11 (22%)	10 (20%)	2 (4%)	4 (8%)	0	1 (2%)	0

Spirometry was performed before and following thoracentesis. According to spirometry parameters before thoracentesis,majority 30(60%) patients had restrictive pattern,7(14%) patients were having obstructive pattern, 3(6%) patients had mixed pattern and 10 (20%)patients were having normal spirometry.[Table-3] Amongst patients having normal spirometry 7 patients had minimal pleural effusion and 3 had moderate pleural effusion. Obstructive pattern in spirometry may be present due to coexisting lung parenchymal damage because of smoking and/or occupational exposure of patients.

After thoracentesis number of patients with normal spirometry increased from 10(20%) to 20(40%) patients, out of which 9 patients had restrictive pattern and one patient had mixed pattern before thoracentesis which improved to have normal spirometry.[Table-3]

Table-3 : Different spirometry pattern before and after thoracentesis in patients with pleural effusion

Amount of pleural effusion	No. of patients with different spirometry pattern before and after thoracentesis							
	Normal spirometry		Obstructive spirometry pattern		Restrictive spirometry pattern		Mixed spirometry pattern	
	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis
Minimal	7(14%)	11(22%)	1(2%)	1(2%)	4(8%)	0	0	0
Moderate	3(6%)	8(16%)	4(8%)	4(8%)	20(40%)	16(32%)	2(4%)	1(2%)
Massive	0	1(2%/)	2(4%)	2(4%)	6(12%)	5(10%)	1(2%)	1(2%)
Total	10 (20%)	20 (40%)	7 (14%)	7 (14%)	30 (60%)	21 (42%)	3 (6%)	2 (4%)

30 patients which had restrictive spirometry pattern were classified further according to severity of restriction according to FVC % predicted before and after thoracentesis.[Table 4][11] 4 patients of minimal effusion had restriction on spirometry before thoracentesis,out of which 2 patients had mild and 2 had moderate restriction.These 4 patients improved to have normal spirometry after thoracentesis.

Amongst patients with moderate effusion before thoracentesis, 6 had moderate restriction,9 had moderately severe,4 had severe and 1 had very severe restriction.After thoracentesis none had severe and very severe restriction,4 patients had moderately severe,5 had moderate and 7 had mild restriction with 7 patient were downgraded to have normal spirometry after thoracentesis.

Amongst patients of massive effusion 1 patient had very severe,2 severe and 3 moderately severe restrictive spirometry before thoracentesis,which had improved after thoracentesis to have 1 patient with normal spirometry , 1 with mild and 3 with moderate restriction and none had severe or very severe restriction after spirometry.[Table-4]

Table-4 : Severity of restriction on spirometry in patients with pleural effusion before and after thoracentesis

Amount of pleural effusion	No. of patients with pleural effusion having restrictive spirometry pattern (severity of restriction according to FVC % predicted)									
	Mild (FVC : <80 to ≥70%)		Moderate (FVC : <70 to ≥60 %)		Moderately severe (FVC : <60 to ≥50%)		Severe (FVC : <50 to ≥35%)		Very severe (FVC : < 35%)	
	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis	Before thoracentesis	After thoracentesis
Minimal	2	0	2	0	0	0	0	0	0	0
Moderate	0	7	6	5	9	4	4	0	1	0
Massive	0	1	0	3	3	1	2	0	1	0

Amongst patients with pleural effusion 30(100%) patients had restrictive spirometry before thoracentesis.After thoracentesis in these patients, 21(70%) patients had restrictive pattern and 9(30%) patients improved to have normal spirometry. The reduction in restrictive pattern after thoracentesis is statistically significant at 95% confidence level, analyzed using McNemar test that showed 'p' value is 0.0027, which is less than 0.05.

In all 50 cases ,in the presence of pleural effusion mean value of FVC before thoracentesis was 1.56 ± 0.5 litre which has improved after thoracentesis with mean value of 1.86 ± 0.46 litre,which showed statistical significance at 95% confidence level with 'p' value <0.0001.

The difference in FEV1 before and after thoracentesis in all patients of pleural effusion is statistically significant with change in mean value of FEV1 from 1.19 ± 0.38 litre to 1.46 ± 0.37 litre respectively and 'p' value <0.0001.

The ratio of FEV1/FVC showed mean value of 0.775 ± 0.07 before thoracentesis and 0.788 ± 0.07 after thoracentesis,which came statistically non significant with 'p' value 0.11195 ('p' value >0.05).[Table-5]

Table-5 : Spirometry test in all cases of pleural effusion before and after thoracentesis

Spirometry parameters	Before Thoracentesis	After Thoracentesis	'p' value
FVC (L)	1.56 ± 0.5	1.86 ± 0.46	<0.0001 (S)
FEV1 (L)	1.19 ± 0.38	1.46 ± 0.37	<0.0001 (S)
FEV1/FVC	0.775 ± 0.07	0.788 ± 0.07	0.11195 (NS)

Data is presented as Mean±SD. Here, (NS) = not significant , (S) = significant

The difference in FVC and FEV1 before and after thoracentesis in patients with moderate amount of pleural effusion showed statistical significance with 'p' value <0.0001 at 95% confidence level. Whereas the difference in ratio FEV1/FVC before and after thoracentesis in patients with moderate pleural effusion came statistically non significant with 'p' value 0.4393.

In patients with massive pleural effusion difference in FVC before and after thoracentesis came statistically significant with 'p' value 0.00452. The difference in FEV1 and ratio FEV1/FVC before and after thoracentesis in these patients showed statistical non significance with 'p' value 0.3124 and 0.5755 respectively.

In patients with minimal pleural effusion difference in FVC ('p' value 0.9188), FEV1 ('p' value 0.1455) and ratio FEV1/FVC ('p' value 0.2126) came statistically non significant with 95% confidence level.[Table-6]

Table-6 : Co-relation of different spirometry parameters with amount of pleural effusion

Spirometry parameters	Minimal pleural effusion			Moderate pleural effusion			Massive pleural effusion		
	Before Thoracentesis	After Thoracentesis	'p' value	Before Thoracentesis	After Thoracentesis	'p' value	Before Thoracentesis	After Thoracentesis	'p' value
FVC (L)	1.53 ± 0.49	1.84 ± 0.46	0.9188(NS)	1.54 ± 0.49	1.86 ± 0.46	<0.0001(S)	1.43 ± 0.42	1.76 ± 0.43	0.00452(S)
FEV1(L)	1.19 ± 0.39	1.45 ± 0.38	0.1455(NS)	1.18 ± 0.38	1.46 ± 0.37	<0.0001(S)	1.2 ± 0.39	1.42 ± 0.35	0.3124 (NS)
FEV1/FVC	0.755 ± 0.08	0.787 ± 0.07	0.2126(NS)	0.775 ± 0.07	0.787 ± 0.07	0.4393 (NS)	0.793 ± 0.05	0.796 ± 0.07	0.5755 (NS)

Data is presented as Mean± SD. Here, (NS) = not significant , (S) = significant

DISCUSSION :

In present study ,aspiration of fluid from the pleural space resulted in an increase in the FVC and FEV 1 after thoracentesis with an evident reduction in dyspnea. These results show that the improvement resulting from emptying the pleural cavity contributing positively toward patients being able to return to their daily activities.

The difference in FVC and FEV1 before and after thoracentesis in our study of 50 cases were statistically significant with 'p' value <0.0001 for both the parameters. The difference in ratio FEV1/FVC in this study came statistically non significant with 'p' value 0.11159. The present study have shown that there is a restrictive pattern of lung function on spirometry which shows a significant improvement in both symptom and lung volumes following thoracentesis.

The results of present study are comparable with previous studies done by Sanjay Sahay et al.[8] and Ana Maria Cartaxo et al.[6].They both reported significant improvement in difference of FVC and FEV1 before and after thoracentesis with 'p' value <0.001[8] and 'p' value 0.001[6] respectively. Whereas difference of ratio FEV1/FVC before and after thoracentesis came to be statistically non significant according study of Sanjay Sahay et al.[8]

The study reported by Falah A Deli et al[7] has also reported the same result for difference in FVC and FEV1 before and after thoracentesis with 'p' value <0.05.[7] These results are in concordance with our present study.[Table-7]

Table-7 : Comparison of different spirometry parameters of present study with other studies :-

Spirometry parameters		Present study	Sanjay sahay Et al.	Ana Maria Cartaxo Et al.	Falah A Deli Et al.
FVC (L)	Before Thoracentesis	1.56 ± 0.5	1.38 (0.351)	1.9 ± 0.6	1.47
	After Thoracentesis	1.86 ± 0.46	2.56 (0.385)	2.2 ± 0.7	1.841
	'p' Value	<0.0001 (S)	<0.001(S)	0.001(S)	<0.05 (S)
FEV1 (L)	Before Thoracentesis	1.19 ± 0.38	1.025 (0.328)	1.5 ± 0.5	1. 21
	After Thoracentesis	1.46 ± 0.37	1.31	1.8 ± 0.5	1.503
	'p' Value	<0.0001 (S)	<0.001(S)	0.001 (S)	<0.05 (S)
FEV1/FVC	Before Thoracentesis	0.775 ± 0.07	74.74 (%)(11.34)	0.8 ± 0.1	-
	After Thoracentesis	0.788 ± 0.07	78.26 (%)(19.29)	0.7 ± 0.1	-
	'p' Value	0.11195 (NS)	<0.05(NS)	0.051	-

Here, (NS) = Non significant
(S) = Significant

In study done by Wand L-M et.al[12] showed statistically significant improvement in pulmonary function (in FEV1 and FVC) following thoracentesis.

The study done by Estenne M et.al [13] has reported that thoracentesis causes improvement in lung function with improvement in mean vital capacity and functional residual capacity and relief of dyspnea following thoracentesis.It is primarily due to reduction in size of the thoracic cage, which allows the inspiratory muscles to operate on a more advantageous portion of their length-tension curve.

Another study done by Light RW et.al [14]suggests improvement in the FVC after therapeutic thoracentesis is small relative to the amount of fluid withdrawn.

In present study moderate and massive amount of effusion in pleural cavity showed more restriction in lung function and after thoracentesis there is statistically significant reduction in restrictive pattern.

CONCLUSION :

Statistically significant improvement in lung function is seen with improved spirometry parameters FEV1 and FVC after thoracentesis.Patients get benefit in situation of exertion by removal of pleural fluid, allowing them better readaptation of their routine activities.Therefore regardless of cause of pleural effusion, therapeutic thoracentesis is advisable in every patients with moderate and massive pleural effusion.

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