# Fayoum Experience in Ultrasonographic Evaluation of DPLD

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## ABSTRACT:

Chest ultrasound has many uses, both diagnostic and interventional. It may be used for a diagnosis of multiple pleural diseases (pleural effusion, pleural masses, and pneumothorax). It is also used in the diagnosis of diseases caused by lung parenchymal lesions, such as neoplasms, pulmonary embolism, pneumonia and lung abscesses**.**

### Aim:

This study aimed to evaluate the sonographic features of diffuse parenchymal lung disease (DPLD).

**Design:** A prospective study.

**Setting:** Fayoum university hospital in Egypt during January 2017 to June 2017.

### Subjects and methods:

This study included 120 participants. 60 of them were diagnosed as DPLD. For the diagnosis of these cases we need a full medical history, a detailed clinical examination, spirometry, 6 minute walk test (6MWT), arterial blood gases analysis, the high resolution computed tomography (HRCT) and chest ultrasound. The other sixty were studied as control.

### Statistical analysis:

The data were collected and coded to facilitate data manipulation and double entered into Microsoft Access and the data analysis was performed by using SPSS software version 18 in windows 7.

The simple descriptive analysis in form of numbers and percentages for qualitative data and arithmetic means as central tendency measurement, standard deviations as measure of dispersion for the quantitative parametric data and the inferential statistic test.

### Results:

There was female predominance with a wide range of age. Most of the cases were nonsmokers, breeding birds and exposed to biomass. All cases had diffuse bilateral B-lines. There was a negative relation between the warrick score from one hand and the B-line number, PaO2, 6MWT and forced vital capacity (FVC) from the other hand.

In contrast a positive relation was demonstrated between the warrick score and B-line distance and pleural thickness.

Most of studied patients (71.6%) had irregular and thickened pleura and (51.6%) have an abolished lung sliding.

## Conclusion:
Chest ultrasound has a significant role in diagnosis of DPLD and also in estimating the severity of the disease according to the number and the distance between B- lines.
Multiple B-lines in the combination of thickened and irregular pleural line are highly suggestive of DPLD.

**KEYWORDS:** Diffuse parenchymal lung diseases, Chest ultrasonography.

## INTRODUCTION:

DPLD is a group of non malignant and non infectious processes caused by multiple causative agents which may be known or unknown **(1).**

(HRCT) may be considered as the gold standard technique for the diagnosis of DPLD,and other non invasive and invasive techniques used for the diagnosis of DPLD such as laboratory and serological tests, pulmonary function tests, transthoracic ultrasound, bronchoscopy with a bronchoalveolar lavage and the transbronchial lung biopsy **(2).**

Chest ultrasonography can play an important complementary role, particularly in the critical care setting where conventional radiography is often suboptimal.

Its lack of ionizing radiation, bedside availability and dynamic imaging capacity afford ultrasound certain advantages over other techniques **(3).**

## Aim of this study:

This study was aimed to evaluate the sonographic findings of diffuse parenchymal lung disease.

**Methodology:**

A case–control prospective study was done in chest department, Fayoum University during January 2017 to June 2017. The study included 120 participants in the form of 60 patients was diagnosed as DPLD and 60 control study from Fayoum governorate. The patients were diagnosed according to diagnostic algorithm of DPLD **(4).**

The study protocol was approved by the Ethical Committee of Faculty of Medicine in Fayoum University and informed consent was obtained from all patients.

## Inclusion criteria:

- Age: from 20 to 75 years old.
- Sex: male and females.
- From Fayoum governorate.

## Exclusion criteria:

The cases with pulmonary edema of different causes, ,pneumonia ,pulmonary embolism and atelectasis were excluded from this study because B-lines may be detected in these cases **(5)**.

All participants were submitted for the following :

## 1. The history:

- Family history.
- The history of breading birds.
- History of biomass exposure.
- The history of respiratory symptoms (chest pain, wheezes ,Cough, expectorations, dyspnea,) with the onset, course and duration of the presenting symptoms .
- History of smoking.
- Occupational history.
- History of systemic disease i.e. collagen vascular disease .

2. **Full clinical examination**:

General and local examination.

3-**Spirometry:**

Was done by using (MiniSpir MIP s.r.l. 00155 Roma-Italy). The Results were obtained for forced vital capacity(FVC), forced expiratory volumein1s(FEV1),ratio of FEV1/ FVC (FEV1/FVC%) and forced expiratory flow at 25–75% of vital capacity.

The Values were obtained when the patient exerted his maximum effort to avoid any expected error in diagnosis.The absolute values and the percentages of spirometric

parameters predicted from the participant's age, sex, and height were calculated. Restrictive ventilatory defect was defined by spirometric findings of FEV1/FVC greater than 70% predicted and FVC less than 80%predicted **(6).**

## 4-Arterial Blood Gases Analysis:

ABGs were analyzed by 'rapid lap analyzer 248' apparatus; the following values were recorded and then calculated: O2 saturation% (SaO2%), PaO2 mmHg, PaCO2 mmHg, HCO3mEq/land pH.

5- **6-Minutes' Walk Test**:

it is measurement of the distance that patients can quickly walk on a flat, hard surface in a period of 6min. Reference values are 576m for healthy male patients and 494m for healthy female patients **(7).** Before and after the test, oxygen saturation% (SpO2%) was measured by a pulse oximeter, and desaturation was defined as a fall in oxygen saturation to 88% or less during the 6MWT **(8).**

## 6.High resolution computed tomography :

The device which used was Asteion Toshiba 4 slice CT scanner.

In this study, pulmonary involvement is identified and scored according to the semiquantitative modified warrick score**(9).**

Modified Warrick scoring was obtained by summation of the point values of parenchymal abnormality pattern ( the severity score) which range from 0 (normal) to 15 (all lesions are present) and (the extension score) by localization of the pulmonary segments number involved in the both lungs which ranged from (0) normal to (15) at which more than nine pulmonary segments are involved.

So the results of summation of the total Warrick score is ranged from (0) no involvement to (30) which represent the worst involvement.

**The results were expressed as following:**

*normal (0 point)

*mild : more than 8 points.

*moderate ranged from 8 to 15 points.

*severe : ranged from 15 to 30 points.

**7-Chest ultrasound**

Chest ultrasound was done for all participants using Philips ClearVue 320 (USA) device.

Lung ultrasound was done using the low frequency (2.5-5 MHz) convex probe for the lung examination and the high frequancy (7.5-10 MHz) linear probe for pleural examination.

**There are different positions during examination:**

-Supine (ventral images), Sitting (dorsal and lateral images) . Raise the arms and crosse them behind the head leading to extention of the intercostal spaces and facilitates access .

## Assessment of the following:

1) B- lines= anterior predominant bilateral B lines (vertical hyperechoic lines arising from the pleural line which spread towards the edge of screen without fading causing erasing of A-lines and move with the lung sliding **(10)**.

A distance between two adjacent B-lines near to pleural line is measured and expressed in milliliters **(11)** .

A positive region is defined through the presence of three or more B-lines in the longitudinal plane between two ribs .The positive examination is defined through the presence of two or more positive regions on both sides .

The number of B-lines are counted per zone **(12).**

2)The lung sliding (to-and-fro dynamic movement of the lung during the respiration which was visible at the pleural line).

3)Assessment of pleura as regards pleural thickness, pleural surface (either smooth, irregular.

The pleural thickening is known as focal or diffuse echogenic lesions which arising from visceral or parietal pleura and the width is greater than 3mm with or without the irregular pleural surface **(13).**

## Statistical Analysis:

The data were collected and coded to facilitate the data manipulation and double entered into Microsoft Access and the data analysis was performed by using SPSS software version 18 in windows 7.

The simple descriptive analysis in form of numbers and percentages for qualitative data, and arithmetic means as central tendency measurement, standard deviations as measure of dispersion for quantitative parametric data and inferential statistic test:

**In cases of quantitative parametric data :**

In the depended **student t-Test** which used to compare measures of two independent groups of quantitative data.

One way **ANOVA** test to compare more than two independent groups of quantitative data.

**For qualitative data**

**Chi square** test is used to compare two of more than two qualitative groups.

The **P-value ≤ 0.05** is considered the cut-off value for significance.

## RESULTS:

This study included 60 patients at which 54 females (90%) and 6 males (10%) the age group was ranged from 20 to 75 years, with mean (47.5 ± 13.6) years .

30% of cases presented with dyspnea only, 36.7% presented with dyspnea and cough, and finally 33.3% of them presented with dyspnea, cough and wheezing.

Most of patients were exposed to biomass and breeding birds (80%), and 90% of patients were non smokers. (41.6%, n=25) have clubbing.

These data were clarified in table (1) which represent the demographic data of the studied patients .

By HRCT most of patients (50% , n=30) were diagnosed as HP and

(16.6% ,n=10) were IPF. This was clarified by table (2)**.**

The mean and SD of B lines number was (6.3±2.1). The B- line distance ranged from ( 3 - 12 millimeter) with mean±SD (7.8±2.7).

The range of the pleural thickness in all studied patients was from

(2 to19 mm) with mean±SD (9.1±5.9) .

The most cases had thickened pleural line (71.7%, n=43), while

(28.3% ,n=17) had normal pleural thickness with mean ± SD (11.6±5.1) and

( 2.7±0.33) respectively.

There was irregular pleural line in (71.6%,n=43),while (28.3% ,n=17) had regular pleural line. All these data were clarified in table (3).

The pulmonary involvement is scored according to the semiquantitative HRCT scoring system (modified Warrick score) which is showen in table (4).

According to this score the pulmonary involvement was classified into three groups:

1) mild group (26.7%, n=16) with mean±SD (6.1± 0.9)

2)moderate group (38.3%,n=23) with mean±SD (10.9± 2.2)

3) severe group(35%,n=21) with mean±SD (19.3±2.8)

These data were illustrated in table (5).

Table (6) illustrates that there is a significant **positive** relation with p-value <0.05 between Warrick score and the distance between B-lines ; which indicated **increasing** in Warrick score will associated with **increasing** in distance between B-lines. Also there is a significant **negative** relation between Warrick score and the following (number of B-line, $PaO_2$ , 6min WT, FVC, and pleural line thickness) which indicated **increasing** in Warrick score will associated with **decreasing in** in all these variables.

On the other hands no relation between Warrick score and duration of symptoms.Figures (1,2,3,4,5,6) show these relations .

Table (7) illustrates that there is a significant difference between the different degrees of Warricks score according to regularity, plural line thickness and B- line distance with high percentage of irregular and thickened plural line and wide distance were noticed among sever degree followed by moderate degree.
There is statistically significant difference between the different degrees of Warricks score according to B-line numbers, 6 M WT, and FVC with high mean among mild degree of severity. This was clarified by Figures (7,8) .

## DISCUSSION:

It has been highlighted that chest ultrasound is sensitive to variations of pulmonary content and balance between air and fluids. In the normal lung, the ultrasound (US) waves are completely reflected by the air while in the lung diseases which impair alveolar air content and increase the interstitial and alveolar fluids a particular artifact will be created **(14)**.

The ultrasound evaluation of DPLD is determined by presence and quantification of B-lines, they generated by reflection of the ultrasound beams from the thickened sub-pleural interlobar septa at lung surface interface **(15).**

In this study 30% of cases presented with dyspnea only, 36.7% presented with dyspnea and cough, and finally 33.3% of them presented with dyspnea, cough and wheezing. The studied group showed female predominance with wide range of age (20-75). Most of them were breeding birds and exposed to biomass (80% ,n=48) and 90% were nonsmokers.

By HRCT most of them were diagnosed as HP (50%, n=30) ,9 patients (15%) were NSIP, 10patients (16.6%) were IPF, 5 patients (8.3%) were sarcoidosis,1 patient (1.6%) was LAM ,1 patient(1.6%) was PPFE , 4 patients (6.6%) were RA.

By using transthoracic ultrasound (TTUS), all patients had diffuse and more than three B-lines bilaterally. The best time to see these B-lines during the real-time examination and this is due to some lines seem to be less clarified on frozen sonograms.

In this study, there are at least 4 B-lines per scan. Mean and SD of the B lines number was (6.3±2.1). While the distance between 2 adjacent B-lines ranged from

(3 to 12 millimeter) and mean±SD is (7.8±2.7).This was illustrated in table (3)

In this study, pulmonary involvement is scored according to semiquantitative HRCT score systems (modified Warrick score) which was showen in table (4).

According to this score the pulmonary involvement was classified into three groups:

1) mild group (26.7%, n=16) with mean±SD (6.1± 0.9)

2)moderate group (38.3%,n=23) with mean±SD (10.9± 2.2)

3) severe group(35%,n=21) with mean±SD (19.3±2.8)

These data were illustrated in table (5).

The same results were obtained by **Mohammadi et al (16)** at which they found a relation between the warrick score and the

severity of the pulmonary involvement (r=0.695, P<0.001).

In this study ,there is a significant negative relation with p-value <0.001 between the warrick score and number of B-line. (Figure 1)

While there is a significant positive relation with p-value <0.05 between warrick score and B-lines distance (Figure 2) .

These data were showen in table (6).

These results were in agreement with **Hasan and Makhlouf (17)** who evaluated 61 patients with DPLD, as they concluded that B-lines seem numerous with a narrow distance between them in those with early DPLD.

They illustrated that there is a relation between the B- line distance and the severity of the disease on chest HRCT at which B3 (the distance was 3 mm) represent the ground glass opacity (figure 3) and B7 (the distance was 7 mm) represent the extensive fibrosis and the honeycombing (figure 4).

Also these results were in compatible with the results of **Farag et al (18)**

who found the degree of the interstitial affection on chest HRCT which detected by the modified Warrick score is inversely correlated with the total number of B-lines among mild, moderate, and severe groups.

In the current study there is a significant negative correlation between Warrick score and the following FVC% , PaO2 and 6MWT (figure 5,6,7) which indicate that the well established pulmonary fibrosis in HRCT will be associated with more impairement in PFTS.

So the severe group has the lowest mean of FVC%.(45±9.4) and this was

showen in table (7).

According to pleural line , linear probe was used for more details .

In this study,the range of the pleural thickness in all studied patients was from

(2 to19 mm) with mean±SD (9.1±5.9) as showen in table (3).

The most cases had thickened pleural line (71.7%, n=43), while

(28.3% ,n=17) had normal pleural thickness with mean ± SD (11.6±5.1) and

( 2.7±0.33) respectively.

There was irregular pleural line in (71.6%,n=43),while (28.3% ,n=17) had regular pleural line. All these data were clarified in table (3).

The mild group had pleural thickness with (3.8±1.6), the moderate group had pleural thickness with (6.4 ± 3.4) and the severe group had pleural thickness with (16.1±2.3) and this was clarified in table (7).

So there was positive correlation between warrick score and pleural thickness .

(figure 8)

This was compatible with the results of Farag et al (18) who found that there was an important significant difference of the pleural thickness in millimeter (mean±SD) between the all groups involved.

In this study (43.8%) of the mild group had irregular thickened pleural line , (65.2%) of the moderate group had irregular thickened pleura line while (100%) of severe cases showed irregular thickened pleural line (figure 9 ,10) .

These data were illustrated in table (7)

These results were supported by the study of **Farag et al (18),** as they demonstrated that 44.4% of mild cases had irregular thickened pleural line just at the lung base, while all severe cases showed irregular pleural line over the whole lung (100%), thickened pleura (83.3%) and the moderate group showed less value for irregularity (83.3%) and thickening (54.2%).

The table (7) illustrated that the lung sliding was present in mild group while abolished in the severe cases of parenchymal affection in HRCT.

This result was in agreement with **Agmy et al ( 19)** who found that abolished lung sliding had a highly significant positive correlation with reticular opacities on MDCT and this could be attributed to the fact that fibrosis

which affects the visceral pleura, will be followed by restriction of lung ventilation and expansion leading to impairment of lung sliding.

**Limitations of the study were:**

The diffusion capacity of carbon monoxide and total lung capacity were not measured and the number of patients (60) is small because the study was controlled by a specific duration (January 2017 to June 2017).

## Conclusion:

Chest ultrasound has an important role for diagnosis and evaluation of DPLD patients. Numerous B-lines which distributed over the lung surface is the most important sonographic feature in combination with a thickened irregular pleural line and the abolished lung sliding .

Chest ultrasound may give an idea about early, or advanced DPLD through the

B-lines number and the B –line distance..

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## List of tables:

## Table (1) illustrate the demographic data of the studied group:

| Variables | Cases | Control | p-value | Significance |
|---|---|---|---|---|
| Age (years)<br>SD±mean<br>Range | <br>13.6±47.5<br>20-75 | <br>9.4±44.1 | 0.1 | NS |
| Sex ( n (%) )<br>Male<br>Female | <br>6 (10%)<br>54 (90%) | <br>8 (13.3%)<br>52 (86.7%) | 0.8 | NS |
| Smoking<br>No<br>Yes | <br>54 (90%)<br>6 (10%) | <br>54 (90%)<br>6 (10%) | 0.9 | NS |
| Occupation<br>Not risky<br>Risky | <br>(56) 93.3%<br>(4) 6.7% | <br>(58) 96.7%<br>(2) 3.3% | 0.7 | NS |
| Biomass<br>Yes<br>No | <br>48 (80%)<br>12 (20%) | <br>16 (26.7%)<br>44 (73.3%) | <0.001 | NS |
| Breeding birds<br>hens ,ducks<br>hens,ducks,pigeons<br>No breading | <br>23 (38.3%)<br>25 (41.7%)<br>12(20%) | <br>16 (26.7%)<br>0<br>44 (73.3%) | <0.001 | NS |
| Clubbing | 25(41.6%) | | | |
| Symtoms<br>Dyspnea<br>Dyspnea &cough<br>Dyspnea &cough & wheezing | <br>18(30%)<br>22(36.7%)<br>20(33.3%) | | | |

## Table 2:The diagnosis of studied patients

| **Diagnosis** | |
|---|---|
| **Hypersensitivity pneumonitis (HP)** | **30(50%)** |
| **Non specific interstitial pneumonia (NSIP)** | **9(15%)** |
| **Idiopathic pulmonary fibrosis (IPF)** | **10(16.6%)** |
| **Sarcoidosis** | **5(8.3%)** |
| **Lymphangioleiomyomatosis (LAM)** | **1(1.6%)** |
| **Pleural parenchymal fibroelastosis (PPFE)** | **1(1.6%)** |
| **Rheumatoid arthritis (RA)** | **4(6.6%)** |

**Table (3):**Thoracic ultrasound parameters in total studied patients.

| Sonographic finding | Case (n=60) | Control (n=60) |
|---|---|---|
| Pleural line<br>Smooth<br>Thickened<br>regular<br>irregular | <br>17(28.3%)<br>43(71.6%)<br>17(28.3%)<br>43(71.6%) | <br>100%<br>0%<br>100% |
| Pleural thickness in mm in total studied patients(mean±SD) | 9.1±5.9 | |
| Pleural thickness for the group with normal pleural thickness (mean±SD) | 2.7±0.33 | |
| Pleural thickness for the group with thickened pleural line (mean±SD) | 11.6±5.1 | |
| 5-B Line<br>Number(mean±SD)<br>Distance(mm) (mean±SD) | <br>2.1±6.3<br>7.8±2.7 | |
| 6-Lung sliding<br>Present<br>Abolished | <br>29(48.3%)<br>31(51.6%) | <br>100% |

**SD: standered deviation**

## Table (4):Semiquantitative modified Warrick score.

| | Grading (points) |
|---|---|
| **Severity score** (parenchymal alteration pattern) | |
| Ground glass opacities | 1 |
| Irregular pleural margins | 2 |
| Septal/subpleural lines | 3 |
| Honeycombing | 4 |
| Subpleural cysts | 5 |
| **Maximal severity score** | 15 |
| **Extension score** (number of bronchopulmonary segments) | |
| Segments 1-3 | 1 |
| segments 4-9 | 2 |
| 9 segment involved > | 3 |
| Bilateral involvement | 4 |
| **Maximal extent score** | 15 |

**Table (5) Classification of Diffuse parenchymal lung diseases severity according to total Warrick score**

| Item | Mild (S=>8) | Moderate (S=8–15) | Severe (S=<15–30) |
|---|---|---|---|
| Total Warrick score (mean±SD) | 6.1± 0.9 | 10.9 ± 2.2 | 19.3 ±2.8 |
| N(%) | 16(26.7%) | 23 (38.3%) | 21(35%) |

**Table (6): Correlation between warrick score and other variables among cases.**

| Variables | Warrick score | | |
|---|---|---|---|
| | R | p-value | Sig. |
| **B -lines (n)** | **-0.49** | **<0.001** | **HS** |
| **Distance between B- line (mm)** | **0.81** | **<0.001** | **HS** |
| **Symptoms duration** | 0.16 | 0.2 | NS |
| **$PaO_2$** | **-0.81** | **<0.001** | **HS** |
| **6 min walk test (m)** | **-0.33** | **0.01** | **S** |
| **Forced vital capacity(FVC)** | **-0.74** | **<0.001** | **HS** |
| **Thickness** | **0.82** | **<0.001** | **HS** |

**Table (7): Comparison of plural line and other findings in different severity degrees among cases.**

| Variables | Warrick score | | | p-value | Sig. |
|---|---|---|---|---|---|
| | Mild | Moderate | Sever | | |
| **Regularity of pleural line** | | | | | |
| Regular | 9(56.3%) | 8(34.8%) | 0(0%) | **<0.001** | **HS** |
| Irregular | 7(43.8%) | 15(65.2%) | **21(100%)** | | |
| **Plural line thickened** | | | | | |
| Not thickened | 9(56.3%) | 8(34.8%) | 0(0%) | **<0.001** | **HS** |
| Thickened | 7(43.8%) | 15(65.2%) | **21(100%)** | | |
| **Others** | | | | | |
| **B-line distance (mm)** | 4.44±0.96 | 7.43±1.3 | **10.7±1.5** | **<0.001** | **HS** |
| **Pleural line thickness** | 3.8±1.6 | 6.4±3.4 | **16.1±2.3** | **<0.001** | **HS** |
| **Number of B - lines** | **8.8±1.6** | 5.3±1.6 | 5.3±1.3 | **<0.001** | **HS** |
| **6 min walk test (m)** | **339.8±60.6** | 220.7±63.8 | 245.1±57.6 | **<0.001** | **HS** |
| **FVC (forced vital capacity)** | **69±8.9** | 67.7±8.3 | 45±9.4 | **<0.001** | **HS** |
| **Warrick score** | 6.1±0.9 | 10.9±2.2 | 19.3±2.8 | **<0.001** | **HS** |
| **Lung sliding Present abolished** | 16(26.7%) | 13(21.6%) 10(16.6%) | 21(35%) | **<0.001** | **HS** |