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# Prevalence of Right Ventricular Dysfunction & Pulmonary Hypertension and their Relationship to the Number of Hemodialysis Sessions in Patients of End-Stage Renal Disease (ESRD)

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## ABSTRACT

**Introduction:** Chronic hemodialysis (HD) ends up with right ventricular (RV) dysfunction and increased pulmonary hypertension (PHTN). Left to right shunt in dialysis patients due to arterio-venous fistula (AVF) causes chronic volume overload, independent of rise in body water leading to worsening RV overload and RV dysfunction (RVD).
**Aims & Objectives:** To determine the prevalence of RV dysfunction & pulmonary hypertension and its relationship to the number of dialysis sessions in patients of ESRD.
**Place and duration of study:** Department of Cardiology & Nephrology, Sheikh Zayed Hospital, Lahore for one year from March 2016 - March 2017.
**Material & Methods:** This cross-sectional analytical hospital based study enrolled 145 Patients of End-Stage Renal Disease (ESRD) on regular 4-hours HD sessions at two or more times per week for at least 3 months. Echocardiography (Echo) with 2-D, M (Motion) Mode & Doppler studies were done. RV dysfunction by TAPSE value less than 15mm & PHTN by Systolic pulmonary artery pressure >35 mm Hg or tricuspid regurgitation velocity ($V_{TR}$) ≥2m/s at rest were noted. Data was analyzed on SPSS version 20.
**Results:** RV dysfunction was seen in 40.7% (59) of patients and the frequency rose across the 4 dialysis session groups (13.8%, 37.3%, 51.7% & 100%, p<0.001). PHTN was observed in 44.1% of the patients and the prevalence progressively increased across the groups (17.2%, 45.1%, 53.3% & 80.01%, p<0.003). There was significant association between RVD and PHTN (p=0.011).
**Conclusion:** We observed positive correlation between RV dysfunction and PHTN with total number of hemodialysis sessions. Early detection of sub-clinical RV dysfunction may improve mortality and morbidity by optimizing treatment options.

**Key words:** ESRD patients on HD, Echo, RV dysfunction, PHTN.

## INTRODUCTION

Cardiovascular diseases are leading cause of mortality among dialysis patients accounting for 50% of deaths,[1] due to congestive cardiac failure (CCF) was found to be most common with poor prognosis.[2] But right ventricle (RV) is the least studied topic. Chronic hemodialysis ends up with RV dysfunction and increased pulmonary pressure. Left to right shunt in dialysis patients due to arterio-venous fistula (AVF) causes chronic volume overload, independent of rise in body water leading to worsening RV overload.[3]
Clinical manifestations of cardiac disease at the start of ESRD therapy are high.[4] And 50% of patients starting a dialysis program have some type of pre-existing cardiovascular disease.[5,6] Available data on RV dysfunction is scarce but there is significant evidence of pulmonary hypertension in patients on chronic hemodialysis and survival of patients has been related to function of heart rather than values of pulmonary pressure.[7]
Also RV dysfunction may affect left ventricular filling through interventricular interactions.[8] Previous studies focused on the relation between dialysis and pulmonary hypertension gave more emphasis to the Tissue Doppler imaging (TDI) indices of Left Ventricle (LV) function and showed that diastolic dysfunction is more prevalent in these patients.[9,11] In 2010 a retrospective study by Paneni et al showed that in presence of Brachial AVF, risk of RV dysfunction increased among hemodialysis patients[10], and showed to predict mortality.[12]

On echocardiography, tricuspid annular plane systolic excursion (TAPSE) is a reliable parameter to evaluate RV function. It is a good prognostic marker for cardiovascular risk stratification and is unaffected by heart rate and rhythm.[13] And 20% of hemodialysis patients with AV fistula showed abnormal TAPSE values (<15 mm).[14]

Another recent study showed that the reduction in RV dysfunction was independent of left ventricular hypertrophy (LVH), diastolic dysfunction of the LV, or pulmonary hypertension.[15] But this has not been described in Pakistani literature up to present.

Our objective is to determine the prevalence of pulmonary hypertension and RV dysfunction & their relationship to the number of dialysis sessions in patients ESRD on maintenance hemodialysis.

## MATERIAL AND METHODS

This is an analytical cross-sectional research study done in Department of Cardiology & Nephrology, Shaikh Zayed Hospital, Lahore during one year, March 2016 - March 2017. 145 patients met the inclusion criteria and were enrolled in the study. The sample size of 145 was estimated by using 95% confidence level, 8% margin of error with expected frequency of RV Dysfunction 60% among hemodialysis cases.[14]

RV dysfunction (RVD) is declared when on transthoracic echocardiography TAPSE value less than 15mm[14] and Chronic kidney disease (CKD) is declared when reduced renal function that is glomerular filtration rate less than 60ml/min/1.73m$^2$ for at least 3 months irrespective of cause.[17] Pulmonary Hypertension is said significant when systolic pulmonary artery pressure >35 mm Hg or tricuspid regurgitation velocity ($V_{TR}$) ≥2m/s at rest.[18]

**Inclusion criteria**: 1) Adults above the age of 18 years. 2) Patients on regular 4 hours HD sessions at two or more times per week for at least 3 months using bicarbonate-buffered dialysate.

**Exclusion criteria**: 1) Echocardiographic or clinical evidence of ischemic heart disease, LV dysfunction, valvular heart disease or previous renal transplantation. 2) Predisposing clinical conditions to pulmonary hypertension, COAD, interstitial lung diseases, primary pulmonary hypertension, congenital left to right shunt, chronic thromboembolic disease and connective tissue disorders.

HD sessions were calculated as Total HD sessions = Frequency per week × 4 × number of months of HD. All of them underwent transthoracic echocardiography including 2D. M-mode and Doppler studies of the RV. Echocardiography was performed within 1 hour after completing hemodialysis in clinically stable patients with optimal dry weight to avoid any overestimation due to volume overload. Images were obtained using GE Vivid I Portable Ultrasound Machine.

**Statistical analysis:**

Collected data was entered and analyzed using SPSS 20.0. Data for age and TAPSE was described using mean ±SD if normally distributed and median (IQR) otherwise. Data for RVD, pulmonary hypertension, smoking, DM, HTN and total number of HD sessions was described by using frequency and percentages.

Furthermore, stratification of the study population was done based on the total number of HD sessions into 4 groups as: <200, 201-300, 301-400 &>400. Comparison of TAPSE between the HD session groups was made using Kruskal Wallis test. Comparison of RVD between the groups was made by using Chi-square test. Also the relationship between RVD and pulmonary hypertension was tested by the Chi-square test. A p-value ≤ 0.05 was considered significant.

## RESULTS

Out of 145 patients 82(56.55%) were male while 63 (43.45%) were female. The average age of the patient was 53.46± 7.75 although the minimum age of patient was 20 years and maximum age was 78 years. Mean duration of HD was 26.22 month with SD 9.0. The minimum duration of HD was 10 months and maximum duration of HD was 30 months. Out of 145 patients, 50 (34.48%) patients were receiving twice-weekly hemodialysis while, 95 (65.52%) patients were on thrice-weekly hemodialysis sessions. As regard to risk factors, diabetes mellitus was found in 48 (33.10%) patients while 97 (66.90%) were non-diabetics. Out of 145 patients, hypertension was found in 39(26.9%) patients, while 106 (73.1%) were non-hypertensive. Fifty three patients were smokers while ninety two patients were non- smokers. Further sub analysis is mentioned in tables given below. The distribution with respect to hemodialysis sessions shown in Table-1, RV dysfunction with respect to hemodialysis shown in Table-2 and pulmonary hypertension is shown in Table-3. Comparison of TAPSE value in different groups are shown in Table-4 & 5.

| HD sessions | N | % |
|---|---|---|
| ≤ 200 | 29 | 20.0 |
| 201 - 300 | 51 | 35.2 |
| 301 - 400 | 60 | 41.4 |
| 401+ | 5 | 3.4 |
| Total | 145 | 100.0 |

**Table-1:** Distribution with respect to Hemodialysis sessions

| HD sessions | Right Ventricular Dysfunction | | | | | |
|---|---|---|---|---|---|---|
| | Yes | | No | | Total | |
| | n | % | N | % | n | % |
| ≤ 200 | 4 | 13.8 | 25 | 86.2 | 29 | 100.0 |
| 201 - 300 | 19 | 37.3 | 32 | 62.7 | 51 | 100.0 |
| 301 - 400 | 31 | 51.7 | 29 | 48.3 | 60 | 100.0 |
| 401+ | 5 | 100.0 | 0 | 0.0 | 5 | 100.0 |
| Total | 59 | 40.7 | 86 | 59.3 | 145 | 100.0 |

**Table-2:** Stratification of RVD with Respect to HD Session Cross Tabulation

| HD sessions | Pulmonary hypertension | | | | | |
|---|---|---|---|---|---|---|
| | Yes | | No | | Total | |
| | n | % | N | % | n | % |
| ≤ 200 | 5 | 17.2 | 24 | 82.8 | 29 | 100.0 |
| 201 - 300 | 23 | 45.1 | 28 | 54.9 | 51 | 100.0 |
| 301 - 400 | 32 | 53.3 | 28 | 46.7 | 60 | 100.0 |
| 401+ | 4 | 80.0 | 1 | 20.0 | 5 | 100.0 |
| Total | 64 | 44.1 | 81 | 55.9 | 145 | 100.0 |

**Table-3:** Stratification of Pulmonary Hypertension with Respect to HD Session Cross Tabulation

| HD sessions | TAPSE | | | | |
|---|---|---|---|---|---|
| | Mean | SD | Q1 | Median | Q3 |
| ≤ 200 | 19.2 | 3.9 | 18.0 | 19.0 | 22.0 |
| 201 – 300 | 17.6 | 5.1 | 13.0 | 19.0 | 22.0 |
| 301 – 400 | 15.4 | 4.2 | 12.0 | 15.0 | 19.0 |
| 401+ | 8.8 | .8 | 8.0 | 9.0 | 9.0 |
| Total | 16.7 | 4.9 | 12.0 | 18.0 | 20.0 |

**Table-4:** TAPSE among 4 HD Session groups

| HD sessions(I) | HD sessions(J) | Mean Difference (I) – (J) | Z | P-value |
|---|---|---|---|---|
| ≤ 200 | 201 - 300 | 1.67 | -1.19 | 0.233 |
| | 301 - 400 | 3.89* | -3.85 | < 0.001 |
| | 401+ | 10.44* | -3.35 | 0.001 |
| 201 - 300 | 301 - 400 | 2.22* | -2.50 | 0.012 |
| | 401+ | 8.77* | -3.39 | 0.001 |
| 301 - 400 | 401+ | 6.55* | -3.46 | 0.001 |

**Table-5:** Group wise comparison of TAPSE among 4 HD Session groups

## DISCUSSION

Patients on long-term hemodialysis (HD) therapy at some stage develop RV dysfunction and pulmonary hypertension and it is more common in HD patients as compared to the patients on peritoneal dialysis (PD).[10] We did this study with a view to determine the prevalence of RV dysfunction and pulmonary hypertension and their relation to the total number of dialysis sessions as local data are lacking in this regard. Although there are some international studies, they showed inconsistent results.

RV dysfunction was seen in 59 (40.7%) of the patients in our study. The frequency increased with increase in total HD sessions. The patients who had less than 200 sessions in total had RVD prevalent among 13.8%, while, 37.3% among cases with sessions 201-300 and 51.7% among cases with 301-400 sessions. There were 5 cases with more than 400 sessions and all had RVD. The total sessions of HD had a significant association with p-value <0.001 (Table-2). Paneni et al. showed 71.3% prevalence of RVD in HD patients and found further that the prevalence was more in HD than PD and brachial than radial AVF[10]. Another study showed that RV dysfunction is increased in HD patients in which they compared the HD patients with the controls.[15]

However these studies did not compare the effects of the total number of dialysis sessions on the RV dysfunction. Regarding PHTN, Yigla M et al in their study reported its prevalence of 40% in HD patients.[19]

Our study has similar results with 44.1% prevalence in the HD patients. Like RV Dysfunction (RVD) the pulmonary hypertension (PHTN) was also prevalent in increasing order with the increase of HD sessions. The minimum prevalence was 17.2% among group with total sessions less than 200 and 80.0% among those with more than 400 sessions (Table-3). It was observed that there were 34 (23.4%) cases that had RVD as well as PHTN while in 56 (38.6%) both were absent. There were 25 cases that had RVD but no PHTN and similarly there were 30 cases that had PHTN but no RVD. Still the association between RVD and PHTN was statistically significant with p-value 0.011.

Present study reported that the RVD parameter viz. tricuspid plane systolic excursion (TAPSE) value decreased significantly with increasing duration of HD sessions.

The mean TAPSE value for the group with HD sessions less than 200 was found to be 19.2±3.9mm with median of 19.0(18.0-22.0). The median (IQR) for other three groups were 19.0 (13.0-22.0), 15.0

(12.0-19.0) and 9.0 (8.0-9.0) respectively. When compared among groups by using Kruskal Wallis test it was noted that the difference of TAPSE among four groups by HD sessions was highly significant (p-value <0.001). Thus, it is evident that once the dialysis crosses 400 sessions the TAPSE value starts falling in the RV Dysfunction range (Table-4).

Mohamed Momtaz et al. reported a statistically significant decrease in tricuspid plane systolic excursion (TAPSE; 2.2±0.94 vs. 2.1±0.63 cm) in HD group as compared to the control group.[15] But unlike this study it was not correlated with the number of HD sessions.

In our study majority (65.52%) of patients was on thrice weekly HD and the rest were on twice weekly HD. The proportion of men was greater than that of the women (56.55% vs. 43.45% respectively) similar to the study by Momtaz M et al. in which they studied the RV dysfunction in HD patients in which men were 62% and women were 38%.[15] So our results are comparable with other studies but the effect of number of HD sessions on RV function and PHTN was significant to make this study different from other studies.

**Limitations:**

There is no control group, the number of patients were less and that it is a cross-sectional study. The relationship of frequency, dose, length and the duration of dialysis on the RV dysfunction and pulmonary hypertension needs to be addressed in larger prospective studies.

## CONCLUSION

This study confirmed the higher prevalence of RV dysfunction and pulmonary hypertension among ESRD patients with higher sessions of HD. So, Periodic echocardiography should be considered for early detection of cardiac abnormalities and prioritize such patients for early renal transplant.

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