|| ISSN(online): 2589-8698 || ISSN(print): 2589-868X ||
International Journal of Medical and Biomedical Studies
Available Online at www.ijmbs.info
PubMed (National Library of Medicine ID: 101738825)
Index Copernicus Value 2018: 75.71
Original Research Article
Volume 3, Issue 11; November: 2019; Page No. 88-94

PULMONARY HYPERTENSION IN END STAGE KIDNEY DISEASE (ESKD) PATIENTS ON MAINTENANCE HEMODIALYSIS (MHD) VIA SURGICALLY CREATED ARTERIOVENOUS FISTULA.

Hamad Jeelani[1], Manjuri Sharma [2], Manzoor A. Parry[3] Prodip.K.Doley[4], Gayatri Pegu [5]
[1]DM Student, Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam
[2]Professor & Head, Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam
[3]DM student, Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam.
[4]Assistant Professor, Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam
[5]Registrar, Department of Nephrology, Gauhati Medical College and Hospital, Guwahati, Assam

Article Info: Received 05 October 2019; Accepted 10 November. 2019
DOI: https://doi.org/10.32553/ijmbs.v3i11.716
Corresponding author: Dr Hamad Jeelani
Conflict of interest: No conflict of interest.

Abstract

Background Pulmonary hypertension is a disorder which worsens systemic diseases. One of the important underlying pathology is end stage chronic kidney disease The aim of this study was to assess the incidence of unexplained PHT, and to relate this to the cardiovascular status and arteriovenous fistula characteristics in ESKD patients on maintenance hemodialysis

Methods*:* 159 patients with end stage kidney disease on maintenance hemodialysis were evaluated, 103 were excluded. Clinical, laboratory parameters were recorded. Systolic Pulmonary artery pressure and cardiac functions were evaluated by echocardiography. Flow across arteriovenous fistula was assessed by Doppler sonography. Patients were divided between the group with and without pulmonary hypertension. It was a cross sectional study.

Result: Out of 159 patients, 56 patients who fulfilled inclusion criteria were evaluated, 36% had systolic pulmonary artery pressure of 35 mm Hg, mean age was 52.42 ± 9.12 years, 71.4% were males, and mean duration of end stage kidney disease was 33.66 ±11.56 months. Pulmonary hypertension patients were exposed to longer duration of hemodialysis therapy (p=0.0001) as compared to the patients with no pulmonary hypertension group, they also had a longer duration of functional Arterio venous fistula (p=0.0001), and flow across Arterio venous fistula was significantly more in pulmonary hypertension group (p=0.022), and these also had higher cardiac output (p=0.0001). Patients with Pulmonary hypertension were significantly more anemic, had more hypoalbuminemia and more interdialytic weight gain.

Conclusions: Pulmonary hypertension is frequent in end-stage kidney disease patients on maintenance hemodialysis. It appears to be a late complication of hemodialysis with surgically created AVF with implications on cardiovascular status.

Keywords: Arterio venous fistula (AVF), End-stage kidney disease (ESKD), Maintenance hemodialysis (MHD), pulmonary hypertension (PHT).Systolic pulmonary artery pressure (sPAP)

1. Introduction.

Pulmonary hypertension (PHT) is a disorder which worsens heart, lung, or systemic diseases, irrespective of initiating pathology and is associated with significant mortality and morbidity [1]. One of the important underlying pathology in these patients is chronic kidney disease (CKD), K. B. Martin et al [1]. Prevalence of PHT in end-stage kidney disease (ESKD) patients is around 40%–50%, Yigla M [2]. With higher incidence in hemodialysis (HD) patients than those who are on peritoneal dialysis (PD) Yigla M et al and F. Nakhoul et al [3, 4]. The exact mechanism of pathogenesis is not known. However, there are several possible explanations for the increased occurrence of PHT in ESKD patients on maintenance hemodialysis (MHD). These patients have high cardiac output (CO) states from the peripherally created arteriovenous fistula (AVF), associated metabolic and hormonal imbalances due to ESKD which may lead to a state of pulmonary arterial vasoconstriction ,Ifudu and Kooman JP, Leunissen KM [5, 6]. Moreover, calcification involving pulmonary vasculature in ESKD patients on MHD has been an implicating factor of pulmonary vascular dysfunction Milliner DS et al [7]. Other factors which will compound this state of high incidence of PHT in these patients are anemia and fluid overload state in them Okura H, Takatsu Y [8]. Clinical features associated

with PHT in ESKD patients on MHD are still matter of consideration.

2.Aims and objective

To evaluate and to correlate clinical features, AVF characteristics and echocardiography findings in our ESKD patients on maintenance hemodialysis (MHD) with pulmonary hypertension (PHT).

3. Subjects and Methods.

This study was carried out in the department on Nephrology at Gauhati Medical College and Hospital, a tertiary care center between January 2017 and Jan 2018, 56 hemodialysis patients underwent systolic pulmonary artery pressure (sPAP) measurement by echocardiography. They were selected from a population of 159 subjects dialyzing in this center after exclusion criteria. One hundred and three patients were excluded due to comorbid factors which can lead to secondary PHT after clinical and laboratory evaluation. Patients with chronic obstructive lung disease (n=58), chest wall deformities or parenchymal lung disease (n=20), history of previous pulmonary thromboembolism (n=6), collagen vascular disease (n=12), and those not willing to participate in the study (n=7), were excluded.

The final study group consisted of 56 patients who were on maintenance hemodialysis (thrice weekly each session lasting four hours) without a known cause of PHT .Each patient underwent complete analysis, regarding clinical and laboratory parameters with special emphasis on any condition that could predispose PHT. X RAY chest, pulmonary function tests (PFTs), 12-lead electrocardiography (ECG), arterial blood gas (ABG) analysis and Doppler echocardiography were performed before enrollment to the study. Interdialytic weight gain was defined by weight taken immediately after the end of dialysis and weight just before the next dialysis session .Patient's general data (age, sex, and comorbidity) , data regarding the kidney disease (etiology, duration of renal failure, duration of hemodialysis) and data pertaining to the AVF (i.e. duration, site and flow through AVF) were recorded from all the patients. Laboratory investigations included blood urea nitrogen (BUN), serum creatinine, serum calcium, serum phosphorus, PTH, hemoglobin, hematocrit, liver functions tests, ABG were performed before dialysis. Doppler echocardiography was performed in all patients. It was done the after dialysis session within on hour after achieving dry weight in all patients to avoid any overestimation of systolic PAP due to volume shift .One experienced operator performed all echocardiographic studies.

Systolic right ventricular pressure (or PAP) was calculated using the Bernoulli Equation: PAP = 4 x (Tricuspid systolic jet) 2 + 10 mm Hg (estimated right atrial pressure) [7]. PHT was defined as a systolic PAP > 35 mm Hg [6]. Cardiac output (CO) was estimated from the left ventricular outflow tract velocity time integral x diameter [8]. Other Echo parameters were also analyzed in all subjects.

AVF flow measurements were taken from an arterialized vein. The Doppler angle was kept between 30 and 60° to correct for the angle between the axis of the vessels for all measurements. All studies were performed with a 10- to 12-MHz linear transducer. It was measured 4 times and the average of these value was taken. As patients studied went under the routine evaluation like other CKD patient admitted in the department and no active intervention was involved in these patients so study was done in keeping the Principles outlined in the declaration of Helsinki.

4. Statistical Analysis.

Data are expressed as a mean ± standard deviation and as a percentage when the value was categorical. Difference between groups was compared with Student's *t*-test for parametric continuous variables, Mann- Whitney-U test for continuous variables. Chi-square test was applied for estimating the occurrence of categorical variables. sPAP and echocardiographic parameters were correlated by using Pearson's correlation coefficient. P value <0.05 was considered as statistical significance. All analyses were performed using Stat View for windows.

5. Results.

Base line characteristics of the 56 patients who participated in the study are summarized in Table1.

20 (36%) of them had pulmonary hypertension (PHT), their mean age was 52.42 ± 9.12 years and 40 (71.4%) were males, mean duration of end-stage kidney disease (ESKD) was 33.66 ±11.56 months.

Clinical and biochemical data of the 20 patients with PHT (37.95 ± 1.499 mmHg) was compared with the 36 patients without PHT (28.23 ± 3.71 mmHg) as shown in Tables 2.

The mean duration of ESKD was significantly longer (47.19±2.839 vs 25.54±5.538 months, P = 0.0001) in patients with PHT, and these were exposed to longer duration of hemodialysis therapy (31±11 vs 19±6 p=0.0001) as compared to the patients without PHT. PHT group had significantly lower hemoglobin levels (5.64± 0.748 vs 4.57 ±0 .397 p=0.0001) and were having more hypoalbuminemia (0.58 ± 0.052 vs 0.39± 0.073 p=0.0001) as compared to the other group. Interdialytic weight gain was significantly more in patients with PHT (2.619±0.4976 versus 1.151±0.4730 Kg, P = .0001) as compared to those without PHT.

Patients with PHT had a longer duration of functioning AVF (17.62±1.322 vs 9.71±1.824 months p=0.0001) (table 2), flow through brachial AVF was significantly higher (781.18 ± 60.2 vs723.0588 ±50.18 P=0.01) as compared to patients with normal PHT (figure 2)

Patients with PHT had a higher cardiac output (7.9±0.2 vs 6.±0.2 p=0.0001) and significantly less diastolic blood pressure (70.00± 9.526 vs 89.95± 11.491 mmHg, P =0.0001). Patients with PHT had higher diastolic left ventricular Volume (124.35±6.915 vs123.64±8.868 P = 0.87), and mitral incompetence was significantly higher in this group {(20, (100.0%) versus 27, (75.0%)} P=0.019). (Figure 1).

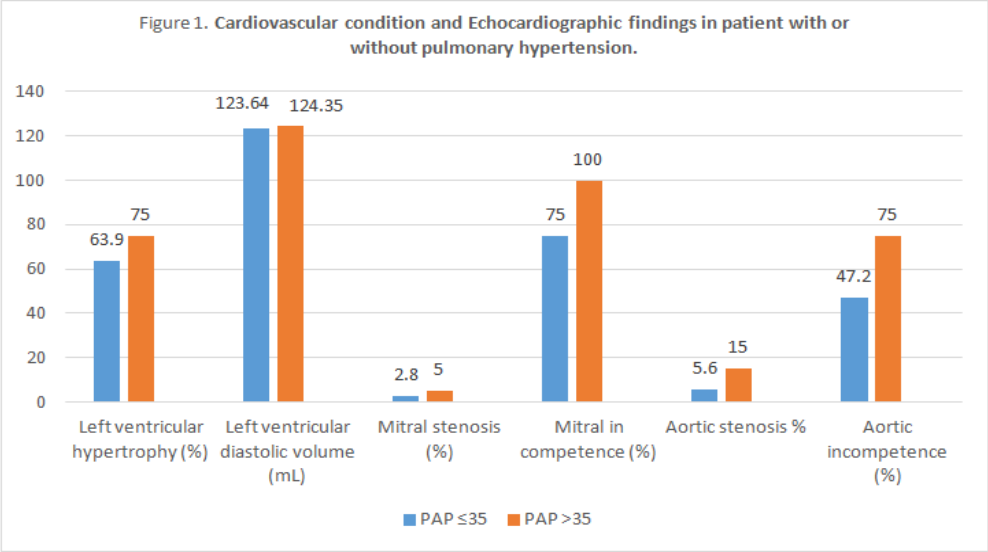

Figure 1: Echocardiographic findings between these two groups of patients.

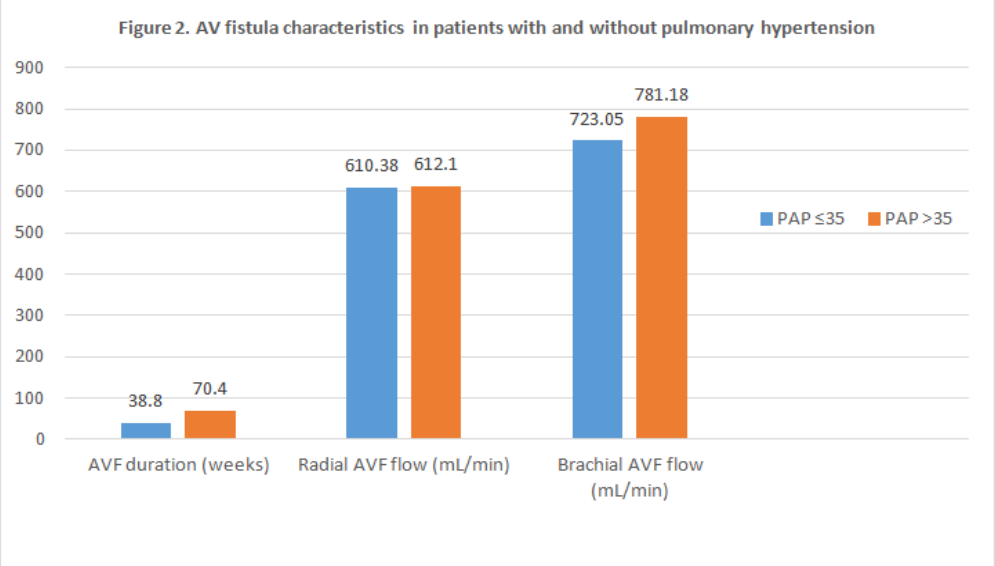

Figure 2: AVF characteristics between the two groups.

Table 1: Clinical Data of patients with ESKD on HD via A-V fistula.

Clinical features	Value
Number of patients	56
Age yrs.	52.42 ± 9.12
Sex (M/F) (%)	40/16 (71.4/28.6)
Duration of end stage kidney disease (months)	33.66 ±11.56
Duration of dialysis (months) Mean ± SD	12.68 ± 4.196
Inter dialytic weight gain(kg)	1.739 ± 0.705
Systolic BP(mmhg) Mean ±SD	143.04 ± 9.53
Diastolic BP (mmhg)	77.13 ± 14.01
Sr. Calcium (mmol/lit)	2.06 ± 0.11
Sr. Phosphate (mmol/lit)	1.76 ± 0.15
Parathyroid(pmol/lit)	37.35 ± 3.217
Hemoglobin (mmol/lit)	5.25 ± 0.82
Hematocrit (lit/lit)	0.331 ± 0.081
Sr. albumin (mmol/lit)	0.49 ± 0.092
Systolic pulmonary artery pressure (mmhg)	31.88 ± 5.651
Arterio venous fistula , Radial/ Brachial (n)	28/28
Duration of arterio venous fistula (months),mean ± SD)	12.68±4.196

Table 2: Clinical and laboratory data between patients with and without pulmonary hypertension.

	PAP≤35	PAP>35	P value
No.of patients	36 (64%)	20 (36%)	
Age (years) mean ±SD	52.53± 9.176	52.25± 9.419	0.789
Gender (M/F) ,%	26/10, (72.2%/ 27.8%)	14/6, (70.0%/30.0%)	1.000
Duration of end stage kidney disease (months)	25.54±5.538	47.19±2.839	0.0001
Diabetic Nephropathy	17	10	0.094
Chronic Glomerulonephritis	7	1	0.073
Hypertension	6	5	0.056
Nephrolithiasis	0	3	0.073
Pyelonephritis	4	1	0.063
Unknown	2	0	0.061
Smoking n,%	20, (55.6%)	15, (75.0%)	0.249
Hemodialysis duration (months)	19 ± 6	31 ± 11	0.0001
Arterio venous fistula duration (months)	9.71 ± 1.824	17.62 ± 1.322	0.0001
Hemoglobin (mmol/lit)	5.64 ± 0.748	4.57 ± 0 .397	0.0001
Hematocrit (lit/lit)	0.36 ± 0.06	0.26 ± 0.061	0.0001
Serum Albumin(mmol/lit)	0.58 ± 0.052	0.39 ± 0.073	0.0001
Calcium (mmol/lit)	2.05 ± 0 .11	2.08 ± 0.11	0.238
Phosphate(mmol/lit)	1.70 ± 0.15	1.77 ± 0.17	0.099
Parathyroid hormone (pmol/lit)	36.98 ± 3.03	37.969 ± 3.51	0.543
Inter dialytic weight gain (kg) mean ±SD	1.151 ± 0.4730	2.619 ± 0.4976	0.0001
Systemic Systolic BP mmhg (mean ±SD)	143.20 ± 10.813	142.76 ± 7.162	0.599
Systemic Diastolic BP mmhg(mean ±SD)	89.95± 11.491	70.00 ± 9.526	0.0001
Systolic pulmonary artery pressure (mmhg)	28.23 ± 3.71	37.95 ± 1.499	0.0001
Cardiac output (l/min)	6.0 ± 0.2	7.9 ± 0.2	0.0001
Left ventricular diastolic volume (ml)	123.64 ± 8.868	124.35 ± 6.915	0.870

6. Discussion.

This cross-sectional study gives an overview of unexplained pulmonary hypertension in ESKD patients on MHD through surgically created AVF and its relation with cardiac and AVF characteristics in these patients.

The incidence of PHT (sPAP>35 mmHg) was seen in 20 (36%) patients in this study (table 2) , as

compared to 39-56% in the literature Duriye Deren Oygar & Guzin Zekican - Fabbian F et al [9-12], the lower incidence could be explained by the fact that our population is younger with mean age 52.25± 9.41years (table 2) as compared to other studies in literature by Nakhoul F et al , Havlucu Y et al , Fabbian F et al [10, 11,12]. Harper et al [13] in a retrospective study suggested that age of ESKD patients was only risk factor for having PHT and each year increased odds of having PHT by 3%., Other possible explanation of having lesser incidence of PHT in this study is that our patients were exposed to shorter duration of HD (31±11 months) as compared to the studies done by Duriye Deren et al [9], and Nakhoul F et al [10]. This is substantiated by the fact that HD duration is significantly associated with higher incidence of having PHT in ESKD patients [9, 11].

The present study showed that duration of ESKD (47.19±2.839 vs 25.54±5.538 p=0.0001) and to the duration these patients are exposed to HD (31±11 vs19±6, p= 0.0001) (table 2) is significantly associated with the development of PHT, which was also demonstrated in the other studies done by Duriye Deren et al [9], Nakhoul F et al [10] and, Fabbian F [12].

In this study , duration of functioning AVF (17.62±1.322 vs 9.71±1.824 months p=0.0001) (table 2) was significantly associated with the development of PHT, which is in accordance with the study done by Y. Havlucu [11] and Beigi et al. [14] who also reported a positive correlation between mean fistula flow and development of pulmonary artery pressure (PAP).

In this study although flow across radial and brachial fistula was higher in patients with PHT than those without PHT, but statistical significance was only seen for the flow across brachial fistula between two group of patients (781.18 ± 60.2 vs 723.0588 ±50.18 ml/min (p=0.01) (figure 2). Study done by Duriye Deren et al [9] showed that mean levels of PAP were significantly correlated with mean levels of AVF flow (r =0.654, p=0.001) and frequency of PHT was higher in brachial versus radial (26.4 % vs 23.2% p= 0.18) but difference was not significant, results which were similar to the findings in this study (55% vs 45% study p=0.78.).

This study showed that patients with PHT have high cardiac output (7.9±0.2vs 6.0±0.2 p=0.0001) (table 2) .which is similar to the observations made in the literature by Nakhoul F et al , Havlucu Y et al, Havlucu Y et al, respectively [10, 11, 14] .This could be explained by the fact that increased flow across arterio- venous access leads to failure of already compromised pulmonary vasculature in ESKD patients to further recruitment and vasodilation mechanism which could dampen the elevation of pulmonary artery pressure .

These findings are indirectly proven by the fact that temporary closure of AVF and in the post-transplant period led to decrease in Pulmonary artery pressures demonstrated by Nakhoul F et al, Anderson CB et al, Ahearn DJ et al and Yigla M et al respectively [10, 15, 16, 17], indicating that both ESKD and AVF contribute to the pathogenesis of PHT.

Contrary to the above findings, Tarrass et al. [27] did not find a difference in cardiac output between patients with and without PHT, and the effect of AVF location was not statistically significant. Between two groups.

Increased levels of calcium, phosphorous and Parathyroid hormone levels could lead to increased micro calcification of pulmonary circulatory bed and there by decrease there capacitance and hence can play role in elevated pulmonary artery pressure in these patients as seen in studies by Akmal M et al, Kuzela DC et al and Conger JD et al [18,19,20]. However, there are studies which do not support this notion Yigla M et al [22].

We found elevated levels of calcium, phosphorus and parathyroid levels in patients with PHT in comparison to those without PHT, however the difference was not statistically significant between two groups. This is similar to the findings shown in the literature by Nakhoul F et al , Fabbian F et al [10, 12].

The relation in our study with low diastolic blood pressure and PHT (89.95± 11.491 vs 70.00± 9.526, p=0.0001) (table 2), should be correlated as and indirect evidence of index of arterial stiffness similar to the study done by Fabbian F et al [12]

We found a higher incidence of valvular damage in patients with PHT, with statistical significance only for Mitral incompetence (fig. 1) which is similar to the observations made by M. Yigla et al. [22].

In this study patients with PHT were significantly more anaemic and had lower serum albumin levels and had higher interdialytic weight gain as compared to those without PHT, these findings were similar to the studies in the literature by Duriye et al , Havlucu

Yet et al and Fabbian F et al [9, 11, and 12]. This could be explained by the fact that serum albumin is well-known marker of malnutrition and inflammation in ESKD patients and wide spread inflammation causes endothelial dysfunction which could lead to or precipitate PHT as shown by Fabbian F, Kaysen GA , Aguilera A et al [23, 24, 25]. Diabetes was leading cause of ESKD in our study similar to the studies in literature by Nakhoul F et al , Manjuri Sharma et al [10, 28] ,which itself leads to diffuse endothelial dysfunction and increased inflammatory burden in these patients and predisposes to PHT.

In addition decrease in serum albumin causes hypervolemia which again adds further to insults which leads PHT in these patients. Anemia is a risk factor for the development of left ventricular hypertrophy (LVH) and increased cardiac output (CO); both these factors can, in turn, lead to PHT as shown by Duriye et al and Havlucu Y et al [9, 11]. Contrary to these findings there are studies which don't show a significant difference in HB, HCT and serum albumin levels between patients with PHT to those without PHT Nakhoul F et al , Fabbian F et al [10, 12]..

7. Conclusion

PHT is a common occurrence in ESKD patients on MHD with increased cardiac vascular implications.

Possible mechanism contributing to its initiation and aggravation in these patients include longer duration of ESKD, long dialysis vintage and long-standing AVF with a high degree of flow through it

These patients also have high cardiac output state, in addition having significantly higher interdialytic weight gain, a greater degree of anemia and lesser levels of serum albumin as compared to patients with no PHT.

8. Limitations to the Study

A sample size of our study is relatively small.
We assessed PAP noninvasively by Doppler Echocardiography without obtaining right heart catheterization.
The radionuclide test for the evaluation of pulmonary calcification could not be applied.
Long-term follow-up of patients with PHT is needed to ascertain Long-term Morbidity and mortality.

Bibliography

1. Martin K B, Klinger JR, Rounds SIS. Respirology .2006; 11: 6–17
2. Yigla M1, Fruchter O, Aharonson D et al. Pulmonary hypertension is an independent predictor of mortality in hemodialysis patients. Kidney Int. 2009 May; 75(9):969-75.
3. Yigla M, Nakhoul F, Sabag A et al. Pulmonary hypertension in patients with end-stage renal disease. Chest 2003 May; 123(5):1577-82
4. F. Nakhoul, M. Yigla, R. Gilman, et al. The pathogenesis of pulmonary hypertension in Hemodialysis patients via arterio-venous access. *Nephrology Dialysis Transplantation* 2005 20: 1686–1692,
5. Ifudu O .Care of patients undergoing hemodialysis N Engl J Med**.**1998 Oct 8; 339(15):1054-62
6. Kooman JP, Leunissen KM: Cardiovascular aspects in renal disease. *Curr Opin Nephrol Hypertension* 1993; 2:791–797,
7. Milliner DS, Zinsmeister AR, Lieberman E, Landing B Soft tissue calcification in pediatric patients with the end-stage renal disease. *Kidney Int* 1990; 38: 931–936
8. Okura H, Takatsu Y: High output failure as a cause of pulmonary hypertension. Intern Med. 1994 Jun; 33 (6):363-5
9. Duriye Deren Oygar & Guzin Zekican Pulmonary Hypertension in Dialysis Patients*, Renal Failure* 2012 ;34: 840-844
10. Nakhoul F, Yigla M, Gilman R, Reisner SA, Abassi Z .The pathogenesis of pulmonary hypertension in hemodialysis patients via arterio-venous access*. Nephrol Dial Transplant.* 2005; 20:1686–1692
11. Ezgi Yenigun, Sevket Balli, Didem Turgut et al. Pulmonary hypertension in patients with chronic renal failure. *Respiration, 2007;.74: 503–510*
12. Fabio Fabbian, Stefano Cantelli, Christian Molino et al. Pulmonary hypertension in dialysis patients: a cross-sectional italian study. International Journal of Nephrology, vol. 2011 Article ID 283475, 4 pages, 2011
13. Harp RJ1, Stavropoulos SW, Wasserstein AG, Clark TW . Pulmonary hypertension among end-stage renal failure patients following hemodialysis access thrombectomy. Cardiovasc Intervent Radiol. 2005 Jan-Feb;28(1):17-22
14. Beigi AA, Sadeghi AM, Khosravi AR, Karami M, Masoudpour H. Effects of the arteriovenous fistula on pulmonary artery pressure and cardiac output in patients with chronic renal failure. J Vasc Access. 2009 Jul-Sep; 10(3):160-6
15. Anderson CB, Codd CR, Graff RA et al. Cardiac failure and upper extremity arteriovenous dialysis fistula: case reports and a review of literature. *Arch Intern Med* 1976; 136: 292– 297
16. Daniel J. Ahearn, John F. Maher. Heart failure as a complication of hemodialysis arteriovenous fistula. Ann Intern Med. 1972; 77(2):201-204.

17. Yigla M, Nakhoul F, Sabag A, et al: Pulmonary hypertension in patients with end-stage renal disease. *Chest* 2003 ; 123: 1577–1582

18. Akmal M1, Barndt RR, Ansari AN, Mohler JG, Massry SG. Excess PTH in CRF induces pulmonary calcification, pulmonary hypertension and right ventricular hypertrophy Kidney Int. 1995 Jan;47(1):158-63

19. D. C. Kuzela, W. E. Huffer, J. D. Conger, S. D. Winter, W. S. Hammond Soft tissue calcification in chronic dialysis patients. Am J Pathol 1977 Feb; 86(2): 403–424

20. Conger JD, Hammond WS, Alfrey AC, Contiguglia SR, Stanford RE, Huffer WE. Pulmonary calcification in chronic dialysis patients. Clinical and pathologic studies. Ann Intern Med 1975 Sep; 83(3):330-6

21. Block GA, Hulbert-Shearon TE, Levin NW, Port FK. Association of serum phosphorus and calcium! Phosphate product with mortality risk in chronic hemodialysis patients: a national study. Am J Kidney Dis. 1998 Apr;31(4):607-17

22. Yigla M, Fruchter O, Aharonson D et al: Pulmonary hypertension is an independent predictor of mortality in hemodialysis patients. Kidney Int 2009 May;75(9):969-75.

23. Kaysen GA, Kumar V. Inflammation in ESRD: Causes and potential consequences. *J Ren Nutr*. 13:158–160, 2003

24. Kaysen GA. Effects of inflammation on plasma composition and endothelial structure and function. *J Ren Nutr.* 2005; 15: 94–98

25. Aguilera A, Sánchez-Tomero JA, Bajo MA, et al. Malnutrition inflammation syndrome is associated with endothelial dysfunction in peritoneal dialysis patients. Adv Perit Dial 2003;19:240-5.

26. Unal A1, Sipahioglu M, Oguz F et al. Pulmonary hypertension in peritoneal dialysis patients: Prevalence and risk factors. Perit Dial Int. 2009 Mar-Apr; 29(2):191-8

27. F. Tarrass, M. Benjelloun, G. Medkouri, et al doppler echocardiograph evaluation of pulmonary hypertension in patients undergoing hemodialysis," Hemodialysis International 2006; 10:356–359.

28. Manjuri Sharma, Prodip Doley, Himanab Jyoti Das. Etiological Profile of Chronic Kidney Disease: A Single-Center Retrospective Hospital-Based Study. *Saudi J Kidney Dis Transpl* 2018 ;29:409-413