A Study of Pulmonary Arterial Pressure with Two Dimensional Trans Thoracic Echocardiography in Patient With Chronic Kidney Disease

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KEYWORDS

chronic kidney disease (ckd), pulmonary pressure, pulmonary arterial pressure, estimated glomerular filtration rate (egfr), ckd stage 5
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ABSTRACT

Abstract
Introduction
This study focuses on assessing pulmonary arterial hypertension (PAH) in individuals diagnosed with chronic kidney disease (CKD), specifically exploring its prevalence across different CKD stages and its association with hemodialysis. The investigation conducted at Krishna Institute of Medical Sciences over two years involved 100 CKD patients, aiming to shed light on the frequency and correlations of PAH within this population.
Aim
To study pulmonary arterial pressure in patients diagnosed with chronic kidney disease.
Objectives
To determine the incidence of pulmonary arterial pressure in chronic kidney disease.
To study the association of pulmonary arterial pressure with stages of chronic kidney disease. To study the association of pulmonary arterial pressure with patients on hemodialysis.
Materials and methods
This study was conducted as a single-center cross-sectional observational study at Krishna Institute of Medical Sciences, Karad, Maharashtra.
Study population
All patients who attended the OPD and IPD of Krishna Hospital, Karad, diagnosed with chronic kidney disease, were studied.
Study duration
The investigation was carried out from 22nd September 2022 to 24th March 2024.
Results: Prevalence across CKD stages: PAH prevalence was notably higher in advanced CKD stages (IV and V) compared to earlier stages (III). Stage V CKD showed the highest incidence of PAH (72.58%), followed by Stage IV (12.00%) and Stage III (4.00%). This association was statistically significant ($p < 0.0001$), emphasizing the link between PAH and CKD progression.
Association with hemodialysis duration: The study observed a trend towards increased PAH prevalence with longer durations of hemodialysis. Patients undergoing hemodialysis for over 12 months exhibited a higher incidence of PAH (50.0%) compared to those with shorter durations (< 6 months and 6-12

months), indicating a potential influence of hemodialysis on PAH development in CKD patients.

Correlations with clinical and laboratory parameters: PAH was associated with higher systolic and diastolic blood pressures, lower estimated glomerular filtration rate (eGFR), elevated blood urea nitrogen (BUN), serum phosphorus, creatinine, and calcium levels. These parameters highlight the clinical relevance of monitoring cardiovascular and renal markers in PAH management among CKD patients.
Age and comorbidity associations: Advanced age (> 60 years) was significantly associated with higher PAH prevalence, underscoring age as a risk factor for PAH development in CKD. However, no significant correlations were found between PAH and common comorbidities like diabetes mellitus (DM) and hypertension (HTN) in this cohort.
Study limitations and implications: The study acknowledges limitations such as its cross-sectional design and the need for larger, longitudinal studies to validate findings. Nevertheless, the results provide critical insights into PAH prevalence patterns and its clinical correlates in CKD patients, emphasizing the importance of early detection and tailored management strategies.
Conclusion : This study contributes to understanding the complex interplay between CKD and PAH, highlighting the need for comprehensive cardiovascular assessments in CKD management protocols. Further research is warranted to elucidate the mechanistic links and optimal therapeutic approaches for mitigating PAH's impact on CKD progression and patient outcomes.
Categories: Cardiology, Internal Medicine, Nephrology
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Introduction

Pulmonary hypertension, defined by a mean pulmonary artery pressure of 25 mm Hg or higher during cardiac catheterization, originated from a 1973 World Health Organization (WHO) meeting following an epidemic linked to aminorex fumarate use. According to the WHO classification, idiopathic pulmonary arterial hypertension is initially termed primary pulmonary hypertension; subsequently, this term is modified to pulmonary artery vasculopathy.
The following are the subsequent classification demonstrated by WHO:Group 1: Pulmonary arterial hypertension (PAH), including idiopathic cases or those associated with conditions like systemic sclerosis and congenital heart disease. Group 2: Pulmonary hypertension due to left heart disease (PH-LHD)Group 3: Pulmonary hypertension due to lung disease or hypoxia (PH-Lung), or a combination Group 4: Chronic thromboembolic pulmonary hypertension (CTEPH)Group 5: Unclear or multifactorial mechanisms [1]
PH frequently coexists with chronic kidney disease (CKD) and end-stage renal disease, with its presence associated with an increased risk of hospitalization and mortality in CKD patients. [2] CKD is a condition marked by persistent alterations in kidney function and structure, exhibits an irreversible and gradual progression, leading to heightened susceptibility to complications and increased mortality, particularly cardiovascular-related issues. In this era, CKD prevails at 13% prevalence, significantly elevating the risk of cardiovascular complications, kidney failure, and associated issues. [3] End-stage kidney disease (ESKD) further amplifies mortality risks, cardiovascular ailments, and the need for specialized healthcare. Notably, long-term hemodialysis in ESKD patients is linked to the occurrence of pulmonary hypertension, with estimated prevalence rates ranging from 17% to 56% based on echocardiographic (ECG) studies. [4]

Pulmonary hypertension can induce elevated levels of cytokines and growth factors, such as fibroblast growth factor (FGF), platelet-derived growth factor (PDGF), activin-mediated transforming growth factor (TGF-β) and activating pulmonary angiotensin-converting enzyme (ACE). This activation leads to abnormal smooth muscle cell proliferation and fibrosis. Concurrently, endothelial dysfunction, decreased nitric oxide synthase (NOS) activation, increased serum endothelin, and heightened fibrin storage contribute to extensive growth of endothelial cells, potentially resulting in the complete obliteration of pulmonary vessels.

PH in individuals with CKD may be intensified by left ventricular disorders and CKD-related risk factors. These factors encompass volume overload, arteriovenous fistula, sleep-disordered breathing and exposure to dialysis membranes, endothelial dysfunction, vascular calcification, and severe anemia. This comprehensive understanding of the interplay between CKD, PH, and associated risk factors underscores the complexity and clinical significance of these conditions in the continuum of health.

In the last two decades, an increasing amount of evidence has emerged, pointing to the higher prevalence of mild to moderate forms of PH. These conditions often go unnoticed due to the extended preclinical asymptomatic phase of the disease. Typically, pulmonary hypertension is only considered when clinical signs such as worsening fatigue, dyspnea, and syncope indicative of right ventricular dysfunction become apparent. There is an increasing acknowledgment that, pulmonary hypertension can affect individuals with CKD beyond those with connective tissue and systemic diseases. Furthermore, it is now understood that, the decline in kidney function itself may serve as a catalyst for the development of this condition.

In this era, determining the precise prevalence of PH in individuals with CKD poses a challenge due to the limited availability of epidemiological data on this condition in CKD patients. The existing information heavily relies on retrospective data and small-scale studies with methodological limitations. Although, international experts recommend diagnosing pulmonary hypertension through right-sided cardiac catheterization, specifically defining it as the presence of a mean pulmonary artery pressure (mPAP) ≥25 mm Hg, only a single study has employed invasive methods to measure pulmonary artery systolic pressure (PASP) in CKD patients.

In the majority of studies involving CKD patients, pulmonary artery pressure has been estimated using Doppler-derived PASP. However, there is a lack of uniformity in the diagnostic criteria applied, with various cutoff values for PASP ranging from 25 to ≥45 mm Hg.

Previous study indicate that, individuals with stage 5 CKD, among them prevalence of PH varied between 9% and 39%. For hemodialysis patients, the reported range was 18.8% to 68.8%, while for patients undergoing peritoneal dialysis therapy, the prevalence ranged from 0% to 42%. However, few epidemiologic data are available for earlier stages of CKD.

Limited research has been conducted on pulmonary arterial hypertension in individuals with chronic kidney disease. Given the intricate correlation of renal and cardiac functions, the assessment of pulmonary hypertension assumes critical importance in individuals afflicted with chronic kidney disease. This evaluation is pivotal as it has the potential to augment the prognostic outlook for these patients. Therefore, the aim of this study was to evaluate pulmonary hypertension in a patient diagnosed with chronic kidney disease.

Materials And Methods

Study design

This study was conducted as a single-center cross-sectional observational study at Krishna Institute of Medical Sciences, Karad, Maharashtra.

Study population

All patients who attended the OPD and IPD of Krishna Hospital, Karad, diagnosed with chronic kidney disease, were studied.

Study duration

The study was conducted from September 2022 to March 2024. Inclusion criteria

Patients with all the following were included:
All CKD stages 2 and above (as per K-DOQI guidelines): (eGFR was calculated using the MDRD formula) (eGFR was calculated using the MDRD formula) {eGFR = 175 x (S Cr.)-1.154 x (age)-0.203 x 0.742 [if female]}.
Age group: >18 years and <65 years of age. Exclusion criteria
All pregnant females.
All known cases of pulmonary hypertension secondary to left-sided heart diseases (e.g., coronary heart diseases [ruled out by normal ECG along with absence of regional hypokinetic segment and ejection fraction of >55% on two-dimensional (2D) ECHO], rheumatic heart diseases, and valvular heart diseases).
Systemic disorders that can cause pulmonary hypertension, such as collagen vascular diseases and HIV infection.
Pulmonary diseases (e.g., COPD, pulmonary embolism, and scleroderma). Sample size
Sample size = n = 100.
Sample
100 patients who attended the OPD and IPD of Krishna Institute of Medical Sciences, Karad, diagnosed with chronic kidney disease, were studied. These 100 patients were subjected to detailed history and thorough clinical examination, and the following investigations were done:
Serum Creatinine Blood Urea Serum Calcium
Serum Phosphorus 2D Echocardiography

Results

Association of Incidence of Pulmonary Arterial Hypertension in various CKD stages

Stage of CKD	**Total CKD N=100**	**PAH absent (%)**	**PAH present (%)**	**Chi-square**	**p-Value**
		N=38	N=62		
III	28 (28.00%)	22(22.00%)	4(4.00%)		
IV	22 (22.00%)	12(12.00%)	12(12.00%)	41.63	< 0.0001
V	50 (50.00%)	5 (12.82%)	45 (72.58%)		

TABLE 1: Association of Incidence of Pulmonary Arterial Hypertension in various CKD stages

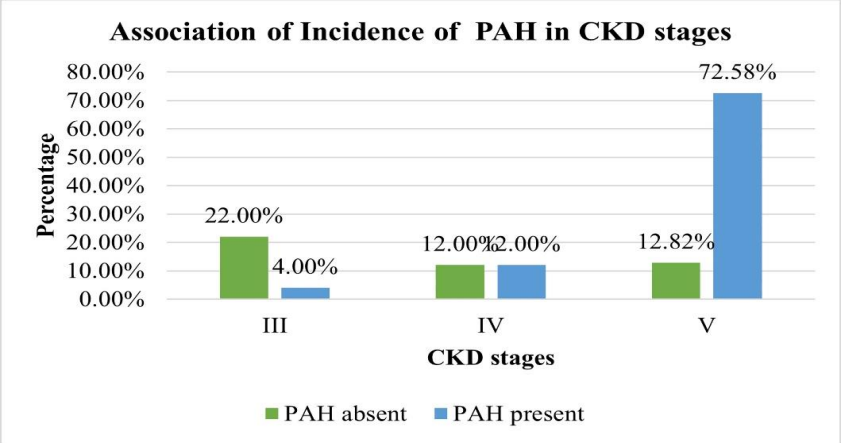

FIGURE 1: Association of Incidence of PAH in CKD Stages

PAH (mmHg)	CKD duration			Chi-square	p-Value
	< 6 months (%)	6-12 months (%)	>12 months (%)		
<35 mmHg	3 (60.0)	14 (423.75%)	7 (29.17)		
35-50 mmHg	2 (40.0)	15 (46.88%)	11(45.83)		
>50 mmHg	0 (0.0)	3 (9.38%)	6 (25.0)	4.44	0.34
Total	5 (100.0)	32(100.0)	24 (100.0)		

TABLE 2: Association of CKD duration and Severity of Pulmonary Arterial Hypertension

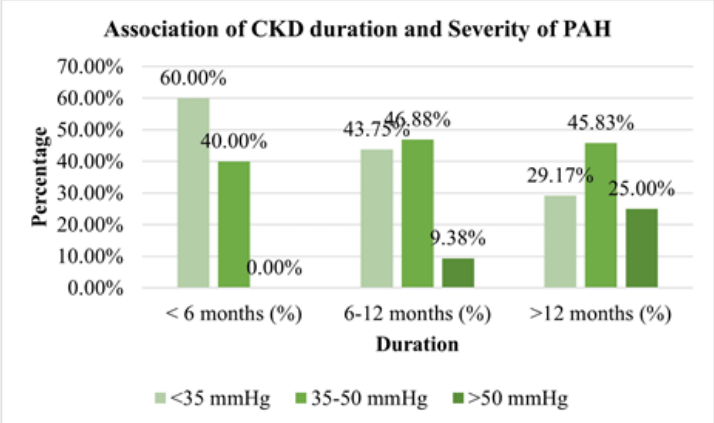

FIGURE 2: Association of CKD duration and Severity of Pulmonary Arterial Hypertension

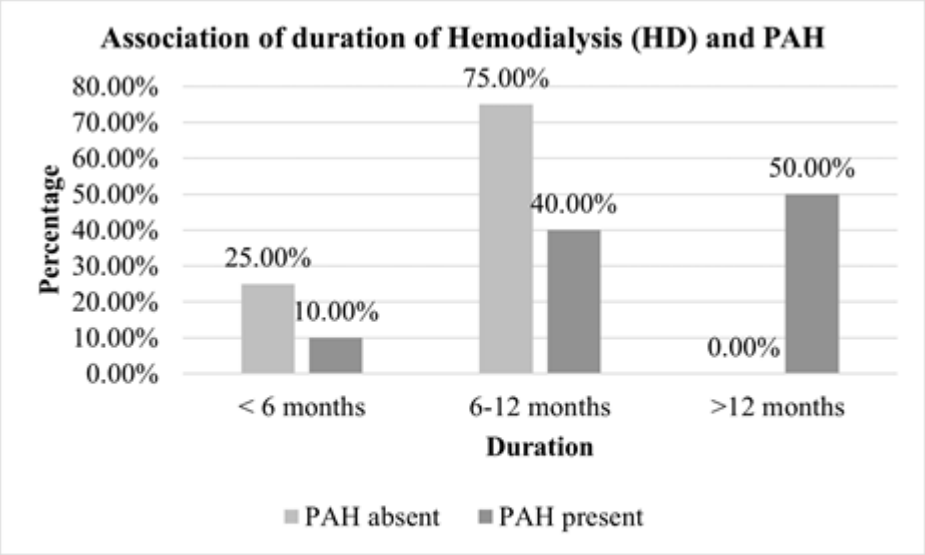

FIGURE 3: Association of Duration of Hemodialysis (HD) and Pulmonary Arterial Hypertension in CKD patients

HD duration	Total (N=100)	PAH absent (%) N=38	PAH present (%) N=62	Chi-square	p-value
< 6 months	5 (11.36)	1 (25.0)	4 (10.0)	3.75	0.15
6-12 months	19 (43.18)	3 (75.0)	16 (40.0)		
>12 months	20 (45.45)	0 (0.0)	20(50.0)		
Total	44 (100.0)	4 (100.0)	40 (100.0)		

TABLE 3: Association of Duration of Hemodialysis (HD) and Pulmonary Arterial Hypertension in CKD patients

Age group	Total (%)	PAH absent (%) N=38	PAH present (%) N=62	Chi-square	p-Value
Age		58.6±10.8	63.2±9.1		<0.001
< 41 years	10 (10.00%)	3(7.89%)	7 (11.29)		
41-50 years	26 (26.00%)	12(31.57%)	13 (20.97)		
51-60 Years	34(34.00 %)	20 (52.63%)	14 (22.58)	19.83	0.0002
> 60 years	30 (30.00%)	2 (5.26%)	28(45.16)		
Total	100 (100.0)	38 (100.0)	62 (100.0)		

TABLE 4: Association of Age wise distribution of PAH in CKD patients

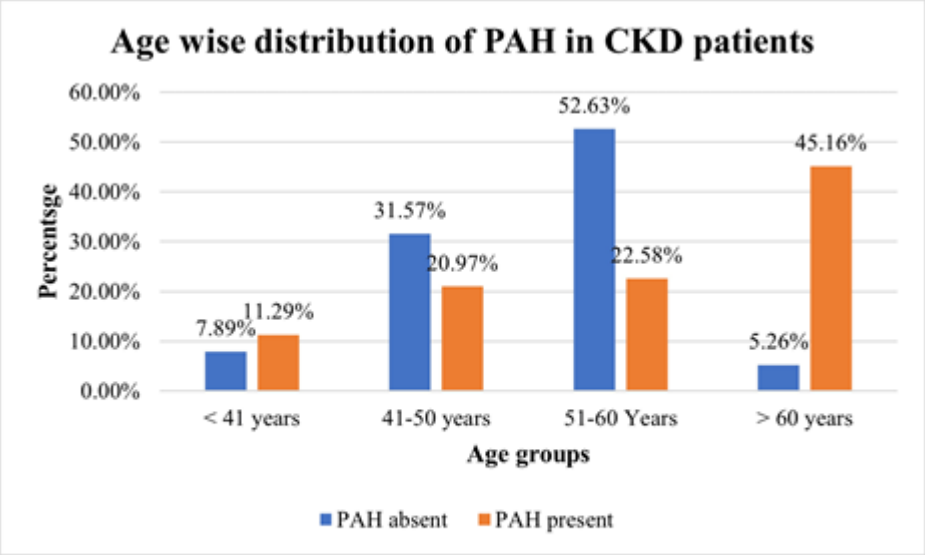

FIGURE 4: Association of Age wise distribution of PAH in CKD patients

Co-morbidities	PAH absent (%) N=38	PAH present (%) N=62	Chi-square	p-Value
Diabetes Mellitus (DM)	8(26.67%)	22 (73.33%)	0.37	0.53
Hypertension (HTN)	6 (35.29%)	11(64.71%)		

TABLE 5: Association of Pulmonary Arterial Hypertension (PAH) and comorbidities of CKD

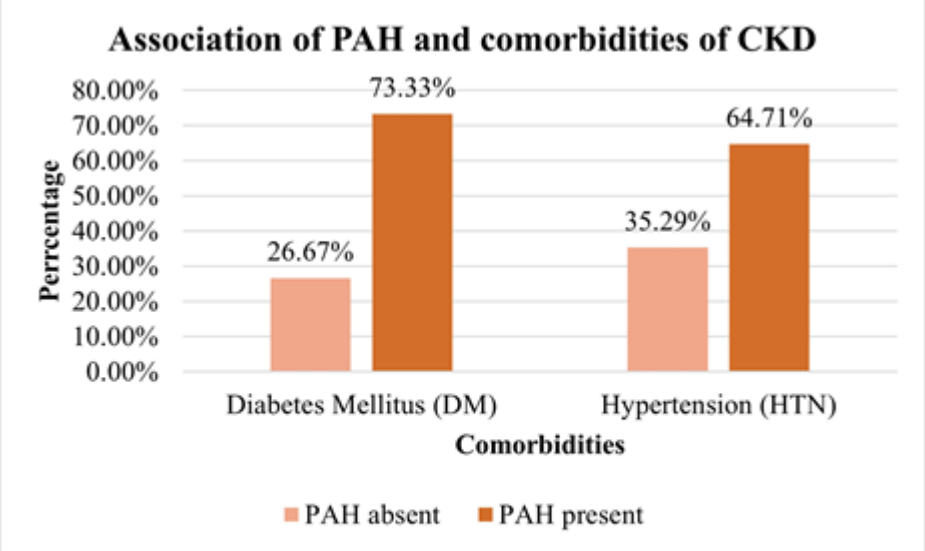

FIGURE 5: Association of Pulmonary Arterial Hypertension (PAH) and comorbidities of CKD

Clinical parameters	PAH Absent N=38	PAH Present N=62	p-Value
Systolic BP (mmHg)	128.7±21.01	141.6±22.30	0.004
Diastolic BP (mmHg)	81.6±19.71	89.21±11.58	0.017

Laboratory parameters			
e-GFR (ml/min per 1.73 m2)	48.78±17.41	38.77±15.22	0.003
BUN	30.02±15.24	36.76 ±7.49	0.007
Serum Phosphorus	3.68 ±1.69	3.87±0.20	0.036
Serum Creatinine	4.96±3.90	6.75±4.00	0.028
Serum Calcium	9.00±0.69	8.50±0.70	0.001
Serum Albumin	3.81±0.47	3.62±0.54	0.074

TABLE 6: Association of Clinical parameters & Laboratory parameters

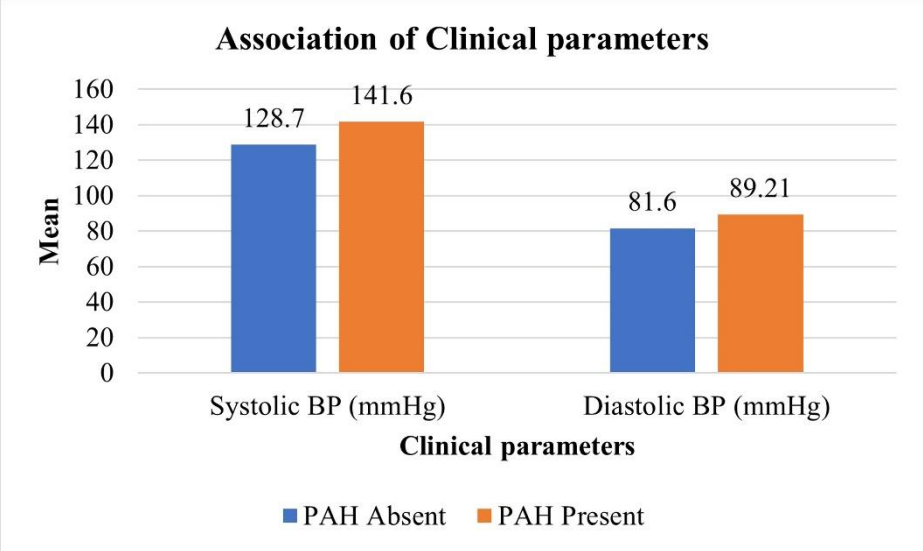

FIGURE 6: Association of clinical parameters

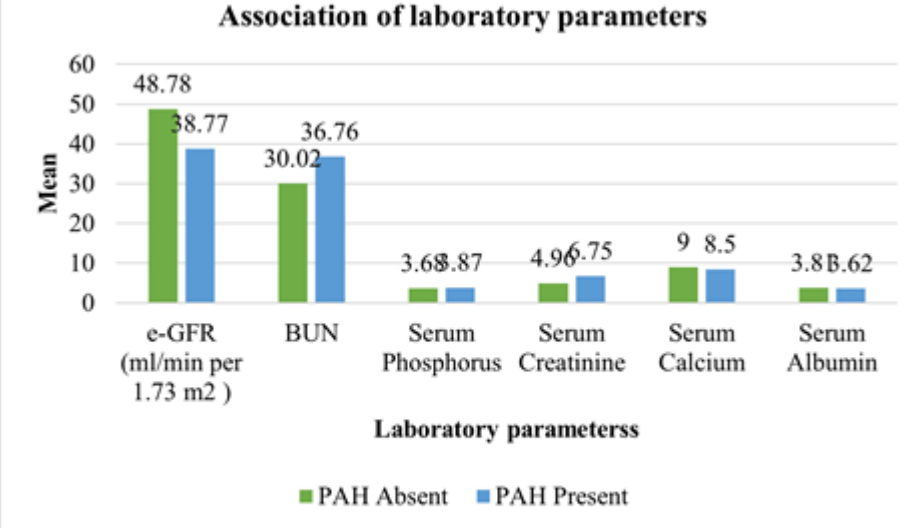

FIGURE 7: Association of laboratory parameters

Variables	Pearson correlation	p-Value
CKD duration (months)	0.28	0.001
Dialysis duration (months)	0.4	0
BUN	0.33	0
Serum creatinine	0.41	0
Serum Calcium	0.4	0
Systolic BP 0.43 0		

TABLE 7: Correlation between Pulmonary Arterial Hypertension and other dependent variables

There was a moderate correlation between PAH and CKD duration ($r = 0.28$, $p = 0.001$), and a strong correlation with dialysis duration ($r = 0.4$, $p < 0.001$). Additionally, PAH correlated moderately with blood urea nitrogen (BUN) levels ($r = 0.33$, $p < 0.001$), and strongly with serum creatinine ($r = 0.41$, $p < 0.001$), serum calcium ($r = 0.4$, $p < 0.001$), and systolic blood pressure ($r = 0.43$, $p < 0.001$).

Discussion

Pulmonary hypertension PH is a condition characterized by elevated blood pressure within the pulmonary arteries, which may cause heart failure on the right side, and other serious cardiovascular complications. In patients with CKD, the prevalence and implications of PH are particularly concerning due to the multifactorial pathophysiology involving fluid overload, arteriovenous fistulas, and endothelial dysfunction.

Chronic kidney disease, a progressive loss of kidney function, is divided into several phases according to the glomerular filtration rate (GFR). As CKD advances, the cardiovascular burden on patients rises, increasing their vulnerability to developing pulmonary hypertension. The purpose of this study is to ascertain how common

Understanding the frequency of PH in CKD patients is vital for early diagnosis and management This might enhance the results of patients .Additionally, examining the association between PH and the stages of CKD can help in identifying at-risk populations and tailoring specific interventions. Since hemodialysis is a common treatment modality for end-stage renal disease, assessing its impact on the development of PH will offer insightful information about the management and the avoidance of this complication in dialysis patients. The Table 1 presents the association between the incidence of pulmonary arterial hypertension (PAH) and various stages of CKD in the study population of 100 patients:

Stage III CKD: Out of 28 patients in this stage, 22% did not have PAH, while 4% did have PAH. The chi-square value was 41.63, indicating a highly significant association ($p < 0.0001$). Stage IV CKD: Among 22 patients, 12% did not have PAH, and 12% did have PAH. Stage V CKD: Of the 50 patients, 12.82% did not have PAH, while 72.58% did have PAH.

These results highlight a significant association between the severity of CKD stages and the presence of PAH, with higher CKD stages (IV and V) showing a notably higher incidence of PAH compared to lower stages (III).It seems like you're providing information about a study by Bolignano et al. was more common (PH) in patients undergoing different types of dialysis. Here's a corrected version of your statement:"Bolignano et al.[5] observed that the prevalence of pulmonary hypertension (PH) differs between patients undergoing peritoneal dialysis (PD) and hemodialysis (HD). They found that PH is less prevalent in PD-treated patients (0%-42%) compared to those undergoing HD (18.8%-68.8%)."

Wang L et al. [6] analyzed the distribution of pulmonary hypertension (PH) severity and chronic kidney disease (CKD) stages. They found no significant differences between mild

versus moderate PH and mild versus severe PH. However, compared to severe PH, the moderate PH group had a higher number of patients with CKD Stage 5 (p = 0.014).

The study by Reque et al. [7] underscores a significant prevalence of pulmonary hypertension (PH) among individuals suffering with long-term renal illness.PH among CKD patients, investigate its association with the different stages of CKD, and explore the relationship between PH and patients undergoing hemodialysis. [8]

(CKD), particularly in advanced CKD stages. PH was found to affect a a significant percentage of CKD patients, with greater frequencies seen in Stage 5 compared to earlier stages. While mean systolic pressure in the pulmonary arteries (PASP) did not vary significantly across CKD stages, there was a notable decline in the anticipated rate of glomerular filtration (eGFR) as CKD severity increased. These findings emphasize the requirement for targeted screening and management strategies for PH in CKD patients, aiming to mitigate its impact on disease progression and clinical outcomes.

In Table-2 the relationship between the duration of CKD and the severity of PAH is illustrated. The severity of PAH is categorized by mmHg among 61 study participants. Among patients with PAH severity less than 35 mmHg, 60.0% had CKD duration of less than 6 months, 43.75% had CKD duration of 6-12 months, and 29.17% had CKD duration exceeding 12 months. The chi-square value was 4.44 with a non-significant p- value of 0.34, indicating no statistically significant correlation between CKD duration and PAH severity in this category. For PAH severity between 35-50 mmHg, 40.0% had CKD duration of less than 6 months, 46.88% had CKD duration of 6-12 months, and 45.83% had CKD duration exceeding 12 months. No patients with PAH severity greater than 50 mmHg had CKD duration less than 6 months, 9.38% had CKD duration of 6-12 months, and 25.0% had CKD duration exceeding 12 months, indicating a potential trend towards higher PAH severity with longer CKD duration.

In their study, Suresh H et al. [9] noted that, out of 108 patients, 57 were receiving thrice-weekly HD, among whom 24 (42.1%) were diagnosed with PHO'Leary JM et al. [10] investigated the distribution of chronic disease of kidney(CKD) stages in their study population. Among the total participants, CKD stage III was observed in 510 individuals, constituting 84% of that stage's group, and CKD stage IV was found in 60 individuals, accounting for 10%. The study noted that The distribution of CKD stages was not statistically significant (P = 0.052), with 1008 participants in Chronic disease of kidney stage III and 170 in Chronic disease of kidney stage IV. This distribution highlights the prevalence of earlier CKD stages in their cohort.

The Table 3 presents data on hemodialysis duration and its correlation Given the widespread PAH among 100 CKD patients in the study. Of the patients undergoing HD for a period shorter than six months (5 patients), 25.0% did not have PAH, while 10.0% did. For those undergoing HD for 6-12 months (19 patients), 75.0% were without PAH, compared to 40.0% who had PAH. Among those with HD duration exceeding 12 months (20 patients), none were free of PAH, with 50.0% diagnosed with the condition. These findings suggest a trend towards a higher prevalence of PAH with longer durations of HD treatment, indicating a potential association between prolonged HD therapy and the development of PAH in CKD patients. On the other hand, 51 patients undergoing twice-weekly HD had 23 (45%) cases of PH. The study found no statistically significant difference in the prevalence of PH between these two groups (P = 0.85). This suggests that the frequency of HD weekly sessions did not significantly impact the occurrence of PH in their cohort of CKD patients Emara et al. [11] (p < 0.001) and Patel et al. [12] (P = 0.001) also found a similar association.

The distribution of PAH among CKD patients shows notable age-related patterns, as depicted in Table-2. Among those who are younger than 41 years, 7.89% were diagnosed with PAH, compared to 31.57% in the 41- 50 age group, 52.63% in the 51-60 age group, and a striking 45.16% in those over 60 years old. These proportions highlight a significant increase in PAH

frequency rising with age among CKD patients. The chi- square test underscored the statistical significance of these associations across age categories ($\chi^2 = 19.83$, $p = 0.0002$), emphasizing that older age is a notable risk element for the emergence of PAH in CKD populations. These findings suggest the importance of age-specific monitoring and management strategies to address PAH risk in CKD patients, particularly as they advance in age. (Table 4)

The Table 5 investigates the correlation between two prevalent co morbidities, DM and HTN, and the occurrence of PAH among 100 CKD patients. Among those with DM, 26.67% of patients without PAH and 73.33% of those with PAH were observed. Similarly, for HTN, 35.29% of patients without PAH and 64.71% with PAH were identified. The chi-square test yielded a value of 0.37 with a p-value of 0.53, indicating there isn't a statistically meaningful correlation between co morbidities and PAH in this cohort

The Table 6 presents significant associations between clinical and laboratory parameters and the presence of PAH in 100 CKD patients. Patients with PAH exhibited higher systolic (141.6 ± 22.30 mmHg) and diastolic blood pressures (89.21 ± 11.58 mmHg) compared to those without PAH (systolic: 128.7 ± 21.01 mmHg; diastolic: 81.6 ± 19.71 mmHg), with p-values of 0.004 and 0.017, respectively. Additionally, PAH patients had lower e-GFR (38.77 ± 15.22 ml/min per 1.73 m^2) and higher levels of BUN, serum phosphorus, creatinine, and calcium compared to non-PAH patients, highlighting these parameters' relevance in PAH management in CKD. Levels of serum albumin did not show a statistically meaningful distinction between the two cohorts.

The Table 7 illustrates the correlation between PAH and various dependent variables among CKD) patients. There were notable positive associations discovered between PAH and several factors: CKD duration ($r = 0.28$, $p = 0.001$), dialysis duration ($r = 0.4$, $p = 0$), BUN, $r = 0.33$, $p = 0$), serum creatinine ($r = 0.41$, $p = 0$), serum calcium ($r = 0.4$, $p = 0$), and systolic blood pressure (BP, $r = 0.43$, $p = 0$). These findings indicate that as these variables increase, there is a corresponding increase in the likelihood or severity of PAH among CKD patients. Such correlations underscore the importance of monitoring these parameters closely in the clinical management of CKD patients at risk for or diagnosed with PAH. Lower diastolic blood pressure (DBP) was discovered to be connected to PH in a study by Kumbar et al. [13].

In their study, Reque et al. examined the relationship between pulmonary hypertension (PH) and clinical parameters in patients with chronic disease of kidney(CKD). They discovered that PH patients had a notably lower the anticipated rate of glomerular filtration (GFR) compared to those without PH (18.9 ± 8.1 vs. 21.3 ± 8.8 mL/min/1.73 m^2, $p = 0.04$). But there were no noteworthy differences in systolic blood pressure (141 ± 19 vs. 142 ± 18 mm Hg, $p = 0.4$) or diastolic blood pressure (82 ± 16 vs. 83 ± 17 mm Hg, $p = 0.4$) between the two groups. These findings underscore the potential impact of PH on renal function in CKD patients, suggesting the need for close monitoring and tailored management strategies to mitigate adverse outcomes associated with both conditions.

Pulmonary hypertension (PH) is prevalent among chronic disease of kidney (CKD) patients due to factors like fluid overload and endothelial dysfunction. This study aimed to determine PH prevalence across CKD stages and its association with hemodialysis. Of 100 participants, 70% were male. Most were aged 51-60 years.

Diabetes mellitus (DM) and hypertension (HTN) were leading CKD causes. Stage V CKD was most common (73%). PH prevalence was 62%, higher in advanced CKD stages. Longer CKD and hemodialysis durations correlated with higher PH incidence. DM, HTN, and advanced years were linked to higher PH risk. Key lab findings included elevated systolic BP and serum creatinine in PH patients.

Conclusions

From the results of this study, it was concluded that, the study highlights several significant findings related to the frequency and contributing variables of PAH in CKD patients. The majority of the study population was male (70%), and a strong association between male sex and CKD was observed. Age distribution showed that the largest proportion of patients were between 51-60 years old (34%). Diabetes Mellitus (35%) and Hypertension (28%) were identified as the leading etiologies of CKD.

A significant majority of patients (73%) were in Stage V CKD, and 62% had PAH. Higher CKD stages, particularly Stage V, showed a significantly higher prevalence of PAH, as did longer durations of CKD. Severity of PAH did not show a significant association with CKD duration, but it was prevalent in those receiving hemodialysis for longer than 12 months (50%). Older age groups and longer CKD durations were closely associated with PAH incidence.

Clinical and laboratory parameters such as blood pressure's diastolic and systolic values, e-GFR, BUN, serum creatinine, and serum calcium levels were significantly distinct between individuals who have and don't PAH. There were found to be moderate to strong relationships between PAH and CKD duration, dialysis duration, BUN, serum creatinine, serum calcium, and systolic blood pressure, underscoring the multifaceted nature of PAH in CKD patients.

Additional Information

Disclosures

Human subjects: Consent for treatment and open access publication was obtained or waived by all participants in this study. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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