

EXCESS RIGHT ATRIAL CONGESTION AND PULMONARY CIRCULATION LOADING OVER THE LONG INTERDIALYTIC INTERVAL IN PATIENTS RECEIVING THRICE-WEEKLY HEMODIALYSIS

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Introduction: Among hemodialysis patients, pulmonary hypertension is a strong and independent predictor of all-cause and cardiovascular mortality [1-3]. It remains unclear whether volume accumulation over the interdialytic period acutely influences right ventricular (RV) sizing and function [1-3]. Accordingly, this study investigated the changes RV function during the 2-day and 3-day interdialytic intervals.

Materials and Methods: Forty-one stable end-stage-renal-disease patients receiving thrice-weekly hemodialysis for at least 3 months underwent 2-dimensional echocardiographic and tissue-Doppler imaging evaluation with a standard cardiac ultrasound device (Vivid 7, GE, Horten, Norway) at start and end of the 3-day and 2-day interdialytic intervals. Participants were randomly assigned into two cross-over sequences of recordings; 3-day followed by 2-day interval or vice versa.

Results: The baseline demographic characteristics and routine predialysis biochemical parameters of study participants are presented in Table (1). Study participants had a mean age of 58.7±14.7 years and were receiving hemodialysis for a mean time-period of 57.8±57.2 months. As shown in Table 2, Inferior-vena-diameter (IVCD), a marker reflecting intravascular volume among patients on dialysis [4], increased during both interdialytic intervals. It was rather expectable that IVCD increase (0.54±0.3 vs 0.25±0.2) was higher during the 3-day versus the 2-day interval (P<0.001). RV systolic function assessed by SM RV and tei index of myocardial performance was stable during both intervals. Significant elevations in right atrial (RA) volume index, RV end-diastolic diameter, E/Em RV, tricuspid regurgitation maximum velocity (TRVmax) and tricuspid regurgitation peak gradient (PGr TRV) were noted during both 3-day and 2-day interdialytic periods. Increase in RV systolic pressure (RVSP) was also evident in both intervals (3-day: 29.3±12.5 vs 44.6±16.3 mmHg, P<0.001; 2-day: 33.1±12.4 vs 37.9±13.7 mmHg, P<0.01). Interdialytic increase in RVSP, TRVmax and PGr TRV was more prominent during the 3-day compared with the 2-day interdialytic interval (Table 3). In order to identify possible factors associated with the interdialytic increase in RV loading, we have performed a univariate and multivariate linear regression analysis with change in RVSP being the dependent variable. As shown in Table 4, in multivariate analysis IDWG (β=1.645; 95% CI= 0.332 - 2.958), E/Em RV change (β=1.142, 95% CI= 0.293 - 1.990), and PVR change (β=7.034, 95% CI = 1.766 - 12.303) were shown to be independently associated with changes in RVSP, whereas changes BP, HR and Sm RV changes were not.

Conclusion: Excess fluid accumulation results in higher RA congestion and pulmonary circulation loading, providing one plausible pathway for the excess cardiovascular risk associated with the long interdialytic interval in thrice-weekly hemodialysis.

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Table 1: Baseline characteristics and routine predialysis biochemical parameters of study participants.

Characteristic	Value
N	41
Age (years)	58.7±14.7
Male, n (%)	24 (59%)
Height (m)	1.65±0.1
BMI (kg/m ²)	25.2±4.8
Duration of dialysis (months)	57.8±57.2
Hemoglobin (g/dl)	12.7±4.4
Hematocrit (%)	36.5±3.3
Serum glucose (mg/dl)	98.5±36.3
Serum urea (mg/dl)	141.7±31.8
Serum creatinine (mg/dl)	8.3±3.0
Total protein (g/dl)	7.4±0.8
Serum albumin (g/dl)	4.3±0.4
Serum calcium (mg/dl)	9.0±0.8
Serum phosphate (mg/dl)	4.7±1.1

Table 2: Echocardiographic indices of RV function and pressure during the 3-day and 2-day interdialytic intervals.

Parameter	3-day Interdialytic Interval			2-day Interdialytic Interval		
	Visit 1 (post-HD, 3-day start)	Visit 2 (pre-HD, 3-day end)	P Value	Visit 3 (post-HD, 2-day start)	Visit 4 (pre-HD, 2-day end)	P Value
Sm RV (m/sec)	0.14±0.04	0.15±0.04	0.4	0.15±0.04	0.14±0.03	0.2
E/Em RV	7.0±2.3	8.5±3.3	<0.001	7.1±2.6	8.0±2.3	0.05
TRV max (m/sec)	2.41±0.5	2.87±0.5	<0.001	2.54±0.5	2.68±0.5	0.009
PGr TRV (mmHg)	24.1±10.9	33.5±12.7	<0.001	26.8±12.4	29.7±12.9	0.008
RVSP (mmHg)	29.3±12.5	44.6±16.3	<0.001	33.1±12.4	37.9±13.7	<0.001
IVC diameter (cm)	1.40±0.4	1.93±0.4	<0.001	1.54±0.4	1.79±0.4	<0.001
RVEDD (cm)	3.2±0.8	3.6±0.9	<0.001	3.1±0.8	3.4±0.8	<0.001
RAVi (ml/m ²)	20.9±9.6	27.3±10.6	<0.001	21.3±10.1	25.0±11.5	0.002
Tei index RV	0.56±0.2	0.52±0.20	0.2	0.59±0.20	0.50±0.13	0.5
PVR (dyn.sec.cm ⁻⁵)	1.58±0.4	1.63±0.4	0.5	1.72±1.02	1.59±0.4	0.3

Table 3: Comparison of the net changes in echocardiographic indices of RV sizing and function between the 3-day and 2-day interdialytic intervals

Parameter	3-day vs 2-day Interval		
	Net Changes 3-day interval	Net Changes 2-day interval	P value
Sm RV (m/sec)	0.006±0.042	-0.007±0.038	0.1
E/Em RV	1.6±2.2	0.9±2.7	0.2
TRV max (m/sec)	0.46±0.45	0.14±0.33	0.001
PGr TRV (mmHg)	9.4±10.2	2.9±6.6	0.001
RVSP (mmHg)	15.3±10.2	4.7±5.2	<0.001
IVC diameter (cm)	0.54±0.3	0.25±0.3	<0.001
RVEDD (cm)	0.4±0.8	0.3±0.5	0.4
RAVi (ml/m ²)	6.7±6.4	3.7±7.1	0.05
Tei index RV	-0.04±0.23	-0.09±0.18	0.3
PVR (dyn.sec.cm ⁻⁵)	-0.04±0.41	-0.02±0.35	0.5

Table 4: Univariate and multivariate linear regression analysis of parameters possibly affecting the change in RVSP during interdialytic intervals

Parameter	Univariate analysis			Multivariate analysis		
	Estimate	95% CI	P value	Estimate	95% CI	P value
IDWG	1.512	0.104 to 2.920	0.04	1.645	0.332 to 2.958	0.02
SBP change	0.171	-0.114 to 0.457	0.2			
HR change	-0.028	-0.283 to 0.227	0.8			
Sm RV change	-2.246	-55.740 to 51.248	0.9			
E/Em RV change	0.820	-0.012 to 1.653	0.05	1.142	0.293 to 1.990	0.009
PVR change	6.177	0.633 to 11.721	0.03	7.034	1.766 to 12.303	0.01

