Results

This prospective, single center study included a total of 20 patients on regular HD 3 times/week at HD unit, pediatric department, Benha university hospital and kafr shukr general hospital HD unit. The diseased patients were divided into two groups, I & II.Twenty normal persons were taken as a control.

Topography of diseased and control groups: *(Table 1& figure 1).*

The topography of both the diseased & the control groups were comparable to each other with no statistically significant difference between both groups as regard age, sex or body mass index.

For age, the mean age in the diseased group was 15.2±2.7 years (ranging from 10 to 18 years) years and was 14.6±2.9 years in control group.

The diseased group included 7 males (35%) and 13 females (65%), while the control group included 7 males (35%) and 13 females (65%)

The body mass index of the diseased group was 19.9±4.2, and in control group was 21.7±1.9.

Table (1): Topography of study and control groups

	diseased group N=20	control group N=20	p
Mean age(years)	15.2±2.7	14.6±2.9	NS
Male sex	7	7	NS
BMI	19.9±4.2	21.7±1.9	NS

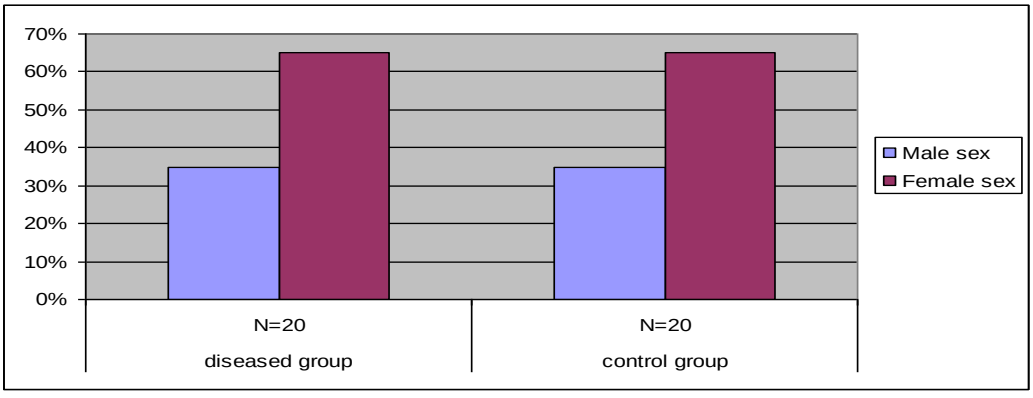


Fig (1): Sex distribution among study and control group.

Comparison between baseline clinical and echocardiographic parameters among diseased and control groups

(Table 2, Fig 2 & 3)

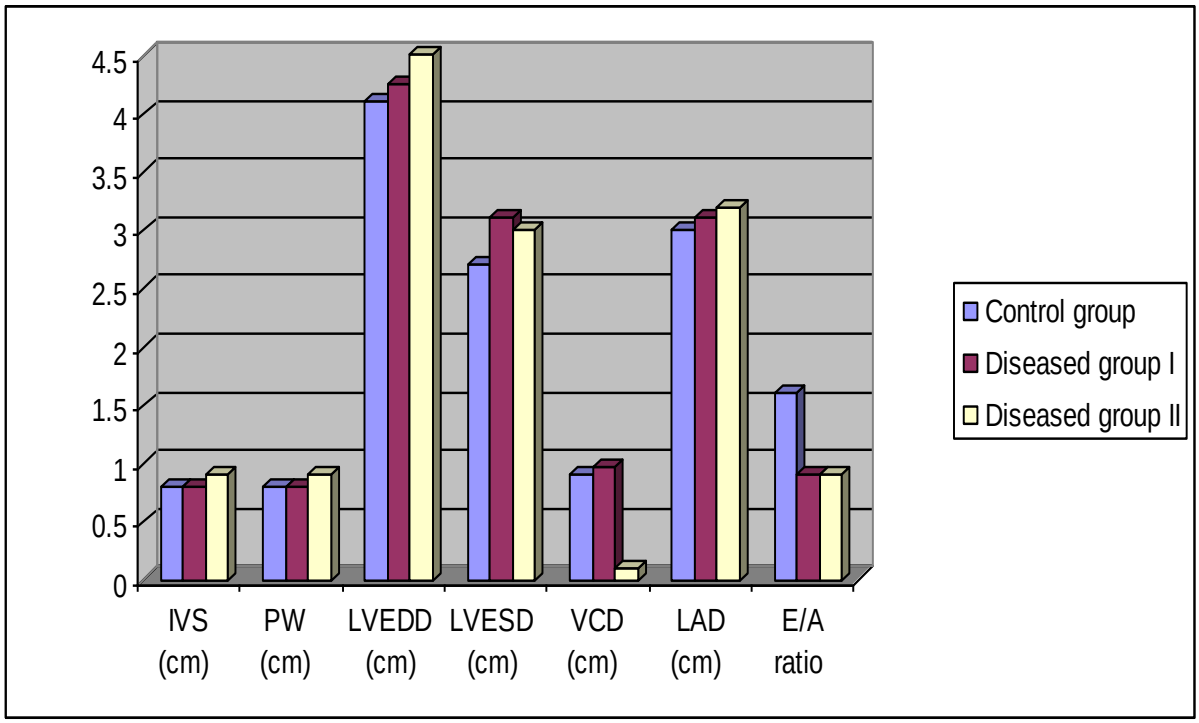
When analyzing the data comparing the control group with the diseased group, there was a significant impact of LV diastolic dysfunction and decreased LV compliance. This is detected by increased A velocity in the diseased group & decreased E/A ratio with mean value of E/A ratio(1.6±0.1) in the control group while it was low in the diseased group(0.9±0.2).

The other issue is the increased predialysis Vena cava diameter in the diseased group denoting increased blood volume in the diseased group due to fluid retention.

Table (2): Baseline clinical and Echocardiographic data among diseased & control groups

	Control group	Diseased group I	Diseased group II
IVS (cm)	0.8±0.2	0.8±0.1	0.9±0.1
PW (cm)	0.8±0.1	0.8±0.1	0.9±0.1
LVEDD (cm)	4.1±0.4	4.25±0.2	4.5±0.3
LVESD (cm)	2.7±0.3	3.1±0.3	3±0.3
EF%	58.7±5.4	60.5±6.3	58.4±9.1
VCD (mm)	9±1	9.6±1	10±1.1
LAD (cm)	3±0.3	3.1±0.3	3.2±0.2
SBP (mmHg)	97.7±12.7	116.4±15.7	104.4±41.3
HR(BPM)	83.1±5.8	83.5±9.6	85.1±7.4
E velocity(cm/sec)	73.7±7	68.7±8.9	76.4±20.3
A velocity (cm/sec)	45.8±6.7	78.7±7.7	74.4±8.1
E/A ratio	1.6±0.13	0.9±0.2	0.9±0.2
DT of E wave (ms)	198±13.5	214±12	203.1±11.6
TVI of aorta (cm)	23.2±2.1	22.3±2	24.1±3.3

IVS: inter ventricular septal thickness, **PW:** posterior wall thickness, **LVEDD:** left ventricular end diastolic dimension, **LVESD:** left ventricular end systolic dimension, **EF:** ejection fraction, **VCD:** inferior vena caval diameter, **LAD:** left atrial diameter, **SBP:** systolic blood pressure, **HR:**heart rate, **DT:** decelation time, **TVI:** time velocity integral.



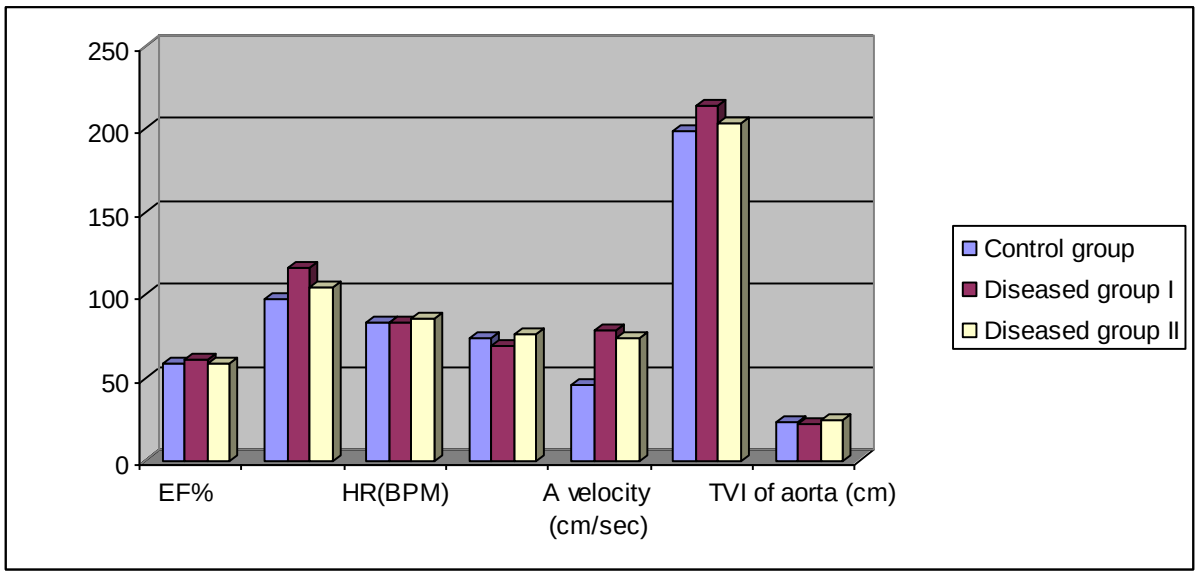


Fig (2) & (3) Baseline clinical and echocardiographic data among diseased & control groups

Clinical and haemodynamic characters of the study group

(Table 3 & figure 4 & 5)

The studied cases were divided into two groups I and II.

Group I included 11 patients while group II included 9 patients.

Group I include patients whose ultrafilteration volume was < 2 liters at the end of hemodialysis session (mean volume 0.8±0.4 Liters), while group II include patients whose ultrafilteration volume was ≥ 2 liters at the end of hemodialysis session (mean volume 2.9±0.9 Liters).

Mean age in group I was 14.9±1.9 years (ranging from 12 to 17 years), and was 15.6±3.5 years in group II (ranging from 10 to 18 years).

Group I included 10 female patients (91%) & one male patient (9%), while group II included 6 males (66%) & 3 females (33%).

As regard to body mass index, BMI was 18.8±2.8 in group I, while it was 21.1±3.9 in group II.

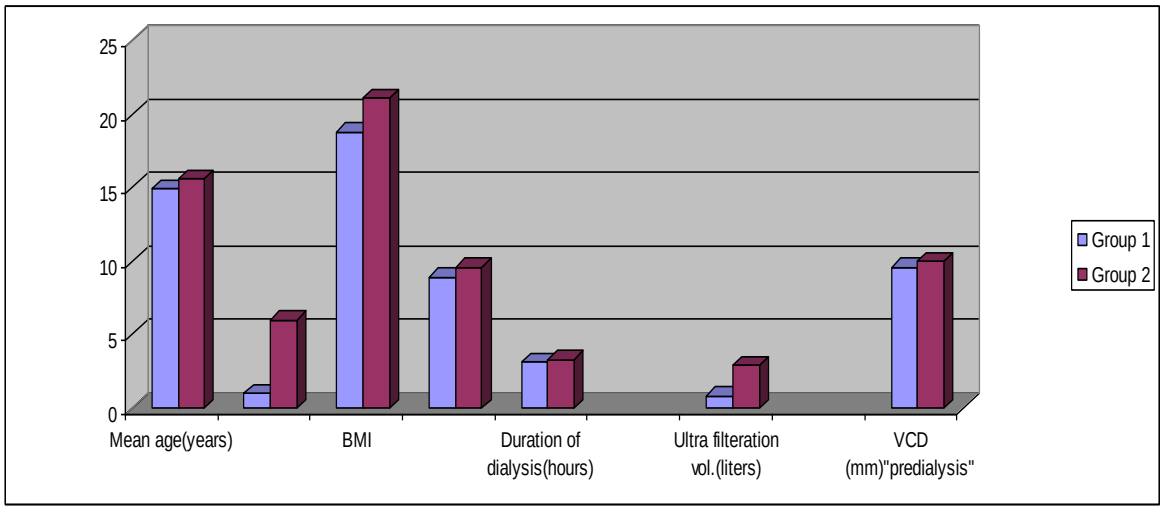
The duration of dialysis was comparable in both groups (3.1±0.2 hours in group I while it was 3.3±0.3 hours in group II).

No statistical differences between group I and II in regard to age, sex, predialysis heart rate, blood pressure, and body mass index.

The hydration status pre dialysis was similar in both groups, as assessed by predialysis measurement of inferior vena cava diameter (VCD) which was 9.6±1mm in group I & 10±1mm in group II.

Table (3): Clinical and haemodynamic characters of study group

	Group 1	Group 2	p
Mean age(years)	14.9±1.9	15.6±3.5	NS
BMI	18.8±2.8	21.1±3.9	NS
HB%	8.9±2.4	9.6±2.7	NS
Duration of dialysis(hours)	3.1±0.2	3.3±0.3	NS
Ultra filteration vol.(liters)	0.8±0.4	2.9±0.9	<0.001 S
VCD (mm)"predialysis"	9.6±1	10±1.1	NS
SBP"predialysis"(mmHg)	116.4±15.7	104.4±41.3	NS
HR"predialysis"(BPM)	83.5±9.6	85.1±7.4	NS



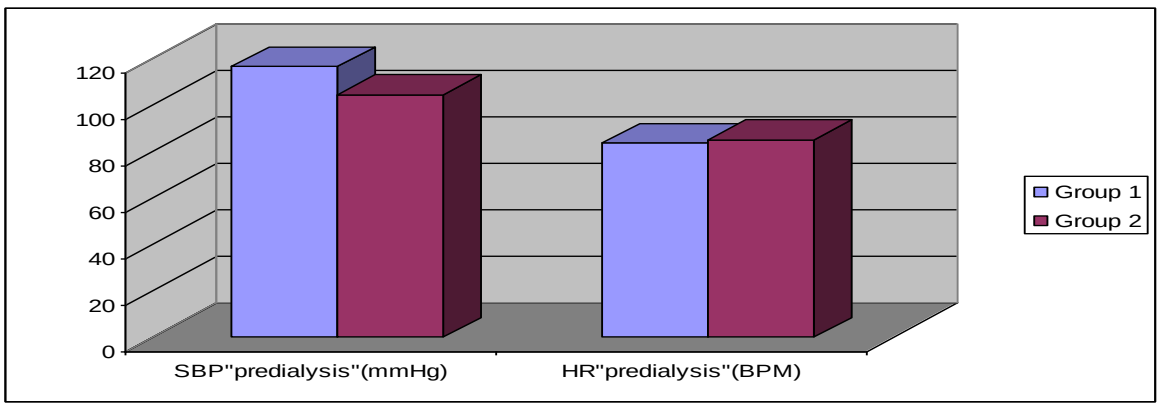


Fig (4) & (5): Clinical and haemodynamic characters of study group

Clinical and echodoppler changes of group I after dialysis:
(Table 4, 5 & figure 6, 7&8)

When analyzing group I results considering pre & post dialysis clinical and Echo Doppler data, there was no statistically significant changes occurred in patients of this group with dialysis.

There was mild reduction of systolic blood pressure after dialysis but not statistically significant (SBP was 116.4±15.7 mmHg in predialysis & 108.2±17.2 mmHg postdialysis, p.value > 0.05).

No significant changes in heart rate were noticed after hemodialysis in this group of patients. (HR was 83.5±9.6 BPM predialysis & 82.3±9.04 BPM postdialysis, p.value > 0.05).

Comparing m-mode Echo parameters, there was no statistically significant difference between pre & post dialysis mean values as regarding septal wall thickness (IVS) (pre was 0.8±0.1 cm, while post dialysis was 0.8±0.09 cm, p.value>0.05), posterior wall thickness (PW) (predialysis it was 0.8±0.09 cm while post dialysis value was 0.8±0.1cm) and LVESD (predialysis was 3.13±0.3 cm, while post dialysis it was 3.1±0.3 cm, p. value >0.05). There was a mild decrease in LVEDD post dialysis but this decrease was mild and not statistically significant (4.25±0.2 cm before & 4.23±0.2 cm after dialysis, with p.value>0.05).

As regard pre and post dialysis pulsed Doppler indices in group I, there was mild decrease in E velocity & A velocity but both were not statistically significant with mild decrease of E/A ratio (Predialysis values for E velocity pre was 68.7±8.9 cm/sec, while post dialysis was 64.5± 10.2 cm/sec, A velocity was 78.7± 7.7 cm/sec , 77.1± 7.3 cm/sec pre and post dialysis respectively, E/A ratio was 0.95± 0.2 pre &0.8±0.1 after dialysis with p value >0.05).

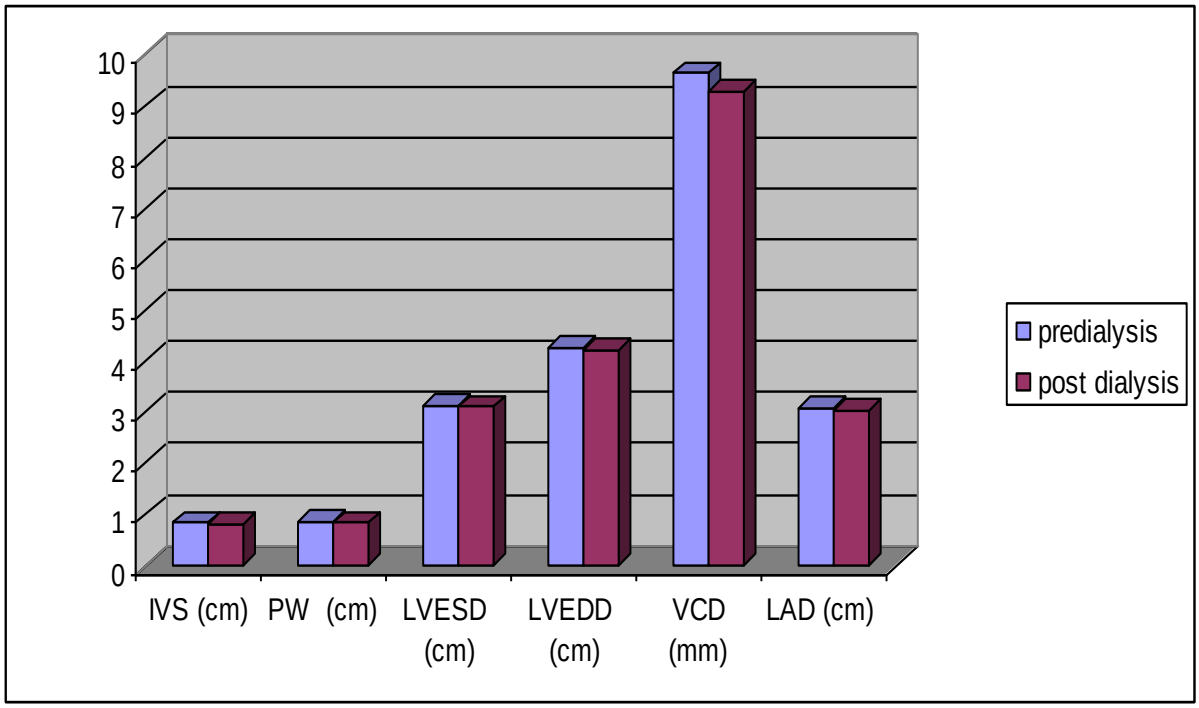
Deceleration time showed mild increase after dialysis (Predialysis mean value was 214.8 ±11.9 ms, while post dialysis it was 218.09±13.8 ms, with p value >0.05).

Similarly, TVI (time velocity integral) showed mild decrease after dialysis (predialysis value was 22.3±2.06 cm, and post dialysis decreased to 21.0±2.7 cm, with p value >0.05).

Table (4): Clinical evaluation and M mode of group 1:

	Mean	Std. Deviation	t	p
SBP (mmHg)before	116.4	15.7	2.04	>0.05 NS
SBP (mmHg)after	108.2	17.2		
HR(BPM) before	83.5	9.6	0.7	>0.05 NS
HR (BPM)after	82.3	9.04		
IVS (cm) before	0.827	0.1252	0.614	>0.05 NS
IVS (cm) after	0.818	0.0982		
PW (cm) before	0.845	0.0934	0.8	>0.05 NS
PW (cm) after	0.827	0.1009		
LVEDD (cm) before	4.2500	0.27839	1.5	>0.05 NS
LVEDD (cm) after	4.232	0.2620		
LVESD (cm) before	3.1309	0.32528	1.4	>0.05 NS
LVESD (cm) after	3.105	0.3482		
EF% before	60.55	6.362	0.8	>0.05 NS
EF% after	60.09	5.957		
VCD (mm) before	9.64	1.027	1.7	>0.05 NS
VCD (mm) after	9.300	1.0844		
LAD (cm) before	3.091	0.3448	0.5	>0.05 NS
LAD (cm) after	3.045	0.3357		

IVS: inter ventricular septal thickness, **PW:** posterior wall thickness, **LVEDD:** left ventricular end diastolic dimension, **LVESD:** left ventricular end systolic dimension, **EF:** ejection fraction, **VCD:** inferior vena caval diameter, **LAD:** left atrial diameter, **SBP:** systolic blood pressure, **HR:**heart rate.



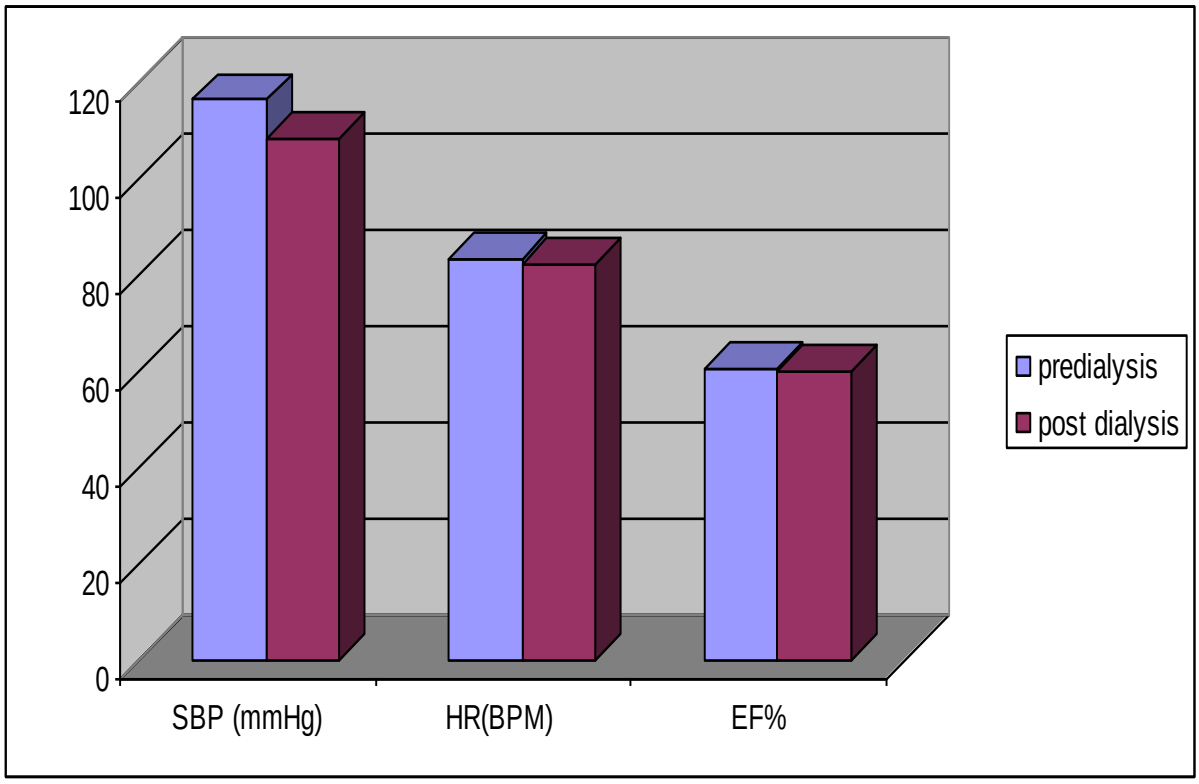


Fig (6) & (7): Clinical evaluation and M mode of group 1

Table (5): Pulsed Doppler indices in pre and post dialysis of group 1

	Mean	Std. Deviation	t	p
E velocity (cm/sec)before	68.73	8.990	2.1	>0.05 NS
E velocity (cm/sec)after	64.55	10.211		
A velocity(cm/sec) before	78.73	7.721	1.9	>0.05 NS
A velocity (cm/sec)after	77.18	7.346		
E/A ratio before	0.955	0.2018	2.2	>0.05 NS
E/A ratio after	0.81	0.134		
DT of E wave(ms) before	214.82	11.973	1.9	>0.05 NS
DT of E wave(ms) after	218.09	13.845		
TVI of aorta (ms) before	22.36	2.063	2.01	>0.05 NS
TVI of aorta (ms) after	21.00	2.748		

DT: decelation time, **TVI:** time velocity integral

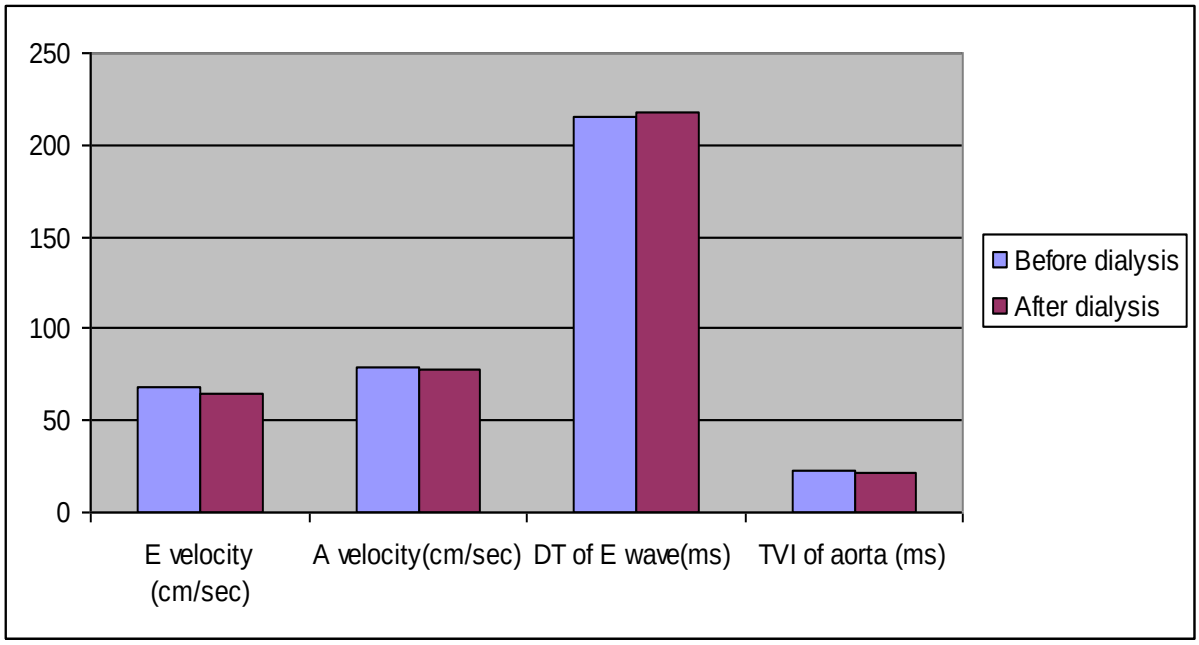


Fig (8): Pulsed Doppler indices in pre and post dialysis of group 1

Clinical and Echo Doppler changes of group II after dialysis:
(Table 6, 7 & figure 9, 10 &11)

In contrast to group I, group II patients showed statitstically significant changes in some of clinical, M-mode & pulsed Doppler indices.

There was a significant reduction of systolic blood pressure (SBP) when comparing pre and post-dialysis mean values (SBP was104.4±41.3 mmHg, before and was 88.9± 35.9 mmHg, after dialysis with significant p value<0.05).

In contrast, there was mild increase in heart rate (HR) post-dialysis (85.1±7.4 BPM in predialysis and 87.2±7.4 BPM in post-dialysis with p value>0.05).

There was a significant decrease in LVEDD mean values with less non-significant decrease in the mean values of LVESD, yielding significant increase in EF% in post dialysis states.

Mean values of LVEDD decreased from 4.58±0.33 cm predialysis to 4.13± 0.33 cm after dialysis, with p value<0.05). While mean values of LVESD decreased from 3 ± 0.3 cm predialysis to 2.98±0.41 cm after dialysis, with p value>0.05). EF% decreased from 61.3±6.4 % predialysis to 58.4±9.1% postdialysis.

Septal and posterior wall thickness showed no significant changes and their mean values were kept around 0.9 cm pre &post dialysis.

There was a significant decrease in blood volume in the patients of this group as assessed by significant reduction of inferior vena cava diameter from mean of 10±1.1 cm to 8.5±0.8 cm post dialysis.

LAD dimensions showed no significant changes after dialysis (was 3.22±0.4 in predialysis, and was 3.16±0.3 in post dialysis).

Comparing pulsed Doppler indices changes in group II patients,there was asignificant decrease of E velocity with dialysis associated with less significant decrease in A velocity resulting in significant decrease of E/A ratio.

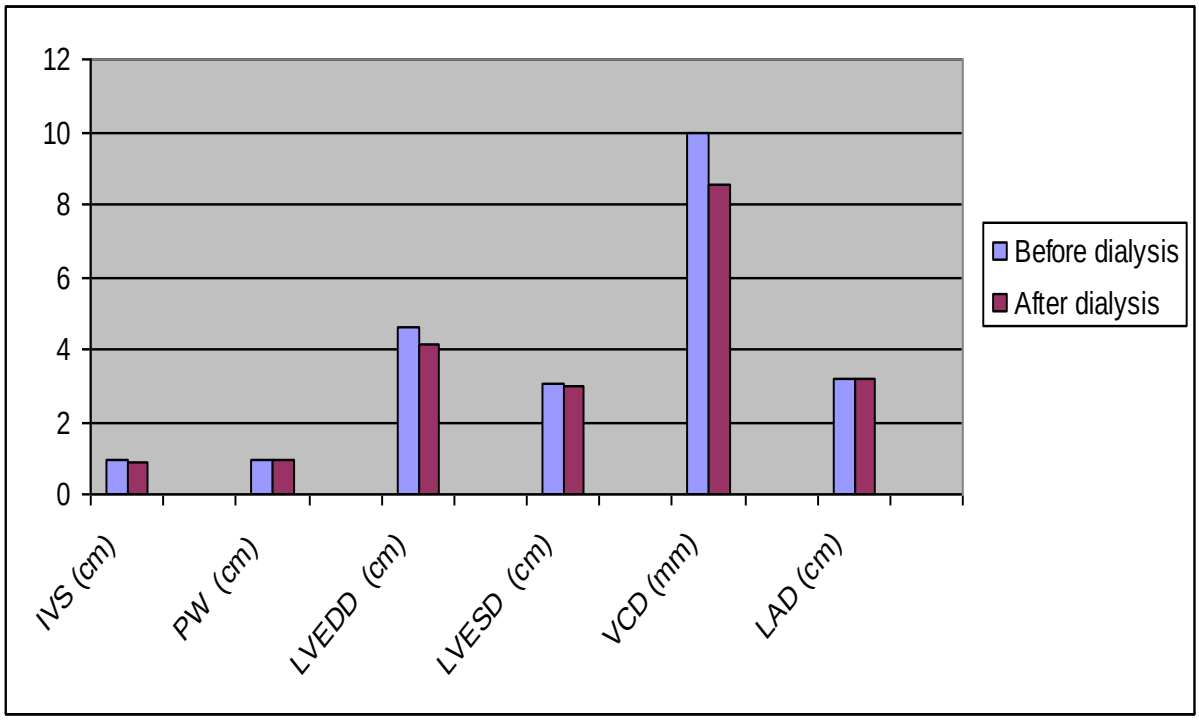
Pedialysis values for E velocity predialysis was 76.4±20.3 cm/sec while post dialysis was 51.9± 19.8 cm/sec, p value <0.05 while A velocity was 74.4± 8.1 cm/sec , 71.4± 10.6 cm/sec pre and post dialysis respectively, p value > 0.05 and E/A ratio was 0.92± 0.2 pre &0.6±0.2 after dialysis with p value <0.05).

Also there was significant increase in mean values of deceleration time (DT) of E wave before & after dialysis (was 203.12±11.5 ms in predialysis and 242.5±10.04 ms after dialysis with significant p value <0.05).

Time velocity integral (TVI) of aorta before and after dialysis showed significant decrease as pre-dialysis was 24.12± 3.3 cm, and decreased in post dialysis to 18.69± 2.9 cm, with significant p value <0.05.

Table (6): Clinical evaluation and M mode of group 2

	Mean	Std. Deviation	t	p
SBP (mmHg)before	104.4	41.3	3.5	<0.05 S
SBP (mmHg)after	88.9	35.9		
HR (BPM)before	85.1	7.4	2.2	>0.05 NS
HR (BPM)after	87.2	7.4		
LVEDD (cm) before	4.5800	0.33305	7.8	<0.05 S
LVEDD (cm) after	4.130	0.3329		
LVESD (cm) before	3.067	0.3937	1.6	>0.05 NS
LVESD (cm) after	2.98	0.418		
EF% before	61.33	6.403	2.3	<0.05 S
EF% after	58.44	9.112		
IVS (cm) before	0.944	0.1014	2	>0.05 NS
IVS (cm) after	0.911	0.1167		
PW (cm) before	0.956	0.1014	2	>0.05 NS
PW (cm) after	0.922	0.1202		
VCD (mm) before	10.00	1.146	12.3	<0.05 S
VCD (mm) after	8.52	0.890		
LAD (cm) before	3.22	0.423	0.8	>0.05 NS
LAD (cm) after	3.162	0.3021		



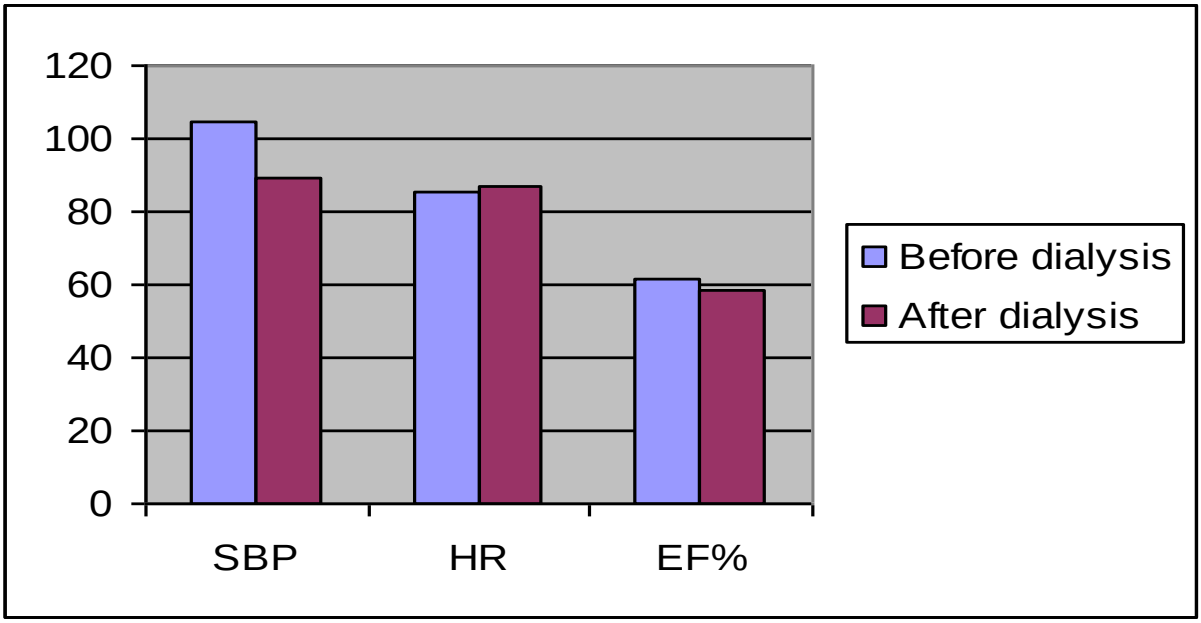


Fig (9) & (10): Clinical evaluation and M mode of group 2

Table (7): Pulsed Doppler indices in pre and post dialysis of group 2

	Mean	Std. Deviation	t	p
E velocity(cm/sec) before	76.43	20.371	16.1	<0.05 S
E velocity (cm/sec) after	51.89	19.814		
A velocity(cm/sec) before	74.44	8.156	1.9	>0.05 NS
A velocity(cm/sec) after	71.44	10.620		
E/A ratio before	0.922	0.2333	10.3	<0.05 S
E/A ratio after	0.694	0.2297		
DT of E wave(ms) before	203.12	11.594	26.5	<0.05 S
DT of E wave(ms) after	242.50	10.043		
TVI of aorta(cm) before	24.12	3.357	21.1	<0.05 S
TVI of aorta (cm)after	18.69	2.963		

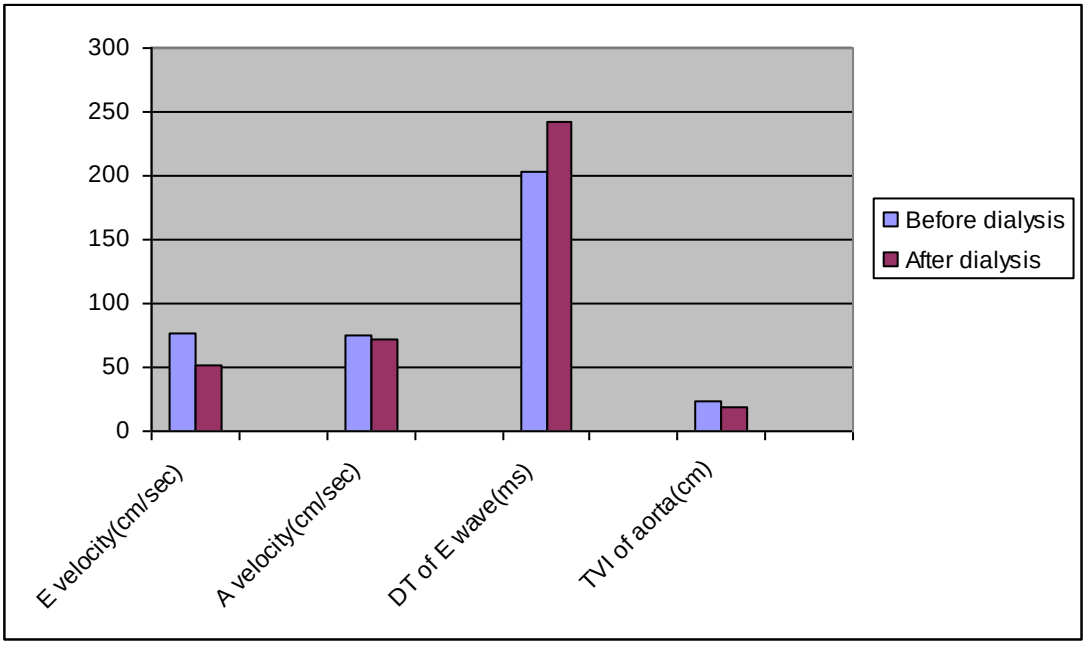


Fig (11): Pulsed Doppler indices in pre and post dialysis of group 2

Clinical events during dialysis:

In the current study, 6 patients (30%) developed single or multiple episodes of intradialysis hypotension towards the end of hemodialysis session.

None of theme developed syncope or giddiness. There was no need to end the hemodialysis session in any of these patients.

Among the patients who developed hypotension, 4 patients (4/9, 44%) were of group II patients while 2 patients (2/11, 18%) were of group I patients.

Characters of the group who developed hypotension:

(Table 8 & figure12, 13 &14)

The patients who developed hypotension were characterized by significant decrease in preload parameters after dialysis which was more noticed in group II of which a larger percent of patients developed hypotension.

There was a significant decrease in E velocity post dialysis with decrease in E/A ratio from 0.8±0.16 pre dialysis to 0.59±0.13 post dialysis.

Also increase of deceleration time of E wave from 214.3±8.09 ms, to 244.6±9.24 ms, post dialysis.

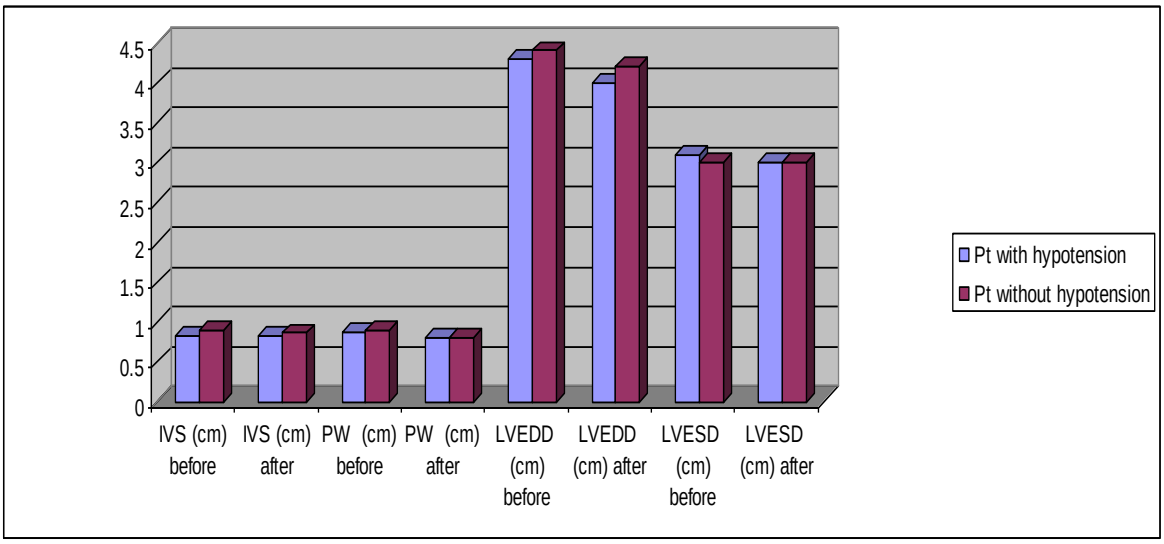
From these data, we observed that the mean deceleration time post dialysis was244.6±9.2 ms, in patients who developed hypotension while it was 222.6±15.72 ms, in the other group of patients. Also the E/A ratio post dialysis was 0.59±0.13 in the group who developed hypotension while it was 0.83±0.16 in the other group.

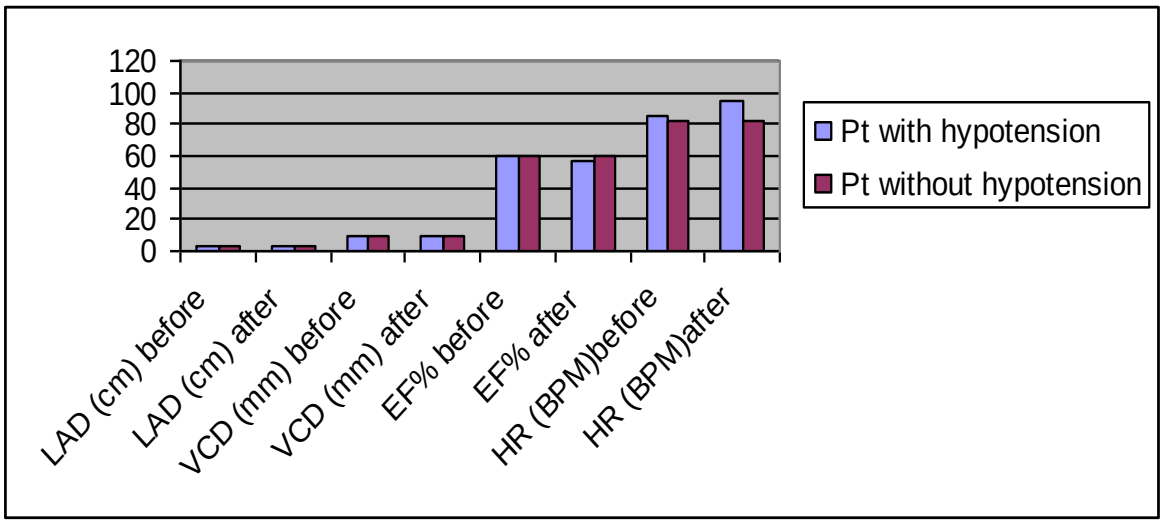
From previous data, it can be noticed that there was a more pronounced excess of preload reduction in the group who developed hypotension compared with the other patients who didn't develop hypotension.

Table (8): Comparison between the 2 groups (hypotensive and non hypotensive one)

	Pt with hypotension	Pt without hypotension	P value
IVS (cm) before	0.83±0.082	0.9±0.14	>0.05
IVS (cm) after	0.82±0.098	0.86±0.11	>0.05
PW (cm) before	0.88±0.11	0.9±0.11	>0.05
PW (cm) after	0.8±0.11	0.8±0.12	>0.05
LVEDD (cm) before	4.3±0.35	4.4±0.3	>0.05
LVEDD (cm) after	4.0±0.33	4.2±0.2	<0.05*
LVESD (cm) before	3.1±0.28	3±0.38	>0.05
LVESD (cm) after	3.0±0.3	3.0±0.4	>0.05
EF% before	60.5±4.8	60.7±6.6	>0.05
EF% after	57.5±4.5	60.5±8.5	>0.05
VCD (mm) before	10±1.2	9.7±1	>0.05
VCD (mm) after	8.8±0.8	9±1.1	>0.05
LAD (cm) before	3.3±0.3	3.0±0.3	>0.05
LAD (cm) after	3.2±0.3	3.0±0.3	>0.05
HR (BPM)before	86±4.4	82.2±9.1	>0.05
HR (BPM)after	95.3±2.8	81.4±7.4	<0.05*
E velocity(cm/sec) before	70.3±14.3	77.6±14.7	>0.05
E velocity (cm/sec) after	47.3±12.1	63.7±15.4	<0.05*
A velocity (cm/sec) before	82.6±6.1	78.4±9.2	>0.05
A velocity (cm/sec) after	76±7.8	74±9.9	>0.05
E/A ratio before	0.8±0.1	0.9±0.1	>0.05
E/A ratio after	0.5±0.1	0.83±0.16	<0.05*
DT of E wave(ms) before	214.±8.09	200.6±11.2	>0.05
DT of E wave(ms) after	244.6±9.2	222.6±15.7	<0.05*
TVI of aorta(cm)before	22.1±2.7	24±2.9	>0.05
TVI of aorta (cm)after	17.4±3.1	20.6±2.9	>0.05

*** Statistically significant**





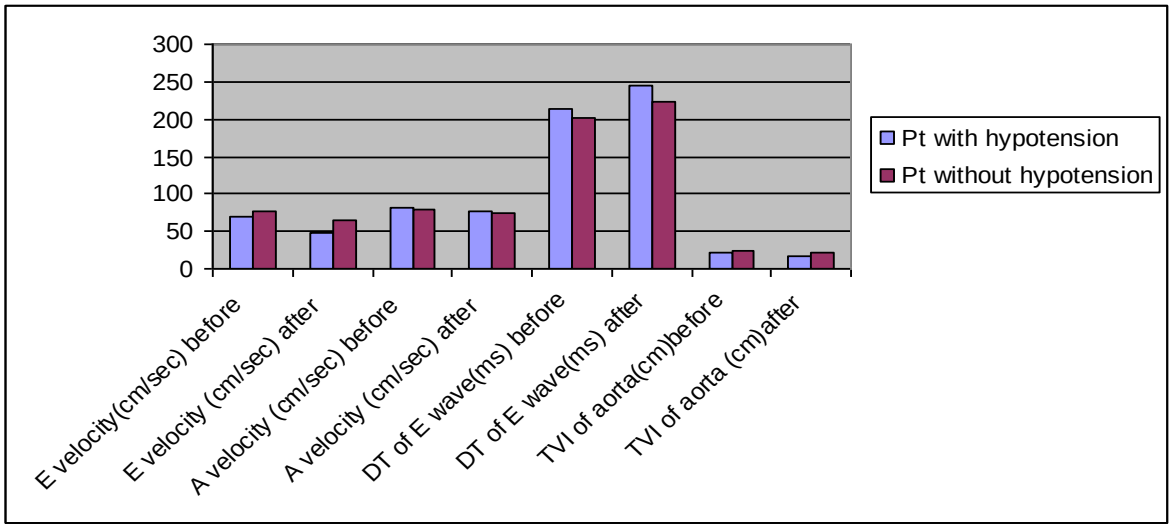


Fig (12) & (13) & (14): Comparison between the 2 groups (hypotensive and non hypotensive one)