https://menj.journals.ekb.eg
Print ISSN: 2735-3974
Online ISSN: 2735-3982
DOI: --------------------------------

MNJ
Menoufia Nursing Journal
Faculty of Nuring
Menoufia University

Effect of Intradialytic Range of Motion Exercises on Dialysis Efficacy and Blood pressure among Patients Undergoing Hemodialysis

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Abstract: Background: End stage renal disease is a major public health problem in developing countries. **Purpose:** To determine the effect of intradialytic exercises on dialysis efficacy and blood pressure among patients undergoing hemodialysis. **Setting:** The hemodialysis unit of Menoufia University Hospital. Sampling: A consecutive sample of 50 adult hemodialysis patients were selected and divided alternatively into two equal groups: 25 patients for each group (study - control). **Instruments:** Four instruments were used for data collection: Structural interview questionnaire, bio-physiological instrument, and observational checklist. Results: There was a reduction in mean urea one month after intervention and mean of blood pressure (128.48 ± 9.70 Vs 134.55 ±3.78). **Conclusions:** Intradialytic exercises were effective in improving dialysis efficacy and blood pressure scores for patients undergoing hemodialysis. **Recommendations:** A health teaching program about intradialytic exercises should be carried out for all hemodialysis patients to improve dialysis efficacy and blood pressure. Besides, a colored booklet should be available and distributed to all hemodialysis patients.

Key words: *Blood pressure, Dialysis efficacy, Intra dialytic exercises.*

Introduction

Kidney disease is defined as a global public health problem that affects more than 750 million persons worldwide. Chronic kidney disease (CKD) is not a functionally static process because it is a progressive one that can lead to end-stage renal disease (ESRD). ESRD substantially alters the patient's lifestyle and imposes increased morbidity and mortality in those patients (Webster et al., 2017).

End-stage renal disease (ESRD) is the point in kidney failure when almost 90% of renal function has been lost, rendering the body unable to maintain proper fluid and electrolyte balance, adequate waste removal, and normal hormonal function. To survive, people with ESRD must undergo some form of renal replacement therapy, namely, a peritoneal dialysis, or hemodialysis (HD), or kidney transplantation (Parsons et al., 2016a).

End-stage renal disease is associated with severe morbidity, mortality, high cost for management and different impacts on general health and patient wellbeing. More than 90% of patients diagnosed with end-stage renal disease (ESRD) regularly receive hemodialysis (HD) as renal replacement therapy. During the last three decades, patients who receive maintenance dialysis globally increased dramatically. In 2010 it was estimated that the number of patients on dialysis was more than 2 million worldwide, and modeling data suggest this number will more than double by 2030 (United States Renal Data System, 2019).

The prevalence of ESRD continues to increase in many countries: more than 2000 person per million populations (pmp) in Japan, about 500 pmp in the USA, and about 800 pmp in the European Union. In developing countries, the figures vary from less than 100 pmp in sub-Saharan Africa to about 400 pmp in Latin America and more than 600 pmp in Saudi Arabia (El-Arbagy et al., 2016).

Patients with end-stage renal disease have only two options in order to stay alive: life-long dialysis (hemodialysis or peritoneal dialysis) or renal transplantation. Of these options, dialysis is considered the treatment of choice. The majority of patients receive hemodialysis, as patients on hemodialysis account for approximately 98.7% of patients receiving hemodialysis and 1.3% who received peritoneal dialysis (Gaipov et-al., 2020).

Hemodialysis (HD) is a life-changing process as it requires the ESRD patient to visit the dialysis unit usually 3 times per week for 3-5 hours. As one would expect, this lifestyle change decreases the quality of life (QOL) of these patients as compared to healthy adults. In fact, the more advanced the CKD stage, the more impaired the QOL (Aggarwal et al., 2016).

In Egypt, the total prevalence of patients on dialysis increased from 225 person per million (pmp) in 1996 to 483 pmp in 2008 (according to last Egyptian renal registry). In Menoufia, the total prevalence rate of hemodialysis patients in Menoufia governorate was 483(pmp) (El-Zorkany, 2017).

The maintenance hemodialysis (MHD) patients are profoundly deconditioned, often vulnerable, and older with muscle wasting and altered nutritional status. Hemodialysis leads to distinct metabolic changes such as hypovolemia, electrolyte imbalance, and systemic inflammation (Cano et al., 2017; Kono et al., 2018).

The hemodialysis nurse has an essential role in hemodialysis unit, as the dialysis nurse typically operates the hemodialysis machine that extracts blood from the patient, cleans it and returns it into the body. Other HD nurses' responsibilities include administration of treatments, monitoring patient vital signs especially blood pressure, communicating procedure details with patients, and assessing the effectiveness of procedures, as well as being responsible for the cleanliness of work area. It is also the responsibility of the dialysis nurse to be sympathetic, caring, patient, positive and responsible when caring for patients (Alyaseen, 2019).

Exercises are very important non-pharmacological method for primary and secondary prevention of cardiovascular disease. Physical activity ameliorates cardiovascular risk factors such as blood pressure (BP) and lipid profiles as well as dialysis efficacy (Abd El-Halim et al., 2017a; Anding et al., 2015).

Intradialytic exercise (IDE) is defined as exercise training program during the hemodialysis (HD) session aiming to increase strength and endurance of HD patients and hence targeting various physiological and psychosocial parameters. The nature of the IDE includes resistance, aerobic and stretching, and using different equipment. IDE has shown to have a positive effect on the overall health and hospitalization rate of HD patients (Kouidi et al., 2019).

Intradialytic exercise revealed strong positive correlations with dialysis efficacy, blood pressure, high-sensitivity C-reactive protein, arterial stiffness, health-related QOL, and depression (Sheng et al., 2014). Moreover, several researches have proven that exercise during hemodialysis is easy and safe showing significant changes in physical and psychological conditions, which positively influence their social life (Motedayen et al., 2017a).

The intradialytic exercises results in increased muscle blood flow and opened capillary surface area. Patients doing exercises during dialysis have toxic substances, also called uremic toxins in the blood. This results in malaise, paraesthesia, peripheral circulatory disturbance, mental impairment and muscle dysfunction move through the dialyzer with a large flux from the tissue to the vascular compartment (Parsons et al., 2016 b; Silva & Marinho, 2015).

An exercise protocol can lead to improvement in many functions, such as blood pressure, heart function (especially ventricular function in hemodialysis patients), muscle strength, and respiratory capacity, and reduce muscle atrophy, with excellent results for the quality of life. Range of motion exercises can be considered as a routine care while delivering hemodialysis as it is performed for 15 min/day, three times a week during dialysis sessions (Heiwe & Jacobson, 2018; Mohamed & Soliman, 2015).

Significance of the study

Worldwide, hemodialysis is a physically stressful procedure. These patients suffer from weakness, fatigue, nausea, vomiting, tremors, abnormal mental function and increase of blood pressure measurements. Also, they are liable to develop uremia and hypertension (Ferrans & Powers, 2017). In Egypt, although all patients undergoing hemodialysis suffer from the same complaints, limited researches were done to alleviate their sufferings. Therefore, this study is conducted to determine the effect of intradialytic exercises on dialysis efficacy and blood pressure among patients undergoing hemodialysis.

Research Hypotheses

The following research hypotheses are formulated in an attempt to achieve the aim of the study:

1) Patients who participate in intradialytic range of motion exercises (study group) will have a higher dialysis efficacy score than patients who don't participate in intradialytic range of motion exercises (control group).
2) Patients who participate in intradialytic range of motion exercises (study group) will experience more stable blood pressure than patients who don't participate in intradialytic range of motion exercises (control group).

Methods

Research Design:

Quasi-experimental (study and control).

Setting:

The study was carried out in the Hemodialysis Unit of Menoufia University Hospital, Shebin El-Kom, Menoufia Governorate, Egypt.

Sample:

A consecutive sample of 50 patients undergoing hemodialysis. **Inclusion criteria** were **a)** Being under hemodialysis for more than 2 months.

b) Receiving hemodialysis sessions 3 times per week. **Exclusion criteria** were **a)** Adhering to other exercise programs to be sure about the effect of exercises on dialysis efficacy and blood pressure. **b)** Instability in hemodynamic parameters before and during the exercises to prevent deterioration of patient's condition. **c)** Patients who have musculoskeletal problems.

Sample size calculation:

Based on the previous studies that examined the same outcomes and found significant differences and on the total number of patients under hemodialysis at University Hospital; 2079 patients (Statistical administrative records of Menoufia University Hospital, 2018), a consecutive sample of 50 patients of both sexes undergoing hemodialysis were selected. Patients were assigned randomly and alternatively into two equal groups for applying the treatment protocol.

Study group (I): Those patients did intradialytic range of motion exercises for 10 to 15 minutes in the first two hours of every hemodialysis session for a period of two month.

Control group (II): Those patients were exposed only to routine hospital care.

Instruments:

Instrument one: Structured Interviewing Questionnaire: This instrument was developed by the researcher to identify the characteristics of the sample. It contained two parts. Part one: Social characteristics: It was included of 6 questions related to patient's age, sex, education, occupation, marital status and residence. Part two: Medical data: It contained 4 items about the past medical history, hemodialysis, practicing sports and patients' vital signs in the first session.

Instrument two: sphygmomanometer: It is a mercury sphygmomanometer. It is made by Omron group in China.

Instrument three: Dialysis efficacy and blood pressure recording chart: It was developed by the researcher. It contained 2 items.

- **Part one:** Dialysis efficacy: Dialysis efficacy was assessed by evaluating the urea reduction ratio. It was determined at a baseline and on a monthly basis during the exercises program.
- **Part two:** Assessment of systolic and diastolic blood pressure.

Instrument four: Observational checklist: It was developed by the researcher to investigate the patient's practice of intradialytic range of motion exercises. It contained exercises related to 3 parts of the body (wrist, elbow and ankle). These exercises were done by the patients and checked by the researcher to decide whether or not they were effective.

Validity of Instruments:

All Instruments were tested for face and content validity by 5 experts in the field of Medical-Surgical Nursing Department Faculty of Nursing, Menoufia University. Modifications were done to ascertain relevance and completeness. **Reliability of Instruments:**

The reliability of Instruments was done to determine the extent to which items in the instruments were related to each other by Cronbach's Co-efficiency Alpha for instruments two (a=.727) and for instruments three (a=.721). So it can be concluded that the instruments have adequate level of reliability. **Pilot study:**

A pilot study was conducted before data collection on 10% of the sample (5 patients). This was performed to test the clarity and applicability of the instruments. Necessary modifications were done.

Ethical consideration:

A written consent was obtained from all participants for participation in the study after explanation of the purpose of study. All patients were reassured that any information obtained would be confidential and would only be used for the purpose of the study. The researcher affirmed that participation in the study was entirely voluntary. Anonymity of the patients was assured through coding the data. Patients were also informed that refusal to participate wouldn't affect their care.

Procedure:

A letter was submitted from the Dean of the Faculty of Nursing to the directors selected settings. Data were collected over a period of 2 months from March, 2020 to May, 2020.The researcher entered the room of patients, introduced herself to them and explained the purpose of the study. Patients who agreed to participate in the study and fulfilled the inclusion criteria were interviewed individually by the researcher. The included patients were divided alternatively into two equal groups (25 patients for each group). The patients in the morning shift were selected to be involved in the study group and the patients in the afternoon shift were included in control group. The researcher deal with the study group (I) first then control group(II) to avoid the contamination of data.

At the beginning of the first session:

Social characteristics of each patient were obtained using instrument one (Structured interview questionnaire). Dialysis efficacy and blood pressure were recorded in a chart. Data collection was done between 8 am and 5 pm.

For the study group, the intradialytic range of motion exercises was explained using a colored illustrative booklet prepared by the researcher. This booklet included data about renal failure, hemodialysis and the intradialytic range of motion exercises. The researcher explained everything about these exercises (definition, benefits, precautions, and description of each exercise). Afterwards, demonstration was done for every patient in the study group using instrument three (Observational checklist). During this session, reinforcement was carried out according to each patient needs. The researcher demonstrated the following exercises:

- 20 rounds per minute (RPM) clockwise of wrist and ankles
- 20 RPM counter-clockwise
- 20 times full flexion and extension of the wrist
- 20 times full flexion and extension of the elbow joint
- 20 RPM of rotating the ankles clockwise
- 20 RPM of rotating the ankles counter-clockwise
- 20 times full flexion and extension of the ankles

The intradialytic exercises were done for 15 minutes, 3 times per week, during the first 2 hours of each dialysis session. No exercise was carried out during the second half of the session. Body parts that were connected to dialysis machine were excluded. Systolic and diastolic blood pressures were assessed before and after each hemodialysis session.

At the beginning of the follow up session: Blood samples were drawn to obtain serum urea concentration. Then, urea reduction ratio was estimated to assess the dialysis efficacy for every patient in the study group by using instrument two (Bio physiologic measurement instrument). The researcher refreshed the previous knowledge and then a re-demonstration for the intradialytic exercises was done using instrument three (Observational checklist). Systolic and diastolic blood pressures were assessed pre- and post-patient dialysis session and recorded to evaluate the patients' blood pressure.

Evaluation of all patients of both groups was carried out twice; at the end of the first month and at the end of the follow up session to assess the effect of intradialytic range of motion exercises on dialysis efficacy and blood pressure. Blood pressure: Systolic and diastolic blood pressures were measured before and after hemodialysis session. Then, the mean of blood pressure measures was estimated at the end of every month for every patient to be prepared for comparison A comparison was done between both groups to determine the effect of intradialytic exercises on dialysis efficacy and blood pressure among patients undergoing hemodialysis.

Statistical Analysis:

The collected data were tabulated and analyzed by SPSS (statistical package for the social science software) statistical package version 20 on IBM compatible computer(SPSS, Chicago, IL, USA).Two types of statistics were done: Descriptive statistics: expressed as mean and standard deviation (X+SD) for quantitative data or number and percentage (No & %) for qualitative data. Analytic statistics (Pearson Chi-square test (χ^2) & Fisher`s Exact Test, Student t- test, Repeated-Measures ANOVA, ANOVA test (parametric test, Pearson correlation).

Results:

Table (1): showed that, the mean ages of study and control groups were 40.28±10.83and 41.72±9.44years old, respectively. More than half 60% and 52%of the studied patients in the study and control groups were males, respectively. ***Concerning marital status***, the majority of the studied patients (80% and 88%) in the study and control groups were married. ***Regarding level of education***, 52% of the studied patients in the study group and 44% of the studied patients in the control group had diploma. ***In relation to occupation,*** more than one third (40% and 36%) of study and control groups had a hand work, respectively.

There were no statistically significant differences between both groups regarding social characteristics.

Table (2): shows that the mean of urea reduction ratio (dialysis efficacy) on pre intervention (baseline) for study and control groups was 59.40±10.84 and 63.29±11.29, respectively. Also, the mean of urea reduction ratio one month post- intervention for study and control groups was 61.44±8.44 and 60.40±14.63, respectively. So, there were no statistically significant differences between study group and control group on pre-intervention and one-month post-intervention. Meanwhile, the mean of urea reduction ratio two-month post-intervention for study and control groups was 67.14±10.19 and 59.66±12.99, respectively. So, there were statistically significant differences between study and control group regarding urea reduction ratio at a level of *P=0.02*.

Figure (I): revealed that the mean of urea reduction ratio (dialysis efficacy) on pre intervention (baseline) for study and control groups was 59.40 and 63.29, respectively. Also, the mean of urea reduction ratio one-month post-intervention for study and control groups was 61.44and 60.40, respectively. So, there were no statistically significant differences between study group and control group on pre-intervention and one-month post-intervention. Meanwhile, the mean of urea reduction ratio two-month post-intervention for study and control groups was 67.14 and 59.66, respectively. So, there was statistically significant difference between study and control group regarding urea reduction ratio.

Regarding study group, there were no statistically significant difference between pre-intervention (baseline) & one month post-intervention. Meanwhile, there were statistically significant differences between pre-intervention (baseline) & two-month post-intervention and between one-month post-intervention & two-month post-intervention.

Regarding control group, there were no statistically significant difference between pre-intervention (baseline), one-month post-intervention and two-month post-intervention (*Repeated measures*).

This means that patients who in the study group had higher dialysis efficacy scores (***Urea reduction ratio***) than patients in the control group.

Table (3): showed that: ***regarding the 1st month,*** there were no statistically significant differences between the study and control groups regarding means of SPB pre-patient connection first month, means of DBP pre- and post-patient connection first month. Meanwhile, there were statistical differences between means of SBP post-patient connection in the first month for the two groups 128.48 ± 9.70 & 134.55 ±3.78, respectively. So, there was a statistically significant difference between the study and control groups regarding SBP post patient connection first month.

Regarding the 2nd month, there were highly statistically significant differences between the study and control groups regarding means of SPB pre- and post-patient connection at 1% level of significance. There were statistically significant differences between the study and control groups regarding mean DBP pre- and post-patient connection at 5% level of significance.

Regarding study group, means of SBP first and second month were137.93 ± 11.17 & 134.52 ± 9.62, respectively, and means of DBP first and second month were 85.09 ± 5.36& 82.64 ± 3.45, respectively. So, there were statistically significant differences between the first and second month concerning SBP & DBP for the study group.

Regarding control group, means of SBP first and second month were 144.80 ±8.68& 145.0 ±8.51, respectively, and means of DBP first and second month were 86.91 ±6.46 & 85.10 ±2.29, respectively. So, there is no statistically significant difference between the first and second month concerning SBP & DBP for the control group.

Also, there were statistically significant differences between the study and control groups regarding mean SBP first month and mean DBP second month. There were highly statistically significant differences between the study and control groups regarding means of SPB post-patient connection.

Figure (II): showed that, ***regarding study group***, means of SBP first and second month were 137.93 & 134.52, respectively, and means of DBP first and second month were 85.09 & 82.64, respectively. So, there were statistical differences between the first and second month concerning SBP & DBP.

Regarding control group, means of SBP first and second month were 144.80 & 145.0, respectively, and means of DBP first and second month were 86.91 & 85.10, respectively. So, there was no difference between the first and second month concerning SBP & DBP.

Table (4): shows the total scores of patients in the first and the fourth week. ***Regarding the 1st week***, about two thirds of the patients (64%) did poor exercises. ***Regarding the 2nd week***, about half of patients did acceptable exercises while about half of them did good exercises 52%&48, respectively. So, there were statistical differences between the first and the fourth weeks regarding the total scores of the patients' practice.

Figure (III): shows the total score of patients' practice at the first and the fourth week. ***Regarding the 1st week***, about two thirds of the patients (64%) did poor exercises. ***Regarding the 2nd week***, about half of patients did acceptable exercises while about half of them did good exercises 52% & 48%, respectively. So, there were differences between the first and the fourth weeks regarding the total scores of the patients' practice.

Table (5): shows that there was high significant positive correlations of mean motion exercises score at the fourth week with the urea reduction ratio one-month post-intervention (P<0.001). There were negative correlations between mean motion exercises score at fourth week and means of systolic blood pressure and diastolic blood pressure post one-month exercises. So, there were statistically significant differences at 5% level of significance.

Table (1): Social Characteristics of the Studied Patients.

Demographic characteristics	**Studied groups**				**χ2**	**P value**
	Study group (n=25)		**Control group (n=25)**			
	NO.	**%**	**NO.**	**%**		
Age (years):						
Mean ± SD	40.28 ± 10.83		41.72 ±9.44		**t- test =** 0.50 ns	0.61
Range	25.0 – 61.0		23.0 – 56.0			
Sex:						
Male	15	60.0	13	52.0	0.32 ns	***FET*** 0.56
Female	10	40.0	12	48.0		
Marital status:						
Single	4	16.0	0	0.0		
Widow	1	4.0	2	8.0	5.42 ns	0.14
Married	20	80.0	22	88.0		
Divorced	0	0.0	1	4.0		
Education level:						
Illiterate	4	8.0	6	24.0		
Read & write	4	8.0	7	28.0	3.18 ns	0.36
Diploma	13	52.0	11	44.0		
High education	4	8.0	1	4.0		
Occupation:						
Hand work	10	40.0	9	36.0		
Administrative work	7	28.0	5	20.0	0.91 ns	0.82
No work	1	4.0	1	4.0		
Housewife	7	28.0	10	40.0		

Table (2): Means of urea reduction ratio of the studied groups on pre, post and follow up tests.

Urea reduction ratio	Studied groups		Students` t- test	P value
	Study group (n=25)	Control group (n=25)		
	Mean ± SD Range	Mean ± SD Range		
pre-intervention (baseline):	59.40 ± 10.84 16.23 – 75.0	63.29 ±11.29 40.0 – 96.0	1.22 ns	0.22
One-month post-intervention:	61.44 ± 8.44 30.76 – 83.33	60.40 ±14.63 6.34 – 94.52	0.30ns	0.76
Two-month post-intervention:	67.14 ± 10.19 52.54 – 91.84	59.66 ±12.99 6.53 – 74.76	2.27(s)	0.02
Repeated measures ANOVA	4.74	0.58		
P value	0.02(s)	0.54ns		
Post hoc test	P1= 0.43ns P2= 0.02 (s) P3= 0.006 (s)	P1= 0.48 ns P2= 0.24 ns P3= 0.83ns		

Figure (I): Urea reduction ratio of the studied groups.

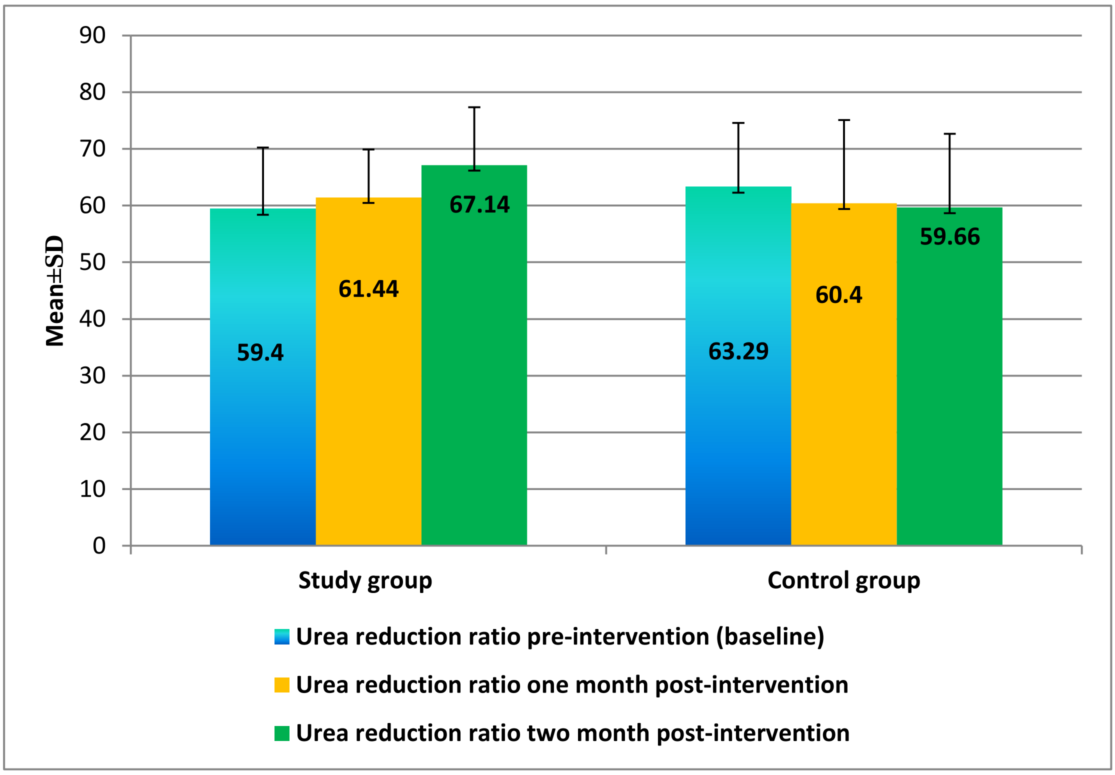

Table (3): Mean blood pressure measurement of the studied groups on pre, post and follow up tests.

Mean Blood pressure measurements	Studied groups		Students` t- test	P value
	Study group (n=25)	Control group (n=25)		
	Mean±SD	Mean±SD		
Mean SBP pre patient connection first month:	147.38 ± 15.37	155.05 ±17.27	1.65 ^{ns}	0.10
Mean SBP post patient connection first month:	128.48 ± 9.70	134.55 ±3.78	2.91 ^{S}	0.007
Mean DBP pre patient connection first month:	90.11 ± 9.58	91.71 ±3.17	0.49 ^{ns}	0.62
Mean DBP post patient connection first month:	80.07 ± 3.37	81.11 ±3.0	1.15 ^{ns}	0.25
Mean SBP pre patient connection second month:	144.93 ± 11.20	157.83 ±13.85	3.66 ^{HS}	0.001
Mean SBP post patient connection second month:	124.11 ± 8.68	132.16 ±6.90	3.62 ^{HS}	0.001
Mean DBP pre patient connection second month:	87.05 ± 3.56	89.63 ±3.13	2.73^{S}	0.009
Mean DBP post patient connection second month:	78.23 ± 3.60	80.56 ±2.31	2.72 ^{S}	0.009
Mean SBP first month:	137.93 ± 11.17	144.80 ±8.68	2.43 ^{S}	0.01
Mean SBP second month:	134.52 ± 9.62	145.0 ±8.51	4.07 ^{HS}	<0.001
Paired t test	2.44 ^{S}	0.16 ^{ns}		
P value	0.02	0.86		
Mean DBP first month:	85.09 ± 5.36	86.91 ±6.46	0.78 ^{ns}	0.43
Mean DBP second month	82.64 ± 3.45	85.10 ±2.29	2.97 ^{S}	0.005
Paired t test	2.33 ^{S}	0.87 ^{ns}		
P value	0.03	0.39		

Figure (II) Mean blood pressure measurements of the studied groups.

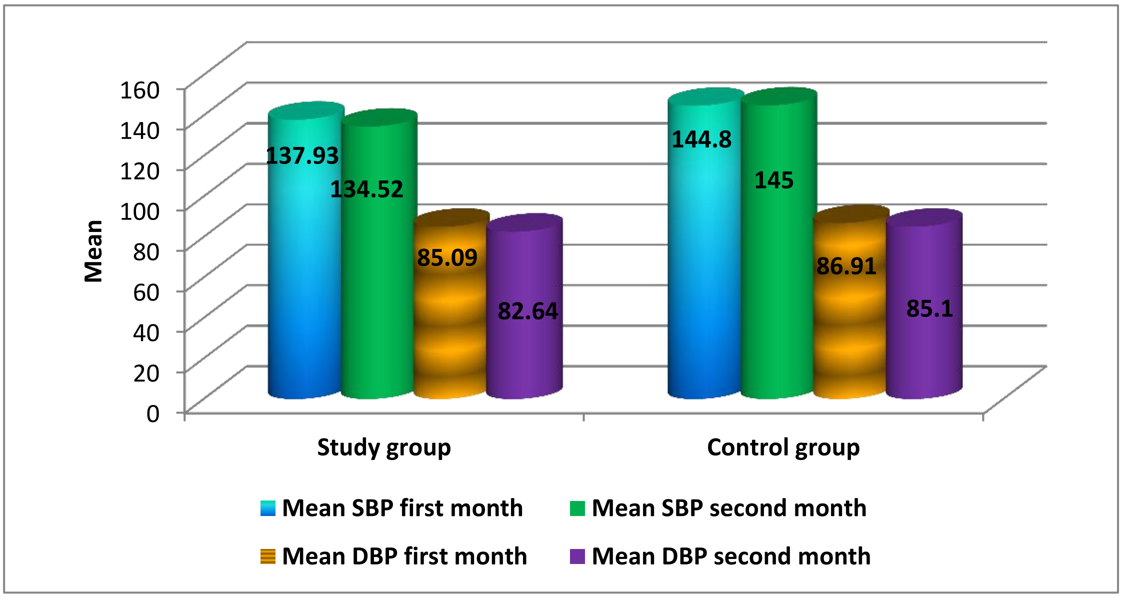

Table (4): Distribution of total score of patients` practice of intradialytic range of motion exercises in the first and fourth weeks

Items	Total score of patients' practice				$\chi^2$1	p-value
	At 1st week		At 4th week			
	No.	%	No.	%		
Poor practice	16	64.0%	0	0.0%	23.979	0.000
Acceptable practice	6	24.0%	13	52.0%		
Good practice	3	12.0%	12	48.0%		

Figure (III): Total score of patients' practices.

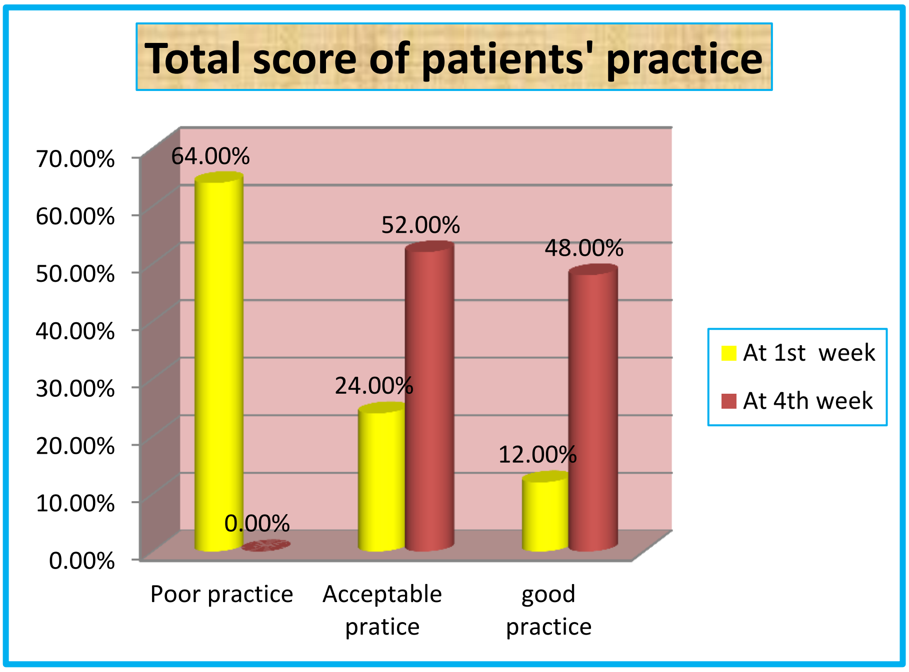

Table (5): Correlation between patients` mean motion exercises score & blood pressure and urea reduction ratio

	Mean motion exercises score at fourth week	
	R (Pearson correlation coefficient)	P value
Urea reduction ratio one-month post-intervention:	0.67	<0.001 HS
Mean SBP first month	-0.44	0.02 S
Mean DBP first month	-0.50	0.01 S

Discussion

End-stage renal disease (ESRD) is defined as a health problem that requires long-term and costly care. The standard management of ESRD is either dialysis or renal transplantation. Hemodialysis is the most common form of treatment modalities for renal replacement therapy offered in hospital based units. In Egypt, the prevalence of dialysis patients is presumed to be increasing (El-Besely et al., 2018).

Basically, a vital point within the management of patients undergoing maintenance hemodialysis is the assessment of the dialysis efficacy. Inadequacy of dialysis is responsible for disability and mortality for dialysis patients. So, to improve prognosis of dialysis patients it's necessary to enhance adequacy of dialysis (Bayoumi & Al Wakeel, 2019).

Previous literature has documented a variety of potential benefits that ESRD patients may achieve from exercise training such as improvement in urea clearance, decrease in blood pressure, increase in aerobic capacity, reduced need for antihypertensive medications, and improvement of the removal of toxins through dialysis (ElShemy et al., 2016).

Hence the purpose of the present study was to determine the effect of intradialytic range of motion exercises on dialysis efficacy and blood pressure among hemodialysis patients.

Intervention & two-month post-intervention, the intradialytic exercise resulted in a substantial increase in dialysis efficacy scores. As intra dialysis exercises increased the muscle blood flow and opened the capillary surface area which subsequently increased the flux of urea from the tissue to the vascular compartment. Such an increase resulted in an increase in serum urea clearance and improvement in the dialysis efficacy. These findings clearly indicated that exercise can be used as an adjunctive therapy to enhance dialysis efficacy. The results of current study were in agreement with the findings of Mohseni et al. (2018a); Parsons et al. (2016) and Sun et al. (2016) who found that there was a significant improvement in URR after 8 weeks of intradialytic exercises program. However, the results were in disagreement with Vaithilingham et al. (2015) who found no changes in equilibrated spKt/V or URR in 12 HD patients who performed intradialytic exercises on average of 13 min/dialysis session for a period of 4 weeks. **One possible explanation for this discrepancy** could be that exercises should be done two months or more in order to enhance urea removal and therefore improve dialysis efficacy.

The results of this study showed that the intradialytic range of motion exercises improved the dialysis efficacy of the study group. So hypothesis (1) was accepted.

In relation to improving blood pressure after practicing intradialytic range of motion exercises, the current study hypothesized that patients who did intradialytic range of motion exercises (study group) had more improvement in blood pressure than patients who didn't do intradialytic exercises (control group).

Regarding systolic blood pressure, the result of the current study showed that there was statistically significant difference between the study and control groups in the first month. Also, there was a high statistically significant difference between the study and control groups in the second month.

Regarding diastolic blood pressure, the result of the current study showed that there was statistically significant difference between the study and control groups in the second month.

This came in accordance with the results done by Henrique et al. (2018)

and Reboredo et al. (2016) who stated that at the end of the exercise program, there was a statistically significant reduction in systolic blood pressure. Also, this finding was consistent with the findings of Miller et al. (2017) which showed that intradialytic exercises was safe during HD and led to significant reductions in systolic and diastolic blood pressure measurements.

Moreover, reduction of BP may be due to reduction of blood volume (reduction in the cardiac load), because of favorable effects of exercise on the peripheral vascular resistance, sympathetic nervous system activity and also possibly to the renin-angiotensin system according to Deligiannis et al. (2019).

The results of this study showed that the intradialytic range of motion exercises improved the blood pressure measurements of the study group. So, hypothesis (2) was accepted.

In relation to exercises performance: Intradialytic exercise is safe and effective but underutilized. It is well documented that dialysis patients have low levels of physical functioning and low exercise performance (Bennett et al., 2017). The present study showed that there were many benefits for intradialytic exercises for hemodialysis on dialysis efficacy and blood pressure. These findings came in line with Mohamed & Soliman (2015) who reported the benefits of exercise training on fatigue, electrolytes level and blood pressure in hemodialysis patients. Also, these findings were in agreement with Mohseni et al. (2018b) who reported that there was a positive effect of intradialytic exercise on dialysis efficacy in hemodialysis patients. Also, these findings were in agreement with Paluchamy & Vaidyanathan (2018a) who reported the positive effect of intradialytic exercise on dialysis adequacy, physiological parameters, biochemical markers and quality of life. Also Cheema et al. (2017) quoted that it is widely accepted that exercise is beneficial in patients with end stage renal failure and that it leads to improvement of physical functioning in general.

The present study presented that there was no statistically significant relation of total scores of exercises performance with socio-demographic characteristic as sex and educational level of study group two months post exercises. This finding was similar to Motedayen et al. (2017b) indicating that there was no statistically significant difference between the socio-demographic characteristics and the exercise performance of the study group.

Correspondingly, Paluchamy & Vaidyanathan (2018b) reported that exercises during hemodialysis session (intra dialtic) increased the muscle blood flow. Thereby, there was more removal of waste products and as a result there was an improvement in dialysis efficacy and improvement in blood pressure measurements.

Also, Abd El-Halim et al. (2017b) reported reduction of systolic and diastolic blood pressure after practicing intradialytic exercises for a period of three months. They reported that this reduction may be due to the effect of exercise on the peripheral vascular resistance, sympathetic nervous system activity and the renin-angiotensin system.

From the forgoing discussion, it can be concluded that the intradialytic range of motion exercises are effective non pharmacologic intervention for improving dialysis efficacy and blood pressure among hemodialysis patients.

Conclusions:

Based on the findings of this study, it can be concluded that:

1) Intradialytic exercises have a high significant effect on improving the dialysis efficacy (urea reduction ratio) among study group compared to control group undergoing hemodialysis.
2) The mean systolic and diastolic blood pressure measurements have been significantly improved among study group compared to control group after application of intradialytic exercises undergoing hemodialysis.

Recommendations:

A. Recommendations for patients:

- A health teaching program should be carried out for hemodialysis patients at hemodialysis unit about the importance of intradialytic exercises to help them improve their quality of life.
- A colored booklet about the disease, complications of hemodialysis, how to overcome it and intradialytic exercises should be available and distributed to all hemodialysis patients.

B. Recommendation for further researches:

- Replication of the study using a larger sample from different geographical areas is important to help generalize results.

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