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Original article

Impact of intradialytic exercise on fatigue, biochemical and physiological parameters in patients on maintenance hemodialysis - A pilot study - Part 1

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ABSTRACT

Introduction: Physical inactivity is most prevalent in hemodialysis population and is associated with a variety of unfavourable clinical outcomes. Fatigue and elevated biochemical markers are directly linked to decreased physical activity. Intradialytic exercise is one of the non-pharmacological interventions for end-stage renal disease (ESRD) patients receiving hemodialysis which is seldom implemented at most of the hemodialysis centers. This pilot study aims to evaluate the effect of intradialytic exercise program (IDEP) on fatigue and biochemical markers in endstage renal disease patients receiving hemodialysis.

Methods: Using quasi experimental design, forty patients from two dialysis centers were recruited and assigned randomly to intervention (n = 20) and control groups (n = 20). Patients in intervention group were taught IDEP for 25 min, two times a week along with routine care whereas control group patients received only routine care. Fatigue, biochemical and physiological parameters were assessed at baseline and at various time points after IDEP. In intervention group there was a gradual decrease in fatigue but the physiological and biochemical parameters such as haemoglobin, urea, creatinine, potassium, systolic blood pressure and diastolic blood pressure remained without much change. In control group, the level of fatigue did not change in most of the patients. In some patients there was an increase in fatigue level.

Conclusion: IDEP is a cost-effective, safe, complementary, non - pharmacological intervention for fatigue which can be performed under medical supervision during hemodialysis. IDEP incorporation in the routine care shall lead to improvement in the fatigue level but will not cost extra time for the patient.

1. Introduction

The prevalence of non-communicable diseases like chronic kidney disease (CKD) is increasing globally both in developed and developing countries. ESRD is the last stage of CKD where there is progressive deterioration of renal function and body fails to maintain metabolic, fluid electrolyte and acid-base balance. End products of protein metabolism accumulate in blood leading to uremia and other symptoms affecting all body systems. Dialysis or renal transplant is imperative for patient survival.[1] Patients receiving hemodialysis face a lot of complications which may be due to disease condition, dietary restriction, psycho-social and behavioural factors or dialysis itself. Fatigue is one of the important symptom experienced by hemodialysis patients and overlooked by healthcare personnel to a large extent. Fatigue is a phrase that refers to a general feeling of exhaustion or a lack of energy. This pilot study aims to evaluate the impact of IDEP on fatigue, biochemical and physiological parameters amongst ESRD patients undergoing hemodialysis.

1.1. Need for the study

Research reports discuss the positive benefits of exercise in patients receiving hemodialysis. During exercise blood vessels in active skeletal muscles vasodilate and the autonomic nervous system are engaged. Intradialytic exercise improves urea clearance by exposing more tissue and opening vascular beds in the working muscle, allowing fluid in the tissue to flow to the intravascular compartment. During exercise, ions such as potassium and phosphate are also shifted from the intracellular compartment to the muscle interstitial fluid.[2]

The results of a study which evaluated the effect of intradialytic exercise program on fatigue in hemodialysis patients indicated that there was a significant difference in the level of fatigue among

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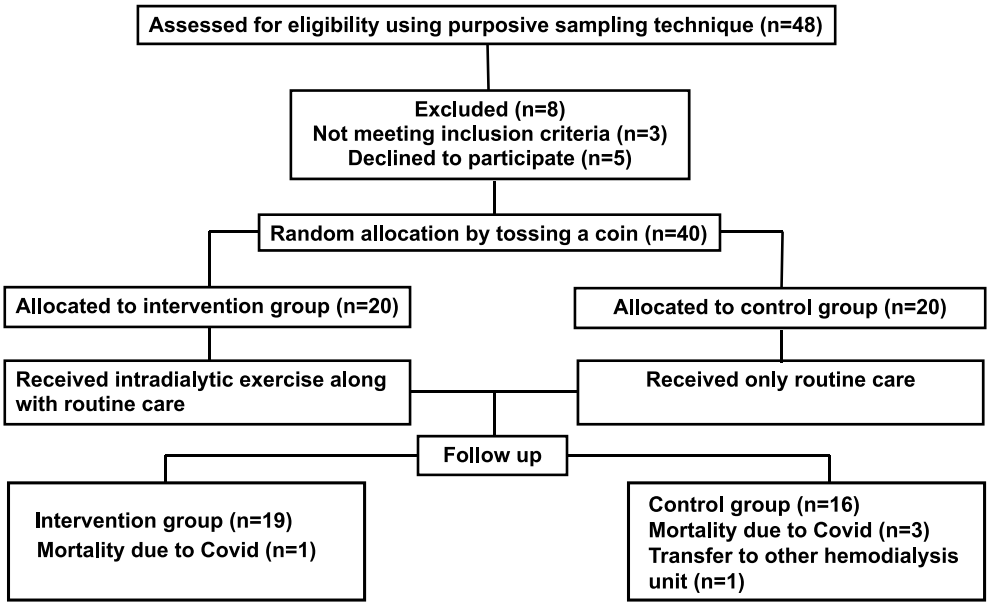

Fig. 1. Flow diagram of methodology.

experimental and control group after intradialytic exercise program. There was a significant difference in the level of fatigue in experimental group before and after intradialytic exercise program. The study concluded that intradialytic exercise program is an effective intervention in reducing the level of fatigue among hemodialysis patients.[3] In another pilot study program it was reported that intradialytic exercise is both safe and beneficial for hemodialysis patients.[4] Incorporating intradialytic exercise program for hemodialysis patients is relatively easy, inexpensive and requires not much of a preparation. But only very few such studies have been reported from India. Hence the investigator felt the need to take up such a study to evaluate the impact of intradialytic exercise program on hemodialysis patients.

Table 1
Analysis of Demographic Variables
Age, sex, education, dietary habit, smoking history and habit of exercise/yoga distribution of study participants.

Age	Group		Total
	Interventional (n = 19)	Control (n = 16)	
20–35	2 (10.5%)	7 (43.8%)	9 (25.7%)
36–50	6 (31.6%)	6 (37.5%)	12 (34.3%)
51–65	9 (47.4%)	3 (18.8%)	12 (34.3%)
66–80	2 (10.5%)	0 (0.0%)	2 (5.7%)
Gender			
Male	17 (89.5%)	8 (50.0%)	25 (71.4%)
Female	2 (10.5%)	8 (50.0%)	10 (28.6%)
Education Status			
No Formal Education	3 (15.8%)	1 (6.3%)	4 (11.4%)
Primary	4 (21.1%)	4 (25.0%)	8 (22.9%)
Secondary	7 (36.8%)	3 (18.8%)	10 (28.6%)
Higher Secondary	4 (21.1%)	5 (31.3%)	9 (25.7%)
Other	1 (5.3%)	3 (18.8%)	4 (11.4%)
Dietary Status			
Non-Veg	12 (63.2%)	14 (87.5%)	26 (74.3%)
Vegetarian	7 (36.8%)	2 (12.5%)	9 (25.7%)
Smoking History			
Current	2 (10.5%)	0 (0.0%)	2 (5.7%)
Past	6 (31.6%)	2 (12.5%)	8 (22.9%)
Nil	11 (57.9%)	14 (87.5%)	25 (71.4%)
Habit of doing Exercise/Yoga			
Daily	3 (15.8%)	0 (0.0%)	3 (8.6%)
Often	1 (5.3%)	0 (0.0%)	1 (2.9%)
Rarely	2 (10.5%)	0 (0.0%)	2 (5.7%)
Nil	13 (68.4%)	16 (100.0%)	29 (82.9%)

2. Methods

A quasi-experimental repeated treatment time series design was used to accomplish the aim to evaluate the impact of IDEP on fatigue, biochemical and physiological parameters. Initially hemodialysis patients were selected using purposive sampling technique based on the inclusion criteria of male and female patients aged between 20 and 80 years on maintenance dialysis for at least 3 months and the hemodialysis patients with uncontrolled hypertension, unstable angina, recent MI and lower limb amputation were excluded from the study. These 40 selected patients from Sri Siddhartha Medical College Hospital, Tumkur and District Hospital, Tumkur were randomly allocated to the intervention and control groups. Patients in intervention group were taught IDEP for 25 min, two times a week which comprised range of motion and resistance exercises for upper and lower extremities along with routine care whereas control group patients received only routine care (Fig. 1).

Multidimensional Fatigue Inventory (MFI 20) scale[5] was used to assess the fatigue level at various time points. MFI 20 scale items are classified under five components namely general fatigue, physical fatigue, reduced activity, reduced motivation and mental fatigue. For each item in the scale, score ranges from 1 to 5. Minimum score with the MFI 20 scale is 20 (20 items x 1) and maximum possible score is hundred (20 items x 5). With this scale, higher the score for a patient, higher is the fatigue. The original language of MFI 20 scale was English and this tool was translated into a vernacular language (Kannada) and reliability of the translated tool was established using Cronbach's Alpha test. Biochemical and physiological parameters were monitored at various time points. Biochemical parameters of haemoglobin, urea, serum creatinine and potassium were obtained from patient record and systolic and diastolic blood pressure were monitored by investigator.

2.1. Ethical consideration

Institutional review board approval (SSMC/Ph.D/IEC-1/Jan-2019) was obtained from Sri Siddhartha Medical College Ethics Committee, Tumkur. This trial has been registered in the "Clinical Trials. gov" (CTRI/2020/02/023367). Permission has been obtained from concerned authority to collect data. Informed consent was obtained from all the participants of the study. The participants were informed that their

Table 2
Analysis of clinical variables.

Frequency of Dialysis	Group		Total
	Interventional (n = 19)	Control (n = 16)	
Weekly Twice	11 (57.9%)	15 (93.8%)	26 (74.3%)
Weekly Thrice	8 (42.1%)	1 (6.3%)	9 (25.7%)
Duration of dialysis			
3–6 Months	6 (31.6%)	0 (0.0%)	6 (17.1%)
6–12 Months	1 (5.3%)	0 (0.0%)	1 (2.9%)
1–3 Years	7 (36.8%)	5 (31.3%)	12 (34.3%)
>3 Years	5 (26.3%)	11 (68.8%)	16 (45.7%)
Comorbidity			
Hypertension	18 (94.7%)	16 (100.0%)	34 (100.0%)
Diabetes mellitus	10 (52.6%)	3 (18.8%)	13 (100.0%)
Anaemia	3 (15.8%)	3 (18.8%)	6 (100.0%)
Erythropoeitin Treatment			
Yes	19 (100.0%)	16 (100.0%)	35 (100.0%)
No	0 (0.0%)	0 (0.0%)	0 (0.0%)

participation in the study was entirely voluntary and they may withdraw from the study anytime.

2.2. Data analysis

SPSS version 20 was used for the statistical analysis of the data. All the study variables were tested for normality using the Kolmogorov Smirnov test and was found to be normally distributed. Hence descriptive statistical parameters of mean, standard deviation and percentage were calculated for socio-demographic and clinical information and parametric test of independent *t*-test was used for inter group comparison and repeated measures ANOVA test for intra group comparison. In this analysis, independent variable is IDEP and dependent variables were fatigue, biochemical and physiological parameters.

3. Results

3.1. Descriptive characteristics

Amongst 35 patients (n = 19 in intervention group and n = 16 in control group), majority were between the age group of 36–65 years (68.6%), 25.7% were between the age group of 20–35 years and only 5.7% of them were between 66 and 80 years. In terms of gender, 25 were males and 10 were females. Out of 35 patients, 4 had no formal education, 8 had primary level, 10 had secondary level and 9 higher secondary level and 4 undergraduate level of education. 8 of the patients had past history of smoking, 2 had current habit of smoking and 25 were non-smokers. Majority of the patients (82.9%) did not have the habit of doing exercise or yoga (Table 1).

Analysis of clinical proforma showed that 26 of the patients were undergoing hemodialysis weekly twice and 9 of them weekly thrice. In terms of duration of hemodialysis, 45.7% of the patients were on maintenance hemodialysis for more than 3 years, 34.3% for 1–3 years and 17.1% for 3–6 months. Most of the hemodialysis patients were hypertensive (34 out of 35) and some were diabetic (13 out of 35) and a

Table 3
Comparison of Fatigue between and within groups (MFI 20).

Time	Interventional	Control	t-value	P-value
General Fatigue				
Baseline	4.04 ± 0.64	3.61 ± 0.85	1.715	0.096
Day7	3.64 ± 0.85	3.64 ± 0.86	0.014	0.989
Day15	3.20 ± 0.94	3.61 ± 0.84	−1.353	0.185
1 Month	2.86 ± 1.01	3.78 ± 0.81	−2.948	0.006
3 Months	2.54 ± 1.07	3.92 ± 0.90	−4.082	0.000
F-value	72.333	4.114		
P-value	<0.001	0.005		
Physical Fatigue				
Baseline	4.36 ± 0.64	3.55 ± 0.98	2.930	0.006
Day7	3.97 ± 0.82	3.53 ± 0.97	1.459	0.154
Day15	3.58 ± 0.90	3.50 ± 0.86	0.264	0.793
1 Month	3.18 ± 0.99	3.66 ± 0.79	−1.539	0.133
3 Months	2.84 ± 1.12	3.83 ± 0.98	−2.735	0.010
F-value	55.25	3.018		
P-value	<0.001	0.025		
Reduced Activity				
Baseline	4.39 ± 0.50	3.86 ± 0.99	2.064	0.047
Day7	4.04 ± 0.72	3.88 ± 0.98	0.571	0.572
Day15	3.62 ± 0.90	3.80 ± 0.96	−0.569	0.573
1 Month	3.26 ± 0.96	3.97 ± 0.91	−2.221	0.033
3 Months	2.75 ± 1.12	3.94 ± 0.96	−3.325	0.002
F-value	59.883	0.916		
P-value	<0.001	0.46		
Reduced Motivation				
Baseline	3.93 ± 0.82	3.08 ± 1.34	2.319	0.027
Day7	3.59 ± 0.97	3.08 ± 1.35	1.306	0.200
Day15	3.09 ± 1.04	3.05 ± 1.35	0.112	0.911
1 Month	2.75 ± 1.06	3.13 ± 1.18	−0.993	0.328
3 Months	2.41 ± 1.09	3.28 ± 1.25	−2.201	0.035
F-value	46.499	1.523		
P-value	<0.001	0.207		
Mental Fatigue				
Baseline	3.53 ± 1.08	3.17 ± 1.26	0.894	0.378
Day7	3.05 ± 1.14	3.20 ± 1.23	−0.376	0.709
Day15	2.79 ± 1.09	3.13 ± 1.20	−0.867	0.392
1 Month	2.46 ± 1.05	3.17 ± 1.09	−1.963	0.058
3 Months	2.14 ± 1.05	3.27 ± 1.27	−2.862	0.007
F-value	37.747	0.534		
P-value	<0.001	0.711		

Table 4
Comparison of biochemical and physiological parameters between and within groups.

Time	Interventional	Control	t-value	P-value
Hemoglobin				
Baseline	9.06 ± 1.13	8.59 ± 0.77	1.412	0.167
1 Month	9.06 ± 1.18	8.53 ± 0.75	1.563	0.128
3 Months	9.03 ± 1.23	8.66 ± 0.68	1.069	0.293
F-value	0.09	1.675		
P-value	0.914	0.204		
Serum creatinine				
Baseline	8.57 ± 3.17	8.87 ± 1.90	−0.332	0.742
1 Month	8.32 ± 2.95	8.88 ± 2.01	−0.643	0.525
3 Months	7.60 ± 3.07	8.99 ± 2.04	−1.551	0.130
F-value	1.973	0.981		
P-value	0.154	0.387		
Serum urea				
Baseline	115.58 ± 55.31	133.56 ± 35.06	−1.123	0.270
1 Month	118.32 ± 46.36	135.50 ± 35.44	−1.213	0.234
3 Months	119.21 ± 46.58	135.63 ± 35.88	−1.150	0.258
F-value	0.352	3.029		
P-value	0.706	0.063		
Serum potassium				
Baseline	5.27 ± 0.83	5.54 ± 0.64	−1.067	0.294
1 Month	26.48 ± 92.63	5.63 ± 0.64	0.898	0.376
3 Months	5.16 ± 0.79	5.66 ± 0.74	−1.900	0.066
F-value	0.997	2.3		
P-value	0.379	0.118		
Systolic Blood Pressure				
Baseline	154.74 ± 11.24	147.50 ± 9.31	2.050	0.048
SBP Day 7	147.89 ± 13.57	144.38 ± 10.94	0.834	0.410
Day 15	149.47 ± 17.15	144.38 ± 11.53	1.011	0.319
1 Month	146.84 ± 11.57	145.00 ± 9.66	0.505	0.617
3 Months	146.84 ± 17.65	142.50 ± 9.31	0.884	0.383
F-value	1.645	1.182		
P-value	0.172	0.328		
Diastolic Blood Pressure				
Baseline	83.16 ± 9.46	83.75 ± 5.00	−0.225	0.823
Day 7	84.74 ± 9.64	84.38 ± 5.12	0.135	0.894
Day 15	83.16 ± 10.57	82.50 ± 4.47	0.232	0.818
1 Month	82.63 ± 8.06	82.50 ± 4.47	0.058	0.954
3 Months	83.16 ± 10.03	83.13 ± 4.79	0.012	0.990
F-value	0.235	0.443		
P-value	0.918	0.777		

few were anemic (6 out of 35). All the patients were receiving erythropoietin treatment (Table 2).

4. MFI 20 average fatigue score comparison between and within group

4.1. General fatigue

After 1 month and 3 months, there is statistically significant difference in fatigue score between intervention and control group indicating that IDEP was effective in reducing general fatigue. General fatigue within intervention group has gradually reduced and the p value of <0.001 indicates that the IDEP was effective (Table 3).

4.2. Physical fatigue

There was a significant difference in fatigue score only at 3 months between intervention and control group. Within the intervention group, there was a statistical decrease of fatigue score and the p value is < 0.001 (Table 3).

4.3. Reduced activity

At 1 month and 3 months of IDEP, there was significant difference between intervention and control group. Within intervention group, there was a gradual decline in fatigue score indicating that IDEP was effective (Table 3).

4.4. Reduced motivation

There is significant difference between intervention and control group at 1 month and 3 months of IDEP indicating that the intervention was effective. The average fatigue score of intervention group has gradually reduced showing that there was a statistical decrease of fatigue in intervention group (Table 3).

4.5. Mental fatigue

Between intervention and control group there is statistical difference at 15 days,1 month and 3 months of IDEP, indicating that the intervention was effective. Whereas within intervention group, there is a gradual decline in fatigue score and p value of < 0.001 indicating that there is a decrease in fatigue score over a period of time. Even at 1 month of IDEP, there was no significant difference between intervention and control group with respect to physical fatigue average score. But with respect to the other four components of general fatigue, reduced activity, reduced motivation and mental fatigue, there was a statistical difference between fatigue score of intervention and control group within 1 month of IDEP. In all 5 components of MFI 20, there was gradual decline in fatigue score at various time points in intervention group indicating that IDEP was effective.

4.6. Biochemical and physiological parameters

Biochemical parameters such as hemoglobin, serum creatinine, serum urea and serum potassium were obtained from clinical records at

the time points of baseline after one month and after 3 months of intradialytic exercise program. Physiological parameters such as systolic blood pressure and diastolic blood pressure were monitored for the hemodialysis patients at the time points of base line after 7 days after 15 days after 1 month and after 3 months of intradialytic exercise program. In terms of physiological and biochemical parameters there was no significant difference observed between intervention group and control group. Similarly there was no significant difference found in terms of physiological and biochemical parameters within the intervention group itself (Table 4).

5. Discussion

The results of the current study demonstrated that three months intradialytic exercise program is effective in improving fatigue but did not make any change in the biochemical and physiological parameters amongst the hemodialysis patients. The results of the previous studies have concluded that intradialytic leg exercise program was effective in reducing fatigue and improving quality of life of patients undergoing hemodialysis.[6] A study conducted using pre test post test with the sample size of 60 concluded that exercise program during hemodialysis improved patients quality of life and reduced fatigue. This study also recommended that exercise program for renal failure patients should be planned during hemodialysis.[7]

Another study results show that after 8 weeks of intradialytic range of motion exercise program a significant reduction was seen in patients fatigue level, serum phosphate, potassium, calcium, urea, creatinine and slight increase in haemoglobin level. Also systolic blood pressure and diastolic blood pressure changed significantly in experimental group. The study concluded that a simplified physical exercise program may be considered as a safe and effective clinical nursing modality in patients with end stage renal disease on Hemodialysis.[8] The overall study results indicate that intradialytic exercise program is effective in reducing fatigue but did not show any improvement in biochemical and physiological parameters.

To summarise, in this present study, intradialytic exercise program did not have any significant impact on the biochemical and physiological parameters of the hemodialysis patients. There are similar studies conducted in the past. One such experimental research aimed to determine the effect of exercise during hemodialysis on the efficacy of dialysis amongst chronic kidney disease patients. Upon analysis statistically significant improvement was seen in the blood urea, nitrogen and slight improvement in hemoglobin level whereas there was no significant difference in the creatinine, URR and Calcium level.[9] One more non-randomized trial study aimed to study the effect of intradialytic exercise with the sample size of 22 patients. Combination of aerobic exercise with bicycle ergometer and anaerobic exercise with elastic bands was conducted during dialysis. Biochemical laboratory results were collected at baseline, after 3 months and after 6 months. The results obtained showed that there is no significant change in dry weight, blood pressure, Kt/V and biochemical variables.[10]

6. Conclusion

Although intradialytic exercise is safe, effective, feasible and beneficial for hemodialysis patients, exercise programs are not a part of routine clinical practice in many dialysis centers in India even now. In addition this pilot study has enabled the investigator to understand the other issues faced by hemodialysis patients such as psychosocial, financial, interdialytic problems etc which were not a part of the present study variables. Further studies and case reports are needed to get an insight into these aspects and develop comprehensive interventional package for hemodialysis patients during dialysis.

Declaration of competing interest

The author(s) confirm that this article's content has no conflicts of interest.

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