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Effect of Prophylactic Intra-dialytic Stretching Exercises (IDSE) on Muscle Cramps among Patients Undergoing Hemodialysis: A Single Blind experimental Study

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Abstract

Background: Muscle cramps are one of the common complications among patients with Chronic Kidney Diseases during their hemodialysis. Non-pharmacological based physical interventions are proposed to have effect on controlling the muscle cramps.

Aim: To investigate the effect of a prophylactic intra-dialytic calf stretching exercise programme on muscle cramps among patients undergoing hemodialysis.

Methods: A posttest only design was used. A group of patients on regular hemodialysis were randomly assigned as study group (n=32) and control group (n=32) at a South Indian tertiary hospital. Socio-demographic and clinical variables were collected. Study group patients were given passive calf stretching exercise at the end of second hour of hemodialysis. Patients are observed for the occurrence of muscle cramps and its characteristics (intensity, duration and frequency) during the next two hours of the hemodialysis session.

Results: The study group participants showed a significant decrease in the intensity (1.6 +/- 2.8 against 6.03+/- 4.7) ('t' 4.42, (P<0.001) duration (1.4+/- 3.3 against 6.9+/-5.4) ('t'5.57, P<0.001) and frequency (.30+/- .54 against1.3+/-1.44) (t value of 2.695, P<0.001) of muscle cramps compared to the control group during post intervention measurement. The intensity of muscle cramps of study group differed from control group significantly during third hour ('t' 3.76 (P< 0.001) and fourth hour (t=3.11(P<0.01) of hemodialysis.

Conclusions: This study proves that prophylactic; intra- dialytic calf stretching exercise is effective in reducing the intensity, duration and frequency of muscle cramps among patients undergoing hemodialysis. Further studies can utilise electro-myographic evidence of decreased muscle and nerve activity following a stretching exercise.

Key words: muscle cramps, intra-dialytic stretching exercise, Chronic Kidney Disease, hemodialysis, experimental design

Introduction

The prevalence of chronic kidney diseases **(**CKD)is increasing worldwide with the percentage of patients in stage 3-5 CKD being 10.6 [(1)]. India has a varying prevalence of up to 13% for CKD. A south Indian study [(2)] conducted in the rural areas identified that 6.3% of the cohort were affected by stage 3 CKD. Approximately 100,000 CKD patients are undergoing hemodialysis in India for survival, as renal transplantation is more expensive [(3)].

The acute complications experienced by patients during hemodialysis are many. They include weakness, cramps, pain [(4)], nausea and vomiting [(5)]hypotension and headache [(6)] . Muscle cramps are essentially distressing for the patient and are reported among 43% of random samples (4).Overall, 7.5% of hemodialysis patients suffered cramps always and 60% frequently [(7)]. The incidence of cramps was reported in 2-3% of the dialysis sessions [(8)]with the mean pain score of cramps being 5.75 [(7)].

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A cramp is a prolonged involuntary muscle contraction that occurs in a muscle when it is already in its most shortened position [(6)]. Muscle cramps are often managed by pharmacological approaches such as Carnitine supplements and gabapentine[(9)] and non-pharmacological approaches like acupressure[(10)] reflexology [(11)]and calf muscle massage [(12)]. Sometimes cramps are also managed by stopping the dialysis for a short period till cramps are relieved or by infusing IV fluids. Since such interventions could not relieve the problem sometimes, the patients may have to discontinue the dialysis and thus results in chronic fluid overload.

The reasons for cramps during hemodialysis include hypoperfusion, electrolyte imbalance, carnitine depletion etc. and results in calf muscle shortening. The existing pharmacological measures are aimed at correcting these chemical imbalances. Conversely, the non-pharmacological measures mentioned above are employed after the muscle cramps has occurred. The investigators were looking for a non invasive, non-pharmacological intervention which can be safely employed for the dialysis patients and also can prevent the muscle cramps before it occurs. There are evidences supporting the

effectiveness of stretching exercises during dialysis for relieving an already cramped muscle. It had been suggested that stretching a muscle prophylactically can reduce the muscle cramps[13]. Thus in the current study, we aimed at employing this IDSE intervention prophylactically during hemodialysis to prevent cramps.

Electro Myo graphic (EMG) activity was very high during muscle cramps [6].Passive stretching relieves muscle cramps by inverse stretch reflex activation [13].In an observational study, which monitored 46 dialysis sessions completely, by recording the EMG activity from a leg muscle of a cramping patient, It was proved that the muscle cramps started after an average 248 minutes after beginning a dialysis and the average duration of a cramp was 10 minutes. There was also a continued increase in the tonic EMG activity in cramping patients during the later part of dialysis[14]. Viewing this and also from the interaction with the dialysis unit nurses, it was inferred that muscle cramps occurred towards the end of hemodialysis and we chose to employ the intervention at the end of the second hour of a four hours dialysis session. Since muscle cramps occur inconsistently among patients and across hemodialysis sessions, this study aim to compare the cumulative incidence, intensity and duration of muscle cramps between the study group with IDSE and control groups at specific point of time.

Methods:

Design

A post-test only experimental design was utilised to assess the effect of IDSE on muscle cramps.

Subjects:

The target population of the study was the patients who were subjected to hemodialysis in the nephrology unit of a selected tertiary care hospital in south India. We approached 96 patients who were undergoing regular hemodialysis. 64 patients who fulfilled the selection criteria and consented to participate were randomized into the study (n=32) and control group (n=32) using simple lottery method. Adult patients subjected to hemodialysis of four hours duration first time in the week were included in the study. We also excluded those who underwent emergency hemodialysis and with femoral catheters/any lower limb pathology.

Setting

The hemodialysis unit of the selected hospital is attached to the nephrology unit and has a bed strength of 30. Hemodialysis services are available round the clock with regular out-

patients attending the service during day time. Night services were limited to the emergency patients and in-patients. The setting had advanced facilities and there was a separate section to cater to the infected patients.

Intervention

We prophylactically employed calf muscle stretching exercise at the end of the second hour of a four hour hemodialysis session, for experimental group. During the next two hours, the subjects were asked to report on the occurrence of any muscle cramps. On the other hand, standard care interventions were continued for all participants irrespective of their study group status. The calf muscles were stretched passively by physiotherapy professional for 3-4 minutes after a warming up period. The calf stretching included separate manures for the gastrocnemius and soleus. Each stretch was offered for 30 seconds and employed for both legs. The average time spent for each patient was 15 minutes.

Calf stretching exercises:

Gastrocnemius stretch: the stretching started with warming up. At first we allowed the patient to bend and extend his lower limbs 3-4 times for warming up. Then the therapist stood on the side of the cot facing the patient with her distal leg flexed. The therapist supported the flexed proximal knee joint of the patient with one palm and pulled the heel down slowly and flexed the foot simultaneously with her inner forearm of the other hand till the patient reported a feeling of stretch in the calf region. This stretch was maintained for 30 seconds and then released slowly. The exercise was repeated for three times with rest period in between.

Soleus stretch: The therapist started the same way as for gastrocnemius stretch till the patient reported a stretch in the calf region. Then the support for knee joint was released. Maintaining pull on the heel, therapist slowly pushed the knee joint down from the flexed position till it is flat on the bed. This stretch was maintained for 30 seconds and slowly released. The exercise was repeated for three times with rest period in between.

Description of the instrument

The instrument consisted of two parts – Part I and II. In part I of the instrument, we utilized demographic (name, age, sex, education, life style) and clinical data sheet (practice of physical exercises, previous experience of muscle cramps, coping strategies adopted, weight of fluid removed during dialysis, number of reuse of dialyser, frequency of dialysis, systemic illnesses, use of membrane

stabilizing agents and frequency of medication use). Part II of the instrument collected the details of three characteristics of muscle cramps namely intensity, duration and frequency.

Data collection procedure

The study followed the guidelines of institutional ethics committee. Informed consent was obtained from each participant. The demographic and clinical variables of the participants were collected in the waiting room of the dialysis unit by the staff in-charge. The participant was then accompanied to the dialysis room and was helped to settle down. The investigator was available in the dialysis unit across the regular shifts. The services of the physiotherapy internees who were on rotatory posting in the dialysis unit was availed for employing the stretching exercise for the study group participants, whose stretching technique was standardized through a pre-intervention training session. The participants were watched for muscle cramps in the post intervention period. Posttest measurements were done by the investigator to ensure uniformity but was blinded towards the participation status of the patient. The intensity of muscle cramps was assessed using the modified numerical intensity scale. Scoring was done based on the patients report after the cramp was settled. The score were interpreted as 0- no cramps, 1 – 3 Mild, 4 – 7 Moderate and 8 – 10 severe. Duration was noted down in minutes and frequency was described as the number of muscle cramps reported in the last two hours of the dialysis session. When the patient reported muscle cramps more than once during the measurement period, the intensity and duration were averaged for the total events.

Statistical analysis

The collected data were grouped and analysed using descriptive and inferential statistics using SPSS package. Descriptive methods of frequency and percentage were used to describe characteristics of the sample and muscle cramps. The mean and standard deviation for the duration, frequency and intensity of cramps were also calculated. Inferential statistics used was independent‘t’ test for between the group comparisons of the effect of intra-dialytic stretching exercises on muscle cramps.

Results

The data collection was at a single point of contact. Two participants of the control group could not complete the four hours of hemodialysis due to severe muscle cramps. One participant from the study group developed breathlessness during dialysis and another had poor flow pressure in the circuit.

Since the dialysis sessions were interrupted for these patients, they were excluded and analysis was done for 30 patients in the study group and 30 in the control group. 15 (50%) of the study group patients belonged to the age group of 51-60 years while, 13 (43.3%) of the control belonged to 41-50 years category. The study group was composed of males and females of equal proportion i.e 15 each (50%) (Table1). At the same time, control group consisted of 13 male patients (43.3%) and 17 females patients (56.7%). When samples were analysed for their life style, 21 patients (70%) of experimental group were active and no one led sedentary life. Similarly, in the control group, 17 patients (56.6%) had limited activity and two patients (6.6%) were leading sedentary life. Three patients (10%) of experimental group and one patient (3.3%) of control group were regularly doing physical exercise. 17 patients (56.7%) of the experimental group had previous experience of muscle cramps, while 22 patients (73.3%) in the control group suffered a cramp before. Out of 39 patients who experienced muscle cramps in the sample, 28 patients (46.6%) employed massaging, two patients (3.3%) applied heat locally for relief of cramps.

On the day of data collection, 10 patients (33.3%) of the experimental group and 14 patients (46.7%) of the control group had their weight removed between 4-5 Kg. 15 patients (50%) of the experimental group and 19 patients (63.3%) in the control group were undergoing dialysis twice weekly.13 study group patients (43.3%) and 11 (36.7%) in the control group reported third or fourth reuse of the dialyser. The highest number of co-morbidity reported among the sample was hypertension with 19 patients (63.3%) of the experimental group and 23 patients (76.7%) of the control group were known hypertensives. A total of five patients (8.3%) of the sample used membrane stabilizing agents to relieve muscle cramps.

Effect of IDSE on intensity of muscle Cramps among Hemodialysis patients

The study showed that there is a significant difference in the numerical intensity scale score of muscle cramps between experimental and control group at level of $P< 0.001$. It was identified that in the post test, 22 (73.3%) of the control group patients experienced muscle cramps. The mean intensity of muscle cramps in the study group was 1.6 +/- 2.8 against 6.03+/- 4.7 in the control group (Table 2).This difference was statistically significant with t 4.42 ($P<0.001$).

Also, the intensity of muscle cramps was calculated for the third hour for study group (.33 +/- 1.24) and control group(2.4 +/-2.77). The mean values differed significantly with

Table 1 Demographic and clinical characteristics of sample (N=64)

Serial Number	Item	Study Group		Control Group	
		n	%	n	%
1	**Age in years**				
	a. 21 – 30	1	3.3	-	
	b. 31 – 40	3	10.0	3	10.0
	c. 41 – 50	11	36.7	13	43.3
	d. 51 – 60	15	50.0	4	46.7
2	**Sex**				
	a. Male	15	50.0	13	43.3
	b. Female	15	50.0	17	56.7
4	**Life style**				
	a. Active	21	70.0	11	36.7
	b. Limited Activity	9	30.0	17	56.7
	c. Sedentary	-	-	2	6.7
5	**Practice of physical exercise**				
	a. Regular	3	10.0	1	3.3
	b. Occasional	1	3.3	3	10.0
	c. Not practicing	26	86.7	26	86.7
6	**Previous experience of muscle cramps**				
	a. Yes	17	56.7	22	73.3
	b. No	13	43.3	8	26.7
7	**Coping strategies adopted for muscle cramps**				
	a. Standing / Walking	1	5.9	5	22.7
	b. Massaging	14	82.4	17	77.3
	c. Hot / Cold Application	-	-	-	-
	d. Medications	2	11.8	-	-
8	**Weight of fluid removal during dialysis**				
	a. < 2 Kg.	8	26.7	4	13.3
	b. 2 - 3 Kg	9	30.0	9	10.0
	c. 3 - 4 Kg	3	10.0	3	30.0
	d. 4 - 5 Kg.	10	33.3	14	46.7
	e. ≥ 5 Kg.	-	-	-	-
9	**Repeated use of dialyser**				
	a. 1 – 2	7	23.3	8	26.7
	b. 3 – 4	13	43.3	11	36.7
	c. 5 – 6	9	30.0	10	33.3
	d. > 6	1	3.3	1	3.3
10	**Frequency of dialysis (Per week)**				
	a. 1	9	30.0	4	13.3
	b. 2	15	50.0	19	63.3
	c. 3	6	20.0	7	23.3
11	**Systemic illnesses**				
	a. Diabetes Mellitus	6	20.0	6	20.0
	b. Hypertension	19	63.3	22	73.3
	c. None	5	22.7	2	11.8
12	**Use of membrane stabilising agents for muscle cramps**				
	a. Yes	2	6.7	7	23.3
	b. No	28	93.3	23	76.7

value of 3.76 at *P*< 0.001(Table 3).Similarly, the comparison of mean scores of intensity of the muscle cramps between the study (1.3 +/- 2.5) and control group (3.6 +/-3.18)during the fourth hour of hemodialysis showed a statistically significant difference at *P*<0.01(t=3.11).

Effect of IDSE on duration of muscle Cramps among Hemodialysis patients

There is a significant difference between the experimental and control group in terms of duration of muscle cramps at level of *P* < 0.00. The mean duration of the muscle cramps was 1.4+/- 3.3 minutes in the study group and 6.9+/-5.4 minutes in the control group (Table 2) and there was a statistically significant difference between the groups with t 5.57 (*P*<0.001).

Likewise, the mean duration of muscle cramps of the study group (.33+/- 1.27) and control group (2.8+/-3.12) during the third of hemodialysis differed significantly (table 3) with 't' values 4.04 (*P* <0.001). The mean duration on cramps during fourth hour for the study group was 1.23+/-2.8 and 4+/- 3.6 for the control group. These mean values had significant difference with't'3.46 (*P* <0.001).

Effect of IDSE on frequency of muscle Cramps among Hemodialysis patients

The difference between the experimental and control group in terms of frequency of muscle cramps is statistically significant at the levels of P < 0.01.The mean frequency of muscle cramps in the study group was .30+/- .54 in the study group and 1.3+/-1.44 in the control group (Table 2) and the comparison of means showed a statistically significant difference between the groups with t value of 2.695 (*P*<0.001).

The same way, The mean frequency of muscle cramps of the study group (.06+/-.63) and control group (.7+/-.86) during the third hour of hemodialysis differed significantly with 't' value of 3.36 (*P* <0.01). Similarly, the fourth hour mean value of frequency of study group (.23+/- .42) and control group (.73+/-.73) differed significantly with t value and 3.33 (*P* <0.01) (Table 3).

Table 2

Comparison of intensity, duration and frequency scale score of muscle cramps between study and control groups (N = 60).

Variable	Group	Mean	SD	Paired 't' Value
Intensity	**Study Group**	1.6	2.8	4.42***
	Control Group	6.03	4.7	
Duration	**Study Group**	1.40	3.3	5.57***
	Control Group	6.9	5.4	
Frequency	**Study Group**	0. 30	0.54	2.695***
	Control Group	1.3	1.44	

****** P<0.001***

Table 3

Comparison of intensity, duration and frequency of muscle cramps among experimental and control group during III and IV hour of hemodialysis (n = 30)

Variable	Hours of Observation	Study Group		Control Group		't' Value
		Mean	SD	Mean	SD	
Intensity	III Hr	0.33	1.24	2.4	2.77	3.76 ***
	IV Hr.	1.3	2.5	3.6	3.18	3.11 **
Duration	III Hr	0.33	1.27	2.8	3.12	4.04 ***
	IV Hr.	1.23	2.8	4	3.6	3.46***
Frequency	III Hr	0.06	0.628	0.7	0.86	3.36 **
	IV Hr.	0.23	0.423	0.73	0.726	3.33 **

****** P < 0.001 ** P < 0.01***

Discussion

The study was conducted in the day care setting and this assured close monitoring and one to one exercise intervention. The intervention was employed by trained professionals. Moreover, the investigator who did posttest measurement was blinded towards the study/ control status of the participants. One of the methodological limitations identified was the medication status of the samples. The main groups of drugs taken by the samples were anti-hypertensive and carnitine preparations. The dose and frequency of these drugs were not uniform among the study and control groups. Moreover, the ultra-filtration rates of the dialysis sessions were not considered for its impact on the occurrence of muscle cramps.

The study was conducted with an aim to evaluate the effect of IDSE on intensity, duration and frequency of muscle cramps among patients undergoing hemodialysis when employed prophylactically. Our study identified that IDSE intervention was effective in reducing the frequency, intensity and duration of muscle cramps among patients undergoing hemodialysis. The mean values of the study group and control group for the above mentioned parameters differed significantly at statistical level $p<0.001$. These findings were similar to the report of an intervention study which identified a significant difference in reduction frequency of muscle cramps between the study and control group (0.8 episodes vs. to 0.4 episodes, P=0.44) following a massage intervention[12]. The reduction in the intensity of muscle cramps resonates the change in the severity of cramps from 5.34+- 3.61 to 3.89+- 3.94 (P=.003) in an experimental study done among hemodialysis patients[15]. Though we did a detailed literature search for evidence of reduction of duration of muscle cramps following an intervention, we could hardly find any. Thus the significant reduction in the duration of cramps following a prophylactic IDSE intervention in the current study stands unique and set a base for comparison for the future studies about the parameter.

The exact mechanism of reduction of muscle cramps were based on the concepts that cramps results from sudden electrolyte and fluid depletion during dialysis which is evident after half of the process. Calf muscles being the dwelling space of more than 20% of cardiac output, the stretching will redistribute the fluid and electrolytes causing reduction of cramps. Simultaneous evaluation of electrolyte values before, during and after the dialysis will further help to explain this finding.

Conclusion

Hemodialysis patients are at high risk for developing muscle cramps. The study ascertains that prophylactic stretching of the cramping muscles reduce the frequency, duration and intensity of cramps. It is necessary to assess the prevalence of muscle cramps among hemodialysis patients at different settings, dialysis duration, co-morbidities, medications and technical backgrounds to timely intervene the cramps and to ensure effective uninterrupted dialysis treatment. We recommend the study to be replicated with larger samples. The effect of the IDSE intervention can be tested and compared for its effectiveness among hemodialysis and peritoneal dialysis patients. The study can be replicated with the samples with similar medication prescription and the ultra-filtration rate. We strongly suggest the study can be replicated with bio-physiological parameters as dependent variables for better objectivity.

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