Original Article

Physiotherapy and Occupational Therapy Journal
Volume 14 Number 3, July – September 2021
DOI: http://dx.doi.org/10.21088/potj.0974.5777.14321.2

Immediate Effects of HIIT on Vital Parameters in Patients with CKD Undergoing Hemodialysis: A Pilot Study

[1]Aishwarya Ramraje, [2]Abhijit Diwate, [3]Arijit Kumar Das, [4]Archana Nagargoje

How to cite this article:
Aishwarya Ramraje, Abhijit Diwate, Arijit Kumar Das, Archana Nagargoje, Immediate Effects of HIIt on Vital Parameters in Pati -ents with CKD Undergoing Hemodialysis: A Pilot Study. Physiotherapy and Occupational Therapy Journal. 2021; 14(2):17-20

Author's Affiliations: [1]MPT Student, [2]Professor & HOD, [3]Associate Professor, [4]Assistant Professor, Department of Physiotherapy in Cardiovascular and Respiratory Sciences, Dr Vithalrao Vikhe Patil Foundation' College of Physiotherapy, Ahmednagar, Maharashtra 414111, India

Corresponding Author: Aishwarya Ramraje, MPT Student, Department of Physiotherapy in Cardiovascular and Respiratory Sciences, Dr Vithalrao Vikhe Patil Foundation' College of Physiotherapy, Ahmednagar, Maharashtra 414111, India.

Email: aishwaryaramraje13@gmail.com

Abstract

Background: In Chronic Kidney Disease (CKD), the kidney doesn't function, and Hemodialysis (HD) is the only treatment choice. However, patients undergoing HD have significantly reduced cardiorespiratory fitness and quality of life. HIIT elicits a more significant change in cardiorespiratory fitness. However, literature is insufficient on intradialytic exercises and HIIT for patients undergoing hemodialysis. Hence, this study aims to determine the immediate effects of HIIT on vital parameters in patients undergoing hemodialysis. ***Methods:*** In this pilot study, nine patients with CKD undergoing HD for more than three months with age ranging between 20- 75 years and who were vitally stable were included from the Dialysis Unit of Tertiary care teaching hospital. Patients with acute infection, unstable angina pectoris, severe arrhythmias, uncontrolled hypertension were excluded. After obtaining written consent from every participant, they performed HIIT on the bed cycle ergometer for 20 minutes on the bed in the supine position during dialysis. Efficacy was measured at baseline and immediately after the intervention from the change in Heart rate, Blood pressure and Oxygen Saturation. ***Results:*** All the participants completed the HIIT exercise without any complication in the given time. A significant change in HR values with a P-value of <0.006 was observed as HR increased within the target heart rate limits. However, there was no statistically significant change in values of SpO2 and BP with a P-value of <0.8 and < 0.6, respectively. ***Conclusions:*** This study demonstrated HIIT as a feasible and safe method for intradialytic exercise and emphasizes the importance of intradialytic exercises.

Keywords: HIIT; Intradialytic Exercise; CKD.

Introduction

Chronic kidney disease (CKD) are heterogeneous disorders affecting the kidney and its function. CKD includes progressive and irreversible destruction of the loss of renal functions leading to accumulation of toxins and fluids in the body. Increasing incidence and prevalence in CKD have been reported in many other countries maintaining renal dialysis and the rate of CKD. For patients with CKD stages 4 and 5, hemodialysis (HD) has been the only treatment choice other than kidney transplant[1]. Patients with CKD undergoing haemodialysis have lower cardiorespiratory fitness, more inferior health-related quality of life (HRQoL) and functional impairment than age matched individuals.[2]

Rehabilitation for these patients significantly impacts the quality of life, and studies have proven that physical therapy during HD sessions can be a significant part of physical life.[3] Intradialytic exercise (IDE) is training performed during the hemodialysis (HD) session to increase the patient's strength and endurance, targeting various physiological and psychosocial parameters. The nature of the IDE includes aerobic exercise, with different equipment used corresponding to the type of exercise. IDE has demonstrated a positive effect on the overall health and hospitalization rate of HD patients.[4] In addition, dialysis patients exercising with bicycle ergometer and resistance training have been reported to

improve physical performance.[5]

Exercise has a significant impact on these factors in patients undergoing HD. Exercise training also provides a unique opportunity to combine training with medical treatment in a highly monitored environment where potential complications can be detected and treated immediately. In addition, the duration of HD is used efficiently, and it has been shown to increase adherence and compliance compared with exercise between HD sessions.[6]

The HIIT has a positive response in increasing strength and cardiovascular conditioning. Also, HIIT has repeatedly been proven to have superior positive effects on health benefits and improve cardiorespiratory fitness significantly and is established as a safe and feasible exercise modality in various somatic illnesses.[7,13,14] Despite this, intradialytic exercise is still not a routine treatment for patients undergoing HD, perhaps because of uncertainty about the best modality for the patient group. In addition, there is a lack of knowledge regarding the efficacy of HIIT patients undergoing HD. HIIT is feasible and safe for hemodynamic stability in dialysis populations has not yet been evaluated.

Hence, the present study was undertaken to demonstrate the immediate effect of intradialytic high-intensity interval training on the bedside ergometer in patients with chronic kidney disease undergoing hemodialysis. The need for the research was to determine the feasibility, safety and efficacy of intradialytic HIIT on dialysis, hemodynamic stability and Oxygen saturation.

Methodology

The institutional ethical committee, registered with the Central governing board, approved the study.

Before the intervention, sufficient explanation and demonstration of the exercise protocol, a written consent form was obtained from the patient. A total of nine patients were enrolled in the study. Hemodynamically stable patient between the age group of 20 to 75 years, irrespective of gender and subjected to HD for >3 months, on HD 2 times per week was included in the study. While the subject had an acute infection, unstable angina pectoris, severe arrhythmias, uncontrolled hypertension (systolic blood pressure (BP) >180 mmHg and diastolic BP>105mmHg), hyperkalemia, uncontrolled diabetes, wheelchair dependence were excluded.[1]

The exercise intervention was performed using a bed cycle ergometer positioned on the bed in front of the patient during the second hour of dialysis.

The patients completed a supervised HIIT exercise, which was scheduled for 45 minutes. The exercise intervention started from the 61st minute after taking baseline outcome measure at the 60th minute. From the 61st-minute warm-up, exercises began, which included: Ankle toe movements, knee flexion and extension in a supine lying position with ten repetitions for each limb, and it lasted for10 minutes. Followed by warm-up exercises, each patient peddled the bed cycle ergometer for 25 minutes with three intervals lasting 3 min each. At an exercise intensity of 85%–95% of HR peak, equaling 15–17 on the Borg scale[16]. Each interval was separated by 4 min of active breaks. The last exercise interval was followed by a cool-down period of up to 10 min which included slow peddling on the bed cycle ergometer[1]. Post-intervention, the outcome measures were taken at the 106th minute.

A physiotherapist individually supervised all patients during the intervention. Similarly, all the patients were closely monitored by a medical practitioner for any complications. The patients were frequently questioned whether they were experiencing chest pain, dyspnea, nausea, vomiting, fatigue and headache during the exercise, but none complained of such issues. The patients' heart rates, blood pressure and SpO2 were also measured at the beginning and the end of the exercise. On average, heart rate increased by ten beats per minute across all subjects.

In addition, the patients were taught to stop the exercise and notify the researcher if they felt any dizziness, headache, palpitations, nausea, anxiety, exhaustion, any other adverse effects, or would like to discontinue irrespective of any complication[4]. As a result, all nine patients completed the study protocol uneventfully, and there were no dropout.

Results

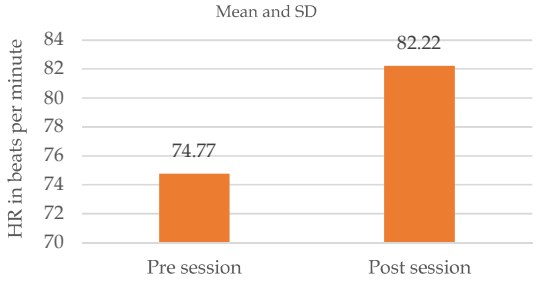
Results of the study were analyzed using Insta Stats Graph pad version 3.

Table no. 1: Baseline characteristics of demographic data of 9 patients.

Demographic data	Mean
Age (in years)	42.8 ± 7.747
Patients on dialysis (in months)	37 ± 1.946507

Table 2: Describes the mean, standard deviation, difference and P-value of all the variables at baseline and post-intervention values.

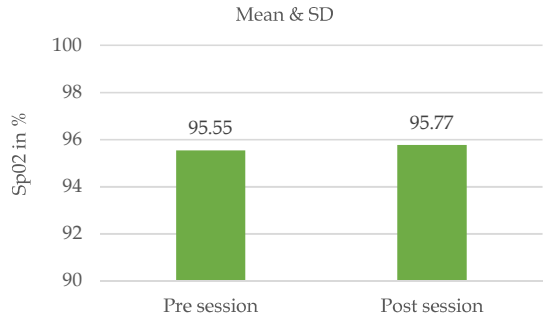
Variables	Pre Mean ± SD	Post Mean ± SD	Difference	Pvalue
HR (In bpm)	74.77 ± 3.93	82.22 ± 3.42	7.45 ± 0.51	0.006
Sp02 (In %)	95.55 ± 2.35	95.77 ± 1.30	0.22 ± 1.05	0.8072
Blood pressure (Systolic and Diastolic) (In mmHg)	143.33 ±19.36 87.77 ± 10.92	147±22.51 85.55±12.36	3.67±3.15 2.22±1.44	0.6915



Graph 1: Demonstrates the mean and standard deviation of Pre and Post Intervention of Heart Rate on X-axis. The Y-axis shows

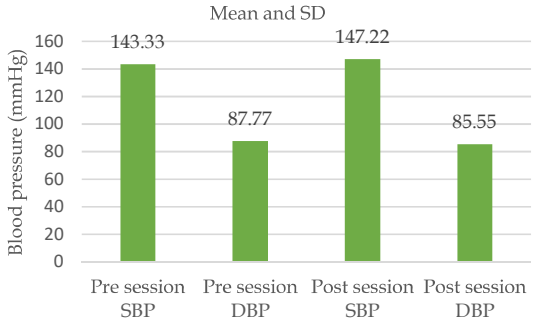
the range of heart rate in beats per minute.

Interpretation: There is a statistical and clinically significant increase in the heart rate post-intervention.



Graph 2: Describes the mean and standard deviation values of Oxygen saturation (Sp02) pre and post-intervention on the X-axis, and the Y-axis shows the range of Sp02 in %.

Interpretation: The graph explains no statistically significant change in the pre and post-intervention, Sp02 value.



Graph 3: The graph demonstrates the change in mean and standard deviation values of Blood Pressure changes pre and post-intervention on the X-axis and blood pressure values on the Y-axis in mmHg.

Interpretation: There was no statistically significant change seen in the blood pressure after the intervention. However, the graph shows that the Systolic Blood pressure (SBP) increased but the diastolic blood pressure (DBP) decrease.

Paired t-test was used to compare the mean of pre and post values of the intervention.

Discussion

The purpose of the study was to determine the immediate effects of HIIT with a cycle ergometer on vital parameters in patients undergoing hemodialysis. All patients undergoing HD have low cardiorespiratory fitness due to a sedentary lifestyle. The circulation is inefficient and sarcopenia of respiratory muscle, leading to reduced lung compliance and fatigue due to dietary restrictions[5]. HIIT has been proven to be effective in improving and maintain hemodynamic stability.[1]

The primary findings of this study were that the intradialytic HIIT exercise program resulted in a substantial increase in heart rate, blood pressure and oxygen saturation. The participants' demographic data include age, since how long they have been on dialysis, and the mean duration of the participants being on dialysis was 37 months. All the participants included in this study were male, as the female participants were not willing to participate. All the participants completed the 45 mins of intervention. No participant reported any adverse event during and after the intervention. There was a significant increase in heart rate by 9.49% immediately after the intervention, as shown in the results. This improvement may be due to the direct beneficial effects of aerobic exercise or the general effects of regular exercise. During intradialytic exercise, there is an increase in the muscle blood flow as the muscle demands blood for energy, hence perfusion of muscle tissue increases and opens the capillary surface area, which subsequently increases the flux of urea from the tissue to the vascular compartment where the heart fulfils the supply which increases the heart rate. This was supported by Shigenori Ito et al.[11] and Brown PDS, Rowed K et al.[17] In this study, we found that the HR was within the target HR limit, which indicates the safety of HIIT on Heart rate, and also, the P-value was 0.006, which shows statistical significant of Heart rate.

Dialysis causes lowered blood oxygen levels. The oxygen levels in the arterial blood can drop 5%-23% during dialysis and interfere with muscle cramps and excessive fluid removal[20]. However, in our study, there was no statistical difference observed in Oxygen saturation. The graphs describe the 0.23% changes in oxygen saturation, and the patient maintained their oxygens saturation level. A similar study by Koh KP, Fassett RG et al. also supports the above findings.[19]

There was an increase in Systolic blood pressure and a decrease in diastolic blood pressure with a 2.5% change. Also, the p-value was not statistically significant, which reports that there was no major increase in Blood pressure. Hence, it proves that HIIT is yet safe for patients undergoing hemodialysis. A similar study by authors T.L Parsons, E.B. Toffelmire et al.[12] states that there is no change in blood pressure during hemodialysis due to decreased fluid levels. Other similar meta analysis had proven that both aerobic exercise and combined exercise could not reduce the patients' blood pressure after the intervention. The results showed no change, which indicated that the results of SBP and DBP were stable and reliable for HIIT during hemodialysis.[18]

The present study demonstrates that the patients well tolerate HIIT exercise during the dialysis session. Furthermore, as the patient pedalled on the cycle ergometer at the intensity of 15-17 on the Borg scale for 25 minutes with an interval of 4 min each, no adverse events were reported, indicating that HIIT can be safely

performed during HD. Furthermore, all patients in the HIIT group achieved their target heart rate and Borg scale score of 15–17 in a minimum of one interval of the completed sessions[5]. Hence, the results of this pilot study indicate that HIIT is feasible during HD.

Conclusion

We conclude that the current study's findings show that the intradialytic HIIT exercise program is feasible and safe for intradialytic exercise and emphasizes the importance of intradialytic exercises. Furthermore, the data confirm that it is feasible to introduce intradialytic exercise with HIIT in a heterogeneous and hemodynamically stable HD population.

Limitation

The main limitations of our trial are the low number of patients and heterogeneity concerning age, gender at baseline.

Future Scope

However, further investigations with larger samples may require the intervention to be prescribed with adjunctive therapy to HD. In addition, further studies can be done to compare the effects of HIIT with individualization of the program supervised by the therapist according to the aetiology and burden of CKD. Furthermore, a large sample size can be studied for a more extended period to find the efficacy of HIIT on the quality of life and cardiorespiratory fitness in patients undergoing HD.

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