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# Experimental Evaluation of Intradialytic Cycling on Vital Signs, Dyspnoea and Pulmonary Function in Chronic Kidney Disease

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**Abstract:** ***Background-*** chronic kidney disease (CKD) patients undergoing haemodialysis often experience impaired respiratory function, dyspnoea and altered vital parameters. This study aimed to evaluate the effect of intradialytic cycling on vital parameters, dyspnoea and Peak Expiratory Flow Rate (PEFR). ***Methodology-*** An experimental design was conducted on 55 patients undergoing routine haemodialysis at Dr. Vasantrao Pawar Tertiary Care Teaching Hospital, Nashik. Participants performed 20 minutes of bed cycling twice weekly for four weeks. Pre- and post-intervention outcomes were analysed using paired t-tests. ***Results***- Demonstrated statistically significant improvements in PEFR ($p < 0.0001$), dyspnoea scores ($p < 0.0001$), oxygen saturation ($p = 0.0065$), respiratory rate ($p = 0.0018$), and blood pressure ($p = 0.0001$). ***Conclusion-***The findings suggest intradialytic cycling is a safe, effective adjunct to dialysis care, improving cardio-respiratory function and patient well-being. ***Keywords-*** Intradialytic cycling, Chronic kidney disease, Haemodialysis, Dyspnoea, PEFR, Vital parameters

**Introduction** – chronic kidney disease (CKD) is a systemic condition with a global prevalence of 11–13%, most commonly in Stage 1[1]. It disrupts energy balance, immunity and neuroendocrine control, leading to inflammation, malnutrition, cardiovascular disease and impaired organ function[2]. Patients often present with vascular dysfunction, systemic inflammation and increased risk of brain and heart disease. Haemodialysis (HD) and peritoneal dialysis, though lifesaving, can impair respiratory function, causing infections, restrictive or obstructive lung defects and myocardial ischemia[3]. HD patients face high cardiovascular morbidity and mortality, with nearly half of deaths attributed to cardiac causes. Dyspnoea is particularly common, affecting about 35% of end-stage renal disease patients and contributes to poor cardio-respiratory performance and reduced quality of life[3]. Peak Expiratory Flow Rate (PEFR), a measure of airflow and ventilation adequacy, is often reduced in CKD patients, reflecting impaired lung mechanics[4]. Monitoring vital parameters such as blood pressure, heart rate, respiratory rate, and oxygen saturation during dialysis is therefore essential for patient safety[5,6].

Intradialytic cycling has emerged as a promising intervention. By increasing blood flow to skeletal muscles, it enhances solute clearance, reduces post-dialysis urea rebound and may improve cardiovascular and respiratory outcomes. Despite these potential benefits, research on intradialytic exercise remains limited, particularly in Indian populations. This study was undertaken to address that gap, focusing on the effect of intradialytic cycling on vital parameters, dyspnoea and PEFR among CKD patients. Understanding these impacts is crucial for improving treatment strategies, enhancing patient safety and ultimately contributing to better quality of life for individuals dependent on dialysis.

**Methodology –** This experimental study was conducted over a period of six months at the Dialysis Unit of Dr. Vasantrao Pawar Tertiary Care Teaching Hospital, Adgaon, Nashik, with a sample size of 55 patients selected through convenient sampling. Ethical clearance was obtained from the Institutional Committee prior to commencement. Participants included male and female patients aged 18 years and above, undergoing routine haemodialysis for at least three months, twice per week. Patients who were vitally unstable, unable to exercise, had cardiovascular disease within the past three

months, suffered from severe musculoskeletal pain, or presented with blood pressure greater than 220 mmHg systolic or 110 mmHg diastolic were excluded from the study.

Outcome measures included Peak Expiratory Flow Rate (PEFR), dyspnoea assessed using the Modified Medical Research Council (MMRC) scale and vital parameters such as blood pressure, heart rate, respiratory rate and oxygen saturation. PEFR was measured using a peak expiratory flow meter, with patients seated upright and instructed to blow forcefully into the mouthpiece three times; the highest reading was recorded. Dyspnoea was evaluated using the MMRC scale, a five-point questionnaire completed within 30 seconds, where patients selected the statement that best described their breathlessness. Vital parameters were monitored using bedside equipment (Solar 8000i; GE Healthcare, Waukesha, WI, USA), which provided synchronized bio-signals including blood pressure and oxygen saturation. This methodology ensured accurate measurement of respiratory function, dyspnoea severity, and vital signs before and after the intradialytic cycling intervention, thereby enabling a comprehensive evaluation of its effects on patients with chronic kidney disease.

The intervention consisted of intradialytic cycling sessions administered twice weekly for a period of four weeks, in addition to standard dialysis care. Each session was initiated once the patient had been connected to the haemodialysis machine, vascular access tubing was secured, alarms were cleared and the patient was clinically stable. The exercise was performed using a bedside bicycle ergometer for a duration of 20 minutes. Patients remained in the dorsal position on the dialysis bed and carried out pedalling movements at their own pace, ensuring comfort and safety. The range of motion involved hip and knee flexion and extension, allowing individualized adjustment according to tolerance. Clinicians supervised the sessions to ensure proper positioning, monitor vital parameters and provide encouragement. This structured intradialytic cycling program was designed to enhance blood flow to skeletal muscles, improve solute clearance, and positively influence cardio-respiratory function without interfering with the dialysis procedure.

**Data Analysis –** A total of 60 subjects was screened of which 54 met the inclusion criteria and were enrolled in the study. The sample comprised 38 males and 16 females. Statistical analysis was performed using GraphPad Prism, with paired t-tests applied to compare pre- and post-intervention values. A significance level of 5% was set and p-values less than 0.05 were considered statistically significant.

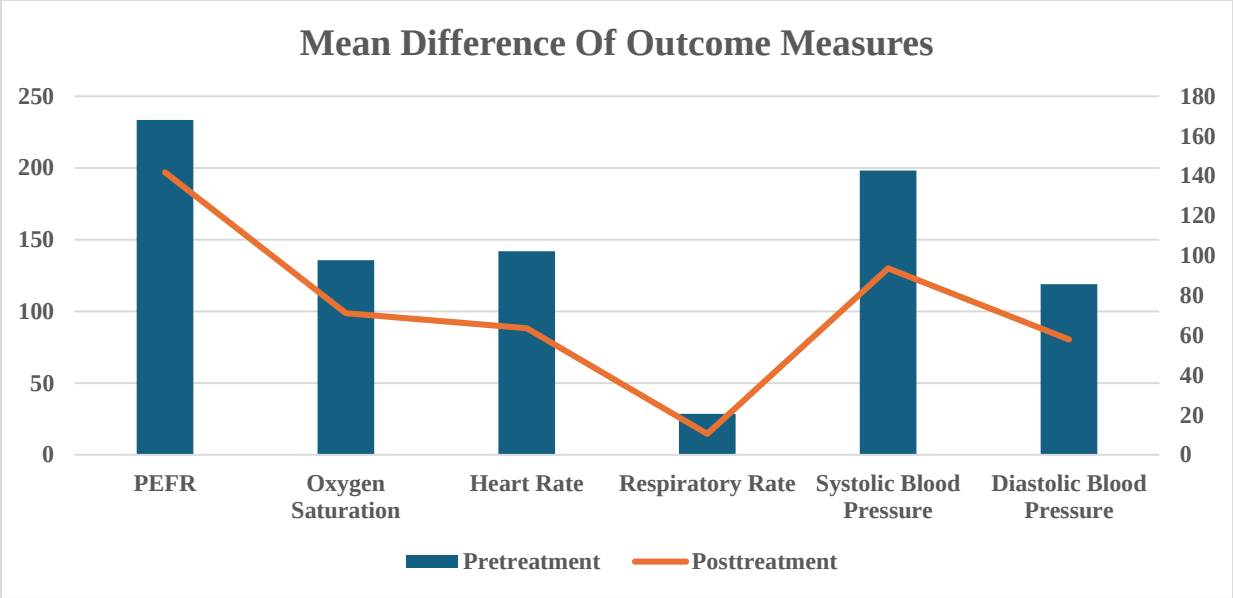
**Results –** The present study demonstrated significant improvements in respiratory, cardiovascular, and hemodynamic parameters following intradialytic cycling. Peak Expiratory Flow Rate (PEFR) increased from a pretreatment mean of 168.09 to 197.03 posttreatment ($p = 0.0001$), indicating enhanced pulmonary function, consistent with earlier reports of improved ventilatory efficiency through intradialytic exercise. Dyspnoea, assessed using the Modified Medical Research Council (MMRC) scale, improved from 2.37 to 1 ($p = 0.01$), reflecting reduced respiratory distress, in line with findings that exercise reduces breathing effort in dialysis patients. Oxygen saturation rose from 97.69% to 98.71% ($p = 0.01$), while heart rate decreased markedly from 102.13 to 88.13 beats per minute ($p = 0.0001$), suggesting improved cardiovascular efficiency.

Respiratory rate showed a significant reduction, dropping from 20.62 to 14.50 breaths per minute ($p = 0.001$), consistent with reduced breathing effort and improved lung mechanics (50,51). Blood pressure values demonstrated notable improvement, with systolic pressure decreasing from 142.60 to 129.92 mmHg ($p = 0.0001$) and diastolic pressure from 85.62 to 80.49 mmHg ($p = 0.01$), supporting previous evidence that intradialytic cycling safely lowers both systolic and diastolic blood pressure. (Table No 1 & Graph No 1)

Table No. 1 : Mean Difference Of Outcome Measures

| | Pretreatment | Posttreatment | p-value | Interpretation |
|---|---|---|---|---|
| **PEFR** | 168.09 | 197.03 | 0.0001 | Statistically Significant |
| **MMRC Scale** | 2.37 | 1 | 0.01 | |
| **Oxygen Saturation** | 97.69 | 98.71 | 0.01 | |
| **Heart Rate** | 102.132 | 88.132 | 0.0001 | |
| **Respiratory Rate** | 20.6226 | 14.5094 | 0.001 | |
| **Systolic Blood Pressure** | 142.60 | 129.92 | 0.0001 | |
| **Diastolic Blood Pressure** | 85.62 | 80.49 | 0.01 | |

Graph No. 1 : Mean Difference Of Outcome Measures




**Discussion** – The study demonstrated that intradialytic cycling produced a wide range of beneficial effects in patients with chronic kidney disease undergoing hemodialysis. Blood pressure was significantly reduced, with both systolic and diastolic values showing clinically relevant decreases, consistent with earlier findings that stationary cycling during dialysis improves vascular compliance, endothelial function, and circulation without increasing the risk of intradialytic hypotension[7,8].

Musculoskeletal adaptations were evident. Exercise enhanced mitochondrial efficiency, oxidative phosphorylation, and myosin heavy chain synthesis, leading to greater muscle mass, capillary density, and reduced fatigue. Improved strength and endurance translated into better functional capacity and independence in daily living activities, particularly in elderly patients[7,8].

Respiratory outcomes were notable. Dyspnoea improved considerably after cycling, linked to enhanced lung mechanics, reduced respiratory effort, and unloading of respiratory muscles. Peak expiratory flow rates increased, reflecting improved ventilatory efficiency. Aerobic conditioning through cycle ergometry likely facilitated recruitment of type I muscle fibers, improving respiratory muscle performance[9,10].

Cardiopulmonary fitness improved as well, with significant increases in $VO_2$max and oxygen saturation. Enhanced blood flow during exercise boosted dialysis efficiency, toxin clearance, and overall well-being (45,47,56). Metabolic benefits included effective potassium regulation through dialysis clearance and a marked reduction in total cholesterol, thereby lowering cardiovascular risk[11,12].

Autonomic nervous system responses were stabilized, minimizing circulatory collapse and supporting cardiovascular resilience[13]. Collectively, these outcomes highlight the central, peripheral, and neural benefits of intradialytic cycling—ranging from improved cardiac performance and muscle resistance to better lipid metabolism and oxygen utilization.

In summary, intradialytic cycling proved to be a safe and effective intervention that improved blood pressure regulation, respiratory mechanics, oxygen consumption, metabolic clearance, and fatigue reduction. Its integration into dialysis protocols offers a promising strategy to enhance physical fitness, functional independence, and long-term well-being in patients with chronic kidney disease.

**Conclusion** – The study concludes that intradialytic cycling has a significant impact on vital parameters, dyspnoea, and peak expiratory flow rate (PEFR) in patients with chronic kidney disease undergoing haemodialysis. These results highlight the importance of incorporating tailored exercise management strategies during dialysis sessions to optimize patient outcomes. Furthermore, the findings emphasize the need for close monitoring of patient symptoms and physiological responses, as this approach can enhance overall

care, reduce complications, and improve long-term quality of life for individuals receiving maintenance haemodialysis.