

[ORIGINAL ARTICLE]

Effect of 4 weeks Inspiratory Muscle Training on Inspiratory Muscle Strength and Quality of Life in Dialysis Patients. A Pilot Study**Ms. Aarya Mehta¹, Dr. Arijit Kumar Das(PT)², Dr. Abhijit D. Diwate(PT)³, Dr. Archana Nagargoje(PT)⁴**¹Under Graduate Student, ²Associate Professor, ³Professor & HOD, ⁴Assistant Professor, Department of Cardiovascular and Respiratory Sciences Physiotherapy, D.V.V.P.F.'S College of Physiotherapy, Ahmednagar.**ABSTRACT :**

Background: Dialysis is the most preferred way to treat chronic kidney disease (CKD). The commonest complication associated with dialysis is uremic myopathy. Inspiratory muscle training (IMT) improves the strength of respiratory muscles.

Methods: 11 patients with Stage 4 and 5 of chronic kidney disease with more than 3 months of dialysis underwent Inspiratory muscle training using self-made inspiratory trainer by taking pre and post intervention values of Maximum inspiratory pressure (MIP) and QOL.

Result: Paired t test was used and the MIP and QOL values are statistically significant with a p-value of < 0.0001 and 0.0124 respectively.

Conclusion: Inspiratory muscle strength and QOL is reduced in dialysis patients and a 4-week inspiratory muscle training using a self-made inspiratory muscle trainer is effective to reverse the adverse effects of dialysis.

Keywords: Kidney disease, complications, respiratory muscles, maximum respiratory pressure, muscle weakness, exercise.

Introduction:

Chronic kidney disease (CKD) is the worldwide public health problem and is a long-standing disease also called as chronic kidney failure. It describes the slow and progressive loss of functioning capacity of kidneys over a period of several months or years. This leads to accumulation of toxins and excess water due to damaged kidney functions. It is associated with abnormal excretion of albumin and is determined by measured glomerular filtration rate. Chronic kidney disease (CKD) is mainly classified into 5 stages and the last stage that is stage 5 is called as the End stage renal disease with a glomerular filtration rate of 15 ml/min or less.^(1,2)

To treat the End stage renal disease, dialysis is the most common and preferred way to remove the accumulated toxins from the body. Dialysis is an artificial method of replacing the kidney functions which involves the process of removing excess of

water, waste, toxins, solutes and salts from the blood in patients with chronic kidney disease whose kidneys can no longer perform these functions naturally.^(3,4) It is treatment that works on the principle of diffusion and ultrafiltration by filtering the impurified blood using a machine through an external filter called as a dialyzer.⁽⁵⁾ There are various complications associated with chronic kidney failure patients undergoing dialysis like hypotension, fluid overload, chest pain, anaemia, pulmonary infections like pulmonary oedema, pneumonia, lung abscess, empyema and the most common is uremic myopathy.^(6,7,8,9) Uremic myopathy is associated with loss of muscle mass that is muscle wasting, decrease in physical capacity, progressive weakness of inspiratory muscles like diaphragm and affects the respiratory system by an increase of extravascular pulmonary fluid, altered response of bronchia and pulmonary calcification.^(9,10,11,12) The end result is

*Corresponding author

Ms. Aarya Mehta

Email : mehtaaarya44@gmail.com

D.V.V.P.F.'s College of Physiotherapy, Ahmednagar

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reduction of the lung capacity causing pulmonary congestion, pulmonary fibrosis, pulmonary hypertension and pleural effusion with obstructive disorders and limitation of air flow to distal airways. (13,14,15)

Inspiratory muscle training (IMT) is technique that includes specific exercises that improves the strength and function of respiratory muscles. (16) The strength of the inspiratory muscles can be assessed by measuring the maximum inspiratory pressure (MIP) which is the most widely used technique, is the maximum negative pressure produced by the inspiratory muscles of the patient during maximum voluntary inspiratory effort.

One of the major criteria that provides the effectiveness of health level, health care, and well-being is the Quality of life. (QOL) (17,18) It has a direct impact on physical performance and problems, mental and general health, and social performance because a relationship exists between quality of life and disease. (19,20)

Considering the complications of chronic kidney failure patients undergoing dialysis and its effects on respiratory muscles and system, it decreases the overall lung capacity of the patient leading to weakness of respiratory muscles and reduces the physical capacity. Also, in Indian rural scenario inspiratory muscle trainer is not readily available neither cost effective, so this study is to find out the effectiveness of self-made inspiratory muscle trainer on chronic kidney patients undergoing dialysis which is cost effective and easily to construct using readily available materials. Because of the paucity of literature on this subject my study aims to evaluate the effect of Inspiratory muscle training on the strength of inspiratory muscles with the help of Maximum inspiratory pressure (MIP) and Quality of life (QOL) of chronic kidney disease patients undergoing dialysis. This study is to find out the effectiveness of self-made inspiratory muscle trainer as in Indian rural scenario inspiratory muscle trainer is not readily available neither cost effective.

Materials And Methods:

The following pilot study was conducted on 11 participants having Stage 4 and 5 of chronic kidney disease with more than 3 month of dialysis patients in the Haemodialysis unit of Vikhe Patil Memorial Hospital, Vilad Ghat, Ahmednagar, Maharashtra, India. This was a pre-post test design and

participants were selected according to purposive sampling.

Both men and women with Stage 4 and 5 chronic kidney disease for more than 3 months of dialysis, between 18-50 years of age who were Haemodynamically stable and capable of performing the intervention were included in the study. Patients who were not on follow up of dialysis, having any other pre-diagnosed pathology and who were not willing to participate were excluded from the study.

The materials required for the study were a self-made inspiratory muscle trainer for inspiratory muscle training, Dhiraj Maximum Inspiratory Pressure Device (DMIPD) device for assessing respiratory muscle strength which has been previously used in studies for similar purpose and has been validated and checked for reliability and World Health Organization Quality of Life (WHO-QOL) Questionnaire for assessing the quality of life.

Procedure:

Ethical approval was taken by Institutional Ethical Committee prior to the commencement of the study. The purpose of the study was explained and a written informed consent was obtained from the participants. Then the Inspiratory muscle training was performed using self-made inspiratory muscle trainer by taking pre and post intervention values of Maximum inspiratory pressure (MIP) and Quality of life (QOL). For MIP, the patient was tested in a sitting position with a considerable amount of back support and arm rest with their knees and hips flexed at 90 degrees. The patient then was asked to inhale maximum air post a maximum expiration, the value of which was denoted on the device signifying the pressure level which can directly be correlated with the inspiratory muscle strength. The value of best of three trials was considered. The World Health Organization Quality of Life (WHO-QOL) Questionnaire was used for assessing quality of life and the pre and post intervention data was compared. The protocol was conducted for 4 weeks.

Self-made Threshold Inspiratory Muscle trainer will be set up for the Inspiratory muscle training (IMT) program. Jirakrit Leelarungrayub et al in their study produced a simple prototype device using Polyvinyl chloride (PVC) pipe and plastic caps. The Polyvinyl chloride (PVC) pipe was modified into a plate-shaped mouth panel using mechanical compressor which is difficult to construct by participants in rural

population. Thus, self-made inspiratory trainer was constructed. The trainer was made using plastic caps, neck portion of bottles and a paper tube as mouth piece. The plastic bottle was cut from the neck portion which was 2.5 cm in length. The diameter of plastic cap is 2.5 cm. Three different plastic caps had different sizes holes of 2mm, 4mm, 6mm. The centre point of the cap was marked by drawing cross lines on it. The holes were made using a 2mm, 4mm, 6mm metal tubes having a sharp border and the metal tubes were heated to create a hole. Once the hole was made it was cleaned using a sand paper. The cut-out portion of plastic bottle was attached to paper tube using adhesive glue. Self-made Nose Clip was made using a Cloth clip which is available locally. A sponge was attached at the both the teeth of the clip and a rubber band was tied at the end of the cloth clip so that the teeth is not very tight on the nose, as cloth clips have strong teeth.

How to use self-made Inspiratory muscle trainer:

- 1) Make sure patient is in sitting position and ask the patient to put on the nose clip and hold the device.
- 2) Instruct the patient to place the mouthpiece in the mouth, making sure the lips are over the outer shield to make a good, airtight seal.
- 3) Start inspiration through a 6 mm hole once daily. Instruct the patient to breathe out as far as he/she can and then take a fast, forceful breath in through the mouth. Ask the patient to take as much air as he/she can, as quickly as possible while expanding the chest.
- 4) Relax your shoulders and breathe out slowly with minimal effort.
- 5) Thirty slowly repeated inspirations should be taken through the device. Ask the patient to take 3-minute interval and then take another fast, forceful breath in.
- 6) Ask the patient to repeat this forceful breath fast.

Increasing the resistance:

For building up the muscle strength, the resistance of trainer can be increased. This will make it more difficult to breathe inwards, which will make the muscles work harder.

- 1) Increase the resistance by changing to 4 mm and 2 mm holes in second and fourth week,

respectively. Repeat 30 inspirations with 3-minute interval.



Fig 1 : Self-made Inspiratory Muscle Trainer



Fig 2 : Patient performing Maximum Inspiratory Pressure Manoeuvre using DMIPD



Fig 3 : Patient performing Inspiratory Muscle Training using Self-made Inspiratory Muscle Trainer

Results:

The present study was conducted on 11 patients with Stage 4 and 5 of chronic kidney disease with more than 3 month of dialysis who were in the age group of 18-50 years admitted in Haemodialysis unit, Tertiary care Hospital. Results were carried out using Paired t-test.

Table 1: Table depicts the Baseline Characteristics and other variables of participants.

MIP	MEAN ± SD	P VALUE	RESULT
PRE-TEST MIP	54.5454 ± 16.949	< 0.0001	Considered extremely significant
POST-TEST MIP	83.6363 ± 18.586		

SD-Standard deviation

Table 2: Table depicting results of Pre-test MIP and Post-test MIP readings using Paired t-test in Dialysis patients.

AGE (MEAN±SD)	41.63636 ± 6.989603
FEMALES/MALES (%)	4(36.36)/7(63.63)
DURATION OF CONDITION (MEAN±SD)	3.090909 ± 1.578261
FOLLOW UP WEEK (MEAN±SD)	11.54545 ± 4.926736

SD-Standard deviation; MIP-Maximum inspiratory pressure

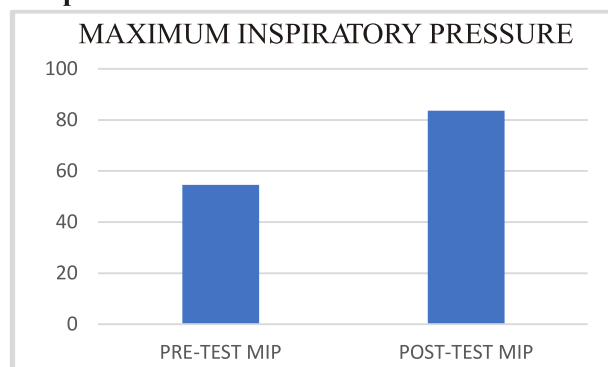
The Pre-test and Post-test readings were compared using Paired t test. This shows that maximum inspiratory pressure is increased after inspiratory muscle training (83.6363 ± 18.586) as compared to the readings before training (54.5454 ± 16.949). The MIP readings are statistically significant (p-value of < 0.0001) in dialysis patients which shows Extremely significant result. (Table 2)

Table 3: Table depicting results of Pre-test QOL and Post-test QOL readings using Paired t-test in Dialysis patients.

QOL	MEAN ± SD	P VALUE	RESULT
PRE-TEST QOL	86.0909 ± 4.614	0.0124	Considered significant
POST-TEST QOL	90.4545 ± 5.837		

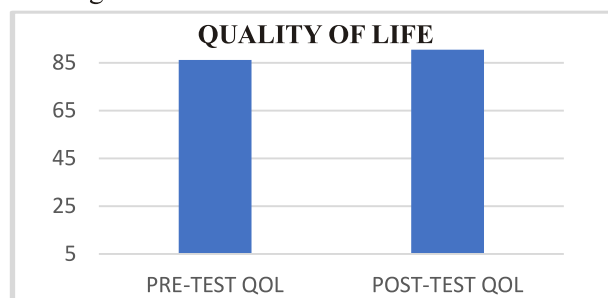
The Pre-test and Post-test readings were compared using Paired t test. This shows that quality of life is increased after inspiratory muscle training (90.4545 ± 5.837) as compared to the readings before training (86.0909 ± 4.614). The QOL readings are statistically significant (p-value of 0.0124) which shows Significant result. (Table 3)

Graphical Presentation:



Graph 1: Depicting mean values of pre-test and post-test readings of MIP

The pre-test and post-test readings are compared using Bar diagram. (Graph 1). The mean value of MIP is 54.5454 before training which is quite lower as compared to mean value of 83.6363 after training. (Table 2)The Graph 1 shows that MIP readings are increased after 4-week inspiratory muscle training as compared to MIP readings before inspiratory muscle training.



Graph 2: Depicting mean values of pre-test and post-test readings of QOL

The pre-test and post-test readings are compared using Bar diagram. (Graph 2). Similarly mean value of QOL is 86.0909 before training which is lower as compared to mean value of 90.4545 after training. (Table 3) The post-test readings are increased as compared with pre-test readings. Graph 2 depicts mean values of QOL which shows that QOL readings are increased after 4-week inspiratory muscle training as compared to QOL readings before inspiratory muscle training.

Discussion:

The present study was conducted to evaluate the effect of Inspiratory muscle training on the strength of inspiratory muscles with the help of Maximum inspiratory pressure (MIP) and Quality of life (QOL) in dialysis patients. Inspiratory muscle training was done with the help of self-made inspiratory muscle trainer.

Results obtained in this pilot study demonstrated that there is improvement in MIP values after Inspiratory muscle training for 4 weeks using self-made inspiratory muscle trainer. P value is < 0.0001 which shows extremely significant result as shown in table no 2. This is because in order to improve the strength of muscles, the training needs to be performed repeatedly so as to allow the muscles to adapt, become stronger and so can work for longer duration. The respiratory muscles respond to training stimuli in the same manner as the skeletal muscles, i.e., improvement in the structural and functional aspects by improving strength, endurance, peak inspiratory flow and maximal inspiratory and expiratory pressure, which in turn improves the respiratory endurance. Once the strength of the muscles has been improved, it shall help in reduction of muscle fatigue, leading to an improvement in the oxygen uptake, which generally gets altered in chronic kidney disease (CKD) patients. This self-made device created a resistance to the inspiratory flow while inspiration through the device. The more the narrow size hole, more resistance was created against the inspiratory flow. The inspiratory muscles worked against this resistance to overcome it and thus the strength of inspiratory muscles was increased.

Also, QOL was assessed and there was increase in QOL after Inspiratory muscle training. P value is 0.0124 which shows Significant result as shown in table no 3. This is because physical activity improves quality of life was proved by several

literatures and Inspiratory muscle training improves functional capacity resulting in greater independence in activities of daily living with an improvement in quality of life.

Several previous studies have proved that Inspiratory muscle training with threshold loading device can be used with varied protocol to significantly increase inspiratory muscle strength and improve QOL. ⁽²⁴⁾ Bahareh Ghiasi et al in their study concluded that quality of life is reduced in Chronic kidney patients and interventional measures will be useful to improve the quality of life. ⁽²⁵⁾ Also, in one study there was an increase in inspiratory and expiratory muscle strength and change in chest wall regional volumes compared to the sham group. ⁽²⁴⁾ Jirakrit Leelarungrayub et al in their study produced a simple prototype device using PVC pipe and plastic caps and proved that similar effects were produced like standard Respiratory muscle trainer (RMT) device and thus it can be used in clinics because of cheaper price. ⁽²⁶⁾ Hence, self-made inspiratory muscle trainer is made and used in this study as many Inspiratory muscle trainer (IMT) devices available are expensive and it is not affordable to use them in rural setup. The following articles also support the result we obtained in our study.

Ana Irene Carlos de Medeiros et al conducted a systematic review which included four studies. They concluded that there was improvement in muscle strength, functional capacity, lung function and quality of life with inspiratory muscle training as compared to control group. The reason they gave is that conditioning and strengthening of respiratory muscles activates inspiratory muscles and can delay complications of wasting of muscle mass. The result is similar to which we found in our research that is improvement in muscle strength. The gap in literature on benefits of increasing in training frequency in dialysis patients is improved in our study as we trained the dialysis patients for a period of 4 weeks.

An interventional study conducted by Heba A. Bahey EL-Deen, PhD et al which was to evaluate the effects of Inspiratory muscle trainer on respiratory muscle strength and pulmonary functions. They found similar result like our study that there was significant improvement in respiratory muscle strength and in all the pulmonary functions except FEV1/FVC in haemodialysis patients and thus Inspiratory muscle training (IMT) is effective

technique. It is because IMT reduces atrophy of respiratory muscles and increases the strength which in turn will enhance pulmonary functions.

Overall, we can say that inspiratory muscle training improves strength of inspiratory muscles and also self-made inspiratory muscle trainer which is affordable and cost effective helps in improving strength and quality of life in dialysis patients after a 4-week protocol.

Conclusion:

The study concludes that the inspiratory muscle strength and quality of life is reduced in dialysis patients according to the pre intervention readings of MIP and QOL and a 4-week inspiratory muscle training using a self-made inspiratory muscle trainer is effective to improve the inspiratory muscle strength and quality of life in dialysis patients and reverse the adverse effects of dialysis. Thus, this cost-effective self-made inspiratory muscle trainer can be used in Indian rural scenario easily to improve inspiratory muscle strength.

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Conflict of Interest: None

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