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Original Research Paper

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COMBINED EFFECT OF UPPER EXTREMITY PNF AND ELASTIC RESISTANCE BAND TRAINING ON INSPIRATORY MUSCLE STRENGTH IN CHRONIC KIDNEY DISEASE PATIENTS UNDERGOING HEMODIALYSIS.

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ABSTRACT

Aim: The study aims to evaluate the effect of unilateral upper extremity proprioceptive neuromuscular facilitation using an elastic resistance band on inspiratory muscle strength in chronic kidney disease patients undergoing hemodialysis. **Materials and Methodology:** 7 patients (4 male; 3 female) were assessed for demographic data (age, weight, height, BMI) and Maximal Inspiratory Pressure (MIP) at baseline. All 7 patients underwent 8-week resistance training for the unilateral upper extremity. The intervention used was unilateral upper extremity proprioceptive neuromuscular facilitation (PNF) exercises combined with an elastic resistance band (ERB). Upper extremity PNF patterns (D1 flexion, extension & D2 flexion, extension) were used in the training protocol. All the exercises were carried out on the dialysis bed during an intradialytic period. 2 sessions per week for 8 weeks; a total of 16 sessions were held. 3 sets of 6 repetitions were given. After completion of the training protocol, MIP was re-evaluated. **Results:** In pre-and post-training comparison, there was statistically significant improvement ($p < 0.0056$) in the post-training Maximal Inspiratory Pressure (i.e., 62.71 ± 27.85 cmH2O) compared to pre-training maximal inspiratory pressure (i.e.,55.71 ± 24.39 cmH2O). **Conclusion:** Intradialytic unilateral upper extremity resistance training can improve the inspiratory muscle strength in chronic kidney disease patients undergoing hemodialysis.

KEYWORDS : Chronic kidney disease, Intradialytic exercises, Proprioceptive Neuromuscular Facilitation, Inspiratory muscle strength.

INTRODUCTION:

The definition and classification of chronic kidney disease (CKD) have evolved over time. The current international guidelines define this condition as decreased kidney function is shown by glomerular filtration rate (GFR) of less than 60 mL/min per 1·73 m^2, or markers of kidney damage, or both, of at least 3 months duration, regardless of the underlying cause.[1] These patients present the typical complications of renal dysfunction only in more advanced stages, while many of them remain asymptomatic most of the time.[2]

Prevalence of CKD is more in the elderly population, while the younger patients with CKD show loss of kidney function progressively. CKD is the leading cause of death globally and in low- middle-income countries and 1.4 million deaths have been noted due to kidney diseases. The disease is also accompanied by progressive muscle weakness and premature fatigue, which is linked to hypokinesis and uremic toxicity. These changes are directly associated with morphological and biochemical alterations. Morphological abnormalities however have been observed in both locomotory and non-locomotory muscles thus not all the dysfunction can be attributed to inactivity.[3]

In a study conducted by Ariel Tarasuik and his colleague to study the effect of chronic renal failure on skeletal and diaphragmatic muscle contraction in which they concluded that moderate and severe uremia increased

fatigability significantly in the diaphragm. Uremia reduces the absolute isometric force per cross-sectional area in both skeletal and diaphragm muscles. This observation suggests that decreased force production results from a specific effect on the intrinsic contractile mechanism of the muscle.[4]

To improve respiratory muscle strength, advanced techniques are available, which imposes a high economic burden on the patient. Also, these techniques are challenging to perform in the rural setup because patients already suffer from numerous disease complications and high treatment costs. Various studies have been done using PNF resistance exercises to improve respiratory function in multiple populations. But until now, the exploration of this combined treatment technique (PNF & ERB) in CKD patients is negligibly investigated. The need of the study is to come up with different treatment approaches to improve pulmonary functions in CKD patients & improve their QoL.

MATERIALS AND METHODOLOGY:

Participation:

At first, the ethical clearance was obtained from the Institutional Ethical Committee. The patients were screened according to the inclusion and exclusion criteria from the dialysis care unit of a tertiary care medical college hospital. Before the initiation of the study, written informed consent was taken from all the patients. Inclusion criteria: 1. Patients diagnosed with CKD (Stage-5) undergoing hemodialysis, 2. Age between 20-60 years, 3. Given consent for participation in the study. Exclusion

criteria: 1. Patients who developed hemodynamic complications during dialysis, 2. Patients having high-grade fever, 3. Patients with severe hypoxia (Anemia, Pulmonary diseases, Cardiac diseases, Respiratory failure, etc.), 4. Patients already diagnosed with any respiratory disease, 5. Patients with orthopedic or neurological conditions that would affect the exercise program.

Outcome Measure:

Maximal Inspiratory Pressure (MIP) was measured using a hand-held manometer instrument – an ABP pressure gauge.

Subjects were instructed to sit in an upright position. The therapist explained the procedure to the patient in the language best understood by them. The nose clip was secured to avoid unwanted inspiration or expiration during the maneuver. Then the therapist asked the patient to hold the mouthpiece in the mouth properly and keep their lips sealed around it tightly so that no air could escape. The subjects were then asked to take a deep inhale through the mouthpiece and maintain it for at least one second. The maneuver was repeated three times, and one best value was considered for further evaluation.[5]

Fig: 1. A patient performing MIP at Dialysis Unit.

Intervention:

Pre-treatment MIP was assessed after the completion of the dialysis session. Then the exercises were imposed on the patients from the next consecutive dialysis session.

Total 7 patients underwent an intradialytic resistance training program for 8 weeks. Intervention protocol includes unilateral upper extremity proprioceptive neuromuscular facilitation (PNF) exercises using an elastic resistance band (ERB).[6] Basic upper extremity PNF patterns were used in the exercise protocol. All the exercises were carried out on the dialysis bed during the dialysis session in the supine lying position. Upper extremity exercises were carried out in only one limb, which was free to do the voluntary movements & was not connected to the dialysis machine. The entire protocol was executed under strict medical supervision.

Patterns–

(D1 flexion/extension) - Flexion-adduction-external rotation & extension-abduction-internal rotation. (D2 flexion/extension) - Flexion-abduction-external rotation & extension-adduction-internal rotation.

The training program included two sessions per week for eight weeks; a total of 16 sessions were conducted. 3 sets of 6 repetitions were given, with a 1-minute rest interval in between sets.[7]

Fig: 2. A patient performing D1-Flexion Pattern with elastic resistance band in a supine position.

Statistical Analysis:

Data analysis was done using GraphPad InStat Demo. The difference between the baseline, pre-, and post-MIP was calculated using paired t-test. A two-tailed test was used at an alpha of 0.0056.

RESULTS:

Demographic characteristic:

Out of initially screened 11 patients, only 7 were eligible for the study according to the inclusion criteria. Table 1 shows the descriptive data of the characteristics of the patients included.

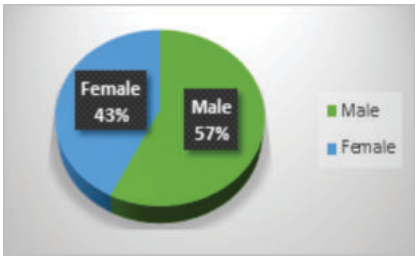


Fig: 3. Distribution of Gender

Table 1: - Patient characteristics and demographic data at baseline

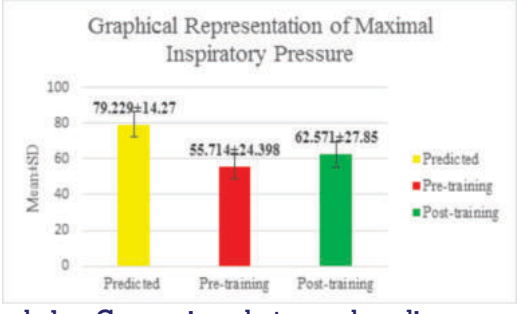
Characteristics/Demographic Data	Mean ± SD
Age (years)	44.71±11.33
Height (cm)	162.2±9.72
Weight (kg)	52.35±13.01
BMI (kg/m2)	19.92±4.75

Table 2: - Maximal Inspiratory Pressure absolute values in terms of the baseline, pre-and post-training measurements.

	Baseline Mean ±SD	Pre-training Mean± SD	Post-training Mean± SD	Mean difference ±SD	P-value	t-value	Significance
MIP	79.228 ±14.279	55.714 ±24.398	62.571 ±27.850	6.857 ±4.298	0.0056	4.221	Very Significant

Abbreviations: -

- MIP (Maximal Inspiratory Pressure)
- SD (Standard Deviation)
- Level of significance at $p < 0.05$



Graph 1: - Comparison between baseline, pre-and post-treatment Mean±SD difference of Maximal Inspiratory Pressure.

Based on the above findings, the pre-training MIP (55.714±24.398 cmH2O) showed a lower mean when compared to the predicted MIP (79.228±14.279 cmH2O). There is an almost 30% mean reduction between the two values. On the other hand, when we compared pre-training MIP (55.714±24.398 cmH2O) with post-training MIP (62.571± 27.850 cmH2O), it showed an improvement in inspiratory muscle strength by (6.857±4.298 cmH2O; $p < 0.05$) which is considered statistically significant. Hence, it proves that maximal inspiratory pressure (MIP) showed statistically significant results when compared at baseline, pre-and post-training in patients undergoing hemodialysis.

DISCUSSION: -

In CKD, as the disease progress, there is a gradual loss of kidney function over a period. At the early stages of CKD, most the people do not have symptoms, but as the disease

progress, the toxins like blood urea nitrogen (BUN) and creatinine start accumulating in the blood due to which patients start feeling sick i.e., extreme fatigue, tiredness, weakness, migraine headaches, nausea, vomiting, loss of appetite, sleep problems, etc.[8] Symptoms become more prominent and progressive in nature as disease become chronic. The most common cause of mortality in CKD is cardiovascular and respiratory complications.[9]There is a loss of inspiratory muscle strength and endurance in end-stage-renal-disease (ESRD), usually resulting from uremic myopathy. This is one of the factors for the reduction in predicted MIP values in CKD patients.[10,11,12]

Considering the normal physiological changes after resistance exercise training, a muscle goes through several changes such as hypertrophy, increased oxidative capacity, and changes in muscle fiber type. By accompanying these physiological adaptations, there will be an increase in muscle force, endurance, and functional exercise capacity. These changes are responsible for the improvement in quality of life and independence in activities of daily living.[5]

Based on the results obtained, the upper limb PNF combined with unilateral resistance training can be used as a treatment option to strengthen the inspiratory muscles such as the diaphragm & external intercostal in chronic kidney disease patients undergoing hemodialysis.

In the present study, resistance exercises were given in the intradialytic phase, henceforth we were more concerned about the hemodynamic changes and the safety of the patient during the exercises. For the same reason, all patients underwent unilateral upper extremity PNF strengthening. These exercises were based on the mechanism of contralateral strength training. If the resistance exercises are performed on one side of the body to increase the strength, voluntary strength can be increased on the contralateral side. This is usually effective in homologous muscles, as in the study of Timothy J. Carroll et al. 2006.[13] In this study, the improvement in the post-intervention inspiratory muscle strength can be linked to the contralateral strength training effect on major inspiratory muscle. Also, the PNF technique used with resistance exercises may have increased the contractile capacity of the muscle, resulting in improved muscle strength.

A study was done by Kraemer; Ratamess et al. 2004 concluded that there will be an increase in the contractile capacity of the muscle while performing resistance exercises, thus providing an increase in muscle strength.[14] We cannot deny the possibility of the same mechanism taking place in the muscle fibers while performing resistance exercise which is to be considered for improvement in the inspiratory muscle strength in CKD patients.

PNF technique is also useful in stimulating and strengthening the muscles located in the neck, rib cage, and upper limbs as stated by Voss et al., 1987.[15] Another study done by Keila Facirolli et al. in 2005 proved that upper limb PNF patterns (D1 & D2 flexion, extension) are effective in improving inspiratory muscle strength, though the effect was of short duration.[7] Also, resisted PNF technique has proved to be an alternative treatment option for gaining inspiratory muscle strength.

CONCLUSION:

Intradialytic unilateral upper extremity resistance training for a period of 8 weeks can improve the inspiratory muscle strength in chronic kidney disease patients undergoing hemodialysis.

Limitations And Future Scope: -

A pulmonary function test (PFT) has not been assessed in the study. There is a possibility of the corresponding improvement in pulmonary functions along with the inspiratory muscle strength. Hence in the future MIP and PFT, both can be taken into consideration for a better understanding of pulmonary functions and its correlation with inspiratory muscle strength.

Conflict Of Interest: -

None declared.

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