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# EFFECT OF NEUROMUSCULAR ELECTRICAL STIMULATION ON QUADRICEPS MUSCLE STRENGTH AND SIX MINUTE WALK DISTANCE IN SPUTUM NEGATIVE PULMONARY TUBERCULOSIS

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## ABSTRACT

*Background:* Pulmonary Tuberculosis (PTB) leads to many physical impairements which can affect the daily physical tasks. Giving neuromuscular electrical stimulation (NMES) to quadriceps muscle can improve the functional status without causing fatigue and compromising oxygen status. The aim of the study was to study the effect of NMES on quadriceps muscle strength and six minute walk distance in Pulmonary tuberculosis.

*Method:* This was an interventional based study conducted in K.J.Somaiya Medical Hospital. 26 patients suffering from pulmunary tuberculosis were taken in the study. Strength assessment of quadriceps muscle was assessed by 1RM and six minute walk distance was assessed by six minute walk test. NMES is given to quadriceps muscles bilaterally for continuous 10 sessions in 11 days.

*Result:* Wilcoxon signed rank test, 't' test and mann whitney test were done to analyse the data. There was significant increase in 1RM (1.808kgs->2.885kgs) and 6MWD (405.23m->493.65m) post NMES training.

*Conclusion:* Therefore the study performed suggest that NMES training performed prior to endurance training is useful for strengthening peripheral muscles, which in turn may augment gains in body weight and improves quality of life, further reductions in ventilation requirements during exercise. Despite the ability to cure tuberculosis, there remains a significant impact on the patient's health status in physical, psychological and social aspects. The study showed significant improvement by giving NMES in 6MWD and 1RM.

*Key words:* Neuromuscular electrical stimulation, sputum negative pulmonary tuberculosis, six minute walks distance, quadriceps strength.

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## INTRODUCTION

Despite great advances in immunology, microbiology and drug development, TUBERCULOSIS remains among great public health challenge. It is still a disease of tremendous importance to human race. Roughly a third of the world's population has been infected with M. tuberculosis, and new infections occur at a rate of one per second. In 2007 there were an estimated 13.7 million chronic active cases, and in 2010, 8.8 million new cases, and 1.45 million deaths, mostly in developing countries.[1]

Tuberculosis a very commonly seen infectious disease; caused by various strains of Mycobacteria (MY.TUBERCULOSIS). Tuberculosis usually affects the lungs but can also affect the other parts of the body (eg. spine).It spreads through air when people with Active MTB infection cough, sneeze or spit. Most infections are usually asymptomatic, latent. Tuberculosis is a disease which occurs gradually, has social stigmatization and symptoms occur over a period of time. Also primary drugs of anti-tubercular treatment have side-effects which affect the patient.[2-3] Patients diagnosed with pulmonary tuberculosis are known to have secondary complications like breathlessness, generalized weakness due to medications, muscle wasting, reduced nutritional status, reduced exercise capacity, fatigue etc. Other Drug induced complications being Peripheral neuropathy, ascites, hepatotoxicity, ototoxicity, etc. Muscle wasting is common in patients with Tuberculosis, and there is no effective treatment other than general physical reconditioning. Characteristic features include the loss of type I fibers, decreased oxidative capacity, leading to impaired quality of life and increased health care utilization.

There are several modalities available for the objective evaluation of functional exercise capacity. Some provide a very complete assessment of all systems involved in exercise performance (high tech), whereas others provide basic information but are low tech and are simpler to perform. The modality used is based on the clinical question to be addressed and on available resources.

The 6MWT is a practical simple test that requires a 100-ft hallway but no exercise equipment or advanced training. Walking is an activity performed daily by all but the most severely impaired patients. This test measures the distance that a patient can walk on a flat, hard surface in a period of 6 minutes (the 6MWD).[4]This test has been used widely for many conditions as well. In one of the studies done on multiple sclerosis comparison was done between 2minute walk test and 6 minute walk test. It was found that the 2MWT may be considered as a practical replacement for the 6MWT in routine clinical assessment. This was because patients with multiple sclerosis become easily exhausted for 6MWT.[5]

These studies hypothesize to have significant change in muscle strength and six minute walk distance with neuromuscular electrical stimulation. Hence, the aim of the study is to observe the effects of neuromuscular electrical stimulation on quadriceps muscle strength and six minute walk distance in sputum negative pulmonary tuberculosis patients. It evaluates the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism. The self-paced 6MWT assesses the submaximal level of functional capacity. It provides a global assessment of the exercise response, an objective determination of functional capacity and impairment, determination of the appropriate intensity needed to perform prolonged exercise, quantification of factors limiting exercise, and a definition of the underlying pathophysiologic mechanisms such as the contribution of different organ systems involved in exercise. Most patients do not achieve maximal exercise capacity during the 6MWT; instead, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at submaximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities.

## METHODOLOGY

This was an intervention based study. Twenty six patients diagnosed as PTB but sputum negative in sputum culture were included in the study. It was a convenience sampling. Age group was 18-60 years. Exclusion criteria was patients diagnosed with extra pulmonary tuberculosis, any musculoskeletal injuries or neurological involvement or any surgeries in lower limbs in past 6 months, neuropathy due to reasons other than Anti-tubercular drugs, breathlessness due to cardiac origin, any other diagnosed respiratory conditions (Eg. COPD, Bronchialasthama), patients with any associated psychiatric conditions.

Materials used for the study were

- Electrical muscle stimulator with carbon electrodes.
- Weight cuffs of 0.5 Kgs;1 Kgs;2 Kgs;3 Kgs;4Kgs

- 30 Meters hallway
- Stopwatch
- Sphygmomanometer
- Pulse oximeter

**Study procedure:** Written consent was taken from patients. Initial assessment of quadriceps muscle strength was done by finding 1RM. Six minute walk distance was calculated by performing six minute walk test as per ATS guidelines. Patients were given breathing exercises and postural drainage (if required) NMES to quadriceps muscle was given in sitting position with knees in 90 degrees flexion and back supported. Patients could put their efforts during the phase of stimulation. Surge duration and Surge interval was 2 seconds and 3 seconds respectively. 3 sets of 10 repetitions each was given with a rest pause of 2 minutes in between the sets. Re-assessment was done after 10 continuous sessions in 11 days.

## RESULTS

Table - 1

| | Mean | Mean | Std Deviation | Std Deviation | P value | Statistical significance |
|---|---|---|---|---|---|---|
| | Pre | post | Pre | post | | |
| **6MWD** | 405.23 | 498.65 | 138.46 | 129.44 | < 0.0001 | Extremely Significant |
| **1RM(Rt)** | 1.808 | 2.885 | 0.722 | 0.765 | < 0.0001 | Extremely Significant |
| **1RM (Lt)** | 1.808 | 2.885 | 0.722 | 0.765 | < 0.0001 | Extremely significant |
| **SBP** | 15.231 | 15.308 | 4.702 | 4.798 | 0.8232 | Not significant |

(MWD- minute walk distance, RM – Repetition Maximum, Rt. – right, Lt. –left, SBP – Systolic Blood Pressure)

**STATISTICAL ANALYSIS:** Wilcoxon matched pair signed rank test was done to analyse the 1 repetition maximum, six minute walk distance and blood pressure. Paired t test was used to analyse heart rate. Mann Whitney test was used to analyse respiratory rate.

## DISCUSSION

In the study, out of 26 patients, 12 were females &14 males with an average age of 32 yrs. (min 20yrs-max 60yrs). Also, in the study 46% patients were from CATEGORY I, 50% from CATEGORY II and 4% from CATEGORY III. It was proved in the study that the strength increased significantly ($p < 0.0001$) after NMES. Pre training the average strength bilaterally was 1.808kg which increased to 2.885kgsi.e.on an average there was an increase of 1.077kgsbilaterally.The reason for increase is that NMES training performed prior to endurance training is useful for strengthening peripheral muscles, which in turn may augment gains in body weight and further reductions in ventilation requirements during exercise. It was also seen that 6MWD increased significantly from 405.23m to 498.65m ($p < 0.0001$). Treatment is said to be effective if the rise in 6MWD is by 30m or more. In this study the rise was by 93.42mts; which is very significant. As the strength of the muscle increases, functional capacity also increases leading to better performance.

The 6MWT has also been used to detect changes following interventions to improve exercise tolerance for healthy older adults[6,7] as well as people with rheumatologic conditions such as knee or hip osteoarthritis[8] and fibromyalgia. The 6MWT has been used with a variety of other conditions such as heart failure[9, 10]chronic obstructive pulmonary disease (COPD)[11] and stroke.[12, 13]

However, change in other parameters like heart rate, respiratory rate and blood pressure during six minute walk test remained non-significant. As the changes in the cardiorespiratory parameters remained almost unchanged, it indirectly proves that due to change in musculoskeletal system i.e. strength of quadriceps muscles functional activities in daily life has improved. Originated from the observation that, despite the severe abnormalities in respiratory mechanics, a good proportion of patients stop exercise due to the subjective feeling of leg fatigue rather than breathlessness or else due to complications such as peripheral neuropathy etc. leading to muscle wasting causing reduced muscle power in turn affecting the exercising capacity and health related quality of life. Application of vigorous exercises which involves active movements of the body is difficult in

patients suffering from pulmonary Tuberculosis due to weakness of peripheral muscles. During vigorous exercise oxygen utilization is more leading to lactic acid production, subsequently making them feel more breathless and fatigue.

Strength training by NMES promotes neural and muscular adaptations that are complementary to the well-known effects of voluntary resistance training.[3] Because of the characteristics of skeletal muscle fibers, different types of fibers can be activated to differing degrees by different types of EMS. Also the modifications that are induced depend on the pattern of EMS activity.

Most patients do not achieve maximal exercise capacity during the 6MWT. Rather, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at submaximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities.

The limitations of the study were patients were from different categories and duration of onset of anti-tuberculous drugs varied. Further research can be carried out specifically in different categories.

## CONCLUSION

This study proves that there is significant increase in muscle strength after neuromuscular electrical stimulation in patients suffering from pulmonary tuberculosis. This increased strength thus helps in improving exercise tolerance of a patient.

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