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Original Research Article

Correlation between aerobic capacity and fatigue in subjects with post-polio syndrome

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Abstract

Introduction: Post-polio syndrome (PPS) is defined by Halstead and Ross as having a period of at least 15 years of neurologic and functional stability followed by onset of two or more of the following new health problems: unexplained fatigue, muscle or joint pain, muscle weakness, and cold intolerance and exclusion of other medical diagnosis. Fatigue occurs in 59–89% of PPS patients. Aerobic capacity during functional activities may also decrease in subjects with PPS which may lead to fatigue or vice versa. This study aimed to correlate the aerobic capacity using the 2 minute walk distance (2MWD) with fatigue using Fatigue Severity Scale (FSS) in subjects with PPS.

Material and methods: An observational study using convenience sampling was conducted in a community setting, in Surat on 19 individuals with PPS. Inclusion criteria were according to the old Halstead criteria and individuals who were able to walk with and without walking aids. Individuals who were on psychotropic medications, a diagnosed respiratory or cardiac condition, who were uncooperative due to cognitive impairment and those who were unwilling to participate were excluded. Outcome measures were Two Minute Walk distance (2MWD) for aerobic capacity and Fatigue Severity Scale (FSS) for fatigue. The subjects were asked to fill a questionnaire which included their demographic data and the Fatigue Severity Scale. They were asked to walk on a 25 m long corridor as far as they could, for 2 minutes. They were explained that if they felt breathless or fatigued, then they could stop. At the completion of 2 minutes, distance was recorded.

Results: The mean 2MWD was 76.02±1.37 m and FSS was 40.25±3.50. The value of Spearman's correlation coefficient was -0.46 (p=0.48).The study shows moderate correlation between FSS and 2MWD which was statistically significant.

Conclusion: Fatigue influences the aerobic capacity of subjects with post-polio syndrome and vice versa.

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Key words

Aerobic capacity, Fatigue, Post-polio syndrome, 2 minute walk distance, Fatigue severity scale.

Introduction

Post-polio Syndrome (PPS) is a condition that can affect survivors many years after the initial paralytic attack caused by the polio virus.PPS is now reckoned to be a condition following paralytic polio in which the muscle strength and clinical function are slowly deteriorating, without any dramatic loss of muscle strength as in motor neuron diseases [1]. PPS is defined by Halstead and Rossi [2] as having a period of at least 15 years of neurologic and functional stability followed by onset of two or more of the following new health problems: unexplained fatigue, muscle or joint pain, muscle weakness, muscle atrophy, functional loss and cold intolerance. No other medical diagnosis should be present to explain these new health problems if PPS is to be the diagnosis [3]. The most widely accepted hypothesis, proposed by Wiechers and Hubbell [4], attributes the symptoms to a distal degeneration of axons from the greatly enlarged motor units that develop during recovery from acute paralytic poliomyelitis. New muscle weakness is the most significant neurological problem. This new muscle weakness usually progresses at a slow rate, is asymmetrical, and can be of a proximal, distal or patchy distribution. It can occur in muscles previously affected or clinically unaffected during the acute attack, but is more likely to occur in the muscles that were originally affected [5].

Prevalence of PPS ranges between 20-85% among polio survivors [6]. It usually begins very slowly, although it can appear suddenly with events like fall, surgery or immobility seeming to be trigger factors. PPS occurs irrespective of age and in people who had paralytic or non-paralytic polio [2]. Progressive weakness and atrophy in post-polio syndrome is probably due to a distal degeneration of post-polio motor units with resultant irreversible muscle fibre denervation [1].

The muscle enzyme levels are significantly lower in individuals with prior poliomyelitis, indicating decreased oxidative and glycolytic potentials in the muscle fibres of the polio patients. The low capillary density and decreased oxidative and glycolytic enzyme potentials might be important factors for the development of muscle weakness, fatigue and muscle pain, which are commonly occurring symptoms in patients with prior poliomyelitis [3].

Fatigue occurs in 59–89% of PPS patients, and its causes are chronic pain, increasing weakness and muscle fatigability, respiratory dysfunction, injury to the brainstem reticular activating system during acute poliomyelitis encephalitis, “type A behaviour”, sleep disorders, muscle abnormalities, fibromyalgia, reduced dopamine secretion, and increased levels of proinflammatory mediators [6, 7]. Aerobic capacity during functional activities may also decrease in subjects with PPS which may lead to fatigue or vice versa.

India is a large country with large number of polio survivors (Polio India Fact Sheet). The prevalence of PPS is around 80% among polio survivors in Gujarat, India [8]. So far, there have been very few research studies that address the problems of PPS and the possible treatment options in India. This study therefore aims to know about the involvement of aerobic capacity and fatigue in subjects with PPS. The objective of the study was to correlate the aerobic capacity using the 2 minute walk distance

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(2MWD) with fatigue using Fatigue Severity Scale (FSS) in subjects with PPS.

Material and methods

An observational study was conducted in a community setting, Surat, India. A convenience sample consisting of 19 individuals with Post-polio syndrome were selected according to the old Halstead criteria. They were between 27 and 52 years of age, diagnosed as PPS, and were able to walk with or without assistive devices. Individuals who were on psychotropic medications, had respiratory or cardiac condition, who were uncooperative due to cognitive impairment or were unwilling to participate were excluded.

Written informed consent was taken from all the participants. The outcome measures were Two Minute Walk Distance (2MWD) and Fatigue Severity Scale (FSS). The subjects were asked to fill a questionnaire which included their demographic data and the Fatigue Severity Scale.

Fatigue was measured using Fatigue Severity Scale (FSS) which is a self-administered questionnaire, developed to measure fatigue in medical and neurological diseases. It has also been used to measure general fatigue in PPS. It has a good internal consistency (Cronbach's alpha=0.81 to 0.95) [9]. FSS consists of 9 statements that are scored on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), to explore severity of fatigue symptoms. A low value indicates that the statement is not very appropriate whereas a high value indicates agreement [9]. Subjects were asked to encircle a number from 1 to 7, depending on how they felt the statement applied during the preceding week.

2-minute walk distance (2MWD) was used to measure functional capacity. It is a recommended measure of functional capacity in PPS [10] and has good validity (r=0.69) and reliability (ICC=0.92 to 0.94). Participants were asked to walk on a 25m long corridor as far as they could for 2 minutes. The test was terminated if subjects reported any discomfort, fatigue or increase in pain. At the completion of 2 minutes, distance was recorded in meters.

Statistical analysis

Analysis was done using SPSS version 16. Level of significance was kept at 5%. Spearman's correlation coefficient was calculated.

Results

Demographic data of participants was as per **Table - 1** along with mean values of outcome measures. There was moderate correlation between FSS and 2MWD (Spearman's correlation coefficient r= -0.460), which was statistically significant (p=0.48) as per **Graph - 1**.

Table - 1: Demographic data.

Age (years)	33.75±5.56
Age of males (N=17)	32.23±5.56
Age of females (N=2)	30.50±5
No. of individuals walking with assistive devices	1 (one axillary crutch)
2MWD (meters)	76.02±1.37
FSS	40.25±3.50

Discussion

This study was done on individuals with post-polio syndrome to evaluate the relationship between fatigue and aerobic capacity. This study was performed on 17 males and 2 females having mean age 33.75±5.56 years. This study included subjects who were able to walk with or without assistive devices. In this study, 1 subject walked using one axillary crutch.

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Mean FSS value was 40.25±3.50 and the mean 2MWD was 76.02±1.37 m. The more the FSS score, more is the fatigue level. Bohannon RW found that the 2 minute walk distance (2MWD) ranged from 64.06 to 300.8 m (mean: 180.9 m) for adults who are 18-85 years old [11]. Gijbels D, et al. found that the 2 MWD ranged from 30 to 223 m (mean: 149 m) [12]. This showed that the 2MWD was reduced in subjects with PPS, which may be due to the reduced aerobic capacity.

In this study moderate correlation was found between fatigue and aerobic capacity, which is statistically significant. The increase in fatigue in subjects with PPS is similar to that seen in [13, 14, 15, 16].

Studies of motor units of patients with post-polio syndrome have revealed an on-going denervation– reinnervation process [17, 18]. This is probably initiated after the acute poliomyelitis, and over time leads to increase motor unit areas caused by collateral sprouting of adjacent motor neurons in the spinal cord in patients with post-polio syndrome; a process also evident during normal ageing, although not until the seventh decade of life. The motor unit area might increase by up to 20 times; reaching a level at which further reinnervation is no longer possible. Uncompensated denervation causes atrophy of muscle fibres and subsequently loss of muscle strength. The underlying cause of the on-going denervation resulting in the motor symptoms of post-polio syndrome is unclear. The loss in muscle strength may contribute to fatigue. Degeneration of damaged activating centre in the brain has been demonstrated to be caused by the disease and may be one, although a rare, explanation for severe fatigue among some individuals with late effects of polio [19].

Fatigue in patients with post-polio syndrome is multidimensional [20] and can be of general or mental character derived from the CNS (caused by early neuronal damage in the brain in the acute poliomyelitis stage, overlapping psychological factors, or both) or muscular from the motor unit [21, 22, 23]. Fatigue is probably the most disabling symptom of post-polio syndrome. Muscle weakness during fatigue is caused by slow recovery of the muscle and could reflect both central and peripheral fatigue [3, 18, 19]. Central fatigue is a voluntary or involuntary failure of neural drive that reduces: the number of functioning motor units, and motor unit firing frequency. Peripheral fatigue is a failure of the muscles ability to generate force, either because of high-frequency fatigue caused by impaired neuromuscular transmission and failed muscle action potentials, or low-frequency fatigue caused by impaired excitation/ contraction coupling.

Fatigue in post-polio syndrome has a negative effect on physical and psychosocial functioning but does not impair mental health [22, 23]. Health-related quality of life for vitality is to a greater extent caused by physical (e.g., decreased physical endurance) than by mental (e.g., mental fatigue) parameters [3]. According to Trojan and colleagues [3], although some risk factors for fatigue (e.g., age and time since the acute poliomyelitis) are non-modifiable, others (e.g., stress and physical activity) are modifiable. Besides a reduction in muscle mass after polio, increased muscle fatigue can also be a result of inactivity with a decreased level of oxidative enzymes and reduced capillarization. These findings are similar to those found in the present study.

Borg K and Henriksson J found that cardio-respiratory deconditioning can lead to fatigue which can be a result of a lower level of physical activity. In the musculature this may result in

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lower than normal levels of oxidative enzymes and capillarization [24].

The study was done on a small sample size with unequal male and female distribution. Only one individual used external aids which may have imposed extra stress. This study measured only general fatigue whereas individuals with PPS report mental as well as physical fatigue. This study was also conducted on individuals who were involved in some form of sports. This may not give a true representation of the aerobic capacity in subjects with PPS.
Future recommendations are to study aerobic capacity and fatigue on a larger sample size. Various factors affecting fatigue and aerobic capacity can be taken into consideration. Outcome measures used to evaluate physical and mental fatigue can be used.

Conclusion

Fatigue influences the aerobic capacity of the individual with post-polio syndrome and vice versa. This may be considered while planning the management of the patient.

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Graph - 1: Correlation between aerobic capacity (2MWD) and fatigue (FSS).