THE EFFECTS OF TAI CHI TRAINING PROGRAMS ON LOWER LIMB NERVE CONDUCTION VELOCITY IN PATIENTS WITH MULTIPLE SCLEROSIS

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Abstract. Objective: Imbalances and injuries due to falls avoid the use of body movement systems and gradually reduce the progression rate of peripheral nervous system. This study aims to investigate the effects of Tai Chi training programs on lower limb nerve conduction velocity in patients with MS. Materials and Methods: The subjects of present study consisted of 24 women with MS who were chosen through convenience sampling and then assigned randomly in two experimental and control groups. The training programs of experimental group included 8 weeks of Tai Chi training programs, 3 sessions in a week. Nervous electroneurographical parameters including nerve message conduction velocity and latency time were studied. The electroneurogram was used to record parameters. In order to analyze the data, dependent and independent sample of t-test were used and the level was considered significantly (p<0.05). Results: The results showed that nerve conduction velocity and time of latency before and after the interference in experimental group (p<0.05) were significantly different. There was also a significant difference in the mean velocity of nerve conduction and time of latency between experimental and control group (p< 0.05), so that the nerve conduction velocity in experimental group increased significantly after training programs and the time of latency decreased remarkably after interference. Conclusion: Tai Chi training programs can increase nerve conduction velocity.
and reduce nerve distal latency in lower limb of patients with Multiple Sclerosis. Moreover, they can be used as a complementary non-pharmacological therapy along with medications to help patients with MS.

**Key words:** nerve distal latency response, Tibial, sural and peroneal nerve, Tai Chi training program.

**Introduction.** Multiple Sclerosis (MS) is a chronic disease and demyelinate central nervous system in which atrophies the myelin sheath of nerve cells. Then some parts of muscles lose their ability gradually (1,2). The exact cause of disease is still unknown and there is no cure for it (3). It is the third largest cause of disability in young people (4).

The most common symptoms include fatigue, muscle spasms, ataxia, dizziness, muscle weakness, and loss of peripheral senses (5). According to the symptoms, collapse and imbalance in patients with MS is very common and the induced injuries are associated with reduction of activity in these individuals.

The lack of body motor system and its early complications such as demyelin is followed by reduction in the progression rate of peripheral nerves (6). Although MS is considered as demyelinating disease of central nervous system, there are sometimes some reports about the involvement of peripheral nervous system. Both peripheral neuropathy (7) and radiculopathy (8) were reported in patients with MS. In addition, electrophysiological abnormalities and subclinical pathology (9) were reported in association with MS. Currently the therapy having proven effect on disease to stop or recover, has not been known (1). Due to lack of certain cure with new medications and their high costs and several side effects, exercise and physical activity is an important and non-pharmacological therapy in order to help and improve patients with MS (10, 11). Recently many studies have shown that therapeutic exercises can be effective to improve these patients (12).

Research showed that exercise plays a significant role in improvement of peripheral nerve conduction velocity. The results of researches by Damirchi, et al. (2006) showed that exercise increases the nerve conduction velocity and reduces the distal latency of response. Proper balancing depends on input interaction of the visual, vestibular, somatosensory system and also proper motor response (6).

Studies showed that Tai Chi training programs can increase the peripheral nerve conduction velocity, balance, reduce falling risk, improve muscle strength and inner stimulations in lower limb through improvement the time of reaction in lower limb (13).

Therefore, due to limited research on effects of Tai Chi training programs on patients with MS and the impact of these programs on neural transition rate of these patients, this study aims to investigate the effects of Tai Chi training programs on peripheral nerve conduction velocity in lower limb in patients with MS.

**Materials and methods.** This study is semi- experimental and practical in terms of objective. The available population of study was women whose ages ranged from 30 years old to 40 with Multiple Sclerosis that referred to MS society in Mashhad city. After a public call of the MS Society of Khorasan and initial registration of women with MS who were interested in participating in this study, information about the nature and implementation of research, possible risks and critical points for participating in the study were given to participants at the presence of a neurologist.

According to the obtained information from questionnaire such as demographic features, medical history, age, body mass index and expanded disability level of Kdotschtke questionnaire, 24 women who were interested in and possessed criteria of study and also filled the consent form for participating and collaborating in the study were chosen through purposive and convenience sampling and then randomly assigned in two Tai chi program (N= 12) and control groups (N= 12). Before the study began, a doctor confirmed that subjects didn’t have any limitation in doing the exercises.

At first electroneurographical parameters of tibial, sural and proneal nerves including nerve conduction velocity and time of distal latency were examined between two groups. To document the electroneurographical parameters, Myto model of electronogram which was made in Italy was used. Subjects exposed to a room with ventilation and constant temperature of 21-23 degrees celsius. Within this temperature, foot skin temperature of the subjects had an average of 34 degrees celsius. Stimulation and receptor electrode were surface type. Electrode connected to the ground had constant temperature without power fluctuations.

The tibial nerve conduction was investigated through abductor hallucis muscle and distal stimulation point was examined at distance of 10 cm to recording electrode, behind the medial malleolus and proximal stimulation point along tibial nerve examined around Poplytal cavity. To investigate the response of peroneal nerve, stimulation point was 8cm above the stable electrode and proximal stimulation was on the head of fibula and Extensor brevis Degenerative muscle. In order to investigate the sural nerve, stimulation made from 10 cm of stable electrode and documentation was done from the Lateral malleolus.

After documentation of the pretest for all participants, the experimental group attend Tai Chi gong program under supervision of a Tai chi training specialist. The program consisted of 24 sessions and each session included 10 minutes warm up, 40 minutes Tai Chi exercises, and 10 minutes to return to the fist state. In order to observe the principle of overload, the number of repeating exercise was added each week.

The intervention training program was based on Tai chi exercises. The training program didn’t include training complex movements (form), but rather was designed for focusing on the principles of balance and weight transfer program to increase proprioception (5). These principles in Tai Chi are known as Chi Gung and include soft and slow movements which have special attention to the development of relaxation and conscious view towards body. This program also included brief meditation and massage.
Results:
Results showed that the age, BMI and EDSS degree of two groups have normal distribution. Descriptive statistics of the data and also result of Kolmogorov–Smirnov test are shown in table 1.
Table 1. Abundance distribution of data in terms of age, BMI and EDSS degree and the results of K-S test in investigated groups

<table>
<thead>
<tr>
<th>Index</th>
<th>group</th>
<th>average</th>
<th>Standard deviation</th>
<th>Z value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Experimental</td>
<td>35/08</td>
<td>3/60</td>
<td>0/67</td>
<td>0/75</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>33/08</td>
<td>3/75</td>
<td>0/73</td>
<td>0/66</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Experimental</td>
<td>25/58</td>
<td>3/67</td>
<td>0/63</td>
<td>0/81</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>25/75</td>
<td>2/49</td>
<td>0/52</td>
<td>0/95</td>
</tr>
<tr>
<td>EDSS degree</td>
<td>Experimental</td>
<td>2/50</td>
<td>0/92</td>
<td>0/66</td>
<td>0/76</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2/58</td>
<td>0/92</td>
<td>0/74</td>
<td>0/64</td>
</tr>
</tbody>
</table>

Table 2. Results showed that the conduction velocity of sural, superficial and deep peroneal nerves, after 8 weeks of exercise were significantly increased in the experimental group (p<0.05), whereas there was no significant change in the control group (p>0.05).

Table 2. Comparison between average grades of impulse conduction velocity before and after 8 weeks intervention exercise in investigated groups

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Group</th>
<th>Pre-test average</th>
<th>Post-test average</th>
<th>Dependent T</th>
<th>P significance of averages</th>
<th>Independent T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibial</td>
<td>Experimental</td>
<td>47/98(1/84)</td>
<td>47/98(1/84)</td>
<td>2/06</td>
<td>0/06</td>
<td>0/94</td>
<td>1/98</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>47/99(3/03)</td>
<td>48(2/96)</td>
<td>0/17</td>
<td>0/86</td>
<td>0/01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>35/91(1/71)</td>
<td>35/20(1/98)</td>
<td>1/16</td>
<td>0/26</td>
<td>0/71</td>
<td></td>
</tr>
<tr>
<td>Superficial peroneal</td>
<td>Experimental</td>
<td>34/06(1/90)</td>
<td>35/24(1/79)</td>
<td>5/06</td>
<td>0/000</td>
<td>1/17</td>
<td>2/46</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>34/61(1/89)</td>
<td>34/75(2/29)</td>
<td>0/37</td>
<td>0/71</td>
<td>0/13</td>
<td></td>
</tr>
<tr>
<td>Deep peroneal</td>
<td>Experimental</td>
<td>47/16(1/56)</td>
<td>48/55(2/27)</td>
<td>3/75</td>
<td>0/03</td>
<td>1/38</td>
<td>3/94</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>49/20(3/61)</td>
<td>49/08(3/44)</td>
<td>1/21</td>
<td>0/25</td>
<td>0/12</td>
<td></td>
</tr>
</tbody>
</table>

In addition, the results of current research showed that the distal latency of deep peroneal and Tibial nerves after 8 weeks exercise, had a significant decrease in experimental group (p<0.05), while there was no significant change in control group (p>0.05). There was a significant difference between averages of distal latency of experimental and control groups in the deep peroneal and Tibial nerves and (p<0.05), whereas in the sural and superficial peroneal nerves despite the decrease in the distal latency, the change was not significantly (p>0.05)
Table 3. Comparison between average grades of distal latency before and after 8 weeks intervention exercise in investigated groups

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Group</th>
<th>Pre-test average</th>
<th>Post-test average</th>
<th>Dependent T</th>
<th>P significance</th>
<th>subtraction of averages</th>
<th>Independent T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibial</td>
<td>Experimental</td>
<td>4/16(0/28)</td>
<td>3/59(0/32)</td>
<td>3/39</td>
<td>0/00</td>
<td>2/16</td>
<td>2/71</td>
<td>0/01</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>4/25(0/37)</td>
<td>4/21(0/33)</td>
<td>1/48</td>
<td>0/16</td>
<td>0/03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sural</td>
<td>Experimental</td>
<td>2/83(0/16)</td>
<td>2/70(0/15)</td>
<td>2/03</td>
<td>0/06</td>
<td>0/13</td>
<td>1/14</td>
<td>0/26</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2/81(0/13)</td>
<td>2/76(0/17)</td>
<td>1/59</td>
<td>0/13</td>
<td>0/05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>superficial</td>
<td>Experimental</td>
<td>2/55(0/18)</td>
<td>2/45(0/21)</td>
<td>3/19</td>
<td>0/00</td>
<td>1/25</td>
<td>1/92</td>
<td>0/06</td>
</tr>
<tr>
<td>peroneal</td>
<td>Control</td>
<td>2/56(0/34)</td>
<td>2/55(0/38)</td>
<td>0/41</td>
<td>0/68</td>
<td>0/01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>deep peroneal</td>
<td>Experimental</td>
<td>4/41(0/48)</td>
<td>4/23(0/48)</td>
<td>4/75</td>
<td>0/00</td>
<td>0/18</td>
<td>3/42</td>
<td>0/002</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>4/61(0/34)</td>
<td>4/60(0/34)</td>
<td>0/56</td>
<td>0/58</td>
<td>0/01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Discussion.** The results showed that Tai Chi training programs considering as complementary and non-pharmacological therapy influence the increase of sural, superficial and deep peroneal nerve conduction velocity and has a significant effect on the decrease of distal latency in tibial and deep peroneal nerves. However, they have no significant effect on tibial nerve conduction velocity and distal latency response in superficial peroneal and sural nerves.

This study showed for the first time that Tai Chi training programs increase nerve conduction velocity and time of distal latency in patients with MS significantly.

No research was found which investigate the effects of Tai Chi training programs on peripheral nerve conduction velocity in patients with MS. But researches by Mal Hutra (2002), Watanabe (2012) showed that yoga and physical activity increase the movement speed of nerve. All of the results mentioned above are consistent with results of present study and they all emphasize on the impact of exercise on nerve conduction velocity (14, 15).

Researchers have reported some factors such as age, temperature of environment, height, being athletes and even different sports affect on nerve conduction velocity (16). Cuman, et al (1984) investigated the posterior tibial nerve conduction velocity and ulna in 91 athletes and non-athletes. Nerve conduction velocity in both nerves among weight lifters was significantly more than other groups. Among these groups, the slowest nerve conduction velocity was in tibialis anterior muscle among male marathon runners. These results suggested that the type of sport is effective in increasing the rate of nerve conduction velocity (17).

According to results, exercise can lead to huge changes in the neuromuscular system, and enhance the implementation, coordination, motor unit firing frequencies of motor units. This indicates increase of neural adaptation which occur as soon as people start exercise (17).

Increase of body temperature is one of the fundamental problems in MS patients during exercise. Since vigorous exercise increases the body internal temperature, it cause worsening the symptoms and sometimes bring new symptoms. Consequently, many MS patients avoid exercise including running and jumping because of increase body temperature, the risk of falling and imbalance.

Research showed that in compare with other sports, Tai Chi is safer and its benefits for health have been proven. The research also suggested Tai Chi increases balance, reduces falling risk and improve muscle strength and inner stimulation in lower limbs through improvement of reaction time in lower limbs (13).

In a study by Hung, et al (2009), the effect of Tai Chi on peripheral nerves of diabetic patients, showed that the peripheral nerve conduction velocity in patients with diabetes increased significantly after 12 weeks exercise and time of distal latency reduced significantly in some nerves. These results are in line with the findings of present study (18).

Tai Chi training programs emphasize on the principles of balance, weight transfer and increase proprioception. Tai Chi exercises require standing on one leg, and slowly transfer weight from one foot to the other foot with a conscious view towards body. The precise weight control and weight change between bipedal stance result in the coordination of postural control in different situations and improvement of balance and reaction time in the lower limbs (13 and 19). On the other hand, Tai Chi exercises need little equipment and facilities so that is applicable with the least cost. All of these factors make Tai Chi training programs suitable for patients with MS. However, MS is considered an autoimmune and chronic inflammation disease. Research showed that regular Tai Chi exercises can increase immune T cells (20, 21) and 1st type of helpful T cells and may improve the immune response (22). Thus, Tai Chi exercises can improve immune system and nerve conduction velocity and in turn decrease peripheral neuritis.

**Conclusion.** Finally it can be concluded that Tai Chi training programs can increase nerve conduction velocity and decrease the time of distal latency in patients with MS and leads to the improvement of balance in these people.
Therefore, it is recommended that doctors use these exercises as a complementary and non-pharmacological therapy along with pharmacological one to help patients with MS.

References