Efficacy of weight bearing exercises versus resistance exercises in improving gait parameters in patients with diabetic peripheral neuropathy

Shaifali¹, Jyoti Jangra*¹,²
¹Prem Institute of Medical Sciences, Panipat, Haryana
²School of Physiotherapy and Paramedical Sciences, Lovely Professional University, Punjab

Abstract

Introduction: Progressive deterioration of sensory and motor deficit in diabetic neuropathy often result in gait related dysfunctions like reduction in gait velocity, cadence, stride and step length, increased stance time as compare to healthy individuals. So this study compared the outcome of weight bearing exercises to resistance exercises on improvement of gait variables in patients with diabetic neuropathy.

Materials/Methods: 30 diabetic patients of age group 45-65 having neuropathy disability score between 2 to 5 were participated in the study. They were divided into two experimental groups and treated with weight bearing exercises and resistance exercises 3 times a week for 4 weeks i.e. 12 sessions. All subjects in both groups were assessed with gait parameters (step & stride length, foot angle, cadence) at pre-test and at post-test.

Results: by the end of intervention both groups showed significant improvement of all gait parameters. There was significant improvement of stride length (0.003) and step length scores (0.018) in weight bearing group than resistance exercises group but there was no difference of foot angle(p=0.854) and cadence scores(p=0.229) between the groups.

Conclusion: weight bearing and resistance exercises are effective in improving gait in diabetic neuropathy patients but prior is beneficial.

Keywords: resistance exercises, weight bearing exercises, gait parameters, diabetes, neuropathy

Introduction:

Diabetic peripheral neuropathy is major consequence of type 2 diabetes which has detrimental effect on gait as a complication. A crucial predisposing factor backing to the growing number of type 2 diabetes in Asian as compare to European is high insulin resistance in Asians which can be due an environment factor or hereditary factor.²

Diabetic peripheral neuropathy is common complication or we can say quality of life damaging factor in diabetic patients.³ Diabetic peripheral neuropathy is a disorder of the peripheral nervous system affecting one or more of its components out one third of persons with DM have peripheral neuropathy. Diabetic neuropathy has mild to moderate sensory loss. they also have deficits in motor area such as decreased muscle power of toe and ankle extensors resulting instability in flexion and extension of the foot which affect the gait. Patient with diabetic peripheral neuropathy has almost 3 times increase in risk of limited mobility as compare to those having neither the frequently reported mobility. Diabetic peripheral neuropathy is directly related to inability to walk.⁴

Diabetes mellitus is a disorder of impaired glucose metabolism resulting in hyperglycaemia, polydipsia, polyuria and delay in healing of wounds. It is related with complications such as cardiac conditions, renal disease, retinopathy and neuropathy. Neuropathy manifests itself as proximal neuropathy, chronic distal symmetrical sensorimotor neuropathy, autonomic neuropathy, mononeuritis multiplex. The most common of all the types is the distal symmetrical sensorimotor neuropathy, which affects lower limbs more than upper limbs.⁵
Resistance training may enhance the strength of the major muscle groups of the lower limbs in distal peripheral neuropathy. Exercise itself can increase the strength of the atrophied muscle in peripheral neuropathy individuals, mainly the ankle dorsiflexors/plantar flexors and knee flexors/extensors. The studies have proved the effects of resistive exercises in older adults.6

Epidemiological studies suggest that nerve degeneration follows in almost 25% of diabetic people after the 10 years of diagnosis in diabetes, and in almost 50% individuals who had the disease from last 20 years. It is a chronic neuropathy, with the gradual onset of symptoms and progressing over months and years. It presents with “length dependent” degeneration of motor and sensory nerve fibres, with impaired sensation in the feet, tactile deficits, impaired proprioception, kinaesthesia and muscular weakness.7

The sensory loss and muscle weakness leads to balance impairments, gait pattern alterations and fall risk. People with neuropathy show greater postural sway while standing. Many studies on gait have shown distinctive changes in pattern of walking along with reduced strength at the ankle joint, reduced knee flexion and reduced ground reaction forces.8 Resistance training can reduce the symptoms of degenerative condition of old age as a strong muscle act as shock absorbers for the joint.9

People with distal peripheral diabetic neuropathy has high accidental damages in walking. Diabetic people are many times more likely to show a injury-related to fall like sprained ankle, fractures, bruises and cuts throughout standing and walking as compare to individuals without diabetes. Peripheral neuropathy also a threat for formation of plantar ulcers. Most of these ulcers are developed throughout the walking.10

Methodology

30 diabetic neuropathy participants from physiotherapy department who were ready to take treatment for 4 weeks, were included for this study. The subjects were divided and placed in either of the two groups- group A (weight bearing training), group B (resistance training) by simple convenient method. A written informed consent was taken from each participant. Inclusion Criteria were (1) 45-65 years of age with diabetes mellitus more than 5 years with controlled hypertension. 2) peripheral neuropathy symptoms include lower extremity. 3) Neuropathy disability score more than 2 and less than 5. 4) Patient who were able to walk household distance without assistance with strength. Patients with CNS, vestibular dysfunction, musculoskeletal deformity, complete sensory loss, hypoglycaemic, angina & lower limb arthritis, pain that restricts standing or weight bearing, diabetic foot ulcer, gangrene at foot were excluded.

Baseline findings of these patients such as age, sex, BMI, neuropathy disability score, diabetic history and any medication were recorded before the treatment protocol.

The patients were asked to walk 12 meters’ distance in which 5-meter walk was on paper. After that their footprint method were taken for the assessment of distance variables (stride length, step length, foot angle) and time variable(cadence). We used time and distance variables of gait as outcome measures. Ink footprint method was used to measure these variables.

Interventions: Group A received weight bearing exercises. Most of weight bearing exercises were conducted in standing so that body weight can be used as resistance. Weight bearing exercises included double leg press, push up on knees, wide stance mini-squat, step-up exercises, quadruped position exercises, heel raise holding railing and one limb stand with arm support. Resistance exercises are given to group B which includes resistance exercises of hip, knee and ankle. Both groups received 3 sets of 10 repetitions for 3 alternate days per week for 4 weeks.

Statistical analysis

Data were summarized using statistics of mean, standard deviation. The analysis was carried out with the help of IBM statistics package (SPSS 22). The analysis includes tables of variables with demographic profile based on Chi – square t test. chi-squared test for qualitative data, were used to do the comparison between groups of
patients. A paired samples t-test was used to compare data before and after treatment protocol in both groups. A p value of <0.05 was reflected statistically significant difference.

Results

A total of 30 participants with DN involving 15 females and 15 males with age group between 45 to 65. No statistically significant difference of age and gender data of the participants between the two groups was found. Mean age of the Group A participants was $53.27 \pm 6.15$ years and that of Group B participants was $54.80 \pm 5.62$ years. Table 1 shows demographic profile of both groups.

Table 1: Demographic Profiles

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=15)</th>
<th>Group B (n=15)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>53.27 ± 6.15</td>
<td>54.80 ± 5.62</td>
<td>0.713</td>
<td>0.482</td>
</tr>
<tr>
<td>Gender (M:F)</td>
<td>7 :8</td>
<td>8 :7</td>
<td>0.133&quot;</td>
<td>0.715</td>
</tr>
</tbody>
</table>

P > 0.05 shows a non-significant difference between groups.

Table 2: Comparison of Mean and SD of Step Length at Pre and Post Interval within Group A and Group B

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Pre</td>
<td>39.47 ± 0.83</td>
<td>38.82 ± 0.98</td>
<td>78.26 ± 0.354</td>
<td>78.44 ± 0.49</td>
</tr>
<tr>
<td>Post</td>
<td>43.31 ± 1.11</td>
<td>42.24 ± 1.20</td>
<td>82.00 ± 0.95</td>
<td>81.00 ± 0.72</td>
</tr>
<tr>
<td>t Value (pre vs post)</td>
<td>22.39</td>
<td>11.02</td>
<td>17.81</td>
<td>11.06</td>
</tr>
<tr>
<td>P Value (pre vs post)</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

P < 0.05 shows significant difference between groups.

TABLE 3: Comparison of Mean value for Cadence at Pre and Post Interval within Group A and Group B

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Pre</td>
<td>83.13 ± 1.45</td>
<td>83.27 ± 0.88</td>
<td>9.07 ± 1.49</td>
<td>9.13 ± 1.35</td>
</tr>
<tr>
<td>Post</td>
<td>86.20 ± 1.48</td>
<td>85.60 ± 1.18</td>
<td>8.00 ± 1.00</td>
<td>8.07 ± 0.96</td>
</tr>
<tr>
<td>t Value (pre vs post)</td>
<td>20.00</td>
<td>9.26</td>
<td>5.88</td>
<td>5.87</td>
</tr>
<tr>
<td>P Value (pre vs post)</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>
P < 0.05 shows significant difference between groups

TABLE 4: comparison of mean value for step length at pre and post interval between group A and group B
Step Length & stride length

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>t value</th>
<th>P value</th>
<th>Group A</th>
<th>Group B</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>39.47 ± 0.83</td>
<td>38.82 ± 0.98</td>
<td>1.953</td>
<td>0.061</td>
<td>78.26 ± 0.354</td>
<td>78.44 ± 0.49</td>
<td>1.140</td>
<td>0.264</td>
</tr>
<tr>
<td>Post</td>
<td>43.31 ± 1.11</td>
<td>42.24 ± 1.20</td>
<td>2.521</td>
<td>0.018</td>
<td>82.00 ± 0.95</td>
<td>81.00 ± 0.72</td>
<td>3.307</td>
<td>0.003</td>
</tr>
</tbody>
</table>

P > 0.05 shows a non-significant difference between groups in pre step length & stride length.
P < 0.05 shows a significant difference between groups in post step length & stride length.

TABLE 5: comparison of mean value for cadence at pre and post interval between group A and group B
Cadence & foot angle

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>t value</th>
<th>P value</th>
<th>Group A</th>
<th>Group B</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>83.13 ± 1.45</td>
<td>83.27 ± 0.88</td>
<td>0.30 4</td>
<td>0.76 9</td>
<td>9.07 ± 1.49</td>
<td>9.13 ± 1.35</td>
<td>0.12 8</td>
<td>0.89 9</td>
</tr>
<tr>
<td>Post</td>
<td>86.20 ± 1.48</td>
<td>85.60 ± 1.18</td>
<td>1.23 0</td>
<td>0.22 9</td>
<td>8.00 ± 1.00</td>
<td>8.07 ± 0.96</td>
<td>0.18 6</td>
<td>0.85 4</td>
</tr>
</tbody>
</table>

P > 0.05 shows a non-significant difference between groups in cadence and foot angle.

Discussion
The primary area of this study was to compare the efficacy of the two types of exercises that are weight bearing exercises and resisted exercises in improving gait variables i.e. step & stride length, cadence and foot angle. Step/stride length and foot angle from distance variable and cadence from time variables were analysed. Our results revealed that gait parameters can be improved with targeted strengthening and weight bearing exercises in diabetic patients.

Weight bearing exercise showed significant difference in step & stride length, cadence and angle of toe out between pre and post scores. Resisted exercise also shows significant difference in step & stride length, cadence and angle of toe out between pre and post scores. The results of this study reveal that the weight bearing exercises are significantly more effective in improving the step length and stride length score than the resisted exercises in patients of diabetic neuropathy. There was no significant difference in post scores of foot angle and cadence between the weight bearing and resistance exercises groups.
Significant improvement in gait parameters in weight bearing exercises group is supported by Michael J. Mueller et. al who found that the weight bearing exercises are significantly effective than non-weight bearing exercises for gait improvement in diabetic neuropathy. The results of weight bearing group showed more gain than the non-weight bearing group which were assessed on the basis of two outcome measures. The outcome measures included 6-minute walk distance test and average step count on the daily basis.

After 4 weeks of resistive exercises protocol group B also showed significant improvement in all gait parameters. Evidence of similar results were found in a study done by Patricia M. Kluding et al demonstrated the improvement in outcome measures related to neuropathy and branches of nerve fibres following resistive and aerobic exercises in diabetic neuropathy. It is also accountable that improvement in neuropathy due to resistive and aerobic exercises may have improved balance which further has direct effect on gait.

Raghav D et. al sustained these results who record the efficacy of schematic exercises on stride length, cadence and dynamic gait index of diabetic neuropathy patients and has demonstrated significant improvement in the stride length and cadence and comparatively lesser improvement in dynamic gait index group which underwent schematic/focused exercise regimen as compared to other group underwent strengthening exercises.

Study that analysed the effects of weight bearing exercises on subjects with diabetes suggested that by increasing the peripheral inference, we can improve balance and postural stability which further leading to a decrease in number of falls related to sensory deficits. Posture control is the result of communication of somatosensory, vestibular and visual systems, and any modifications in one or more factor of these systems, such as sensory deficits on the feet or vestibular dysfunction may result in posture instability.

In a study done by Lallets S Armand showed that the specific balance and gait training protocol centred on a circuit approach and balance exercise regime combined with function-oriented strengthening can improve the balance, speed of gait and increase both joint mobility and muscle strength in diabetics.

Limitations of the study were the small sample size, only immediate effects were observed and bilateral comparison of both lower was not done.

The study is relevant in accordance with development of treatment protocol, by stimulating the proprioception we can improve the balance and gait improvement by strengthening the muscles. Future study can be done on wider sample and on other variables of gait.

Conclusion
This study compared the effectiveness of WEIGHT BEARING EXERCISES and RESISTED EXERCISES in improving step length, stride length, cadence and angle of toe out in diabetic neuropathy and it is concluded that Step length and stride length score is improved in group A significantly so the weight bearing exercises are better than resistance exercises in diabetic neuropathy.

References
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35 Raghav D (2013). The efficacy of schematic exercises on stride length, cadence and dynamic gait index of diabetic neuropathy. Indian journal of physical therapy, vol 1,issue .2