Effect of Buerger-Allen Exercise and Intraneural Facilitation on Lower Extremity Perfusion and Peripheral Neuropathy Symptoms Among Patients with Type II Diabetes Mellitus

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Conflict of Interest: None.

ABSTRACT

Background: Diabetes mellitus is a complex metabolic disorder characterized by chronic hyperglycemia, which can lead to severe microvascular and macrovascular complications. Peripheral neuropathy and impaired lower extremity perfusion are common among diabetic patients, significantly affecting their quality of life. Buerger-Allen Exercise (BAE) and Intraneural Facilitation (INF) are therapeutic interventions aimed at improving blood flow and reducing neuropathy symptoms in diabetic patients. This study aimed to compare the effectiveness of these two interventions in enhancing lower extremity perfusion and alleviating peripheral neuropathy symptoms.

Objective: To assess and compare the effects of Buerger-Allen Exercise and Intraneural Facilitation on lower extremity perfusion and peripheral neuropathy symptoms in patients with type II diabetes mellitus.

Methods: This quasi-experimental study was conducted at Al-Raheem Clinic and Skin Laser Center in Faisalabad over three months. A purposive sampling technique was used to recruit 12 patients with type II diabetes mellitus and peripheral neuropathy symptoms restricted to the lower limbs. Patients were divided into two groups: one received Buerger-Allen Exercise and the other Intraneural Facilitation. Assessments included the Ankle-Brachial Index (ABI) to measure lower extremity perfusion, the Michigan Neuropathy Screening Instrument (MNSI) for neuropathy symptoms, and monofilament testing for sensory function. Ethical approval was obtained, and informed consent was collected from all participants. Data were analyzed using SPSS version 25, employing paired and independent t-tests to evaluate pre- and post-intervention outcomes.

Results: The ABI scores showed significant improvement in both groups post-intervention (BAE: pre 0.6883 ± 0.10980, post 1.0250 ± 0.10968, p < 0.001; INF: pre 0.6467 ± 0.06919, post 0.9617 ± 0.08909, p < 0.001). MNSI scores also decreased significantly (BAE: pre 7.5000 ± 1.04881, post 4.5000 ± 1.37840, p = 0.003; INF: pre 7.3333 ± 1.21106, post 4.1667 ± 1.16905, p < 0.001). Monofilament testing scores improved notably in both groups (BAE: pre 3.3333 ± 2.33809, post 6.3333 ± 1.86190, p = 0.002; INF: pre 3.1667 ± 2.31661, post 6.0000 ± 2.44949, p < 0.001).

Conclusion: Both Buerger-Allen Exercise and Intraneural Facilitation effectively improved lower extremity perfusion and reduced peripheral neuropathy symptoms in patients with type II diabetes mellitus. Buerger-Allen Exercise demonstrated better patient compliance and ease of administration. Further research with larger sample sizes and longer follow-up periods is recommended to validate these findings and explore the long-term benefits of these interventions.

Keywords: Diabetes Mellitus, Buerger-Allen Exercise, Intraneural Facilitation, Lower Extremity Perfusion, Peripheral Neuropathy, Ankle-Brachial Index, Michigan Neuropathy Screening Instrument, Monofilament Testing, Diabetic Neuropathy Treatment, Non-Pharmacological Interventions

INTRODUCTION

Diabetes mellitus is a complex metabolic disorder characterized by chronic hyperglycemia due to defects in insulin secretion, insulin action, or both. The persistent elevation of blood glucose levels adversely affects carbohydrate, lipid, and protein metabolism. This
chol. hyperglycemia leads to various microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy, coronary artery disease, stroke, and peripheral arterial disease (1-3). Despite the diverse perspectives on diabetes, it is medically defined as a group of metabolic disorders brought on by partial or complete insulin insufficiency, resulting in hyperglycemia (4-7). Chronic exposure to high blood glucose levels can cause microvascular complications in the kidneys, retina, and peripheral nerves, although these are not immediate diagnostic tools due to their delayed onset. Conversely, macrovascular complications such as myocardial infarction, stroke, and peripheral arterial disease often manifest earlier and are more prevalent in pre-diabetic states, highlighting the importance of early diagnosis and management (3, 8-13).

Historically, diabetes has been recognized since ancient times, with descriptions of its symptoms and treatments found in the Ebers Papyrus circa 1500 BC. The Indian surgeon Sushruta, around 500 BC, referred to diabetes as “madhumeha,” noting the sweetness of the urine, a characteristic observed by other ancient medical practitioners (5, 7, 14). The understanding of diabetes has evolved significantly, with pivotal advancements such as the identification of insulin by Frederick Banting and Charles Best in 1921, which revolutionized diabetes treatment (5). The prevalence of diabetes has dramatically increased over the past forty years, attributed to lifestyle changes, dietary habits, and physical inactivity. According to the International Diabetes Federation, approximately 415 million adults worldwide had diabetes as of 2015, with projections indicating that this number could rise to 642 million by 2040. Additionally, 542,000 children globally have type 1 diabetes, and one in seven pregnancies is affected by gestational diabetes (15-19).

Diabetes mellitus primarily exists in three forms: type 1, type 2, and gestational diabetes. Type 1 diabetes involves the autoimmune destruction of pancreatic beta cells, leading to absolute insulin deficiency. Type 2 diabetes, which accounts for over 90% of diabetes cases, is characterized by insulin resistance and relative insulin deficiency. Gestational diabetes occurs during pregnancy and increases the risk of type 2 diabetes and obesity in the offspring (20-26). Physical activity plays a crucial role in the management of diabetes, significantly improving glycemic control and reducing the risk of cardiovascular diseases. Regular exercise enhances insulin sensitivity, lowers blood glucose levels, and contributes to overall well-being (27-32).

Autoimmune diabetes, particularly type 1 diabetes, is one of the most common autoimmune diseases in children, with its incidence increasing annually by 3% since 1990. This condition involves the early destruction of pancreatic beta cells, resulting in hyperglycemia and various metabolic complications such as peripheral neuropathy, retinopathy, nephropathy, and cardiovascular disease (9). Type 1 diabetes requires lifelong management through insulin therapy, dietary regulation, and physical activity to maintain blood glucose levels and prevent complications. Obesity is a significant risk factor for both type 1 and type 2 diabetes, exacerbating insulin resistance and contributing to earlier onset and increased severity of the disease. The prevalence of overweight and obesity among individuals with type 1 diabetes ranges from 25% to 80%, further complicating disease management (33-39).

Pre-diabetes, a condition of elevated blood glucose levels not yet high enough to be classified as diabetes, is a critical period for intervention to prevent the progression to type 2 diabetes. Lifestyle modifications, including dietary changes and increased physical activity, are essential in managing pre-diabetes and preventing the onset of diabetes (11). Type 2 diabetes, characterized by insulin resistance and progressive beta-cell dysfunction, is strongly associated with obesity and physical inactivity. The global increase in type 2 diabetes prevalence parallels the rise in obesity rates, underscoring the importance of addressing these modifiable risk factors (12).

Complications of diabetes are extensive and can significantly impact quality of life. Coronary artery disease is the most common complication, followed by renal failure, blindness, and a combination of microvascular and macrovascular complications. Diabetes-related comorbidities, including arthritis, depression, dyslipidemia, and hypertension, further exacerbate the disease burden (13). Diabetic neuropathy, particularly distal symmetric polyneuropathy, is a common and debilitating complication of diabetes, affecting up to 50% of individuals with diabetes. This condition leads to sensory loss, pain, and a higher risk of foot ulcers and amputations (40-43).

Interventions to improve lower extremity perfusion and alleviate peripheral neuropathy symptoms are crucial for managing diabetes-related complications. Buerger-Allen exercises, which involve a series of postural changes to promote blood flow, have been shown to enhance lower limb perfusion and reduce neuropathy symptoms in diabetic patients (15). Similarly, intraneural facilitation, a novel manual therapy technique, aims to restore blood flow to ischemic nerves, potentially improving clinical function in patients with diabetic neuropathy (16). This study aims to compare the effectiveness of Buerger-Allen exercises and intraneural facilitation on lower extremity perfusion and peripheral neuropathy symptoms among patients with diabetes. By evaluating these interventions, we hope to identify the most effective strategies for managing and mitigating the complications associated with diabetic neuropathy.
MATERIAL AND METHODS

The study was a quasi-experimental research conducted at Al-Raheem Clinic and Skin Laser Center (Al Raheem Tower) in Faisalabad over a duration of three months. The aim was to compare the effectiveness of Buerger-Allen Exercise (BAE) and Intraneural Facilitation (INF) on lower extremity perfusion and peripheral neuropathy symptoms among patients with type II diabetes mellitus experiencing complications due to peripheral sensorimotor neuropathy. A sample size of 12 patients was selected based on previous literature (55). The sampling technique employed was purposive sampling, targeting patients with type II diabetes and neuropathy symptoms localized to the lower limbs, particularly below the ankles (36-39).

Patients were recruited based on specific inclusion and exclusion criteria. Inclusion criteria were patients aged 25 to 60 years, diagnosed with type II diabetes mellitus regardless of the duration, and exhibiting symptoms of distal symmetrical neuropathy restricted to the lower limbs, below the ankle joint. Patients were required to walk without assistance and be free from any other systemic diseases or severe co-morbidities. Exclusion criteria included the presence of foot sores or ulcers, other metabolic diseases, hypertension, uncontrolled blood glycemic index, critical illnesses, and autonomic neuropathy (13, 27).

Data collection involved several assessment tools to ensure comprehensive evaluation. The Michigan Neuropathy Screening Instrument (MNSI) was used to assess neuropathy symptoms, featuring a total score of 13 divided between a patient questionnaire and a foot examination form. Lower extremity perfusion was measured using the Ankle Brachial Index (ABI) scale, utilizing a sphygmomanometer and hand-held Doppler. Monofilament testing with a 10-gram monofilament was conducted to assess sensory function on the plantar surface of the feet. Vibration perception was evaluated with a tuning fork, and ankle reflexes were tested to ensure the inclusion of only those with intact motor functions (2, 17).

Ethical considerations were strictly adhered to, in line with the principles of the Declaration of Helsinki. Participants were assured of the confidentiality of their personal information, and informed consent was obtained. The study received approval from the clinic’s management and authorities. Patients were briefed on the study’s aims and methods and were provided with demonstrations of the techniques to be performed.

The data collected were meticulously organized, coded, and processed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics, including percentages, frequencies, means, standard deviations, and graphical representations, were used to define the study population. Paired sample t-tests were employed to compare pre- and post-intervention values within each group. Independent t-tests were used to compare the outcomes between the BAE and INF groups.

The results were evaluated to determine the effectiveness of Buerger-Allen Exercise and Intraneural Facilitation in improving lower extremity perfusion and reducing peripheral neuropathy symptoms. The findings aimed to provide insights into the most effective therapeutic strategies for managing diabetic neuropathy and improving patient outcomes.

RESULTS

The results of this study are presented below, detailing the demographics of the participants and the effects of Buerger-Allen Exercise (BAE) and Intraneural Facilitation (INF) on lower extremity perfusion and peripheral neuropathy symptoms. The analysis was conducted using SPSS version 25, with descriptive statistics and paired sample t-tests employed to evaluate pre- and post-intervention outcomes.

Table 1: Age Distribution of Participants

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-40</td>
<td>4</td>
<td>33.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>41-50</td>
<td>5</td>
<td>41.7%</td>
<td>41.7%</td>
</tr>
<tr>
<td>51-60</td>
<td>3</td>
<td>25.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 2: Gender Distribution of Participants

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>7</td>
<td>58.3%</td>
<td>58.3%</td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>41.7%</td>
<td>41.7%</td>
</tr>
</tbody>
</table>
Gender Frequency Percent Valid Percent
Total 12 100.0% 100.0%

Table 3: Duration of Diabetes

<table>
<thead>
<tr>
<th>Duration</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than a year</td>
<td>2</td>
<td>16.7%</td>
<td>16.7%</td>
</tr>
<tr>
<td>1-5 years</td>
<td>4</td>
<td>33.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>5-10 years</td>
<td>6</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 4: Pre- and Post-Intervention ABI Scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Intervention ABI (Mean ± SD)</th>
<th>Post-Intervention ABI (Mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAE</td>
<td>0.6883 ± 0.10980</td>
<td>1.0250 ± 0.10968</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>INF</td>
<td>0.6467 ± 0.06919</td>
<td>0.9617 ± 0.08909</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

The ABI scores significantly improved in both groups post-intervention, indicating enhanced lower extremity perfusion.

Table 5: Pre- and Post-Intervention MNSI Scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Intervention MNSI (Mean ± SD)</th>
<th>Post-Intervention MNSI (Mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAE</td>
<td>7.5000 ± 1.04881</td>
<td>4.5000 ± 1.37840</td>
<td>0.003</td>
</tr>
<tr>
<td>INF</td>
<td>7.3333 ± 1.21106</td>
<td>4.1667 ± 1.16905</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Both groups showed a significant reduction in MNSI scores, indicating a reduction in peripheral neuropathy symptoms.

Table 6: Pre- and Post-Intervention Monofilament Testing Scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Intervention Monofilament (Mean ± SD)</th>
<th>Post-Intervention Monofilament (Mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAE</td>
<td>3.3333 ± 2.33809</td>
<td>6.3333 ± 1.86190</td>
<td>0.002</td>
</tr>
<tr>
<td>INF</td>
<td>3.1667 ± 2.31661</td>
<td>6.0000 ± 2.44949</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

The monofilament testing scores significantly improved in both groups post-intervention, indicating enhanced sensory function.

Table 7: Independent t-test for Pre- and Post-Intervention ABI Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Intervention ABI (Pre-tech)</td>
<td>BAE</td>
<td>6</td>
<td>0.6883</td>
<td>0.10980</td>
<td>0.450</td>
</tr>
<tr>
<td></td>
<td>INF</td>
<td>6</td>
<td>0.6467</td>
<td>0.06919</td>
<td></td>
</tr>
<tr>
<td>Post-Intervention ABI (Post-tech)</td>
<td>BAE</td>
<td>6</td>
<td>1.0250</td>
<td>0.10968</td>
<td>0.298</td>
</tr>
<tr>
<td></td>
<td>INF</td>
<td>6</td>
<td>0.9617</td>
<td>0.08909</td>
<td></td>
</tr>
</tbody>
</table>

The independent t-test showed no significant difference between the groups pre- and post-intervention in ABI scores, suggesting that both interventions were similarly effective in improving lower extremity perfusion.

**DISCUSSION**

The study aimed to evaluate and compare the effects of Buerger-Allen Exercise (BAE) and Intraneural Facilitation (INF) on lower extremity perfusion and peripheral neuropathy symptoms in patients with type II diabetes mellitus. The findings demonstrated significant improvements in both groups, indicating the efficacy of these interventions in managing diabetic neuropathy and enhancing lower extremity blood flow (12).

The improvements in Ankle-Brachial Index (ABI) scores in both BAE and INF groups were statistically significant, reflecting enhanced lower extremity perfusion. These results align with previous studies, such as those by Radhika et al., which showed that Buerger-Allen Exercise effectively increased ABI values and improved blood flow in diabetic patients (20). Similarly, the reduction in Michigan Neuropathy Screening Instrument (MNSI) scores and the improvements in monofilament testing scores suggest a significant reduction in neuropathy symptoms and enhanced sensory function. These findings corroborate earlier research indicating the benefits of exercise and manual therapy in managing diabetic neuropathy (1, 7, 13).
The strengths of this study included the use of validated assessment tools like the ABI scale, MNSI, and monofilament testing, which provided comprehensive and reliable measures of neuropathy symptoms and lower extremity perfusion. Additionally, the quasi-experimental design allowed for a controlled comparison of the two interventions. However, the study also had limitations, including a small sample size and a short duration, which may limit the generalizability of the findings. The small sample size, although based on previous literature, may not fully represent the broader diabetic population. Furthermore, the study duration of three months might not capture long-term effects and sustainability of the interventions (42).

A significant finding of this study was the ease of compliance with Buerger-Allen Exercise, which patients could perform independently. This active exercise routine was well-tolerated and led to significant improvements in perfusion and neuropathy symptoms. In contrast, Intraneural Facilitation, while effective, required a trained therapist to administer the treatment, making it less feasible for routine self-care and possibly affecting patient adherence. This distinction is crucial for clinical practice, as interventions that patients can perform independently are often more sustainable and accessible in the long term (43).

The findings of this study are consistent with those of Gill et al., who reported that various forms of exercise significantly improved glycemic control and reduced complications in type II diabetes patients (13). The study also aligns with the research by Wahyuni et al., which emphasized the importance of foot care and exercise in preventing complications and improving quality of life in diabetic patients (3). The benefits of physical activity and targeted exercises in managing diabetic neuropathy have been well-documented, supporting the current study’s conclusions (44).

Despite the positive outcomes, the study highlighted the need for further research with larger sample sizes and longer follow-up periods to validate the findings and explore the long-term benefits and potential side effects of these interventions. Future studies could also investigate the combined effects of Buerger-Allen Exercise and Intraneural Facilitation to determine if a synergistic approach could yield even better results.

CONCLUSION

In conclusion, this study demonstrated that both Buerger-Allen Exercise and Intraneural Facilitation are effective in improving lower extremity perfusion and reducing peripheral neuropathy symptoms in patients with type II diabetes mellitus. Buerger-Allen Exercise, in particular, showed advantages in terms of patient compliance and ease of administration. These findings underscore the importance of incorporating such non-pharmacological interventions into the routine management of diabetic neuropathy. However, further research is needed to confirm these results and optimize treatment protocols for broader clinical application.

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