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Effects of neurodynamic exercises on the management of diabetic peripheral neuropathy of the upper limb: a case series

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Abstract

Introduction. This study was designed to find out the effectiveness of neurodynamic exercises in patients with diabetes mellitus having peripheral neuropathy in the upper limb.

Methods. This was a case series. A total of 40 patients were selected in this study who had diabetes mellitus type 2 with peripheral neuropathy pain. The consecutive sampling technique was used. Standard neurodynamic sliders techniques were applied for radial, ulnar, and median nerves in appropriate positions by a qualified physical therapist for 10 s with a 2-s rest and 10 repetitions. Transcutaneous electrical nerve stimulation (80 Hz and 150 μs) was applied for 20 minutes. The neuropathic pain questionnaire DN4 served to collect the data. Pre-test and post-test values were calculated on the basis of the questionnaire. The paired sample t-test was used to compare the pre-test and post-test values.

Results. Finally, 31 females and 8 males with peripheral neuropathy were involved in this study. The mean age of the patients was 51.22 ± 6.712 years. The mean total pre-test value was 6.42 ± 1.152 and the mean total post-test value equalled 3.68 ± 1.095.

Conclusions. Neurodynamic exercises were effective in managing diabetic peripheral neuropathy pain. Neurodynamic techniques for peripheral nerves can reduce diabetes-associated peripheral neuropathy symptoms in the upper limb.

Key words: diabetic complication, neurodynamic techniques, diabetic peripheral neuropathy, numbness

Introduction

Type 1 diabetes is insulin-dependent diabetes; only 5–10% of diabetic patients suffer from it. Type 2 diabetes is also known as non-insulin-dependent diabetes and is mainly due to insulin resistance. This type is more common than type 1 and affects 90–95% of diabetic patients [1]. Diabetic peripheral neuropathy, a common complication of diabetes, is present in almost 50% of people suffering from diabetes mellitus [2]. In 26.4% of diabetic patients, it has a considerable negative impact on the quality of life [3]. In the United States, the total calculated annual cost associated with diabetic individuals is between $4.6 and $13.7 billion, and 27% of the medical cost of diabetes is ascribed to diabetic neuropathy and the resultant impairments [4].

Diabetic peripheral neuropathy is caused by hyperglycaemia and diminished blood supply to the peripheral nerves. It more commonly affects the lower limb [5]. According to a survey, symptoms of diabetic peripheral neuropathy were dominant among diabetes patients aged less than 40 years in the United States [6].

The clinical changes which occur owing to peripheral neuropathy are altered sensations in the form of tingling, numbness, and severe pain, while some patients experience a feeling of electric shock [7]. A cross-sectional survey reported the relationship between diabetes type 2 and lower limb mechanism of sensitivity, where diabetic patients had little response to straight leg raise neurodynamic testing [8]. These changes further increase the likelihood of injuries, burns, and infections. Some patients report sleep disturbance and restlessness at night due to pain in hands and feet [9]. Foot infections are the most common impairments caused by diabetic peripheral neuropathy. Peripheral neuropathy is, in turn, the most common reason for foot ulcers in diabetic patients, responsible for more than 80% of these ulcers [10, 11].

There is no specific treatment guideline for neuropathic pain and a small number of studies describe the effect of exercise training and lifestyle modification on diabetic peripheral neuropathic pain. According to a study, a conservative treatment program had a positive and long-lasting effect on pain [12]. Another research showed that aerobic exercise training applied for a long time could save patients from neuropathic pain or change the pattern of neuropathic pain by decreasing its extent and severity [13]. Conservative management including non-neural tissue interventions and neurodynamic mobilization techniques can be effective in addressing musculoskeletal presentations of peripheral neuropathic pain [14].

Neuromobilization is one of the conservative methods used in physical therapy [7]. It is an innovative management tool which involves conservative decompression of nerves, applying different neural mobilizing techniques and patient education techniques. These techniques, implemented along with routine physiotherapy, are effective in treating shoulder

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impingement syndrome [15]. This is a concept devised by Michael Shacklock and David Butler [16]. Over the past 20 years, further researchers, such as Dr. Michel Coppieters and Dr. Alf Brief, have added a great volume of research on this topic. According to Michael Shacklock, there are 3 main components indispensable to understand neurodynamics: the mechanical interface, the neural structures, and the innervated tissues [16].

If employed at an early stage, peripheral nerve mobilization can reduce diabetes-associated peripheral neuropathy [17]. Neuromobilization of the sciatic and peroneal nerves resulted in restoration of full function of the lower leg in a 24-year-old male with severe compression of the peroneal nerve [18]. In a quasi-experimental study to investigate the effect of the neurodynamic technique on neuropathic pain, no increase in pain was observed [19]. According to a systematic review, addition of neurodynamic exercises to a treatment protocol for diabetic patients with peripheral neuropathy brought about positive results in modulating pain and functional disability [20]. Studies revealed that exercise of low-level mechanical stimuli, such as 'slide'/'glide' and stretch 'tension,' decreased clinical symptoms and acted directly on the Schwann cells [21]. A case report suggested the use of neurodynamics along with electrical stimulation and dry needling for the treatment of peripheral neuropathy [22].

Many studies were conducted which showed the prevalence of diabetic peripheral neuropathy and the role of neurodynamic exercises in lower limb neuropathy management. Not a single study was found to support the impact of neurodynamic exercises in the upper limb.

Subjects and methods

Study design and patients

A case series was presented. The non-probability convenient consecutive sampling technique was used. Data were collected from Allama Iqbal Memorial Teaching Hospital Sialkot.

Successive diabetic patients with neuropathy who visited the Allama Iqbal Memorial Teaching Hospital Sialkot in the previous 3 months were selected; the sample size was determined with the use of the online Google calculator. Confidence interval was 95% and the margin of error equalled 0.5%. A total of 40 diabetic patients were selected for this study. Males and females were included aged over 40 years, with type 2 diabetes mellitus for at least 2 years and peripheral neuropathy in an upper limb. Diabetic patients having frozen shoulder, history of altered mental health status, or history of particular shoulder injury surgery were excluded.

The neuropathic pain questionnaire Douleur Neuropathique 4 (DN4) was used to collect data. The test is characterized by 80% sensitivity and 90% specificity [23]. The questionnaire consisted of 2 parts: one part was subjective (patient interview) and the other part was objective (examination part). DN4 was applied twice: once before the treatment and once after the treatment. Pre-test and post-test values of peripheral neuropathy pain were calculated on the basis of the questionnaire. Neurodynamic (tension) techniques were applied in the patients with type 2 diabetes and peripheral neuropathy in the upper limb by a qualified physical therapist with 2 years of experience in practising neurodynamic techniques.

Data were analysed by using the SPSS 21 software. The paired sample *t*-test served to compare the pre-test and post-test values.

Median nerve

In the median nerve, a slider technique in appropriate positions was applied. The patient lay in supine position; sequentially, shoulder girdle depression was employed, then slight abduction of the shoulder, extending the elbow, laterally rotating the arm, and supinating the forearm. Wrist, finger, and thumb extensions were then added; finally, the shoulder was taken into further abduction. The full stretch position included contralateral cervical side flexion [24] (Figure 1).

Figure 1. Median nerve neurodynamics

Ulnar nerve

The patient lay in supine position. Sequentially, wrist extension, forearm supination, followed by elbow flexion (full range) were applied; then, shoulder girdle depression was added. While maintaining this position, shoulder lateral rotation and abduction were practised. In the final position, the patient's hand was near their ear, with fingers pointing posteriorly. In the full stretch position, contralateral side flexion of the cervical spine was added [24] (Figure 2).

Figure 2. Ulnar nerve neurodynamics

Radial nerve

The patient lay in supine position; sequentially, shoulder abduction, elbow extension, medial rotation of the arm, and pronation of the forearm were applied. While keeping the elbow in extension, wrist, finger, and thumb flexion, and finally ulnar deviation of the wrist were added. The full stretch position included contralateral side flexion of the cervical spine [24] (Figure 3).

Figure 3. Radial nerve neurodynamics

General characteristics of the intervention

Tension techniques were applied for 10 s with a 2-s rest and 10 repetitions in each session, along with traditional therapy consisting of transcutaneous electrical nerve stimulation of 80 Hz and 150 μs for 20 minutes on the cervical area [25].

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Sialkot College of Physical Therapy Institutional Review Board (approval No.: SCPT-IRB/2018/410).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

For this case series, a total of 40 patients were selected. Of them, 31 female subjects and 8 male diabetic patients with peripheral neuropathy were finally included in the research. The mean and standard deviation of age were 51.22 ± 6.712 years. The mean value of painful cold was 1.54 before the treatment and 1.18 after the treatment. The mean and standard deviation of pre-test value of burning sensation were 1.78 ± 0.505; after applying the neurodynamic exercises, the post-test value decreased to 1.15 ± 0.389. Numbness was also present along with neuropathic pain; its mean and standard deviation value before the treatment equalled 1.79 ± 0.409 and after the treatment, the value was reduced to 1.10 ± 0.307.

Numbness was the component most affected by the neurodynamic techniques. Similarly, the pre-test mean and standard deviation values of itching were 1.18 ± 0.385 and the post-test values were 1.05 ± 221. The patients with diabetic peripheral neuropathic pain also complained that they felt pins and needles. Before the neurodynamic exercises, the mean value of pins and needles was 1.72 ± 0.452 and after the treatment, the value decreased to 1.12 ± 0.335. The results showed that 60% of the patients had hypoesthesia to touch. The pre-test value of hypoesthesia to touch equalled 1.62 ± 0.493 and the post-test outcome was 1.15 ± 0.366. Tingling sensation was also present in those patients, with the value of 1.45 ± 0.504 before the treatment and 1.12 ± 0.335 after the treatment. The mean value of pain with brushing before the treatment equalled 1.23 ± 0.427; after the treatment, it was reduced to 1.08 ± 270.

The total pre-test mean and standard deviation of all variables were 6.42 ± 1.152. The total post-test mean and standard deviation of all variables were 3.68 ± 1.095.

Discussion

A cross-sectional study was conducted in the United Kingdom according to which the commonest problem related to diabetes was diabetic peripheral neuropathy. It is present in more than 50% of type 2 diabetic patients aged over 60 years and the incidence increases with both age and duration of diabetes [26]. The majority of patients with diabetic peripheral neuropathy do not experience any pain. Almost 11% suffer from pain, and the consequences of pain include sleep disturbances, which affect the activities of daily life and patient progress to depression [2].

The neurodynamic exercises were effective in diabetic peripheral neuropathy. Peripheral nerve mobilization can reduce the diabetes-associated peripheral neuropathy. In this study, the DN4 pain questionnaire was used before and after the treatment. The mean value of the pre-test was 6.42 and the mean post-test value was 3.68. The values of painful cold, burning, hypoesthesia to touch, itching and tingling were decreased. Hypoesthesia to pinprick was also reduced after the treatment. Numbness was the most affected component as its value decreased more than that of other components of the DN4 questionnaire. This shows that the neurodynamic exercises were effective in diabetic peripheral neuropathy.

According to a quasi-experimental study among 20 diabetic patients, there was no increase in the severity or irritability of symptoms, which suggests the manoeuvre to be safe in diabetic neuropathy [19]. Moreover, the limb to which the tensioner technique was applied presented a bigger straight leg raise range as compared with the other limb, mainly owing to a decrease in sensitivity to painful stimuli [19].

A systematic review demonstrated the effectiveness of adding neurodynamic mobilization to the treatment protocol for patients with lower limb symptoms. Neural mobilization appeared to modulate the pain, flexibility, and range of motion [20]. Another systematic review reported that the use of transcutaneous electrical nerve stimulation helped alleviate pain in patients with diabetic neuropathy, in contrast to electromagnetic field treatment [27].

Limitations

Diabetic peripheral neuropathy is more common in the lower limb. As a result, fewer patients were available for the study investigating upper limb neuropathy.

This study suggests that further research may be conducted to explore the effectiveness and safety of these neurodynamic exercises performed in more than one session. These exercises may be used for the management of upper limb type 2 diabetic peripheral neuropathy.

Conclusions

The neurodynamic exercises were useful in reducing type 2 diabetic peripheral neuropathic pain. They can help to decrease diabetes-associated peripheral neuropathy symptoms. All participants of this study completed their neurodynamic exercise intervention but their pain and other neuropathic symptoms did not aggravate. Painful cold and the sensation of pins and needles were reduced. Numbness was significantly decreased. All participants felt comfortable during the process of applying the neurodynamic exercises.

Disclosure statement

No author has any financial interest or received any financial benefit from this research. The abstract of the study was

presented as a poster at the World Physiotherapy virtual congress 2021.

Conflict of interest

The authors state no conflict of interest.

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