Original article

Effectiveness of strength training on hand function in patients with Diabetic neuropathy

Komal.D.Thorat[1], Dr Suvarna..Ganvir[2]

[1] Intern, PDVVPFs College of Physiotherapy, Ahmednagar , India

[2] Associate Professor, PDVVPFs College of Physiotherapy, Ahmednagar, India

Corresponding author: Komal.D.Thorat

Abstract:

Introduction: Diabetes mellitus is the major public health problem in India**.** The crude prevalence rate in the urban areas of India is thought to be 9 per cent. In rural areas,it is 3 per cent. Neuropathy, a common complication of diabetes mellitus, is generally considered to be related to duration and severity of hyperglycemia and causing Hand dysfunction in patients with Diabetic Neuropathy.

Study Design Experimental (pre-post) study

Procedure: Ethical clearance was obtained from IEC, PDVVPF, and COPT. Written Inform consent plan was taken from all participants. The exclusion criteria being History of cerebrovascular accident

1. Upper limb nerve injury
2. GBS & MND
3. Other neurological disorders

Grip strength was measured with hand dynamometer before the strength training program, strength training was done by spring hand dynamometer, squeeze ball and rubber band after 4 weeks again grip strength was measured with hand dynamometer.

Result: The result found for strength training on hand function in Diabetic neuropathy was significant i.e after strength training exercises for hand their was significant improvement in grip strength.

Conclusion: The present study shows the significant improvements in hand function in both the hands. This study concludes that grip strength training improves hand function in diabetic neuropathy

Introduction

Diabetes mellitus is a chronic disease that causes serious health complications including renal (kidney) failure, heart disease, stroke, and blindness. Peripheral nervous system brings information to and from the brain and spinal cord to the rest of the body. Peripheral neuropathy (PN) occurs when damage occurs at one (mononeuropathy) or multiple (polyneuropathy) nerves.[1] Neuropathy, a common complication of diabetes mellitus, is generally considered to be related to duration and severity of hyperglycemia. However, it may also occur acutely even with hypoglycaemia**.**[1,2] usually more than 50% of patients with duration of diabetes of 25 years or more are affected, making it as one of the most common disease of the nervous system. One of the largest published series reported a prevalence of 7.5% even at the time of diagnosis of diabetes. [1,3]

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About 60 to 70 percent of people with diabetes have some form of neuropathy. People with diabetes can develop nerve problems at any time, but risk rises with age and longer duration of diabetes. The highest rates of neuropathy are among people who have had diabetes for at least 25 years [4,5]

Diabetes mellitus (DM) is the most common cause of neuropathy in the western world. At present 20% of people >age 65 have DM, by 2010 it will be >30%. Neuropathy occurs in NIDDM and NIDDM, but may develop sooner after diagnosis in NIDDM. Neuropathy was present in 66% of diabetic patients in one series 8% have neuropathy at the time of diagnosis of DM, 50% after 25 years. The commonest neuropathy was polyneuropathy, with a prevalence of 54% in IDDM, and 45% in NIDDM, while focal forms account for 25%. 2% of diabetic children have neuropathy. The prevalence increases with the duration of DM.[4,5] Hand function commonly affected in diabetic neuropathy studies show that, the grip and pinch strengths were significantly lower in diabetic patients than the no diabetic controls and low hand strength was found to cause functional disability of hand in our type 2 diabetic patients. Hand grip strength test values were significantly lower in the diabetic group compared with the control group. Key pinch power value was significantly lower in the diabetic group.[6]

Kruse et al found no increase in incidence of foot ulceration following an exercise program consisting of leg strengthening, balance exercises, and a graduated, self-monitored walking program. Moderate increase in weight-bearing activity.[9] A follow up to this study in 2010 did not find any significant differences in balance, lower extremity strength, or fall rate. Two studies by Van Schie et al found improvement in balance and a trend towards increased lower extremity strength.[10]

In Strengthening Exercises Initial focus is on core, hip, knee, and ankle strengthening Progress into functional activities and important focus on grip muscle strengthening exrecises. Physiotherapists, with their knowledge of physiology and anatomy, can sug¬gest specific exercises for people with coexisting complications, cautioning against certain movements that might be detrimental to their health. Carpal tunnel syndrome and sciatica are other neurological conditions that are commonly suffered by people with diabetes In all these conditions, physiotherapy plays a pivotal role in returning people to normal levels of health and well-being. The physiotherapist uses a combination of active and passive exercises, and mechanical and electrical aids to improve musculoskeletal and neurological functions. Physiotherapy offers various effective non-pharmacological approaches for pain relief.[11,12]

Transcutaneous electrical nerve stimulation (TENS) involves electrical nerve stimulation through the skin, sending a painless current to specific nerves. The mild electrical current generates heat that serves to relieve stiffness, improve mobility, and relieve pain. Interferential therapy (IFT) uses the strong physiological effects of low frequency electrical stimulation of nerves.[11]

Strength training is a type of physical exercise specializing in the use of resistance to induce muscular contractions which builds the strength, anaerobic endurance and size of skeletal muscles. When performed properly, strength training can provide significant functional benefits and improvement in overall health and wellbeing, including increased bone, muscle, tendon and ligament strength and toughness, improved joint

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function, reduced potential for injury, increased bone density, increased metabolism, improved cardiac function, elevated HDL cholesterols. Training commonly uses the techniques of progressively increasing the force output of muscles through incremental weight increases and uses a variety of exercises and types of equipment's to target specific muscle groups. The basic principles of strength training involve a manipulation of the number of repetitions, sets, tempo, exercises and force to cause desired changes in strength, endurance or size by overloading a group of muscles.[12,13]

Muscle weakness has been associated with type 2 diabetes, even among subjects with high body mass indices(Balogun et al, 1991; Bohannon, 2001; Clerke and Clerke, 2001). Helmersson et al (2004) attribute this to insulin resistance and hyperglycaemia, which cause a reduction in the number of mitochondria in the muscle cells, a decrease in glycogen synthesis and an increase in the amount of circulating systemic inflammatory cytokines, all of which have a detrimental effect on the skeletal muscles. The relationship between muscle contractile functions and force generation on one side and hyperglycaemia had earlier been proposed by Helander et al (2002). Furthermore, Deal (1998) associated the duration of diabetes (>6 years) and poor glycaemic control with even poorer muscle quality and an increased incidence of musculoskeletal conditions like carpal-tunnel syndrome, muscle atrophy and Duputyren's contracture.[13,14]

However, little is known of the trend between long duration type 2 diabetes and handgrip strength in southeast Nigeria.[14] The purpose of this study was to find out and see the effectiveness of grip muscle strength training on hand function in diabetic neuropathy.

Need of the study

Hand dysfunction in patients with Diabetic neuropathy needs scientific approach for effective treatment .Strength training which employs principles of working at the level of motor neurons can benefit the hand dysfunction. Hence it is imperative to study the effect of strength training on Hand dysfunction in patients with Diabetic neuropathy.

Aim & objective

1. To assess the hand function in patients with Diabetic neuropathy.
2. To study the effect of strength training on hand function in patient with diabetic neuropathy.

Materials & methodology

- **Sample Size:** 10 participants
- **Participants:** Male and Female individuals with clinical diagnosis of diabetic neuropathy who were refer to physiotherapy department and medicine department and who were willing to participate in the study from Vikhe Patil Hospital Vilad Ghat, Ahmednagar.
- **Sampling Method:** Purposive sampling.
- **Equipment Used**: MNSI scoring chart, Action Research Arm Test equipment and chart , squeeze ball , spring hand dynamometer ,rubber band.
- **Selection Criteria**

Inclusion Criteria

1. Patient with both type of DM
2. Age group between 30 to 60yrs
3. Patients with duration of diabetes of 25 year

Exclusion Criteria:

1. History of cerebrovascular accident
2. Upper limb nerve injury

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3. GBS and MND
4. Other neurological disorders

The following were materials used for this study:

1. Materials used for the study:
    a. Hand Dynamometer
    b. Consent form
    c. Action Research Arm Test equipments
    d. MNSI scoring chart
    e. Squeeze ball
    f. Spring Hand Dynamometer
    g. Rubber

Outcome Measures

Action research arm test

Grip strength by hand dynamometer

1) Action research arm test: outcome measure was used to assess the Hand function in Diabetic Neuropathy patients. Where following components were used to assess hand function.

Grasp Grip, pinch grip and gross movement.

Following instrument were used to assess hand function.

And patient was asked to pick up the object according to the sheet which was used to assess hand function called as Action research arm test

2) Grip strength by Hand Dynamometer: Patient is asked to sit on a chair and hands supported by arm rest of the chair the hand dynamometer is given in the hand and patient is asked to grasp the dynamometer and press and hold it then the recording is noted. Three reading were taken and average was recorded for final value.

Treatment: strengthening exercise for hand

Procedure

The study received approval from Institutional Ethical Committee

10 participants were selected and screened, individually with the inclusion and exclusion criteria

The details about the study and intervention were explained to the participants and written informed consent was obtained.

Demographic details of each participant were noted including name, age, gender, duration of Diabetes.

Before starting the intervention, participants were assessed for the baseline parameters ----Grip strength by Hand Dynamometer.

At the end of 4 weeks every participant were reassessed with same outcome measure

Following exercises were performed to see the effect of strength training on hand function in Diabetic neuropathy

1) **Squeeze ball exercise**: patient was asked to sit in high sitting position and squeeze ball

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was given in the hand and asked to squeeze the ball and hold for 10 sec count.

2) **Spring Hand Dynamometer**: Patient was asked to sit in high sitting position and spring hand dynamometer was given in the hand and asked to press the hand dynamometer and hold for 10 sec.
3) **Rubber band exercise**: i] Patient was asked to sit in high sitting position and shoulder neutral and elbow flexed and finger flexed(metacarpo phalangeal joint) flexion and rubber band was wrapped around the fingers and patient was asked to do extension of fingers.

   Ii] Patient was in sitting position and shoulder neutral and elbow flexed and forearm prone position and rubber band was wrapped around fingers and patient was asked to perform finger abduction

Data analysis and result

Statistical analysis was carried out utilizing the Instat software and $p<0.05$ is considered as level of significance. Statistical measures such as mean, standard deviation (S.D.) were calculated and Student's Paired't' test and Unpaired't' test was applied to analyze the data. The results were concluded to be statistically significant with $p<0.05$ and not significant with $p>0.05$.

Therefore the total number of participants were selected for study was t 10 (4 Male and 6Female) aged were screened for the study considering the inclusion and exclusion criteria.

Table. No.1. Gender wise distribution of patients

Gender	Male	Female
No of Patient	04	06

MNSI SCORE:

In this study michgan neuropathy screening instrument (MNSI) score is measured in all the patients

5 (50%) Patients have shown 4 0N 10 MNSI score , 3 (30%) Patients have shown 5 on 10 MNSI score and 2(20%) patients have shown 6 on 10 MNSI score (Table no.)

Table no.2. No of patients of MNSI score

Sr.no.	MNSI Score	No of Patients (Percent)
1	4 ON 10	5 (50%)
2	5 ON 10	3 (30%)
3	6 0N 10	2 (20%)

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Grip Strength Measurement:

In this study hand function has assessed by grip strength of both the hands (table & graph no.3)

a) **In Right side of hand -** Before the intervention the mean value of Grip strength in Right side was 37.4±11.20 and after grip strengthening mean value was 39.4±11.20. The difference between the pre and post values of Right side hand was 2.00±1.2. t value was 2.86 and p value was 0.0185. there was significant improvement of grip strength in right hand
b) **In left side of hand -** Before the intervention the mean value of Grip strength in left side was 36.11± 14.60 and after grip strengthening mean value was 37.62±14.60 . The difference between the pre and post values of Left side hand was 1.51±1.4 . t value was 2.642 and p value was 0.068. there was significant improvement of grip strength in left hand hand

Comparison of Improvement of Grip Strength Between Both Hands:

In grip strength comparison for both the hands, mean difference of grip strength for right hand was 1.64±1.80 and for left hand was1.51±1.80 so this comparison result was not significant.

There was equal improvement seen in both the hands (graph & table no.5)

Table no.3.. Pre-post comparison of Grip strength in both the hands

Side of Hand	Pre Test Mean±SD	Post Test Mean±SD	t-value	p-value
Right	37.4±11.20	39.4±11.20	2.86	0.0185,p<0.05 Significant
Left	36.11± 14.60	37.62±14.60	2.642	0.068 ,p<0.05 Significant

In this study 7 patients were dominant of right side hand 3 patients were dominant of left side hand

Table .4. No of patients dominant side

Dominant side of hand	No of Patient
Right	7
Left	3

In grip strength comparison for both the hands, mean difference of grip strength for right hand was 1.64±1.80 and for left hand was1.51±1.80 so this comparison result was not significant.

There was equal improvement seen in both the hands

Table.5 Mean difference comparison of grip strength of both the hand

Side of Hand	Right	Left	t value	p value
Mean difference	1.64±1.80	1.51±1.80	0.65	0.526, p<0.05 Not significant

In comparison of improvement of grip strength in between dominant hands, There was equal improvement in grip strength in right side dominant hand and patient with left side dominant hand

Mean difference of right side was 1.22±1.06 and left side was 0.77±2.03, this result of both dominant hands was not significant.

Table 6. Comparison of grip strength between dominant hands

Dominant side (no of patient)	Right (7)	Left (3)	t value	p value
Mean difference	1.22±1.06	0.77±2.03	0.675	0.52, p<0.05 Not significant

Discussion

The present study "Effectiveness of strength training on hand function in diabetic neuropathy " was carried out at the Dept. Of Physiotherapy, PDVVPF,s COPT vilad ghat Ahmednagar, Maharashtra. In this study action research arm test and grip strength measurement by hand dynamometer were taken as outcome measure to find out hand function and grip strength in diabetic neuropathy.

Despite these difficulties, exercise contributes to improved glucose control—which slows or stops the progression of diabetic neuropathy—among other benefits.[6] Although current treatments for diabetic neuropathy have not been proven to reverse pathogenesis and progression and are thus aimed largely at pain control, it is still worthwhile to explore the benefits that exercise has to offer and promote exercise to patients as a viable therapeutic option.[14,15] Resistance training has the potential to improve muscle strength and endurance, enhance flexibility and body composition, decrease risk factors for cardiovascular disease, and result in improved glucose tolerance and insulin sensitivity. Modifications to exercise type and/or intensity may be necessary for those who have complications of diabetes. [14,15]

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Grip muscle strength training c done by theraband and spring and it improved strength of grip muscles of hands and hand function of hands in patient with diabetic neuropathy. Strength training improves glycemic control and improves grip strength and endurance and it leads to improvement in hand function in patient with diabetic neuropathy.[15] Ezema C.I and Olawale O.A. conducted study on Handgrip Strength in Individuals with Long- standing Type 2 Diabetes Mellitus,. This study was designed to determine the effect of type 2 diabetes on handgrip strength inadults. Twenty adult patients with a clinical diagnosis of type 2 diabetes mellitus (10 males, mean age: 52.9 ± 9.01years and 10 females, mean age: 52.6 ± 5.71 years) and 20 apparently healthy adults (10 males, mean age: 53.1 ± 8.94 years and 10 females, mean age 54.5yrs±5.56 years) who met the inclusion criteria participated in the study. [16]

Handgrip strength was measured with an isometric hand dynamometer and comparisons were made between diabetic and non-diabetic males as well as between diabetic and non-diabetic females. Results showed significant differences in the mean handgrip strength between the male diabetic and non diabetic subjects ($p<0.004$), as well as between the female diabetic and non-diabetic subjects ($p<0.002$).Long-standing type 2 diabetes mellitus seems to result in a decrease in handgrip strength in both male and female adults. This physical limitation may contribute to low productivity in people with type 2 diabetes mellitus.[17]

Insulin resistance may have been responsible for the muscle weakness (Sayer et al, 2005) and, therefore, the decreased grip strength. Rantanen et al (1999) and Leveille et al (2004) have independently reported decreased handgrip strength in individuals with type 2 diabetes mellitus.

However, Andersen et al (1997) and Andersen et al (2004) opposed this view, insisting that grip strength is not compromised in long-standing diabetes type 2. [18] These differences in the reports may be due to the lack of baseline record of grip strength in all the studies, thereby making it impossible for the change in grip strength after the onset of diabetes to be determine.

Conclusion

The present study shows the significant improvements in hand function in both the hands. This study concludes that grip strength training improves hand function in diabetic neuropathy.

Suggestion and limitation

Clinical Implication for practice: The above result suggests that 4 weeks of grip strength training exercises improved hand function in patient with diabetic neuropathy. it is important that early initiation of grip strength training should be included intervention in diabetic neuropathy.

Limitation of Study: 4 weeks of grip strength has shown significant improvement in hand function in diabetic neuropathy. But follow up of participants who participated in the study was limited to know whether the effectiveness of these exercises is sustained over the time.

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