International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 11; Issue 03 (A); March 2022; Page No.392-396
DOI: http://dx.doi.org/10.24327/ijcar.2022.396.0088

Research Article

EFFECT OF DURA DISC EXERCISES ON BALANCE IN PATIENTS WITH DIABETIC PERIPHERAL NEUROPATHY: EXPERIMENTAL STUDY

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A R T I C L E I N F O

Article History:
Received 6th December, 2021
Received in revised form 15th January, 2022
Accepted 12th February, 2022
Published online 28th March, 2022

Key words:
Dura disc, Diabetic Peripheral Neuropathy, balance training, Functional Reach Test, Y balance test

A B S T R A C T

Background: Diabetic peripheral neuropathy (DPN) is a microvascular complication of Diabetes Mellitus expressed by the presence of peripheral nerve dysfunction in diabetics after exclusion of other causes. It involves somatic, sensory, motor & autonomic nerves. The motor impairments & sensory loss causes balance impairments, alterations in gait leading to increased fall risk.
Method: 25 diabetic patients with DPN participated out of which 22 completed the study. The participants were randomly divided into 2 groups. Control group received conventional physiotherapy while experimental group received Dura disc exercises along with conventional physiotherapy for 30 mins, 3 times/week for 3 weeks. The outcome measures included Functional Reach Test & Y- Balance Test assessed at the beginning of the intervention and at completion at 3 weeks.
Results: The results showed statistically significant difference ($p<0.01$) in the pre and post intervention measurements of FRT and YBT in both the groups. While the intergroup comparison showed statistically significant difference ($p<0.05$) in the FRT and YBT values in dura disc group compared to the control group.
Conclusion: The study concludes that dura disc exercises along with conventional physiotherapy are more beneficial compared to conventional physiotherapy alone to improve balance in patients with Diabetic Peripheral Neuropathy.

INTRODUCTION

Diabetes is a group of metabolic disorders characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both (Ranasinghe *et al*.,2021, Javed et el.,2015)The long-term high blood glucose in diabetics is related with damage, dysfunction & various organ failure, especially the eyes, kidneys, nerves, heart, and blood vessels. Diabetic peripheral neuropathy is a heterogenous group of disorders defined as the presence of peripheral nerve dysfunction in diabetics after exclusion of other causes. It involves somatic, sensory, motor & autonomic nerves affecting various parts of the nervous system and has vast clinical manifestation. It is the most prevalent complication of diabetes, the prevalence being 29% which increases with age and duration of diabetes (Pop-Busui *et al*., 2017, Young *et al*., 1993) Somatosensory system impairment is reflected by posture instability. Adequate posture control requires keeping center of gravity over base of support while both static & dynamic situations. The body must be able to respond to translations of the COG voluntarily or unexpectedly introduced. The postural control system makes use of data from the visual, vestibular, and somatosensory systems (Diener & Dichgans, 1988). There are many factors that potentially affect the postural control system and may lead to an increased fall risk.

Dura disc, also known as stability trainer or ankle disc, is an inflatable disc made up of Polyvinyl Chloride material, having 33 cm diameter 5 cm height. Unstable surfaces help to stimulate mechanoreceptors within the Golgi tendon organs, joint capsule & muscle spindle which improves proprioceptive inputs to the CNS (Ahmad *et al*., 2020). This study aimed to assess the effect of dura disc exercises compared to conventional balance training. There are many exercise protocols to improve balance using various unstable instruments like Swiss ball, balance board, bosu ball, mini-trampoline, Thera Disc, etc used to improve balance in DPN patients. But most of those instruments are either costly or not portable. Dura disc being affordable, easy to use, transportable and simple to set up can prove useful for treating balance impairments in DPN patients in clinical setting. There is lack of evidence of the effect of dura disc exercises on balance compared to conventional balance training alone in patients with DPN, hence the need.

MATERIALS AND METHODS

- Study Design- Experimental study
- Sampling Technique- Convenient sampling

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- Subjects

25 participants with moderate diabetic peripheral neuropathy (51.86±5.15 years, duration of diabetes 7.45±1.91, HbA1c 9.77±1.33, CNE score 14.46±2.33 and TUG 15.60±2.46 sec) were selected based on the inclusion and exclusion criteria. The inclusion criteria were age between 40-60 years, uncontrolled Diabetes Mellitus (HbA1c level 8-12) checked in past 6 months, diagnosed Diabetes Mellitus for >5 years, Diabetic Peripheral Neuropathy [clinically diagnosed using Clinical Neurological Examination (CNE) with score between 10-18 i.e. [moderate], patients who can perform TUG in 10-20 seconds. The exclusion criteria were Vertigo/ vestibular dysfunction, any neurological or musculoskeletal condition, cognitive impairments, plantar pressure ulcers.

Study Protocol

The study was started after taking ethical clearance from the Institutional Ethics Committee. The subjects were selected according to the inclusion and exclusion criteria and involved in the study after taking written informed consent. The participants were explained the procedure and purpose of the study, also the risks and termination criteria. Total 25 subjects were enrolled in the study, who were randomly divided into 2 groups using chit method.

- Group A (n=12):- Control group (Conventional balance training)
- Group B (n=13):- Interventional (Dura disc + conventional balance training)

Baseline evaluation was done for balance using Functional Reach test and Y-Balance test. Both groups received conventional balance training for 30 minutes each session, 3 sessions/week for 3 weeks (Salsabili *et al*., 2011). Additionally, the interventional group was trained on dura disc for balance. Post 3 weeks intervention, again the subjects were evaluated for the outcome measures (FRT & YBT).

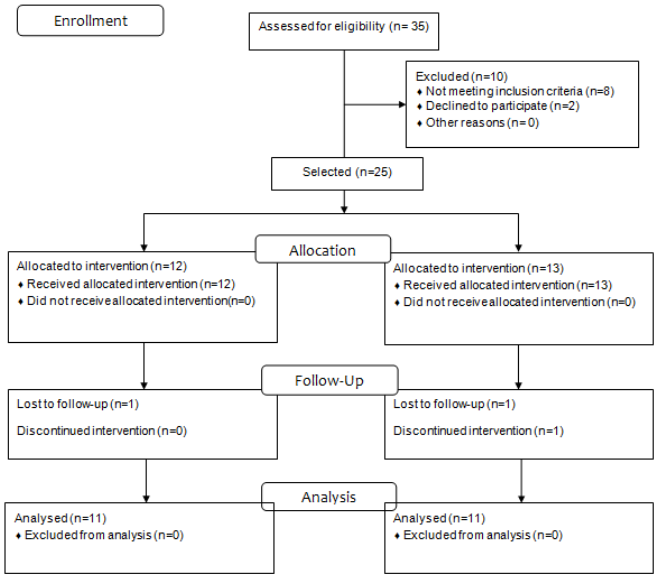

Figure 1 Flowchart of methodology followed in the study

Intervention

Conventional Balance Training

1. ***Flexibility:*** Calf, hamstring, quadriceps, hip flexors & hip adductors stretching (15 sec hold and 5 repetitions).
2. ***Strength:*** Abdominal (curl ups), spinal extensors (prone extension), hip abductors (side lying), hip extensors (in prone), hamstring (prone knee flexion) and quadriceps (knee extension in high sitting): all movements are given for 10 repetitions.
3. ***Postural control:*** Stepping in all direction, reaching to limits of stability in different position (kneeling, half kneeling, standing: on hard surface and foam surface), step up and down, tandem standing and walking, single limb standing (eyes open and closed).
4. ***Endurance:*** Walking for 12 minutes at self-selected comfortable pace on a level surface (Khot & Hande, 2017).

Dura disc training (fig 2)

Standing on the dura disc

1. Subject will be standing on dura disc while maintaining the balance ask the subject to do Bipedal heel rise for 20 seconds x 3 reps.
2. One leg balance: balance on one leg over the dura disc; keep the posture for 15 seconds x 3 reps. Repeat the exercise over the other leg.
3. Hip flexion: balance on one leg, lift the other leg to keep the hip at 90-degree flexion, maintain for 15 seconds x 3 reps and repeat the exercise over the other leg
4. Hip extension: balance on one leg, extend the other leg behind the body, maintain the posture for 15 seconds x 3 reps and repeat the exercise over the other leg.
5. Knee bending: balance on one leg, bend the other leg to keep the knee up to 90-degree flexion, maintain the posture for 15 seconds x 3 reps and repeat the exercise over the other leg (Jannu *et al*, 2017).

Safety precautions*:* While doing the dura disc exercises two therapists/ assistants stood near the patient.

The subjects were given rest period between two exercises to prevent fall.

Termination Criteria: The subject was allowed to discontinue his/her participation in the research study if he/she was not comfortable doing the dura disc or any other exercises.

Figure 2 Dura disc exercises for balance in patients with Diabetic Peripheral Neuropathy

Outcome Measures

1. ***Functional Reach Test (FRT)***- The Functional Reach Test is a single item test developed as a quick screen for balance problems. A measuring tape is attached to a wall at about shoulder height. The patient is positioned in front of this so that upon flexing the shoulder to 90 degrees, an initial reading should be measured. The patient is asked to flex from trunk and reach as far as possible without losing balance (Maranesi *et al*, 2014).This test has excellent intrarater (r= .98) and interrater (r= .98) reliability and excellent concurrent validity.
2. ***Y Balance test (YBT)***- The YBT has the patient stand on one leg while reaching out in 3 different directions with the other lower extremity. They are anterior, posteromedial and posterolateral. The maximal reach for each leg in each direction is recorded. The limb being tested is the stance limb (Khot & Hande, 2017). This test has excellent interrater (r= .99) and intrarater (r= .91) reliability and good validity.

RESULTS

Table 1 Baseline demographic characteristics of the control and experimental groups

Parameters	Group A (n=11)	Group B (n=11)	P value
Mean Age	53.09 ±4.70	50.64±5.59	0.28
Duration of Diabetes (years)	7.64±2.24	7.27±1.57	0.66
HbA1c	9.72±1.49	9.82±1.17	0.88
CNE score	13.91±2.26	15±2.4	0.29
TUG (sec)	15.55±2.58	15.64±2.33	0.93

Out of 25, total 22 participants completed the study protocol for 3 weeks. The demographic parameters such as age, duration of diabetes, HbA1c values, CNE score, TUG duration were comparable in both the groups and did not affect the study results. Table 2 showed statistically significant difference between the pre and post values of outcome measures (FRT & YBT) in both control and experimental groups. While the intergroup comparison also showed statistically significant difference between the control group and experimental group.

DISCUSSION

DPN leads to deterioration of the somatosensory system in the lower limbs which progresses from distal to proximal direction. Somatosensory function contributes almost 60-70% for postural control and balance in standing position (Horak *et al*., 2002). The sensory receptors in the sole of feet are concerned mainly with exteroceptive skills like estimation of the quality of the supporting surface and texture. This cutaneous input gives information about the properties of the surface. In DPN patients, the decline in this function of the somatosensory system results in inaccurate proprioceptive information from the feet to the higher centers of brain. Eventually, the patients become prone to postural instability, increased risk of falls and functional dependence (Lafond *et al*., 2004).

The improvement seen in the dura disc group is consistent with thestudy which proved that training for balance on unstable surfaces results in improved postural control, balance and gait in patients with diabetic peripheral neuropathy.

Table 2 Comparison of outcome measures within groups

	Control			Experimental		
	Pre-test (mean±SD)	Post-test (mean±SD)	P value	Pre-test (mean±SD)	Post-test (mean±SD)	p value
FRT	34.73±2.45	37.18±2.64	0.00**	32.00±5.06	37.27±5.00	0.00**
YBT (Rt)- Anterior	56.45±6.81	59.09±7.85	0.00**	59.45±9.31	64.82±9.30	0.01*
YBT (Rt)- Posteromedial	59.36±8.51	61.73±9.22	0.00**	52.36±7.24	58.27±6.87	0.00**
YBT (Rt)- posterolateral	61.09±6.07	63.64±6.85	0.00**	57.91±6.24	63.45±5.87	0.00**
YBT (Lt)- Anterior	56.82±7.4	58.45±6.54	0.00**	60.45±9.94	66.73±8.83	0.00**
YBT (Lt)- Posteromedial	58.55±6.29	61.27±7.30	0.00**	54.09±7.69	60.91±8.91	0.00**
YBT (Lt)- Posterolateral	62.00±6.89	64.18±6.32	0.01*	59.00±8.41	64.45±7.26	0.00**

p value *significant, ** highly significant

Table 3 Intergroup comparison of outcome measures

Outcome Measures	Control	Experimental	p value
	Difference between pre-test and post-test (mean±SD)	Difference between pre-test and post-test (mean±SD)	
Functional Reach Test	2.36±0.81	5.09±1.3	0.00**
YBT (Rt)- Anterior	2.73±1.19	6.46±3.27	0.00**
YBT (Rt)- Posteromedial	2.36±1.12	5.55±3.91	0.02*
YBT (Rt)- posterolateral	2.64±1.03	5.55±3.91	0.03*
YBT (Lt)- Anterior	1.82±0.75	6.36±3.50	0.00**
YBT (Lt)- Posteromedial	2.73±1.35	6.82±5.44	0.03*
YBT (Lt)- Posterolateral	2.36±1.29	5.36±4.00	0.03*

p value *significant, **highly significant

Statistical analysis was performed by using Epi Info 7, Primer and Microsoft Excel software. Shapiro Wilk test was used to check the data for normality and appropriate tests were applied. Paired t-test was used to find the before and after treatment effects within the groups. While, unpaired t-test and Mann-Whitney U test were used to compare the effect between the two groups. The confidence interval was set at 95%.

They also compared the effect of two unstable surfaces (wobble board & stability disc) which showed greater improvement on stability disc (Maruboyina, 2018)

Nizar Abdul Majeed Kutty *et al,* 2013, in a study explained that standing on wobbly surface requires stabilization of the body by somatosensory, visual and vestibular systems. Lower centers use the peripheral proprioceptive inputs for automatic postural responses while higher centers use these inputs for anticipatory postural adjustments (Majeed & Latheef, 2013).

Thus, training on wobbly surfaces improves proprioception which in turn improves balance.

As the dura disc has added texture on the surface, it helps in stimulating the cutaneous receptors. Dawson. J. Kidgell *et al* in their study on athletes with functional ankle instability, used dura-disc for balance training and found improvement in postural sway (Kidgell *et al*., 2007). Ankle disc training also facilitated the development of a correct pattern of muscle contraction in healthy individuals and helped to prevent ankle sprain (Tropp, 1988).

Another study done in 2020, demonstrated that sensorimotor training including balance exercises on different instruments like stability disc, wobble board, bosu ball &Swiss ball increased the stimulation of mechanoreceptors present in the Golgi tendon organs, joint capsule and muscle spindle responsible for enhancing proprioception inputs from foot, ankle and trunk (Ahmad *et al*., 2020). Therapeutic exercise program on unstable surfaces improves balance during Single Leg Stance & Star Excursion Test as evident by previous research (Rojhani *et al*., 2017). This can support our finding of improved Y- balance test in the experimental group.

The better improvement in the dura disc group compared to the control group in our study, might be due to the fact that, practicing balance training in progressive challenging levels can enhance somatosensory integration. Also, unsteady surfaces challenge the body to maintain balance (El-wishy & Elsayed, 2012) Varun Kumar *et al*., 2019; S. Maruboyina, Sanjeev Attry *et al*., 2019, did studies on DPN patients and found that sensory specific balance exercises using stability trainer effectively improves balance. These exercises help the proprioceptive inputs from the joint receptors to reach cerebellum via the spinocerebellar tracts. These somatosensory inputs increase the sensitivity of the receptors and thus improves balance (Maruboyina *et al*., 2019, Varun *et al*., 2019).Dura disc exercises is a useful adjunct to improve balance in patients with moderate diabetic peripheral neuropathy, as it is cost effective and easy to perform under supervision. The limitations of our study were that follow-up was not taken and functional activity level of participants was not considered. This intervention can be further studies in mild and severe DPN and comparison can be done.

CONCLUSION

The present study concludes that dura disc exercises along with conventional physiotherapy are more beneficial compared to conventional physiotherapy alone to improve balance in patients with Diabetic Peripheral Neuropathy.

Acknowledgement

We acknowledge the contribution made by the participants and thank them for their active and sincere participation in the study.

Conflict of Interest- None

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How to cite this article:

Deepika Dattaram Pawar *et al* (2022) 'Effect of Dura Disc Exercises On Balance In Patients With Diabetic Peripheral Neuropathy: Experimental Study', *International Journal of Current Advanced Research,* 11(03), pp. 392-396.
DOI: http://dx.doi.org/10.24327/ijcar.2022.396.0088

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