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INFLUENCE OF VESTIBULAR EXERCISE IN ANTHROPOMETRY AMONG TYPE 2 DIABETIC PATIENTS: A RANDOMISED CONTROL TRIAL

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Abstract

Diabetes Mellitus (DM) is a growing in an epidemic proportion in the world. Sedentary life style and unhealthy food habits are the reason. To address these issues, interventions such as Vestibular exercise (VE) have been explored.VE is a simple, cheap and non- invasive procedure. Vestibular system present within the inner ear and plays role in maintaining balance and spatial orientation. Exercises which can stimulate vestibular system is known as vestibular exercises. Vestibular stimulation may prevent the development of DM. The present study focuses one valuating the effects of VE interventions on anthropometry among Type 2 Diabetic patients. Anthropometric parameters were assessed before and after the intervention. The results indicated significant improvements in various Anthropometric parameters, including Body Mass Index (BMI), Body Fat Percentage (BF%), Waist Hip Ratio (WHR), Thigh circumference (TC), Neck circumference (NC), and Arm Circumference (AC), among the experimental groups that practiced VE. Comparisons between the control and experimental groups showed noteworthy differences in the above-mentioned parameters, supporting the benefits of VE practices. This study confirms that VE offer significant health benefits for Type 2 Diabetic patients. Considering the positive outcomes, it is recommended to include VE practices in the Diabetes management programs to maintain their better anthropometry.

Keywords: Vestibular exercise, Anthropometry, Type 2 Diabetes, Diabetes management, Vestibular stimulation.

INTRODUCTION

Approximately 360 million people globally may suffer from diabetes mellitus by 2030, according to startling data on the disease's morbidity and death from this chronic metabolic condition. [1] In India, the frequency among people aged 30 to 69 is approximately 21.1%. It is anticipated that 11.9% of senior citizens in the State of Kerala have diabetes mellitus. [2]

One of the most populous nations, India is currently ahead of other Western nations in the amount of individuals afflicted with non communicable diseases, which are the main causes of morbidity and mortality. These diseases include cardiovascular problems and type-2 Diabetes Mellitus.

A person with a positive family history of diabetes has a two- to four-fold increased risk of developing the disease in their offspring, and they also have a higher body mass index (BMI) than controls. [3]

One important strategy for the management and prevention of diabetes mellitus is physical activity. [4] Regular practice coupled with stretching can lead to more flexible joints, maintaining the corporal and coordinated balance, and increasing mobility and independence.[5]

Thus, the American Diabetes Association has recommended particular standards for regular physical activity programs, which are deemed vital for individuals with

ISSN 1462 2815

diabetes. [6] Patients with Type 2 Diabetes Mellitus (T2DM) have three times the prevalence of overweight and obesity as the general population. [7] According to data from the Health Unic System (HUS), type 2 diabetes is one of the top 10 causes of death worldwide.

Anthropometry has been suggested as a low-cost, easily clinically applicable tool to evaluate body composition and confirm obesity levels in diabetics. [8] In addition to the abdominal circumference and the percentage of body fat measured through the skin folds, which are frequently utilized as a complementary source of information regarding the distribution of body fat, the waist circumference, the body mass index (BMI), and the waist-hip ratio (WHR) are among the anthropometric measurements recommended for clinical verification of excessive body mass. [9-11]

BMI is a straightforward indicator of body size that compares weight to height. As an alternative to BMI, there is waist circumference and waist-hip ratio (WHR). The most effective basic indicator of total fat and intra-abdominal fat mass is waist circumference. [12]

The vestibular system, which is housed in the inner ear's posterior region, is vital for preserving equilibrium because it recognizes and processes movement. The sensors, neuronal connections, vestibular nuclei, and cortical regions that receive fused vestibular inputs are all part of this system. Five sensory structures make up the peripheral vestibular system: two otolith organs (saccule and utricle) and three semicircular canals (lateral, superior, and posterior).

Specialized sensory hair cells are placed within each sensory receptor to facilitate the transduction of head motion in many planes into neural impulses. The otolith organ is engaged in linear acceleration, such as walking and swinging, and transmits information mainly about changes in the head's position in relation to gravity. Three planes, each at a right angle to the others, are where the semicircular canals are located.

They react to changes in motion velocity, especially angular or rotational acceleration. Rotation in three planes can cause this angular acceleration: rotation in the vertical plane (such as rotating the head from shoulder to shoulder), rotation in the horizontal plane (such as shaking the head side to side), and rotation in the anteroposterior plane (e.g., nodding the head up and down). [13]

People have been calmed, soothed, and even treated using vestibular stimulation over extended periods of time. Vestibular stimulation has historically been accomplished through a variety of techniques. Conventional methods make use of motion apparatuses like Hallaran's swing and Cox's chair. [14]

Caloric vestibular stimulation is achieved by irrigating the external auditory canal with air or water, either warm or cold. [15] On the other hand, galvanic vestibular stimulation entails putting electrodes to the mastoids behind the ears and using a direct current to stimulate them. [16]

Additionally, vestibular stimulation can be produced naturally through activities like dancing, swinging, and rocking. These motion-based activities provide vestibular stimulation in the form of linear or rotatory motions.[17,18.]

Regulating the release of hormones from endocrine glands, the vestibular system is connected to the dorsal and median raphe nuclei, the autonomic nervous system, the substantia nigra, and the hippocampal formation. [19]

The vestibular nucleus directly projects to both the dorsal motor nucleus of the vagus nerve (DMX) and the Nucleus Tractus solitarius (NTS). [20] A single vestibular stimulation shock causes the vagus nerve on the same side to react. The regulation of pancreatic insulin secretion is influenced by the vagus nerve. [21]

The two neuroendocrine axes that regulate the stress response are the sympathetic adrenomedullary (SAM) and the hypothalamic-pituitary-adrenocortical (HPA) systems. [22,23] A review of the literature revealed that vestibular stimulation inhibits the HPA and SAM axes, which lowers cortisol levels, reduces anxiety, and lowers blood pressure and heart rate. [24,25]

However, there are studies showing the impact of VE on anthropometry among patients suffering from type-2 diabetes mellitus is scanty. The present study is aimed to evaluate the effect of VE on anthropometry of type-2 diabetes mellitus patients.

METHODOLOGY

Subjects: The study was conducted on 90 subjects of both genders with a history of Diabetes Mellitus for the past 1 to 5 years, age group of 30-40 years.

Study setting

The current study was conducted at Department of General Medicine, Believers Church Medical College Hospital, Thiruvalla,Kerala, India.

Inclusion criteria

Type 2 Diabetic patients, both male and female, aged 30 to 40 years, who were under Metformin treatment considered for recruitment into the study group. All subjects who gave informed consent were included in the study.

Exclusion criteria

All the subjects not meeting the inclusion criteria and those who had been practicing any kind of exercise previously, Those who are taking medicine other than Metformin DM patients with vestibular and balance disorders. Patients with a history of hypertension, DM patients have severe medical complications, Patients who have already started the exercise. Were excluded from the study.

Ethical approval and clinical trial registration

This study was approved by the Institutional Ethical Committee. (IEC-no: IEC/ 2021/06/217) at Believers Church Medical College Hospital, Kuttappuzha, Thiruvalla, Kerala. And the study was registered under Clinical Trials Registry – India on 14.12.2021 with the CTRI Number CTRI/2021/12/038616.

Study design

This Randomised control Trial included two groups. Control group and the experimental group. The subjects were divided into two groups by simple random sampling (Lottery method) each group contains 45 subjects.

ISSN 1462 2815

Group – 1: Control (Diabetic patients who are not performing any type ofexercise.)

Group – 2: Experimental group. Subjects with Vestibular exercise for the duration of 3 month

Vestibular Exercises

Each session of exercises comprises of 45 minutes. [26] Time in between morning 8.30 to 9.15 am. Three sessions per week was administered to the participants for a period of 3 months.

The exercise comprises of 2 cycles per day. Repeated one cycle after 1 minute interval (2 cycles per day). 3 minutes interval given in between each exercise.

Table No. 1 represents Vestibular Exercise Protocol

Table 1: Protocol for Vestibular exercising group

Sl. No.	Vestibular Exercise	Duration
1	Move head to right and left	1 min
2	Move head to up and down	1 min
3	Shifted to lying on their right side, then to their left side.	2 min
4	Shrugging shoulders	2 min
5	Opening and closure of eyes	1 min
6	Lean forward and backward	1 min
7	Clock wise and anti-clock wise head rotation	1 min

Outcome Measures

All the study subjects underwent evaluation pre-test and post-test. The anthropometric parameters were assessed by standard methods.

- **Body Fat Percentage:** Measured by using Tanita Segmental Body Composition Analyser.
- **Height:** Measured by using stadiometer.
- **Weight:** Measured by using Tanita Segmental Body Composition Analyser.
- **BMI:** Measured by calculation method. The formula for BMI is weight in kilograms divided by height in meters squared.
- **Waist circumference:** Measured by using measuring tape.
- **Hip circumference:** Measured by using measuring tape.
- **Waist Hip ratio:** Measured by calculation. The formula is: WHR= Waist circumference / Hip circumference.
- **Arm circumference:** Measured by using measuring tape.
- **Thigh circumference:** Measured by using measuring tape.

Statistical analysis

Data was analyzed using SPSS 20.0. Paired t-test was used to observe the difference between the groups and student t test were used to analyze pre and post values.

ISSN 1462 2815

RESULTS

Table: 2 presents the baseline demographic data of the participants of this study.

Table 2: Baseline data of the study subjects. N- number of subjects, SD-Standard deviation, DM- Diabetes Mellitus, VE- Vestibular Exercise

	Control group (group 1) N= 45	Experimental group (VE group) Group 2 N= 45
Age (Years) Mean ± SD	35.30 ± 2.26	35.52 ± 2.19
GENDER (N %)		
Male	23 (51%)	25 (55%)
Female	22 (49%)	20 (45%)
DM-Duration (Mean ± SD)	3.67 ± 1.27	3.03 ± 1.52
PLACE OF LIVING (N %)		
Urban	25 (55%)	26 (58%)
Rural	20 (45%)	19 (42%)
FAMILY HISTORY OF DM (N %)		
Yes	23 (51%)	25 (55%)
No	22 (49%)	20 (45%)
FOOD HABIT (N %)		
Mixed Diet	37 (82)	38 (84%)
Vegetarian	5 (11%)	2 (5%)
Ovo-vegetarian	3 (7%)	5 (11%)

In the control group, the average of the subjects 35.30 ± 2.26 and in the experimental group, the average of the subjects 35.52 ± 2.19 years. Age distribution is almost equal in both control and the experimental group. Gender is distributed almost equally in both groups as more than half of the population were Males in both groups and more than half of the subjects were living in Urban area. Most of the subjects are living in Urban area. It is observed that, more subjects are having mixed diet habit.

Within group comparison of Anthropometric parameter in control group

Within group comparison of anthropometric parameters among control group shows that in control group, compared to initial value, Body Mass index (BMI), Body Fat Percentage (BF%), Waist circumference (WC), Hip Circumference (HC),), Arm Circumference (AC), Waist Hip Ratio (WHR) , Thigh Circumference (TC) and Neck Circumference (NC) were not shown any significant change after 3 months. (Table: 3).

Table 3: Within group comparison of Anthropometric parameters among control group. P < 0.05 shows statistical significance

		Mean	SD	p-value
BMI Kg/m^2	PRE	27.40	2.73	0.228
	POST	27.32	2.55	
BF%	PRE	28.12	3.49	0.634
	POST	27.95	3.47	
WC (cm)	PRE	100.14	6.48	0.143
	POST	100.00	6.51	
HC(cm)	PRE	103.63	5.21	0.141
	POST	103.52	5.16	
WHR	PRE	0.97	0.04	0.708
	POST	0.97	0.04	
AC(cm)	PRE	13.95	3.40	0.237
	POST	13.80	3.45	
TC(cm)	PRE	22.22	4.13	0.039
	POST	22.03	4.16	
NC(cm)	PRE	37.23	2.57	0.115
	POST	37.13	2.52	

ISSN 1462 2815

Within group comparison of Anthropometric parameter in Experimental group

Within group comparison of anthropometric parameters among experimental group shows that in experimental group, compared to initial value, Body Mass index (BMI), Body Fat Percentage (BF%), Waist circumference (WC), Hip Circumference (HC),), Arm Circumference (AC), , Thigh Circumference (TC) and Neck Circumference (NC) were shown significant reduction after 3 months. (Table: 4). Whereas Waist Hip Ratio (WHR) doesn't have any change.(Table:4)

Table 4: Within group comparison of Anthropometric parameters among experimental group. P < 0.05 shows statistical significance

		Mean	SD	p value
BMI (kg/m^2)	PRE	27.44	2.57	<0.001
	POST	27.14	2.63	
BF%	PRE	29.33	4.41	0.013
	POST	27.95	3.47	
WC (cm)	PRE	100.27	6.57	0.01
	POST	99.70	6.29	
HC (cm)	PRE	103.66	5.20	<0.001
	POST	102.87	5.24	
WHR	PRE	0.97	0.04	0.345
	POST	0.97	0.03	
AC(cm)	PRE	13.88	3.42	<0.001
	POST	13.33	3.29	
TC(cm)	PRE	22.08	4.18	<0.001
	POST	21.02	4.19	
NC(cm)	PRE	37.14	2.53	<0.001
	POST	36.34	2.43	

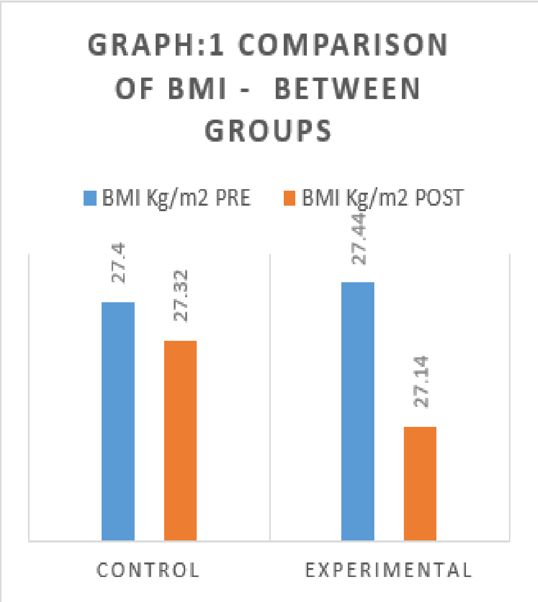
Inter group comparison of Anthropometric parameters between control group and experimental group

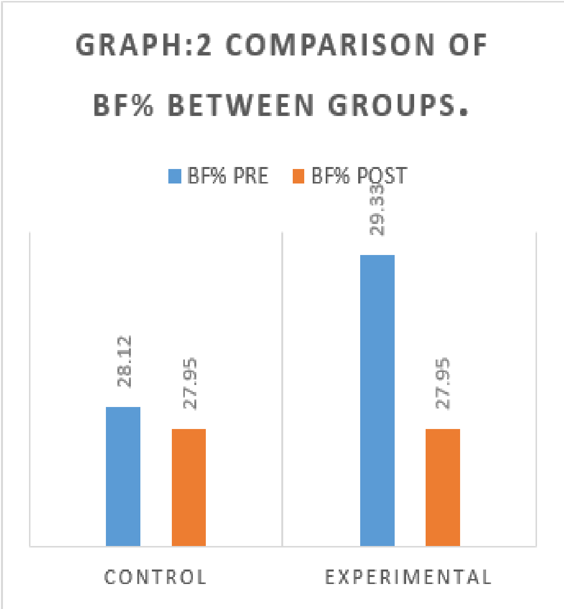
Graphical representation of comparison of selected anthropometric parameters in between control and experimental group is given below.

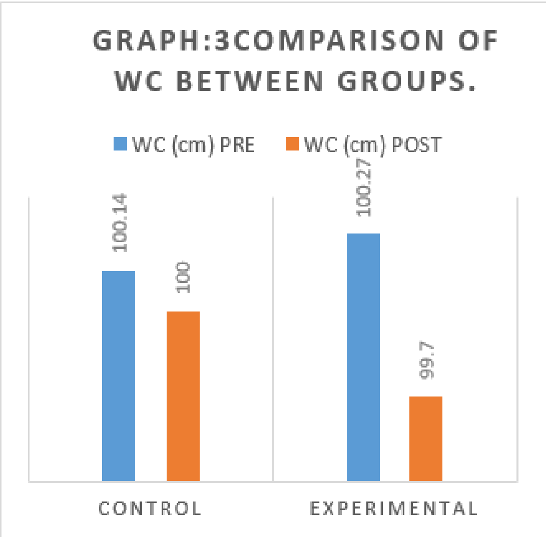
Body Mass Index (BMI) (Graph:1), Body Fat Percentage (BF%) (Graph:2), Waist circumference (WC) (Graph:3), Hip circumference (HC) (Graph:4), Neck Circumference (NC) (Graph: 5) and Thigh Circumference (TC) (Graph: 6) were decreased significantly after three months practice of vestibular exercise by compare with control group.

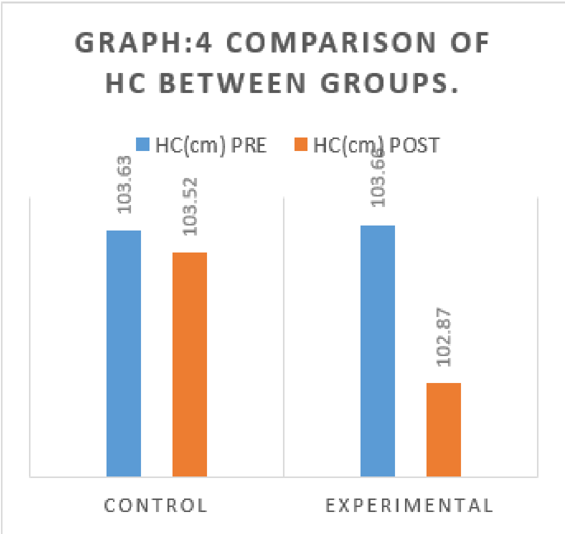
The Waist-to-Hip ratio (WHR) was same in both the groups before and after the intervention period. (Table 3 and 4)

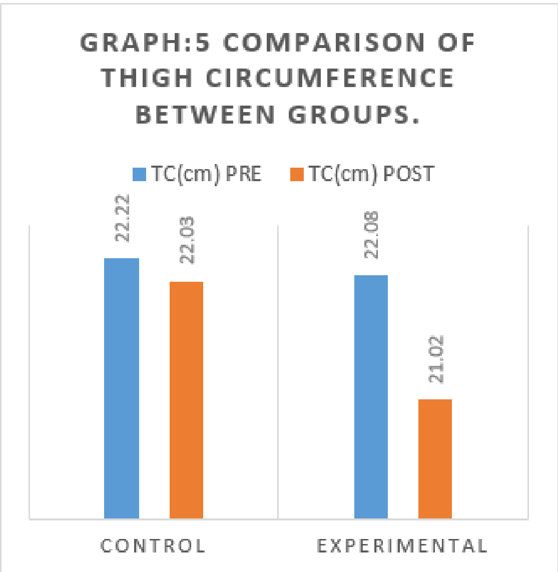
ISSN 1462 2815

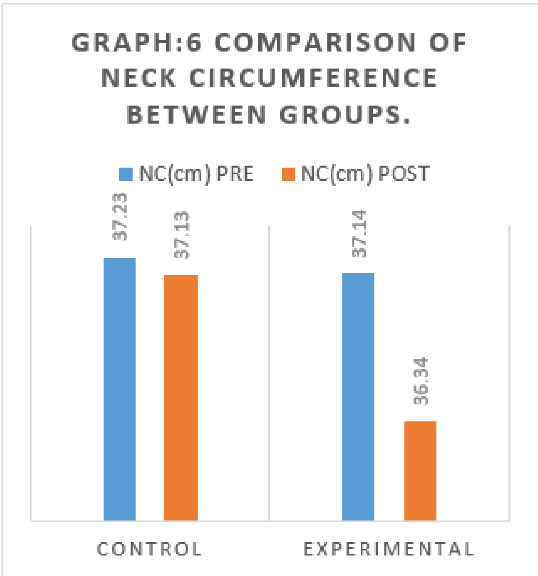












ISSN 1462 2815

DISCUSSION

Our study was investigated the effect of VE on Anthropometric parameters among T2DM patients. Vestibular exercises, designed to enhance balance and spatial orientation, have emerged as a promising intervention in influencing body mass index (BMI) and other anthropometric markers. These exercises, which involve stimulating the vestibular system located in the inner ear, play a crucial role in regulating posture and equilibrium.

Presentt research has underscored a significant correlation between vestibular exercises and anthropometric markers, indicating a profound impact on parameters such as BMI and other measures of body composition. In a current study, compelling evidence has demonstrated a robust and statistically significant effect of vestibular exercises on anthropometric markers, suggesting a promising avenue for addressing aspects of body weight and composition through targeted interventions. Our investigation suggests that VE have a role in manintaining normal anthropometric measurements among T2DM patients.

Previous investigations examining the neuro-anatomy of rabbits and cats have revealed descending vestibulo-autonomic pathways originating from the distal section of the medial vestibular nucleus and the IVN (Inferior Vestibular Nucleus). [27] Above mentioned pathways reach of the dorsal motor nucleus of the vagus nerve, the nucleus of the solitary tract, and certain sympathetic regions within the brainstem. The responsiveness of the ipsilateral vagus nerve to single shock vestibular stimulation. The pancreatic islets are specially innervated by the branches of the right vagus nerve. Through M4 receptors, stimulation of these parasympathetic pathways increases insulin secretion. Notably, acetylcholine promotes insulin secretion while atropine blocks the response to this stimulation. Similar to the effects of glucose, acetylcholine also activates phospholipase C. As a result, the endoplasmic reticulum releases calcium ions in response to the released IP3, which facilitates the release of insulin.[28]

Vestibular stimulation can balance the food intake.[29] It is yet unknown why vestibular system stimulation might be important for maintaining metabolic homeostasis. According to one theory, the vestibular system serves as an actimeter for the hypothalamus and other central nuclei, giving them information about the body's acute and long-term physical conditions. Long-term physical activity, or chronic vestibular stimulation, may give an evolutionary advantage by decreasing fat storage and simultaneously increasing substrate use towards muscle and bone. On the other hand, establishing a homeostatic state that allows fat accumulation to be maintained during a time of reduced physical activity (like hibernation) may be advantageous from an evolutionary perspective. If this is the case, increasing vestibular activity would promote metabolic equilibrium toward decreasing obesity, and the vestibular system, among other sensory feedback mechanisms, would serve as a reference point for body composition.[30] Given the available data, it would make sense to speculate that targeting the vestibular system could be a viable treatment option for type 2 diabetes and obesity. Furthermore, this potential therapeutic approach may realistically be implemented in the form of a wearable device that applies an electrical stimulation waveform to both mastoids on a daily basis, as vestibular nerve stimulation is a well-established and safe method of activating the vestibular system. Notably, this method has the capacity to reduce side effects because it allows the user to self-adjust and, if necessary, quickly stop stimulation deliver something that makes it different from weight loss medications. In fact, this theory will be put to the test in a randomized, double-blind, sham-controlled study intended to evaluate the possible therapeutic benefits of daily vestibular nerve.[31]

Previous research revealed that using a centrifuge to create hypergravity decreases body fat in mice in part by activating the vestibulo-hypothalamic system.[32] Furthermore, Abe et al. found that rats' hypergravity-induced hypophagia is mostly dependent on serotonergic neurons connected to the vestibular system.[33] Numerous conditions, including diabetes, osteoarthritis, and cardiovascular ailments, are made more likely by obesity. Effective and non-invasive treatment options for obesity are still scarce, despite the fact that treating and preventing obesity is crucial for extending healthy life expectancy in the elderly. According to a recent study, alterations in the set-point of energy expenditure and a reduction in calorie intake may be two ways that bariatric surgery can manage obesity.[34] As a result, obesity and poor glucose metabolism may be prevented or treated by using the vestibular exercise.

CONCLUSION

In conclusion, we herein provide novel evidence to show that Vestibular exercise helps to manage obesity and maintain better anthropometry among Type 2 Diabetic patients.

Author contribution

P.P.Sheela Joice : Conceptualization, Methodology, Formal analysis, Validation Writing - review & editing, Supervision.

Athira.M.S: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Datacuration, Validation, Writing - original draft, Visualization.

Mohan Varughese : Conceptualization, Methodology, Supervision.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

We thank Ms. Dhanya Binod, Physiotherapyst for all the help provided during intervention. We express our gratitude to Dr. Roshin Mary Varkey, Associate Professor & HOD, Physical Medicine and Rehabilitation, BCMCH, Thiruvalla, Kerala, India for the valuable suggestions. We are also grateful to the subjects who are participated in the study.

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