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Effect of inspiratory muscle training on autonomic symptoms in pateints with type ii diabetes

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ABSTRACT

Background

Diabetic autonomic neuropathy (DAN) is a serious and common complication of diabetes. Major clinical manifestations of DAN include resting tachycardia, exercise intolerance, orthostatic hypotension, impaired neurovascular functions. Inspiratory muscle training (IMT) demonstrates beneficial outcomes in a number of cardiovascular population, which may potentially extend to patients with type II diabetes mellitus. The aim of this study was to further evaluate the effect of IMT on autonomic symptoms in patients with long standing diabetes mellitus.

Method

Thirty patients with long standing diabetes were randomly assigned to an four-week IMT program. We assessed autonomic dysfunction in the patients with survey of autonomic symptom (SAS) scale. Score was recorded by the scale before and after the treatment program.

Results

There was significant decrease in the autonomic symptoms in males compared to females. There was significant decrease in the Q1a symptom score in male population (2.235±0.9034mmHg, 1.824±1.015mmHg, p= 0.0299) There was also reduction in Q1b total impact score in males as well (5.353±2.290mmHg, 4.059±1.191mmHg, p= 0.0001). Significant difference was also seen in orthostatic dysfunction (1.588±1.121mmHg, 1.176±0.8828mmHg, p= 0.0144) in male population. Difference was also seen in females in their Q1b total impact score (5.846±1.819mmHg, 4.769±1.739mmHg, p= 0.0093).

Conclusion

IMT demonstrates beneficial effects on autonomic symptoms in patients with type II diabetes.

Keywords: IMT, Autonomic dysfunction, SAS, Autonomic symptoms, Type II diabetes

INTRODUCTION

Diabetes mellitus, also called simply diabetes, is a disorder of carbohydrate metabolism characterized by high blood sugar level (hyperglycemia) and presence of sugar in urine (glycosuria). It develops when there is inadequate production of insulin by the pancreases or an inability of insulin to facilitate the transport of glucose into the cells [1].

Type 1diabetes is accused by the inability of the pancreas to produce sufficient insulin as a result of failure of the β-cells in the pancreas. Thus, this type is also referred to as insulin-dependent diabetes mellitus (IDDM). Type 1 account's 5% to 10% of all cases of diabetes.

Type 2 diabetes is the result of ineffectiveness of insulin to facilitate the transport of glucose into the cells and is a result of insulin resistance. It is also referred to as non-insulin-dependent diabetes mellitus (NIDDM). Type 2 diabetes accounts for 90% to 95% of all cases of diabetes. [1]

Diabetic autonomic neuropathy (DAN) is a serious and common complication of diabetes. Major Clinical manifestations of DAN include resting tachycardia, exercise intolerance, orthostatic hypotension, constipation, gastrointestinal, erectile dysfunction, impaired neurovascular function. [2] Multiple etiologies of diabetic neuropathy include a metabolic insult to nerve fibres, neurovascular insufficiency, autoimmune damage, and neuro hormonal growth factor deficiency. [3]

IMT is a device used for training of inspiratory muscles against resistance. Devices have been developed to increase inspiratory strength. IMT typically uses basic principles of resistance training. Ventilatory muscles have shown similar adaptations to training as that of the other skeletal muscles by using training principles (frequency, intensity, duration). The functional improvement and adaptive changes in structure of ventilatory muscles in response to IMT are similar to those changes seen in limb muscles. [4] Inspiratory muscle training (IMT), which does impose an external resistance to respiratory musculature, has demonstrated beneficial training effects in patients with cardiovascular diseases, specifically in patients with chronic heart failure. [5]

Patients with diabetes have various chronic complications, such as retinopathy, neuropathy, nephropathy, and other cardiovascular diseases. Among them, previous studies have reported that the prevalence of autonomic neuropathy was between 7.7% and 90% on the based of autonomic testing, [2] and autonomic symptoms may occur frequently in patients with diabetes. However, they could not be detected easily because the symptoms are very vague. Survey of Autonomic Symptom (SAS) scale was reported as an easy instrument to assess the autonomic symptoms in patients with diabetes. [6] The SAS scale consists of 11 items in females and 12 items in males (Table 1) It helps to assess both, the presence of autonomic symptoms and the degree of severity.

MATERIALS ANS METHODS

A experimental trial was conducted in patients with type II diabetes. The primary endpoint of this study was to assess the autonomic symptoms by Survey of Autonomic Symptoms (SAS) scale, and secondary endpoint was to evaluate the effects of IMT on autonomic symptoms in type 2 diabetics. Inclusion criteria for the study were: patients between the age group of 40 to 60 years, and patients who were diagnosed with diabetes for more than one year. Exclusion criteria were: the presence of any comorbidity (hypertension, chronic heart failure, etc.), unstable angina, myocardial infarction, chronic metabolic, orthopaedic, or infectious disease; treatment with steroids, hormones, or cancer chemotheraphy. Individuals with a previous diagnosis of pulmonary diseases, a history of asthma, and/or use of tobacco use were not recruited.

Eligible subjects were conveniently assigned and then assessed with the SAS scale for the presence of autonomic symptoms. They were then trained with threshold IMT for 4 weeks. Before and after the intervention SAS scale was assessed to evaluate any difference in the symptoms. No changes were made to the methodological design throughout the study.

The assigned patients performed IMT for 30 minutes, 7 days per week, for 4 weeks using Threshold Inspiratory muscle Training device. During training, the inspiratory load was set 30% of maximal static inspiratory pressure, and training load was increased by 30% in every week, but with no inpiratory hold. [7]

Survey of Autonomic Symptoms (SAS) scale had 4 components like orthostatic, sudomotor, vasomotor, and sexual dysfunction 5 were assessed. These components had 11 items for females and 12 items for males were explained to the patient and their score was reported. This was assessed before and after the intervention of 4 weeks.

Table No. 1: Survey of Autonomic Symptom Scale [8]

	Q1a. Have you had any of the following health symptoms during the past 6 months? (1, yes; 2, no)	Q1b. If you answered yes in Q1a, how much would you say the symptom bothers you? (1, not at all; 2, a little; 3, some; 4, a moderate amount; 5, a lot)
Symptom/health problem		
1. Do you have lightheadedness?	1 0	1 2 3 4 5
2. Do you have a dry mouth or dry eyes?	1 0	1 2 3 4 5
3. Are your feet pale or blue?	1 0	1 2 3 4 5
4. Are your feet colder that the rest of your body?	1 0	1 2 3 4 5
5. Is sweating in your feet decreased compared to the rest of your body?	1 0	1 2 3 4 5
6. Is sweating in your feet decreased or absent (for example, after exercise or during hot weather)?	1 0	1 2 3 4 5
7. Is sweating in your hands in creased compared to the rest of your body?	1 0	1 2 3 4 5
8. Do you have nausea, vomiting, or bloating after eating a small meal?	1 0	1 2 3 4 5
9. Do you have persistent diarrhea (more than 3 loose bowl movements per day)?	1 0	1 2 3 4 5
10. Do you have persistent constipation (less than 1 bowl movement every other day)?	1 0	1 2 3 4 5
11. Do you have leaking of urine?	1 0	1 2 3 4 5
12. Do you have difficulty obtaining an erection (men)?	1 0	1 2 3 4 5

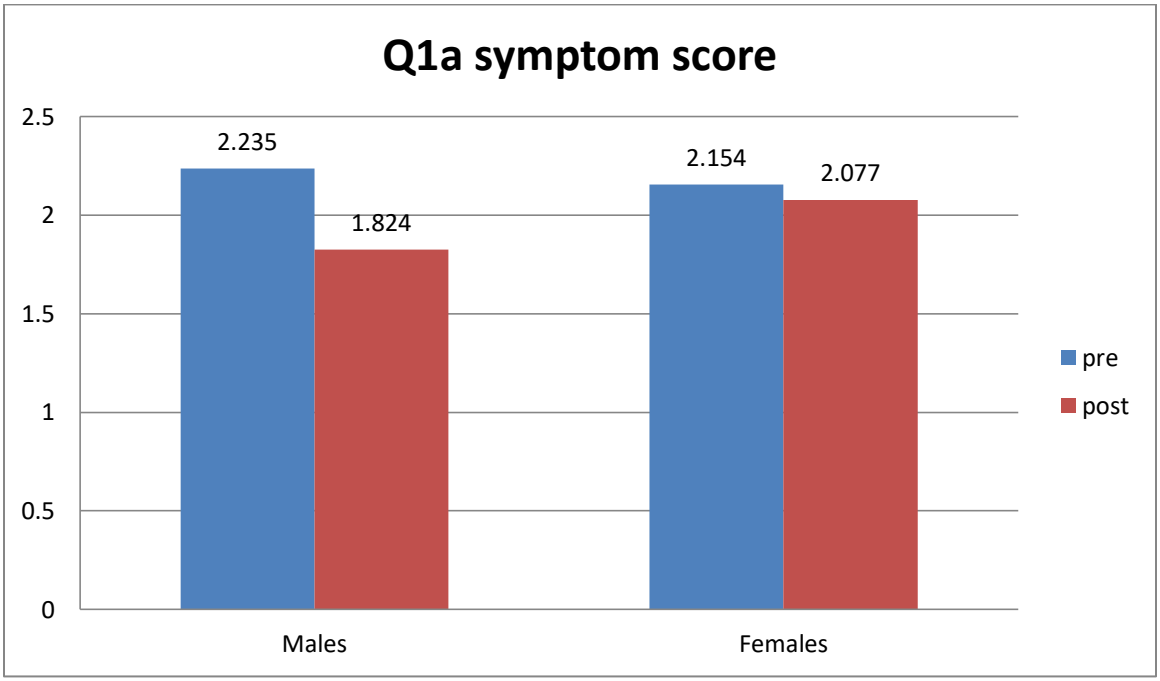
RESULTS

The present study was conducted among 45 patients with type II diabetes mellitus. SAS scale was scored before and after the treatment protocol of 4 weeks.

Graph No. 1: Q1a Symptom Score

Table No. 2:

Groups	Pre (Means)	Post (Mean±SD)	P value
Males	2.235±0.9034	1.824±1.015	0.0299
Females	2.154±0.6887	2.077±0.7596	0.337



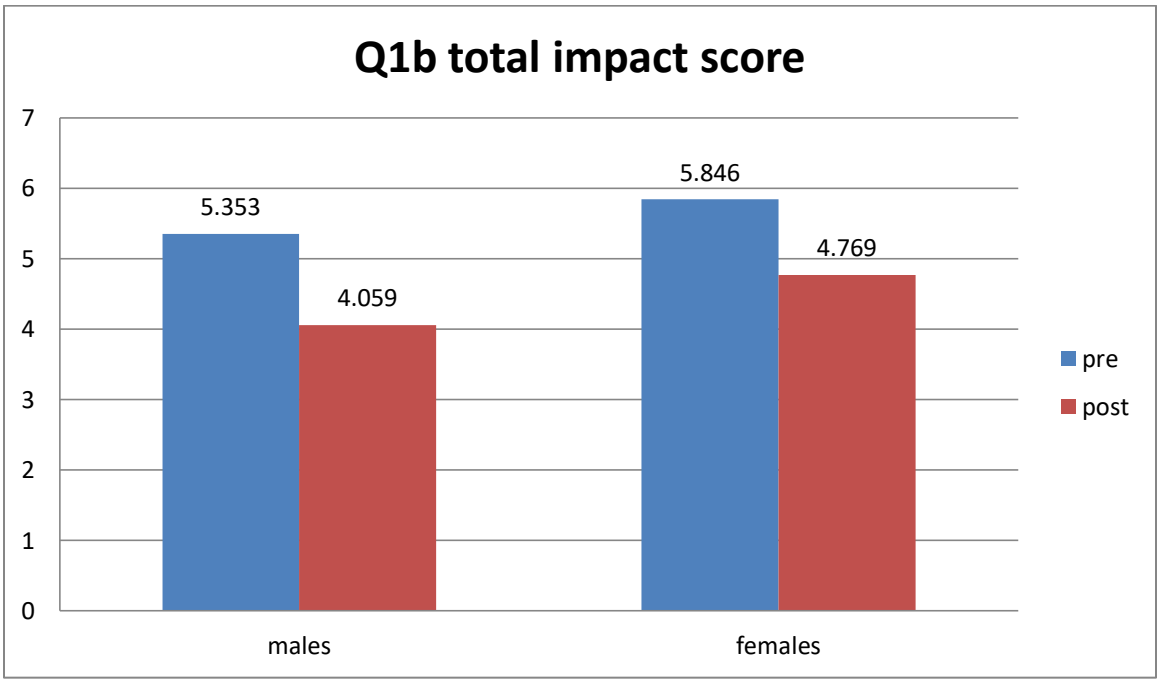
Interpretation

Graph No. 1 shows the pre and post intervention mean values of males (2.235±0.9034, 1.824±1.015) respectively with p=0.0299; pre and post intervention mean values of females (2.154±0.6887, 2.077±0.7596) respectively with p=0.337.

Graph No. 2: Q1b Total Impact Score

Table No. 3

Groups	Pre (Mean±SD)	Post (Mean±SD)	P value
Males	**5.353±2.290**	**4.059±1.191**	**0.0001**
Females	**5.846±1.819**	**4.769±1.739**	**0.0093**



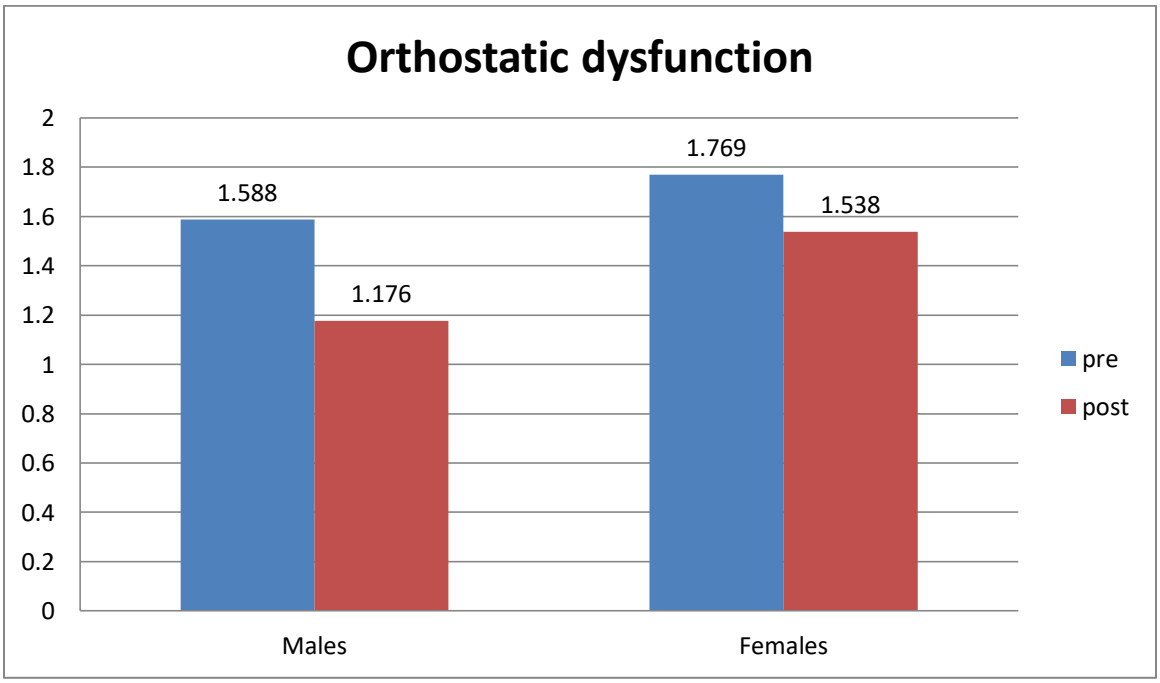
Interpretation

Graph No. 2 shows the mean value of the Q1b total impact score pre and post intervention in males (5.353±2.290, 4.059±1.191) with p= 0.0001 and in females (5.846±1.819, 4.769±1.739) with p= 0.0093.

Graph No.3: Orthostatic Dysfunction

Table No. 4:

Groups	Pre (Mean±SD)	Post (Mean±SD)	P value
Males	1.588±1.121	1.176±0.8828	0.0144
Females	1.769±1.363	1.538±1.198	0.1902



Interpretation

Graph No. 3 shows the mean values of pre and post intervention in males (1.588±1.121, 1.176±0.8828) respectively with p=0.0144; and in females (1.769±1.363, 1.538±1.198) respectively with p=0.1902.

Table No.5

Survey item	Males			Females		
	Mean±SD		p value	Mean±SD		p value
	Pre	Post		Pre	Post	
Q1a symptom score	2.24±0.90	1.82±1.01	0.0299	2.15±0.68	2.08±0.75	0.337
Q1b total impact score	5.35±2.29	4.06±1.19	0.0001	5.85±1.81	4.77±1.73	0.0093
Orthostatic dysfunction (Q1a-1)	1.59±1.12	1.18±0.88	0.0144	1.77±1.36	1.53±1.19	0.1902
Sudomotor dysfunction (Q1a-2,5,6,7)	0.94±1.43	0.76±1.39	0.1876	0.92±1.25	0.69±0.94	0.1902
Vasomotor dysfunction (Q1a-3,4)	0.70±1.21	0.47±0.79	0.1037			
Gastrointestinal dysfunction (Q1a-8,9,10)	0.94±1.39	0.70±1.04	0.1037	1.46±1.80	1.07±1.32	0.0544
Urinary dysfunction (Q1a-11)	1.11±1.45	1.00±1.32	0.1635	1.23±1.69	1.00±1.41	0.1902

DISCUSSION

The present study was conducted among 30 patients with diabetes mellitus. The study was conducted on patients residing in Pune. The study was conducted with the aim to see the effect of inspiratory muscle training on autonomic dysfunction in patients with diabetes mellitus. Patients within age group of 40 to 60 years were assessed. There were 17 males and 13 females with the ratio of had participated. Long standing diabetes mellitus of more than 10 years' duration were included in the study. Total number of 56 patients were assessed out of which 26 were dropped out of the study. Out of 26, 5 patients were in the exclusion criteria, 13 did not follow the treatment protocol and 8 patients did not co-operate with the follow up.

Compliance was evaluated by the use of a follow up diary, in which all the patients documented their daily practice and also a weekly interview was conducted by the same physiotherapist. Thus we are highly confident that subjects were compliant with the home-based intervention.

Inspiratory muscle training

Many studies have showed that respiratory modulation is related to cardiovascular modulation and it plays a pivotal role in blood pressure control, indirectly reducing the work on sympathetic flow. This relationship is likely related to baroreceptor and chemoreceptor sensitivity [9] interaction and its influence on the autonomic nervous system.

In our study a significant difference was seen the autonomic symptoms. There was a significant reduction in the autonomic symptoms specially more in males than females as shown in Graph No.2 with mean value of the Q1b total impact score pre and post intervention in males (5.353±2.290, 4.059±1.191) with p= 0.0001 and in females (5.846±1.819, 4.769±1.739) with p= 0.0093 respectively. This graph showed reduction of autonomic symptoms in both males and females, but there was significant reduction found within the males. Previous studies have shown that there is significant effect of IMT on autonomic control, they proved that slow breathing leads to RR fluctuations, which are related to blood pressure changes mediated by respiratory modulation and with enhanced baroreflex activity. [10] They did not evaluate baroreflex activity in their study, although they established that both baroreflex [10, 11] and chemoreflex [12] sensitivity among the mechanism involved in sympathetic modulation. This made it reasonable to hypothesize that besides the reduction of sympathetic activity they found, there was also some positive effect on baroreflex and/or chemoreflex.

Another study proves and supports our study that induction of inspiratory muscle fatigue in healthy humans results in an increase of muscle sympathetic nerve activity, heart rate and arterial pressure [13] Hence, experimental research shows that a fatiguing diaphragm leads to increased sympathetic outflow [14] which moreover stimulates the autonomic nervous system and helps to reduce the autonomic dysfunction.

In our study Survey of Autonomic Symptom (SAS) scale was used which consisted of 11 items in females and 12 items in males. But we assessed only 11 items in both males and females (Table No.5)

Table No.5: Survey of Autonomic Symptom (SAS) scale with 11 items scored in both males and females.

Graph No 1: (Q1a) showed significant reduction in the symptoms, with (p= 0.0299) very significant in males then in (p=0.337) not quite significant in females. There was also significant reduction seen in graph no 2: (Q1b) which showed there was reduction of symptoms in males with (p=0.0001) which was extremely significant and in females with **(**p= 0.0093.) which was also significant. Graph no.3 shows that the orthostatic dysfunction item (Q1a-1) was also seen reduced in males with (p=0.0144) which was considered significant.

CONCLUSION

In conclusion the orthostatic dysfunction component was improved out of all the components, hence it was concluded that there was effect of inspiratory muscle training on autonomic symptoms in patients with type II diabetes.

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