Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12882 - 12887
Received 05 March 2021; Accepted 01 April 2021.

Assessment of Strength, Coordination and Balance in Patients with Moderate to Severe Copd

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a disorder of the lungs in which there is obstruction in the airway leading to difficulty in breathing leading to difficulty in performing daily activities. To perform functional activities of daily living one requires Strength, Balance and coordination of movement. But these components of activities of daily living have not been studied enough related to COPD in India.
Objective: To assess strength, coordination & balance in patients with moderate to severe chronic obstructive pulmonary disease (COPD).
Methodology: Comparative study in which 30 participants were recruited by convenient sampling. According to inclusion and exclusion criteria, in group A, 15 participants with COPD, whereas in group B, 15 age sex matched normal healthy participants were taken. Five times sit to stand test, Berg Balance Scale and toe tap test were used to assess lower limb muscle strength, balance and lower limb co-ordination, respectively.
Result: COPD participants shows significant difference in Berg Balance Scale (P 0.00), Toe Tap Test (P 0.00), and five times sit to stand (P 0.00), when compared to age matched normal healthy participants.
Conclusion: Highly statistically significant differences were seen in balance, strength and co-ordination

Keywords:
COPD, Strength, Balance, Co-ordination

1.Introduction

Chronic obstructive pulmonary disease (COPD) is a disorder of the lungs in which there is obstruction in the airway leading to difficulty in breathing leading to difficulty in performing daily activities. It is one of the most important causes of morbidity & mortality worldwide and is expected to reach at third rank in 2020 global burden of disease. In COPD primary underlying pathology is pulmonary but associated systemic effects contributes significantly to the symptoms and mortality. COPD also leads to peripheral skeletal muscle dysfunction which leads to reduction in exercise capacity.[1]

Pulmonary component of the disease is characterized by chronic airflow limitation and that limitation is usually not fully reversible. As the disease progresses, this airflow limitation also progresses. Along with the airflow limitation, COPD is also associated with an abnormal inflammatory response of the lung to various noxious or hazardous particles or gases.[2]

Under the systemic effects of COPD, Skeletal muscle dysfunction is a common abnormality which includes muscle weakness and atrophy and is also a better predictor of mortality. Patients with muscle weakness and atrophy will have exercise limitation and is a major contributor for the reduction in quality of life and it also increases need for medical assistance. Patients will have problems during hurried walking, stair climbing and simple activities of daily living (ADL).[3]

Changes in skeletal muscles includes decrease in proportion of type I fibers along with increased proportion of type II fibers. Reduction in capillarity and related metabolic enzyme levels and atrophy of type I and II fibers are also seen in skeletal muscles. Multiple factors have been

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identified as contributing to skeletal muscle dysfunction including hypoxia, hypercapnia, inflammation, nutrition deficit, deconditioning, and steroid-induced myopathy.

Deficits in skeletal muscle mass and strength in COPD patients are well reported in the literature. Reduced skeletal muscle strength leads to balance impairment which is a major risk factor for falls which is common in COPD. Postural control is a complex skill that requires integration and coordination of neuro-musculo-skeletal system (i.e., strength, flexibility, range of motion, motor sensory and high level pre-motor process). Lower limb muscles weakness and impairment in activities of daily living were considered as well-established impairments in patients with COPD.[4,5] While other intrinsic risk factors such as gait, balance and coordination deficits, depression and side-effects of medications were possible deficits. Clinical trials and systematic reviews have shown positive and strong correlations between skeletal muscle dysfunction particularly (lower limb muscle weakness) and incidence of falls.

Compared to healthy population, muscle strength, length and endurance are reduced in people with COPD. Lower limb muscles, which are actively involved in balance and prevention of fall, are specifically impaired in COPD patients. Mathur et al, found that patients with moderate to severe COPD are having reduced girth, strength, and increased intramuscular fat of the thigh muscles, in comparison to age, gender and body mass matched control subjects.[3] All these factors are associated with falls, increased loss of function and mobility issues in older population with COPD. Muscle endurance is also reduced and it reflects increased muscle fatigability, which has been associated with impaired postural control measured by single-leg stand in young normal population.[7]

Recent studies on COPD population have also shown that reduction in the functional balance and mobility. The exercises component of pulmonary rehabilitation program (PRP) is considered as the cornerstone of the program which includes strength, balance and endurance training of upper limb and lower limb along with respiratory muscles training. But in a standard PRP, assessment of balance and training is not considered as a standard guidelines.[8,9] Despite the fact that individuals with COPD possess many of these risk factors, limited information is available regarding balance and falls in this population. To our knowledge, there are very few studies assessing strength, balance and co-ordination in subject with COPD.[10,11,12] Therefore, the present study aims to measure the strength, balance & coordination in patient with moderate to severe COPD.

2. Materials and Methods

A prospective, longitudinal, comparative study was conducted on patients with moderate to severe COPD at Dhiraj Hospital, Vadodara over a period of 1 year. Total 30 subjects aged between 50 to 70 years were selected using convenient sampling.Normal healthy control participants were taken from the community. Patients with acute exacerbation, musculoskeletal and neurological problems were excluded from the study. Berg balance scale, five times sit to stand test and toe tapping test (TTT) were used as an outcome measure.

Functional balance was assessed with Berg balance scale (BBS). After performing BBS, 5 minutes of rest was given. Strength of the muscles of lower limb was assessed by five times sit to stand test. After performing five times sit to stand, 5 minutes of rest was given. Lower limb coordination was assessed by and toe tapping test.

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3. Results

In this study mean age of the subjects in COPD group was 66.66 (SD 5.47) whereas it was 58.33 (SD 6.44) in control Group.

Table 1: Baseline characteristics of the study population

	COPD		NORMAL	
	MEAN	**SD**	**MEAN**	**SD**
AGE	66.66	5.47	58.33	6.44
PR	70.86	6.36	65.6	5.17
RR	21.73	1.33	17.86	1.55

Table 2: Mean of BBS, TTT and Five times sit to stand test

	MEAN with SD (COPD group)	**MEAN with SD (Control group)**	**p**
AGE	61.67± (5.47)	58.33± (6.44)	.138
PR	70.87± (6.36)	65.60± (5.17)	.019
RR	21.73± (1.33)	17.87± (1.55)	0.00
SBP	1.233	1.183	.179
DBP	70.0	64.66	.035
BBS	51.33± (2.87)	56.00± (0)	0.00
TTT	19.00± (3.44)	28.13± (4.33)	0.00
5TSTS	17.28± (4.98)	11.04± (1.13)	0.00

Above table shows significant difference in means of BBS, TTT and Five times sit to stand test in COPD patients in comparison to control group.

Table 3: Mean rank of one leg standing, tandem stand and 3600 turning (subtests of BBS)

COMPONENTS	**MEAN RANK (COPD group)**	**MEAN RANK (Control group)**	**p**
One leg standing	10.50	20.50	.001
Tandem stand	12.50	18.50	.061
360 degree turning	8.50	22.50	.000

Above table shows significance difference in one leg standing ($p < 0.05$) and 360 degree turning ($p = 0.01$) in COPD patients compared to age-sex-gender matched control subjects whereas in tandem stand, there was no significant difference.

4. Discussion

The present study aimed to assess the muscle strength, balance and co-ordination in patient with moderate to severe COPD and compare them with sex and age matched normal subjects. In Group A there were 15 subjects with COPD and in group B, 15 healthy subjects were recruited. In each group 11 were males and 4 were females. The mean age was 61.67 ± 5.47 in COPD group whereas it was 58.33 ± 6.44 in control group. The groups were equally distributed (p=0.138).

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Berg Balance Scale was used to assess balance, Toe Tap Test to assess coordination of lower limb, and the strength of lower limb muscles was assessed with 5 times sit to stand test.

There was a significant difference between two groups, with regards to BBS, the mean value of BBS score was 51.33 ± 2.87 in COPD group, whereas it was 56 in Group B (p value 0.00), indicating significant reduction in the balance of the COPD patients. In current Study two components of BBS were seen to be significantly affected. These were one leg standing, and 360 degree turning. There was highly significant difference between the groups on these subtests. One leg standing, p value was 0.01 and in 360 degree turning p value was 0.00. There was no significant difference in tandem stand.[13]

Eisner and colleagues in their prospective cohort study found that patients with moderate COPD (FEV1 62% predicted) performed significantly worse on two tests of functional balance i.e, on tandem stance task and Functional reach test as compared to age, gender and race-matched controls.

A deficit in berg balance scale score in patients with COPD identifies the various risk factors of fall therefor; BBS is an established measure for the determination of fall risk.

Several studies [14,15,16,17] have studied physical and functional deficits in COPD. Butcher et al. in 2004 [14] studied 30 patients with severe COPD (FEV1 38% predicted) identified increased postural sway and impairments in functional balance as measured by the Timed Up and Go test and the Community Balance and Mobility Scale compared to aged matched healthy controls, Eisner et al in 2008[15] have used Short Physical Performance Battery, functional reach test whereas Chang et al in 2008 [16] have used time up and go test and postural sway in quiet stance to study physical and functional deficit.

Chang and colleagues in their study investigated static postural control and sub-maximal exercise in 19 COPD (FEV1, 46% predicted) patients. They concluded that in the absence of visual input patients with COPD demonstrates impaired static postural control (i.e. increased sway) following a standard six-minute walk test.[17] COPD patients demonstrated increased medio-lateral sway and angular motion of the hips compared to healthy subjects.

Another component of current study was Toe tap test which was used to assess coordination of lower limb. The first investigation in this area was conducted by want and colleagues, who concluded that COPD patients exhibits deficits in motor speed, strength and coordination in comparison to normal control.

In the present study, mean value of toe top test score was 19.00 ± 3.44 in COPD participants whereas it was 28.133 ± 4.33 in healthy participants which shows there is significant difference (p 0.00) between the groups and it indicates there is reduction of toe tap repetitions in both the groups, a minimal reduction in normal group as compared to significant reduction in COPD group. [16]

In general, human skeletal muscle function decreases with age. However, it has been observed that the loss of muscles strength in aging may exceed that of muscles mass, resulting in a decrease in specific tension in the muscles (force per unit muscle). The performance of repeated, rapid foot tapping was significant slow in elderly subjects, which impairs in their ability to perform rapid repetitive foot tapping. [19]

In current study, five times sit to stand was used to assess lower limb muscle strength. The mean value of five times sit to stand was 17.2840 ± 4.98 in COPD patients, whereas it was 11.04 ± 1.13 in control normal subjects. [20] There is significant difference between the groups (p = 0.00) and it indicates there is reduction in the muscle strength in COPD patients. Study done by Mathur at also concluded the same reduction in muscle strength in COPD subjects.

Rob Wust et al [21] suggested that there is definitely a weakness of lower limb muscles in COPD which is one of the most intrinsic factors in contribution of fall. Results of current study show that COPD subjects had reduced functional strength, balance & coordination when compared to normal healthy age sex matched subjects. It also concludes that COPD subjects came under moderate limitation category while the healthy subjects had minimal limitation.
The minimal limitation that occurs in normal healthy individual could be due to age related detrimental changes in the muscles structure and function. Corticosteroids being given as a part of treatment to most of the subjects with COPD. This may lead to peripheral muscle weakness in them as they affect the production of contractile proteins and down regulation of insulin like growth hormone factor (IGF-1), and thus may down regulate protein synthesis and increases intracellular proteolysis. All this may result in reduction in muscles mass and strength in these subjects. [22]

Conclusion

In this study there is highly significant reduction occurs in lower limb muscle strength, coordination and balance in patients with COPD. One leg standing and 360 degree turning (subtests of BBS) were also more predominantly affected.

Conflict of interest

We declare that there were no conflicts of interest in the entire journey of the study.

References

[1] Beauchamp MK, Hill K, Goldstein RS, Janaudis-Ferreira T. Brooks D. Impairments in balance discriminate fallers from non-fallers in Respiratory Medicine 2009;103(12):1885-91.

[2] James K. Stoller. Chronic Obstructive Pulmonary Disease. Cleveland Clinic, 2012.

[3] Florent Baty et al. Comorbidities and burden of COPD: A Population Based Case-Control Study, Plos One.2013; 8(5).

[4] Campbell AJ et al, Exercises in preventing full and all related injuries in older people: a review of randomized controlled trials, Br J Sporu Med 2000:34:7-17.

[5] Moreland JD et al. Muscle weakness and falls in older adults: a systemet review and meta-analysis. J Am Geriatr Soc. 2004; 52:1121-9.

[6] From the Global Strategy for the Diagnosis, Management and Prevention of COPD. 2011; http://www.goldcopd.org. Accessed 02/21/2012.

[7] Tinetti ME et al. Risk factors for falls among elderly persons living in the community. The New England Journal of Medicine 1988; 319 (26):1701- 1707.

[8] Roig M et al. Falls in patients with chronic obstructive pulmonary disease: a call for further research. Respiratory Medicine 2009 Sep; 103(9):1257-69.

[9] Mathur S et al. Preservation of eccentric torque of the knee extensors and flexors in patients with COPDJ Cardiopulm Rehabil Prev. 2007; 27.411-6.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 12882 - 12887
Received 05 March 2021; Accepted 01 April 2021.

[10] Visser M et al, Muscle mass, muscle strength, and muscle fat infiltration as predictors of incident mobility limitations in well-functioning older persons. J Gerontol A Bio Sci Med Sci. 2005; 60 324-33.

[11] Janaudis-Ferreira T et al. Thigh muscle strength and endurance in patients with COPD compared with healthy controls. Respir Med 2006; 100:1451-7.

[12] Mia Conradsson et al. Berg Balance Scale: Intrarater test-retest reliability among older people dependent in activities of daily living and living in residential care facilities, APTA september 2007 vol 87 no. 9 1155-1163.

[13] Butcher SJ et al. Reductions in functional balance, coordination, and mobility measures among patients with stable chronic obstructive pulmonary disease J Cardiopulm Rehabil. 2004;24(4):274-280.

[14] Eisner MD et al. COPD as a systemic disease: impact on physical functional limitations. Am J Med. 2008;121(9):789-796.

[15] Chang AT et al. Static balance is affected following an exercise task in chronic obstructive pulmonary disease. J Cardiopulm Rehabil Prev.2008; 28(2):142-145.

[16] Smith MD et al. Balance is impaired in people with chronic obstructive pulmonary disease. Gait Posture. 2010;31(4):456-460.

[17] Jane A et al. Specific strength and voluntary muscle activation in young and elderly women and men J Appl. Physiol. 87.22-29, 1999.

[18] Mathur S et al. Estimation of thigh muscle mass with magnetic resonance imaging in older adult and people with chronic obstructive pulmonary disease. Phys Ther.2008; 88:219-3.

[19] Wust RC et al. Factors contributing to muscles wasting and dysfunction in COPD patients. International journal of COPD 2007; 2: 289-300.

[20] Maria K Beauchamp et al. deficits in postural control in individual with Copd emerging evidence for an important secondary impairment, multidisciplinary Respiratory Medicine 2010;5(6):417-421.

[21] Marla Beaucham et al. Effect of Pulmonary Rehabilitation on Balance in Persons with Chronic Obstructive Pulmonary Disease. Archives of Physical Medicine and Rehabilitation September 2010;91(9):1460-1465.

[22] Beauchamo Mk et al Effects of pulmonary rehabilitation on balance in person with chronic obstructive pulmonary diseases. Arch Phys Med Rehab 2010; 91:1460-4