Original research

The change in pulse rate and saturation pattern in normal, COPD, and DPLD patients

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Abstract :

Background : Desaturation on exercise occurs in patients of COPD and DPLD. The degree and dimension of desaturation may vary between them as the underlying mechanism is different.

Method : We selected a set of subjects who were diagnosed to have normal health with normal lungs through investigations. We also selected groups of COPD and DPLD patients based on appropriate evaluations. All the three groups were subjected to a fix and defined but simple exercise protocol made by moving between two chairs kept at a fixed fashion at a fixed distance (2 chair test). The pulse rate and the arterial oxygen saturation were measured with the help of a pulse oximeter at rest (before starting exercise), just after completion of exercise, and then in every 10 seconds for 120 seconds. The changes (maximum, at one minute and at two minutes were noted) for both the parameters and analyzed statistically.

Results : The desaturation in normal individuals was transient, minimal and not significant but the same in the other two groups of patients COPD & DPLD were significant compared to the normal subjects ($p < 0.00001$). The desaturation in DPLD patients at the end of 60 seconds were significant compared to the COPD groups ($p < 0.05$). The changes in the pulse rate was similar in all the three groups; they did not return to normal in the diseased groups.

Inference : There has been significant desaturation in the disease affected persons both (COPD and DPLD) and the degree of desaturation at 60 seconds appears most significant to give an idea to distinguish between them.

Keywords : Six minute walk test, two chair test, saturation, pulse rate, COPD, DPLD
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Abbreviations :
COPD – Chronic obstructive pulmonary disease
DPLD – Diffused parenchymal lung disease
2CT – Two chair test
ECG – Electrocardiogram
IPF – Idiopathic pulmonary fibrosis
6MWT – Six minute walk test

INTRODUCTION:

Increase in pulse rate in response to exercise is universal in health with negligible change in saturation. But in disease state, involving the cardio-pulmonary system, the later is more marked. The change of pulse rate and saturation thus noted in a set of normal patients and patients of advanced COPD (FEV1< 50 %) and DPLD with moderate restriction severity. Here we present the degree and the pattern of changes in these two variables over a length of 2 minutes following a mild and easy to perform but fixed exercise protocol.

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METHODOLOGY:

The protocol was first approved by the Institutional Ethics Committee. Selection of the participants was done into three groups as a) normal, b) COPD, and c) DPLD. The normal populations were selected based on an interview on a format that included questions to learn regarding any ongoing disease followed by evaluation as routine hemogram and biochemistry (fasting blood glucose, creatinine, bilirubin with liver enzymes and serum albumin

and globulin, uric acid, and lipid profile), chest x-ray (PA view), ECG, and spirometry. Those who answered in favour of normal health and did not have any abnormality in the investigations were included. COPD was diagnosed based on GOLD criteria (1) based on spirometry done according to the ATS guideline (2). DPLD was diagnosed on clinical suspicion supported by suggestive chest x-ray, spirometry, and finally by the presence of findings of diffuse interstitial fibrosis in HRCT chest.

All the three groups of subjects underwent a fixed and defined exercise as detailed below after providing informed consents. Two chairs were kept at 5 feet apart facing each other. The volunteer was asked to keep seated in any of them for five minutes and relax while his pulse rate and the saturation were measured by a pulse oximeter. When the investigator felt that the patient has achieved a stable baseline state, the volunteer was ashed to move up and sit on the other chair and immediately return to the previous one without delay. This up and down movement from one chair to the other and returning back formed one unit of movement. The volunteer was instructed to complete five such units of movement continuously and then rest again on the initial chair. They were requested to do the movement with normal pace and stop to close the exercise protocol as and when it appeared difficult for him or her to continue. The exercise done was recorded as the number of units been covered and the complete protocol of exercise meant 5. Following the completion of the exercise we measured the baseline pulse rate and saturation immediately after the exercise been over and on every 10 seconds thereafter until 120 seconds. We kept a safety back up of oxygen and other resuscitative measures. We have taken the maximum difference from baseline for both the pulse rate and saturation after the exercise, and the maximum difference from the baseline after 60 and 120 seconds of the completion of the exercise.

The test was named '2-Chair test'and it was performed by a single research assistant. The lung functions and the results of the two chair tests were plotted on a excel sheet and statistical calculations were subsequently done by application of 'Student's *t*-test' for the change in saturation at 60 and 120 seconds and ANOVA for the area under the curve for both the pulse rate and saturation. Line pictures were drawn for the three groups for the changes been seen in the pulse rate and SaO2 of the participants.

RESULTS:

We could recruit 14 normal, 38 COPD, and 23 DPLD patients from our out- patient services between periods of 20th February, 2015 to 30thApril, 2015. The table 1 elaborates their age, lung function (post bronchodilator spirometric values) and the change in pulse rate and Sao2 just after exercise, and 60 and 120 seconds thereafter. The trend line of the change in pulse rate and saturation is shown in figure1.

	Mean age	Mean max. diff. in pulse rate (PR)	Mean max. diff. of PR from baseline at 1 min	Mean max. diff. of PR from baseline at 2 mins	Mean max. diff. in SpO_2	Mean max. diff. of SpO_2 from baseline at 1 min	Mean max. diff. of SpO_2 from baseline at 2 mins	Mean FVC (%)	Mean FEV1 (%)	Mean FEV1/ FVC (%)
A. Normal (N=14)	36.71 ± 11.31	26.07	4.79	-1	0.36	0.07	0.07	3.47 (87.54)	2.83 (86.85)	81.95 (96.85)
B. COPD (N=38)	66.38 ± 7.69	15.76	7.68	2.03	2.89	2.47	0.47	1.84 (58.81)	1.06 (42.62)	52.55 (66.86)
p-value **(A to B)**	0.00	0.0008	0.29	0.09	**0.00**	**0.00**	**0.05**			
C. DPLD (N=23)	57.74 ± 12.21	19.30	11.13	1.17	4.39	4.26	0.43	1.65 (56.2)	1.39 (62.21)	89.35 (111)
p-value **(B to C)**	0.004	0.14	0.09	0.34	0.16	**0.04**	0.87			

Table 1: Elaborates the age, lung function status with the change in pulse rate and saturation in patients on serial measurement at every 10 seconds for 120 seconds after a fixed defined exercise.

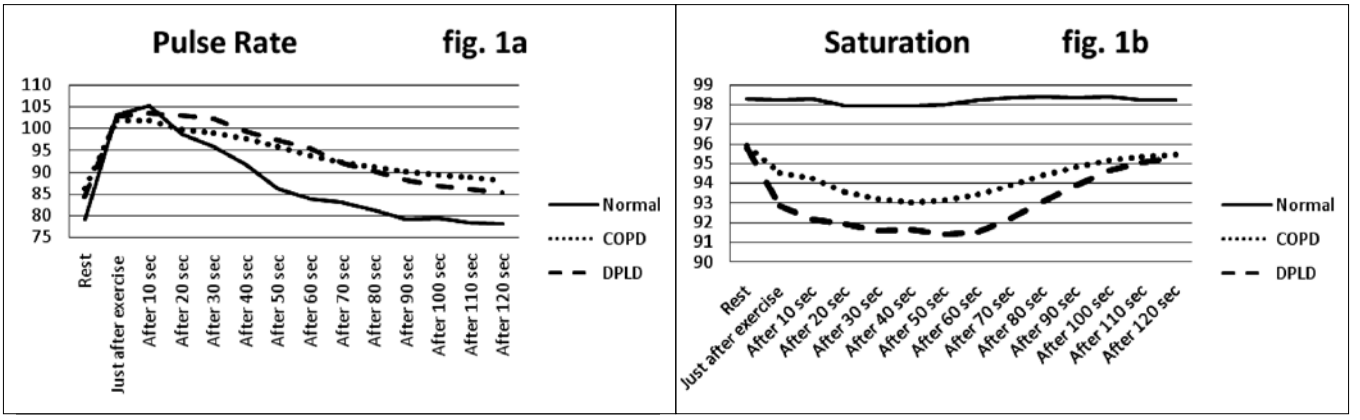

Figure 1 : The figure depicts the change in both the pulse rate (1a) and SaO_2 (1b) over time for normal, COPD, and DPLD patients separately (figure 1). It elaborates the changes visually

The table 2 elaborates the difference between the three groups as regards the change in pulse rate (table 2a) and arterial oxygen saturation (table 2b) through the application of the analysis of variance. While the changes in pulse rate are not significant considering the area under the curve, the drop in saturation in both the COPD and the DPLD groups are statistically significant. However the change between the COPD and the DPLD patients does not appear significant.

Table–2a

Changes in pulse rate		p - value
Normal	DPLD	0.342
	COPD	0.314
DPLD	Normal	0.342
	COPD	0.997
COPD	Normal	0.314
	DPLD	0.997

Table–2b

Changes in saturation		p - value
Normal	DPLD	0.000
	COPD	0.003
DPLD	Normal	0.000
	COPD	0.399
COPD	Normal	0.003
	DPLD	0.399

Table 2: the table elaborates the comparison using two-way ANOVA between the normal persons, COPD, and DPLD patients for the changes in terms of pulse rate (table 2a) and saturation (table 2b):

DISCUSSION:

In our observation, we have noticed an early surge in the pulse rate in all the three groups (see figure 1 and table 1) and the maximum changes in normal and as well in the disease groups were comparable (statistically not significant). The decline in pulse rate with time in these three groups of patients have also been parallel. Although the pulse rate returns to resting level at 120 seconds in normal subjects, the same in the COPD and DPLD patients remain above the baseline at the same point of time suggesting that a recording for a longer duration should have been better to appreciate the change. However, when we compared the saturation, there have been significant desaturation in both the groups at 60 seconds compared to normal and the same between the COPD and the DPLD group also shows a significant widening with the DPLD showing higher desaturation compared to the COPD sufferers (see table 1). Once we compared the change as per the area under the curve, the results (see table 2) show that the difference of both DPLD and COPD groups are significant in desaturation compared to normal, but, the change between this two abnormal groups are not significant.

The change in pulse rate with exercise is physiological and normal peoples as well as athletes have been found to have negligible and transient desaturation on exercise. (3) Exercise desaturation is exacerbated in disease states that involve the lungs and/or the heart with several mechanisms been involved in impaired gas exchange. (4)

Both COPD and DPLD patients show exercise desaturation (5, 6). The oxygen desaturation in COPD has been found to be related to poor prognosis (5) and the baseline oxygen saturation has been found to predict the exercise desaturation (7). Exercise desaturation has been a feature of DPLD (4, 6, 8) and the patient of usual interstitial pneumonia show increased hazard as death with the presence of desaturation on exercise. (9)

Cardiopulmonary Exercise Test has been a very important tool to understand the functional cardiopulmonary reserve and status. Formal cardiopulmonary exercise test measures exercise tolerance and desaturation. To understand the physiological impact of disease pathology a simple 6 minutes walk test (6MWT) was innovated and it has turned a very important tool in clinical practice and research (10). It has been regarded as simple, inexpensive, reproducible alternative of cardiopulmonary exercise test (11). Whatever simple it may be, it is difficult to organize the statutory requirements for the test and its use is restricted more to the research set up than in clinical practice. People have shown a much simpler 15 steps climbing exercise (12, 13) that shows desaturation as a marker of severity of COPD demanding oxygen supplementation (12). The same exercise protocol when applied to the patient of IPF, it was found that the test could evaluate the functional capacity of the patients reliably (13). For COPD again it was found that low FEV_1, Increased pulmonary artery systolic pressure, and higher MMRC score had higher desaturation on exercise (14).

We have passed through a series of experiments to evolve an easy exercise test that suits our patients with different respiratory problems. The 6 minutes walk test appear logistically difficult especially in relation to access to a 100 feet long corridor with similar environmental conditions round the year. We have observed that many of our patients show desaturation even on walking a distance of 10 to 15 yards. We have noted that mostly these patients belong to DPLD or advanced COPD with or without pulmonary hypertension or heart failure. This helped us to develop the 2 chair test (2CT) as described through several interacting sessions between the members of the institute. This appears to be a simple test without much time consumption that suited our practice requirement. After performing it to a number of our patients, we have decided to try it formally and thus taken the record on patients of different conditions. The present manuscript has been an outcome of the effort.

The observation reveals that a) the cumulative deviation of pulse rate is nearly same for COPD and DPLD on the defined exercise but is different for saturation, and b) the saturation returns to respective base line by 120 seconds in all the groups but for pulse rate the values fail to reach the base line in both COPD and DPLD. This suggests that longer a record will be worthwhile to assess the trend in the pulse rate change in these two pathological conditions. The study also endorses the view of innovating such simple and defined exercise protocol that easily suits the practice of a busy physician. We feel that the proposed 2 chair test (2CT) can be an useful adjunct on proper establishment of validity and the reproducibility.

There are serious weaknesses of the study. All our COPD subjects had severe disease (mean FEV_1/ FVC of 52.55 % and the mean FEV_1 42 % of predicted only) and the lung function in the DPLD patients showed moderate restriction (FVC being 62.21 % of predicted). Some of these patients could have have concomitant diastolic dysfunction (heart failure with preserved ejection fraction) and pulmonary hypertension and our analysis does not include these co-factors that can have serious impact on the saturation behaviour on mild exercise. It is unwise to confer the actual impact of unmixed COPD or DPLD from the observation. The number of patients in each group is small and only severe COPD and moderate DPLD patients have been included. Adequate number of recruitment with incorporation of the patients from different severity stage (spirometric) of the disease and different co-morbidities are needed for a valid understanding before recommendation of the effort (2 chair test) in clinical practice.

Despite obvious such shortcomings we feel that the very observation has a potential for being a screening tool to our practitioners to diagnose

and differentiate COPD and DPLD patients from normal. We also feel that the proposed 2 chair test needs further attention and scientific validation.

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