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A Case Study on Breathing Rehabilitation in a 32-year-old Male with Dysfunctional Breathing

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Abstract

Despite having a significant impact on the personal, psychological, and social dimensions of a person's health, health professionals' emphasis on the epidemiological, pathological, and physiological basis of the dysfunctional breathing, therefore, fails to provide patients with an appropriate treatment. Given the multifarious and psychophysiological nature of dysfunctional breathing, a holistic and multidimensional management would seem the most appropriate way to manage such a prevalent condition This case study presents a holistic approach to comprehensively manage dysfunctional breathing. That being the case, interventions for four key domains — biochemical aspects, biomechanical aspects, psychosocial aspects, and respiratory symptoms — were provided. It was obvious from the outcome findings that dysfunctional breathing can only be successfully understood by relating it to the person's life experiences including their, beliefs, values, emotions, influences, and social relations.

Keywords: Breathing pattern disorder, Breathing retraining, Dysfunctional breathing, Hyperventilation, Stress

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Introduction

In normal circumstances, any alteration of optimal breathing in response to physical, emotional, or metabolic demands is temporary and is controlled by the autonomic nervous system. However, if the inappropriate breathing is persistent enough to cause symptoms without any apparent cause, then breathing is termed as dysfunctional breathing.[1] Dysfunctional breathing or breathing pattern disorder is synonymously used as "hyperventilation" since the term was first introduced in 1937.[2]

Hyperventilation or "breathing more than metabolic needs" results in excessive expulsion of carbon dioxide, thereby creating carbon dioxide deficit producing a state known as hypocapnia.[3] This decrease in carbon dioxide further leads to respiratory alkalosis, which generates a fright-flight response in the entire body.[1] Furthermore, during an episode of acute hyperventilation, chronic hyperventilation can mimic serious symptoms indicating cardiorespiratory, neurological, or gastrointestinal dysfunction. These changes, in turn, influence the person's ability to cope with day-to-day activities eventually leading to fatigue. Furthermore, a vicious circle of exhaustion aggravates hyperventilation that ultimately attributes to deprived sleep, visual disturbances, behavioral issues, social interaction, observational ability, defensive mechanism, and also produces anger and depression.[4]

In addition, inappropriate posture contributes to breathing pattern disorder by diminishing lateral expansion of the chest wall and by reducing diaphragmatic activation.[5] Besides, forward protrusion of the head increases the resting length of the diaphragm and affects its ability to return to its usual resting position. This results in dynamic hyperinflation and pressure change further contributing to dysfunctional breathing.[1] Besides, coordination of the diaphragm, transverse abdominis, and pelvic floor muscles is crucial in controlling motor activity, posture, and breathing. However, if this coordination changes, the functional ability of the muscles gets compromised, and the possibility of back pain and injury increases.[6]

From psychological point of view, anxiety can occur as a result of hyperventilation or anxious behavior can itself be a primary initiating factor for hyperventilation.[7] In a normal scenario, when a person is exposed to any threat or fear or shows excitement or faces an uncomfortable situation, it is obvious to notice the shift from diaphragmatic breathing to upper chest movement. It has also been reported that in individuals who panic, it is common to see anxiety-related physical sensations such as dyspnea, chest tightness, or tachycardia.[8] It has been found that people who are sensitive to panic behavior or anxiety are those who reflect the characteristics of Type A personality, for instance hardworking, perfectionists, and people who have high expectations of themselves.[9]

The relationship between anxiety and work was further clarified by studies conducted in 1997[10] and in 1998.[11] According

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to these studies, individuals who have high anxiety levels are more susceptible to alteration in respiratory patterns in response to the completion of a stressful task. These individuals showed a remarkable rise in their tidal volume, respiratory rate, and reported a decline in expiratory time with a significant reduction in fractional end-tidal carbon dioxide. It was further highlighted the positive relationship between work-related hyperventilation and initiation of its symptoms.[12] It was shown that in people with sedentary jobs, due to ongoing work stress, the presence of respiratory alkalosis is not overcome by the physical response and therefore carbon dioxide level remains low. This further compels respiratory centers in the brain to adjust accordingly, thereby making these individuals more susceptible to anxiety or stress-induced hyperventilation.[12] To summarize, dysfunctional breathing is a whole person problem – it can destabilize mind, muscles, mood, and metabolism. It can be considered both a cause and consequence of poor health.

Whilst, this explains breathing pattern disorder in from biomechanical, biochemical, and psychosocial viewpoint; the present research paper is not intended to be a historical review, nor there is any intention to define dysfunctional breathing but rather presenting a case study to improve understanding of the management of dysfunctional breathing, based on the available evidences, on the part of health-care professionals.

Case Study

Sam, a 32-year-old married man, was working as a software engineer in a reputed firm in India. He gradually started to develop upper back pain. He denied any trauma but reported having a sedentary lifestyle. To rule out the cause of deep dull intermittent upper backache, X-ray was undertaken along with the necessary physical assessment. However, no structural impairment was detected except functional faulty postures adaptations due to repetitive work-related activities. Sam's family physician advised him to work on improving his posture and adapt a healthy lifestyle. Despite having high workloads which required prolonged sitting, Sam improved his lifestyle by including a healthy diet and exercise in his routine and reduced his weight to 75 kg from 85 kg. Despite significant weight loss, this change did not help him much as his pain becomes constant and has made his job increasingly difficult.

Few months later, Sam migrated to New Zealand with his family and got a new job where he was always under pressure to complete the tasks. His exposure to the new culture and different working environment, prolong sitting hours, poor posture, stiffness in the neck and shoulder, fatigue, and mental exhaustion at the end of office hours aggravated his existed upper back pain. He also noticed that gradually he developed mood swings, poor concentration, headache, confusion, and sweating in meetings. These changes affected his overall health and made him anxious about his condition which eventually affected his work in the office and his relationships with his family.

His wife suggested that he should take a break from his hectic schedule which encouraged him to plan a vacation to have some quality time with his family. During the holiday period, while watching television Sam noticed that he was breathing differently and felt pain in his chest with some tightness along the left arm. He got worried and decided to go for another consultation. The physician performed a detailed clinical investigation including cardiopulmonary and neurological examination but no specific cause for his symptoms was identified. After his general practitioner recommended him to a physiotherapist, he decided that he would try anything to make the pain go away but was unsure how exercise will help improving his condition? [Figure 1, atypical breathing patterns].

Assessment and Treatment

Patient approached the clinic in New Zealand for his dysfunctional breathing pattern. At the time of initial assessment, it was noticed that Sam was breathing into his upper chest and there was almost no diaphragmatic movement. As observed, he had postural changes including forwarded head-and-neck protrusion, increased cervical lordosis and thoracic kyphosis, elevated and protracted shoulders, and along with slight winging of the scapulae. There was tightness of the upper trapezius and levator scapula on the dorsal side crossed with tightness of the pectoralis major and minor. The initial assessment also identified weakness of the deep cervical flexors, ventrally, crossing with weakness of the middle and lower trapezius. Postural analysis was performed in standing posture: (posterior view, anterior view, and lateral view). Muscle strength and flexibility were also assessed. On the basis of examination, it was evident that there was muscle imbalance in the strength and flexibility of the antagonist muscle group; indicating "upper crossed syndrome" [Figure 2].[5]

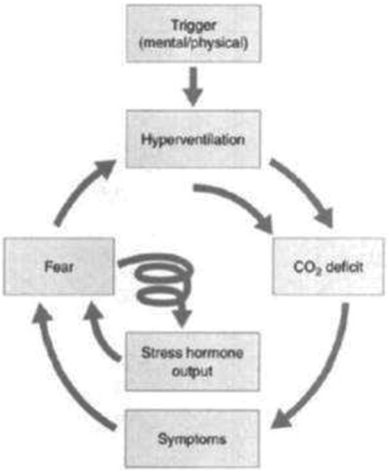

Figure 1: Atypical breathing pattern. From (Chaitow *et al*., 2002)

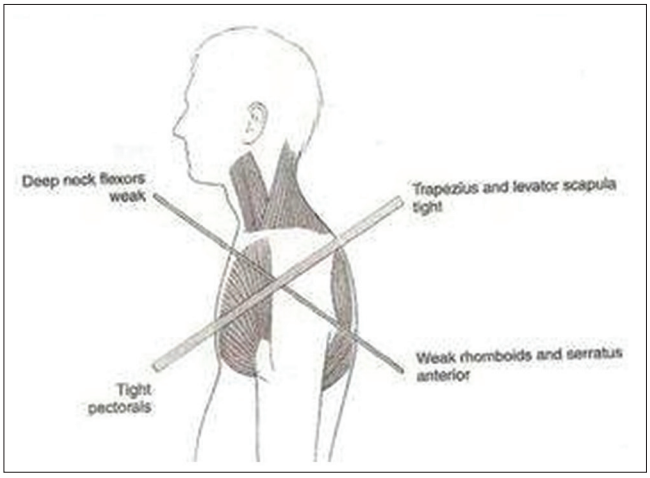

Figure 2: Janda's Upper crossed syndrome from (Chaitow *et al*., 2002)

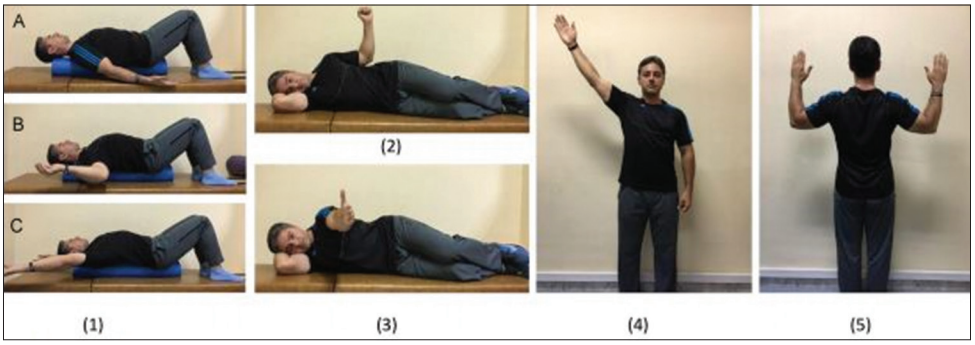

Figure 3: Initial phase exercise of comprehensive corrective exercise program from https://www.physio-pedia.com/Upper-Crossed_Syndrome

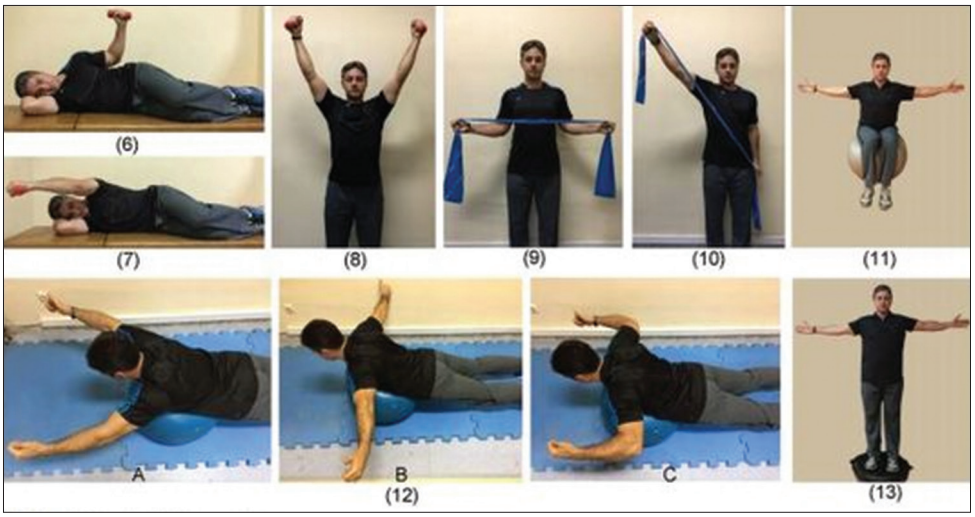

Figure 4: Improvement phase exercises of comprehensive corrective exercise program from https://www.physio-pedia.com/Upper-Crossed_Syndrome

Further clinical examination identified Sam's high respiratory rate (22 breaths/minute) with an inspiratory to the expiratory ratio of 1:1. His breath-hold time was 19 s and he scored 25/64 on the Nijmegan questionnaire, which was positive for hyperventilation [Appendix 1, Nijmegen Questionnaire]. He did not report major sleep disturbances and did not have any vocal cord dysfunction associated with his breathing. Although, he complained of frequent sighs throughout the day.

While the assessment session did require a lot of talk and inquiry, sessions following the initial assessment were more action-based, focusing not only on the traditional structural biomechanical approach to the upper crossed syndrome, including stretching of short muscles and strengthening of weakened muscles at the site of problem, but comprehensive corrective exercise program was administered.[13][14] The selected exercises are designed in three phases: Initial, improvement, and maintenance where each exercise session begins with 10 min of warm-up activity and ends with 5 min of cool-down [Figures 3 and 4].

Furthermore, contrary to the standard physiotherapeutic approach for upper back pain, educating the patient, breathing retraining, and relaxation therapy were introduced along with exercise program. The outcome of the assessment was discussed with Sam explaining him the difference between apical breathing and diaphragmatic breathing. He was explained how the overuse of his postural muscles due to continuous work targets and without balancing his personal and social life have contributed to the ongoing back pain and generalized fatigue. He was conveyed how his ignorant attitude toward his physical and psychological symptoms affected his level of carbon dioxide and pH balance in his body. Although educating him helped to develop the therapeutic patient-practitioner relationship, but Sam was still worried about his chest pain.

As part of breathing retraining, Sam was taught to perform diaphragmatic breathing in "beach pose position" [Figure 5, beach pose position], which helped him in keeping upper chest still and facilitating the use of diaphragm muscle.[15] He was advised to continue it daily at home for 12–15 min. Furthermore, to reduce the stress on postural muscles, Sam was advised to put "break reminder" at an interval every 2–3 h and instructed to perform upper body stretch during that break. Another useful method, "Brugger's relief position-in sitting," was suggested for postural improvement.

To provide symptomatic relief, relaxation therapy was also administered as part of rehabilitation. The relaxation technique was taught by asking him to tighten his whole body followed by the gentle release of all the tensed muscles. It was an attempt to improve his participation by showing the difference between a tensed and relaxed state of muscles

Three weeks after the initial management, Sam started to feel a bit better. His Nijmegen score improved (23/64), but

was still positive for hyperventilation. Knowing of his progress with diaphragmatic breathing, he was encouraged to put a pause at the end of expiration to slow down the breathing rate and the position was progressed from lying to sitting. In addition, Sam was encouraged to relax in the prone position with eyes closed for feeling the movement of the abdominal wall [Figure 6].[16]

Six to 8 weeks after the initial assessment, Sam reported that his concentration and his performance at work improved a lot. He felt that he was a lot more relaxed now and had reported no episode of panic attack under stress. His Hospital Anxiety and Depression Score (HADS), which was 13 for anxiety and 9 for depression before our first meeting, has reduced to 11 for anxiety and 5 for depression. Sam's Nijmegen score was 18, which indicated he was asymptomatic. Sam's breath-hold time increased to 32 s and his breathing rate of 14 breaths/minute showed a positive outcome in response to chosen treatment interventions. No active trigger point was noted during breathing at rest.

Nine to 12 weeks post the first consultation, Sam was encouraged to progress diaphragmatic breathing to a standing position. Furthermore, it was suggested that he should incorporate yoga into his routine, which will promote further relaxation by reducing anxiety[17] and will improve his overall well-being.

Following 12 weeks of total 24 physiotherapy sessions, further sessions were organized until the patient felt stabilized and felt more confident in self-management skills. Appointments were then spaced out with half-hour checkups or teleconsultations only when required. Breathing retraining was the primary treatment strategy following 12 weeks until 28 weeks. Recording objective markers at 2-monthly intervals – such as redoing the Nijmegen questionnaire, rechecking thoracic trigger point pain levels, mobility and balance provided positive feedback to the patient.

Patient's consent was obtained for the purpose of assessment and treatment. Furthermore, after obtaining the approval from the Institutional Ethical Committee, the written consent was obtained from the patient regarding the publication of case report. No funding was provided for conducting the research and there was no conflict of interest.

Figure 5: Bradley (1998). Beach pose. From Chaitow *et al*. (2002)

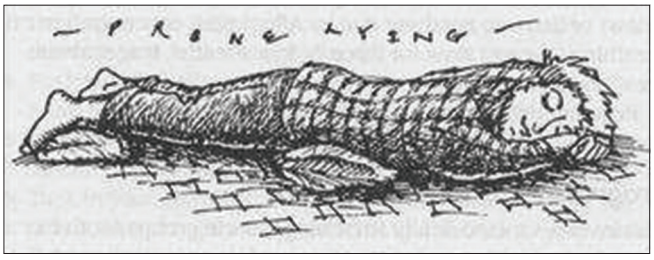

Figure 6: Relaxation in the prone position. From Bradley (2006)

Discussion

Efficacy of Test Measurements

Nijmegen questionnaire

The efficacy of Nijmegen questionnaire in regards to hyperventilation was first demonstrated by Van Dixhoom and Duivenvoorden.[18] Since then, it has been used in the clinical setting as well as in research settings. The Nijmegen questionnaire provides a non-invasive test of high sensitivity (up to 91%) and specificity (up to 95%).[19] However, many of its components are not specifically related to breathing. Warburton and Jack[20] pointed that many of the symptoms of the Nijmegen questionnaire tool are common to organic disease and, therefore, cannot be considered as a stand-alone tool for diagnosis for hyperventilation. However, in Sam's case, it can be considered specific to hyperventilation syndrome as no other organic disease or any specific reason behind the symptoms was diagnosed during the detailed medical investigation including musculoskeletal impairment apart from functional postural changes, neurological, and cardiorespiratory examination.

Breath hold time

Breath-holding as an aspect of breathing functionality is commonly altered in people with dysfunctional breathing.[20] From a clinical perspective, if an individual fails to hold breath for longer than 30 s then it suggests a positive diagnosis of chronic hyperventilation.[7] However, it should be noted that people who do not have hyperventilation syndrome but experience breathlessness might show difficulty in breath-holding.[7]

Hospital anxiety and depression scale

The HADS was originally developed by Zigmond and Snaith[20] and since then, it has been assessing both anxiety and depression, which commonly coexist.[21] According to Zigmond and Snaith,[22] the HADS is a 14-item scale, where seven of the items related to anxiety and seven related to depression. The scores for anxiety and depression can, therefore, vary from O to 21; a score between 0 and 7 does not indicate the presence of the symptoms of anxiety or depression; a score between 8 and 10 indicates the presence of the symptomology but to a moderate degree, a score greater than or equal to 11 indicates a significant number of symptoms of anxiety or depression.[20] It has been revealed by a literature review of a large number of studies that for anxiety (HADS-A) specificity is 0.78 and a sensitivity of 0.9 and for depression (HADS-D) specificity is 0.79 and a sensitivity of 0.83.[23]

Effectiveness of Treatment Techniques

The impact of breathing retraining and biofeedback protocol on patients with hyperventilation syndrome was investigated in a study.[24] Significant improvement was reported in end-tidal carbon dioxide levels along with positive results related to resting respiratory rate and self-reported psychological measures in the intervention group. Another study reported that the frequency and intensity of panic attacks and physical symptoms of anxiety can be reduced in response to breathing retraining in participants having panic disorder.[25] However, de Ruiter *et al*.[26] questioned the role of hyperventilation in panic disorder. The study investigated the effect of breathing pattern retraining with cognitive therapy and showed no significant change in the frequency of panic attacks in response to breathing retraining combined with cognitive therapy. Although the study reported non-significant changes, it should be noted that out of a total of 12, 10 of the participants in the study indicated a decrease in the frequency of panic attacks[27] Furthermore, it was evident from a study that breath therapy may enhance proprioception and, therefore, may be an appropriate complementary intervention particularly for patients with back pain.[28] These studies highlighted that breathing retraining can have a positive influence not only on breathing patterns and back pain but also in associated anxiety and panic attacks, which was evident in Sam's case.

Further to this, Han *et al*.[29] determined the effectiveness of education and supervised breathing pattern retraining on 92 participants with hyperventilation syndrome and reported positive changes in breathing frequency as well as in breathing pattern. Tweeddale *et al*.[30] used breathing retraining treatment protocols similar to protocols used in Han *et al*.[29] study and showed significant improvement in anxiety and depression symptoms as well as in end-tidal carbon dioxide in participants experiencing behavioral breathlessness.

Across most of the discussed studies, education was a component of breathing retraining. Education is an important pathway of providing reassurance to the patient that their condition is treatable and it also helps in detecting trigger factors that could further influence abnormal breathing.[5] While treating Sam, explanation of the outcome measures throughout the sessions and feedback about his breathing helped in relieving his stress to some extent. Through education, he got convinced that positive thoughts and a relaxed mind will help to overcome his worries and can improve his health status. Another intervention worth considering in individuals having breathing dysfunction was relaxation. In Sam's case, the relaxation response helped him to regain his confidence and he learned how to identify and switch off anxiety or stress responses (mediated by the parasympathetic branch of the autonomic nervous system).[31]

Conclusion

DB is often underdiagnosed or misdiagnosed, given the similarity of its associated symptoms (dyspnea, tachycardia, and dizziness) to those of other common cardiopulmonary diseases such as COPD and asthma. Throughout studying Sam's case, it has been explored how biomechanical, biochemical, and psychosocial factors can contribute to the development of dysfunctional breathing. The altered length-tension relationship of the diaphragm, overuse of his postural muscles without adequate relaxation, ignorance of his upper back pain, and anxious behavior had attributed to Sam's abnormal breathing or hyperventilation. However, from a treatment perspective, it is difficult to explain the efficacy of one intervention over the other but it was obvious that mind and body cannot be separated in hyperventilation and it is crucial to consider person as whole. Improvement in Sam's health status showed how the administration of simple treatment techniques can resolve such a complex health condition. However, there is a possibility of reappearing of Sam's symptoms in the future. Thus, adopting a healthy lifestyle is equally important in preventing the reoccurrence of abnormal breathing and maintaining optimal breathing patterns. It is also evident from this study that patients with serious symptoms such as chest pain must be assessed for breathing pattern disorders and irrespective of the presence or absence of any organic disease. It would be useful for the future research to focus on hyperventilation associated with work stress as mental exhaustion and postural problems are common in city dwellers.

Contribution of Paper

- Dysfunctional breathing requires a holistic and multidimensional management of the condition
- It is important to see person as a whole while managing breathing pattern disorder or hyperventilation rather than just focusing on traditional structural biomechanical approach
- Patients having symptoms such as dyspnea, chest pain, and tachycardia should be assessed for dysfunctional breathing and irrespective of the presence or absence of any disease.

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Appendix

Appendix 1: Nijmegen questionnaire

	Never	*Rare*	*Sometimes*	*Often*	*Very often*
	0	*I*	*2*	*3*	*4*
Chest pain					
Feeling tense					
Blurred vision					
Dizzy spells					
Feeling confused					
Faster or deeper breathing					
Sho11of breath					
Tight feeling in chest					
Bloated feeling in stomach					
Tingling fingers					
Unable to breathe deeply					
Stiff fingers or anns					
Tight feeling around mouth					
Cold hands or feet					
Palpitations					
Feelings of anxiety					
Total	25/64				