

Aerodynamic Changes on Post Radiation Therapy – A Preliminary Study



Medical Science

KEYWORDS : aerodynamic measures, peak flow, vital capacity, phonation quotient, mean air flow rate

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ABSTRACT

Introduction: The purpose of this study was to investigate aerodynamic changes in patients undergoing radiation therapy for non-laryngeal head and neck cancer. An insight into their respiratory measures is necessary for the identification and management of these individuals and also to provide necessary changes in the treatment regimen to be followed during rehabilitation. | Method: Recordings were carried out on 15 non laryngeal head and neck cancer participants on two time basis, once prior to the treatment regimen and another on post treatment using Aerophone II, Voice function analyser. | Results: The parameters showed significant difference on post treatment measures. Paired t test with $P < .025$ was considered as statistically significant. | Conclusion: Radiation therapy for non-laryngeal head and neck cancer significantly affects aerodynamic measures required for adequate voice acoustics. |

INTRODUCTION

Aerodynamic measures aid in the understanding of respiratory source required for the production of voice. These measures provide airflow rate and volume, subglottal pressure, laryngeal resistance, and phonation threshold pressure (Benninger, Grywalski, & Phyland, 2007) and many other measures including peak flow, vital capacity etc. Aerodynamic measures reflect the presence of vocal pathology to a higher degree compared to acoustic spectral measures (Holmberg, Doyle, Perkell, Hammarberg, & Hillman (2003). Due to this reason aerodynamic measures are of high importance in evaluating vocal pathologies. They provide insight to the voice therapist about aerodynamic aspects of voice which would possibly be a resultant of abnormal voice.

Cancer is the abnormal growth of cell mass which proliferate in an uncontrolled way. According to Ruddon (2007), cancer is defined as abnormal growth of cells due to numerous changes in gene expression resulting in dysregulated balance of cell multiplication and cell death which ultimately evolves into a population of cells which invade tissues and has the capability to metastasize to distant sites, causing morbidity and, if untreated the death of the host. Cells become cancerous when normal cells change and grow uncontrollably, forming a lump or mass of cells termed tumor which can be of benign (noncancerous) or malignant (cancerous) by the process of metastasis. These tumors can originate in any part of the body. Head and neck cancer; as term signifies is the uncontrolled growth of cells and tissues in any part of head to the neck region. Almost all cancer individuals are treated with a series of treatment regimen such as radiotherapy, chemotherapy or a combination of both namely chemoradiotherapy and also by surgical excision of cancer sites. All these treatment procedures targets to reduce and eliminate cancerous cells. Though these treatment regimens are of high significance in cancer treatment, they also have side effects as they affect other healthy tissues too. As suggested by Stoicheff (1975) participants' voice analysis before, during the course of treatment and following treatments by means of aerodynamic, acoustic and audio instrumentation would yield additional information on recovery of laryngeal function on head and neck cancer patients.

Aerodynamic voice measures show deviancy in individuals undergoing radiation therapy on phonatory function assessment (Miller, Harrison, Solomon, & Sessions, 1990). Quiox et al., (1997) reported that radiotherapy and chemotherapy may induce various respiratory complications which can be of varying shades of difficulty. From the above review it can be observed that the

treatments set for a head and neck cancer can lead to number of effects, which would affect their quality of life. These associated factors can be identified and intervened effectively. As there is little understanding of acoustic, aerodynamic, and swallowing issues in these individuals with head and neck cancer, it is necessary to have an insight to these factors and hence the present study was taken up.

This study was conducted to find the effect of radiation therapy on aerodynamics in nonlaryngeal head and neck cancer patients. This study followed a Prospective study design with Convenient Sampling. The study protocol was approved by the Institutional Ethical Board.

METHOD

15 participants in the age range of 18 to 74years with mean age of 60.34years who were newly diagnosed with carcinoma of non-laryngeal head and neck cancer; undergoing radiotherapy was taken for the study. All participants with laryngeal cancer was excluded. These subjects were treated with radiation therapy alone with no chemotherapy. Among the 15 individuals enrolled for the study, 4 had carcinoma of tongue, 3 had carcinoma of thyroid gland, 2 with brain tumours, 2 with carcinoma of mandible, 2 with nasopharyngeal cancer and 2 with carcinoma of buccal mucosa. These participants were carefully enrolled for the study by excluding all those with any previous history of neurological disorders, swallowing issues, respiratory disorders and related issues prior to radiation treatment.

Aerodynamic measures were carried out in these participants using Aerophone II, Voice function analyser (Manufacture FJ Electronics, Ellebuen 3 DK-290 Vedback, Denmark). The Voice Function Analyzer, Aerophone II, takes the advantage of a sophisticated combination of a hard-ware transducer system with transducers for recording airflow, air pressure and acoustic signal, and a computerized data processing system. Measures for vital capacity, Peak flow, Phonation Quotient, Mean Air Flow Rate were noted in thin study.

For the measurement of Vital Capacity, the participants were instructed to take a deep breath and blow slowly as long as possible into the mouth piece connected to the Aerophone. This measure is important as it provides an estimate of the amount of air potentially available for the phonation. High value of the Vital Capacity is correlated to a longer duration of phonation and to a higher flow rate. For the measurement of Peak Flow, the participants were asked to take a deep inspiration and then make expiration as fast and as strong as possible. A higher val-

ue of peak flow means a faster velocity of the exhaled air, and thus a stronger and more sudden contraction of the expiratory muscles. The Phonation Quotient was calculated as Phonation Quotient = Vital Capacity / Maximum Phonation Duration. For Mean Air Flow Rate, the participant was asked to phonate vowel /a/ as long as possible through the mouth piece connected to a head flow attached with a sensitive microphone on one end. These values were obtained before the commencement of the treatment and also soon after the treatment is over. The findings were statistically analysed used paired t test and p values < .025 was considered as significance.

RESULT

The aerodynamic measures such as Peak Flow, Vital Capacity, Mean Air Flow Rate (MAFR), and Phonation Quotient were measured among the participants using Aerophone II (Voice function analyser). Table 1 depicts the results of aerodynamic measures. On paired t-test, statistical significance was seen for peak flow and mean air flow rate when pretreatment and post treatment measures were compared.

Table 1: Aerodynamic parameters among Radiotherapy participants

Parameter		Mean	Standard Deviation	Pre treatment Vs post treatment p Value
Peak Flow ml/sec	Pre Treatment	4.152	1.02327	.003*
	Post Treatment	2.0303	1.04582	
	One Month Post Treatment	3.0743	1.03347	
Vital Capacity L	Pre Treatment	1.3966	1.1571	.686
	Post Treatment	1.0057	0.7237	
	One Month Post Treatment	0.6067	0.5219	
Mean Air Flow Rate (l/sec)	Pre Treatment	0.5337	0.31628	.010*
	Post Treatment	0.2109	0.14943	
	One Month Post Treatment	0.3963	0.21408	
Phonation Quotient	Pre Treatment	0.0643	0.04315	.987
	Post Treatment	0.0553	0.03664	
	One Month Post Treatment	0.0401	0.03688	

* Significant difference (p<0.025)

Discussion

Aerodynamic measures help in understanding the difference and 'real' air support during all tasks of speaking and phonation. Peak flow. Peak Flow relates to the strength of the expiratory muscles. It provides the description of how fast air moves out of the lungs. It gives information on physiological changes in the respiratory system such as constriction of the bronchi or any other factors which narrows the airway. Significant difference in

peak flow measures can be supported by study done by Sjögren, Rossum, and Langeveld (2008), which revealed abnormal aerodynamic measures among cancer patients due to impairment in vocal fold vibration such as reduced closure, mucosal wave and ventricular activity. Flow of exhaled air from the lungs which determine peak flow can be restricted due to inflammation and mucosal irritation which is the resultant of radiation. Vital capacity is the maximum volume of air that can be exhaled forcefully following a deep inspiration. It is amount as it provides information on amount of air available for the phonation. It varies based on age, body weight and size of the individual. There are three factors that can affect Vital Capacity, which includes the position of body during the measurement, the strength of the respiratory musculature and the distensibility of the thorax-lung unit or, in other words, pulmonary compliance. Also it is known that size and sex of an individual, lung volumes and capacities vary with age. No significant difference in vital capacity was seen in these participants. Hence, there is a need for additional research input on this aspect. Mean air flow rate; is the total volume of air used for phonation divided by the duration of phonation. It provides information about the coordination of respiratory and phonatory system. Pretreatment and post treatment comparison of MAFR showed significant difference. These findings are in line with findings delineated about changes in aerodynamics measures by Miller, Harrison, Solomon, and Sessions, 1990. Phonation Quotient was considered relevant for both lung and laryngeal functions because it provides information regarding the air use during phonation.

Speech language pathologist become involved in the diagnosis and therapeutic regimen plan for head and neck cancer as one more of the speech subsystems such as respiration, phonation, resonance, articulation, and swallowing may be affected to varying degrees. Speech language pathologist has to be involved at every stage of patient care continuum, from pre diagnosis to post treatment rehabilitation. The timing of services is an important factor in the management of these participants.

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REFERENCE

Benninger, M. S., Grywalski, C., & Phyland, D. (2007). Rehabilitation of head and neck cancer patients, *Medical Speech-language Pathology: A Practitioner's Guide*. | Holmberg, E. B., Doyle, P., Perckell, J. S., Hammarberg, B., & Hillman, R. E. (2003). Aerodynamic and acoustic voice measurements of patients with vocal nodules: variation in baseline and changes across voice therapy. *Journal of Voice*, 17(3), 269-282. | Ruddon, R. W. (2007). *Cancer Biology* (4th ed.). Oxford university press. | Stoiceff, M. L. (1975). Voice following radiotherapy. *Laryngoscope*, 85, 608-618. | Miller, S., Harrison, L. B., Solomon, B., & Sessions, R. B. (1990). Vocal changes in patients undergoing radiation therapy for glottic carcinoma. *Laryngoscope*, 100, 603-606. | Quoix, E., Mornex, F., & Milleron, B. (1997). Radiation- and chemically-induced respiratory manifestations. *Revue des maladies respiratoires*, 14, 341-353. | Sjögren, E. V., Rossum, M. A., & Langeveld, T. P. M. (2008). Voice outcome in T1a midcord glottic carcinoma: laser surgery versus radiotherapy. *Archives of Otolaryngology - Head and Neck Surgery*, 134, 965-972. | Miller, S., Harrison, L. B., Solomon, B., & Sessions, R. B. (1990). Vocal changes in patients undergoing radiation therapy for glottic carcinoma. *Laryngoscope*, 100, 603-606. |