Original Research Article

Phonatory Function Parameters in Females with Prolonged Usage of Inhaled Corticosteroids for Asthma: An Exploratory Laryngeal Aerodynamic Study

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ABSTRACT

The present study aimed to document the aerodynamic parameters in adult females with prolonged usage of inhaled corticosteroids. Bronchial asthma, labored breathing and wheezing, and allergies can also cause sore throat and inflammation around the vocal cords. So the voice sound becomes hoarse or scratchy when swollen, inflamed cords don't vibrate efficiently. Aerodynamic analysis assesses the interaction of both respiratory and laryngeal function. Twenty female participants within the age range of eighteen to twenty five years were included in this study. They were divided into two groups. The control group constituted of ten participants (Mean age- 21.4 years, SD-2.073; Mean height-158.49 cm, SD-4.61; Mean weight- 59.46 kg, SD- 2.43) with no history of asthma. The second group (experimental group) had ten female participants with asthma. Voice Function Analyzer, Aerophone II was used in this study for assessing the laryngeal aerodynamic parameters. The study documented reduced vital capacity (p =0.0013) at 5% level of significance which is manifested as short utterances and reduced loudness in these speakers. The change of aerodynamic characteristics can be due to the effect of remodeling of airway wall associated with steroidal usage. Hence inclusion of voice function analyzer Aerophone II a non invasive aerodynamic measurement in phonatory studies, may be substantial in diagnosing this disorder and to monitor the steroidal dosage during course of treatment.

Keywords: Asthma, Dysphonia, Bronchoscopy, Vital capacity

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways associated with increased airway hyper-responsiveness, recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night/early morning. Middle airway obstruction at the level of the vocal cords may convert mild asthma to severe disease if causing obstruction in addition to asthma itself. Asthma is the most common non-communicable disease among children. The global asthma report in 2014, there are more than 334 million people who are currently suffering from asthma. Asthma is one of the major public health problems worldwide. It can hurt the sound quality of the voice. The medical treatment often includes inhaled steroids with known pathological changes in voice. The frequent use of corticosteroid inhalers (CSIs) has been accompanied by affect on systemic and local adverse reaction (Tanaffos, 2016). Clinical studies have reported the incidence of dysphonia with inhaled steroids to be as high as 55%. Phonatory function studies (PhFS) support subjective and objective dynamics of normal and pathologic phonatory processes. Aerodynamic analysis is interpreted as indicator of laryngeal activity. Aerodynamic analysis assesses the interaction of both respiratory and laryngeal function (Grillo, Perta, and Smith, 2009) and provides information related to the valving efficiency of the glottis during phonation. It provides

measurement of air volume, flow and pressure and overall respiratory function. Bronchoscopy can be associated with serious complications, of which bronchial obstruction is of particular relevance to asthma. Bronchoalveolar lavage has also been performed to evaluate the effects of asthma therapies (corticosteroids, theophylline, beta-agonists, cromolyn sodium, nedocromil sodium, cetirizine, leukotriene inhibitors, etc.) on parameters of airway inflammation.

Need:

The impact of prolonged usage of inhaled steroids and resultant change in Phonatory dynamics was of interest to the authors. Further the enigmatic change in pattern of prevalence of asthma being more in female adults influenced us to document the aerodynamic parameters in adult females.

Aims and Objective:

The study is aimed to document the aerodynamic parameters in adult females with prolonged usage of inhaled corticosteroids. Further the study also proposes oi to document the changes in lung function in the participants, if any.

METHODOLOGY

Subjects

Twenty female participants within the age range of eighteen to twenty five years (Mean age- 21.2 years, SD- 2.34; Mean height-157.49 cm, SD-4.94; Mean weight- 57.9 kg, SD- 5.36) were included in this study. They were divided into two groups. The control group constituted of ten participants (Mean age- 21.4 years, SD- 2.073; Mean height-158.49 cm, SD-4.61; Mean weight- 59.46 kg, SD- 2.43) with no history of asthma. The second group (experimental group) had ten participants (Mean age- 21 years, SD- 2.82; Mean height- 156.5 cm, SD- 5.59; Mean weight- 56.48 kg, SD- 7.29) with asthma.

Inclusion criteria

The study included females with asthma, diagnosed by pulmonologist to have mild-moderate severity. They have been under corticosteroid treatment for over 5 years. The participants who had no history of smoking, GERD, recent environmental changes were included in this study.

Exclusion criteria

Females who were menstruating during the data collection were excluded. The participants who had BMI <25, hypertension, diabetes and other endocrinal and systemic diseases were excluded from the study.

Equipment used

i. Voice Function Analyzer, Aerophone II (F.J. Electronics, Ellebuen 21, DK- 2950 Vedbaek, Denmark) was used in this study for assessing the laryngeal aerodynamic parameters. It takes the advantage of a sophisticated combination of a hardware transducer system with transducers recording airflow, air pressure, and acoustic signal and a computerized data processing. All electronics including the microprocessor and the transducers are miniaturized and built into a small box mounted in the holder for handle and mask.

ii. Calibration of Equipment - Calibration of the equipment was done as per Aerophone II manual (2005).

a) Calibration of air pressure: a calibration factor for the air pressure is not necessary as it is fairly stable and not influenced by patients' responses. The air pressure transducer is adjusted from the factory and does not need any further adjustment.

b) For calibrated SPL recordings from aerophone, the microphone is factory tested (by means of Bruel & Kjaer, Integrating Precision Sound Level Meter, type 2230) and the appurtenant calibration factor is 0.72. If no calibration factor is typed when the programme asks for a calibration factor to ensure the SPL values are exact (within ±0.2 dBSPL), a default calibration factor is used which is an average of several microphone calibration factors as measured by F-J

Electronics. To ensure that the microphone measures correctly, the microphone was pushed so far through the PVC rubber sleeve that all the side holes are free.

Microphone positions for range,

30–80 dB in flow head,

50–100 dB in flow head,

70–120 dB in flow head.

Table 1: Relation between viscosities of air to the temperature (Aerophone II manual, 2005)

Temperature in °C	0	10	20	30	40
Viscosity in Cp	170.9	175.9	180.8	185.6	190.4

c) Calibration of airflow: 1 liter calibration syringe (accuracy ±0.5%, calibrated at 20°C) was taken. While calibrating the approximately one second airflow for big flow head and approximately four seconds for the small flow head was taken. The piston of the syringe was pressed with a constant and a stable movement during the calibration. The calibration was started with a coarse calibration making 3-5 measurements with the 1 liter syringe. When the result was within 1-2% from the correct value, a new calibration with several successive recordings was done. The programme calculated the average calibration factor of the recordings made, which is stored in the setup file. The same procedure was repeated for both flow heads.

d) Warm-up time: the airflow and pressure transducers need approximately 15 minutes in order to obtain a stable zero line after the system has been turned on. After that time the auto zeroing circuit is able to keep the zero line stable during normal recording sessions, which normally do not exceed 60 seconds. When not recording, the system is constantly auto zeroing.

e) Room temperature: the room temperature was kept at 29°C. It was recommended to keep the room temperature between 10°C and 40°C.

f) Viscosity of air: when the expired air passes the gauze in the flow head, it has a temperature of 35 °C as the air is cooled 2°C below body temperature when passing the speech organs and the flow head tubes. The software takes the changed viscosity of the expired air into account. Table 1 relates the viscosity of air to the temperature.

iii Spirometer was also used to measure the lung function.

Procedure:

For the medical clearance and candidacy plain chest X-ray P-A view was used to rule out any COPD/lungs fibrosis. ENT examination and videolaryngo-stroboscopy was done to assess larynx and any vocal fold pathology, signs of reflux, and Paradoxical vocal Movement differentially diagnosing it from asthma. Diagnostic procedures included the case history and GRBAS was used to grade voice by three speech language pathologists with more than 10 years of experience. Additional instrumental procedures included acoustic analysis of the participant's voice; fundamental frequency (average F0), jitter%, shimmer%, N/H ratio were noted. Two of the subjects agreed for Bronchoscopy while others refused it on financial ground.

To analyze the laryngeal aerodynamic parameters; vital capacity, peak airflow, maximum sustained phonation, fast abduction-adduction rate were taken. During data collection, the procedure was first demonstrated to the subjects until they were familiar with it.

Following procedures were used to measure the following parameters:

(1) Vital Capacity:

1. The following setting was made in the programme as per the instruction given in the manual which were kept constant for all subjects. Flow head

F1000LS was used for the registration with pressure setting of flow range 0-10 l/sec.

2. The subject was asked to inhale as deep as possible and then to exhale all the airs through the mouth tube until the lungs are completely empty. The registration was made in standing position. It was told to take care that the lips close airtight round the disposable mouth tube. The nose clamp was used during the registration. The instructions were repeated whenever needed and demonstrations were made.

3. The subject exhaled into the mouth tube and the data was stored in the computer. Each subject was asked to give three trials and the highest was considered as the vital capacity for that subject. Thus, the vital capacity and its duration were calculated.

(2) Peak air flow:

1. The following setting was made in the programme as per the instruction given in the manual which were kept constant for all subjects. Flow head F1000LS was used for the registration with pressure setting of flow range 0–10 l/sec.

2. The subject was asked to inhale as deep as possible and then to exhale all the air through the mouth tube as fast and as strong as possible.

3. The registration was made in standing position. It was told to take care that the lips close airtight round the disposable mouth tube. The nose clamp was used during the registration. The instructions were repeated whenever needed and demonstrations were made.

4. The subject exhaled into the mouth tube and the data was stored in the computer. Each subject was asked to give three trials and the highest value was considered for that subject. Thus the peak flow, forced volume 1 second and Duration was calculated from the result.

(3) Maximum Sustained Phonation:

1. The following setting was made in the programme as per the instruction given in the manual which were kept constant for all subjects. Flow head F 300LS was used with pressure setting of 5.0 l/s and 50-100dB was selected from the SPL menu.

2. The subject was asked to fix the mask covering mouth and nose over the face and was asked to take care that there was no leakage through the mask during the measurement.

3. The subjects were instructed to take a deep breath and try to produce a matching tone produced by the computer, maintaining its loudness. They could use the indicator (computer monitor) to maintain the loudness. The subjects were asked to say /a/ as long as and as comfortable as possible.

4. The instructions were repeated whenever needed and demonstrations were made.

5. After the phonation, the data were stored in the computer.

(4) Fast Abduction-Adduction rate:

1. The following setting was made in the programme as per the instruction given in the manual which were kept constant for all subjects. Flow head F300LS was used with pressure setting of 1.00 l/s and intensity range was 30–80 dB was selected from the SPL menu.

2. The subject was asked to fix the mask covering mouth and nose over the face and was asked to take care that there was no leakage through the mask during the measurement.

3. The subjects were instructed to say "*ah ah ah ah*" as fast as possible after taking in deep breath. The voiced production was recorded.

4. The instructions were repeated whenever needed and demonstrations were made.

5. After the recording, the data were stored in the computer.

Three trials were done for each case for the above mentioned parameters to attain test retest reliability.

Data Processing and Statistical Analysis:
Statistical analysis such as mean, standard deviation and independent t-test was done for the collected data.

RESULTS

The aerodynamic score for Vital capacity in control group shows the mean value of 2.88 litre /second, (SD= 0.071 litre/second) and asthma group shows the mean value of 1.61 litre /second, (SD= 0.353 litre/second) the independent t test result showed there is significant difference in the vital capacity (p =0.0013) at 5% level of significance.

Table 2: Mean and standard deviation values of vital capacity (in litre/sec), for control group and asthma group.

Subject	Mean (litre/ sec)	Standard deviation (litre/ sec)
Control group	2.88	0.071
Asthma group (experimental group)	1.61	0.353

The aerodynamic score for peak air flow in control group shows the mean value of 2.77 litre /second, (SD= 0.477 litre/second) and asthma group shows the mean value of 2.34 litre /second, (SD= 0.243 litre/second) the independent t test result showed there is no significant difference in the peak flow (p =0.123) at 5% level of significance.

Table 3: Mean and standard deviation values of peak air flow (in litre/sec), for control group and asthma group.

Subject	Mean (litre/ sec)	Standard deviation (litre/ sec)
Control group	2.77	0.477
Asthma group (experimental group)	2.34	0.243

The aerodynamic score for maximum sustained phonation in control group shows the mean value of 16.35 second, (SD= 0.971 second) and asthma group shows the mean value of 15.62 second, (SD= 1.71 second) the independent t test result showed there is no significant difference in the peak flow (p =0.441) at 5% level of significance.

Table 4: Mean and standard deviation values of maximum sustained phonation (in seconds), for control group and asthma group.

Subject	Mean (Seconds)	Standard deviation (Seconds)
Control group	16.35	0.971
Asthma group (experimental group)	15.62	1.71

The aerodynamic score for Fast abduction-adduction rate in control group shows the mean value of 2.77 cycles per second, (SD= 0.585 cycles per second) and asthma group shows the mean value of 2.24 cycles per second, (SD= 0.223 cycles per second) the independent t test result showed there is no significant difference in the peak flow (p =0.113) at 5% level of significance.

Table 5: Mean and standard deviation values of Fast abduction- adduction rate (in cycles/sec), for control group and asthma group.

Subject	Mean (cycles/sec)	Standard deviation (cycles/sec)
Control group	2.77	0.585
Asthma group (experimental group)	2.24	0.223

DISCUSSIONS

The present study aimed to document the aerodynamic parameters of individuals with prolonged usage of steroid inhalers in asthma. The study documented reduced vital capacity which is manifested as short utterances and reduced loudness in these speakers. The change of aerodynamic characteristics can be due to the effect of remodeling of airway wall associated with steroidal usage. Often faulty usage techniques might also contribute for the same, which hinders the steroid to properly be inhaled and pockets at oropharyngeal level. Since vital capacity is an important indicator of lung function, hence it might be beneficial to use aerodynamic parameters in monitoring dosage and usage technique of steroids in asthma. Although all other parameters where not significant in this study but the increased prevalence of dysphonia might indicate the need to differentiate supraglottal, glottal and subglottal involvement in asthma.

SUMMARY AND CONCLUSIONS

This study has explored an interesting finding, being reduced vital capacity in subjects with prolonged usage of CSI's in asthma. Further this study needs to be validated by comparing these parameters in control group and subjects with asthma under steroidal usage and without it. Inclusion of voice function analyzer Aerophone II, in phonatory studies in asthma, may be substantial in diagnosing this disorder and to monitor the steroidal dosage which might be a boon in respiratory medicine.

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