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Nasal Airflow Measurement During Quiet Respiration In Normal Subject Using Nasal Anemometer

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Abstract:

Measuring the nasal airflow during quiet respiration can be used for screening, diagnosis, and assessment of treatment of the upper respiratory system. It also gives information about the lower respiratory system such as lung capacity. Spirometer can be replaced by the nasal anemometer with the technique of measuring nasal airflow during forced respiration.
To fulfill these functions, the nasal anemometer using the quiet respiration technique must be standardized. Measurement of airflow during quiet respiration has been carried out on 50 male normal subjects. A range of some parameters has been defined. These parameters are time of one respiratory period, the maximum of respiratory signal, and average amount airflow signal in 10 respirations.

Key Words:

Medical instrumentation – Nasal airflow – Anemometer

I. Introduction

Much studies and yet still are incompletely understood aspect of nasal physiology in nasal resistance. Airflow through any path flow is associated with a resistance whose degree depends on various factors: flow rate, pressure, pressure differential, lumen diameter and turbulence. What is well known and at first glance surprising, is that despite the fact nasal airflow resistance is at least twice as great as oral resistance, individuals not only prefer to breath through their noses, but often quit uncomfortable they forced to mouth breath because of temporarily nasal obstruction.
Paradoxically, an equal discomfort is experienced during nose breathing by patients who have made surgical procedures, which significantly increase nasal patency and thus decrease the normal resistance [1].

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Nasal anemometer has been used to diagnose the soft palate [2, 3] and nasal obstruction [4]. The technique used in these cases is the measuring of the total nasal airflow during speech. Using the same technique, the nasal anemometer can be considered a diagnostic tool for bronchial asthma [5] and adenoid.

In this study, a new technique is introduced which is measuring of total nasal airflow during quiet or forced respiration. This technique provides more information by which not only used for the previous cases but also for the lower respiratory system such as lung capacity or to replace the spirometer.
The main objective of this article is the standardization of that system to fulfill these functions. This is done by the measurement of quiet respiration of nasal airflow for normal subjects. Therefore, some parameters will be extracted statistically.

II. Material and Method

(a) Subjects:

Inclusion criteria for individuals sharing this study are:

- Ear, nose and throat examination revealed no abnormalities as regard the phono-articulatory system.
- Age ranged between 18 to 40 years old.
- 50 male subjects.

(b) The Nasal Anemometer

It is an instrument to measure the nasal airflow during speech [2]. Also it measures the airflow due to quiet respiration, and due to forced respiration. It is two-channel instrument: the first channel is an audio one and the second channel is low speed airflow channel. The audio channel is not used in this normal respiration technique but used in the measuring of the total nasal airflow during speech.
The airflow sensor used is a naked thermistor, which is one arm of DC bridge circuit. The bridge circuit is cooperated with bridge amplifier. The output signal from this airflow channel is proportional to airflow due to respiration. The output airflow signal is fed to an A/D converter (Dash16f) [7] fixed in one of the slots of an IBM microcomputer. Dash16f has a timer of type INTEL8354, using this timer; we can control the sampling rate of recording signal. It is clear that the nasal anemometer system includes low speed airflow channel beside an audio channel, signal conditioning circuits and data logging unit. The signal processing is carried out by the PC as well as two software packages, one of them is used for data logging and the other is used for the signal processing. The system configuration is shown in Fig. 1.

(c) Software Package

A special software program has been written by the author in Turbo Pascal [8]. The main menu of this package provides three options:

Option 1: Data collection: for 35 seconds the subject respires normally. The data collected with a sample rate of 200 Hz (ten times more than respiration rate).

Option 2: Data plotting: for the file stored by the first option.

A sample of this output is shown in Fig. 2, for subject X48. The data collected is analyzed by a commercial package called Dadisp ver: 4.3 [9], which are used for digital signal processing.

Option 3: Help: to explain previous two options.

III. Result

A normal respiration test is carried out on 50 normal subjects. An example, Fig.2 shows the result of subject X48. The results of these 50 subjects have been statistically analyzed. This statistical technique is the descriptive statistics. Descriptive statistics are calculated separately for each variable, and they provide such basic information as the mean, minimum, and maximum values. Probably the most often used descriptive statistic is the mean. The mean is a particularly informative measure of the central tendency of the variable [10]. Dadisp 4.3 software is used to carry out this statistical analysis on the signals of normal subject. The following parameters have been defined and calculated:

- The time of one respiratory period,
- The maximum of respiratory signal.
- The average airflow for 10 respiratory periods

Based on that statistical analysis a range of the values of these parameters is shown in table 1.

IV. Discussion

The main aim of the quiet respiration test is:

(i) To follow up some troops that must be at a certain level of their job such as pilots, submarine teams, and communication officers.
(ii) Selection with high standard for military colleges.
(iii) Assessment of treatment in upper respiration system or lower.

Result of normal subject X48 is shown in Fig.2. For abnormality cases, two artificial cases have been introduced. The first case subject C48 of bio-complete nasal obstruction (i.e. both nostril obstructed). Its time of respiratory period is 5.13 sec, its maximum of respiratory signal is 1.753 V, and its average airflow of 10 respirations is 0.151 V. All these values are out of normal referring to Table 1. The result of subject C48 is shown in Fig.3. While the second case subject P48 has one (nostril) complete and the other partial nasal obstruction. Its time of respiratory period is 4.77 sec, its maximum of respiratory signal is 2.191 V, and its average airflow of ten respirations is 0.423 V. In this case the second and the third parameters are out of normal subject range. Fig.4 shows the nasal airflow signal of subject P48.

V. Conclusions

The nasal anemometer system, enhancement version, is developed at Egyptian Military army. It is a non-invasive, easy to use system. Measurement techniques are measuring the nasal airflow during speech and measuring the nasal airflow during normal respiration. The available technique is used not only for examining the upper respiratory system but also for lower respiratory system.
This research is carried away to standardize the system for normal respiration technique. Some parameters have been defined to be a measure for screening, diagnosing, and assessment of different treatment. The system can be used as a training tool for special troops, broadcasting personals, and also singer. It was not easy to get normal subject because the misunderstanding and different culture or both.

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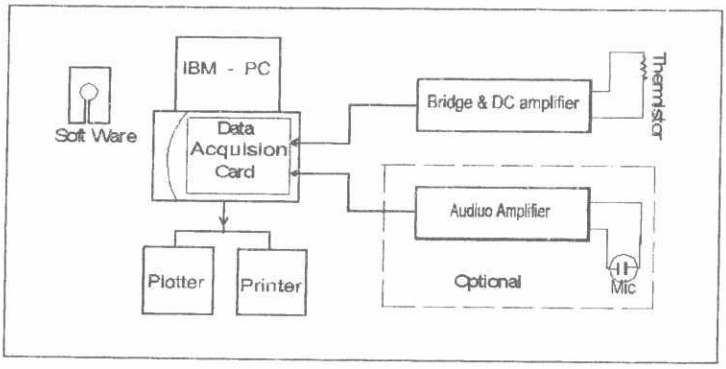

Fig.1. The Nasal Anemometer Configuration

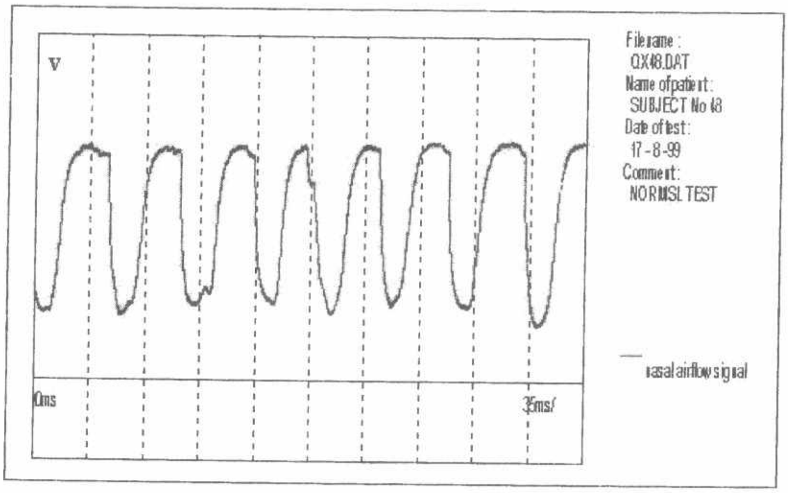

Fig.2. The result of quiet respiration of normal subject X48

Table 1. Quiet respiration parameters for normal subject

Parameter	Minimum	Maximum
The time of one respiratory period (s).	2.173	4.71
The maximum of respiratory signal (V).	0.964	2.377
Average amount airflow signal in 10 respirations (V)	0.511	2.314

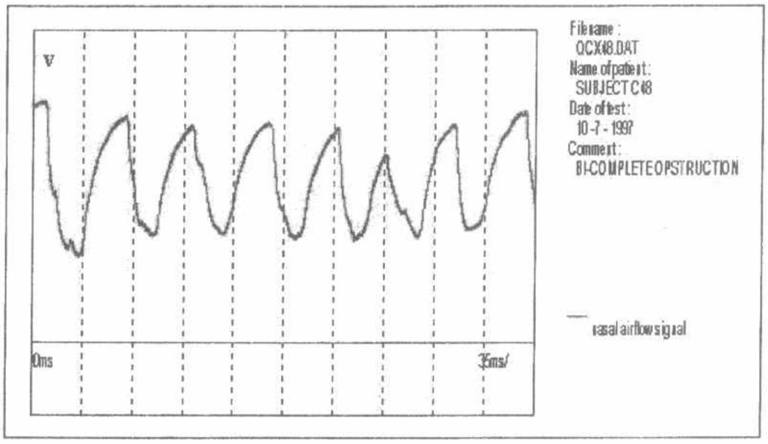

Fig.3.The nasal airflow of Bi-complete obstruction subject

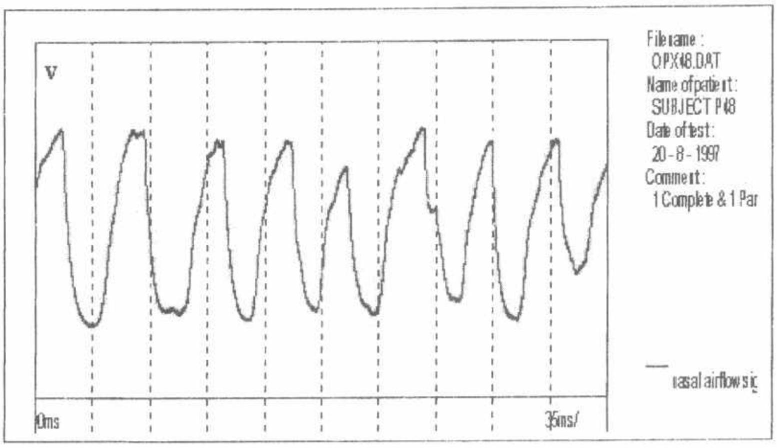

Fig.4. Nasal airflow of abnormal subject with one (nostril) complete and the other is partial obstruction.