Main Article

A Comparative Study on Laryngeal Aerodynamics in Dysarthrophonic versus Normophonic Male Subjects

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ABSTRACT

Introduction

Dysarthria is a motor speech disorder. It occurs due to paralysis, weakness, or incoordination of the speech musculature. The authors with this study want to enrich clinical understanding of the difference of the aerodynamic characteristics in normophonic and dysarthric population.

Materials and methods

The aerodynamic characteristics in normophonics and in dysarthric population were compared and documented using Voice Function Analyzer (Aerophone II®). Forty male individuals within the age range of thirty five to fifty five years participated in this study. The control group had twenty normophonic cases with no history of neurological disorder. The second group had twenty cases with dysarthria.

Results

Significant difference was found between the two groups in peak flow, forced volume and duration, vital capacity and fast adduction-abduction measurements.

Discussion

The difference in results from both the groups and their implications are discussed based on these findings.

Conclusion

The present study has assessed the parameters of speech and voice disorder in male dysarthric individuals. It suggests inclusion of aerodynamic measurement in test protocol and for evidence based research and prognosis documentation. Measurement of laryngeal or vocal tract resistance may be useful in documenting a variety of the perceptual voice characteristics.

Keywords

Speech Disorders; Dysarthria; Dysphonia; Documentation.

Dysarthria is a collective name for a group of speech disorders resulting from disturbances in muscular control over the speech mechanism due to damage of the central or peripheral nervous system.[1] Dysarthrophonia, denotes "neurological dysphonia that presents one aspect of dysarthria."[2,3] In dysarthria one or all speech sub - system may be affected. The power generator of speech is the respiratory system, which plays an important system of speech mechanism. One of the assessment parameter of respiratory system is the assessment of subglottal air pressure. This can be measured by Voice Function Analyzer (Aerophone II®). The analyzer analyses different parameters of voice as mentioned in Table I and Fig. 1.

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Voice Function Analyzer, Aerophone II® was used in this study to measure the aerodynamics characteristics in normophonics and in dysarthric population

In aerodynamic measurement of vocal function, the presence of laryngeal hyperfunction would be expected to manifest as increased resistance, increased pressure, decreased laryngeal airflow during phonation and a decrease in the adduction/ abduction rate (Ad/Abd) of the vocal folds.[4,5] The authors undertook the study to find there is difference of the aerodynamic characteristics

Table I : Parameters of voice measured by Voice Function Analyzer

PARAMETERS	RATINGS
Airflow	Peak airflow. Forced 1 second expiration. Vital capacity. Volume of any air flow. Duration of air flow. Mean Airflow rate. Phonation quotient.
Air pressure	Oral air pressure. Pharyngeal air pressure. Subglottal air pressure.
Sound parameters	Maximum sound pressure level. Minimum sound pressure level. Average sound pressure level. Phonation time (used for mean flow rate calculation).
Glottal parameters	Aerodynamic input power. Aerodynamic output power. Glottal resistance. Glottal efficiency.
Pitch calculations	Average Pitch Sigma Pitch
Rate of movement	Ab-/adduction rate of glottis. Ab-/adduction rate of velum. Rate of lip closures.

between normophonic and dysarthrophonic population.

The aim of the present study was to compare the aerodynamic measurement of males with dysarthria with their age matched normophonic peers. The study may help to reflect the varying physiological symptoms associated with dysarthria. The study further highlights the importance of aerodynamic measurement of dysarthric speech.

Materials and Methods

Subjects

Forty male cases within the age range of thirty five to fifty five years (Mean age- 42.8 years, SD- 4.1; Mean height-5’4”, SD-2.7”) were included in this study. They were divided into two groups. The control group constituted of twenty normophonic cases (Mean age-

39.6years, SD-2.9; Mean height-5'35", SD-3.2") with no history of neurological disorder. The second group (experimental group) had twenty cases (Mean age-44.6year, SD-2.9; Mean height-5'3", SD-3.8") with dysarthria. The nerulogical assessment was done by neurologists through imaging tests, electrophysiological evaluation and serological tests. Dysarthria was diagnosed by Speech Language Pathologistby using Frenchay Dyasarthria Assessment (FDA),[6] cranial nerve evaluation. Western Aphasia Battery (WAB)[7] was used to evaluate associated language deficits. Mayo Clinic Protocol was used to assess the dysarthria.

phonation, vital capacity and fast AD/ ABD. For the measurement of vital capacity, the subjects were instructed to take a deep breath and blow slowly as long as possible into the mouth piece connected to the Aerophone II®, as shown in Fig.2.

For the measurement of mean airflow rate, the subjects were instructed to take a deep breath and phonate /ae/ as long as possible in the mouth piece connected to the Aerophone. The data was collected while placing a circumferentially placed mask. Three trials were done for each case for the above mentioned parameters to attain test retest reliability and an average was obtained of all the values. Statistical analysis was done to find the

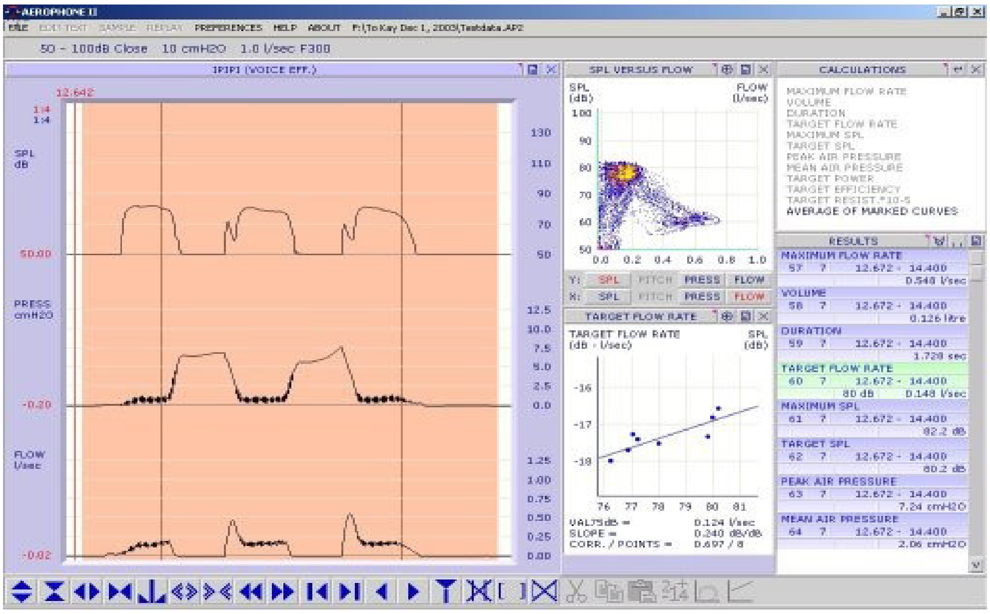

Fig.1. Illustration showing an output of aerodynamic measurement

Tools

Aerophone II®, by F.J. Electronics, Ellebuen 21, DK-2950 Vedbaek, Denmark a voice function analyzer was used in this study. It has a circumferentially vented mask to identify and record the inspiratory and expiratory air flow direction.

Procedure

The cases were asked to do tasks on peak flow, sustained

difference of the aerodynamic measurements between these two groups. Then the statistical analysis was done to find the mean value for each of the difference between the normophonic and dysarthric population. One sided t-test was measured to identify the significant difference between the two groups.

Results

Significant difference was found between the two groups in aerodynamic measurement (Table II). There

Fig.2. Recording of sample using Aerophone II®

was a significant difference at the level of 95% CI in the result of one sided t-test. In peak flow measurement there was significant difference in mean values of peak flow (control group mean- 6.37, SD- 2.50 , experimental group - 2.50, SD- 2.64), forced volume (control group mean- 1.21,SD-0.83 , experimental group–6.62, SD-7.46) and duration(control group mean- 3.43, SD- 1.28 , experimental group – 5.00, SD- 2.94). In vital capacity, significant difference was found in mean values of maximum flow rate (control group mean- 2.33, SD- 1.48, experimental group – 2.78, SD- 1.72), vital capacity (control group mean- 5.49, SD- 2.66, experimental group – 4.13, SD- 2.93) and duration (control group mean- 8.82, SD-3.74, experimental group –9.19, SD-3.76). In sustained phonation, a significant difference was also found in all the parameters. Fast adduction (AD)/ abduction (ABD) measurements also show a significant difference in all the mean values between the two groups.

Discussion

The present study aimed to document the dysarthrophonic characteristics of individuals with dysarthria. A variety of laryngeal impairments were noted in the study. Low peak flow and reduced duration in airflow measurement may be because of the reduced pliability in laryngeal muscle kinematics. The laryngeal resistance was found to be more which may emphasize on excessive muscle tension either at the level of the glottis or supraglottis.

The study documented reduced vital capacity which is manifested as short utterances and reduced loudness in dysarthric speakers. Dysarthric patients show weak respiratory support, low volume, incoordination of the respiratory stream. The change of aerodynamic characteristics can be due to the neurological impairments, which is common in dysarthric population. Since the vital capacity (VC) reflects mainly lung function, it was expected that there will be statistical difference between the two groups. The most frequent speech deviations observed were impaired loudness control and harshness; less frequently occurring deviations were defective articulation, restricted use of vocal variations for emphasis, poor pitch control, hyper-nasality, inappropriate pitch level, and breathiness. The pathological explanation lies with the fact that the Dopamine deficiency induces a dysfunction of the respiratory muscles that is partly responsible for dysarthria.[8]

The overall poor control of expiratory airflow, an alteration of the air quantity needed for the vibration of vocal cords.[9,10] The fast abduction and adduction rate might be due to inadequate closure of the vocal cords. Pressure and flow information can aid in identifying

Table II : Statistical analysis of laryngeal aerodynamics between normal and dysarthrophonic subjects

		NORMAL			DYSARTHROPHONIC			RESULT 95% CI
		MEAN	SD	DF	MEAN	SD	DF	
PEAKFLOW	Peak flow	6.37	2.50	29	2.50	2.64	9	t= 4.1827; p=0.0002
	Forced vol.	1.21	0.83	29	6.62	7.46	9	t= -3.9905; p=0.0003
	Duration	3.43	1.28	29	5.00	2.94	9	t= -2.3678; p=0.0231
VITAL CAPACITY	Max. flow rate	2.33	1.48	29	2.78	1.72	9	t= -0.8001; p=0.0286
	Vital capacity	5.49	2.66	29	4.13	2.93	9	t= 1.3661; p=0.00799
	Duration	8.82	3.74	29	9.19	3.76	9	t= -0.2706; p=0.003882
FAST AD/ABD	Max. flow rate	0.9	0.31	29	0.67	0.15	9	t= 0.2457; p=0.0306
	Volume	1.4	1.05	28	0.69	0.57	9	t= 2.029; p=0.0495
	Duration	13.0	7.33	29	6.94	4.04	9	t= 2.4776; p=0.0178
	Mean airflow	0.4	0.23	28	0.13	0.12	9	t= 3.5339; p=0.0011
	Ad/Abd rate	6.8	2.72	29	11.74	2.53	9	t= -5.0552; p=<0.0001

laryngeal manifestations of pathophysiology affecting phonatory characteristics and glottal efficiency[11]

Conclusion

The present study may help to document the parameters of speech and voice disorder in male dysarthric individuals. The study may be helpful to include aerodynamic measurement in test protocol and for evidence based research and prognosis documentation. Further elaborated study is needed with more number of subjects and inclusion of females with dysarthria to study the commotion of quality of life in these individuals. This will aid in further enrichment of clinical understanding and formulate appropriate intervention plan. From this limited sample it is possible to suggest but not to confirm that laryngeal or vocal tract resistance measures may be useful in documenting a variety of the perceptual voice characteristics

Conflict of Interest

The authors declare no conflict of interest and certify that the project was not funded by outside agency or company.

References

1. Darley FL, Aronson AE, Brown JR. Differential diagnostic patterns of dysarthria. Journal of Speech Language and Hearing Research 1969; 12(2):246-9
2. Condor NP, Ludlow CL, Schulz GM. Stop consonant production in isolated and repeated syllables in Parkinson's disease. Neuropsychologia1989; 27(6):829–38
3. Forrest K, Weismer G, Turner GS. Kinematic, acoustic, and perceptual analyses of connected speech produced by parkinsonian and normal geriatric adults. The Journal of the Acoustical Society of America 1989; 85(6): 2608–22
4. Hillman RE, Holmberg EB, Perkell JS, Walsh M, Vaughan C. Objective assessment of vocal hyperfunction: An experimental framework and initial results. Journal of Speech Language and Hearing Research 1989; 32(2): 373–9
5. Smitheran, JR, Hixon TJ. A clinical method for estimating laryngeal airway resistance during vowel production. Journal of Speech and Hearing Disorders 1981; 46(2): 138–46
6. Enderby P. Relationships between dysarthric groups. International Journal of Language & Communication Disorders 1986; 21(2):189–97
7. Shewan CM, Kertesz A. Reliability and validity characteristics of the Western Aphasia Battery. Journal of Speech and Hearing Disorders 1980; 45(3): 308–24
8. Murdoch BE, Chenery HJ, Bowler S. Respiratory function in Parkinson's subjects exhibiting a perceptible speech deficit. Journal of Speech and Hearing Disorders 1989; 54(4): 610–26
9. Jiang J, Lin E, Wang J, Hanson DG. Glottographic measures before and after levodopa treatment in Parkinson's disease. The Laryngoscope 1989; 109(8): 1287–94
10. Solomon NP, Hixon TJ. Speech breathing In Parkinson's disease. Journal of Speech Language and Hearing Research 1993; 36(2):294–310
11. Abbs JH, Gracco VL, Cole KJ. (1984). Control of multimovement coordination. Journal of Motor Behavior 1984;16 (2): 195–232