International Journal of Speech and Audiology

E-ISSN: 2710-3854
P-ISSN: 2710-3846
IJSA 2023; 4(1): 08-12

www.rehabilitationjournals.com
Received: 05-11-2022
Accepted: 16-12-2022

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A comparative study of maximum phonation duration between normal individuals and individuals with lung cancer

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Abstract
Speech is the oral manifestation of language. Speech is produced by bringing air from the lungs to the larynx (respiration), where the vocal folds may be held open to allow the air to pass through or may vibrate to make a sound (phonation). In individuals with lung cancer the anatomical and physiological function is deprived. This leads speech problem due to the insufficient supply of breath to the phonatory system. This study shows reduced maximum phonation duration in individuals with lung cancer in comparison to that with normal individuals. This difference is due to the anatomical changes that takes place in the airway results in poor physiological function. The vital capacity reduces as the structure of the lung varies. In individuals with airway cancer the lung volume is deteriorated due to the growth of cancer cells or due to the increases mass of the lungs. This leads to poor breathing. Due to the shallow inspiration and expiration the duration of voicing reduces. Hence it leads to poor MPD.

Keywords: Speech, speech disorder, maximum phonation duration (MPD), respiratory system, voice, cancer patients

Introduction

Speech Subsystems

Speech is a human vocal communication using language. Each language uses phonetic combinations of vowel and consonant sounds that form the sound of its words, and using those words in their semantic character as words in the lexicon of a language according to the syntactic constraints that govern lexical words' function in a sentence. In speaking, speakers perform many different intentional speech acts, e.g., informing, declaring, asking, persuading, directing, and can use enunciation, intonation, degrees of loudness, tempo, and other non-representational or paralinguistic aspects of vocalization to convey meaning.

Speech is the oral manifestation of language. Speech is produced by bringing air from the lungs to the larynx (respiration), where the vocal folds may be held open to allow the air to pass through or may vibrate to make a sound (phonation). The airflow from the lungs is then shaped by the articulators in the mouth and nose (articulation).The sub-systems of speech include: Respiratory system, Phonatory system, Resonatory system and Articulatory system.

Respiratory system

The respiratory passage includes the nasal and oral cavities, pharynx, larynx, trachea and bronchi. These structures can form a continuous open passage leading from the exterior to the lungs, and it is in the lungs, of course, that the actual extinct of gas takes place. The larynx is modification of the uppermost tracheal cartilages. An extremely important function of larynx is to serve as a protective device. The larynx is located within the anterior aspect of the neck, anterior to the inferior portion of the pharynx and superior to the trachea. Its primary function is to protect the lower airway by closing abruptly upon mechanical stimulation, thereby halting respiration and preventing the entry of foreign matter into the airway. Other functions of the larynx include the production of sound (phonation) and coughing. The larynx is composed of 3 large, unpaired cartilages (cricoid, thyroid, epiglottis); 3 pairs of smaller cartilages (arytenoids, corniculate, cuneiform); and a number of intrinsic muscles.

Respiration is the act of breathing

Inhaling is the act of breathing in oxygen. Exhaling is the act of breathing out carbon dioxide.

The respiratory system is made up of the organs included in the exchange of oxygen and carbon dioxide. Parts of the respiratory system include: nose, mouth, throat (pharynx), voice box (larynx), Windpipe (trachea), Large airways (bronchi), Small airways (bronchioles), Lungs.

The upper respiratory tract is made up of the: Nose, nasal cavity, sinuses, larynx and trachea.

The lower respiratory tract is made up of the: lungs, bronchi and bronchioles, and air sacs (alveoli).

Phonatory System

Act of phonation occurs in the larynx where the vocal folds are located. Larynx (voice box) is composed of cartilagenous muscles and ligaments. When the air from lungs is forced through closed vocal folds, the vocal folds will vibrate and phonation occurs. Pitch of the sound produced in larynx is dependent upon the tension of the vocal cords.

Vocal folds are closed when we swallow to protect our airway, open when we breathe in order to allow air in and out and vibrates during phonation.

Resonatory System

Speech resonance is the result of transfer of sounds produced by the vocal folds through the vocal tract comprised of pharynx oral cavity and nasal cavity. The resonance of the person depends upon size and shape of the vocal tract oral cavity and nasal cavity the resonant frequency of each of our voice will differ depending on the size and shape of the resonatory structure. The voice generated by the vocal folds will be modified as oral sounds in which the velopharyngeal is closed or it is nasalized (nasal sounds) in which the velopharyngeal wall is open

Articulatory System

The movement of structures to produce speech sounds is called articulation. The structures involved are called articulators.

Process of articulation: Voice generated by larynx is modified by the resonatory systemand is shaped into speech sounds by several structures. Shaping of speech sound is known as articulation.

There are two types of articulators, they are

Active Articulators: Articulators that moves during speech gesture is known as active articulators. That is Lips, Tongue, Soft palate, Mandible (lower jaw).

Passive articulators: Articulators which do not move during a speech gesture is known as passive articulators. They are Teeth, Alveolar ridge, Hard palate and Maxilla.

Voice is the sound produced by humans and other vertebrates using the lungs and the vocal folds in the larynx, or voice box (NIDCD) [National institute of deafness and other communication disorder], 2017). The human voice conveys information about the speaker through paralinguistic features such as: pitch, loudness, resonance, quality and flexibility. The importance of human voice in modern society cannot be overstated. It is primary instrument through which most of us project our personalities and influence our compatriots.

Voice problems usually include pain or discomfort when you speak, or difficulty controlling the pitch, loudness, quality of the voice. as you exhale, air gently passes through your throat, across your open vocal cords, and out of your mouth and nose. It mainly affects the ability to speak normally. The voice may quiver, be 'hoarse', or sound strained or choppy. It might also have pain or a lump in throat when speaking. Muscle tension dysphonia, vocal fold lesion (Eg. nodules and polyps), cyst, vocal fold scaring, changes in vocal fold mobility, and age-related alterations are all common problems in related patients.

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the lungs, it is called lung cancer. Lung cancer begins in the lungs and may spread to lymph nodes or other organs in the body, such as the brain. Cancer from other organs also may spread to the lungs. When cancer cells spread from one organ to another, they are called metastases. Lung cancers usually are grouped into two main types called small cell and non-small cell (including adenocarcinoma and squamous cell carcinoma).

Some people with lung cancer can develop a hoarse voice. It may be caused by the cancer pressing on a nerve in the chest called the laryngeal nerve. If this nerve is squashed, one of the vocal cords in your throat can become paralyzed, leading to a hoarse voice. If your vocal cord is not working properly, you may also find it more difficult to swallow effectively and there is a risk that food and drink could be inhaled into the lungs.

Lung cancer typically doesn't cause signs and symptoms in its earliest stages. Signs and symptoms of lung cancer typically occur when the disease is advanced.

Signs and symptoms of lung cancer may include: A new cough that doesn't go away, Coughing up blood even a small amount, shortness of breath, Chest pain, Hoarseness, losing weight without trying, bone pain, headache.

Causes of lung cancer may include: Smoking, Radon, Genetics, asbestos, arsenic, cadmium, chromium, nickel, uranium and some petroleum products

The maximum phonation duration (MPD) is the longest that a client can sustain a vowel sound at a comfortable pitch and loudness on a deep breath. Adult female should achieve 15-25 seconds whereas adult males exceed this at between 25-35 seconds.

Different laryngeal and respiratory pathologies affect a persons ability to phonate a sound, which can be quantified by using Maximum phonation duration (MPD), which allow to assessing the efficiency of respiratory and phonatory system.

Methodology

AIM

The aim of the study was to investigate respiratory (vital capacities) related parameters with the following objective

- To analyze distinction in Comparing the Maximum phonation duration of lungs cancer patients with normal individuals.
- To analyze distinction in Maximum phonation duration in adult lung cancer patients.

Participants selection

- Group 1: 25 normal healthy individuals. Group 2: 25 lung cancer patients.

- A detailed case history was administered to rule out the presence of hoarseness, loss of high or low frequencies, pitch breaks, throat clearing, dryness in throat, and vocal fatigue for both the groups
- Selected individuals had a history of neoplasm of the lung, metastatic carcinoma of lung, NSCLC - non small lung cancer, adenocarcinoma of the lung, carcinoma with lung metastasis, renal mess with lung secondary, lower lobe mucinous adenocarcinoma which in turn lead them to lung cancer.

Each subject was evaluated with the following
> MPD - Maximum phonation duration.

Inclusion criteria
- No history of past speech, language or hearing problems.
- The individuals who had lung cancer prior to smoking of cigarettes, consuming tabacco and other items including radon, asbestos, arsenic, cadmium, chromium, nickel, some petroleum products and uranium.
- The individuals at a age range of above 18 years.
- Individuals who had malignant neoplasm of the lung, metastatic carcinoma of lung, NSCLC - non small lung cancer, adenocarcinoma of the lung, carcinoma with lung metises, renal mess with lung secondary, lower lobe mucinous adenocarcinoma were included.

Exclusion criteria
- Subjects who have not undergone medical or surgical management for voice disorders, after taking case history we confirmed that the patient was not undergone any voice disorders before lung cancer.
- Individuals below 18 years were excluded.

Test room condition
Recording for experimental group was carried out in a quiet room with ambient noise level, recording was done in lab conditions.

Procedure
- Subjects were explained the purpose of the study and with prior consent the test was carried out.
- Subjects were made to sit comfortably on a chair and their phonation were recorded.
- The subjects were clearly instructed to take a deep breath before phonation.
- Subjects were asked to phonate /a/ as long as possible. This was done for 3 trials. There was 2 minutes interval between each trial. Same procedure was followed for /i/ and /u/.
- The longest among the 3 trials was taken for further analysis.
- Each subjects were tested individually.

Result and Discussions
The present study aimed at comparing Maximum Phonation Duration of individuals with lung cancer and normal individuals. Maximum phonation duration was recorded which was later averaged and analyzed.

The results are discussed below

Table 1: shows maximum phonation duration of vowels /a/, /i/ and /u/ in normal adults.

Normatives			
Case No	**MPD /a/**	**MPD /1/**	**MPD /u/**
1	20	19	20
2	18	17	16
3	17	18	20
4	16	15	19
5	21	18	16
6	17	15	19
7	18	18	16
8	20	16	18
9	16	16	19
11	21	20	18
12	20	18	17
13	20	19	20
15	17	15	16
16	16	15	15
17	15	16	14
18	18	16	15
19	17	14	15
20	16	15	16
21	15	16	17
22	19	17	16
23	15	16	14
24	20	19	20
MEAN	16.32	15.36	15.64

Table 2: shows maximum phonation duration of /a/, /i/ and /u/ in individuals with lung cancer.

Clients			
Case No	**MPD/a/**	**MPD/1/**	**MPD/u/**
1	9	9	8
2	6	6	7
3	19	16	17
4	13	10	11
5	6	8	9
6	7	6	7
7	6	12	7
8	1	1	1
9	1	1	1
10	3	1	2
11	9	8	8
12	9	10	9
13	8	10	10
14	6	3	5
15	1	1	1
16	1	1	1
17	19	14	12
18	6	7	7
19	13	14	13
20	6	6	6
21	8	6	10
22	3	5	4
23	4	9	8
24	7	9	9
25	8	8	8
MEAN	7.16	7.24	7.24

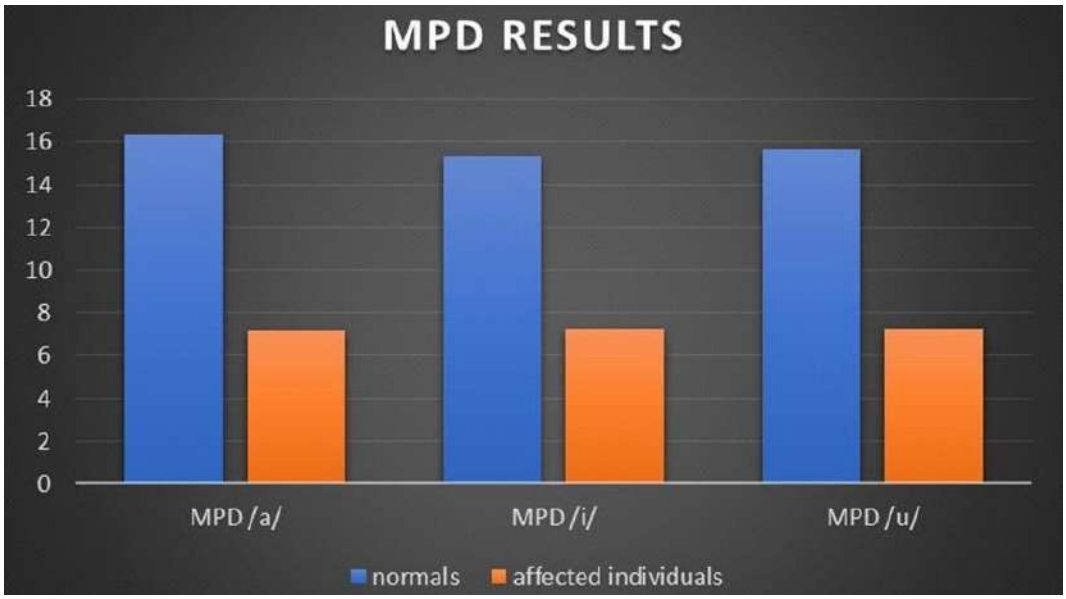

Fig 1: Depicting comparison of maximum phonation duration of /a/, /i/ and /u/ in normal adults and individuals with lung cancer.

The maximum phonation duration (MPD) is the longest that a client can sustain a vowel sound at a comfortable pitch and loudness on a deep breath. Adult female should achieve 15-25 seconds whereas adult males exceed this at between 25-35 seconds.

The current study compares the Maximum Phonation Duration of vowels /a/,/i/,/u/ in normal adults and individuals with lung cancer. Mean Maximum Phonation Duration Value of /a/ for normal adults were 16.32 and that for individuals with cancer were 7.16. The mean difference among the two groups were 9.16. The mean Maximum Phonation Duration value of /i/ were lesser in individuals with lung cancer compared to that of the control group, i.e Maximum Phonation Duration value was 15.32 for normal individuals and for individuals with lung cancer it was 7.24. The mean difference was 8.08. And the mean Maximum Phonation Duration value of /u/ for normal adults were 15.64 and that for individuals with cancer were 7.24. The mean difference between the two were 8.40. The mean MPD values were lesser for all the three vowels in individuals with lung cancer in comparison to that of normal individuals. So this study proved that comparing the Maximum Phonation Duration of normal individuals were better and more sustained compared to the individuals affected with lung cancer.

The data also showed that, an individual with malignant

neoplasm of lung had better maximum phonation duration values compared to other individuals with lung cancer. He had a history of regular breathing exercises on a daily basis.

Conclusion

The current study is carried out to investigate whether, there is any change in Maximum Phonation Duration in Lung Cancer patients. To compare the obtained data on Maximum Phonation Duration of normal adults and lung cancer patients.

25 normal individuals in the age range above 18 years and 25 lung cancer patients in the age range above 18 years were considered for the study. Subjects were asked to phonate vowel/a/,vowel/i/ followed by vowel/u/ with interval time of 2 minutes between the vowels. Subjects were clearly instructed to take a deep breath before phonation of every vowel and also to phonate each vowel as long as possible which was recorded using ASR application.

Air from the lungs is forced through closed vocal folds, the vocal folds will vibrate and thus phonation takes place. Lung cancer can cause complications such as shortness of breath if cancer grows to block the major airways. Lung cancer can also cause fluid to accumulate around the lungs making it harder for the affected lung to expand fully when you inhale. This limited air flow resulted in the reduced maximum phonation duration in individuals.

This study shows reduced maximum phonation duration in individuals with lung cancer in comparison to that with normal individuals. This difference is due to the anatomical changes that takes place in the airway results in poor physiological function. The vital capacity reduces as the structure of the lung varies. In individuals with airway cancer the lung volume is deteriorated due to the growth of cancer cells or due to the increases mass of the lungs. This leads to poor breathing. Due to the shallow inspiration and expiration the duration of voicing reduces. Hence it leads to poor MPD.

Implications of the study

This study helps in diagnosing voice problems and deformities in the respiratory system which in turn leads to strained work on breathing and reduced maximum phonation duration in the lung cancer patients. To help lung cancer patients to distinguish various vocal behaviors, hoarseness of voice, reduced vital capacity and to be realistic in counseling, setting goals, providing treatment and predicting prognosis in lung cancer individuals by Speech Language pathologist. This study does make sense to look after one's voice and respiratory system, building on the skills necessary for its effective use and maintaining vocal health and awareness.

Limitations of the study

1. The study has been limited only upto 50 subjects.
2. Only individuals above 18 years was been considered for the study.
3. Only individual with lung caner were included.
4. Individuals with complication other than lung cancer were not added.
5. No comparison between gender

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