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REVIEW

The logophoniatric articulatory apparatus

El aparato articulatorio logofoniátrico

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ABSTRACT

Communication from the socio-historical point of view arose in the very beginnings of humanity as a process of exchange of messages understood in a symbolic way. That is, from the first moments in which the human being faces the process of transformation of nature to obtain from it the necessary elements for its subsistence. In order to describe the morphofunctional characteristics of the organ systems that participate in the phonoarticulatory processes for the production and emission of the voice, a review of the literature was carried out, finding a total of 50 articles of which 20 met the validity criteria. The human organism is conceived as a whole, an example of which is the nervous and hormonal regulation of all its functions. Hence, the organs in isolation cannot perform those functions that are inherent to the entire organism.

Keywords: Speak; Phonoarticulatory; Voice; Communication.

RESUMEN

La comunicación desde el punto de vista socio-histórico surgió en los inicios mismos de la humanidad como proceso de intercambio de mensajes comprendidos de manera simbólica. Es decir, desde los primeros momentos en que el ser humano se enfrenta al proceso de transformación de la naturaleza para obtener de ella los elementos necesarios para su subsistencia. Con el objetivo de describir las características morfofuncionales de los sistemas de órganos que participan en los procesos fonoarticulatorio para la producción y emisión de la voz se realizó una revisión de la literatura encontrándose en total de 50 artículos de los cuales 20 cumplían los criterios de valides. El organismo humano se concibe como un todo, siendo un ejemplo de ello la regulación nerviosa y hormonal de todas sus funciones. De ahí que los órganos aisladamente no pueden realizar aquellas funciones que le son inherentes al organismo entero.

Palabras clave: Habla; Fonoarticulatorio; Voz; Comunicación.

INTRODUCTION

From a socio-historical perspective, communication emerged at the very dawn of humanity as a symbolic exchange of messages. In other words, from the earliest moments when human beings faced the process of transforming nature to obtain the elements necessary for their survival, communication became an indispensable element of human beings' practical transformative activity.

According to Marx and Engels, communication was indispensable for developing consciousness from the

beginning and developed parallel to work activity. The growing complexity of the relationship with nature, the development of work, and its specialization drove the evolution of social relations. It made the interaction between people in the work process more complex. All this required an ever-increasing improvement in the communication that ensured this interaction.

The vocal apparatus forms an inseparable whole. Numerous hypotheses have been put forward to explain and understand the relationships between the various components of the vocal apparatus, which has given humans supremacy over the musical instruments they use. This is because the vocal instrument is closely dependent on a living organism with a developed nervous system capable of coordinating the functioning of all the systems involved in speech. For this reason, it is of great importance for speech therapists to have basic anatomical and functional knowledge since the specific realizations of voice and speech depend on the state and functioning of organs and systems, as well as on functions such as breathing, phonation, resonance, articulation, hearing control, and overall coordination by the nervous and endocrine systems.

The objective is to describe the morpho-functional characteristics of the organ systems involved in the phono-articulatory processes for voice production and emission.

DEVELOPMENT

Oral communication occurs structurally at different levels: language, speech, and voice, which we define below.

Language is a capacity possessed only by humans, consisting of the power to abstract and generalize phenomena of reality and then reflect them using conventional signs. It is a higher cortical function from a neurophysiological point of view, which, in addition to being a psychological fact, is also a social fact. As Marxist theory posits, language arose from the need of early humans to communicate their ideas during the course of work. Marx and Engels emphasized that "language is the immediate reality of thought" and that "without language, there is no social production or society itself." Language, with its historical and social character, arose in humans along with their consciousness and subsequently became the instrument for developing that consciousness and thought.[1]

Speech: speech, that fantastic art reflected in signs and words, so closely linked to thought, which is said to be its material envelope, has developed over the long evolutionary history of man. It is inherent to him and conceptually one of the essential elements that characterizes him. Everything that man thinks and feels is fundamentally channeled through verbal communication. Speech has a fundamental semantic value. As the vehicle of ideas, concepts, and the expression of thought, its production requires well-defined, precise movements of the respiratory and phono articulatory apparatus, which occur in a fluid and automatic manner, giving rise to complex and sequential movements governed by the system that coordinates speech and voice functions (the endocrine and nervous systems).[1]

Voice: the voice is the sound emitted by the laryngeal organ. It serves as a vehicle for words; in other words, speech is something like its musical background.

If words are the intellectual vehicle for speech, conveying meaning, the voice is the emotional vehicle, conveying the individual's feelings and internal states.[1]

Principles Governing Oral Communication

Functional unity: functional unity is one of the aspects present in the anatomy and physiology of speech and voice. It states that all the organs that make up the speech and voice apparatus function harmoniously as a whole, unit, and team. Each of them's tasks is closely related to the others. This means that if one does not function properly, it will affect the rest, disrupting them.[2]

Anatomical Parasitism: this means that none of the organs of the speech and voice apparatus were created by nature to perform that function; each performs a primary biological task for preserving life and, secondarily, serves the purposes of oral communication. Thus, the lungs, which serve as an air reservoir for speech, are primarily organs for the exchange of oxygen and nitrogen in the blood, a vital function for humans.[2]

The larynx, which produces the sound of the voice, is a valve to prevent foreign bodies from entering the respiratory tree. The mouth, where sounds are articulated, is fundamentally an organ for the first phase of digestion, and so on.[2]

This is why it is said that speech and voice are anatomically parasitic on organs that have a primary biological purpose.[2]

Ambivalence of function: this refers to the fact that the verbal-vocal function can be performed in two different ways: statistically or ideally.[2]

a) Statistical manner: this is how most people function in a given place or time.[2]

b) Ideal manner: this is the way, according to physiological principles, in which one should function. It is the preferred manner.[2]

Hyperfunction

This is a muscular effort at some point in the phono-articulatory apparatus to compensate for the disorganization resulting from the dysfunction of the functional unit.[2]

Common sites of hyperfunction

- Subglottic level.
- Glottic level.
- Base of the tongue.
- Pharyngeal.
- Velar.
- Lingual.
- Labial.
- Lower jaw.

Systems involved in oral communication. General study of the systems and structures related to language, speech, and voice functions.

Respiratory System

This system provides the air necessary for the vibration of the vocal cords. It is divided into:

- Upper Respiratory Tract: mouth, nose, and nasopharynx.
- Lower Respiratory Tract: pharynx, larynx, trachea, and lungs.[2]

Tonal System

Represented by the larynx. The primary biological function of the larynx is to prevent foreign bodies from entering the respiratory tree. Therefore, the closing and opening functions necessary for breathing predominate.[2]

Phonation depends solely on the true vocal cords. At the same time, other functions of the larynx, such as coughing, support during acts of force, or difficult defecation, are attributed to the ventricular bands or false vocal cords.[2]

Resonator System

It comprises the resonance cavities (pharynx, mouth, nose, paranasal sinuses). To a lesser extent, there is resonance in the bronchi. They have an amplifying function and modify the vocal timbre.[2]

Articulatory System

Represented by the oral cavity, tongue, teeth, soft palate, and lower jaw. Their multiple positions determine the articulation of sounds, which, when linked together, produce words.[2]

Control System

The main organ is the ear, which, with its regulatory function, allows for correct expression in terms of voice intensity and modulation.[2]

Coordinating System

This is composed of the nervous system and the endocrine system. The former has coding functions, providing the motivation to speak, the conditions for speech and voice production, and distributing commands to the other systems so that they can perform the function of speech. The latter regulates the neuromuscular balance for the production of both functions.[2]

Organisms involved in oral communication

Respiratory System

This is the set of organs involved in the function of respiration. The function consists of the exchange of gases between the organism and the environment in which it acquires oxygen and eliminates carbon dioxide.[3]

The respiratory system is divided into Upper airways (mouth, nose, and nasal pharynx) and lower airways (pharynx, larynx, trachea, and lungs).[3]

Breathing

Humans have learned to use their breath for speech by holding their exhalations for phonation, whether speaking or singing. Without air, neither speech, singing, nor voice are possible. They require an air outlet capable of activating the vibration of the vocal cords. The lungs supply the air necessary for sound production. Breathing is the vital function that ensures the arrival of air to the lungs (gas exchange); it is performed by

external musculoskeletal forces acting on the different organs of the respiratory tract. Although some organs of the respiratory tract have muscles and are capable of independent movement, they cannot, as a whole, affect the exchange of air between the lungs and the environment.[3]

The perfect execution of the breathing action determines the quality and ease of vocal sound.[3]

Phases of breathing

Every breathing act consists of two phases: inhalation and exhalation

For inspiration to occur, the intrapulmonary pressure must be lower than the atmospheric pressure. Air then enters through the upper respiratory tract to the pulmonary alveoli. During expiration, the intrapulmonary pressure rises, becoming greater than the atmospheric pressure, causing air to flow out.[3]

Inspiration: inspiration is most often performed through the nose so that the air can be filtered and warmed. When pauses are very short, it can be done through the mouth and nose. Inspiration should be rapid, deep, and silent for proper voice production. The diaphragm provides the most significant inspiratory force. When it contracts, it lowers and pushes out the abdominal contents, pulling down the floor of the rib cage. At the same time, it expands the last six ribs, increasing the anteroposterior and transverse diameters and the longitudinal dimension of the thorax. The main muscles involved in this phase are the diaphragm and the external intercostal muscles.[3]

Exhalation: initially, this is a passive process as the structures involved in inspiration return to their resting position, which causes the ribs to close mainly due to the contraction of the internal intercostal muscles and the elevation of the diaphragm. However, when exhalation is greater, the oblique and transverse abdominal muscles also come into play by contracting, which helps lower the ribs, as does the rectus abdominis. The contraction of the abdominal girdle increases intra-abdominal pressure, causing the diaphragm to rise. The slow and regular rise of the diaphragm ensures expiratory pressure depending on the pitch (intensity), tone, and duration of the voice.[3]

Types of breathing

- Clavicular: in this type of breathing, the shoulders are raised during inspiration using the accessory muscles of the neck as the primary movement. There is a noticeable elevation of the clavicles, and it is considered unsatisfactory for achieving a good voice because this muscle contraction blocks the free movement of the larynx, and the amount of air taken in is insufficient.[3]
- Thoracic: there is virtually no noticeable expansion or inhalation of the upper chest or abdomen. The fixed ribs of the thorax allow only a slight increase in lung volume.[3]
- Costoabdominal or costodiafragmatic: shows expansion of the abdominal waist. The diaphragm always descends, and the lungs increase in volume, especially when aided by the floating ribs, which can open and close. Usefulness: increased flexibility with better control of the chest muscles and increased lung capacity, which offers excellent fatigue resistance.[3]

Breathing in phonation

Breathing for spoken and sung voice should be costal-abdominal, requiring better coordinated and more controlled movements.[3]

- Rhythm: in normal biological breathing, the inhalation/exhalation ratio is more or less equal in duration, approximately 2 seconds (I/E 1/1 or 1/1,5). In phonation, inhalation is modified and should be done rapidly, briefly, and silently through the nose. Exhalation depends on the length of the phrase (I/E 1/2). The phonation time is 15 to 20 seconds and can reach 50 seconds with training. Most specialists who have researched the subject consider exhalation the most critical breathing phase because we can consciously control and lengthen it through abdominal contraction. However, it is equally essential to bear in mind that achieving adequate exhalation is impossible with poor inspiration. A fundamental requirement for the trained speaker or singer is the ability to prolong exhalation, which involves maintaining a smooth and steady airflow.[3]

Exhalation pressure

This is the air pressure generated when the glottis closes, placing the vocal cords in an adduction position. This pressure must be regulated variably by permanently adjusting abdominal contraction depending on the voice type: high, low, loud, or soft. Therefore, good management of breath use and the tone of the abdominal muscles and lower ribs are essential elements of effective and satisfactory voice production.[3]

Respiratory capacity

The volume of air moved depends on vocal activity, but it is always greater than in quiet breathing.[3]

- Tidal volume (TV): amount of air moved during resting respiration (400 to 500 ml).[3]

- Functional reserve capacity (FRC): amount of air contained in the lungs after normal breathing (TV plus IR) (2700 ml).[3]
- ERV (Expiratory Reserve Volume): starting from a normal breath, a forced exhalation is made (1500 ml).[3]
- IRV (Inspiratory Reserve Volume): starting from a normal breath, a forced inhalation is made (2500 ml).[3]
- RV (Residual Volume): this is what remains after a forced exhalation (1200 ml).[3]
- VC (Vital Capacity): VVP+VRE+VRI. This is measured using spirometry, which varies according to sex, age, and approximate height (4500 ml).[3]

Exhalation control is more critical than increasing vital capacity in developing good phonation. A significant inhalation is not necessary to achieve controlled and prolonged exhalation. A "super" inspiration will probably cause excessive elastic recoil, i.e., faster exhalation and alterations in subglottic pressure and airflow volume 3.

Hence, the more correctly an individual breathes, the better their vocal performance will be, as they can adapt the amount and pressure of their breathing to the function of the larynx.[3]

Tonal System

The voice, as a laryngeal sound, makes us appear as we are with its resonant modifications—it "bares us before others." This constitutes another form of personal identity, as each human being has an exceptional vocal sound by which we are identified.

The larynx is the essential organ for sound production. It is an unpaired, central, symmetrical organ located in the front of the neck, whose movement is determined by the action of muscles inserted into a cartilaginous framework. It communicates with the pharynx behind and above through the laryngeal aditus (entrance opening). Below, it continues into the trachea.

Its cartilaginous skeleton consists of five fundamental cartilages:

- Thyroid cartilage: this is the largest cartilage. It is located below the hyoid bone and above the cricoid cartilage. It contributes to the protection and lateral and anterior support of the larynx. It comprises two plates that join at the front at an angle, forming the shape of a book open at the back. The two vocal folds are inserted into its inner angle.
- Cricoid cartilage: it is shaped like an inverted seal ring, with the broad lamina facing backward and the arch facing forward. It is a differentiation of the first ring of the trachea. It articulates with the arytenoid cartilage and the thyroid cartilage. Cricoid cartilage: lateral and posterior view.
- Arytenoid cartilages: two symmetrical, pyramid-shaped cartilages are articulated at their base to the posterior part of the cricoid cartilage and with their apexes pointing upward. At their base, there are two processes: the vocal or anterior process, where the vocal folds are inserted, and the muscular or lateral process, where the intrinsic muscles of the larynx are inserted.
- Epiglottis cartilage: this is a sheet of elastic cartilaginous tissue in the shape of a leaf, located above and in front of the entrance to the larynx, which can cover and close to prevent liquids or food from being aspirated during swallowing. It is inserted by its lower end into the incoming angle of the thyroid cartilage.
- Corniculate cartilages: there are two of these, each articulating with the apex of its respective arytenoid. They have no significant function in the larynx.
- Above this cartilaginous framework is the horseshoe-shaped hyoid bone, where the muscles and ligaments are inserted. This bone helps to support and move the entire larynx.

Muscles of the larynx. Responsible for moving the cartilage and changing the dimensions of the laryngeal cavity. Intrinsic muscles. Three muscle groups can be distinguished:

Constrictor muscles (close the glottis)

1. Lateral cricoarytenoid.
2. Thyroarytenoid.
3. Transverse and oblique arytenoid (arytenoid).

Dilator muscles (open the glottis)

1. Posterior cricoarytenoid (most important).
2. Thyroepiglottic.

Tensor muscles (vary the tension of the vocal cords)

1. Cricothyroid.
2. Vocal muscle: it is located in the thickness of the vocal folds, closely attached to the vocal ligament.

The internal thyroarytenoid muscle and the vocal ligament form the vocal fold (vocal cord). It has three segments: a small fibrocartilaginous (anterior) segment, a larger fibroelastic (middle) segment, and a posterior cartilaginous segment. The muscle fibers of the internal thyroarytenoid are short and striated, which allows one part to contract more than another (necessary for high or low tones). They insert at the front of the internal angle of the thyroid cartilage and the posterior end of the vocal processes of the arytenoids, delimiting a space called the glottis.

Extrinsic muscles include the muscles above the thyroid that insert into it: geniohyoid, mylohyoid, hypoglossal, digastric, stylohyoid, stylopharyngeal, palatopharyngeal, and others below the hyoid bone, such as the sternohyoid, thyrohyoid, and omohyoid; all of which assist in the upward and downward movement of the larynx.

Innervation

The superior laryngeal and recurrent or inferior laryngeal nerve branches innervate the larynx. The superior laryngeal nerve, with its internal branch, is responsible for the sensory innervation of the epiglottis's mucous membranes and the larynx's interior. In contrast, its external branch is a motor nerve for the cricothyroid muscle and the inferior constrictor of the pharynx. The recurrent laryngeal nerve runs along the larynx and descends toward the neck and upper thorax before returning to the larynx to innervate all the intrinsic muscles except the cricothyroid. Both nerve branches originate from the spinal vagus nerve.[4]

Relationships of the larynx

It is located below the hyoid bone at the level of the IV, V, and VI cervical vertebrae. Behind the larynx is the pharynx, which communicates through the laryngeal aditus or entrance to the larynx. The most important vessels of the neck run along the sides, and it is covered in front by extrinsic muscles (infrahyoid), the cervical fascia, and the lateral lobes of the thyroid. The trachea continues below.[5]

Functions of the larynx

Firstly, the larynx protects the lower respiratory tract by preventing foreign objects, mucous secretions, or food from entering the wrong airway.[5]

The coughing function is evident when particles that reach the vocal cords are expelled once the glottis has closed tightly, causing it to open explosively during exhalation. The respiratory function allows life to be sustained by facilitating the entry and exit of air through the separation of the vocal cords, and the effort function, mainly at the expense of the ventricular bands, is present in acts such as carrying weight, defecating, childbirth, and coughing. The phonatory function is secondarily responsible for voice production, as the vocal cords vibrate.

The laryngeal cavity opens through an orifice (laryngeal aditus). Above the vocal folds is the supraglottic cavity or laryngeal vestibule, which encompasses the ventricular folds or bands on both sides of the cavity. The vestibular ligament is included in the thickness of these folds. Between the bands and the vocal cords are the laryngeal ventricles or Morganni's ventricles.

The vocal folds, which are located below the bands and protrude into the cavity more intensely than the upper ones, delimit the vocal cleft (glottis), the narrowest part of the cavity. It can be divided into an intermembranous (anterior) portion and an intercartilaginous (posterior) portion.[5]

The lower portion of the cavity (below the vocal cords) narrows (infraglottic cavity) and continues into the trachea.[5]

The laryngeal image obtained using a laryngeal mirror consists of the following structures: epiglottis, true vocal cords, false vocal cords (ventricular bands), arytenoid cartilages, arytenoid-epiglottic folds, and piriform sinuses.

In the laryngeal image, the upper part is anterior, and the lower part is posterior. The right side remains on the right and the left on the left (vice versa for the examiner).[5]

Movements of the larynx

The position of the larynx can change during singing, breathing, and swallowing due to the following movements:

a. Vertical movement: it is determined by how it is fixed, raised, and lowered in the neck, thanks to the movements of the extrinsic muscles of the larynx. Respiratory movements are linked to the respiratory phases: inspiration (down) and expiration (up). When swallowing, it rises; while in singing it moves according to the tone sung, i.e., it rises in the high notes and falls in the low notes.

b. Movement at the level of the vocal cords:

1. Adduction and abduction movement: caused by the action of the intrinsic laryngeal muscles that move the cartilage, causing the vocal cords to come together (adduction) or move apart (abduction).

2. Vibratory movement, involving horizontal and vertical vibration and a wave-like movement as the mucosa moves over the vocal muscle and ligament. This is very delicate at the edge.

Resonance system

The air current resulting from controlled exhalation forms a constant, regular column and is converted into sound by the vibration of the vocal cords. The resonator modifies and amplifies this sound. Resonance is, therefore, the reinforcement of the sound originally emitted. The resonance system gives the voice its color, timbre, richness, and amplitude.

The guitar or violin strings would produce an inferior sound on their own if these instruments did not have a sound box. The same is true of the human voice: the sound produced at the glottis would be very thin without resonant structures to amplify it. This is because the primitive fundamental sound produced by the vibration of the vocal cords is a sound without timbre or color since the supraglottic structures cannot amplify it, making the overall quality of the voice very poor and with a barely audible tone.[6]

Resonance structures

According to Boone, when sound travels from the vocal cords to the mouth, it passes through a supraglottic resonance system that provides harmonics, which play an essential role in the various colorations of timbre. An impression of resonance can be perceived in other infraglottic structures, which can be a guide to vocal technique.[7]

Supra-glottic resonance structures

- Nasal cavity.
- Paranasal sinuses.
- Oral cavity.
- Pharynx.
- Laryngeal ventricle.

Infraglottic resonance structures (studied in the respiratory system)

- Trachea.
- Bronchi.
- Lungs.
- Thoracic cage.

Nasal cavity: it has a bony portion and a cartilaginous portion, the external nose. The nasal cavity is divided by a septum into two symmetrical halves; the posterior superior part is bony, and the anterior inferior part is cartilaginous. Each half of the nasal cavity has four walls: upper, lower, inner, and outer. The upper wall is formed by the cribriform plate of the ethmoid bone, the hard palate forms the lower wall or floor, and the inner wall is common to both halves and is formed by the nasal septum. The outer or lateral wall is more complex, containing three protrusions or conchae called the superior, middle, and inferior turbinates below the nasal meatus. It communicates with the nasal openings in front and with the pharynx behind through the choanae. It is lined with ciliated epithelium that warms and purifies the air reaching the larynx.[7]

The paranasal sinuses are complementary cavities of the nose located in the bones that form the walls of the nasal cavity and communicate with it through holes in the superior and middle turbinates. They are maxillary, frontal, ethmoid, and sphenoid sinuses. Their walls are lined with a mucous membrane.[7]

Mouth: this is the initial part of the digestive tract and serves as an organ of speech and for breathing when the nasal passage is obstructed. It is divided into the vestibule and the oral cavity proper. It will be discussed in more detail as an organ of the articulatory system.[7]

Soft palate: this muscular formation, suspended obliquely downward, separates the oral cavity from the pharynx. Formed by the palatine muscles, when relaxed, they allow the soft palate to hang freely, and when contracted, it rises and moves backward. Its anterior edge is inserted into the bony palate, while its posterior portion ends in the center with the uvula. It continues on both sides with the anterior and posterior pillars and, between them, the palatine tonsil.

Muscles of the palate. There are five muscles in the palate:

- Internal peristaphyline: it inserts into the petrous portion of the temporal bone and the cartilaginous wall of the Eustachian tube. The insertion of this muscle forms a large part of the soft palate. The internal peristaphyline raises the palate.
- External peristaphyline: it is located anterolaterally to the internal peristaphyline muscle. It inserts into the sphenoid spine's internal pterygoid plate and into the Eustachian tube's cartilaginous wall. The external peristaphylinus tightens the velum. Both muscles (internal and external) open the

auditory tube, as in the case of yawning, to allow air to enter the tympanic cavity.

- Palatopharyngeal muscle: it originates from a pair of tongues on the posterior edge of the hard palate on each side of the midline and from the palatine aponeurosis behind the soft palate; the tongues extend backward on each side of the midline to form the uvula.[7]
- Palatoglossus or glossopharyngeus: this thin muscular plate begins on the underside of the soft palate and forms the anterior pillar of the soft palate, inserted into the dorsum and side of the tongue.[7]
- Palatopharyngeus or pharyngopharyngeus: covered by a mucous membrane, it forms the posterior pillar of the soft palate.[7]

Innervation: the external peristaphyline muscle is innervated (motor) by a branch of the trigeminal nerve; the spinal nerve innervates the other four palate muscles through the pharyngeal plexus. The sensory innervation of the palate is from the nasopalatine, palatine, and glossopharyngeal nerves.[7]

Pharynx: this muscular tube can vary in shape and volume depending on the harmonics it needs to reinforce during phonation. It is a portion common to the digestive and respiratory systems. It extends from the base of the skull to the VI-VII cervical vertebrae. Its anterior surface communicates with the nasal cavities, mouth, and larynx and can, therefore, be divided into three portions: the nasopharynx, oropharynx, and laryngopharynx, respectively.[8]

Nasopharynx: the nasal segment of the pharynx is located behind the nose and above the soft palate. Unlike the oropharyngeal and laryngeal segments, the nasopharynx always remains open. It is connected through the choanae to the two nasal cavities in front of it. There is an opening in the Eustachian tube on each side wall of the nasopharynx. Between the upper third and middle of the posterior wall of the pharynx, the superior constrictor muscle forms a ring called Pasavant's ring, which contributes to velopharyngeal closure, an essential act in resonance.

Oropharynx: this is the buccal portion of the pharynx. It communicates above and behind the soft palate with the nasopharynx; in the anterior plane, it communicates with the mouth through the isthmus of the fauces, and downward, it is limited by the posterior or pharyngeal portion of the tongue, continuing to reach the sides and back to the epiglottis, the portion of the larynx that protrudes upward, continuing with the laryngeal portion or laryngopharynx.

Laryngopharynx: this is the laryngeal portion of the pharynx that continues into the oropharynx at the level of the posterior edge of the epiglottis; it is wide at the top but narrows rapidly at the level of the cricoid cartilage of the larynx, continuing into the esophagus at the lower edge of the cartilage.[9]

It should be noted that the pharyngeal tonsils in the posterior and superior direction, the palatine tonsils to the sides, and the lingual tonsil in the anterior and inferior direction form an oblique ring of lymphatic tissue around the pharynx that appears to serve to prevent infections from penetrating and spreading beyond this level. Still, when they enlarge due to disease, they cease to constitute a defense mechanism, and their hypertrophy causes obstruction.[9]

Within these structures are complex, fixed, immobile bony parts (bones of the face) that cannot be modified by work, study, or willpower. However, there are soft, membranous parts that are mobile, such as the larynx, soft palate, isthmus of the fauces, tongue, cheeks, and lips, which we can control through exercise and use to the fullest extent of the resonance cavities.[9]

When the opening between the soft palate and the pharyngeal wall opens, air escapes through the nose. Nasal resonance is particularly noticeable in the consonants m, n, and ñ. The degree of nasalization when speaking also depends on linguistic and dialectal influences, linguistic patterns, and habits. The participation of nasal sounds is called nasality. Malfunction of the velopharyngeal structure can influence resonance, either as a resonance chamber or as the wall of a resonance cavity. Open nasality (hyperrhinophonia) can be caused by organic disorders such as paralysis of the soft palate, cleft palate, or habitual functional inactivity. This nasality is considered unattractive and is a problem that cannot be resolved in the short term, even if there are no anatomical defects.[10]

Closed nasality (hypergraphia) occurs when the nose or nasal pharyngeal cavity is closed. It can be caused by colds, adenoids, polyps, and deviated septum, among others, which obstruct the passage of both air and sound to the nasal cavity.[10]

Variations in nasality can also be heard in allergic processes, which is common in our population when allergic disease is not controlled.[10]

The oropharynx and the base of the tongue participate in the modification of sound when the former contracts and the latter rises to produce a narrowing of the throat. The sound is placed very far back, and the voice becomes guttural, making it challenging to express nuances in speech.[10]

Articulatory system

This consists of the structures in the oral cavity.[11]

Oral cavity: this consists of the vestibule and the oral cavity itself.

Vestibule: this space is bounded at the front and sides by the lips and cheeks and at the back by the teeth and gums.[11]

The lips form a muscular roller made up of the orbicularis oris muscle, which is covered by skin on the outside and mucosa on the inside. As it passes from the lips to the alveolar processes of the upper and lower jaws, this mucosa adheres strongly to them and forms the gums. Superiorly and inferiorly, there are folds of this mucous membrane from the cheeks and lips to the upper and lower gums and a fold in the midline that is the frenulum of the lips and connects the upper and lower lips to the gums. When the orbicularis muscle contracts, it presses one lip against the other. Multiple muscles around the mouth control the different movements of the lips. The cheeks are muscular formations consisting of the buccinator muscle, covered on the outside by skin and inside by mucosa that lines the entire oral cavity except for the teeth.

The teeth are arranged in two arches (upper and lower) reinforced in the alveoli of the upper and lower jaws. Each tooth has a crown that protrudes from the jaw's alveoli and a root located in the alveolus.[11] The crown shape divides them into incisors, canines, and molars. The interrelationship between the dental arches is called occlusion. In normal occlusion, as the upper dental arch is slightly larger than the lower one when the jaws come together, the lower teeth are somewhat covered by the upper teeth, while all the teeth of the upper arch rub against their corresponding teeth in the lower arch.[11]

The oral cavity itself: this is bounded above by the hard and soft palate, below by the tongue, in front by the teeth, and behind by the pharynx. The opening that connects the mouth to the pharynx is called the isthmus of the fauces.[11]

- Palate: it consists of two parts: the bony or hard palate occupies the anterior two-thirds and separates the oral cavity from the nasal cavity. It is formed in its anterior part by the palatine processes of the upper jawbone and in its posterior part by the horizontal plates of the palatine bones. The mucous membrane that covers it is firmly attached to the periosteum. The bone suture can be seen in the midline. Its shape gives it a vaulted appearance. The soft portion, or soft palate, constitutes the posterior third and was described above.[11]
- Tongue: a solid muscular organ: when the jaws are closed, the tongue occupies almost the entire oral cavity, coming into contact with the palate on its dorsal surface, which reduces the oral cavity to an almost virtual cavity in the form of a cleft.[12]

The anterior part is mobile, and the posterior part is fixed. The following parts can be distinguished: the root, which is inserted into the jaw and the hyoid bone; the body or dorsum, which faces forward and is conventionally divided into three parts (anterior, middle, and posterior); and the apex or tip.[12]

The tongue is the most mobile element of the articulators and has intrinsic and extrinsic muscles that facilitate raising or lowering it, extending it forward or backward, narrowing it, flattening it, lengthening it, or shortening its body. The contractions of the muscles inserted into the bony skeleton (genioglossus, hyoglossus, and styloglossus) ensure the movement of the tongue as a whole. Those attached at both ends to different parts of the mucous membrane (upper, middle, and lower lingual) modify the shape and position of the other parts of the tongue.[12]

The tongue can change position and shape within the mouth without limitation by contracting or distending, becoming round or pointed, and moving its tip closer to any part of the inside of the mouth. The mucous membrane of the mouth, as it passes to the underside of the tip of the tongue, creates the lingual frenulum, the length of which is essential to consider in the articulation of the phonemes R and L.[12]

The organ offers the most significant variation in size and shape due to the different positions of the lips, tongue, teeth, and the degree of opening of the lower jaw. The latter determines an increase in the size of the oral cavity due to a lowering of the floor of the mouth and often a lowering of the larynx, thereby increasing the size of the pharyngeal cavity.[12]

The movement of the mouth is a presentation to other people, but its adjustments and variations in size and shape, with the various combinations and contractions of the tongue, as well as the structural adequacy and normal functioning of the soft palate, allow us to assert that the oral cavity and its mobile structures (tongue and soft palate) are essential in articulation and resonance.[13]

Such is the case that improper tongue transport, poor mouth opening, superficial articulation (standard in our environment), and excessive opening are considered factors that affect normal voice resonance during articulation.[13]

The lower jaw is the only movable bone. These movable organs cause the shape and size of the resonators to vary considerably.[13]

Based on the above, the enlargement of the oral cavity, the position of the tongue, the shape of the lip opening, and the movement of the lips give the voice good placement, resonance, and timbre through articulation.[13]

The points of articulation of phonemes vary according to the sound that precedes them and occur according to their position in the word, by the social norms of each linguistic entity, and by the individual norms of the speaker, reinforced by habit.[13]

Characteristics of the voice

The voice has many characteristics, which are listed and described below to give future speech therapists an overview of them:

Pitch: the pitch of a sound corresponds to the number of vibrations per second.[14]

The pitch is low if the sound has few vibrations per second.[14]

Pitch is synonymous with frequency and height. In voice physiology, the pitch is determined by the tension of the thyroarytenoid muscle; the more significant the tension of this muscle, the greater the number of vibrations per second and the higher the pitch of the voice. The lower the muscle tension, the fewer the vibrations and the lower the pitch of the voice.[14]

Timbre: this is synonymous with quality. It refers to the sound quality and depends mainly on the consistency and shape of the sound body and the resonant modifications that the sound undergoes.[15]

Intensity: this is determined by the acoustic wave's size and the force's equivalents. If the acoustic waves of a sound are large, the sound will be loud; if they are small, the sound will be weak.[15]

Volume: this is related to intensity and pitch and is enhanced by thick or low tones, giving a memorable impression.[16]

Projection: this is related to the direction in which it is projected and is based on placement.[16]

Placement: this is based on resonance and is rooted in the kinesthetic sensations of the peripheral buccal and nasal organs.[17]

Resonance: in one sense, it is a physical phenomenon of phoneme reinforcement; in another, it is a set of subjective sensations experienced at different levels.

Support: this is an abdominal muscular effort of the intensity and duration of the sound, which serves as the basis for both.

Inflection: this is a tonal change between syllables; intonation is the general tonal direction of the phrase (which may be the word), and melody is the result of the inflections and intonations of speech.[18]

Tonal fields are specific areas of the tonal range where vocal performance occurs, from which the usual or customary tonal levels are derived.[18]

Time: this encompasses the speed and duration of sounds and the pauses between them.[18]

Pauses: in oral communication, these have a dual value: in terms of breathing needs, they should be short and frequent, and in terms of meaning, depending on their duration, they can emphasize the meaning of the phrases that precede or follow them.[18]

Rhythm: this refers to the periodic repetition of one or more elements of sound production over time, which may be regular or irregular.[18]

Prevention of voice disorders

- Use your voice as little as possible during breaks or when not teaching.
- Drink plenty of water.
- Do not smoke.
- Exercise regularly.
- Do not drink alcoholic beverages or coffee or overeat spicy or highly seasoned foods to avoid acidity and gastric reflux.
- Develop listening skills (learn to listen).
- Do not compete vocally with excessive ambient noise.
- Do not use forced voice production.
- Avoid coughing and clearing your throat excessively.
- Avoid laryngeal irritants.
- Eliminate bad habits (do not shout).[19]

Mechanism of phonation integration

The voice represents the acoustic support of words.[20]

1. The production of optimal phonation for speech and singing requires that the expiratory air pressure (subglottic pressure) from the lungs pass through the laryngeal tube where the vocal cords are located.[20]
2. The vocal cords gently come together and adopt the phonatory position (adduction), contracting and vibrating under the control of the motor centers (recurrent and superior laryngeal nerves).
3. These vibrations of the vocal cords generate sound frequencies in the resonators, which modify and amplify the sound to join it with articulation and form words.[20]

CONCLUSIONS

Communication is a necessary condition for human existence and one of the most critical factors in social development. As one of the most significant aspects of any activity and a condition for the development of individuality, communication reflects the objective need of human beings for association and cooperation. It reveals the transmission of ideas and emotions, reflecting the unity between the affective and the cognitive; therefore, it is necessary to evaluate not only the form of communication but also its effectiveness. Consequently, we can say that.

The human organism is conceived as a whole, playing a leading role with respect to its parts. An example of this is the nervous and hormonal regulation of all its functions. Hence, isolated organs cannot perform those inherent to the entire organism.

BIBLIOGRAPHIC REFERENCES

1. Rodríguez Prieto M, Díaz Gómez O, Rodríguez Prieto Y, Oquendo Alvarez J A. El aparato fonoarticulador: importancia en la comunicación hablada de profesionales de la educación. EDUMECENTRO. 2021. 13(1): 295-301. http://scielo.sld.cu/pdf/edu/v13n1/2077-2874-edu-13-01-295.pdf

2. https://revistas.udg.co.cu/index.php/roca/article/download/4804/12242/25348?inline=1

3. Barreiro Moreira D, Guzmán Chacón G E, Rosa Leonor Parrales Choezel R L. Aparato fonoarticulatorio y su incidencia en el desarrollo de dislalia funcional en niños de 4 a 5 años de edad en la Escuela de Educación Básica Particular Guayas del período lectivo 2019 – 2020. Guayaquil: Universidad Laica Vicente Rocafuerte De Guayaquil; 2020. http://repositorio.ulvr.edu.ec/bitstream/44000/3953/1/T-ULVR-3319.pdf

4. Medina Guerrero A K, Ordoñez Vásquez M E, Guerrero Vásquez L F. Estimulación fono articulatoria en inicial l, con ayuda del asistente robótico misa en el centro de educación inicial la cometa. Año 2024. Ecuador: Universidad Salesiana; 2024. https://dspace.ups.edu.ec/bitstream/123456789/27012/1/UPS.CT011198.pdf

5. Méndez Hurtado D E, Vargas Pico J V. Recursos tecnológicos para estimular el desarrollo del lenguaje oral en niños de 4 a 5 años. Ecuador: Universidad Técnica De Ambato; 2021. https://repositorio.uta.edu.ec/server/api/core/bitstreams/afd85402.eced.42c3.a3a6.d0ec02a9c287/content

6. Agudelo Montoya C L, Pasuy Guerrero G Y, Ramírez Osorio J F. Adquisición y desarrollo del nivel fonológico del español en niños de 0 a 7 años, una aproximación desde la lingüística y la psicolingüística. Rev. Latinoam. Estud. Educ. 2020. 16(1): 70.92. https://www.redalyc.org/journal/1341/134166565004/html/

7. Cueva Rey A S, Rebolledo Yange N E. El desarrollo del lenguaje oral en niños con estrabismo y ambliopía. Papel de la familia. Revista Transdisciplinaria de Estudios Sociales y Tecnológicos. 2023. 3(3): 5.11. https://revista.excedinter.com/index.php/rtest/article/view/86/78

8. Yépez ER, Padilla Álvarez GC. La oralidad y las dimensiones del lenguaje en los infantes. Revista CoGnosis. 2021. 6(EE1): 01.22. https://revistas.utm.edu.ec/index.php/Cognosis/article/view/1973

9. Alás Rupérez A, Ramos Sánchez I, Machado Casas I S, Fernández.Mayoralas D M, Gortázar Díaz M, Aguilera Albesa S. Trastornos del lenguaje, del habla y de la comunicación. Conceptos, clasificación y clínica. Protoc diagn ter pediatr. 2022. 1: 19.30. https://www.aeped.es/sites/default/files/documentos/03.pdf

10. Morgado Gutiérrez C, Rodríguez del Rey Noy L, León Román CA. Hiperentorno Educativo para el aprendizaje de la asignatura Morfología Humana en enfermeros técnicos. RCIM. 2021; 7(2):[aprox. 11 p.]. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1684.18592015000200007

11. Gómez Álvarez A, Cardellá Rosales L, Hernández Fernández M. Disciplina Morfofisiología Humana: Problemas de la renovación educativa y sus requerimientos. Panorama Cuba y Salud. 2022; 3(2):[aprox. 6 p.]. http://www.revpanorama.sld.cu/index.php/panorama/article/view/156

12. Uriarte Prego M, Hernández Batista S, Ramos Hernández L, Boudet Cutié O, Martí Carvajal L. Satisfacción de los actores del proceso formativo en la asignatura Morfofisiología II. Educ Med Super. 2023; 27(4):[aprox. 6 p.]. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S086

13. Infante Tavío NI, Cano Reyes JC, Hernández Lin T. Efectividad del laminario histológico interactivo

de Morfofisiología II en estudiantes de primer año de la carrera de medicina. Medisan. 2021; 18(10). http://scieloprueba.sld.cu/scielo.php?script=sci_arttext&pid=S1029.30192014001000007&lng=es&nrm=iso

14. Pérez Marqués LU, Murillo Jorge G, Cobas Pérez JL, et al. Validación de la calidad de las preguntas en un examen final de la asignatura Morfofisiología Humana. Medisan. 2021 Mar; 17(3). http://scieloprueba.sld.cu/scielo.php?script=sci_arttext&pid=S1029.30192013000300009&lng=es&nrm=iso

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