ROLE AND FUNCTIONS OF THE TORSO IN THE PROCESS OF VOCALIZATION

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Summary

The article deals with one of the important problems of studying the role and function of the torso in the process of vocalization and related singing breathing and the formation of correct posture during singing. This will make it possible to scientifically substantiate the physiological patterns of the human body and make the process of singing activity as a whole more understandable and transparent. ***The issue is*** revealed in the relationship of such components as: the work of the autonomic nervous system, which signals motor tasks to muscle fibers in the human body, and the general functioning of the respiratory system, which performs a full respiratory cycle. In this context, the process of breathing during vocalization is analyzed in detail and the role of each torso organ is determined separately. ***The methodology*** of this study is to change its angle, which will allow us to identify the essential components of the torso and analyze their role in the process of vocalization. Scientific novelty consists in identifying the mechanisms of interaction between various components of the human torso and their influence on the process of sound extraction. ***The practical significance*** of the study lies in the focus on safe approaches in the formation of singing breathing skills during the vocalization process. The results of the study can be used for further research and development of vocal techniques.

Keywords: respiratory physiology, complete respiratory cycle, anchoring, vocal support, torso.

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1. Introduction

In modern vocal pedagogy, one of the fundamental issues is the study of the role of various components of the body in the process of correct formation of phonation sound formation. However, unfortunately, there is no clear opinion on the characteristics of the human torso as an important component of the vocalization process. Various vocal techniques developed by specialists in the field of phonopedia, phoniatry, physiology and other fields of knowledge

explain the role of the human torso in the process of vocalization in different ways, and sometimes with different terminological bases. Some researchers recognize the important role of different parts of the human body in the process of vocalization, while others do not focus on this at all. This has led to the emergence of radically different views on this problem, which makes it relevant and promising.

Analysis of recent research and publications. Singing is the subject of study of many branches, including: special vocal training, acoustics, physiology, musical psychology, music pedagogy, methods of musical education, etc. However, each of these sciences considers only one aspect of singing activity. Thus, the problem of vocal training in the aspect of physiology and voice production is thoroughly covered in the works of D. Aspelund, A. Zasedatelev, A. Zdanovich, A. Egorov, M. Mikisha, V. Morozov, L. Rabotnov and many others. The issues of development and formation of singing abilities are revealed in the works of domestic (V. Antonyuk, L. Vasilenko, L. Dmitrieva, V. Emelyanova, O. Stakhevich, P. Troninoi, V. Yushmanova, Yu. Yutsevich), and foreign (A. Menabeni, J. Estill, J. Hoit, Leanderson R, V. Pettersen) scientists. Despite a large number of studies and a fairly thorough source base, the stated problems still remain relevant today. In this regard, ***the purpose of this article*** is to systematize research in various scientific fields related to the work of the torso during the vocalization process. This will allow us to understand the processes of singing breathing and the formation of correct posture from the point of view of physiology. From this perspective, it is possible to scientifically substantiate the physiological laws of the human body, which makes the process of singing activity as a whole more understandable and transparent.

2. Presentation of the main research

The safest way to work with the voice is considered by phonopedia and phoniatry specialists to be a physiological and scientific approach, as opposed to an empirical one, which is based on subjective feelings of sound reproduction by the performer in the process of vocalization. The physiological and scientific approach make it possible to reveal singing as a complex of physiological processes occurring in the human body, to study the components of the vocal apparatus that perform a specific function in the process of sound formation. One of the fundamental components of singing is the process of breathing, which occurs not only with the help of the respiratory organs, but also muscle and bone structures located in the human torso, and is controlled by the autonomic (ANS) and central (CNS) nervous systems in order to maintain the viability of the body (*Gardiner, 1957*). That is, the bones and muscles of the back, chest, shoulders, windpipe, lungs and abdominal muscles, which are components of the torso, are fully or partially involved in the process of breathing and sound formation. Let's consider in detail the process of breathing and determine the role of each organ of the torso separately in the process of vocalization. Human breathing is an uncontrolled process of consciousness, during which inhalation and exhalation are carried out using the nasopharynx (mixed type), where both phases are short and equal in time (*Sokolenko, 2019*). The main structures responsible for the breathing process are the lungs and diaphragm, and ancillary structures are the nasopharynx and trachea, which together form a cycle controlled by the ANS (*Steinhauer, 2017*). With the help of neural impulses sent to the brain, they control the processes in muscle tissues, creating a motor unit. At the same time, the ANS controls not only the inhalation process, but also the overall process of breathing, which is based on the coordination of motor activity through neural stimulation of a number of skeletal muscles. They create negative intrathoracic pressure, causing air to enter the lungs.

The main source that controls the inhalation is the diaphragm, or muscle septum of the thoracic and abdominal cavities, divided into parts: the rib one (where the fibers extend outward from the central sinew and enter the lower ribs and back) and the spinal (where the fibers enter the lumbar spine). The diaphragm is filled with air and reflexively descends during inhalation, after which its neutron activation forms transdiaphragmatic pressure, which creates a physiological breath retention followed by exhalation. The diaphragm is currently in a stationary phase and retains its previous position. Next, the motor function is selected, which regulates the speed of response to the task, which is transmitted to the ANS muscle fibers. There are four types of such" tasks", or motor units, in muscle fibers, conventionally divided into the following: *slow set; fast set; medium set; fatigue* (*Gardiner, 1957*). All types of motor units are responsible for muscle contraction and, with the help of nerve impulses coming from muscle fibers, transmit information to the motor cortex of the brain about the need for tonus, or about the work of certain muscles in the human body. Since the diaphragm is not only a respiratory organ, but also a muscular one, it has all the motor units described above. Consequently, the diaphragm can contract physiologically at four speeds, of which only three are suitable for the sound formation process, in particular:

– at a slow pace, that happens during singing and due to which a long exhalation is formed;

– at an average tempo, which is used by singers in the process of stage speech and recitative parts of vocal works;

– at a fast pace, used by singers to perform various complex strokes (for example, staccato), accentuate musical beats, or perform melismatics, etc. (*Gardiner, 1957: 201-210*).

The fourth motor unit is not suitable for the formation of singing breathing and has a protective function of the muscle fiber during overexertion and is responsible for its instantaneous contraction. That is, a phenomenon is created that is called a "diaphragmatic clamp" in vocal pedagogy (*Gardiner, 1957)*. After selecting the ANS motor task (for example, speed), there is a reflex ejection of air by the muscle fibers of the diaphragm and auxiliary muscles (upper back muscles, intercostal muscles, etc.). Physiological breathing is regulated by various types of motor tasks (slow set, fast set, medium set in the muscle fibers of the diaphragm during exhalation) and performs a full respiratory cycle. In general, this process is called a complete respiratory cycle, it is carried out spontaneously several times per minute, supporting the vital activity of the body, and has a different amplitude of cycles depending on the age of the person.

The human respiratory cycle as a process of filling the lungs with air and its transfer to the diaphragm is quite conditionally divided into different types (thoracic, lower rib, diaphragmatic, abdominal, clavicular, etc.) (*Steinhauer, 2017: 185*). In this process, an important role is played by the lungs, which are located in the chest and are an elastic, spongy structure that holds the volume of inspiration of a person by increasing the space in the chest, as a result of which air enters the lower parts of the lungs and includes the internal walls of the chest and thoracic and intercostal muscles. Because of this, vocalists feel that they are breathing a lower-rib type of breathing (*Steinhauer, 2017*). During breathing, the flow of air quickly descends from the lungs to the diaphragm, bypassing the walls of the chest. This type of breathing – abdominal – involves the straight and oblique abdominal muscles. During vocalization, during this type of breathing, the singer can see the movement of the abdominal wall, feel the upper dome formed by the diaphragm, and part of the abdominal wall to increase the internal space in the body, which allows for more subtle control of the exhalation process *(Pettersen, 2005)*. Before the ANS and brain coordinate the process of breathing by contracting the muscle fibers of the diaphragm, a person may feel the expansion of the abdomen or lower ribs while the diaphragm is in a stable position. After that, the diaphragm contracts and exhalation occurs, which can also

cause certain sensations *(Pettersen, 2005)*.

The physiological process of breathing includes the entire plane of the lower torso, which involves the lower ribs, diaphragm, back muscles, and chest, which can work simultaneously. In this case, the amplitude of human respiratory movements will depend on the physiological and psychoemotional state of the person (*Ghrymak, 1989*). For example, the clavicular type of breathing, which involves only the upper part of the lungs, which has a small volume, can manifest itself in cases of nervous excitement of the body precisely because inhaling and exhaling is carried out by raising and lowering the clavicles. This type of breathing is called stressed. In order to avoid it, it is necessary to reduce psychoemotional tension, because when the body relaxes, breathing becomes less shallow than during the period of a stressful stimulus. After several cycles of deep breathing, a person returns to the physiological type with the inclusion of all the components of the torso in the work.

During the process of vocalization to stabilize breathing, certified teachers of Estill Voice Training (*Steinhauer, 2017*) suggest the following scheme of actions:

– take a comfortable inhalation without straining any muscles, and then release the air from the lungs without any pushes or presses, where the time of inhalation and exhalation is unlimited, because everyone adjusts it for themselves;

– when the air pressure in your lungs drops to the level of atmospheric air pressure, exhalation will stop by itself and your glottis (the space between the vocal folds) will remain open, so you don't need to "hold" anything;

– wait for this, give your body time, and it will inhale when necessary. Sometimes it happens immediately, and other times you may be surprised by seconds of "rest", but none of the results are right or wrong;

– feel the "movement of the breath" during this inhalation, connect your senses to understand how your body is moving. Cover your ears to enhance your auditory senses of breathing noises when inhaling. What you see may be a visualization created by the mind, and the movement may be too small to see.

These and other exercises allow you to: not focus on individual side effects during singing and breathing in general; understand the algorithm of the torso during breathing and feel the work of the ribs, back, diaphragm and abdomen in general; reduce stress levels and avoid clavicular breathing, and so on. However, the division of breathing into different types and the search for the most correct one among them is impractical, because the process of human breathing is influenced by many factors, in particular: psychoemotional and physiological state; the involvement of ANS in the process of breath control; inclusion in the process of a group of muscles of the torso, lower ribs and spine that support singing breathing, and so on.

Muscles in the human body do not have universal rules of movement or a sequence of alternating disconnection of muscle groups during breathing, because this process involves a whole complex of different components of the torso, belonging to the so-called "large respiratory muscles", namely: rectus abdominis, external oblique muscles, internal oblique muscles, transverse abdominis, latissimus dorsi, square lower back muscle, pectoralis major muscle, intercostal muscles. Since all these muscles are involved in the formation of exhalation, their coordinated work will always be reflex, that is, the movement of the ribs, chest and other components of the torso occurs without conscious control on the part of a person (*Matthew, 2018*).

The work of the torso is closely related to the process of "supporting breathing", or "anchoring" – from the English "anchor", so "to anchor" – literally "throw an anchor", "stand on an anchor", that is, firmly rely on breathing in the process of vocalization (*Steinhauer, 2017*).

From the point of view of vocal pedagogy, it is the support on the diaphragm that gives the voice strength, reveals the singing timbre and allows it not to get tired. Among the vocal exercises aimed at the posture of singing breathing and finding the support of sound, there are also those that are firmly established in vocal pedagogy. In particular, these are strength exercises aimed at developing the elasticity and tone of the diaphragm due to the influence of external power factors on it. Among these exercises, the most common is the following: put something heavy on the diaphragm area and ask to first lift the object with the force of inhalation, and then lower the object with the force of exhalation. According to some vocal teachers, this exercise forms the ability to hold your breath and vocal support. However, recent studies in the field of vocal pedagogy have allowed us to conclude that the ratio of rib and dorsal forces of the diaphragm does not depend on an increase in nervous agitation and does not affect the breathing process both with voluntary inhalation and with involuntary one. That is, vocal support is not a consequence of the work of the diaphragm, because it does not have sensitivity receptors. This indicates that any strength exercises do not affect the development of the diaphragm, so such exercises are not appropriate and effective.

Phonators and physiologists explain the phenomenon of anchoring as a respiratory support by a complex of dynamic effects on the timbre quality of sound and the amplitude of the sound wave produced by large muscles, but which are not directly involved in voice generation (*Estill, 1990*). That is, the survey mechanism has a complex anatomy. In particular, during the formation of respiratory support, the pectoralis major and latissimus dorsi muscles work together to lift and expand the chest. The square muscle of the lower back is attached to the inner edge of the lower rib, to which the fibers of the diaphragm are firmly attached, and thus this muscle is involved in the breathing process and can regulate how slowly or quickly the diaphragm rises during exhalation. In addition, anchoring involves a group of muscles that straighten the spine and can affect other muscles of the chest and abdomen. So, while the singer performs high and powerful sounds, you can track the inclusion of almost all the torso muscles in the work to stabilize and control the air flow.

The fixation of the torso during singing was noted by V. Petersen, who found out that professional opera singers used higher levels of activity in the abdominal muscles, which made it possible to maintain a more uniform sound. Other scientists, in particular A. Watson, S. Williams, B. James, in their research concluded that compression of the latissimus dorsi muscles contributed to the expansion of the chest (*Peultier-Celli, 2020*). At the same time, the work of these muscles increased under the conditions of designing the singer's voice. Thus, the support of breathing during the vocalization process is a feeling of internal pressure from the force of contraction of the auxiliary muscles of exhalation, namely: the muscles of the upper back and intercostal muscles; the muscles of the neck and head during phonation. The last two muscle groups play the role of maintaining a uniform sound during the process of sound formation (*Pettersen, 2005*).

Since there are two modes of operation for human muscles, and breathing support is the process of muscle fiber contraction, it makes sense to consider the contrast mode of operation carried out by these structures. So, in a state of relaxation, the pastoral muscles of the torso of the upper chest and back and lower back are minimally involved. Phonation in such cases is quieter, which can be useful for quiet pronunciation and singing. When using relaxed torso muscles to form quiet sounds, the singer's voice remains stable and without anchoring. However, there are only two options available for the muscles that support breathing during the vocalization process, namely: relaxation and tension. With smooth actions such as speech and singing, the torso is rarely fixed in one of these positions.

This is because, as with the diaphragm muscle fibers, the anchoring system has its own motor tasks, which are controlled by the central nervous system and are responsible for the strength and speed of response to maintain exhalation during the singing process. So, when the vocalist uses different vocalization techniques, the anchoring force will be different or not used at all. In this case, it makes sense to consider the most commonly used techniques for performing high notes and systematize them by the strength of anchoring. In particular, this is:

– falsetto-sound formed due to the main register at the partial closure of the vocal cords with a large amount of air exhaled during the phonation process and does not require anchoring by the torso muscles;

– the main sound formed due to the main register at the partial closure of the vocal cords (it is with this type of sound that the vocal cords close only at the edges, and the vocal sound requires minimal anchoring by the torso muscles);

– mixed sound as a simultaneous sound of the chest and main registers (mixing them in a certain proportion is necessary for a specific artistic idea during the performance of a vocal work and requires medium anchoring by the torso muscles);

– "belting" as singing high notes by the thoracic type of closing of the vocal cords without mixing or with minimal mixing of the "main" type of sound of the vocal cords (this sound requires a strong connection of the anchoring system and support by all auxiliary muscles involved in this process), etc. (*Pettersen, 2005*: 255-277).

The process of anchoring in the near and middle range of the singer's voice follows the same rules as when playing high notes. That is, the richer and brighter the vocal sound, the greater its anchoring will be, which the performer can adjust according to their own feelings. However, this rule only applies in a static body position. When the singer begins to move or changes the position of the body during the vocalization process, then the indicators of anchoring and breathing in general change, as the body adapts to new conditions *(Linklater, 2006***)**. That is, during active movement, the force of muscle pressure generated during the performance of a motor task by the cerebral cortex from the ANS will be different and depends not only on the vocal aspects of the performance, but also on the stage tasks that the performer faces.

An additional aspect that can affect the process of anchoring and phonation in general is the spine as a bone structure located in the torso and consisting of a base in the form of vertebrae, intervertebral cartilage, joints of vertebral processes and a ligamentous apparatus that binds the vertebrae together (*Steinhauer, 2017*). For the process of vocalization, the position of the spine and correct posture associated with its coordination are extremely important, because the muscles responsible for the alignment of the spine are involved in the formation of breath support *(Soloviova 2006: 38-40).*

At the current level of development of physiology, the concept of "posture" is understood as the usual, relaxed pose of a person who takes it without excessive muscle tension. In a broader sense, ‘posture’ is both the position of the body in various static poses, and the features of muscle work during various movements. The presence of different approaches allowed us to group them and distinguish varieties, namely:

– dynamic posture is the support of the muscles during movement during the walking or running phase (usually the body needs to form a strong posture during movement, so the muscles that do not contract work in such a way as to adapt to changing circumstances);

– static posture is support during a static position, when body segments are aligned and held in a fixed position (usually achieved by coordination and interaction of various muscle groups that work statically to counteract gravity and other forces).

– It’s important to note that the muscles that surround the spine provide two of its opposite functions – mobility and stability. At the same time, the mobility in each intervertebral

joint is small, but the spine itself is a fairly flexible system, coordinated by the work of the muscles and ensures harmonious movements of the spine. The main role in maintaining an upright posture is played by the back muscles that straighten the spine, and the iliopsoas muscles *(Yeo, et al., 2018)*.

For the stability of the spine, pressure in the chest and abdominal cavities is important. The abdominal muscles are no less important for maintaining posture and protecting the vertebrae from injury and injury than the back muscles. Muscle traction produces curves of the spine, stimulates its normal development. A well-developed muscular corset is able to protect the spine from traumatic loads, and vice versa, a violation of muscle tone occurs with any problems in the spine. Weakness of the muscular corset and uneven muscle tone are associated with strengthening or compaction of the physiological curves of the spine or its curvature. Consequently, poor posture is the result of physiologically unjustified movements of the joints of the arms and legs, which leads to displacements of the fulcrum points of parts of the body and violations of the weight ratios of its parts (*Soloviova, 2006*). Overstrain of the entire muscle sphere is inevitable, since overstrain of muscle groups in any part of the body is always dangerous for the spine.

This was noted in her research by Kristin Linklater , who considered the spine to be the support of all breathing in general: " the general task of working with the spine is to develop physical self-awareness through specific relaxation" *(Levangie, 2011:10*). Physiologically, this can be explained as follows: when tension is removed from certain muscle groups that are included in the vocalization process, the muscles that control posture provide freedom in the body as a whole. That is, a state of relaxation and potential mobility of the body and breathing is formed: "найважливішим the most important discovery for you will be the following: the performance of the vocal apparatus depends on the alignment of the body in which this apparatus functions" *(Levangie, 2011:10*). When the spine is not level and the muscles that provide posture do not work, then its ability to support the body decreases. This occurs in the presence of such disorders as: lordosis and kyphosis (physiological, but too pronounced changes where they should not be (for example, cervical kyphosis); scoliosis (curvature of the spine to the right or left); retrolisthesis (a pathological condition in which the vertebra moves forward or backward in relation to the vertebra that is located below), etc. (*Valik, 2006*). Under such conditions, the body is supported by muscles designed for other purposes. This situation can occur with muscle weakness of a healthy person, when the lower part of the spine does not perform its functions, then the body is supported by straining other muscles (for example, the abdomen), which allows them to compensate for the needs of breathing *(Levangie, 2011)*. Or, for example, when the upper part of the spine refuses to support the chest and shoulder girdle, then the pectoral muscles come to the rescue, which because of this cannot participate in the breathing process. And, in the end, when the cervical vertebrae are not aligned, the entire sound channel narrows. If the cervical vertebrae are relaxed and unable to hold the head, this function is performed by the muscles of the jaw, tongue, larynx, even the lips and eyebrows, but then it is impossible to articulate the sound to normal phonation *(Levangie, 2011)*.

Moshe Feldenkreis emphasized this in his work "Observation of motion": 'some poses are acceptable as long as they do not begin to conflict with the natural laws of gravity' *(Levangie, 2011:11)*. The opinion of Kristin Linklater is consonant: "...the skeleton should be able to neutralize this law, leaving the muscles free to move" *(Levangie, 2011:13)*. That is, the nervous system and skeleton under the influence of gravity develop in such a way that the skeleton supports the body without spending energy, despite the pull of gravity. When muscles

do the work of the skeleton, they not only support the body, but also use additional energy. That is why they are protected from performing an unusual function by the ability to change the position of the body, that is, to exclude movement.

So, the first step to a beautiful and healthy voice is to get to know your spine *(Levangie, 2011:12)*. That is why muscle exercises for the back and strengthening the muscles of the lower limbs, or muscles that provide a long vertical pose, will be useful. For independent classes or for classes in the vocal class, it is advisable to use elements of aerobics using special balls "resist-a-ball". Such exercises help to strengthen the muscular corset, train dynamic posture, a sense of natural coordination, etc.. At the same time, it is necessary to train the muscles of the back and abdominal press, which are extremely important for correct anchoring during the vocalization process. Exercises "resist-a-ball" can be recommended for people of different age groups with different degrees of physical fitness and can add a game element to the process of voice training (*Soloviova, 2006*).

In vocal pedagogy, the concept of "posture" is associated with the position of the torso and the interaction of its various parts. The best position for the phonation process is a body position in which the abdominal press is stretched, and the chest is in a free, unfolded state. This posture can be provided when training the back muscles. Taking into account recent research in the field of physiology, we can say that a person is physiologically able to maintain correct posture in any position, but the spine must maintain a straight position, which in fact guarantees the correct work of the muscles that support the spine (*Traser, 2020*). That is, under the conditions of proper physical effort, singing becomes possible in various positions, which can be provided by postural control and the work of the ANS, which correctly regulate the position of the torso during the vocalization process.

Therefore, while singing in a sitting position, experts advise to carry out the main support on the back and legs, because under such conditions the abdominal press gets the best opportunities for anchoring. The expanded chest creates optimal opportunities for the work of the respiratory muscles and diaphragm. However, to do this, all the muscles involved in the proper functioning of posture must be well developed (*Traser, 2020*). That is why it is important to know what exercises strengthen and improve this apparatus for the further vocalization process.

3. Conclusions

The complex and insufficiently studied issue of the function of the human torso in the organization of the vocalization process is complex due to its multidimensional and multidirectional nature. Specialists in various fields that are closely related to vocal pedagogy solve the influence of different components of the torso on the vocalization process in different ways. However, the didactic discourse of the stated problem itself and its implementation indicate the right vector in its understanding, which is an important step towards reaching the solution to the problem.

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