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A REVIEW OF THE PHYSIOLOGICAL FUNCTION OF *PRAN VAYU* AND ITS CORRELATION WITH CONTEMPORARY SCIENCE

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ABSTRACT

In *Ayurveda*, *Tridosha* is a unique concept and has summarized all the bodily functions and phenomena in three biological entities called *Vata*, *Pitta*, and *Kapha*. Among *Tridosha*, *Vata* is undoubtedly the most fundamental and crucial *Dosha* for survival. It is derived from the root word '*Gati'* means movement and '*Gandhaya'* means senses, and knowledge perception. *Vata Dosha* is the most important factor of *Tridosha* which is responsible for controlling all types of movements. Among five *Vata Dosha*, *Prana Vayu* is situated in the head and travels across *Urah* (thorax region) and *Kantha* (throat region). It is reasonable for the functioning of spitting, sneezing, eructation, respiration, and deglutition and also maintains the proper functioning of *Buddhi* (intelligence/judgment), *Hridaya* (heart), and *Chitta* (mind). Hear head refers to the brain and brain stem as it controls all these functions. All the functions of *Prana Vayu* are compared to modern medical science. Basically, the functions of the limbic system, cranial nerves, cerebral cortex, basal ganglia, and other structures might be compared with the functions of *Prana Vata*. Most of the *Vatik* disorders discussed in *Ayurveda* are being diagnosed under neurological disorders in modern medicine.

Keywords – *Ayurveda*, *Vayu*, *Prana Vata*, Modern Science.

SITE AND FUNCTION OF *PRANA VATA* BY DIFFERENT *ACHARYA*:

The location of *Prana* is the vertex, thorax, trachea, tongue, mouth, and nose and it performs functions of spitting, sneezing, eructation, respiration, deglutition etc.[1] The *Vayu* which moves inside the mouth is known as *Prana Vayu*. It supports the body function, helps in deglutination, and sustains the functions of prana.[2] *Pranavata* is located in *Murdha* and it traverses along *Uras* (thorax), and *Kantha* (throat), it maintains the proper functioning of *Budhhi* (intelligence/judgment), *Hridaya* (heart), and *Chitta* (mind). It also performs functions such as *Sthivana* (spitting), *Ksavathu* (sneezing), *Udgara* (belching), *Nisvasa* (respiration), and *Annapravesha* (deglutination).[3] Here *Hridaya* is annotated as *Adhisthan* of *Mana*.[4] *Prana* is situated in the head and moves in the throat and chest. It controls or maintains the intellect, sense organs, heart/brain, arteries (blood vessels), and functions of supporting, expectoration, sneezing, belching, breathing, and swallowing of food.[5] Here *Hridaya* is annotated as *Adhisthan* of *Buddhi Adhara Bhutam*.[6] *Sharangdhar* refers to the location of *Prana Vata* at *Nabhi*. After reaching the proximity of the heart it passes outside through the throat to consume a nectar-like substance called *Vishnupadamrita* (oxygen) from the external atmosphere. After consuming within no time through the same route it gets back into the body. This *Prana Vayu* maintains the entire body and nourishes the *Jiva* and *Jatharagni*.[7] In all textbook sites, *Prana Vayu* is mentioned as *Murdha*. But *Acharya Sharngadhara* has mentioned it as *Nabhi*. The term *Nabhi* in *Sanskrit* means a center. This has to be perceived as a center in the head i.e., the respiratory center. The proximity of the heart means lungs. According to *Acharya Sushruta*, *Jiva*, and *Rakta* are synonyms.

MOVEMENT OF *PRANA VATA*:

The *Gati* or movement of *Prana Vayu* is in the entire body considering its functions. It can travel from all directions to all directions as it is extremely powerful. For upward to downward, it includes *Nihswas*, anna *Pravesha*, for downward to upward it includes *Sthivana*, *Kshavathu*, *Udgara*, for entire body movements it includes *Hridaya-Chitta Dhrik*, *Prinayan Deham Akhilam Jivam Cha Jatharanalam*. The swash function includes both inspiration and expiration. Normal expiration is not *Pratiloma Gati* of *Prana Vayu*. *Pratioma Gati* is the reverse movement of *Prana Vayu*. *Pratioma Gati* has to be associated with *Kapha* to cause *Swasa* and *Hikka* and others. *Pratiloma Gati* means there is variation in the movement of *Prana Vayu* that may be upward to downward, downward to upward, or overall entire body movements. These variations appear due to *Avarana*. For example, *Anna Praveshakrit*, and *Prana Vayu* help in entering the food from outside to inside or from upward to downward. If there is variation in the movement of *Prana Vayu*, *Hikka* is produced.

MODERN ASPECTS

The primary site of *Prana Vayu* is the head. Here is an attempt to compare the function of *Prana Vayu* with its modern aspect as per contemporary science.

***STHIVANA*:**

Sthivana means the function of spitting. It is the action of ejection of saliva or other substance from the mouth which is conducted by the nucleus of the facial nerve. It is the seventh cranial nerve containing sensory, motor, and parasympathetic nerves. The sensory fiber carries the sensation of taste from the anterior 2/3rd of the tongue to the brain. The somatic motor fibers of the seventh cranial nerve supply the muscle of facial expression and the muscle of the scalp. Its nucleus is located in the pons. The parasympathetic fibers arise from the superior salivary nucleus and supply to the submandibular as well as sublingual salivary gland.[8]

***KSHAVATHU*:**

Kshavathu means the function of sneezing. It means to throw out mucus containing foreign particles or irritants and cleanse the nasal cavity. It is reflex action when any dust particles disturb the nasal passage. A reflex action contains a receptor, a sensory nerve, an integrating center, a motor nerve, and an effector. The receptors which are nerve ending in the nasal pathways detect an irritant. The maxillary branch of the trigeminal nerve transports these impulses to the sneezing center of the brain stem. The sneezing center sends the information to the facial nerve along with the nerves that lead to the lungs and diaphragm. Then eyes begin watering, the nasal mucosa secretes fluid, and the diaphragm moves to take a deep breath. Then the muscle in the chest contracts and it causes the air to leave the nose and mouth suddenly. The whole function is under the control of both the trigeminal and facial nerves.[9]

***UDGARA*:**

Udgara means belching reflex which is a polysynaptic visceral reflex. It is found in a period of fewer than two seconds. It is formed of three independent reflex responses. Due to the contraction of the lower esophagus and diaphragm, there is inhibition of the muscle barrier between the stomach and esophagus. It is the first belching reflex. This reflex is triggered by air causing tension in the muscle fibers of the wall of the stomach that is under the esophagus. So, the air bolus rapidly escapes into the lower esophagus which is under pressure from the stomach wall. This reflex is determined by the brain through the vagus nerve. The rapid movement of air into the lower esophagus concurrently activates the other two reflexes. The inhibition of the muscle barrier between the esophagus and pharynx is the second belch reflex. It is developed by pharyngeal muscles. This reflex also activates muscles whose main function is to pull the esophago-pharyngeal barrier open. It is the rapid air movement across the pharynx that causes the sound of the belch. This reflex is also mediated by the brain through the vagus nerve. At the same time, the third belch reflex is activated. It begins a contraction wave of the upper esophagus which moves upward toward the mouth bringing the air bolus to the top of the esophagus. This reflex is possibly decided by the spinal cord. The result of these two reflexes is to propel the air bolus from the lower esophagus into the oral cavity. The area postrema which is in the medulla or hindbrain primarily controls the belch response.[10]

***SWASA*:**

Swasa means the process of respiration. The group of neurons is located bilaterally in the medulla oblongata and the pons of the brain stem is the respiratory center of the brain. It is branched into three major colons of neurons. A dorsal respiratory group is situated in the dorsal portion of the medulla and it causes inspiration. A ventral respiratory group which is located in the ventero-lateral part of the medulla mainly causes expiration. The pneumotaxic center which is present dorsally in the superior portion pons mainly controls the rate and depth of breathing.[11]

***ANNA PRAVESHA*:**

It consists of mastication, salivation and deglutination. The fifth cranial nerve i.e., the trigeminal nerve is a mixed type of nerve. The motor fibers which supply the muscle of mastication arise from the nucleus in the pons. The seventh cranial nerve i.e. facial nerve contains sensory, motor, and parasympathetic fibers. The parasympathetic fibers arise from the superior salivary nucleus and supply the submandibular and sublingual salivary glands. The 9th cranial nerve i.e. gloss pharyngeal nerve contains sensory, motor, and parasympathetic fibers. The motor fibers arise from the nucleus ambigus situated in the medulla and supply the stylopharyngeal muscle. The 10th cranial nerve i.e. vagus nerve contains sensory, motor, and parasympathetic fibers. The somatic efferent fibers arise from the nucleus ambigus and supply the laryngeal and pharyngeal muscles. The 11th nerve (accessory) is purely a motor nerve. Its spinal root supplies the sternocleidomastoid and trapezius muscle whereas its bulbar root supplies some of the muscle of the larynx, pharynx, and soft palate. The 12th cranial nerve i.e. hypoglossal nerve contains only motor fibers that arise from the medulla. It supplies the muscle of the tongue.[12] The sensitive tactile areas of the posterior mouth and pharynx are present in a ring around the pharyngeal opening. It helps to initiate the pharyngeal stage of swallowing. Impulses are transmitted from these areas into the medulla oblongata, either into or closely associated with the tractus solitarious through the sensory portions of trigeminal and glossopharyngeal nerves. Then the medulla oblongata receives all sensory impulses from the mouth. The stages of the swallowing process are started by the medulla and lower portion of the pons. The areas in the medulla and lower pons are called the swallowing center. The motor impulses are transmitted by the 5^{th}, 9^{th},10^{th}, and 12^{th} cranial nerves.[13]

According to modern science[14]

This function of *Prana Vayu* can be correlated with deglutition. The process of deglutition is conducted in three stages. During these three stages, systematic movements of different muscles and organs take place and food in the oral cavity is swallowed. These movements are as follows –

1st stage – Oral preparatory stage – Movements – 1. The anterior part of the tongue is retracted and depressed. 2. Posterior part of the tongue is elevated and retracted against the hard palate. 3. Hard palate is lifted upwards and food is pushed into the pharynx.

2nd stage – Pharyngeal stage – Movements – 1. Due to the entry of food into the oropharynx, impulses are generated in the deglutition center in the medulla and pons. 2. Soft palate and uvula move upwards to close the nasopharynx. 3. Opening of the larynx is closed by the epiglottis and the bolus enters into the esophagus. **3rd stage** – esophageal stage – Movements – 1. As food enters the esophagus, the upper esophageal sphincter closes. 2. Peristalsis – Circular muscles from the superior part of the bolus contract and longitudinal muscles inferior to the bolus contract to shorten the inferior section of the bolus. The food is pushed forwards. 3. Lower esophageal sphincter relaxes as food approaches it. Food enters the stomach. It can be stated that for the above movements of muscles and organs during deglutition, *Prana Vayu* is responsible for *Pranavaha Srotasa*.

***HRIDAYA DHARANA*:**

It holds the function of the heart. The parasympathetic motor fibers of the vagus nerve, arising from the dorsal motor nucleus situated in the floor of the fourth ventricle, in the medulla. The fibers supply the viscera of the thorax (heart and lungs) and the gut in the upper abdomen. The vasomotor center controls the activity of the heart. Whenever there is a need to increase heart rate and contractility, the lateral portion of the vasomotor center transmits excitatory impulses through the sympathetic nerve fibers to the heart. On the contrary, the vasomotor center sends a signal to the adjacent dorsal motor nuclei of the vagus nerve whenever there is a requirement to decrease heart pumping, which then transmits parasympathetic impulses through the vagus nerves to the heart. It causes a decrease in heart rate and heart contractility. Therefore, the vasomotor center has an important role in either increasing or decreasing heart activity. Every part of the reticular substance of the pons, mesencephalon, and diencephalon carries a large number of small neurons. These neurons can either excite or inhibit the vasomotor center. The vasoconstrictor system is controlled by the hypothalamus. It brings powerful excitatory or inhibitory effects on the vasomotor center. The vasomotor center can also be excited or inhibited by many parts of the cerebral cortex. The vasomotor center is excited by stimulation of the motor cortex because the impulses are transmitted downward into the hypothalamus and then to the vasomotor center. Also, stimulation of the anterior temporal lobe, the orbital areas of the frontal cortex, the anterior part of the cingulated gyrus, the amygdala, the septum, and the hippocampus can either excite or inhibit the vasomotor center. These are depending upon the precise portion of areas that are stimulated and the intensity of the stimulus.[15]

***BUDDHI INDRIYA CHITTA DHARANA*:**

Buddhi means *Intelligence*, *Indriya Dhaarana* means all sensory and motor functions, and *Chitta Dhaarana* means the function of mana (mind). Things requiring thought, consideration, hypothesis, attention, determination, or whatever can be perceived by the mind, are regarded as their objects. Control of sense organs, self-restraint, hypothesis, and consideration represents the action of the mind. Beyond that flourishes the domain and intellect.[16] Apart from this memory, emotion, and knowledge through direct perception, inference, analogy, and verbal testimony are considered to be the function of the mind. Emotional behaviour and encouragement are basically controlled by the limbic system. The Hypothalamus, the septum, the para-

olfactory area, the anterior nucleus of the thalamus, portions of basal ganglia, the hippocampus, and the amygdala are the basic structures in the limbic system. Hypothalamus is one of the central elements of the limbic system. Limbic structures are concerned with the affective nature of sensory sensation whether the sensations are pleasant or unpleasant. These affective qualities are also called reward or punishment functions. The major reward centers are situated in the lateral and ventromedial nuclei of the hypothalamus. The most potent areas for punishment are found in the central grey area surrounding the aqueduct of Sylvius in the mesencephalon. It extends upward into the periventricular zones of the hypothalamus and thalamus. The reward and punishment centers control our bodily activities, our unwillingness, and our motivations.[17] Incoming sensory signals can introduce behavioral reactions for different desires through Hippocampus. It can cause any of the different behavioral patterns such as happiness, anger, obedience, or excess sex drive. It can become hyperexcitable. Hippocampi can exhale prolonged output signals even under normal conditions. Hippocampus originated as part of the olfactory cortex. Very early in the evolutionary development of the brain the hippocampus most probably became a critical judgment-making neuronal mechanism, determining the significance of the received sensory signals. Once the critical decision-making capability had been recognized, the remnants of the brain also began to call on the hippocampus for decision-making. The hippocampus also supplies the drive that causes the conversion of short-term memory into long-term memory. The amygdale appears as behavioral awareness areas that operate at a semi-conscious level. The amygdala makes the person's behavioral response suitable for each event. The ability of the prefrontal areas to keep track of many beats of information concurrently and to cause recall of this information immediately as it is needed for subsequent thoughts. So, it is called the brain's working memory.[18] Learning is described as the process of acquiring knowledge while memory is the process of storing knowledge. The neural mechanism of thoughts is not clearly illustrated in texts. Destruction of a large portion of the cerebral cortex reduces the depth of the thoughts and degree of awareness of the surroundings but it does not prevent a person from having a thought. Each thought involves instantaneous signals in many portions of the cerebral cortex, thalamus, limbic system, and reticular formation of the brain stem. A thought results from a pattern of stimulation of any part of the nervous system most importantly the cerebral cortex, thalamus, limbic system, and upper reticular formation of the brain system. This theory is described as the holistic theory of thoughts. The general nature of thought is determined by the stimulated area of the limbic system, thalamus, and reticular formation. It gives the qualities like pleasure, displeasure, pain, comfort, and crude modalities of sensation localization to all the areas of the body. Memories are stored in the brain. It changes the basic sensitivity of synaptic transmission between neurons. The facilitated pathway is called memory traces. They are important because once the traces are recognized; they can be selectively activated by the thinking mind to repeat memories.[19] Wernicke's area is important for language comprehension. It is situated behind the primary auditory cortex the posterior part of the superior gyrus of the temporal lobe. It is the most significant region for higher intellectual function. All the intellectual functions are language based. An angular gyrus area is needed for the initial processing of visual language (reading). The anterolateral region of the occipital lobe lies posterior to the language comprehension area. It is a visual association area that feeds visual information suggested by words read from a book into the

Wernicke area. The limbic association area is found in the anterior pole of the temporal lobe, in the ventral portion of the frontal lobe, and in the cingulated gyrus lying deep in the longitudinal fissure on the mid surface of each cerebral hemisphere. It is concerned primarily with behavior, emotions, and motivation.[20] The basal ganglia help plan and control complex patterns of muscle movement. Relative intensities of the separate activities, way of movements, and sequencing of multiple successive parallel movements to achieve specific complicated motor activity are regulated by basal ganglia.[21]

DISCUSSION

Basically, *Vata*, *Pitta*, and *Kapha* constitute three regulatory systems i.e., nervous, endocrine, and immune systems respectively of all living systems. Among such important *Tridoshas*, the supremacy of *Vata* is explained by all our *Acharyas*. *Vata* is the only principle having a predominance of *Vayu Mahabhuta* and its main *Lakshana* is *Gati* (movement) and *Gandhana* (knowledge perception). It is generally attributed to the nervous system of contemporary science presenting the same functional properties. As per *Ayurveda* Science *Murdha* (head region) is the primary site of *Prana Vata*. Because it is the region where all pranas are situated and all sensory and motor activities are controlled from. That is why the head is called the most superior organ among all organs of the body. Head in this context refers to the brain. *Indriyas* stand for sensory, motor organs, and mind.[22] All sensory and motor organs with their *Pranavaha Srotamsi* are basically attached to the brain in a fashion homogeneous to the connection between the sun rays and sun which means different descending and ascending tract comprising of individual neurons in the nervous system connects the CNS with peripheral structures.[23] The mind is situated between the head and palate. Its efficiency is beyond any other sensory and motor organ. It perceives all sensations. The site of mind explained in the statement indicates the situation of the brain in the cranial cavity and its functioning.[24] From the above details as per the functions of *Prana Vayu*, it can be compared with many structures like cranial nerves regarding *Sthivana*, *Kshavathu*, *Udgara*, and *Anna Pravesha*. Medulla may be compared for the functions of *Swasa* and *Udgara*. The limbic system, basal ganglia, somatosensory area, somatic association area, primary motor cortex, premotor cortex, supplementary motor area, Wernicke's area, and vasomotor centre may be compared with *Budhhi Hridaya Indriya Chitta Dhrik*.

CONCLUSION

It can be concluded that the *Prana Vata* cannot be limited by simply comparing it with the central nervous system as *Vata Dosha* is involved in any systemic activity. So, the functions of *Prana Vata* can be partially correlated with the functions of the central nervous system. There is a need for further research to evaluate in detail of all other *Vata Dosha*, *Kshaya*, *Vriddhi*, and *Avarana* for the betterment of mankind.

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