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Vocal apparatus and its use by the singers

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Abstract

For a vocalist the vocal cords contained in the sound box are the most important organs expressing in a manifest form an ordered array of sounds stored in the musicians' brain, in an unmanifest form. The English call it 'vocal box' and scientists name it 'larynx'. This vocal box containing the vocal cords is used by man to develop speech, language, and music as we perceive or render them today. Disciples are guided to follow several practices to acquire and produce good voice. A balance of practice and rest is suggested to prevent any damage (temporary/ permanent) to the voice and to keep it healthy. This paper evaluates these practices with regards to the anatomy of the voice box. It gives an overview of the various parts of the voice box and how these are used for producing sound and vocal music. It gives information on their use by different Hindustani Classical vocalists to give perfect rendition.

Key words: Vocal cords, Voice production, Volume, Pitch, Registers, Range

Research Paper

Basic structures of the voice box are similar in singers and non-singers. However, difference mainly lies in the manner these parts are used by the two. Certain finer changes in these structures may occur over a long period of time in some singers. Excessive use of muscles related to the sound production, requires good blood supply. This may result in visible blood vessels in organs associated with singing in the professional performers. Several structures of the voice box work in harmony to deliver accurate rendition. Precise controls of air pressure created in the glottis by the lungs (actuator), its passage through the partially closed vibrating vocal cords (vibrator), resonance in the spaces - larynx, pharynx, and nasal cavity and mouth (resonators) and articulation by lips and the tongue (articulators) makes a perfect singer. For this one must build-up the vocal strength giving adequate rest to the vocal box to avoid over exertion and damage. Generally, a rest of 10 min after every hour and a half of practice/ performance is suggested.

The vocal cords (Fig 1)

The vocal cord is a flat band, pearly white in colour but whiter in the female than in the male. It consists of a mesh of yellow elastic tissue in which many fat cells are embedded. Size of the vocal cords increases from birth to the adulthood. The length of the vocal cords is usually larger (17-25 mm) in the males than females (12.5 to 17mm). The ratio of the length of the vocal cord to the diameter of the larynx (1:1.5) is maintained in the females and until puberty in the male. At puberty in the male the ratio is altered to 1:1.3 over a short period of time due to the increase in length of the vocal cords. Because of the sudden transition, control of the voice is temporarily lost, and the voice tends to crack until such time as it has completely broken and settled. After this change vocal control is regained in a lower key than before, by as much as an octave at its lowest limit. During the transition of the voice, the teenage boys are advised not to strain their vocal cords beyond a certain limit. As per Ustad Amir Khan, he used to practice mentally more in those years when his voice was undergoing a natural change.[1] Extensive vocal practice in that period may cause an irreparable damage to the vocal cords.

It is not only the length of the cord which determines the pitch of the voice but also the total mass of vibrating cord. In the female not only are the cords shorter than in the male, but its free edges are also sharper. In the males

this is more rounded and a greater area of cords come into contact. The anatomical differences are responsible for the characteristic quality of the voice in the male and the female.

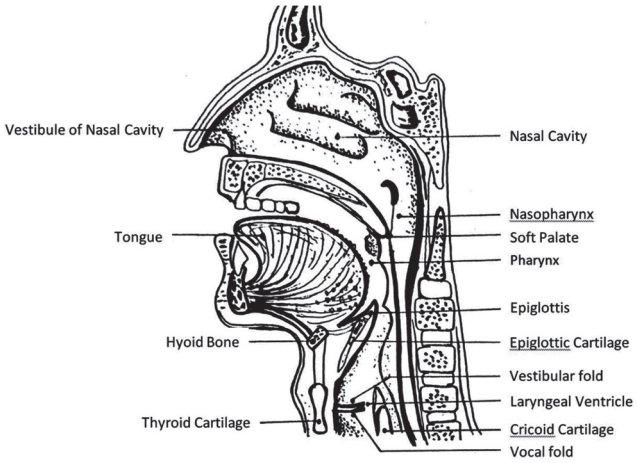

Fig 1: Paramedian section through Larynx, Pharynx, Mouth and Nose

Overuse of the voice while performance /practice may result in formation of the lesion or nodule in the vocal cords.[2] Pain or discomfort in the throat and more than two weeks of change of the voice are the signs of the damage to the vocal cords needing medical interventions. Singers are also suggested not to perform or practice just after the meals as it may result in reflux of the acid from the stomach to the mouth that may damage the vocal cords. In fact, experienced Gurus advise to keep stomach empty before a performance. It is said that just as the Tambura sound resonates due to the hollowness in its Tumba similarly one must not fill stomach prior to singing for a good resonance in singing.

Voice production

Two main mechanisms are involved in the voice production:

Air passes through the space below the vocal cords (glottis) which are closed/ partially opened

A) The respiratory bellows

Just as in Harmonium, the outside air is thrust inside the instrument and when this air passes through the reeds, a sound is produced, same way the inhaled air when expelled helps in voice production. The bellow is provided by the lungs and the muscles of expiration in the thorax and abdominal wall. When the intra-thoracic and infra-glottic pressures reach an adequate level, the vocal cords are set in vibration with the production of a laryngeal tone. The effortless tone is 'Shadja'. Controlled respiration is the key to good singing. One must fill the air in the lungs quickly and release it at a stable controlled rate for fine singing.[3] Yogic and physical exercises increase the lung capacity. Kapal Bhati pranayam is one such yogic exercise.

B) The reeds of vibrating mechanisms (Fig 2-6)

The human voice is both a stringed and wind instrument, the reeds being the vocal cords; but, unlike those in other instruments, these reeds are flexible and mobile. Different notes of varying pitch, quality and intensity are produced by varying size and shape of the vibrating cords. As the column of air is forced through the narrow aperture of the glottis, the vocal cords, and particularly their edges are set in vibration. Segmental vibration of the cords adds harmonics to the basic tone produced.

The adducted vocal cords are set in vibration during phonation. The cord movements have a vertical as well as a horizontal component. The vibrations may involve the entire length of the vocal cords or only segments of the same. The duration of the closed contact of the cord varies with the pitch of the note produced, the lower the note, the longer the period of closure. The air-stream cut up into a series of very rapid puffs produce a tone.[4] The force or power of the airstream determines the volume or loudness of the tone. The other theory postulated is that the movements are due to the rhythmic contraction and relaxation of the (thyro-arytenoid) muscles and are independent of the airstream. Perhaps a better explanation could be the combination of both of these theories

Pitch

The pitch of the tone is determined by the length and tension of the vibrating segments of the cords, the configuration of the contact areas of the cord edges and the air pressure. In the production of the lowest tones, the so-called chest register, the cords are broad, their tension is relatively low and the whole length vibrates. The sub-glottic air pressure which governs the intensity and loudness of the tone has a very slight effect on the pitch, there being a tendency for the note to 'sharpen'.[5] The tendency to 'sharpness' is corrected by a corresponding reduction in the tension of the cords in the well-trained singer. As the tones produced rise in pitch a gradual lengthening of the vocal cord is observed. As the pitch of the tones produced rises, larynx as a whole rise. It is a tendency generally held to be undesirable in singing. Most well trained singers will have corrected this tendency during the period of training. This is one of the most important factors for optimizing the impact at its origination.

Volume

The loudness of a note is governed largely by the sub-glottic air pressure. The higher the pressure the louder the voice. With the invention of electronic gadgets enabling the control of loudness, it does not continue to be as important as in the past. The relief thus afforded has enabled the modern musicians to concentrate more on intricate nuances essential for the melody predominant Hindustani music thus further refining the already rich old style.

The resonators

The pure laryngeal sound in itself is thin and weak. Several anatomical factors influence the quality or timbre of the voice. The most important of these are the thoracic cavity and tracheobronchial tree, larynx, pharynx, soft palate, oral cavity, nose and nasopharynx, paranasal sinuses, and lips and tongue.

The thoracic cavity

Perhaps all parts of the thoracic wall and particularly the sternum act as sounding boards. There are two sets of inter-costal muscles present between the two ribs - internal and external inter-costal muscles. The ribs are pulled downwards with the help of internal intercostals. As a result, the air is expelled out. The external intercostals govern the breathing-in process by pulling the ribs in upward direction. Slow, controlled escape of air from the lungs causes the least degree of alteration in size of these lower resonators. Hence sufficient air capacity and the efficient control of breathing give the best results in singing, the latter being acquired through training.**[6]**

The pharynx

During phonation the pharynx is open in varying degrees. The capacity and shape can be varied by movements of the tongue and action of the constrictor muscles. Elevation of the larynx when singing up a scale greatly reduces the size and dimensions of the pharynx. Contraction of the muscular walls of the pharynx can greatly influence the quality of the voice.

The soft palate

The soft palate can shut off the nasal and nasopharyngeal resonators from the larynx and is hence of considerable importance, it is raised in all pure vowel sounds. Many famous teachers and singers lay particular emphasis on correct positioning of the soft palate so that their tone and tenor are appropriate. This we can feel in the singing of great maestros, particularly Late Abdul Karim Khan, Late Naseer Ahmed Khan, Late Pt Jasraj and Late Ganesh Ramchandra Behra Buwa.

The Oral Cavity

The oral cavity has a semi-rigid roof, the hard and soft palate, and its outer walls and floors are composed of soft tissue. The dimensions of the hard palate, particularly the length and degree of doming, affect the quality of the voice. Racial characteristics may play a part in this feature of the supraglottic resonators. Negro singers by virtue of the dimensions of these resonators often have a characteristic quality of voice. The position of the tongue can appreciably alter the capacity of the oral cavity. It is often stated by singers that if the tongue is kept flat, with the tip in contact with the posterior aspect of the lower incisor teeth, it ensures that the capacity of the oral cavity is kept at a maximum and maintains an open throat. Elevation of the tongue is a frequently encountered fault in untrained singers. The lips, teeth, and tongue are of particular importance in articulation of consonants. The trilled "r", as in Hindi, is produced by the tongue tip tapping rapidly against the teeth. The uvula trilled "r", as in French, consists of a rapid succession of contacts and releases between the uvula and the back of the tongue [7]. The best use of oral cavity is made possible by considering it to be a bell, the tongue being the tong of the bell.

Nose and Nasopharynx

These two resonators are inseparable. The effect of the nose as a resonator is great. The nasal cavities act as resonators because the contained air is thrown into forced vibrations. Hence, anatomical defects such as a deviated nasal septum or inflammatory processes can affect the timbre of the voice. In spite of the frequently mentioned term sinus tone amongst singers and vocal teachers, the paranasal sinuses themselves do not appreciably alter the resonance of the voice[4,7].

The registers

As variations in pitch occur during singing, certain changes are observed in the vocal cords themselves. In the very lowest notes, the whole length of the vocal cords vibrate and the free edges are thickened and rounded (Fig 2). With a rise in the pitch there is progressive thinning or sharpening of the opposing vibrating edges. In the highest notes only the membranous parts of the cords vibrate and the amplitude of the vibrations

diminishes as the pitch rises. It must be remembered that the characteristic sound of a note in a particular register depends not only on the changes in the vocal cords but on the resonators called into play. Hence in the chest register the singer experiences a maximum sense of vibration in the thoracic cavity, while in the uppermost notes in the head register this appears to be experienced mainly in the head. Some singers refer to a middle register (in addition to these two main registers). In the inadequately trained singer, the listener can often hear a distinct 'break' as the voice passes from the one register to another. Correct training and the intelligent use of the voice enable the artist to pass from one register to another with no audible break and a resultant seamless scale, the voice having the same quality throughout its range. This is perhaps most enjoyably demonstrated in the recordings by Ustad Amir Khan and Ustad Bade Gulam Ali Khan.

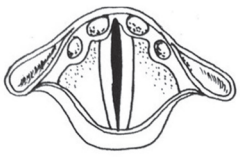

Fig 2. Position of Vocal cords for the lower range of chest notes

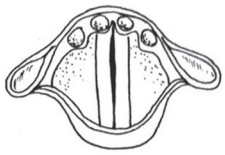

Fig 3. Position of Vocal cords for the higher range of chest notes

Fig 4. Position of Vocal cords for head notes

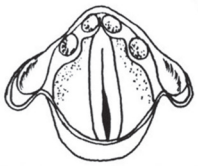

Fig 5. Position of Vocal cords for falsetto notes

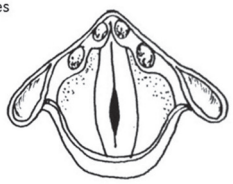

Fig 6. A very exceptional position of Vocal cords for head notes

The coup de glotte

Good singing requires that the tone should start rapidly and smoothly and be accomplished in such a manner that the throat offers no resistance to the out-flowing breath. Many celebrated singers and singing teachers have taught the coup de glotte as the best starting point in the training of the voice. In this, "before the onset of tone, the air accumulates under the tightly closed vocal cords being released by a sharp opening and closing of the glottis" [8]. If the mechanism of the larynx is not clearly understood by the singer, this method can cause damage. When, however, the mechanism is fully understood, as it was by Ustad Amir Khan and Roshnara Begam, onset of voice will be instantaneous and smooth. It must not be practiced without expert knowledge and guidance.

Range

In normal conversation, the frequency of 80 Hz in adult man to 400 Hz in adult woman, extending barely an octave is common. In well trained musicians specially practising range - improvement, this may exceed 3 octaves (3.5 in Ustad Nasir Ahmad Khan, Ustad Bade Gulam Ali Khan and Begam Parveen Sultana). Absolute copying is not so desirable as ingenuity and creativity further refined by copying to the extent of enriching one's own originality.

Conclusion:

The quality of larynx hardly differs amongst a reputed vocalist and an ordinary non-musical person. The musicianship is the combination of natural gift, interest and practice, emotivity and will-power. Precise control of various structures in the voice box is required to deliver accurate rendition. The vocal cords have limitless potentials. However, excessive use of vocal cords may lead to muscular fatigue and temporary or permanent damage to the cords, therefore, rest for 10 min is suggested after every 90 min of performance.

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