RELATING HUMAN VOICE ANATOMY TO SINGING AND ITS TRAINING AS A MUSICAL INSTRUMENT

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ABSTRACT
In this paper, the place of human voice as the most beautiful of the musical instruments which art or nature has made at its best was established. The anatomy and physiology of the vocal organs which include the nose, oral cavity, tongue, pharynx, larynx, diaphragm and lungs that make up the human voice that we hear in singing were discussed and some tips that will enable the effective use of the voice as a musical instrument were given. Application of some basic, special and specific vocal exercises for vocal training was also suggested. Similarly, correct body alignment and other techniques for better voice production were presented. The study also offered some lessons on breath control during singing.
Keywords: Voice, Musical Instrument, Vocal Organs, Voice Production

INTRODUCTION
The voice, according to Oxford Advanced Learner's Dictionary is defined as "sound formed in the larynx and uttered through the mouth by a person speaking or singing". Similarly, the Cambridge Advanced Leaner's Dictionary defined voice as "the sounds that are made when people speak or sing". Hence, voice can be said to be principally meant for speaking or singing. So while the author appreciates the first function of voice (speaking), this paper addresses the second function which is singing. Indeed, voice is the raw material for producing songs and the level of appreciation of songs can depend largely on the quality and sonority of the singer's voice.

From time immemorial, singing has been the most widespread and spontaneous way of making music (Machlis, 1963:7). It is a prime source of music. Riggs (1985:113) says of singing thus: "Artistically speaking, singing is using your voice in a musical manner to communicate ideas and emotions to an audience. Technically, however, singing is nothing more than sustained speech over a greater pitch and dynamic range". When one talks of singing, one is inadvertently talking about voice as an instrument of music. Voice as a musical instrument given by nature to man existed before any man-made musical instrument;

therefore no instrument can outlive or has outlived the human voice. It is the oldest of all musical instruments.

The possession of a voice is the foremost requirement of singing. Graves (1954) rightly notes that:

> The first thing required of every singer is to have a voice. By a voice I do not mean simply the product of the vocal cords, the breathing apparatus and the resonance chambers, which every normal human being possesses, but a voice which can be listened to without distaste and which does not deviate seriously from the melodic line it endeavors to follow in singing – in other words a voice which is more or less true. (p. 3)

The human voice has its tone–colour and quality and when in bad quality and ill nurtured, is an unpleasant phenomenon but at its best remains the most beautiful of all musical instruments. The voice is a musical instrument given by nature as a gift even though all cannot use it effectively for singing. Song is the most natural form of music issuing from within the body. It is projected by means of the most personal of all instruments, the human voice (Machlis, 1963:7). Supporting Machlis's statement, Linklater in Hampton and Acker (1997:12) highlighted the voice as "air and vibration; it is infinitely malleable, transformable and expressive. It can communicate more intimate nuance over a greater distance than the body can. It is the bridge between souls".

There are some instruments that can compare in beauty with the human voice, instruments like flute, clarinet, piano, violin, cello, et cetera. But none can combine speech with music and carry a direct message to the ear of the listener. The combination of speech with music, which is only possible with the human voice, is absolutely the clear-cut distinction between the voice as an instrument and other man-made musical instruments. According to Kamien (1976:10) "the voice's unique ability to fuse a word with a musical tone is the reason that poetry and singing have been inseparable in many cultures". Singing, as a familiar way of, making music cannot be separated from any culture; it is part and parcel of any culture of the world. On voice, Kerman (1972:14) asserts that the most distinctive tone colour of all however belongs to the first most beautiful and most widely used of all the sources of music - the human voice.

Production of Voice

A voice does not just come about. Certain things make up the voice we hear in singing. Vocal cord vibration and resonance are the two factors involved in creating the voice. For a voice to be produced by a singer, certain organs in the body function in one way or the other to bring it about, as Graves (1954) writes:

> The voice is produced by directing a stream of air taken into the lung and controlled by the muscles of the rib and the diaphragm on to the vocal cords situated in the larynx and distributed thence through the open throat into the numerous resonance chambers formed by the mouth with the soft and hard palates and teeth and the nasals, face and head cavities as well as the regions of the chest, which also act as sound boxes. (p. 14)

"Voice is primarily a result of the vibrations of the vocal cords, the nature of vibrations being dependent on the respiratory muscles" (Rose, 1962: 69). Greenish (1953:103) has a similar definition of voice as Arnold Rose, "The sound that issues from the mouth, and which is produced by the vibrations of the vocal cords". The vocal cords continually adjust to meet the pitch and dynamics (the degree of intensity or loudness) requirements for each note one sings.

Different nature of vibration of the vocal cords gives rise to different tones but (Riggs, 1985) comments otherwise:

> We simply refer to all vocal cord adjustments in terms of the physical sensations they produce in the singer. Your *chest voice* or *chest register*, refers to the lowest tones in your range, while your *head voice, or head register*, refers to the highest ones. The part of your range where qualities of both head and chest overlap is called your *middle voice,* or *middle register*. Yes the sensations you *feel* are not the result of vocal cord vibration – they are the result of resonance. (p. 25)

Resonance is a process of transformation, which exists during the time a tone leaves the vocal cords and the time it exits the mouth. It is seen by the researcher as the resulting sound of the vibration of the vocal cord as it reverberates in the soft palate.

Hall (1980) analysing the voice as a wind musical instrument says:

> In common with all wind instruments the human voice has (1) an air reservoir with a means to maintaining pressure above atmospheric, (2) an outlet channel with a narrow contrition (or in this case several) where air flow can be interrupted or modulated, and (3) a resonant cavity to strengthen some aspects of the resulting sound waves. (p. 317)

Some people may not for some reasons such as the inability to procure a musical instrument be unable to play but everybody has his/her singing voice readily availabile to them. Although it will be a serious under estimation to think or infer that singing is cheap going by the availability of the voice, which is the instrument of singing.

Anatomy and Physiology of the Human Voice

The anatomy and physiology of the human voice is all about the study of the vocal organs which make up the human voice that we hear in singing. Like a wind instrument, it has an air reservoir, an outlet channel with several narrow constrictions and a resonant cavity. The air is located in the lungs and it holds a maximum of about 4 liters of air in an adult. Air is expelled from the lungs by contracting abdominal muscles which forces the abdominal contents up into the chest cavity. When air is exhaled in breathing, there is still over a liter left in the lungs, so the total available for singing from a single breath is about 1 to 2 liters.

The vocal organs which include the nose, oral cavity, tongue, pharynx, larynx, diaphragm and lungs which make up the human voice that we hear in singing are briefly discussed. In the course of discussions tips that will enable effective use of the organs for a better song production were given.

Nose: Situated above the mouth is the nose, an organ for breathing and smelling. The muscles related to the superstructure of the nose are extremely important to the tone quality

and for maintaining strength while singing. The singer should avoid extreme temperature when performing, and also avoid singing where there is danger of inhaling excess dust, smoke or other pollutants. These are necessary as any obstruction in the nose will alter the resonance which in turn affects the quality of the tone.

Oral Cavity: This starts with the lips and teeth. The hard and soft palate along with the upper teeth form the upper surface, while the tongue and lower teeth take the lower portion as shown in Fig 1 below. The vocal cords are a pair of ridges of soft-layered tissue on the inside walls of the *larynx*, the airway can also be blocked by them. Just as shown in Fig 1, the vocal cords have an opening in-between which is called the *glottis* and is v–shaped. The vocal cords close for swallowing as a backup in case anything gets past the *epiglottis* and are open during normal breathing. The vocal cords nearly close for phonation and the lungs apply a pressure which the excess forces the cords to open and admit bursts of air into the vocal track. The cords vibrate at a frequency controlled by the tension applied in their muscles. The teeth and hard palate as part of the oral cavity are extremely important in the production of sound and its resonance and also in articulation of words.

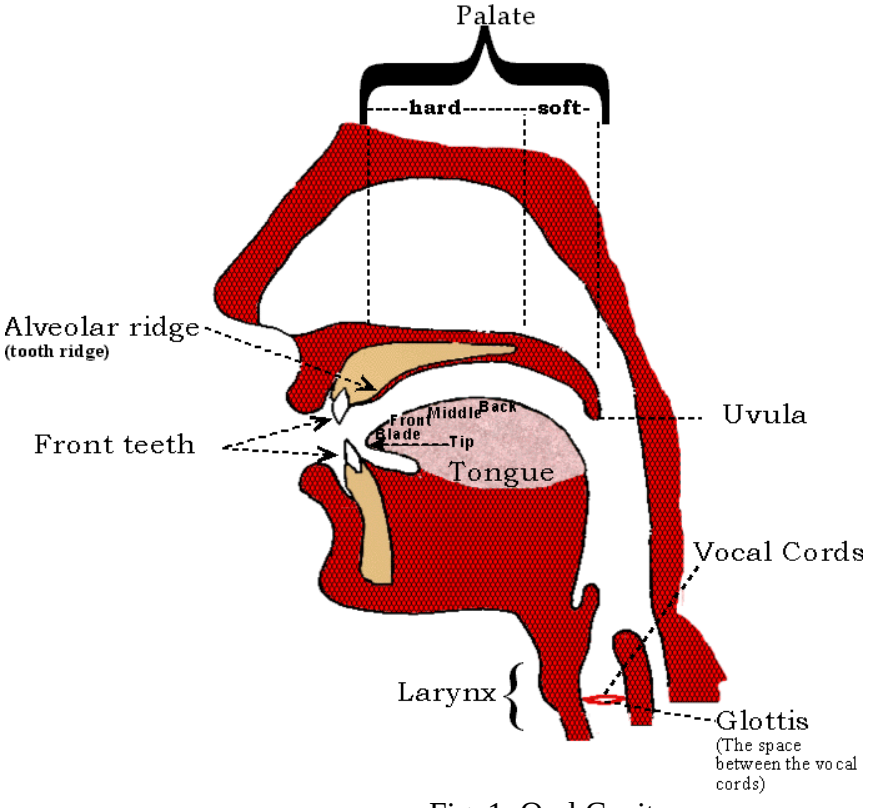

Fig. 1: Oral Cavity

The resonant cavity which strengthens some aspects of the resulting sound waves comprises of the pharynx or throat cavity, which is located immediately above the *larynx*. This opens to the outside through the mouth, with the tongue, teeth, and lips providing additional means of restricting or blocking the airflow.

Tongue: The tongue attaches underneath to the hyoid bone while the Larynx is suspended from the hyoid bone as shown in Fig 2. The tongue helps greatly in the formation of words. When it is not properly aligned, the tongue can constrict the tone and make good resonance of the voice impossible. The size and shape of the vocal tract can vary greatly and thereby produce widely differing sound. This is as a result of the tongue's ability to change both its position and its shape in several ways.

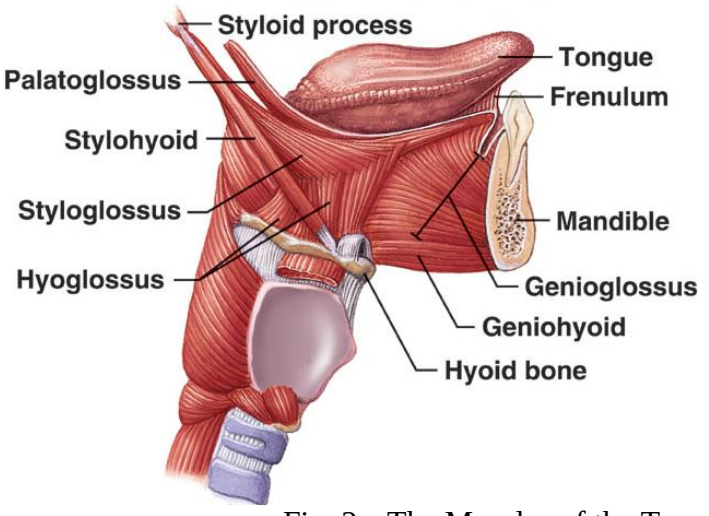

Fig. 2: The Muscles of the Tongue

Pharynx: This is the common passage for both air and food from the nose and mouth to the *esophagus* and *larynx.* The *esophagus* is a long tube leading to the stomach.

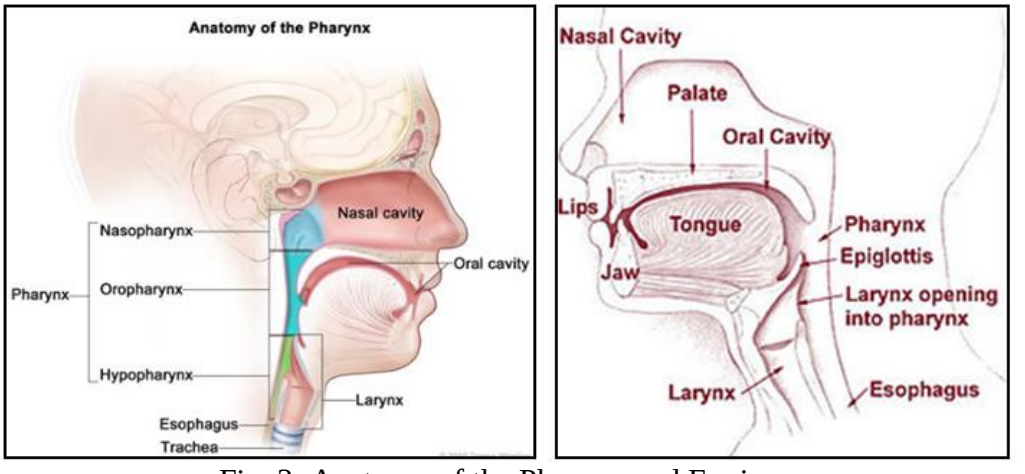

Fig. 3: Anatomy of the Pharynx and Environs

The three divisions of the *pharynx* are: The *nasopharynx, oropharynx*, and *hypopharynx* as shown in Fig 3. The muscular portion of the palate closes off the *nasopharynx* and hence the

nose when one swallows. The *oropharynx* is the space between the soft palate and the *epiglottis*. The *epiglottis* is a liplike valve on top of the *larynx*, also shown in Fig 3 which comes down and closes the larynx during swallowing to prevent food from getting into the trachea but opens for phonation. The *hypopharynx* is the area in which food and air passage divides into the esophagus and into the *larynx* – the entry way into the lungs.

Larynx: The *larynx* or voice box is situated behind the Adam's apple which is the opening of air to the lungs. It houses the vocal cords where the vocal sound begins. The vocal cords are sometimes called vocal folds because the edge of the fold has different texture than the rest of the fold and that edge is called the vocal cords. The *larynx* is controlled by the involuntary nervous system. Therefore the singer will only have to decide on the pitch he wishes to get to and the *larynx* through the involuntary nervous system takes care of the rest.

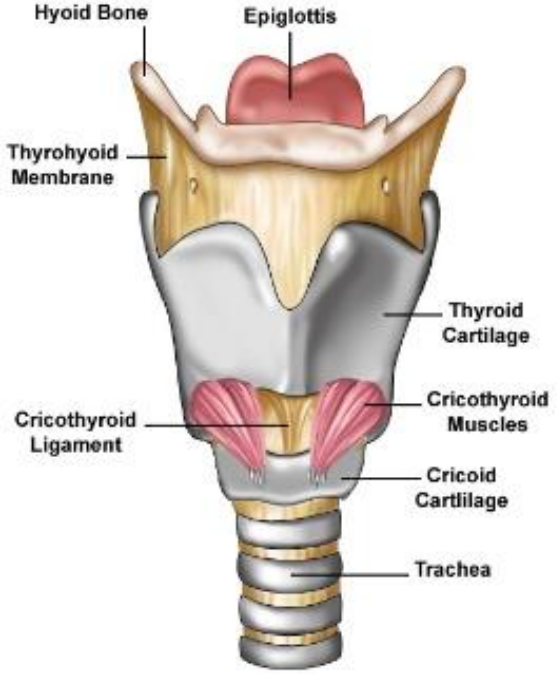

Fig. 4: Larynx

The spaces above the *larynx* reinforce and augment sound waves of certain frequencies, while damping or even getting rid of others. The process is referred to as resonance.

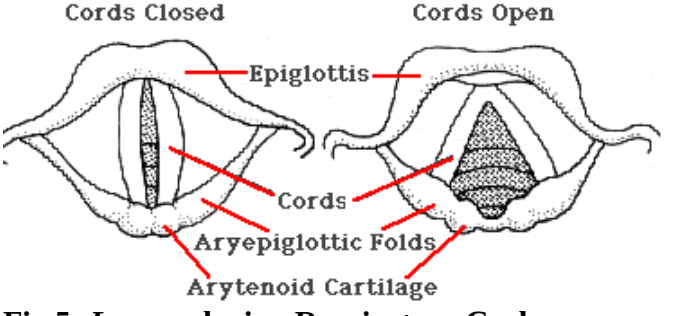

Fig 5: *Larynx* during Respiratory Cycle

Fig 5 shows the changes in the larynx during the respiratory cycle. The cords are closed during the end of the expiratory phase and rest, and they open at the beginning of the inspiratory phase.

Diaphragm: The diaphragm is a parachute or doom shaped muscle attached to the breast bone in front, radiating around and under the lower ribs and then attached to the twelfth rib in the back as shown in Fig 6. The lungs and abdominal area are the other parts of the anatomy related to the diaphragm and proper breathing. Poor alignment of the body makes the diaphragm not to be in the best position to perform its functions in the breathing process. By the *diaphragm's* ability to alter the volume of the thoracic cavity, it functions as the major expiration (exhalation of air) and inspiration (inhalation of air) muscle.

Fig. 6: Attached Diaphragm

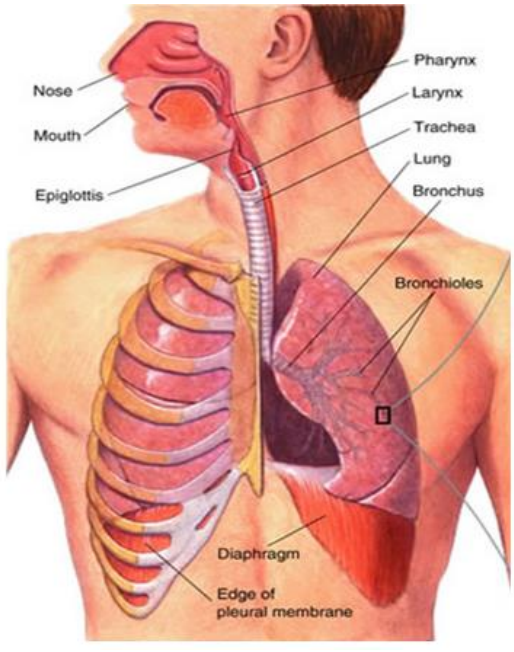

Fig 7: Human Respiratory System

Lungs: The *larynx* opens into the lungs through the *trachea* as shown in Fig 7. The two lungs take the oxygen from the air and exchange it for the carbon dioxide from the blood stream. The chest should be seen as the cylinder in which the *diaphragm* moves up and down to get the air in and out of the chest. The lungs and heart lie above the *diaphragm* while from right to left lie the lever, stomach and spleen, respectively. Considering this location of the stomach it is impossible for one to sing one's best having eaten a big meal. At that time, the *diaphragm* will be unable to lower itself having a full stomach pressing upward. This observation was also supported by Ramalingam (1990) in his study of inhalation and exhalation of air during singing. It should be noted that the co-ordination of the *diaphragm* is performed through the involuntary nervous system. Through the use of exercises, the diaphragm and all other muscles associated with breathing can be strengthened for

maximizing the control of air during exhalation. According to Henderson (1979:55) "such control allows for beautiful and resonant singing as well as for a steady vocal line."

Vocal Training and Techniques

Singing is done with the whole body. It involves the vocal mechanism and facial area as well as the abdomen, chest and the legs. Singing technique is a way of using one's voice in performance of different singing styles. It is a way of using the voice to its maximum degree of efficiency and effectiveness. It involves applying some special and specific vocal exercises in the correction of vocal problems. The emphasis on human voice is on vibration of the vocal cords therefore the training of the vocal muscles (all the muscles involved in singing) is of great importance to every voice student/singer.

Good vocal training and techniques can make one to sing with a strong, clear and flexible voice and a range that he/she never imagined possible. Using good technique makes a singer never to experience any discomfort in the laryngeal area. It is also possible to extend one's vocal range upward and improve vocal quality, tone, size and texture through vocal exercises. It frees one to sound confident and natural when one sings. A fine vocal technique allows a singer to go on to become a great interpreter of the vocal literature.

Voice training involves having or knowing some basic principles about how your voice works, how it works best and also how you will get it to work for you. It means learning to coordinate and strengthen the muscles in your *larynx* so you can sing with ease over a wide pitch and dynamic range. Therefore, it should be noted that singing song is not vocal technique. Style and interpretation are also no substitute for vocal techniques. But good vocal techniques bring out good style and interpretation.

Some basic exercises needed for developing vocal techniques and artistry as written by Henderson (1979) should embrace the following:

- Exercises to strengthen the chest muscles and lower abdominal muscles.
- Exercises to start the movement of air and strengthen the thoracic muscles.
- Exercises to strengthen the soft palate.
- Exercises to obtain co-ordination between the tongue and the jaw.
- Exercises to acquire facility in focusing vowel sounds.
- Exercises for extending both the lower and upper ranges, and also to bridge the voice over from one range to another.
- Exercises to open up the spaces of the nasal cavity, giving resonance to the short vowels.

"Inside Smile" – a vocal technique and terminology as used by Henderson (1979:35) is A technique whereby you close the mouth, but not the teeth (feeling an openness in the whole oral cavity) and smile as though you were smiling at someone across the room, *a smile you do not wish to be noticed by others.* You feel a slight lifting of the cushions under the eyes and a space opening up over the soft palate – you almost feel as though you are going to

break into a yawn. The soft palate goes up. *You have not pulled it up.* Both are extremely important – the cushions under the eyes and the soft palate.

The inside smile according to him, frees the soft palate and other muscles of the *oropharynx* to act in their most efficient fashion. The position of body, jaw, tongue, head etc have to be correct for the best possible production of tone.

Similarly, correct body alignment makes for good vocal production. The alignment includes the following:

- The flexed knee position gives freedom in singing from low range to high range.
- The head should be level, the shoulders straight and the chest wide.
- The back should not curve inside so that the knees do not remain locked throwing the pelvis and hips backwards. It can affect the correct positions of the diaphragm, abdomen, knees, etc.
- The best alignment for the head is that in which the head is held at a level position – the chin should not he held higher or lower than is correct. The head position is necessary because the neck being part of the head encompasses the spinal column, the larynx, vocal cords and tongue muscles.
- The correct position of the tongue while singing is when it lies wide and soft against the lower teeth, moving freely with the jaw every time the tongue changes position for different vowels. The tongue directly affects the sound of a tone.
- Speech – level singing is an ideal vocal posture for singing. It is a position in which the larynx is allowed to rest in a relatively stable condition. It is a natural technique in which your voice is produced without effort (not allowing muscles outside your larynx to interfere with your tone-making process) and in which your voice is balanced in quality.

Other techniques of good singing which will definitely benefit the singers are as follows:

- Learn to listen attentively to good music; it is a great benefit to any singer who wishes to improve his/her vocal talent. A good ear is a prerequisite to becoming a decent singer.
- Humming is a useful preliminary to singing. It establishes the connection between the voice and the resonance surfaces. It warms the voice and can be done anywhere.
- The throat should be kept in what can be described as in a state of permanent yawn while singing.
- Daily voice exercise should be taken seriously and religiously followed. It keeps the voice maintained and in tune.
- Sing songs of suitable range. Singing beyond one's voice range can really crack the voice. You do not develop your voice by pushing it to its limit.
- Articulate well while singing in order to properly convey the meaning of a song. If words are not distinctly uttered, one can find no great difference between the human voice and a cornet or oboe (Scott: 1980:4)

Developing Breath Control:

The ability to inhale and exhale air properly in singing is of utmost importance to the singer. It is generally accepted that proper breath control is fundamental in singing (Adedeji, 2000:26). All singing requires complete breath control. Therefore, lessons on breath control should always be the singers' first lesson as beginners. Good breathing makes for good sound production. In analysis of the physical components necessary for sound production, Fitzmaurice in Hampton and Acker (1997) says that:

> The energy impulse that excites the vibration in the vocal folds and the resulting resonance in the body – starting, continuing, and stopping it. Because of the living and therefore infinitely changeable quality of the particular actions and structures that are responsible for this sound vibration, the way in which the human body breathes affects the voice a great deal, much as the hands of a good pianist and a beginner create different sounds with the same instrument. Breathing, then, makes an essential difference in quality of vocal production. (p. 248)

Generally, it is necessary for singers to be aware of the fact that securing good breathing technique is a paramount factor in singing. Breathing exercises improve the physical control of the voice. Cranmer (1974:25) has the following suggestions on breathing exercise, "the breath therefore is something which keeps the voice in place and does not push it there. If you hear yourself breathe your throat is tightened. In other words you breathe is passing over an obstacle".

To sum up the above statement:

- Raise your ribs and keep them up throughout your song.
- Breathe deeply and grip on belt of muscles at seat of diaphragm i.e. just above waist, fighting there to prevent collapse.
- Never tighten your throat or chin when breathing. The only tightening one should feel in one's body when singing should be at base of diaphragm.
- Whenever possible start to breathe at least a beat before you have to sing.

Miller (1988:126) suggests that too much air should not be used particularly at the beginning of a phrase. It results in either running out of breath or of the tone growing thin toward the end of the phrase. It is common practice for singers to use too much air at the beginning of music or a phrase. Air should be treated by singers as a piece of diamond, in other words it should be used carefully. With proper effort this wrong use of air while singing can be overcome. The breath is controlled by the abdominal muscles and diaphragm; therefore, breathing from the diaphragm is best for good breath control. The breathing technique where the chest is lifted is an improper breathing technique for singers. The consciously controlled diaphragm provides all the breath the voice student needs. Shirley-Quirk (1972:24) gives a practical suggestion as follows:

> Try to breathe from the diaphragm. A simple exercise that will help develop this muscle and your control over it is to lie on the floor on your back with a reasonably heavy book on your stomach. Breathe in, and try to raise the book by say, half an inch, when this is achieved then use heavier book until you can lift quite a pile through two or three inches. (p. 24)

Vocal projection (volume) will increase as one builds more the thoracic and abdominal areas and gains excellent breathe control in the process. The following two factors are basic to increasing breath control by Henderson (1979:65):

- The study and practice of breathing exercises.
- The actual physical exercise of the muscles involved in breathing.

The study and practice of breathing exercises will indicate to the singer exactly where and how the different structures such as abdominal area, diaphragm, thoracic cavity, lungs, mouth, et cetera are used together to assure proper breathing technique. The actual physical exercises come from the daily practice of breathing exercises, which strengthen the muscles, from which breath support and control are initiated and maintained. Improper breath control and an incorrect seat for the tones cause breaking of the vocal line (an evenness in the singer's voice). It is necessary to note that other forms of regular physical exercises example running, swimming, jumping, tennis et cetera serve as a method to increase breath support and control.

Conclusion

Knowledge of the anatomy of the human voice is essential and a very useful guide to any singer. The knowledge no matter how superficially handled will surely help the singer appreciate how the sound he/she produces in singing come about. This study has succeeded in establishing the indispensability of human voice as a musical instrument of intriguing standard. It has gone ahead to x-ray the knowledge of anatomy and physiology of the human voice facilitated with diagrams and has provided proper tips on how to make proper voice production. It has also suggested the application of some basic, special and specific vocal exercises for vocal training. Correct body alignment and other techniques for better vocal production were also presented. Finally, the study offered some lessons on breath control during singing for the overall benefit of the singer and the listener.

References

Adedeji, F. (2000). *Voice training manual* (Book 1). Lagos: Femad Music Co.

Cambridge Advanced Learner's Dictionary of English, (2005) In K. Woodford & G. Jackson (Eds.). United Kingdom: Cambridge University Press.

Cranmer, A. (1974). *The art of singing.* London: Dennis Dobson.

Greenish, A. J. (1953). *The students' dictionary of musical terms.* London: Stainer and Bell.

Graves, R. M. (1954). *Singing for amateurs.* London: Oxford University Press.

Hall, D. E. 1980. *Musical acoustics: An introduction.* California: Wardsworth.

Hampton, M. & Acker, B. (Eds.) (1997). *The vocal vision: Views on voice by 24 leading teachers, coaches & directors.* London: Jessica Kingsley.

Henderson, L. B. (1979). *How to train singers.* New York: Parker.

Kamien, R. (1976). *Music: An appreciation.* (5th ed). New York: McGraw Hill.

Kerman, J. V. (1972). *LISTEN* (2nd ed.). New York: Worth.

Machlis, J. (1963). *The enjoyment of music: An introduction to perceptive listening.* New York: W. W. Norton.

Miller, K. E. (1988). *Vocal music education.* New Jersey: Prentice-Hall.

Oxford Learners Advanced Dictionary of Current English. (2007). (7th ed.) In A. S. Hornby, (Ed.), New York: Oxford University Press.

Ramalingam, S. T. (1990). *Modern Biology for Senior Secondary Schools (New Edition)*. Onitsha: Africana First Publishers.

Riggs, S. (1985). *Singing for the stars*. In J. D. Carratello (Ed.). USA: Alfred Publishing Co. Inc.

Rose, A. (1962). *The singer and the voice*. London: Faber and Faber.

Scott, M. (1980). *The record of singing*. New York: Holmen & Meier.

Shirley-Quirk, J. (1972). Voice. In D. Epps and G. Renolds (Eds.*), Spare Time for Music*. London: BBC.