

Avicenna's Anatomical Legacy as Seen Through the Relevant Topics in Modern Anatomy

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Abstract

Background: Makhaarej Al-Horouf, the study of speech sounds by Avicenna is a valuable piece of work in the study of speech sounds, which was written about ten centuries ago. It contains six chapters on sound, anatomy of vocal tract, and phonetics. It is amazing to find that Avicenna's explanations are congruent with the findings of modern scholarship in relevant topics. The study was intended to compare Avicenna's explanations on the anatomy of the vocal tract to today's modern advancements.

Results: Avicenna describes three cartilages of the larynx, which are known in our time as thyroid, cricoid, and epiglottis (or maybe arytenoids) as well as many of the muscles of the larynx and the tongue.

Conclusion: The findings show that Avicenna's explanations of the anatomy of vocal tract are comparable to today's knowledge on the subject. They also indicate that the study of Makhaarej Al-Horouf and other ancient works would be beneficial in the investigation of the history and development of science around the world.

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Introduction

Iranians have had a great influence globally on the history of arts miniature and poetry. In addition to influencing art history, Iranians have had a remarkable impact on the modern medical sciences. The development of both theoretical and practical medicine began in the 10th century A.D. in Iran. At that time, Iran was the main center of both practical and theoretical medicine of the world.¹

Many famous philosophers in the past were also physicians, artists, and writers being specialized in many different areas of scholarship. Avicenna (Ibn Sina), a famous Iranian philosopher, was also a physician. In the 10th century A.D Avicenna became famous in the world of sciences. At the age of 16, Avicenna began practicing medicine. Although modern medicine is marked as beginning 200 years ago, much of what is known today can be found in Avicenna's work dated many years before.² Avicenna's major contribution to medicine was his book "Al Ghanoon Fi Teb" (The Canon in Medicine). Canon is said to be one of the best encyclopedias containing more than a million terms. Many of the ancient and Islamic sources giving Avicenna the title of the "King of Medicine".³ Comparing this book to one of

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the major books used today by physicians we can grasp the importance of this book. The 11th edition of Harrison's Principles of Internal Medicine summarizes 2.8 million terms in modern medicine written by 280 authors and 6 editors, while Canon has one million terms all from one author.³

The aim of this study was to compare Avicenna's explanations on the anatomy of vocal tract with modern medicine's explanations.

The History of Anatomy in the World

Ancient anatomy began as early as 1600 B.C, the date of publication of an Egyptian anatomical papyrus that has survived to these days. Hippocrates, Aristotle, Herophilos, Erasistratus, and Galen were the major anatomists of ancient times from late 6th century B.C. to the 2nd century A.D. The major advances in anatomy after Galen were made mostly by some Arab and Iranian scientists.⁴

In Europe at the beginning of the 16th century, the founding stone of modern anatomy was the work of Andreas Vesalius. He was the first to publish a text that challenged Gallen.^{4,5}

The History of Anatomy in Islam and Iran

Many Islamic scientists studied anatomy in order to understand philosophy of creation. Although during Avicenna's time dissecting the human body was seen as a proscribed act, many notes were written at that time on this subject.² During that time, universities in Baghdad taught anatomy by the dissection of monkeys as well as investigation of skeletons, while in other universities anatomy was studied theoretically.¹ Moslem scientists including Avicenna, Mansour Ibn Elias, AL-Baghdadi, Ibn Nafis, Jorjani, and Antaki made major contributions to anatomy. One of them, Mansour Ibn Elias wrote "Tashrihe Badane Ensan" in Persian, which means "Dissection of the Human Body". It was one of the most comprehensive books of its time in anatomy, comprising five chapters covering four systems of skeleton, nerves, muscles, and vessels. The book contains full diagrams for each system, as well as description of the heart and the brain, and the development of the embryo.²

Makhaarej Al-Horouf

Makhaarej Al-Horouf was written in Arabic by Avicenna about 1024 A.D. The book was translated into Persian by Khanlary in 1954,⁶ and into English by Khalil Semaan in 1963. It is a valuable legacy in phonetics, although linguists have not paid due attention to it.⁶

The book is comprised of six chapters on sound, anatomy of vocal tract and phonetics. The first chapter describes sound, sound waves, and the energy for the articulation of

these waves. The second chapter is about speech sounds, and explains the pitch of sounds and its determinants. It also briefly describes the place and the manner of articulation of speech sounds. The third chapter is on the anatomy of vocal tract. The fourth and fifth chapters explain Arabic and Persian phonetics, respectively. The last chapter is about how to articulate speech sounds artificially by tools.⁶

Although Makhaarej Al-Horouf was written ten centuries ago, most of Avicenna's explanations are the same as those in modern texts. The book has rarely been studied in detail. This paper will focus on the third chapter, and show the importance of looking back at Avicenna's work.

Results and Discussion

A Comparison of Avicenna's Anatomy of Larynx and Tongue with Modern Anatomy

The third chapter of Makhaarej Al-Horouf investigates the structure of the larynx and the tongue. It introduces the muscles and cartilages of the larynx as well as the muscles of the tongue and explains their functions and locations.⁶ Avicenna's descriptions of anatomy of larynx and tongue and those in the modern medicine are compared below.

Larynx

Cartilages of the Larynx

Avicenna states that the larynx is made up of three cartilages.⁶ However, the larynx is made up of nine small and large cartilages, which are connected by joints, membranes, and muscles.^{7,8} Avicenna thoroughly describes the functions of three of the nine cartilages as well as the location of the cartilages found in the larynx. He states that one cartilage is located on the front and can be felt above the neck and below the chin in very thin people. It is bowl-shaped, and its convex portion is positioned towards the front part of the body and the concave portion is positioned towards the inside or back of the body. It is named Al-Daraghy and Al-Torsee.⁶ In the Dehkhoda's encyclopedia this cartilage is named Daraghy, Torsee and Thyroid.⁹ Modern anatomy states that the cartilage is not completely bowl-shaped; however, Avicenna's description of the convex portion of the larynx is correct. In addition, his description of the position of the cartilage and his statement that the cartilage can be felt in very thin people have also been proven to be correct.⁵⁻⁸

Avicenna states that the second cartilage lies behind the first one, its surface faces to the Al-Daraghy. The two cartilages are connected to left and right by joints, and are separated on the top. The second cartilage was named by

Avicenna as Adim Al Ism, which means innominate.⁶ Avicenna did not describe the cartilage completely, which might be the reason as to why it was named by Avicenna as Adim Al Ism. In Zakhire Kharazmshah and Bahr-Al-Javaheer this cartilage was named La Ismon Lah, which means "no name for it" in Arabic.⁹ The second cartilage is known as cricoid cartilage today. The Avicenna's description that the second cartilage is connected to the Al-Daraghy by a joint is correct, since there are two shared joints between these two cartilages.^{6,8}

Avicenna states that the third cartilage, which he named Al-Mekabbi and Al-Tarjahali, is similar an upside down bowl placed above the first and second cartilage. He also explains that it is separated from the Al-Daraghy and connected to the Adim Al Ism cartilage by two joints, which derive from two outgrowths from the top of the adim Al-ism and are fixed in two holes located on the third cartilage.⁶

Dehkhodah, Moein, and Mohammadi describe the Al-Mekabbi and Al-Tarjahali as the epiglottis.⁹⁻¹¹ Based on the descriptions of Mesbah this cartilage is not bowl-shaped, but leaf-shaped.⁷ Avicenna's description that the third cartilage is separated from the Al-Daraghy is correct to an extent, because the wider main portion of the cartilage is not connected to the Al-Daraghy, but at the narrow part, it is connected to the Al-Daraghy. Contrary to Avicenna's belief, this cartilage does not connect to the cricoid. Avicenna's meaning of the outgrowths could be the lower horn of the Al-Daraghy cartilage and his description of the two holes in the Adim Al Ism cartilage could be the connection of the cartilage to the cricoid, and does not have any relation to the epiglottis.⁶⁻⁸

The book of Dissection by Mirzah Ali states that this cartilage is the arytenoid cartilage.⁹ In the Dorland Medical Dictionary translated into Persian by Houshmand, the word arytenoid is translated to pyramid-shaped, cone-shaped and Al-Tarjahali.¹² Avicenna's statement that this cartilage is separated from the thyroid and connected to the cricoid is correct.⁶ The two described joints are in fact the ligaments that connect the cricoid cartilage to the arytenoid cartilages. It must be noted that Avicenna does not consider that the cartilage is paired, which is a very important attribute in describing the roles that these cartilages play in opening and closing of the vocal cords in articulating sounds.⁶ By contemplating on Avicenna's work we cannot conclude whether he is describing the epiglottis or the arytenoid cartilages because we cannot relate his descriptions to either one. From an anatomical perspective, Avicenna's description relates to the epiglottis; however, from a phonetic perspective it relates to the arytenoid cartilages.

Sepanta has also described the Al-Tarjahali as the arytenoid cartilages.¹³

In addition to the cartilages described above, there are also two pairs of cartilages in the larynx named cuneiform and corniculate, which were not mentioned in Avicenna's work.^{7,8}

As mentioned before, Avicenna describes three cartilages of the larynx, which are known today as thyroid, cricoid, and epiglottis (or arytenoids). Avicenna explains the location, shape, and function of each in articulating speech sounds. Considering the time of his work, his descriptions are very relevant. There is just an ignorable confusion in his description of Al-Tarjahali, which can be either the epiglottis or the arytenoid cartilages.

Muscles of the Larynx

Avicenna describes many of the muscles of the larynx, and mentions their locations and functions, but has not named them.⁶ It seems that the muscles he describes are the thyro-epiglotticus, oblique arytenoid, ary-epiglotticus, cricothyroid, posterior cricoarytenoid, suprahyoid, thyrohyoid, and sternothyroid. His descriptions of these muscles match those of the modern anatomy of them.^{7,8,14,15}

Tongue

Avicenna briefly describes the muscles of the tongue, specially the structure of the tongue and its movements in different directions.⁶ He introduces styloglossus, genioglossus, and hyoglossus muscles without naming them, and describes the important role of these muscles in speech. However, Avicenna does not mention the intrinsic muscles of the tongue.^{7,14}

Conclusion

The discussion presented shows that much of the description by Avicenna of the anatomy of vocal tract matches the descriptions offered in modern anatomy. By studying Avicenna's work and others alike we can attain a better understanding of sciences and their evolution. Avicenna's work deserves greater contemplation and attention by the world of science.

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