



Review

Morphology of the heart associated with its function as conceived by ancient Greeks

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ABSTRACT

According to their writings, ancient Greek physicians had explored the anatomy of the heart. Although pre-Hippocratic medicine, which relied on religion and mysticism, has nothing more to present than implausible theories and speculations, younger physicians thanks to their animal dissections were able to depict the heart with detail. Hippocratic “On the Heart”, Aristotle’s, Herophilus’, Erasistratus’ and Galen’s writings provide us with the necessary data to take a look at the anatomy of the heart as it was described back then. Despite of some confusing passages in their writings and some erroneous notions, the heart was described with relative accuracy. In the years after antiquity and in the Middle Age the only information about the anatomy of the heart could be derived from the ancient Greek works and only anatomists of the Renaissance managed to displace them. In this paper we present the knowledge of all known ancient Greek physicians about the heart, with emphasis on its anatomy.

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1. Introduction

The heart as an organ of the human body has constituted from even the prehistoric times an object of mystery which aroused the curiosity and stirred the imagination. Since man started either to hunt or to be hunted, he has understood the crucial role of the heart for the body to stay alive. This, in combination with the fact that the heart is by the law of nature protected and hidden from the eye in the thorax, drew his interest. Specifically, there was a progressive evolution in the way man conceived the heart. Initially, he considered it as the house of the soul or even the center of mind, logic and thinking. Later and as scientific thinking developed and was gradually released from the dynasty of religion and mysticism, man tried to explain the function of the heart by connecting it with its structure, namely its anatomy.

Greece of the antiquity has always been admired for its love for science and rational thought. For ancient Greeks, heart constituted always an object of constant study and research, which gradually shed light on the anatomy of the heart. Clearly, modern cardiology owes many of its accomplishments to these first steps of the Greeks. Using as a reference point the eminent figure of Hippocrates, whose captivating personality altered the meaning of medicine establishing a new era, we divide the ancient time into two periods, the pre-Hippocratic and the post-Hippocratic.

1.1. The pre-Hippocratic era

Ancient Greek nomenclature for the heart is “καρδία” or “καρδιά”. According to Chrysippus, its name derives from the fact that it carries the soul, while Leon, physician and philosopher, believed that it derives from the verb “κρᾶδαίνω” meaning to move continuously [1]. Pre-Hippocratic medicine, going back to the first half of the first millennium B.C., was obviously under the influence of religion and mysticism. Basic medical sciences like anatomy and physiology were ignored and only practical medicine was executed, such as surgery and dietetics. The first reference about anatomical regions in Greek literature are said to be detected in Homeric poetry which was written down in the eighth century B.C. In Homeric poems, and especially in Iliad, descriptions of wounds as a cause of body conflict during warfare can be found. These early descriptions roughly delineate anatomical features [2]. Moreover, Homer referred to the heart as the seat of courage and bravery [1]. The close connection between medicine and religion can be easily recognized by the multiple deities attributed with medical skills. Asclepius, known also with the Latin “Aesculapius”, was the greater Greek deity of medicine. Son of Apollo and the mortal woman Coronis, and as a consequence a demigod, Asclepius had a great knowledge of herbal curing and of the art of healing. He even, according to some myths, had the ability to resurrect the dead [3]. Asclepius had two sons, Machaon and Podalirius, referred by Homer as the best physicians at Troy, possessing great surgical skills [4].

After the Homeric poems, appear in the history of ancient Greece the famous Greek philosophers, whose rationality and restless spirit continuously raised questions about everything in nature. This led to an astonishing evolution of not only philosophy and social sciences but natural sciences as well. From the interests of ancient Greeks, were impossible to be absent the mysteries of the human body. One of their first

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concerns was to understand the source of what we nowadays call mind, spirit and soul. The human heart as an organ of the human body recognized to play an inextricable role in the wellness of the organism, was sometimes attributed with the property of carrying the soul, others the mind, or even both of them. For instance, a philosopher of the Italic School, Philolaus identified four main organs which served four fundamental functions: the brain which was the center of thought, referred to as “*νοῦς*”, the heart, which was the house of the soul, referred to as “*ψυχὴ*”, the umbilicus, which constituted the origin of growth and lastly the genital organs responsible for reproduction [5].

Unlike Philolaus, Alcmaeon believed that both mind and soul originate from the brain. Alcmaeon was a pre-Socratic physician and philosopher who lived in Croton, a Greek colony in South Italy (ca. 550–450 B.C.). According to some historians of the past he was a student of Pythagoras. Controversy arises over the question whether Alcmaeon performed dissections. Chalcidius and Singer strongly support that Alcmaeon was the first to perform animal dissections, while Doty doubts and Llyod rejects such a theory [6]. Alcmaeon believed that brain is the center of consciousness, while he associated the circulation of blood into brain vessels with sleep and death. He regarded also as origin of all blood vessels the brain [7]. Alcmaeon was the first to roughly understand the difference between veins and arteries [8], and the first to describe some kind of blood circulation [9].

Alcmaeon's contemporary, Empedocles, was born in the Greek colony of Agragas in Sicily around 492 B.C. and is mostly known for his theory of the four elements composing the universe. Among his theories we come upon his belief that the heart is the center of the vascular system and, according to some historians, it used blood as a vehicle for the soul and in order to distribute “*pneuma*” to the whole body [7]. The word “*pneuma*” in this philosophical theory known as “*pneumatism*” was used to represent an airy substance, the spirit of life, which mobilizes the organism [8]. This vital spirit penetrated the body through extremely fine tubes opening to the skin and connected with the vessels containing blood. According to Empedocles, the heart was the most essential organ for its ability to distribute “*life*” through the vessels [10].

1.2. Hippocratic era

A turning point in the history of medicine was the establishment of medical thinking and ethics by Hippocrates and his followers. Hippocrates elevated medicine from a practical and empirical art to real science established on experiment, rational thinking, exploratory mood and observation.

One of Hippocrates' contemporaries, Democritus, was said to have been his teacher. Democritus had a wide range of interests and his writings cover many aspects of anthropology and medicine. His legacy was so strong that traces of his influence can be recognized in the Hippocratic Corpus [11]. Democritus was born in Thrace around 460 B.C. or even earlier and travelled to Egypt, Babylon, Iran, Arabia and Ethiopia gathering knowledge and experience from all over the world. While mostly known for his “*atomic theory*”, according to which universe is composed from particles called “*atoms*”, he is also known to have sent a letter to Hippocrates about human nature and anatomy. In this letter, Democritus characterizes the brain as the “*protector of the body*” and “*ruler and guardian of the mind*”, distancing himself from the theory supporting that heart is the principle organ, seat of thinking and mind. Regarding the heart, Democritus claimed that it has the “*shape of a cone*” and it is protected in the thorax from any harmful power. Moreover, he called the heart the “*queen*” of the body from where originates anger and madness, considering it as the controller of emotions [12].

Hippocrates, the so-called “*Father of Medicine*” is estimated to have lived from 460 to approximately 375 B.C. Born in the island of Kos, where can still be found a very old plane tree remembered as the tree under which Hippocrates gave lessons to his medical students, he was a descendent of Asclepius and Hercules. His name in Greek (Ἱπποκράτης) derives from the words “*ἵππος*” and “*κράτειν*”, meaning

“*horse*” and “*drive*” respectively. His main contribution was the release of medicine from the bonds of religion, magic and superstition and its distinction from philosophy [13].

In his writings about 70 books are included under the title “*Hippocratic Corpus*”. Nevertheless, it was difficult for historians to estimate the date of creation of each book and even today the question whether all of them were actually written by Hippocrates remains unanswered. Jones (1923–1931) has suggested that the Hippocratic collection might have been the library of Hippocrates' school of medicine on Cos and not the writings of one specific person [13]. One of the works belonging to the Hippocratic Corpus, “*Περὶ καρδίας*”, meaning “*On the Heart*”, or otherwise known in Latin as “*De Corde*”, is of special interest. It is the only anatomical text having survived in full from the Classical or early Hellenistic Greece [11]. Despite the fact that “*On the Heart*” belongs to the Hippocratic writings, it is doubtful that it is written by Hippocrates himself. Neither Erotian nor Galen included it in the list of the authentic Hippocratic writings, while both Littré and Adams share the opinion that although an ancient piece of work used and even copied by Galen, it must not be attributed to Hippocrates [14]. According to Littré, “*On the Heart*” might have been written in the years after Hippocrates and specifically in Aristotle's and Praxagoras' era. Another testimony supports that it was a work of the Sicilian Medical School, influenced by Empedocles, since it considered the heart as the center of “*pneuma*”. On the other hand, Ermerins stated that it was written by a younger physician from Knidos in Asia Minor [1].

According to Lonie (1978), “*On the Heart*” is an example of a classical scientific treatise, since the “*egotistic style*” common in the fifth-century writings, is totally absent. The renovation is that facts are represented strictly scientifically without any philosophical mood [15]. The text offers various information on topographical anatomy and also some mentions of comparative anatomy. Although from the text someone can get a clear impression of the heart as an anatomical subject, there are some particular fragments that provide unclear and even erroneous information [16].

According to the author, the heart lies in an ovoid hollow surrounded by the lungs in the left half of the human body. This location grants to the heart the privilege to use the natural “*coldness*” of the lungs and the drop of the temperature because of respiration, in order to deal with the excessive heat provoked by its continual movement. The heart is pyramidal in shape and dark red in color, while its walls are thick enough to render it a strong muscle. Unlike the rest of the body, which is nourished with food and liquids from the abdomen, the heart is nurtured with a clear and pure substance created during the dialysis of blood. Astonishing is the fact that it seems to the writer that the heart somehow radiates, referring presumably to its electrical activity. He recognized the presence of two ventricles, separated but stitched together under the same covering. The word “*γαστέρων*” used to describe the ventricles, literally means “*abdomens*”. Several differences in the shape and the quality of the walls of the ventricles are mentioned. Specifically, the right ventricle is described as wider and looser than the left, which in turn lies exactly below the right one and in straight line with the left breast. The right ventricle is described as stitched from outside to the left one. According to the author of “*On the Heart*”, there is also an orifice through which the right ventricle communicates to the other. As for the inner texture of the ventricles it is characterized as rough like it has undergone corrosion, especially the inner of the left ventricle. Trying to explain the greater thickness of the walls of the left ventricle, he stated that with this special characteristic they stand the more intense heat released by the faster rate of its beat. The left ventricle is the seat of the “*heat*” and the “*pure air*” of life and houses the mind and the spirit, which predominates over the rest of the soul. Using as proof the absence of blood in the left ventricle after a dissection of an animal, he supported that the left ventricle unlike the right one is empty of blood and that it contains only a humor, yellow bile and membranes. The heart in this treatise is considered to be the origin of vessels transporting life to all parts of the body. Each vessel

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