

The Discoverer of Pulmonary Blood Circulation: Ibn Nafis or William Harvey?

¹Saeed Changizi Ashtiyani and ²Mohsen Shamsi

¹Department of Physiology Faculty of Paramedicine, Arak University of Medical Sciences, Arak, Iran

²Department of Public Health, Arak University of Medical Sciences, Arak, Iran

Abstract: Ibn Nafis is one of the most acclaimed physicians in the 7th Hajeria century (1210 A.D.) that in addition to medicine had expert ideas in syntax, logic and Islamic sciences. His theory on pulmonary blood circulation has challenged many scientists regarding the first person who discovered pulmonary blood circulation. In this descriptive study, an attempt was made to gain access to reliable sources for investigating various opinions regarding the earliest discovery of pulmonary blood circulation. In so doing, through the application of appropriate key words to library and on-line search, reliable data were gathered for answering the central question of this study. Based on the theories of Ibn Nafis on pulmonary blood circulation, the movement of blood initiates from the right ventricle and through pulmonary artery, it flows to the lungs. Then through pulmonary veins it circulates back to the left ventricle. Ibn Nafis, for the first time throughout the history of medicine, in addition to describing blood circulation, stated that blood is refined in the lungs. This idea was proposed three centuries before William Harvey could announce its discovery. Thus the primary discoverer of pulmonary blood circulation is Ibn Nafis and his theories have affected what has been proposed after him. In conclusion, Noticing his precise descriptions of pulmonary blood circulation three centuries before Harvey, Ibn Nafis can be named the primary discoverer of pulmonary blood circulation. However, Arabs and Muslims' insufficient attention to their scientific legacy have paved the way for some Western scientists to name many of their invaluable and groundbreaking theories after themselves.

Key words: History of Medicine • Ibn Nafis • Pulmonary Blood Circulation • William Harvey

INTRODUCTION

Ibn Nafis, is one of the most outstanding Muslim physicians in the 7th Hajeria century. Born in Damascus, he began taking up medicine with his companion Ibn Asibe, the author of the famous "*the purest and clearest news in classification of physicians*", under the supervision of some of the most renowned scientists in the field of medicine in that era, e.g. Andol Rahim Ibn Ali known as Al- Dakhwar [1, 2].

Ibn Nafis was known for his modesty, great memorization ability and intelligence. In addition to medicine, he also excelled in syntax, logic and Islamic sciences. In 1236 Ibn Nafis moved to Egypt and worked in Al-Mansouri Hospital where he became chief of physicians and the sultan's personal physician [3]. He also trained many students among whom Abolfateh Iskandai, Abolfazl Benkusk and Ibn Ghaf who are the most famous ones that compiled a book in surgery.

In his compositions and compilations, Ibn Nafis did not refer to reference books and instead, relied on his memory. He followed this same style in his prescriptions. He tried to treat his patients through diets instead of prescribing medications as much as he could. He also preferred humble drugs to the complex ones. In addition to medicine, he was also active in the realm of literature. Ibn Nafis did not imitate others' style and was never a mere follower. Thus references to the scientists and writers before him are barely seen in his books [4].

In his practice of medicine, originality and innovation are easily observable due to his belief that traditional methods should be removed in order to get free from the dominance of old time physician' thoughts. Some physicians of his time did not dare to disagree with the theories of famous scientists in the field of medicine such as Galen, Hippocrates and Avicenna [5]. Ibn Nafis criticized many theories of these scientists and corrected these theories. Although he admired Avicenna a lot, he

stated: "in few cases, I disagree with him; however, I think these [mistakes] might be due to the note-takers and editors of his books."

His Major Works Are as Follows:

- *Al-Shamel Fi Teb* which is a medical encyclopedia.
- *Al-Mohzeb Fi Alkahol* in which all of the Islamic physicians' information in Ophthalmology has been completely, but not so originally, included.
- *Moje Al-Qanun* which is an abridged version of all sections of Ave Sina's *Al-Qanun* except for "the dissection and function of its parts" chapter. This book is a summary in medicine which is particularly useful for physicians who practice medicine. Of all his books, this one became very popular in the east. *Moje Al-Qanun* has been translated into Persian, Turkish and Hebrew.
- *A detailed elaboration on Ave Sina's Al-Qanun* that various editions exist to it. In this book, Ibn Nafis has classified the explanation of issues better than *Al-Qanun*, especially the section related to anatomy which summarizes the first three sections of *Al-Qanun* in one section. In this section, Ibn Nafis elaborates on his theory on pulmonary blood circulation. His elaboration on the fifth chapter of *Al-Qanun* was translated into Latin by Andrea Alpago, the renaissance researcher and physician and it was published in Viennese after his death in 1547 [5-7].

In addition to the scientific aspect of his character, Ibn Nafis was a faithful and religious man. Regarding his profound religious belief, it suffices to note that at the time his death was near, one of the physicians who happened to be his friend prescribed him some wine, but Ibn Nafis refused to drink it and said: "I do not want my soul to be contaminated with wine when I face God" [8]. On December 17, 1288 he died at the age of 78 after an unknown illness [3].

MATERIALS AND METHODS

The discovery of the pulmonary circulation is an interesting and debated subject. It is commonly believed that the discovery of the pulmonary circulation had its inception in Europe in the sixteenth century by Servetus, Vesalius, Colombo, then Harvey. However, in view of the discovery of ancient manuscripts, we propose that the real credit for the discovery of the pulmonary circulation

belongs to an eminent physician of the thirteenth century: Ibn Nafis. Therefore in this descriptive study, an attempt was made to gain access to reliable sources for investigating various opinions regarding the earliest discovery of pulmonary blood circulation. In so doing, through the application of appropriate key words to library and on-line search, reliable data were gathered for answering the central question of this study: The Discoverer of pulmonary blood circulation: Ibn Nafis or William Harvey?

RESULTS AND DISCUSSION

Ibn Nafis'es greatest work in the field of medicine is his theory on pulmonary blood circulation. In his view, blood circulation gets started from the right ventricle and through pulmonary artery, it flows to the lungs. Then through pulmonary veins, the blood circulates back to the left ventricle. This theory is the basis of a major section of Harvey's important discovery. In his elaboration on dissection in Ave Sina's *Al-Qanun*, Ibn Nafis for the first time in the history of medicine, in addition to the description of blood circulation, states that blood is refined in the lungs. In fact, this theory was first put forward by Ibn Nafis almost three centuries before its presentation by the first European scientist, Servetus.

This part of Ibn Nafis'es discovery about pulmonary blood circulation was first understood by the Egyptian physician, Mohey Al-Dam Tatavi who expressed it publicly in his doctoral dissertation in 1924.

For a better understanding of the importance of Ibn Nafis'es discovery and further elaboration on his theory regarding pulmonary blood circulation, first, it is necessary to consider the views of several great physicians' on the operation and function of heart briefly.

"The heart acts like a pump that circulates the blood. But from where does the blood get to the heart and what is its destination after the heart? The ancient Greek physicians' primary mistake was that they just viewed veins as transferors of blood. Observing the depletion of arteries in cadavers, they came to think of them as "airway passages." On the other hand, the word "Artery" which is attributed to the arteries is derived from a Greek word meaning "airway passages." Yet, Herophilis showed that both veins and arteries are responsible for blood delivery. These two meet each other in the heart and had it been revealed where they join each other outside the heart, the issue of blood circulation would have been settled. However, precise anatomic investigations had indicated

that veins and arteries are divided into narrower branches which are, in turn, divided into such narrow veins that they cannot be seen any more" [5, 9-10].

Based on Galen statement, "The right heart blood is named *natural spirits* while the left heart blood is called *via spirits* and there are major differences between these two. None of these two types of blood circulates in the body; however, with a specific, constant ebb and flow, they run in their own special zones."

For explaining this impossible concept, Galen assumed that blood moves through the many invisible holes that exist between the two hearts. No one had been able to observe these holes since they were not only invisible but also absolutely non-existent. Yet, Galen, the God of Greek medicine and nine centuries later, Avicenna, the most remarkable physician in medieval ages, had claimed this with such certainty and faith that this impossible and baseless thought had been accepted as the absolute truth.

Even a genius like Da Vinci with his great creativity and incredible innovation, who had dissected heart and other body organs with great precision, had embraced such an irrational theory.

Nevertheless, the first person who came to suspect this idea of Galen and clearly refuted it, was Ibn Nafis. He had investigated the anatomic studies of Avicenna and Galen and set to criticize them. Ibn Nafis gathered the results of his investigations in *Mojez Al-Qanun* and for the first time discovered the pulmonary blood circulation; a discovery which placed him among the greatest physicians of the world. Ibn Nafis describes the pulmonary blood circulation in the following way:

"After refinement in the right ventricle, the blood must go to the left ventricle to gain a vital spirit, but there are no holes between the two ventricles since the heart is much thicker in this part or as some have hypothesized, there are no visible holes. Hence, after refinement, it has to go to the lungs through pulmonary artery to spread there and get mixed with air so that the thinnest particles in it are refined. Then it enters the pulmonary veins so as to transfer the blood which has been mixed with air and is ready the birth of spirit to the left spirit" [6, 9, 11].

Ibn Nafis is the first person who described blood circulation and referred to the air bags of the lungs. Ibn Nafis repeated his explanations of pulmonary blood circulation five times which indicates that he had a thorough understanding about it, one without even a shred of doubt. Thus Ibn Nafis is the first person who gained a complete understanding of the combination of lungs and arteries which are located between the

pulmonary arteries and veins. He gained this knowledge almost three centuries before the Italian scientists and defined it in a way that there is no place for suspicion or doubt. He is the discoverer of the foundation of blood circulation in veins. He explains that blood enters the lungs and in contact with the air that lungs absorb from outside and getting mixed with it, it is refined.

Accordingly, Ibn Nafis, through his visual observations and his logic, corrected the wrong ideas of Galen [11].

Galen relied on the old theories of blood circulation as his guideline and based on these, he put forward his famous theory. The two conditions are:

- Veins that enter the heart are wider than those that exit it.
- Rupture of the arteries leads to bleeding. He accompanies this with an important explanation and states: "Having reached the right ventricle, blood enters the left ventricle via the layer which is between the two ventricles and passes through the small visible and invisible holes. There it gets mixed with the vital air that has been transferred by the lungs through pulmonary veins which are called arterial veins. After being saturated from vital qualities in the brain, the blood is distributed to all parts of the body. Eventually, through these arterial veins, it is sent back to the heart. In others words, the blood follows an "ebb and flow" movement". By this expression, he implies that except for the holes which are located in the walls of ventricles, the arterial system is totally independent of the system of veins and the movement of blood from the two systems is done through an ebb and flow procedure from the lungs and the heart to other organs and vice versa. This idea was commonly practiced as part of formal training in Europe in medieval ages up to the 17th century. Leonardo Da Vinci reflected this idea in his famous anatomic pictures [12].

Some Arab writers had a different view about this theory of Galen and in their book, *A summary of the history of pharmacy and medicine among Arabs*, they noted, "Galen proposed his theories of medicine on blood circulation based on dissection of children with early (premature) birth and hence, he states that there is a hole between the right and left ventricles. This condition existed in children with congenital abnormalities that were unknown to Galen. Ibn Nafis, on the other hand, through his comprehensive theory, managed to refute

Galen theory that had been widely accepted for centuries. He corrected Galen mistake and put the theory of respiratory blood circulation forward".

Avicenna completely followed the idea of Galen and added some simple concepts that he had adopted from the instructions of Aristotle. Unfortunately, what Avicenna added was wrong and had already been rejected by Galen. Among these wrong theories that Avicenna had quoted was the idea that the heart consists of three ventricles which is exactly in accordance with Aristotle's idea, in that he believes that the number of ventricles depends on the animal weight. Ibn Nafis corrected many of the mistakes that existed in Avicenna books, especially those related to the veins that are connected to the heart and the lungs. He came to the conclusion that blood is transferred from the right ventricle to the lungs, where the blood gets mixed with the air and then, it moves to the left ventricle. With this theory, Ibn Nafis proved that blood is refined in the lungs. This is, indeed, equal to the so-called pulmonary blood circulation. This great discovery which was made by Ibn Nafis is observable in his remarks on the dissection of the lungs and the heart. Regarding the dissection of the lungs, he states, "the lungs are composed of several sections: 1) larynx antenna, 2) arteriolar veins and 3) veins. The location of all these sections is a soft, porous tissue.

Ibn Nafis was engaged in anatomy and dissection. This can be inferred from his reputation after the discovery of blood circulation in the lungs and also from Sami Hadad's comments in his book, *The good deeds of Arabs in Medicine*. In this regard, Ibn Nafis wrote a commentary on the dissection chapter of Ave Sina's *Al-Qanun* which was entitled *The explanation of Al-Qanun dissection*. In this book, he refers to the pulmonary blood circulation and sets to present a precise and detailed explanation for it. Here he clarifies Galen mistake in claiming that "blood exists the right ventricle and enters the left ventricle through small holes". Ibn Nafis demonstrated that blood reaches the lungs through the right ventricle and there it gets mixed with air. Then it leaves the lungs for the left ventricle [12, 13].

This indicated that Ibn Nafis criticized the scientists that came before him and proposed new ideas not based on theoretical or philosophical arguments but based on his practical experiences in opening up the cadavers and dissecting them. Naturally, he could not publicize or announce this act; therefore, he had to keep this to himself which I think is reason enough for supporting my claim.

Ibn Nafis criticized Galen theory on arterial passages existing between the right and left ventricles and wrote: "The wall between the right and left ventricles has invisible holes through which blood moves from one side of the heart to the other. The lungs are responsible for moving and shaking the upper section of the heart to bring about a reduction in temperature in the heart which takes away the heat from the blood and keeps it cool. This feeds some of the small organisms through the holes that exist between the lungs and the heart and also, feeds the heart and the blood." Ibn Nafis is among the few scientists that had sufficient experience and knowledge over the criticisms that they made of the ideas that Galen and Avicenna falsely believed in Khulusi [11].

In his book, *The explanation of anatomy of Ave Sina's Al-Qanun*, Ibn Nafis states that "one who says and of course, God knows better, that since one of the functions of the heart is giving spirit and this is only plausible when the blood is completely thin and mixed with air, should know this point that very thin and mixed with air blood should be placed in the heart so that spirit is laid in the heart space.

The left ventricle is the place where spirit is created and there must be another hole in the human and animal heart connected with the lungs for the blood to get thin and mixed with air because if air is mixed with thick blood, an similar substance will not be obtained unless it gets thin in the right hole of the heart.

When the blood gets thin in the right hole of the heart, it must pass through the left hole where spirit is generated. But there is not a hole between them because the heart mass is tough and there are not any visible holes as some have thought or holes that are suitable for passing this blood as Galen states.

Delicate and microscopic holes that exist between the two holes of the heart are very tight and the heart mass is highly solid; therefore, when the blood gets thin, it has to reach the lungs through arterial veins and spread in the body of the lungs and get mixed and then refined completely. After getting mixed with air, it enters the artery to move to the left holes of the heart and it gets qualified for generating the spirit" [11, 14].

George Satron in his book, *An introduction to the history of sciences*, states, "Ibn Nafis was the first person who discovered the pulmonary blood circulation which was unknown before him. This discovery was named after the English scientist, William Harvey (born in May 1578), who was renowned in medicine".

In 1324, Dr. Mohey Al-Din Tatavi found an old manuscript in which Ibn Nafis had explained his theories

regarding pulmonary blood circulation at Scorial Library. Therefore, Ibn Nafis is the first discoverer of the pulmonary blood circulation [15, 16].

Michael Servetus who lived in Spain in 1600s claimed to be the discoverer of pulmonary blood circulation and many physicians in their compilations quoted this claim, but certainly, Servetus Columbus and Harvey who had described the pulmonary blood circulation had already learned about the theories of Ibn Nafis and his books which had been translated from Arabic to Latin. Servetus simply ignored Ibn Nafis's remarks on this issue and claimed it to be his. Later on, he came to be known as the one who discovered the pulmonary blood circulation while the true discoverer was Ibn Nafis. Shahda, Hadad, Bine, Herbin, Meyrhof and several other professors and physicians had shown this to be the truth [17].

The discoveries of Ibn Nafis were made three centuries before other European scientists; however, many European Scientists claimed his discovery to be theirs. For instance, Servetus who lived in 1600s did refer to the fact that he had used the ideas of Ibn Nafis. Many of the scientific works of Ibn Nafis had been forsaken in libraries for several centuries and scientists in the field of medicine had not realized their real value until recently [18].

The commonly held belief among the scientists contemporary to Ibn Nafis was that blood is composed in the liver and is transferred to the right ventricle and, then, it is distributed in veins all over the body to feed it. Another part of the blood passes through the tiny holes which exist between the two ventricles and enters the left ventricle and there, it gets mixed with the air which comes from the lungs. This fallacy that was passed down to scientists was quite dominant since it had been proposed by Galen, the God of medicine. However, Ibn Nafis with his remarkable audacity, self confidence and respect for his colleagues turned away from this old fallacy and theorized that the refinement of blood is done in the lungs when it gets mixed with air in the course of respiration. Therefore, the blood in the right ventricle runs to the lungs and there it gets mixed with air and is refined. Then it is transferred to the left ventricle [19].

Nowadays, especially for those who are engaged in the history of science, it is quite clear that Western scientists have seriously been trying to duplicate many of the scientific theories proposed by Arab and Muslim scientists and record them in their own name while we are irresponsible to this issue. This act has, in fact, turned into a routine that whenever they find an early extant

written by Muslim scientists, they translate it to their own language and call it their own. Naturally, there are those who are ready to publish these unoriginal documents. Nevertheless, what matters is this bottom line reality that Ibn Nafis referred to the existence of the respiratory blood circulation (the minor circulation) in his book nearly three centuries before Europeans could come to this conclusion by the Spanish scientist, Servetus (1553-1509), in a book named *Chrtianisml Restituto* which was so close in concept to the ideas of Ibn Nafis that one could not help noticing the impact of his theory on Servetus [20].

Seril Algod in Safavid history of medicine states that the time when Harvey in *Demotn Gordis* explained blood circulation was coincident with the middle period of Shah Abass reign, when one of the most acclaimed Iranian physicians in the 10th century had referred to the relationship between beating (arteries) and non-beating (veins) vessels based on the fact that when an artery is cut, all the blood in the veins also moves out. End branches of arteries are tied to vessels in the brain and they come together at the mouth and are grouped in a parallel fashion [21, 22].

In studying the genesis of blood circulation, two scientists are mentioned above all: Claudius Galen (131-201) and William Harvey (1572-1659). Galen, the symbol of old medicine, is the one who developed and transferred the findings of his era which modified the findings of old medicine after 1500 years. He freed himself from the rotten thoughts and old prejudices and is, indeed, the founder of our current knowledge on blood circulation and vessels. On the other hand, the Italian anatomist, Marcello Malpighi (1628-1694) completed William Harvey's discovery through the use of microscope and showing the relationship between arteries.

A noteworthy issue about this book is that the explanations and the words which are stated about Galen idea are totally compatible with the remarks and comments of Ibn Nafis in this regard. He has even quoted some sentences from *Mojez Al-Qanun*, which definitely indicates that he has followed what Ibn Nafis has proposed. This becomes more tenuous when we understand that Andrea Alpago is translator who was in search of books in Arabic and could translate many such books of which only few were published in 1520 and the rest were probably published after 1520.

Mohey Al-Din Tatavi, the Egyptian physician, in his doctoral dissertation at faculty of medicine in Freiburg in 1924 referred to Miguel Zorroto's imitation of Ibn

Nafis. Nowadays, many European researchers and authors, like Sarton and Max Egrhof relate the discovery of pulmonary blood circulation to Ibn Nafis and see his place somewhere between Galen and Harvey [18, 12].

Noticing the precise descriptions of Ibn Nafis on pulmonary blood circulation nearly 300 years before William Harvey, it can be stated that he was first person who discovered this fact; however, due to Arab and Muslims' negligence towards their scientific legacy, some western scientists came to plagiarize many of his great and invaluable theories and named them as theirs [23-27]. For instance, Servetus that came three centuries after Ibn Nafis, claimed that he himself had discovered the pulmonary blood circulation, an issue which has recently been proven to all scientists in the field of medicine to be belonging to Ibn Nafis. In fact, Muslim scientists have left the earliest extant of Ibn Nafis and other scientists' workshops in the dark corners of world libraries where they are coated with cobweb.

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