Anatomy In Medieval Islam

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Summary

The author reviews the status of anatomical knowledge, essentially Galenic, in the Islamic world during the Middle Ages and quotes the description of the anatomy of the uterus by Rhazes, Al-Majusi and Avicenna. The contribution of Ibn al-Nafis to the knowledge of the anatomy of the heart, a contribution that played a fundamental role in the discovery of the pulmonary circulation, is also discussed together with the discovery, by Al-Baghdadi, that the mandible consists of one piece and not two, as Galen had taught.

It is concluded that, by the end of the twelfth century, although Galen was still considered the supreme authority, there were signs in Islamic anatomy and medicine of a tendency toward a more objective medical knowledge based on experience and observation rather than authority.

Key Words: Medical Ethics, Anatomy, Islamic Ethics.

Early in the Middle Ages, systematic dissections of the human body were performed neither in Islam nor in Christian lands (1). The reason is commonly ascribed to religious prohibitions (2), which, however, are not the only explanation. In fact, the systematic study of anatomy (involving dissection) takes place only when the knowledge of the structure of the human body is considered important for surgery (and this was not the case in ancient and medieval times) (3), or when the level of intellectual curiosity at the threshold of a scientific revolution impels physicians to dissect human bodies, as was the case at the time of Herophilus and Galen (4), and of Renaissance Italy.

Islamic anatomy, from the 9th to the 12th century, was essentially Galenic (5), as was the anatomy in the Western World. Descriptions of the anatomy of the uterus by Rhazes (865-925), Al-Majusi (c.925-994), and Avicenna (980-1037) give us an idea of the knowledge of the time:

> The uterus is situated between the bladder and the rectum but in its superior part it is higher than the bladder. The uterus of virgins and of nulliparous women is small; it is larger in women who have conceived and given birth to children… The uterus has two cavities that join in a single one, two prolongations called the horns of the uterus. Behind these prolongations are the two testicles of women [ovaries], which are smaller than those of men and flatter and it is from these two organs that the women's sperm is poured into the cavity of the uterus. The neck of the uterus ends near the vulva and it is analogous to the penis (6).
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> The uterus resembles the bladder except that it has two lateral prolongations similar to horns… The uterus is situated over the rectum and over it there is the bladder… The neck of the uterus reaches the vulva… and on the outside has some appendixes of the skin called clitoris. It is analogous to the prepuce in man and its function is to protect the uterus against cold. The uterus has two cavities, one on the left and the other on the right, which join in a single one, which is called the neck of the uterus… The two cavities are necessary because in case of twins each is formed in one of the two cavities; it is for this reason that women, in most cases, have no more than two children at the time… The two women's testicles are smaller than those of men and their form is round and flat… from each testicle arises a conduit through which the sperm flows to the uterus… The uterus of women who have conceived is larger than in nulliparous (7).
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> The reproductive organ of women is the uterus, which is analogous to the reproductive organ of the male, that is to the penis and annexed organs. However, in one case [in men] it is turned toward the outside whereas in the other [in women] it is turned inside and is, so to speak, the reverse of the men's organ… Women have testicles like men but in men they are big, oblong, and situated outside the body, whereas in women they are small, round, flat and situated on each side of the uterus, one on each side, that is, separated… The spermatic vessels [of men and women] differ in that those of women are united to their testicles; in the two accessory parts [of the uterus], in the form of horns, there is in each an organ that originates from each testicle and that ejects the sperm into the vessels. These two organs are

> called the ejectors of sperm… The uterus is much smaller in those who are virgin than in those who are not. In humans it has two cavities whereas in animals it has as many cavities as the animal has mammary glands (8).

At the time, following Galen, Islamic physicians believed that there was direct communication between the left and right ventricles of the heart (9). The following are accounts of such communication by Rhazes, Al-Majusi, and Averroes:

> [The heart has two ventricles, one on the left and one on the right]… and there are passages from the right to the left ventricle (10).

> [There are two cavities in the heart, the left and the right]… Concerning the passage from the right to the left cavity, it is large on the right side and gradually narrows as it reaches the left because the blood that comes from the liver in the vena cava must pass from the right ventricle to the left and the opening is narrower on the left so that only the most subtle part of the blood can pass into the left cavity (11).

> The heart has two large cavities, one on the left and one on the right… from the left to the right there are passages (12).

In the "Canon," Avicenna gives a few more details:

> The heart has three cavities (13), two large ones and another, so to speak, in the middle… and a passage between the two [large ones]. This passage dilates when the heart dilates and contracts when the heart elongates (14).

Although at the time no systematic dissections of the human body were performed, occasional animal dissections likely took place and these, together with a new spirit of observation that was developing in Islamic medicine, were probably responsible for two noteworthy contributions to anatomy made by Islamic scholars, one of which shed light on a fundamental aspect of human physiology, that is, the circulation of the blood, and the other corrected a Galenic misconception.

The first of these two contributions was made by Ibn al-Nafis (c.1210-c.1288), who asserted, contrary to Galen, that there were no interventricular openings in the heart; the other contribution was made by Al-Baghdadi (1162-1231), who showed that, again contrary to Galen's belief, the lower jaw was not composed of two bones.

Ibn al-Nafis wrote medical, theological and philosophical works as well as commentaries on several Hippocratic writings and on the "Questions of Medicine" by Hunayn Ibn Ishaq. His epitome of the *Canon* of Avicenna (*Mujiz al-Qanun*) was famous (15). In *Sharh tashrih ibn Sina* ("Explanation of the Dissection of Avicenna"), a commentary on the anatomy of the *Canon* (16), he made his famous contribution to the discovery of the pulmonary circulation (17). The crucial passage reads as follows:

> The blood, after it has been refined in this cavity [i.e., the right ventricle], must be transmitted to the left cavity where the [vital] spirit is generated. But there is no passage between these two cavities; for the substance of the heart is solid in this region and has neither a visible passage, as was thought by some persons, nor an invisible one which could have permitted the transmission of blood, as was alleged by Galen. The pores of the heart there are closed and its substance is thick. Therefore, the blood after having been refined, must rise in the arterious vein [i.e., pulmonary artery] to the lung in order to expand in its volume and to be mixed with air so that its finest part may be clarified and may reach the venous artery [i.e., pulmonary vein] in which it is transmitted to the left cavity of the heart. This, after having been mixed with the air and having attained the aptitude to generate the [vital] spirit. That part of the blood which is less refined is used by the lung for its nutrition (18).

There is no question that Ibn al-Nafis, in the above passage, described the pulmonary circulation. In addition, he showed both a high degree of originality by denying the existence of the Galenic foramina between the two ventricles (he was the first author to do so) and a remarkable courage in openly contradicting Galen.

How could Ibn al-Nafis know that there were no interventricular foramina? Such a definite statement about the solidity and thickness of the septum and such a clear denial of the existence of visible or invisible pores in contradiction to Galen's authority can only mean that Ibn al-Nafis practiced dissection (19). Only somebody who has seen again and again with his own eyes the continuity of the septum of the heart can make such statements with such confidence. A residual question remains: how could Ibn al-Nafis rule out, by inspection alone, the existence of *invisible* foramina? It is logical to assume either that he performed some experiments to prove that there is no

possibility for a liquid to pass through the septum, or that he concluded, after observing the compactness and thickness of the septum in many animals, that the possibility of invisible foramina was remote.

In either case, it is evident that Ibn-al-Nafis' contribution was crucial. Once the impermeability of the septum was established, the idea of the pulmonary circulation would inevitably follow.

As for Al-Baghdadi, as a result of his visit to Egypt he wrote a valuable work about the flora and fauna, the Nile flood, and Pharaonic monuments (*Al-Ifadah w-al-Itibar fi al-Umur al Mushahadah w-al-Hawadith al-Muayanah bi Ard Misr*, "Book of Instruction and Admonition on the Things Seen end Events Recorded in the Land of Egypt" (20)), which was widely known in Europe in Latin, German and French translations. In this work, he described the terrible famine that befell the country in 1200-1201 and in this connection he made an anatomical observation that corrected an error of Galen. He had occasion to see many skeletal remains of those "who had died from starvation or had been eaten by their fellows" (21) (at one place near Cairo more than two thousand skulls were piled up), he examined them and established that the mandible consists of one piece, not two as Galen had taught (22).

In *De ossibus ad tirones*, Galen said that the lower jaw consists of two parts and that this can be proven by the fact that it disintegrates in the middle when cooked (23). The Galenic criterion is, of course, dubious at best and al-Baghdadi based his view on repeated observations. He underlines, in fact, that the best evidence is obtained from observation rather than from "reading Galen":

> The following fact is one of the most remarkable among those I have witnessed … because there was a great difference between a verbal saying and a seeing of things. Having then learned that there was at Al Maks a hill in which had accumulated a large quantity of human bones, we went there, and we saw a small hill of considerable extent composed of the remains of human corpses. They occupied much of the land, and we estimated there were 20,000 corpses and more than the eye could perceive. They were separated into various classes by reason of their more or less decay. In considering these corpses we saw the shape of the bones and their joints, fitting them together in their respective proportions and positions, which gave us knowledge not obtainable from books, because the books did not mention them, or because their wording was insufficiently precise for one to form a just idea. Also the idea in the book [of Galen] is contrary to that which we have recognized by inspection, for the best evidence is from feeling [i.e., seeing and touching] rather than from hearing. Although Galen was the first in science to examine and be most careful and exact in what he said and reported, yet the witness of our senses is better than reading Galen … For instance, the lower jawbone; all the anatomists agree in saying this jawbone is composed of two bones which are firmly joined near the chin. When I say here all the anatomists, it is as though I say Galen only, for it is he only who has practiced personally anatomical operations, and who has made this the particular object of his studies and researches, and who has composed the greater part of those works of which we possess the principal; the others have not been translated into Arabic.
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> What I saw of this part of the corpses convinced me that the bone of the lower jaw is all one, with no joint nor suture. I have repeated the observation a great number of times, in over two thousand heads. I have employed all kinds of means to assure myself of its truth, and I have never seen anything but a single bone. I have been assisted by various different people, who have repeated the same examination, both in my absence and under my eyes and, like myself, they have never seen anything but a single bone, as I have said (24).

The emphasis of the author on the superiority of observation over authority is to be noted.

Al-Baghdadi's discovery was totally ignored and is not mentioned in any medical work written after his time (25), probably because it was published in a book about the geography of Egypt and also because the medical establishment was not yet ready to give prominence to observation over the word of ancient authority.

The anatomy at the time, in spite of the contributions of Ibn al-Nafis and Al-Baghdadi, remained essentially Galenic. It must be noted, however that Saladin's (d. 1193) physician, Ibn Jumay al-Israeli, about a century before the first autopsies were performed in Italy, wrote the following in a tract concerning the state of anatomy at the time, suggesting measures to improve it:

> … [necessary is] the enumeration of the parts of the human body part by part and the knowledge, gained through experience (*hiss*) and observation (*mushahada*), of the characteristics of the nature of each one of them with regard to the color, the normal state, and the like; [and, for each organ, knowledge] of its structure, that is, its shape, its smoothness or its roughness, whether there is a

> cavity or duct in it and what this cavity or duct contains; of the extent of its size and the number of its component parts and the nature of each component, if it has component parts; of its position, that is, its position in the body and whatever association and connection there may be between it and other parts; and of its function and useful purpose or purposes for which it is needed.
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> Pursuit of these things by experience only comes about through the anatomical dissection of human bodies (*tashrih al-abdan al-bashariya*). But anatomical dissection of these bodies is not [done] with ease and convenience at all times, [and] it does not suffice for the knowledge of these matters unless it is preceded by extensive practice in the anatomical dissection of other similar animals whose parts for the most part are like the parts of man, such as apes, [and] in the presence of instructors who are skilled in it, as the excellent Galen clearly and concisely outlined (26).

Obviously, by the end of the twelfth century, although Galen was still considered the supreme authority, the necessity for a more objective medical knowledge, based on experience and observation, was felt in the Islamic world. We begin to detect, in Islamic medicine, the first breezes that were harbingers of the winds of science that were to blow later.

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19. Animal dissection, of course. In a passage of Buchs (Mina Buchs, "Histoire d'une découverte: Ibn al-Nafis et la circulation pulmonaire," *Medicina nei Secoli*, VII, 95-108, 1995), it is suggested that Ibn al-Nafis may have performed human dissections. The evidence brought forward is, however, insufficient although the author quotes a passage of Ibn al-Nafis explaining how easy it is to study anatomy after letting the body decompose and how difficult it is to do the same in the living body because of the spasms caused by pain.
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