



A Review on the Structure and Function of Liver from Avicenna Point of View and Its Comparison with Conventional Medicine

Azadeh Zarei, Samaneh Noroozi, Ebrahim Khadem*

Department of Persian Medicine, School of Persian Medicine, Tehran University of Medical Sciences, Tehran, Iran

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Abstract

Persian medicine (PM) scholars have explained the structure and function of each organ based on clinical observations and past experiences. The liver is one of the three commanders in the body (brain, heart, liver) that manages nutrition and growth. This study was aimed to evaluate the anatomy and physiology of the Liver as presented in PM school and compare with conventional medicine. Relevant keywords were searched through PM reference books, Google scholar, PubMed, Web of Science and Scopus. After extracting the data, the results were classified in terms of concepts and categories. PM scholars believe that liver is one of the first organs created in the fetal period. In their view, the liver has a warm and wet temperament. In this manner the natural blood's temperament is warm and wet and it arises from the temperance of the liver and its correct function. In conventional medicine, the Liver consists an operational unit called hepatic lobule and plays an important role in the metabolism of the nutrition's and growth of tissues. Overview of fetal origin, structure and function of the liver between these two schools of medicine interpreted in many ways, revealed many similarities. Thus, we can utilize PM's point of view on the liver and its important functions in the body, especially in the field of disease prevention and treatment.

Keywords: Liver; Persian medicine; Avicenna, Iranian traditional medicine

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*Corresponding Author: Ebrahim Khadem (MD, Ph.D)

Department of Persian Medicine, School of Persian Medicine, Tehran University of Medical Sciences, Tehran, Iran

Tel: 021 88990837

Email: ekhadem@sina.tums.ac.ir

Introduction

Persian Medicine (PM) is an old and rich medical school which dates back to the 7th century BC [1]. Well-known Iranian physicians like Avicenna recorded their observations and experiences regarding keeping health and preventing and curing illnesses during many years. These doctrines were used as the main resources of medicine for a period of time [2] and even known as the root of Greek medicine [3].

The interesting fact is that, Avicenna and other Iranian physicians described the structure and the function of every single body organ based on clinical observations and the use of past experience [4]. Liver as a critical organ (along with brain and heart) plays a vital role in the body [5-7].

The other important point about Avicenna and other Iranian physicians is that despite the lack of using any advanced equipment and technology currently used to diagnose the structure and cellular and tissue function of the liver, their achievements are quite close to the findings of the conventional medicine. This study aims to represent embryology and the structure and functions (anatomy and physiology) of liver from Avicenna point of view, who was a famous Iranian physician in 11th century, and make a comparison with the conventional medicine. A comparison between the similarities and differences in these two points of view can help prevention, diagnosis and treatment of liver-related diseases by offering a combined medical viewpoint.

Methods

In this study, we review the original Iranian medical books, especially “The Canon of Medicine” by Avicenna and also the major conventional medicine books in the fields of embryology, anatomy, liver physiology, temperament, and nature. So, first we studied for the term “liver” in Iranian medical books like “The Canon of Medicine” by Avicenna (11th century), “Zakhireye Khwarazmshahi” by Jorjani (12th century), “Kamel-al-Sana’a” by Majusi Ahvazi (10th century), “Eksir Azam” by Nazem Jahan (19th century), and “Kholasa-al-Hekma” by Aghili Shirazi (18th century). In the conventional medical resources, the keywords of ‘embryology, psychology, anatomy, and liver’ were searched through databases like ISI Web of Knowledge, PubMed, SCOPUS, Guyton Physiology book, Gary’s Anatomy, Longman’s Embryology, and Jonquiere’s histology.

Findings

Liver from the Persian Medicine’s view

Liver is one of the three commanders in the body (brain, heart, liver) that manages nutrition and growth [7-9]. Also, stomach is an organ that supports liver; although it is not as vital as liver.

Embryology

Since liver plays an important role in the growth of the body, Iranian physicians

believed that it should have been one of the first organs created in the fetal period [8,10].

Anatomy

In order to determine the reason and kind of illness in an organ, first we need to know the structure and anatomy of the organ. In the Iranian traditional medicine (ITM), anatomy is the science that studies the organs regarding number, form, location, and their proportion [8,11-13]. In ITM, organs are divided into two groups of single and compound. A single organ is one that all its components are similar in the definition like “nerve”; a compound one includes components that are not similar in definition like “hand”. In fact, “hand” is a combination of its components [11-13]. Single organs are divided into two types of “Manavi” (semen originated) and “Damavi” (blood originated). The first group -Manavi- includes the ones that could not heal completely in case of damage unless in childhood; like cartilage, nerve, veins and large arteries. The latter one -Damavi- includes the organs that can easily heal during life; like muscles and fat tissues [7,8,14]. According to these definitions, in the point of view of ITM liver is a single and Damavi organ in form of a crescent [7,8,10] that has a fleshy texture [10,15,16]. It has 4 or 5 lobes [15,16] the biggest of which is connected to the gallbladder [7,8]. Liver is different in people regarding size and number of lobes [15]. Avicenna and other Iranian physicians believed that liver is connected to other organs like spleen and gallbladder via its lower part.

Also, that it is connected to stomach and intestines through vascular arteries. It is also connected to kidneys, diaphragm and lungs through the vena cava. It is also connected to the brain via nerves [7,8,10,16,17].

In Iranian medical books like “Canon of Medicine” it is considered to be insensitive and it is formed by a membrane that has nerves and feeling. This membrane creates a sensitive level for the liver to be aware of any internal or external damage [7,8,10].

For the vascular system of the liver, two regions of Arterial and Venous ones are defined in Iranian medical resources. In the arterial region, two branches of the left and the right go to the diaphragm from the lower branch to the aorta (descending aorta); from which a branch separated and goes into the liver. This is how liver receives arterial blood from the heart.

Avicenna and the others believed that liver was the source of all the veins in the body. Two main veins of “Baab” (Port) and “Ajvaf” (Venacava) are directly connected to the liver. The “Baab” vein enters the bottom of the liver and takes the digested food from the stomach to the liver. The “Ajvaf” vein takes blood from the liver and takes it to the right ventricle [7,8,10,15,16].

Physiology

From the PM’s point of view, digestion has four steps. The first occurs in stomach, the second in liver, and the third and fourth in veins and tissues. The liver is the place where the food is cooked in the body and quadruple

humors are created in body (blood, phlegm, choler, and melancholy). In this process the digested food in the stomach goes into the liver through mesenteric arteries and then Bab veins. Bab veins are dispersed in the liver in form of very small hair-like branching. On the other hand, they are connected to root-like branching in the curvy side of the liver. Despite the minute formation of vein branching and their dispersion in all the tissues of liver, practically all the liver is in contact with the chyle created from digestion so the function of liver is quite fast and heavy. Stomach chyle turns into one of the humors of blood, phlegm, yellow bile, and black bile under the influence of liver temperature. The blood segregated from the liver enters kidney via the first branching of vena cava for treatment. Kidneys feed on the aforementioned artery and dispose the extra water through urination system. The spleen receives the sediment of the blood (natural blood humor) via the concave area of kidney and stores it. On the other hand, the gallbladder takes the bile from the concave part of the liver and stores it in itself [7-10, 15,16].

Temperament

Temperament is an important concept in the Iranian medical school and it is important in preventing, diagnosis and treatment of illnesses. Avicenna and other physicians considered temperament for all the body and all the organs one by one; for example, the temperament for heart in the natural

circumstances is warm and dry, brain is cold and wet, bone is cold and dry and liver is warm and wet.

The temperature of liver is lower than blood [9], but in fact, natural blood's temperament is warm and wet and it arises from the temperance of the liver and its correct function [7-9,15,20].

When people are young, creation of the two warm humors of blood and yellow bile is higher. Organic temperament of liver is also warmer. As the person ages and the creation of melancholy, which is cold and dry, increases, this temperature decreases.

Iranian physicians believed that the emergence of some signs like big and widespread artery, great amount of hair grown on the stomach, higher temperature of liver area when touched, red hue of the body, as well as constipation, excessive production of bile in the body and consequently Increasing urine and stool color, great appetite, thirst, etc. are all signs of warm liver. The opposite signs imply the cold temperament of the liver. Other signs like thinness, especially in stomach and constipation could be signs of the dryness of liver temperament [15,16].

Liver from the point of view of the conventional medicine

Embryology

During the fetal period, liver creation starts from the digestive epithelium of the embryonic endoderm layer in the third week. Since the end of the 10th to the last

two months of the fetal development, liver weighs approximately %10 of the total body weight, due to its effective role in hemopoiesis. During the last two months, the hematopoietic activity is reduced in the liver. Then the liver's weight turns to be about %5 of the total body weight. Another important task of the liver in the embryonic period is the production of bile by liver cells that begins at the 12th week of the embryonic development.

Anatomy

In the anatomic study, liver is observed as a big reddish-brown bulk that is full of blood. Liver has restoration ability and weighs 1.5 kg. It is the biggest organ in the body and constitutes %2 of the weight of the adults. It is located in the right and upper part of the abdomen, under the diaphragm and covered by a fibrous capsule with sensitivity and a mesenchymal membrane of visceral peritoneum. Liver is divided into two lobes of the right big one and the left small one. The right big one is divided by gallbladder, inferior vena cava, ligament, falciform into two lobes of quadrate and caudate. Porta hepatics is located between the lobes of the quadrate and the lower posterior side of the liver, which is the entrance of the hepatocyte and portal vein, as well as the exit of the hepatic vein, lymphatic vein and CBD [21, 22]. Liver has an operational unit called hepatic lobule. Inside every hepatic lobule there is a central venue. Every lobule is made up of many hepatic cellular layers, that go from the

center to the outside in a radial arrangement. The thickness of every layer is as big as 2 hepatic cellules.

Every lobule takes branching from the bile ducts, liver arteries, portal veins and lymph vessels [23]. The venous, arterial, bilious and lymphatic branching are as follows:

Venous branches

Blood and the small veins, which are mainly come from the gastrointestinal tract, flow into the space between the cells cellular layer called the liver sinusoid, and from there into the central vein of the lobule and then the liver vein and the lower vena cava.

Arterial branches

Arterioles separate from the hepatic artery that go into to the lobule membrane and take blood to the tissue between the lobules; and arterioles directly go into the liver sinusoid, and this results in formation of arterial branching of the liver.

bile duct branches

From the bile duct, some branches go into the hepatic lobules. In each lobule, these branches split into bile canaliculus in the space between the liver cells. Thus the bile flow begins with these canaliculi. Bile is secreted in 2 stages of the liver; the primary secretion of hepatocytes and contains high amounts of bile acids, cholesterol and other organic components. The second stage of the hepatic secretion of epithelial cells that

cover the bile ducts, added to the primary bile containing sodium and bicarbonate ions (24). Each day, 600 ml of bile is made in these canaliculus. These bilious salts are placed more than 10 times in the Intestinal circulation of the liver [24,25].

Lymphatic branches

From the lymphatic vessels, the branches go into hepatic lobules. Finally, a space called "Space of Disse" is formed in the space between hepatic cellular layers next to the Sinusoids. With high permeability of liver sinusoids, a large amount of lymph is created in the Disse space; so that half of the produced lymph in resting position of the body originates from the liver.[24]

Physiology

From the point of view of the contemporary medicine ,liver operates as follows:

Filtration and storage of blood as a dilatable organ [25],

Performing the metabolism of the carbohydrates, lipids, proteins and external chemicals,

Helping the digestion and absorption of fat in the digestive system by bile and bile salts [24-26],

Storage of the vitamins B12, A, D and Iron [24-27].

Making coagulation factors

Helping the cleansing and immunity of the body using Kupffer cells [8,20,21,24,28,29]. And helping with the synthesis of the immunity-related proteins

(proteins of the complement system, acute-phase proteins) [24,25]

Removing and detoxifying the body's internal and external matters, such as hormones, medications, etc.

Discussion and conclusion

With an overall and comparative study of the resources of ITM and conventional medicine regarding embryology, anatomy, and physiology of liver we came across many similarities in the both viewpoints.

Regarding the structure, according to Avicenna and other Iranian physicians, liver is an organ located in the right side of the body with 4 or 5 lobes. The size and number of lobes vary in different people. Conventional medicine believes that liver is an organ with 2 or 3 lobes with different sizes. Avicenna's Canon of Medicine and conventional resources regard liver as an organ with high reparability. Both say that liver is insensitive with a sensitive membrane.

According to the "canon" and other Iranian books, stomach, gallbladder, diaphragm and intestines are adjacent to liver. They cooperate with liver not only structurally but also operationally. In conventional medicine, stomach, diaphragm and gallbladder are mentioned to be the adjacent organs of the liver. Also, the cooperation between the liver and other organs is affirmed.

Both viewpoints believe in the entrance of blood through mesenteric vein to the liver and both believe that it continues into port vein. The Iranian physicians, including Avicenna

in the book of “*canon*”, speak of fine hair-like vessels, such as the vein of the Baab, and the subsequent association of these small branches with hair-like extensions such as the venous vein. This is a notable point in the description of the anatomical venous system of the liver in this medical school. It is similar with the description of liver sinusoids from the perspective of conventional medicine [7]. Both viewpoints believe that blood exits liver through vena cava.

Regarding performance, Avicenna believed that liver plays an important role in the metabolism of the nutrition’s and growth of tissues. He believed that liver is one of the main organs of the body. According of Iranian traditional medicine, liver plays an important role in digestion. The second phase of digestion, among four, happens in the liver. According to this perspective, since liver is closely related to other organs, problems and failures in many organs arise from the liver failures. Reinforcing and cleansing the liver can be very effective in preventing other illnesses that are irrelevant to the liver. The conventional medicine addresses many critical duties for liver like metabolism of the carbohydrates, fat, proteins, treatment and storage of blood, creating coagulation factors, helping with human immunity, storing some vitamins, iron, etc.

In terms of embryology, Avicenna and the scientists have also considered liver as a vital organ in embryo nutrition, and believed that it was the first organ of the fetus. It is worth mentioning that many of the above findings

mentioned in “*The Canon of Medicine*” and other Iranian resources were gained without any advanced equipment and technology currently used to recognize the structure and function of the cells and tissues [30].

Despite the many similarities in the field of embryology, anatomy and liver physiology, they are not necessarily similar regarding other aspects. Among other things, the warm and wet temperament of liver is directly stated in the Iranian school. From the other perspective, there is no such reference. The conventional medicine considers the liver to be the main center of metabolism of many substances in the body and, of course, this requires a higher temperature and humidity of the organ in compared with the other organs. Also, Avicenna and other sources of ITM consider the liver as the source of venous system and heart as the source of arteries. But, in the conventional medicine, heart is just regarded as the common origin of the arteries and veins of the body.

It seems that despite the similarity between the views of the two viewpoints of medicine in terms of the anatomical, physiological and embryology characterization of the liver, despite the fact that both of these schools define a significant and effective role for this organ in the metabolism and growth of the body; in the field of etiology and treatment of non-hepatic diseases, Avicenna and other Iranian medicine scholars have emphasized more on the importance and role of the liver in comparison with the conventional medicine scientists [7,8,15,16,31,32].

Table 1. A brief comparison of the two viewpoints regarding embryology, anatomy, physiology and temperament.

Liver	Iranian point of view	Contemporary point of view
Embryology	<ul style="list-style-type: none"> - The formation of the organ in the beginning of the fetal period - A single organ, with blood temperament (repairable) 	<ul style="list-style-type: none"> - The formation of the organ in the third week of the fetal period - formation from the digestive epithelium of the embryonic endoderm layer - repairable
Structure (anatomy)	<ul style="list-style-type: none"> - crescent form, fleshy texture, in the right and upper part of the abdomen - with 4 -5 lobes - with many arteries - insensitive organ with a membrane that has sensitivity and nerve 	<ul style="list-style-type: none"> - A big bloody reddish-brown bulk located in the right and upper part of the stomach - With 2-3 lobes - With hepatic sinusoids - With operational unites called hepatic lobules (including venous, arterial, bilious and lymphatic branching) - insensitive mass and a capsule with sensitive nerves - adjacent to stomach, diaphragm and gallbladder
Function (physiology)	<ul style="list-style-type: none"> - performing maturity and the second stage of food digestion - creating the four humors (blood, phlegm, choler, and melancholy) - Operational cooperation with other organs (like stomach, kidneys, lungs, brain, spleen, gallbladder, etc.) 	<ul style="list-style-type: none"> - treatment and storage of blood Doing the metabolism of the carbohydrates, lipids, proteins and chemicals - helping with the digestion and absorption of fat - storing some vitamins and iron - creating coagulation factors - helping with cleansing of blood and immune system - body detoxication
Organ temperament	Warm and wet	-

Acknowledgment

None.

Conflicts of Interest

None.

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