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Review Article

Systematic review of the concept of *Yakrutotpatti* (embryology of liver)

Nilesh V. Kasar, Yogesh S. Deole[1], Shivprasad Tiwari[2]

Department of Sharira Rachana, [1]Department of Kaya Chikitsa, G. J. Patel Institute of Ayurveda Studies and Research, New Vallabh Vidya Nagar, Anand, Gujarat, [2]Department of Sharira Rachana, Bhanwar Lal Nahata Smriti Sansthan, Mandsaur Institute of Ayurveda Education and Research, Mandsaur, Madhya Pradesh, India

Abstract

Ayurveda has its own view to understand the development of human body and its various organs. As the quotations are in a concise manner, it is essential to amalgamate the basics stated by various *Acharyas* with comprehensive explanation of modern science. The liver is a vital organ for metabolism. *Acharyas* have opined about the genesis of *Yakrut* (liver) from *Rakta Dhatu* (blood tissue). Parallel opinion in conventional anatomy states that abundant quantity of blood is responsible for the formation of sinusoids of liver. This huge quantity of blood comes from broken viteline and umbilical veins in the septum transversum. On the other hand, the raw material for the formation of blood cells and liver (septum transversum) is the same, being mesenchymal cells from the mesoderm. The present review was conducted to discover the similarities about the genesis of liver in the opinions of ancient and conventional medical science. This may be useful for utilizing the ancient medical science in a new perspective. Therefore, it is attempted to correlate the genesis of liver in Ayurveda with modern science.

Key words: *Angapratyanga Nirman*, embryology, liver, *Yakrut*, *Yakrutsharira*

Introduction

According to modern science, the visceral organs can be studied with two perspectives, viz. anatomical observations and physio-pathological derangements. Ayurveda *Samhitas* concise the study under one heading of "*Sharir*". The subject covers the anatomical as well as physiological studies related with the specific organ.[1]

Ayurveda narrates the basic principles including *Panchamahabhoota*, *Tridosha*, *Saptadhatu*, etc., in view of embryology and organogenesis. The various organs generate from different combinations of these *Bhavapadarthas*. Liver is a vital organ for metabolism. *Acharyas* have opined about the genesis of *Yakrut* from *Rakta Dhatu* (blood tissue). A parallel opinion in conventional anatomy states that an abundant quantity of blood is responsible for the formation of sinusoids of the liver. This huge quantity of blood comes from broken viteline and umbilical veins in the septum transversum. On the other hand, the raw material for the formation of blood cells and liver (septum transversum) is the same, being mesenchymal cells from the mesoderm. Many new diseases like liver cirrhosis, carcinoma liver and hepatitis are introduced by modern science. It is essential to conceptualize the basic genesis of liver in order to form the exact pathogenesis and treatment in Ayurveda. The present research is carried out to understand this concept in the light of contemporary science. This may be helpful while treating the disorders of the liver.

Address for correspondence: Dr. Nilesh V. Kasar,
104, Parth Apartment, V. V. Nagar, Anand,
Gujarat - 388 120, India.
E-mail: drnileshvk@gmail.com

Aim of the Study

This study has been conducted to assess the views of Ayurveda and contemporary science on the basis of genesis of the liver.

Review of the Literature

The liver is a well known organ for Ayurveda. In *Vedas*, it is named as "*Takima*" or "*Yakna*".[2]

Paryaya (Synonyms)

Synonyms like *Kalakhanda*,[3] *Jyotisthana*,[4] *Yakrutkhanda*,[5] *Yakrutpinda*,[6] *Raktadhara* and *Raktashaya*[7] are found in the ancient literature.

Kalakhand: This word is also used as a synonym of *Yakrut* in the *Sushruta Samhita*.

Jyotisthana: *Jyoti* means *Agni*. The site of *Agni* is called the *Jyotisthana*.

Fetal nutrition usually depends on *Ahara Rasa*, categorized under maternal factors and *Vayu* present in *Jyotisthana* and responsible for cell division. The *Ahara Rasa* is first received by *Jyotisthana*, which further nourishes the whole body. Therefore, *Jyotisthana* means "liver".

Yakrutkhanda: In *Ashtanga Hrudaya*, *Acharya Vagbhata* has used this word with regards to the description of diseases. In modern science, *Yakrutkhanda* means lobes of liver.

Raktadhara/Raktashaya: *Yakrut* is a site of *Rakta Dhatu*. Blood is stored in the liver; therefore, *Raktadhara* or *Raktashaya* words have been used in Ayurveda *Samhitas*.

Varna (Color)

In the classics, various references regarding the color of *Yakrut* can be seen during the elucidation of signs and symptoms of diseases. The color of *Vidradhi* is similar to the color of *Yakrut*,[8] i.e. *Krushnalohitam* (reddish brown).

Acharya Vagbhata has compared the color of *Pittaja Arsha* with *Shukajihva*, i.e. tongue of parrot, *Yakrutkhanda* and *Jalouka*.[5] In *Sharira Sthana*, he has stated the critical condition of the patient in *Atisara* (diarrhea). - "If the color of stool is like the *Yakrutpinda* or *Mansadhavana*, the patient will not survive".[6]

Svarupa (Appearance)

According to *Bruhadarunyaka Upanishad*, the appearance of *Yakrut* and *Pleeha* are solid structures like mountains.[4]

Sthana (Site)

The site of the liver is below and right to the heart.[9] *Acharya* Arundatta has given the same statement.[10]

Karya (Physiology of liver)

Many *Acharyas* have stated that the main function of *Yakrut* is to offer red color to *Rasa Dhatu*, i.e. *Ranjana* of *Rasa Dhatu*. However, according to *Acharya* Vagbhata, this function is carried out by *Amashaya*,[11] i.e. the stomach. According to Sushruta, the function of *Pitta*, which has its seats in the liver and spleen, consists of imparting its characteristic pigment (*Ragakrut*) to the *Rasa Dhatu* (lymph chyle) and hence it is known as *Ranjakagni*.[12] *Acharya* Sharangadhara also has a similar opinion about the formation of blood.[13]

Utpatti

In relation to the development of body parts, *Yakrut* is developed or generated from *Matrujabhava*,[14] as stated by *Acharya* Sushruta and Charaka in *Sharira Sthana*.[15]

Acharya Sushrut in *Sharirsthan* states that *Yakrut* is also engendered from *Rakta Dhatu*.[16] According to *Acharya* Arunadatta, the three *Bhavapadarthas*, i.e. *Samana Vayu*, *Dehoshma*, and *Rakta Dhatu* take part in the formation of *Yakrut*, *Pleeha*, and *Kloma*.[10] While considering these verses, it has been cleared that all the *Acharyas* were sure about the major role of *Rakta Dhatu* in the development of *Yakrut* (liver).

Review of the Modern Literature

Development of liver and the bile duct

The liver begins as a hollow endodermal bud from the foregut during the 3rd week of the gestation. The bud separates into two parts, viz. hepatic and biliary. The hepatic part contains bipotential progenitor cells that differentiate into hepatocytes or ductal cells that form the early primitive bile duct. This collection of rapidly growing cells penetrates in the adjacent mesodermal tissue (septum transversum), and it is met with an ingrowing capillary plexus from the vetelline and umbilical veins, which ultimately form sinusoids. The biliary part of the endodermal bud will form the gall bladder and extra hepatic bile duct. Due to the connection between these growing masses of cells and foregut, bile comes into gastro-intestinal tract and it begins to flow at about the 12th week of intrauterine life. Hemopoietic cells, Kupffer's cells and connective tissue cells are derived from the mesoderm of septum transeversum.

The fetal liver has major hemopoitic function up to the first and second trimesters. This subsides during the last 2 months of intrauterine life so that only few hemopoietic cells remain at birth.[17] The similarities and opinions about hepatogenesis are depicted in Table 1.

Discussion

According to Ayurveda *Samhitas*, the liver develops from *Rakta Dhatu*. The correlation of this in modern science is:

The development of liver is from the hepatic bud and septum transeversum that is the unsplit part of the mesoderm.

On the first hand, the mesoderm produces septum transversum and the liver develops from the same. On the other hand, the mesoderm also produces mesenchymal cells, which in turn produce myoblast, chondroblast, lymphoblast, hemocytoblast,[18] etc. The blood cells develop from hemocytoblast and lymphoblast. Last but not the least, it is seen that the raw material for liver and blood is the same, i.e. mesoderm.

Secondarily, septum transversum is the first site of maternal blood. The umbilical and vitelline veins open at the septum transversum; due to this, the septum transversum is rich in blood supply.[19] Hepatic bud grows in the septum transversum and, due to it, the umbilical and vitelline veins are broken up forming the liver sinusoids.[20] It indicates that blood plays an important role in the development of liver. Hence, in this manner, the references in Ayurveda can be correlated with modern science regarding the development of *Yakrut*.

According to Ayurveda, the *Rasa Dhatu*, which comes to *Yakrut* and *Pleeha*, get colored by *Ranjakagni*. But, this is too difficult to correlate with modern science. In the term of modern science, it can be matched with hematopoiesis. Hematopoiesis is carried out by *Yakrut* only in intrauterine life. However, after birth, this is carried out by red bone marrow. In some pathological conditions, the liver may help in forming blood cells with red bone marrow. Actually, the function of *Yakrut* is metabolism of fats, proteins, etc., or storage of certain vitamins, nutrients or glycogen and not coloring the chyle. On the whole, the term of *Ranjakagni* related to the liver is too difficult to match with any of the components present in the liver.

The above discussion shows that embryological origin of liver is blood tissue as per Ayurveda as well as modern science. Hence, in case of any liver disorder, the baseline treatment for blood disorders may be adopted. However, the study

Table 1: Similarities and opinions about hepatogenesis

Observations	Ayurvedic view	Modern view	Discussion
Varna (color)	*Krushnalohitam Jalouka Shukajihva Pittaja Arsha*	Reddish brown or dark brown in color	The color of *Yakrut* can be correlated with the color of *Jalouka Shukajihva* and *Pittaja Arsha*
Swarupa	*Parvatam* (like a mountain)	Solid and friable	Structure of the liver is described similarly both in Ayurveda as well as in modern medical science
Sthana	Below and right to the heart	Major part lies in right hypochondrium	Location of the liver is also mentioned equally in both the sciences
Karya	Formation of blood	Metabolism, detoxification storage of nutrients, formation of plasma proteins and hemopoasis in the first two trimester of intrauterine life	Upto certain extent this point can also correlates with contemporary science. As the liver is the site of *Agni* the metabolism is seen. As it forms certain plasma protein (globulin) the part of hemoglobin, and formation of blood is in the first two trimester of intrauterine life
Development	From *Rakta Dhatu*	Hepatic bud and septum transeversum, the umbilical and vitelline veins	The basic material for the development of liver (septum transversum) and blood is same, i.e., mesoderm. Hepatic bud grows in septum transversum and due to it, umbilical and vitelline veins are broken up forming the liver sinusoids. It indicates that blood plays an important role in the development of liver

opens a new window on the applicability of this concept in management of hepatic disorders. The efficacy of drugs acting on *Raktavahasrotasa*, like *Sariva*, *Manjishtha*, *Triphala*, etc., needs to be evaluated in the perspective of hepatic disorders.

Conclusion

Except the method of presentation, no differentiation is being identified in the development of liver in both Ayurvedic as well as modern perspectives. In view of the above facts, it is clear that Ayurvedic classics have a fabulous scientific approach in understanding the fundamentals in general and *Rachana Sharira* in particular.

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हिन्दी सारांश

यकृत उत्पत्ति का समीक्षात्मक अध्ययन

निलेश व्ही. कासार, योगेश एस. देवले, शिवप्रसाद तिवारी

शरीर के अङ्गप्रत्यागों के निर्माण के विषय में आयुर्वेद का अपना एक अलग दृष्टिकोण है और उसी को आधुनिक परिवेश मे विश्व के सामने रखना हमारा कर्तव्य है । इस विषय को ध्यान मे रखते हुये हमने यकृत की उत्पत्ति के विषय में आधुनिक शास्त्र के साथ समन्वय करके अपना मत प्रदर्शित करने का प्रयास किया है । प्राचीन आचार्यों के अनुसार यकृत की उत्पत्ति रक्त धातु से होती है, और इस विषय को आधुनिक शास्त्र की दृष्टिकोण से सोचा जाये तो यकृत की उत्पत्ति होते समय सेप्टम ट्रान्सव्हर्सम मे व्हीटेलाइन व्हेन के विदीर्ण होने से रक्त की अत्यधीक मात्रा होती है, और उसी कारण से यकृत की साईनसोइडस तैयार होती है । यदि दूसरी तरह से सोचा जाये तो सेप्टम ट्रान्सव्हर्सम और रक्त धातु दोनों की उत्पत्ति के लिये लगनेवाला भाव मेसेनकाइमल सेल्स ही होता है ।