International Journal of Applied Ayurved Research ISSN: 2347- 6362

CONCEPT OF RAKTAGNI WITH REFERANCE TO IRON METABOLISM AND ERYTHROPIOSIS

Chormore M Prashant[1] Waghulde S Sayali[2] , Bangarwar Y Chandrashekhar [3]
[1,2]P.G Scholar Dept.of Kriya Sharir YMT Ayurvedic Medical College Kharghar Navi Mumbai.
[3]HOD & Professor Dept.of Kriya Sharir YMT Ayurvedic Medical College Kharghar Navi Mumbai.

ABSTRACT

The "*Agni*" occupies entire body, and various biotransformation's are carried out in living body at all places. "*Dhatwagni*" is that part of *Agni*, which assimilates or synthesizes "*Dhatu*" of living body. *Dalhan* says, by *Trividh parinaman, dhatu* is converted into three parts by its own *dhatwagni*. *Raktagni* acts on *Rakta poshakansha* and transforms it into 1. *Sthayi Rakta dhatu*, 2.*Poshakansha of mamsa dhatu* and *Upadhatu (Sira and kandara)*, 3.Its *mala*. *Raktagni* can be correlated in modern science to various substances (erythropoietin, apotransferrin, aconitase, B12 vitamin, folic acid etc) and biochemical reactions occurring in the process of iron metabolism and erythropoiesis.

Keywords: *Rakta, Raktagni,* erythropoietin, apotransferrin, B12 vitamin

AIM: Literary study of *raktagni* with reference to iron metabolism and erythropoiesis.

OBJECTIVES:

- To study *raktagni.*
- To study iron metabolism and erythropoiesis
- To study other factors responsible in erythropoiesis like vitamins and minerals, mainly vitamin B12,folic acid and vitamin C
- To study the concept of *raktagni* with reference to iron metabolism and erythropoiesis.

INTRODUCTION:

Formation of *raktadhatu* requires *Raktagni;* with its help *rasa dhatu* gets converted into *raktadhatu. Agni* occupies entire body, and various biotransformation's are carried out in living body at all places. "*Dhatwagni"* is that part of fire, which assimilates or synthesizes "*Dhatavaha"*of living body.(1) Dalhan says, by *Trividh Parinaman, dhatu* is converted into three parts by its own *dhatwagni. Raktagni* acts on *rakta poshakansha* and transforms it into 1. *Sthayi Rakta dhatu*, 2.*Poshakansha* of *mamsa dhatu* and *Upadhatu (Sira*and *kandara),* 3.Its *mala* (2).The meaning of *Ranjaka* is "*Ranjana*" or "to color". When *rasa dhatu* is colorless then how come *rakta dhatu* becomes red (3).Charaka has mentioned that when *teja* portion of *ahara rasa* and *ranjaka pitta* with *Raktagni* acts upon *rasa*, it acquires redness(4).*Sushruta*, and *Charaka* describe that *Ranjana Karma* occurs in *Yakrit, Pliha*,(5)and *Vagbhat* says it occurs in *Amashaya*.(6)We can say that in the formation (erythropoiesis) and regulation of *Raktadhatu*,

1. Hormone Erythropoietin whose principle site is kidney as well as liver.
2. Absorption, metabolism and recycling of iron (*Loha*) through certain enzymes, also vitamins like Vitamin C.
3. Absorption and metabolism of Vitamins and minerals mainly vitamin B12 and folic acid through certain enzymes are important.

By all this biotransformation the blood gets its red color and all this biochemical reactions are necessary in erythropoiesis and regulation of blood. Thus *Raktagni* can be correlated to hormones & enzymes which are responsible for these biochemical reactions.

MATERIALS:

Bruhatrayi and *Laghutrayi* of Ayurvedic texts.

Modern Texts related to Physiology.

Research journals in Ayurveda.

REVIEW OF LITERATURE

***Conceptual Study* Formation of Blood:**

Sushruta describe that liver and spleen are formed with *rakta* in *garbhavastha*[7].The root (*mool)* of *Rakta* formation and *Raktavaha strotas* is *Yakrit* and *Pliha* by *Charaka* and *Sushruta* Also *rakta vahidhamanya* by *Sushruta*[8,9].As per modern science, Blood is circulating in whole body by blood vessels and its formation is in the liver and spleen. Liver is the principle site of erythropoiesis and spleen is the storage depot of erythrocyte. *Sushruta* has mentioned that the formation of *vrikka* (Kidney) is by *prasada bhaga* of *rakta* and *meda*[10]. The principle site of erythropoietin is said to be kidney by modern science.

As per modern science: In the early weeks of embryonic life, primitive, nucleated red blood cells are produced in the yolk sac. During the middle trimester of gestation, the liver is the main organ for production of Red blood cells, but reasonable numbers are also produced in the spleen and lymph nodes. Then, during the last month or so of gestation and after birth, Red blood cells are produced exclusively in the bone marrow[11]. In fetus and neonatal life, liver is the principle site of erythropoiesis. The principle site of erythropoietin is kidney and 15% is from liver.The liver is the main erythropoietic tissue of human fetus at midterm.

Action of erythropoietin[12]: Erythropoietin, a protein actively synthesized in cultures of fetal hepatocytes. It is a polypeptide hormone. It stimulates the production of red blood cells. It acts on the bone marrow to promote the development of the erythroblast stem cells, which then matures into reticulocytes and red blood cells without the need for further hormonal action. It can augment the production of haemoglobin within the red blood cells, increasing the cell volume and haemoglobin content. It has been found in the foetal serum of mammals but seems to play a role late in the erythropoietin development of the liver. Thus this erythropoietin can be considered as *raktagni* which helps in *Rakta utpatti*.

Liver and its importance: A person can live without a gallbladder or spleen, a kidney or lung but they cannot live without a liver. Everything that enters the body through any method must pass through the liver. Liver has blood cleansing function, i.e. detoxification. It is considered as high blood flow organ. It stores iron in the form of ferritin and it also stores vitamin B12. Coagulation factors are also formed in Liver. Hepatocytes also synthesize most plasma proteins[13]. It helps to build muscles by metabolizing proteins; i.e. it can be seen here that *rakta poshakansha* is converted into *mamsa poshakansha* with the help of *Raktagni* in *Rakta vahastrotas*.

It regulates energy by storing glucose in the form of glycogen for use when needed. It maintains hormonal balance by regulating hormonal production. It helps to process vitamins and minerals as well as any ingested drugs.

Iron metabolism: *How loha (iron) or different forms of loha kalpa (forms of iron) is important in Rakta utpatti with help of Raktagni. Loha* is used extensively in the Ayurvedic literature for the management of various diseases like *Pandu, Shotha, Kamala* etc. It is very hard metal hence it should be made into *bhasma* for using it for medicinal purposes. Examples:

1. *Loha Bhasma* is an Ayurvedic medicine prepared from Iron. It is used in Ayurvedic treatment of *Pandu*, (Ch. Chi. 16/69. *Rasamrit,* 3/134-136.
2. *Lohasava* is used as Ayurvedic medicine for *Pandu.* Apart from anemia, *lohasava* is also used in the treatment of swelling, inflammation, liver and spleen conditions, itching, cough, fistula, certain

digestive diseases. *Sharangdhara Samhitama*.10/34-38and *Bhaishajya ratnavali*.

Liver has the maximum concentration of iron.15 to 30 per cent is stored, mainly in the reticulo-endothelial system and liver parenchymal cells, principally in the form of ferritin. Ferritin is protein and important in the metabolism of iron. Roughly 2/3rd of the body's iron pool is bound to haemoglobin. About 1/4th exist as a stored iron (ferritin, hemosiderin), the rest as functional iron (myoglobin, iron containing enzymes). Iron absorption occurs mainly in the duodenum and varies according to the need[14].

Location of *Amashaya* is between umbilicus and breasts, so the duodenum part is also considered in *Amashaya* in Ayurveda. It is also said that,(15)

Ranjaka pitta, which exists in the stomach, is responsible for staining rasa into red color forming *Rakta*.(16) This reference indicates research and progress in scientific fundamentals about the origin of *Raktadhatu3*. With the aid of haemeoxygenase, Fe in mucosal cells cleaves from haeme and oxidizes to Fe (III). The triferric form either remains in the mucosa as a ferritin-Fe (III) complex and returns to the lumen during cell turnover or enters the blood stream. Absorption of ferrous form of iron is more than ferric iron. Therefore, Fe (III) must first be reduced to Fe2+. Ferric iron can be converted in the presence of gastric acid by ferric reductase and ascorbate in the duodenal brush border to ferrous iron.The absorption of iron into the bloodstream is regulated by the intestinal mucosa. When an iron deficiency exists, aconitase (an iron regulating protein) in the cytosol binds with ferritin mRNA, thereby inhibiting mucosal ferritin translation. As a result, larger quantities of absorbed Fe (II) can enter the bloodstream. Fe (II) in the blood is oxidized to Fe (III) by ceruloplasmin (and copper)[17].

This can be seen in the reference of *kalpa "Arogyavardhini"*, that the yog has the combination of main contents like *loha, abhraka, tamra, shilajatu, guggulu, chitrak, kutaki, triphala, kajjali* and *nimbi patra swaras.* It acts best on *Yakrit*. It is said to be *sarva rog prashamani*.(Ra.Yo.Sa). Also the *kalpa Panchamrit parpati* containing *loha bhasma, tamra bhasma, abhrakabhasma, kajjali of shuddha parad* with double its *gandhaka,* acts on *Yakrit* and works in *pandu.(Syatpanchamrit parpati,*Yo.Ra).

It then binds to apotransferrin, a protein responsible for iron transport in plasma. Transferrin [apotransferrin loaded with 2Fe (III)], is taken up by endocytosis into erythroblasts and cells of liver, placenta, etc. with the aid of transferrin receptors. Once the iron has been released to the target cells, apotransferrin again becomes available for uptake of iron from the intestine and macrophages[18].

Iron storage and recycling[19]: Ferritin, one of the chief forms in which iron is stored in the body, occurs mainly in the intestinal mucosa, liver, bone marrow, red blood cells, and plasma. It contains binding pockets for up to 4500 Fe3+ ions and provides rapidly available stores of iron, whereas iron mobilization from hemosiderin is much slower [Fe in macrophages of liver and bone marrow]. Hb-Fe and heme-Fe released from malformed erythroblasts (so called in efficient erythropoiesis) and haemolysed red blood cells bind to haptoglobin and hemopexin respectively. They are then engulfed by macrophages in the bone marrow or in the liver and spleen, respectively, resulting in 97% iron recycling.

Vitamin B12 (cobalamins) and Folic acid[20]: Vitamin B12 and **folic acid** are also required for erythropoiesis. Especially important for final maturation of the RBC are two vitamins, Vitamin B12 &Folic acid. Both of these are essential for the synthesis of DNA. Vitamin B12 is stored in large quantities in liver and released slowly as needed to the bone marrow and

other tissues of the body. It is found only in food of animal origin. Smith said that an amorphous red principle from liver was very effective in anaemia in very small dose around half a milligram. The red colour is due to cobalt salt and this is now called as vitamin B12. This is obviously that it is an **erythrocyte maturation factor**.

Folic acid / Folate (pteroylglutamic acid).N5, N10-methylene-tetrahydrofolate, is the metabolically active form of folic acid (daily requirement 0.1-0.2 mg) is needed for DNA synthesis in final maturation of RBC. *Amalaki*(*Emblicaofficinalis*) is richest source of Vitamin C, which helps in absorption of iron.

Vitamin C reduces ferric iron to ferrous iron[21], which remains soluble even at neutral pH and is better absorbed. *Amalaki* enhances the production of RBCs and increases immunity in the body.

Importance of Spleen*[22]*: Spleen has primary role in making red blood cells in a developing fetus.*Pliha* or spleen form leucocytes and is a storage depot of erythrocyte. The life span of RBC is around 120 days. RBC regularly exits from arterioles in the splenic pulp and travel through small pores to enter the splenic sinus, where old RBC are stored out and destroyed (haemolysis). Macrophages in the spleen, liver, bone marrow etc. engulf and breakdown the cell fragments, Haeme, the iron containing the group of Hbreleased during haemolysis is broken down into bilirubin and rest of iron and globin are again reuptake and iron (ferritin) is stored as non haeme part, for the production of RBC[22].

DISCUSSION: Charak has mentioned that when *teja* portion of *ahara rasa* and *ranjaka pitta* with *Raktagni* acts upon rasa, it acquires redness. *Dalhan* states *Raktagni* acts on *Rakta poshakansha* and transforms it into 1. *Sthayi Raktadhatu*, 2.*Poshakansha* of *mamsa dhatu* and *Upadhatu (Sira*and *kandara)*, 3.Its *mala*.1. In Erythropoiesis, **Erythropoietin** augments the production of haemoglobin within the red blood cells, increasing the cell volume and haemoglobin content. Thus this erythropoietin can be considered as *raktagni* which helps in *rakta utpatti* (formation). 2. **Aconitase**(an iron regulating protein), **Ceruloplasmin**(and copper), **apotransferrin,** a protein responsible for iron transport in plasma**. Transferrin** [apotransferrin loaded with 2Fe (III)], **Vitamin C** reduces ferric iron to ferrous iron; **Haptoglobin**and **hemopexin**are the proteins responsible in reuptake of iron and recycling. These enzymes and vitamins helping in iron absorption and regulation can be called as Raktagni. 3. Absorption of vitamin B12, which is cobalt salt and has red color, may be due to this the color of blood is red. So, vitamin B12 can be called as *Rakta poshakansha* that is needed to form *Sthayi Rakta Dhatu.* 4. Folic acid is needed for DNA synthesis in final maturation of RBC. It may be also called as *Rakta poshakansha.* These hormones, enzymes & vitamins works in various parts of the body, as and when required. As *rakta*(blood) is circulating all over the body, these reactions or biotransformation takes place, as required at any place i.e. in *rakta vaha strotas* related to its formation and regulation.

CONCLUSION: By the law called *kedarkulyanyaya,* nourishing fluid Rasa replenishes *Rakta* in the beginning. Thus the biotransformation taking place is carried out in living body at all places that is due to *Agni.* Whatever part of *Rasa* is necessary for *Rakta* is offered to *Rakta dhatu* in *rakta vaha strotas,* which is not possible without *Raktagni.* So *Raktagni* can be correlated in modern science to various substances like hormones, enzymes, & vitamins which are responsible for biochemical reactions occurring in the process of iron metabolism and erythropoiesis. So thus, Erythropoietin, Aconitase, Ceruloplasmin, Apotransferrin, Transferrin and Vitamin C

etc. can be correlated as *rakta dhatwagni* in *rakta utpatti.*

REFERANCES:

1.Charak samhita (Chikitsastan-15/15) part-2, Acharya VidyadharShukla, Chukamba Sanskrit Pratishtan, Delhi, Reprint 2007, p. 361

2.Dalahana, commentator, Sushruta SamhitaDr.Anantram Sharma, ChuakhambasurbhartiPrakashan,Varanasi.

3.Charak samhita (Chikitsastan-15/15) part-2, Acharya VidyadharShukla, Chukamba Sanskrit Pratishtan, Delhi, Reprint 2007, p. 365

4.Charak samhita (Chikitsastan-15/15) part-2, Acharya VidyadharShukla, Chukamba Sanskrit Pratishtan, Delhi, Reprint 2007, p. 366

5.ShushrutSamhita(Sutrastan14/5)part1,Dr .AnantramSharma,ChuakhambasurbhartiPrakashan,Varanasi, reprint 2006.P.100.

6.Ashtang Hruday (Sutrastan- 12/13) Dr.BramhanandTripathi, Chukhamba Sanskrit Prakashan, DelhiReprint 2009. P.172

7.Shushrut Samhita (Sharir Stan – 4/25) part-2, Dr.Anantram Sharma, ChuakhambasurbhartiPrakashan,Varanasi, reprint 2006.P.53.

8.Shushrut Samhita (Sharir Stan – 9/12) part-2, Dr.Anantram Sharma, ChuakhambasurbhartiPrakashan,Varanasi, reprint 2006.P.122.

9.Charak Samhita (Viman Stan-5/8) Part-1, vd.Joshi, vaidyamitraprakasahn, Pune. Reprint 2005p. 540

10.Shushrut Samhita (Sharir Stan – 4/30) part-2, Dr.Anantram Sharma, ChuakhambasurbhartiPrakashan,Varanasi, reprint 2006.P.54.

11.Textbook of Medical Phisiology, Gyton and Hall, 2006.International Edition ISBN 0-8089-2317-X. p.420

12.Textbook of Medical Phisiology, Gyton and Hall, 2006.International Edition ISBN 0-8089-2317-X. p.423

13. Essential of medical physiology, K sembiulingam, 2001, 2nd edition p.179

14.Textbook of Medical Phisiology, Gyton and Hall, 2006.International Edition ISBN 0-8089-2317-X. p.426

15. Charak Samhita (Viman Stan-2/17) Part-1, vd.Joshi, vaidyamitraprakasahn, Pune. Reprint 2005 p.514

16.AshtangaHrudaya(Sutrastan-12/13)Dr.BramhanandTripathi,Chukhamba SanskritPrakashan, Delhi Reprint 2009. P.172

17. Human Physiology, C.C.Chatterjee, 11th edition p.160.

18. Essential of medical physiology, K sembiulingam, 2001, 2nd edition p.53

19. Essential of medical physiology, K sembiulingam, 2001, 2nd edition p.53

20. Essential of medical physiology, K sembiulingam, 2001, 2nd edition p.50

21. Human Physiology, C.C.Chatterjee, 11th edition p.160.

22. Essential of medical physiology, K sembiulingam, 2001, 2nd edition p.102

Corresponding Author:
Prashant M Chormore
P.G Scholar Dept. of Kriya Sharir YMT Ayurvedic Medical College Kharghar Navi Mumbai,India.

Source of support: Nil

Conflict of interest: None Declared