A review on role of Ranjaka Pitta - As coloring of Blood

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ABSTRACT

Background: Tridosha, Sapthadhatu and Trimala are the basic elements of the body. The Dosha that is most important for digestion and metabolism is the Pitta Dosha. One of the five type of Pitta, Ranjaka Pitta aids in Ranjana Karma. The seven steps of Raktotpatti (Erythropoiesis) and the colour transition from Shweta to Aalaktaka were elucidated by Acharya Sharangadhara. Erythropoiesis is seen in which the uncommitted pluripotent hematopoietic stem cells passes through different stages and finally become the matured RBC. The intrinsic factor of castle, vitamin B12, iron, and other substances found in the stomach, liver, and spleen are the factors that cause erythropoiesis. Objective: The relationship between the functions of Ranjaka Pitta and the variable influencing erythropoiesis is discussed in this article. Materials and Methods: Literature searches were conducted using classical text in Ayurveda and contemporary books and many others. Conclusion: Various Acharyas state that the Ranjaka Pitta, which is situated in Amashaya, Yakruth, and Pleeha, engages in both Rasa Ranjana Karma and Raktothpatti. Possible interpretations for Ranjaka Pitta include the stimulant factor and maturation factor found in the stomach, liver, and spleen that are necessary for the manufacture of red blood cells.

Key words: Pitta Dosha, Ranjaka Pitta, Raktotpatti, Erythropoiesis

INTRODUCTION

Ayurveda is an ancient science emphasizes Tridosha theory viz Vata, Pitta, and Kapha.¹ Pitta Dosha, one among the Tridosha that is in responsible for bio-transformation.² Pitta Dosha classified into five types. Each type has its function. Out of the five varieties, Ranjaka Pitta takes the functioning as colouring of Rasa while transferring to Rakta. The term Ranjaka is the one which imparts the color.³ According to Acharya Sushruta, Pitta is found in Yakruth and Pleeha and is known as Ranjakagni, which aids in the colouring of Rasa. Sites of Ranjaka Pitta according to different Acharya is given in table no. 1.

Table 1: Sites of Ranjaka Pitta according to different Acharya.

<table>
<thead>
<tr>
<th>Name of the Acharya</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acharya Vagbata</td>
<td>Amasaya⁴</td>
</tr>
<tr>
<td>Acharya Sharangadhara</td>
<td>Yakruth⁵</td>
</tr>
<tr>
<td>Acharya Sushruta</td>
<td>Yakruth and Pleeha⁶</td>
</tr>
<tr>
<td></td>
<td>(Ranjakagni)</td>
</tr>
<tr>
<td>Acharya Bhavaprakasha</td>
<td>Yakruth and Pleeha⁷</td>
</tr>
</tbody>
</table>

Rakta Dhatu

Derivation: The Root Raja Ranjane means to stain⁸ since this Dhatu is red in colour. It named as Rakta, when the white cloth stained with this Rakta, it becomes red colour, Rakta is Ragakruth.
Origin of Rakta Dhatu

Rakta gets produced in the Raktavaha Srotas (channel carrying Rakta Dhatu). When Rasa Dhatu forms in Rasavaha Srotas, Rasadhatwagni acts on Ahararasa and its nutrients to produce the Rasadhatu. Teja part of Rasadhatu enter Raktavaha Srotas, there the Rasa converted to Rakta Dhatu.[9] As stated by Trividha Nyaya in Ayurveda, the Dhatus are produced and nourished from Ahara Rasa. In Kshiradadh Nyaya (Law of Transformation), Acharya Charaka has mentioned Rasagni act upon Rasa Dhatu and converted into Rakta Dhatu.[10] Nutrients coming from Ahara Rasa and Rasavaha Srotas are travelling through Yakruth, and Pleeha imparts red colour and by which Rakta forms.[11] According to Acharya Charaka, the Rakta is not having redness.[12] The Tejabhaga of Ahararasa and Ushma of Pitta acts upon Rasa, it acquires redness, which forms the Rakta Dhatu.[13] Acharya Sushruta says the Rakta forms in Yakruth and Pleeha with the help of Ranjakagni.[14]

Method of Rakta formation

Sharangadhara Samhita (Deepika commentary) mentioned Varnoparivartana, stages of formation of Rakta Dhatu. Rakta is formed in seven days. The colour gradually changes from Sweta to Alakthaka.[15]

1. Sweta
2. Kapota
3. Harita
4. Haridra
5. Padma
6. Kimsuka
7. Alakthaka

Erythropoiesis: Erythropoiesis is the process of origin, development and maturation of erythrocytes.[14]

Site of Erythropoiesis[17]

During foetal life RBC are produced in 3 stages namely, Mesoblastic stage, Hepatic stage and Myeloid Stage. During the initial two months of intrauterine life, mesenchyme from the yolk sac produces red blood cells (RBCs) in the mesoblastic stage. RBCs are made in the liver during the hepatic stage commencing in the third month of intrauterine life. The lymphoid organ and spleen also aid in erythropoiesis. In children, RBC are produced from red bone marrow and in adult, RBC are produced from membranous bones like vertebra, sternum, ribs, scapula, iliac bones and skull.

Process of erythropoiesis[18]

Colony forming unit-erythrocytes (CFU-E) are the precursors of erythrocytes; the unit’s cells differentiate into erythrocytes. This is formed from Hematopoietic stem cells. Stems cells are the primitive cell which is having the capacity to regenerate and differentiating in to a specialized cell. Various stages between CFU-E cells and matured RBCs are[19] given in table no. 2.

Table 2: Stages of Erythropoiesis

<table>
<thead>
<tr>
<th>Stages of erythropoiesis</th>
<th>Diameter (μ)</th>
<th>Nucleus</th>
<th>Staining property</th>
<th>Important event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pronormoblast (Megaloblast)</td>
<td>20</td>
<td>Has 2 or more nucleoli and chromatin network</td>
<td>Basophilic</td>
<td>Synthesis of haemoglobulin starts</td>
</tr>
<tr>
<td>Early normoblast (Basophilic erythroblast)</td>
<td>15</td>
<td>No nucleoli Dense chromatin network</td>
<td>Basophilic</td>
<td>Nucleoli disappear</td>
</tr>
<tr>
<td>Intermediate normoblast (Polychromatic erythroblast)</td>
<td>10 to 12</td>
<td>Further condensation of chromatin network</td>
<td>Polychromophilic or polychromatic</td>
<td>Haemoglobulin starts appearing</td>
</tr>
<tr>
<td>Late normoblast (Orthochromatric erythroblast)</td>
<td>8 to 10</td>
<td>Small with very much condensed chromatin</td>
<td>Acidophilic</td>
<td>Nucleus disappears by pyknosis</td>
</tr>
<tr>
<td>Reticulocyte (Immature RBC)</td>
<td>7 to 7.5</td>
<td>Absent</td>
<td>Basophilic</td>
<td>Reticulum is formed Cell enters capillary from site of production</td>
</tr>
<tr>
<td>Matured RBC</td>
<td>7.2</td>
<td>Absent</td>
<td>Acidophilic</td>
<td>Reticulum disappears</td>
</tr>
</tbody>
</table>
Factors necessary for Erythropoiesis\textsuperscript{[20]}

A multitude of factors are necessary for the development and maturation of erythrocytes, including stimulant factor, maturation factor, and other factors for haemoglobin maturation. Hypoxia is known to increase the formation of erythropoietin, which in turn stimulates the production of red blood cells (RBCs). Ninety percent of erythropoietin is formed in the kidney, and the remaining portion is formed in the liver. The maturation factors include vitamin \(B_{12}\), intrinsic factor of castle, and folic acid. One of the fundamental components of DNA, thymidine triphosphate, can only be synthesised with the help of vitamin \(B_{12}\) and folic acid.\textsuperscript{[21]} A glycoprotein known as intrinsic factor is secreted by the parietal cells of the gastric glands. This glycoprotein reacts with vitamin \(B_{12}\) in the food to enable the gut to absorb it. The maturation of haemoglobin requires iron, copper, cobalt, nickel, protein, and amino acids as well as vitamins \(B_2\), \(B_3\), and \(B_6\).

**DISCUSSION**

Among Sapthadhatu, Rakta is the second Dhatu. It is formed in the Raktavaha Strotas.

**According to Acharya Charaka**

The Teja portion of Ahararasa and Ushmata of Pitta acts upon Rasa, it acquires redness. This forms the Rakta Dhatu. Proteins are essential for hemoglobin formation. Amino acids derived from this protein are required for the synthesis of globin part of hemoglobin. Iron is necessary for the formation of heme part of the hemoglobin. Copper is necessary for the absorption of iron from the gastrointestinal tract. Cobalt and Nickel are essential for the utilization of iron from the gastrointestinal tract. This together helps in the formation of hemoglobin. So, this biotransformation may be the function of the Teja Bhaga of Ahararasa mentioned by Acharya Charaka. Erythropoietin is the stimulant factor for erythropoiesis. Major quantity of erythropoietin is secreted by peritubular capillaries of kidney. A small quantity is also secreted from liver and brain. Intrinsic factors of castle are the maturation factor for erythropoiesis. It is necessary for the absorption of vitamin \(B_{12}\) (which is called extrinsic factor) from GI tract in to the blood. This together helps in the formation of matured RBC. This can be co related with the Ushma of Pitta mentioned by Acharya.

**According to Acharya Sushruta**

Acharya mentioned that, the Apya Bhaga of Rasa reaches the Yakruth and Pleeha gets the colour of Raga, the forms the Rakta. The red colour of blood indicates the presence of Ranjakagni. During the third month of intrauterine life, the liver and spleen work together to produce red blood cells, this is known as the hepatic stage. After the lifespan of 120 days, the RBC is destroyed in the reticuloendothelial system, particularly in spleen and the hemoglobin is degraded in the reticuloendothelial cells and split in to globin and heme. Globin is utilized for the resynthesis of hemoglobin. Heme is degraded into iron and porphyrin. Iron is stored in large quantities in reticuloendothelial cells and liver hepatocytes. Iron is stored as ferritin and hemosiderin, which is reutilized for synthesis of Hb. Thus, breakdown of RBC in spleen and storage of iron in liver which in turn helps in formation of hemoglobin. This all can be considered as the Ranjaka Pitta explained by Sushruta as located in Yakruth and Pleeha.

**According to Acharya Vagbhata**

Pitta present in the Amashaya, helps in the Ranjana Karma of Rasa. Intrinsic factors of castle, secreted by parietal cells of gastric glands play an important role in erythropoiesis. Which also present in the small intestine and secreted by argentaffin cells or enterochromaffin cells. It is necessary for the absorption of vitamin \(B_{12}\) from GI tract in to the blood. Vitamin \(B_{12}\) is an important maturation factor during erythropoiesis. Absence of intrinsic factor in gastric juice causes deficiency of vitamin \(B_{12}\), leading to pernicious anemia. So gastric glands can be considered as the Sthana of Ranjaka Pitta explained by Ashtanga as located in Amashaya.
According to Sharangadhara (Deepika commentary)

Varnaparivartana stages of Rakta formation in 7 days by gradual change of color from Sweta to Aalakthaka (given in table no. 3). This stage of Varnaparivartana follows the Kshiradadi Nyaya mentioned by Acharya Charaka. Similar to that in modern science 6 stages of erythropoiesis is seen where in which the uncommitted pluripotent hematopoietic stem cells passes through different stages finally become the matured RBC. It requires 7 days for the development and maturation of RBC from proerythroblast. The color of the cytoplasm changes from blue at proerythroblast and basophilic stages to a pinkish red as a result of increasing expression of hemoglobin as the cell develops. The factors necessary for maturation factor etc. in each stages follows Khale Kapota Nyaya (selective process) mentioned by Charakacharya.

Table 3: Stages of erythropoiesis according to Sharangadhara (Deepika Commentary).

<table>
<thead>
<tr>
<th>Varnaparivartana (Acco. To Sharangadharra)</th>
<th>Number of days for Varnapari vartana</th>
<th>Stages of Erythropoiesis</th>
<th>Colour of cytoplasm (After staining)</th>
<th>Number of days for Erythropoiesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweta</td>
<td>1</td>
<td>Pronormoblast (Megaloblast)</td>
<td>Blue</td>
<td>1</td>
</tr>
<tr>
<td>Kapota</td>
<td>2</td>
<td>Early normoblast (Basophilic erythroblast)</td>
<td>Intensely blue due to RNA abundanc e</td>
<td>2</td>
</tr>
<tr>
<td>Harita</td>
<td>3</td>
<td>Intermediate normoblast (Polychromatic erythroblast)</td>
<td>Greyish green due to accumula tion of Hb</td>
<td>3</td>
</tr>
<tr>
<td>Haridra</td>
<td>4</td>
<td>Late normoblast (orthochromat ic erythroblast)</td>
<td>Grey orange/ bright yellow colour</td>
<td>4</td>
</tr>
<tr>
<td>Padma</td>
<td>5</td>
<td>Reticulocyte (Immature RBC)</td>
<td>Purple colour or blue red</td>
<td>5</td>
</tr>
</tbody>
</table>

From this all information and references it can be inferred that Rasa and Usma of the Pitta are the main factors by which Rakta is formed and Yakruth, Pleeha and Amashaya are the organs in which this process is taking place.

CONCLUSION

The Ranjaka Pitta which is located in Amashaya, Yakruth and Pleeha according to different Acharya does Rasa Ranjana Karma and also takes part in Raktotthpatti. Intrinsic factor secreted by the gastric glands and intestine which is responsible for the absorption of Vitamin B12. This absorbed vit B12 is required for the synthesis of RBC, which is the Ashraya for Hb. Iron, is the content material of hemoglobin. Hence Castle intrinsic factor, Vit B12 and Iron can be taken as possible interpretations for Ranjaka Pitta.

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6. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the


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