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RELATIVE STUDY BETWEEN *MAJJA DHATU, SHUKRA DHATU* AND BONE MARROW WITH SPECIAL REFERENCE TO INFERTILITY.

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ABSTRACT

Ayurveda postulates the unique principle of *Tridosha*, *Dhatu* and *Mala* for homeostasis of the body. Dhatu nourishes the body, supply nutrients to other vital tissues, supports the body and keeps the body healthy. Among all the seven Dhatus *Shukra Dhatu* is considered as the Saar or best among all Seven *Dhatus*. Every Former *Dhatu* is responsible for the nourishment and formation of the successive Dhatu (Body tissue). Similarly, *Majja Dhatu* is responsible for nourishment and proper formation of *Shukra Dhatu*, it fills internal cavities of the bone (forms bone marrow) and is the chief source of body strength. *Charak Acharya* enumerates the *Asthi* (bones) and *Sandhi* (Joints) as the *Mool* of *Majja vaha Srotasa. Majja dhatu Kshaya* leads to *Alpashukrata* (Oligospermia) also *Asthishaushirya* (Osteoporosis). Human bone marrow contains Osteoblast derived hormone named Osteocalcin and Mesenchymal stem cells. Osteocalcin solely regulates the male fertility by enhancing the secretion of Testosterone production by Leydig cells, also the mesenchymal stem cells are multipotent that has got a capability to develop into precursors of sperm cells. Lower oestrogen level leads to Osteoporosis in females. Hence while diagnosing and treating Infertility it is important to consider not only *Shukra dhatu* but *Majja dhatu*, bone mass density, serum Osteocalcin levels as well. This concludes Skeletal endocrine control over reproduction.

KEYWORDS: *Dhatu, Tridosha, Shukra, Majja.*

INTRODUCTION

Formation of *Majja dhatu* (Bone marrow and Nervous tissue)

According to Acharya Charaka *Vata dosha* creates empty spaces in the *Asthi* (bones). These spaces are filled with nourishing tissue of *Medas* (Fat). This is *Majja* (Bone marrow). Refined *Asthi dhatu* processed by *Majja-agni* to form *Majja dhatu* (marrow). The *Anjali pramana* of *Majja dhatu* is one *Anjali*.[1] The *Updhatu* (secondary tissue) for *Majja* is the sclerotic fluid in the eyes. Kaviraj Ganna-Naath Sen acclaims that this nourishing tissue of Fat/*Medas* present is transformed into.

1. *Peet Majja* (Yellow bone marrow) - present in *Nalakasthi* (long bones).
2. *Rakta Majja* (Red bone marrow) – present in other bones.

Majja vaha-srotasa

The main *sthana* of *Majja vaha-srotasa* are *Asthi* (bones) and *Sandhi* (Joints).

Functions of *Majja dhatu* (Vagbhata)[2]

- Nourishing and strengthening the body.
- Nourishments and formation of *Shukra Dhatu* and.
- Filling up the cavities of the bones.

Majja dhatu saar: *Apatya* or better progeny is one of the main indications of *Majja dhatu* saar person.[3]

Tridosha disequilibrium:

Majja dhatu kshaya causes[4]

- *Asthi daurbalya or Asthi bhangata* (Osteo-porosis),
- *Alpashukrata* (Oligospermia),
- *Timir -Darshana* (due to hypoxia).

Majja dhatu vruddhi leads to heaviness in eyes and body.[5]

Formation of *Shukra dhatu* (Sperm and Ovum)

Shukra dhatu is one and ultimate dhatus of the body and *Pranayatana of Sharira*. Refined *Majja dhatu* (marrow and nerve) processed by *Shukragni* to form *Shukra dhatu* (seminal fluid-sperm and ovum). The formation results into following two *saar* and *kitta* parts.

- *Sthool Saar*,
- *Sukshma Saar (Shukra)*,
- *Kitta bhaag*.

Four proto-elements of *Shukra* are *Prithvi, Vayu, Jala, Agni* except *Aakash Mahabhuta*. According to Ayurveda

acharyas time required for formation of *Shukra dhatu* formation varies from 24 hours, 6 days or even 30 days. Chakrapani says it also depends on the *Dhatwagni*.

Mode of conversion of *Ahar rasa* into *Shukra dhatu*
According to Ayurveda, conversion of *Ahar Rasa* into *Shukra dhatu* occurs according to follow *Nyaya*.

- *Ksheera-Dadhi Nyaya*.
- *Khale- Kapot Nyaya.*
- *Kedari -Kulya Nyaya.*
- *Eka-kaal dhatu poshana Nyaya*.

Characters of *Shukra dhatu*[7]
Sarva-Sharir Gata Shukra is responsible for all systemic body activities. *Roop dravya* or *Shuddha Shukra* is responsible for *Garbhotpadana*. The following character represents *Shukra Dhatu* as Semen and Sperm.

- Semen- *Guru guna*.
  Ghana guna.
- *Retas*/Sperm- *Phalatva* (motility and viability).
  Anutva (micro- scopic structure).

***Shukra dhara kala*[6]**
It is home to hold and spread *Shukra dhatu* for performing *Sarva daihik* (whole body) functions. Also helps in Transformation of *Shukra Dhatu* into *Roopa Dravya* (Ejaculatory part) that takes place in *Vrushana* (Testis) the *Mula* of *Shukra- Vaha Srotasa*. The main indication of *Sarva-daihik Shukra* (Systemic *Shukra*) is *Apatyabahula* (many offspring).

Functions of *Shukra dhatu*

- Systemic/*Sarvadaihik- Dhairya, Deha bala, Ojo Poshak.*
- *Maithuna gata* (Sexual act) – *Bijartha, Garbhotpaadan.*
- *Roopa Dravyagata- Phalatva* (Fertlization).

***Tridosha* disequilibrium**
The main indication of *Shukra Dhatu kshaya* is *Klaibya* (Infertility). *Shukra dhatu vruddhi* leads to indications mainly including *Ati-stree kaamta* (engaged in sexual activity), *Shukrashmari* (Urolithiasis).

DISCUSSION

Bone-marrow: Bone marrow is spongy / gelatinous tissues that fills the medullary cavities of Bones. Types of Bone marrow.

a. Red bone marrow / Myeloid Tissue: Site of red bone marrow or myeloid tissue are mainly the central skeleton (pelvis, sternum, cranium, ribs, scapulae, epiphyseal ends of long bones like humerus and femur) in adults. Consist of Haemopoietic stem cells.
b. Yellow bone marrow / Fatty Tissue: Site of yellow bone marrow cavities of all long bones in the shaft surrounded by red bone marrow. Consist of Mesenchymal cells.

Stem cells: Stem cells are immature cells that can turn into a number of different types of cells (multi-potent). These cells are found in an.[8]

- Embryo.
- Bone-marrow.
- Peripheral blood found in blood vessels throughout body.
- Cord blood found in umbilical cord and collected after birth.

Properties of stem cells: Mesenchymal stem cells are multi-potent cells that are able to develop and form any type of connective tissues such as.

- Osteocytes (bone).
- Chondrocytes (cartilage).
- Myocytes (muscles).
- Fibroblasts (skin, tendons and ligaments).
- Adipocytes (fat).
- Stromal cells (marrow).
- Astrocytes (CNS).

Myeloid stem cells further disintegrate and develop into.

- Red blood cells.
- Platelets.
- Myeloblast (white blood cells).
- Blood stem cells.
- Lymphoid stem cells (Lymphoblast) – White blood cells.

This over all process is known as Hemopoieses that occurs in the red and yellow bone marrow.

Hormones related to bone marrow
Osteocalcin hormone
It is a versatile bone derived hormone (derived from osteoblast). It performs an endocrine function and is able to induce testosterone production by the testes promoting the germ cell survival.

Parathyroid hormone Calcitonin
Osteoporotic changes in the females occur after menopause, this shows that hormones such as oestrogen and progesterone also regulate the bone strength.

Recent cases and Articles related to the topic
A. Case Study
Case of- Bone marrow transplant in Acute myeloid leukemia.
Recipient's name- Chris Long (IT worker).
Donor's name- Unknown German.
Observation: After bone marrow transplant, the lab investigations of the recipient showed that recipient's semen contained only donor's DNA. After repeated investigations and samples taken from the other site of the body showed that rest of the samples collected from other regions of the body collected the recipient's DNA itself except the sample of his semen that still contained donor's DNA.

B. Research article on Mesenchymal stem cells.

Research conducted by- Scientists of Huntsman Cancer Institute at University of Utah and its collaboration.

Goal- To see the stages of development in a sperm also study of causes of infertility in males.

Conducted on- Mice (animal study).

Observation and Conclusion: Mesenchymal stem cells can grow into a male reproductive cell (Sperm producing cell) i.e., Spermatogonia stem cells. These Spermatogonia stem cells can help infertile men to produce their own sperm by directly inducing it in their testes so that they can produce naturally as opposed to use IVF.

C. Mini research article on the hormone Osteocalcin.

Authors- Sarah C. Moster
Bram C.J. Van Der Eerden.

Department- Internal medicine.

Address - Erasmus Mc, Rotterdam, Netherlands.

Observation and Conclusion: Osteocalcin is a versatile bone derived hormone (derived from Osteoblast). It performs an endocrine function. It is able to induce testosterone production by the testes promoting the germ cell survival.

OBSERVATIONS

From the term '*Purvam Dhatu Param Kuryat*' in Ayurveda can be assumed that the nourishment of former biological tissue (*Dhatu*) is responsible for proper growth and nourishment of latter dhatu. The functions of the *Majja dhatu* is nourishment and strengthening of the body, filling the bone cavities and nourishment and formation of *Shukra dhatu*. The functions of systemic and *Roop dravyagat Shukra dhatu* is to provide stability, physical strength, *Ojo-poshan*, reproduction and fertilization. Bone marrow is a spongy gelatinous tissue filling the medullary cavities of the bone. Stem cells found in the bone marrow are multipotent. According to the research articles mentioned above it is observed that mesenchymal stem cells present in bone marrow are capable to grow into a male reproductive cell that is Spermatogonia cell. Osteocalcin is an Osteoblast derived hormone that induces testosterone production by the testes promoting the germ cell survival. Systemic hormones such as testosterone and oestrogen have regulation on the remodelling of the bones (e.g., osteoporotic changes seen after menopause in females is due to decrease in oestrogen level).

CONCLUSION

The nousrishment and function of *Majja dhatu* affects the nourishment and function of *Shukra dhatu*. Bone marrow (*Rakta and Peet majja*) is the *sthana* of *Majja vaha strotasa*. *Guru* and *Ghana guna* of *Shukra dhatu*, *Phalatva* (motility and viability) and *Anutva* (microscopic structure) *guna* of *Shukra dhatu* are the characters that represent Semen and Sperm accordingly. Stems cell present in the bone marrow are multi-potent and have capability to develop themselves into male reproducing cells (Spermatogonia cells). Skeletons have an endocrine regulation on reproduction (e.g., hormone Osteocalcin). During diagnosis and treatment of infertility in males *dhatu pariskhan* of all three that is *Asthi*, *Majja* and *Shukra* should be done.

Also, additional diagnosis of.

a. Vitamin D,level,
b. Ca level (blood and bones),
c. Serum osteocalcin,
d. Bone mass density should be done.

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