



UNDERSTANDING OF MAJJA DHATU AND MAJJAVAHA SROTAS

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ABSTRACT

Introduction: *Dosha, Dhatu, and Mala* are the three basic physiological elements of the human body. Among these, the *Dhatus*, which help to nourish and support the body. The sixth *Dhatu*, *Majja Dhatu*, is made in the *Majjavaha Srotas* from the *Prasada Bhaga* of *Asthi* with the support of *Majja Dhatwagni* and *Bhutagni*. *Vayu Mahabhuta* makes space in the *Asthi Dhatu*, or bone, during its creation. These spaces are occupied by the *Meda Dhatu* (nourishing fat), it is referred as *Majja* or bone marrow. *Majja Dhatu Vahana Srotas* are explained in detail by *Acharya Charaka*. *Majja Dhatu* is said to be present within the *Sthula Asthi*, although *Acharya Susruta* has not explained a unique entity to carry it in the body. Since *Majja Dhatu* is the one who performs *Asthi Puranam*, *Asthi Dhatu* is most impacted when *Majja Kshaya* occurs. **Aims and Objectives:** To understand *Majja Dhatu* and the *Srotomoola* in relation to modern physiology of bone marrow. **Material and Method:** Literature searches were conducted using classical text in *Ayurveda*, contemporary books, articles and many others. **Discussion and Conclusion:** Various *Acharya* state that the *Majja Dhatu*, which is present inside the *Asthi* engages *Purana* (filling), gives strength to the body and nourishes the *Shukra Dhatu*. Possible interpretations for *Majja Dhatu* can be taken as bone marrow present inside the bone.

Keywords: *Majja Dhatu, Majja Dhatwagni, Majjavaha Srotas, Bone marrow*

INTRODUCTION

Ayurveda says, *Shareera* (body) is made up of *Dosha*, *Dhatu* and *Mala*¹. The entity which upholds the body is known as *Dhatu*². The food which taken by the individual will undergo digestion and metabolism process and divided into *Sara Bhaga* (essence part) and *Kitta Bhaga* (waste product). The waste parts are eliminated from the body and the useful parts called *Anna Rasa*, which helps in the formation and nourishment of *Dhatu*s of the body. According to *Parasara*, the sixth *Dhatu* named *Majja Dhatu* forms 7th day after taking food³. According to *Acharya Sushruta*, *Majja Dhatu* is formed in a time span of 15075 *Kala* (twenty-five days)⁴.

Etymology of *Majja* word: -

Majja Dhatu is considered to be the unctuous part or *Sara* found inside *Asthi* just like the pith found inside the tree.

Panchabhautic predominance of *Majja Dhatu*

Ap is predominant *Mahabhuta* in *Majja Dhatu*.

Location of *Majja Dhatu*

Acharya Charaka says, the *Moolasthan* of *Majja Dhatu* is *Asthi* and *Sandhi*⁵. Along with *Sandi*, *Acharya Vagbhata* added *Parva*⁶ (smaller joint). While explaining the context of *Medodhara kala* by *Acharya Sushruta*, *Acharya* mentioned that the substances present in the large bone is known as *Majja*. The *Majja* present other than large bone is known as *Saraktameda*⁷. The *Majja* present inside the *Kapala* is termed as *Mastulunga Majja*⁸. It is having the consistency of *Grita* (ghee)⁹.

FORMATION OF MAJJA DHATU

Srotas are the channels meant to carry *Dhatu* during the process of transformation from one *Dhatu* to another *Dhatu*. *Asthi Dhatu* is produced in the *Asthivaha Srotas*. When *Asthi Dhatu* takes its origin in *Asthivaha Srotas*, *Asthi Dhatwagni* acts on its nutrients coming from *Ahararasa* and *Mamsavaha Srotas*. Part of *Asthi Dhatu* reaches next *Srotas* that is *Majjavaha Srotas*. It takes part in the production of *Majja Dhatu*. Nutrients coming from *Ahara Rasa* and from *Asthivaha Srotas* are acted upon, by *Majja Dhatwagni* and give rise to *Majja Dhatu* proper¹⁰. From *Majja Dhatu*, its *Upadhatu* i.e., *Kesha* is generated¹¹, *Mala* of *Majja Dhatu* gets also produced^{12,13,14}. The oily components of the conjunctival secretion, secretion of faeces and skin secretion are the waste product of *Majja Dhatu* according to different *Acharya*. There are several other opinions on the time taken for the formation of *Dhatu* from *Ahara Rasa*. *Parasara* opinions that food becomes *Rasa* on next day, *Rakta* on the third day, *Mamsa* on the fourth, *Meda* on the fifth day, *Asthi* on sixth day, *Majja* on seventh and *Sukra* on eighth day.

FUNCTIONS OF MAJJA DHATU

Poorana (filling) is the specific function of *Majja Dhatu* by *Acharya Vagbhata*¹⁵. *Acharya Sushruta* says *Majja Dhatu* provides unctuousness, strength and nourishment to *Sukra Dhatu* and fills *Asthi*¹⁶.

CONCEPT OF MAJJAVAHA SROTAS

Srotomoola: Concept of *Majjavaha Srotas* has been explained by *Acharya Charaka* and *Vagbhata*, whereas *Acharya Sushruta* does not have the opinion of the existence of *Majjavaha Srotas*. While explaining the *Kala*, *Acharya* has mentioned *Majja* is present in *Sthula Asthi* and *Saraktameda* is present in *Anuvasthi* and *Udara*. *Majja* is present all over the body but specifically it is getting circulated throughout the body in its *Srotas*. *Moola* (roots) of *Majjavaha Srotas* is told to be *Asthi*, *Sandhi* and *Parva*.

Asthi: Just as the tree remain firm on the ground by their pith inside them, similarly body remains erect by the support of the bone and marrow inside it. Skin and muscle get destroyed after sometime, bones do not destroy since these are the essence of the body¹⁷. During the formation of *Asthi*, *Vayu Mahabhuta* makes space in the *Asthi Dhatu*, or bone¹⁸. These spaces occupied by the *Majja* or bone marrow. In modern science, Nutrient foramina or vascular channel is present in the bone containing a nutrient artery that supplies the bone. After entering in to the bone, nutrient artery run parallel to the to the long axis in the central part of the marrow cavity.

Sandhi & Parva: *Sandhi* is the place where union of bones takes place¹⁹. Fourth *Kala* named *Sleshmadhara Kala* present in the *Sandhi* which supports its function²⁰.

DISCUSSION

The sixth *Dhatu* named *Majja Dhatu* present inside the *Asthi* does the filling and nourishing function according to different *Acharya*. The functional activity of *Majja* will be more in *Asthi* and *Sandhi*. According to modern it is said that there are two types of marrow; yellow bone marrow and red bone marrow which can be correlated to *Majja* and *Saraktameda*. It can be observed as the thin layer of tissue called endosteum. This is the lining in the bone cavity that separates bone cells and bone marrow. Bone marrow is the soft, spongy, gelatinous tissue found in the hollow spaces in the interior of bones²¹.

Development of Bone and bone marrow- *Utharottara Dhatuposhana Krama*

Acharya Charaka says *Majja* is formed from *Asthi Dhatu* during *Utharottara Dhatuposhana Krama*. In modern science, the bone marrow is produced during the formation of bone. Bone formation requires a template for development. This template is mostly cartilage, derived from embryonic mesoderm, but also includes undifferentiated mesenchyme (fibrous membranes) in the case of intramembranous ossification. By the time of birth, the majority of cartilage has undergone replacement by bone, but ossification will continue throughout growth and into the mid-twenties.

There are two essential pathways by which bone tissue is produced during foetal development. This will also help for the formation of bone marrow.

1. Intramembranous ossification
2. Endochondral Ossification

Intramembranous ossification involves the direct conversion of mesenchyme to the bone. It begins when neural crest-derived mesenchymal cells differentiate into specialized, bone-forming cells called osteoblasts. Osteoblasts group into clusters and form an ossification center. Osteoblasts begin secreting osteoid, an unmineralized collagen-proteoglycan matrix that can bind calcium. The binding of calcium to osteoid results in the hardening of the matrix and entrapment of osteoblasts. This entrapment results in the transformation of osteoblasts to osteocytes. As osteoid continues to be secreted by osteoblasts, it surrounds blood vessels, forming trabecular/cancellous/spongy bone. These vessels will eventually form the red bone marrow. Mesenchymal cells on the surface of the bone form a membrane called the periosteum. Cells on the inner surface of the periosteum differentiate into osteoblasts and secrete osteoid parallel to that of the existing matrix, thus forming layers. These layers are collectively called the compact/cortical bone²².

Endochondral ossification process involves the replacement of hyaline cartilage with bone. It begins when mesoderm-derived mesenchymal cells differentiate into chondrocytes. Chondrocytes proliferate rapidly and secrete an extracellular matrix to form the cartilage model for bone. The cartilage model includes hyaline cartilage resembling the shape of the future bone as well as a surrounding membrane called the perichondrium. Chondrocytes near the center of the bony model begin to undergo hypertrophy and start adding collagen X and more fibronectin to the matrix that they produce; this altered matrix allows for calcification. The calcification of the extracellular matrix prevents nutrients from reaching the chondrocytes and causes them to undergo apoptosis. The resulting cell death creates voids in the cartilage template and allows blood vessels to invade. Blood vessels further enlarge the spaces, which eventually combine and become the medullary cavity; they also carry in osteogenic cells and trigger the transformation of perichondrium to the periosteum. Osteoblasts then create a thickened region of compact bone in the diaphyseal region of the periosteum, called the periosteal collar. It is here that the primary ossification center forms. While bone is replacing cartilage in the diaphysis, cartilage continues to proliferate at the ends of the bone, increasing bone length. These proliferative areas become the epiphyseal plates (physeal plates/growth plates), which provide longitudinal growth of bones after birth and into early adulthood. After birth, this entire process repeats itself in the epiphyseal region; this is where the secondary ossification center forms²³. This both processes will help to form and gives shelter to bone marrow.

Asthi as Moolasthan

Types of bone

There are two types of bone. Compact bone and Spongy bone. Compact bone is also called cortical bone, present in the outer layer of bone. They are heavy, hard and compact in nature. Compact bone is formed from a number of osteons. Osteons are the functional unit of compact bone, created by the network of bone cells and blood cells. Compact bone stores yellow bone marrow, which is composed primarily of fat in its medullary cavity.

Spongy bone is commonly found at the end of long bone, also found in ribs, skull, pelvic bone and vertebrae. In spongy bone numerous large spaces seen that gives a spongy appearance. It is highly vascularized and

contain red bone marrow. Spongy bone is composed of cells called osteocytes that situated in small cavity known as lacunae. The lacunae and the osteocytes give space for bone marrow and blood vessels.

Sandhi & Parva as Moolasthan

Sandhi & Parva is the site at which two or more bone articulates is called joint. Joints consist of mainly cartilage, synovial membrane and synovial fluid. Cartilage is a type of tissue that covers the surface of a bone at a joint. Cartilage helps reduce the friction of movement within a joint. This cartilage may be the template for the bone development. Synovial membrane is a tissue lines the joint and seals it into a joint capsule. The synovial membrane secretes a clear, sticky fluid (synovial fluid) around the joint to lubricate it. It reduces friction while moving the joints. Synovial fluid lubricates articular cartilage and provides nourishment through diffusion. This may be the *Sleshmadhara Kala* found in the *Sandhi* according to *Acharya Charaka*.

Mastulunga Majja- Brain and skull

The human brain develops from the tip of a 3-millimetre-long neural tube. The ectoderm is the key initiating player in the embryogenesis of the CNS. The ectoderm is further sub-specialized as the neural ectoderm, which gives rise to the neural tube and neural crest, which subsequently give rise to the brain, spinal cord, and peripheral nerves. At three to four weeks after conception, the neural groove closes into a tube, and three distinct region- a hindbrain, midbrain, and forebrain- begin to take form²⁴. This will take the shelter in the skull. The skull consists of 22 bones in most adult specimens, which come together via cranial sutures. The function of the skull is both structurally supportive and protective²⁵.

Embryologically, the skull derives from ectodermal neural crest and mesoderm. Mesoderm begins to form in the third week of gestation after early mesenchymal cells have migrated through the primitive streak. These cells then proliferate in a longitudinal fashion adjacent to the notochord (paraxial mesoderm) and eventually divide into various early connective tissue populations, including the sclerotome and myotome. The sclerotome develops into the mesodermal portions of the skull. (parietal bones, occipital bone, and petrous portion of the temporal bone). The frontal, ethmoid, and sphenoid bones derive from the neural crest, while the parietal and occipital bones originate from the mesoderm. The temporal bones derive from both the mesoderm and neural crest. From this reference we can find the brain and skull takes the same origin.

CONCLUSION

Acharya Vagbhata says *Poorana* is the main function of *Majja Dhatu*. During the formation of *Asthi Dhatu* or bone, *Vayu Mahabhuta* creates spaces in the *Asthi Dhatu*. These spaces are filled with nourishing tissues of *Meda Dhatu* or fat which is known as *Majja* or Bone Marrow. In the modern science, apoptosis of chondrocytes resulting cell death creates voids in the cartilage template and allows blood vessels to invade. Blood vessels further enlarge the spaces, which eventually combine and become the medullary cavity. This space filled with bone marrow. As osteoid continues to be secreted by osteoblasts, it surrounds blood vessels, forming trabecular/cancellous/spongy bone. These vessels will eventually form the red bone marrow. When the age

grows the redbone marrow transferred as yellow bone marrow. No where *Acharyas* mentioned *Raktotpatti* for *Majja Dhatu*. It may be because the yellow bone marrow helps in the stability of bone. So generally, we can correlate the *Majja Dhatu* as bone marrow which present inside the bone takes as the function of filling the bone and gives stability for bone.

REFERENCE

1. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023, P.99
2. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya , chaukhamba Surbharati prakashan Re print. 2023, P. 64
3. Dhargalkar Nadini Dilip, sharira kriya vignana, Varanasi: Chowkhamba sanskrit series office; Ed. 2, 2010, P.511
4. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya , chaukhamba Surbharati prakashan Re print. 2023, P. 62
5. Charaka Samhita of Agnivesa with ayurvedadeepika commentary by sree chakrapanidatta, ed. yadavji trikamji acharya, chaukhamba Surbharati prakashan, Re print. 2023, P. 251
6. Astangsamgraha of vrddhi Vagbhata with sasileka Sanskrit commentary by Indu, Ed. Dr. Shivprasad Sharma, Chowkhamba sanskrit series office; Ed. 6, 2022, P.314
7. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya , chaukhamba Surbharati prakashan Re print. 2023, P 356
8. Astangsamgraha of vrddha Vagbhata with sasileka Sanskrit commentary by Indu, Ed. Dr. Shivprasad Sharma, Chowkhamba sanskrit series office; Ed. 6, 2022, P.302.
9. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of Sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023, P.391 Sh.10/42-Dalhana.
10. Dhargalkar Nadini Dilip, sharira kriya vignana, Varanasi: Chowkhamba sanskrit series office; Ed. 2, 2010, P.511
11. Sarangadhara Samhita Prof. K R Srikantha Murthy, Chaukhamba Orientalia, Reprint edition.2017, P. 22
12. Charaka Samhita of Agnivesa with ayurvedadeepika commentary by sree chakrapanidatta, ed. yadavji trikamji acharya, chaukhamba Surbharati prakashan, Re print. 2023, P. 515
13. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023. P.253

14. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, P.399
15. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, P. 183
16. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023. P. 67
17. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023, P.366
18. Charaka Samhita of Agnivesa with ayurvedadeepika commentary by sree chakrapanidatta, ed. yadavji trikamji acharya, chaukhamba Surbharati prakashan, Re print. 2023,P. 515
19. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023, P.366
20. Sushruta samhita of susruta with the nibandhasangraha Commentary of sri dalhanacharya and the Nyayachandrika Panjika of sri Gayadasacharya on Nidanasthana, Ed. Vaidya Jadavji Trikamji Acharya, chaukhamba Surbharati prakashan Re print. 2023, P.366
21. Rubin R, David S. Strayer. Rubin's Pathology: Clinicopathologic Foundations of Medicine. Lippincott Williams & Wilkins; 2007. 90.
22. Percival CJ, Richtsmeier JT. Angiogenesis and intramembranous osteogenesis. Dev Dyn. 2013 Aug;242(8):909-22.
23. Ortega N, Behonick DJ, Werb Z. Matrix remodelling during endochondral ossification. Trends Cell Biol. 2004 Feb;14(2):86-93.
24. <https://www.ncbi.nlm.nih.gov/books/NBK234146/>
25. <https://www.ncbi.nlm.nih.gov/books/NBK499834/>
26. <https://www.ncbi.nlm.nih.gov/books/NBK499834/>