



Review Article

**MAJJA DHATU AND BONE MARROW: AN INTEGRATIVE PHYSIOLOGICAL PERSPECTIVE**

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ABSTRACT

*Majja Dhatu*, one of the seven fundamental *Dhatus* described in Ayurvedic physiology, plays an important role in maintaining structural strength, nourishment, and vitality of the body. *Majja Dhatu* is described as the substance that fills the cavities of bones and imparts unctuousness, stability, and strength to the skeletal system. Its major functions as *Asthi Purana* (filling and nourishing bone cavities), *Bala Pradana* (providing strength), *Snehana* (lubrication), and *Śukra Puṣṭi* (nourishment of *Śukra Dhatu*). *Majja Dhatu* plays an important part in sustaining skeletal stability, improving tissue nourishment, and enhancing physical strength and endurance. In modern science, *Majja Dhatu* can be considered primarily with bone marrow, which occupies the medullary cavity of bones and is responsible for hemopoiesis and immune cell production. Its fatty composition and stem cell activity support lubrication, immunity, and systemic nourishment. Thus, the Ayurvedic concept of *Majja Dhatu* shows significant parallels with the structure and functions of bone marrow in modern physiology.

INTRODUCTION

A person is regarded as healthy when the *Doṣas*, *Dhatus*, *Malas*, and *Agni* remain in a balanced state, along with proper functioning of *Atma*, *Indriya*, and *Mana*<sup>[1]</sup>. Among these factors, *Dhatus* play a crucial role in sustaining the structure and nourishment of the body. Ayurveda describes seven *Dhatus* (*Saptadhatus*)-*Rasa*, *Rakta*, *Mamsa*, *Meda*, *Asthi*, *Majja*, and *Śukra*<sup>[2]</sup> which collectively maintain growth, stability, and vitality.

Among them, *Majja Dhatu* occupies an important position as it follows *Asthi Dhatu* in the sequential process of *Dhatu* formation and contributes significantly to the strength and nourishment of the body. In Ayurveda, *Majja Dhatu* is described as the substance that fills the cavities of bones and imparts unctuousness, stability, and strength to the skeletal system. Its major functions include *Asthi Purana* (filling and nourishing the porous spaces of bones), *Bala Pradana* (providing strength), *Snehana*

(maintaining lubrication within the body), and *Śukra Puṣṭi* (nourishment of *Śukra Dhatu* in the sequential *Dhatu* transformation). Therefore, proper nourishment of *Majja Dhatu* is essential for maintaining structural integrity, vitality, and overall physiological balance.

From a modern perspective, the concept of *Majja Dhatu* shows close resemblance with bone marrow, the soft tissue present within the medullary cavities of bones. Bone marrow plays a vital role in hematopoiesis, immune cell production, and metabolic support, all of which are essential for maintaining systemic health. Understanding the similarities between *Majja Dhatu* and bone marrow helps create a conceptual link between Ayurvedic principles and modern biomedical science.

OBJECTIVES

1. To explain the concept, functions, and significance of *Majja Dhatu* in Ayurveda to improve understanding of its physiological role.
2. To compare the Ayurvedic description of *Majja Dhatu* with the modern understanding of bone marrow, helping students gain a clearer idea of its structure and functions.

MATERIALS AND METHODS

References were collected from classical Ayurvedic texts including Laghu Trayī and Bṛhat Trayī. In addition, seven research articles available in online

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search engines were reviewed for supporting information. Relevant modern medical textbooks were also consulted to understand the contemporary perspective related to the topic.

### **Majja Dhatu**

*Majja* is the sixth *Dhatu* which support the body. It is the purest unctuous portion of *Asthi*. When *Asthi Dhatu* is formed in the *Asthivaha Srotas*, the *Asthidhatvagni* acts upon the nutrients derived from *Ahara Rasa*, leading to the formation of *Asthi Dhatu*. A portion of this *Asthi Dhatu* then reaches the next channel, the *Majjavaha Srotas*, where it participates in the formation of *Majja Dhatu*. In this stage, nutrients obtained from *Ahara Rasa* and *Asthivaha Srotas* are metabolized by *Majjadhatvagni*, resulting in the proper formation of *Majja Dhatu*. From this *Majja Dhatu*, its *Upadhatu* and *Mala* are also produced.

Charaka Saṃhita describes another explanation for the formation of *Majja Dhatu*. According to Charaka, when *Vata* creates porosity within the *Asthi Dhatu*, the unctuous component of *Meda Dhatu* fills these cavities. The fatty substance occupying the porous spaces of the bones is known as *Majja Dhatu*<sup>[3]</sup>.

Location of *Majjavaha srotas* is *Asthi* (bones) and *Sandhi* (joints). It is situated inside *Asthi* and bone marrow can be regarded as a component of *Majja Dhatu*, playing an important role in processes such as erythropoiesis. Acharya Suśruta has described the association of *Saraktameda* with *Majja*. The *Asthi* (bones) and *Sandhi* (joints) are considered the roots of *Majjavaha Srotas*, and the quantity of *Majja Dhatu* in the body is described as one Anjali. During the formation of *Asthi Dhatu*, *Vata* creates hollow spaces within the bones. These cavities are subsequently filled by the nourishing and unctuous component of *Meda Dhatu*, which is referred to as *Majja* or bone marrow. *Majja* is regarded as one among the four types of *Chatuḥ Sneha* (lipid substances) and also as one of the *Sapta Dhatus* present within the bony structures. The brain, enclosed within the skull, and the spinal cord, protected by the vertebral column, together constitute the central nervous system. Hence, *Majja Dhatu* is also considered to have an association with the nervous system. Chakrapāṇi has stated “*Mastishkam śirastho majja*”, indicating that the brain represents *Majja* situated in the head. Indu Tīka explains that *Medo Dhatu* undergoes transformation to form *Mastulunga* (brain tissue) and further modifies into *Majja*. *Majja Dhatu* is formed when the *Poṣaka Asthi Dhatu* moves through the *Majjavaha Srotas* into the *Majjadhara Kala*, where it is metabolized by *Majjagni*, resulting in the formation of stable *Majja Dhatu*<sup>[4]</sup>.

**Types** - It is of two types *Pita* and *Rakta majja*. *Peetha majja* is situated inside *Nalakasthi* (long bones) and *Rakta majja* in all other bones<sup>[5]</sup>.

According to Charaka, Properties of *Majja* is *Mrudu* (smooth) and *Snigdha* (unctuous). It is *Ap mahabhuta* predominant.

**Functions-** *Majja dhatu* provides oleation (*Sneha*), strength (*Bala*), *Sukrapushti* (nourishment to *Shukradhatu*) and fill up the bones<sup>[6]</sup>.

### **Understanding of Majja Dhatu in Modern View**

Bone marrow is a soft, spongy tissue located in the central cavity of large bones. It is responsible for the formation of all blood cells and contains important stem cells. Every day, the bone marrow produces nearly 200 billion new blood cells. Bone marrow exists in two forms- red bone marrow and yellow bone marrow- both found inside bones but performing different functions.

**Red Bone Marrow:** Red bone marrow is the site where red blood cells, white blood cells, and platelets are produced. It forms all red blood cells and platelets and most types of white blood cells. Red blood cells transport oxygen from the lungs to organs and tissues, which is essential for survival. White blood cells help protect the body by fighting infections. Platelets assist in blood clotting by gathering at the site of injury and forming a barrier to stop bleeding. Red bone marrow is present inside long bones such as the femur and also in other bones including the shoulder blades, pelvis, skull, ribs, and other flat bones. It contains hematopoietic stem cells, which are the precursor cells for all blood cells. These stem cells are already committed to becoming blood cells and gradually differentiate into various types such as red blood cells and different kinds of white blood cells.

**Yellow Bone Marrow:** Yellow bone marrow is mainly found in the hollow central cavity of long bones and is usually surrounded by red bone marrow. At birth, bone marrow is almost entirely red, but starting around 7 years of age, some of it gradually converts into yellow marrow until nearly half becomes yellow in adults. The primary function of yellow bone marrow is fat storage, which helps support the bone and serves as an energy reserve. It contains mesenchymal stem cells, which have the ability to develop into fat, cartilage, and bone cells<sup>[7]</sup>.

The concept of *Majjavaha Srotas* has been described by Acharya Charaka, whereas Acharya Suśruta does not specifically mention a separate *Majjavaha Srotas*. Instead, Suśruta explains that *Majja* is present in *Śūla Asthi* (large bones), while *Sarakta Meda* is located in *Anuvasthi* and *Udara*. Although *Majja* is distributed throughout the body, it is believed to circulate through its specific *Srotas*. The *Mula* (roots) of *Majjavaha Srotas* are described as *Asthi* (bones) and *Sandhi* (joints), indicating that the functional activity of *Majja* is more prominent in these structures.

From a modern viewpoint, bone marrow is classified into two types: yellow bone marrow and red bone marrow, which may be explained in relation to the concepts of *Majja* and *Sarakta Meda*. Yellow bone marrow is mainly found in the hollow interior of the diaphysis (shaft) of long bones. Red bone marrow is primarily present in flat bones such as the sternum, skull, ribs, vertebrae, hip bones, and scapula, and also in the epiphyseal and metaphyseal ends of long bones like the femur, tibia, and humerus, where the bone has a spongy or cancellous structure.<sup>[8]</sup>

### Functions of *Majja dhatu*

#### **Sneha (Oleation)**

*Majja Dhatu* is well known for its *Snehana* quality, as it provides unctuousness and supports the nourishment and lubrication of bodily structures. Bone marrow- especially yellow bone marrow- is rich in adipose tissue (fat cells). These fats act as an energy reserve and also contribute to the maintenance of tissue lubrication and metabolic support. The presence of lipids within bone marrow helps in sustaining the unctuous environment necessary for the proper functioning of bones, joints, and surrounding tissues. This lipid-rich nature of bone marrow can be correlated with the *Snehana* function of *Majja Dhatu*, as it supports lubrication, nourishment, and structural stability of the skeletal system. Adequate *Majja* helps maintain flexibility and prevents dryness and degeneration of bones. Conversely, depletion of *Majja* may lead to *Rukṣata* (dryness), weakness of bones, and reduced lubrication within the body. Thus, both Ayurvedic and modern viewpoints suggest that the fatty composition of bone marrow contributes to the oleation and nourishment of the skeletal system, supporting overall strength and structural integrity of the body. *Majja* is prescribed for *Snehana* with *Manda* (scum of gruel) especially in the month of *Madhav*. Bone marrow (*Majja*) contains a high proportion of fat, especially in yellow bone marrow. Yellow bone marrow contains about 80–85% fat (mainly adipocytes). Red bone marrow: about 40–50% fat, the rest being hematopoietic cells and supporting tissue<sup>[9]</sup>. According to Charaka, *Snehadyaya*, *Majja* is used as *Snehana Dravya* for proper oleation.

#### **Bala**

*Majja Dhatu* is considered an important contributor to *Bala* (strength) in the body, particularly in maintaining the strength and integrity of *Asthi Dhatu* (bones). According to Ayurvedic principles, bones possess minute pores formed due to the predominance of *Akaśa* and *Vayu Mahabhutas*. *Majja Dhatu* fills these porous spaces with unctuous, fatty substances, thereby nourishing the bones and enhancing their stability and durability. By occupying these cavities and providing lubrication and nourishment, *Majja* helps maintain the firmness and strength of the skeletal system,

ultimately supporting the overall strength of the body. In conditions where *Majja Dhatu* is depleted or deficient, various structural abnormalities may arise in bones, such as *Asthi Daurbalya* (bone weakness), *Śunyata* (emptiness or hollowness), and *Laghuta* (lightness or fragility). These conditions reflect the loss of nourishment and structural support normally provided by *Majja Dhatu*<sup>[9]</sup>.

From the Ayurvedic perspective, the ultimate essence of all *Dhatu*s, from *Rasa* to *Śukra*, is known as *Ojas*. *Ojas* acts as the fundamental cause and *Bala* manifests as its functional expression in the body. In modern understanding, *Ojas* can be correlated with the concept of immunity, which represents the body's ability to defend itself against pathogens, toxins, and other harmful agents that may damage tissues and organs. It is of two types; innate and acquired immunity. Acquired immunity is of 2 types cellular and humoral immunity. Cell-mediated immunity is primarily mediated by T lymphocytes, which become activated upon exposure to specific antigens. Humoral immunity, on the other hand, is mediated by B lymphocytes, which differentiate into plasma cells that produce antibodies (gamma globulins). Both T and B lymphocytes arise from a common lymphoid progenitor within the bone marrow, underscoring its central role in the formation of immune cells. The bone marrow not only serves as the primary site of hematopoiesis but also supports the early development and differentiation of lymphocytes. Once these cells migrate to peripheral lymphoid organs, their interaction with antigens initiates specific immune responses that help in the rapid recognition and elimination of pathogens. In addition to lymphopoiesis, bone marrow provides a specialized microenvironment, including stromal cells and growth factors, which regulate the maturation, proliferation, and survival of immune cells.

From an Ayurvedic perspective, *Majja Dhatu* show resemblance with bone marrow and is considered essential for strength (*Bala*), immunity (*Vyadhikshamatva*), and nourishment of the body. Proper functioning of *Majja Dhatu* supports the integrity of the skeletal system, enhances *Ojas*, and sustains overall vitality. Thus, both modern science and Ayurveda emphasize that healthy bone marrow or *Majja Dhatu* is fundamental for maintaining immunity, resilience, and the overall strength of an individual<sup>[10]</sup>.

#### **Shukrapushti**

Nourishment of *Śukra Dhatu* is an important function of *Majja Dhatu*. During the metabolism of *Majja Dhatu*, *Poṣaka Śukra Dhatu* is formed, which helps in nourishing the *Śukra Dhatu*. According to the principle of *Uttarottara Dhatu Poṣaṇa Nyaya*, *Dhatu*s are nourished sequentially. *Śukra Dhatu* is nourished after *Majja Dhatu*.

Bone marrow plays an indirect but significant role in maintaining reproductive health. It produces stem cells and various blood cells that support the body's metabolic and physiological functions, including those necessary for the proper functioning of reproductive organs. Bone marrow contains mesenchymal stem cells and hematopoietic stem cells, which are capable of differentiating into multiple cell types. These cells contribute to tissue repair, regeneration, and hormonal balance, indirectly supporting reproductive tissues

#### Pooranam asthi

According to Ayurvedic concepts, *Asthi Dhatu* (bone) contains minute pores created by the predominance of *Akaśa* and *Vayu* Mahabhutas. These porous spaces are filled by *Majja Dhatu*, which consists of fatty and unctuous tissue. By occupying these cavities, *Majja* nourishes the bones and provides strength and stability to the skeletal system<sup>[11]</sup>.

The skeletal framework that supports the human body and enables movement possesses a distinctive microarchitecture. The spaces formed within the trabecular network of the bone are occupied by a mixture of developing blood cells and adipocytes. This tissue, known as bone marrow, plays a crucial role in the production of blood cells (hematopoiesis). *Majja dhatu* located in the marrow cavity and performs the function of *Asthi Purana* (filling the bone cavities).<sup>[12]</sup>

#### CONCLUSION

*Majja Dhatu* plays a vital role in maintaining the structural integrity, strength, and proper functioning of the body according to Ayurvedic principles. It nourishes *Asthi Dhatu*, fills the bony cavities, and contributes to *Bala*, *Sneha*, and *Śukra Puṣṭi*, thereby supporting overall vitality. From a modern perspective, these functions closely resemble those of bone marrow, which is essential for hematopoiesis, immune cell production, and metabolic support. The correlation between *Majja Dhatu* and bone marrow helps bridge Ayurvedic concepts with contemporary biomedical understanding. Healthy bone marrow ensures adequate production of blood cells, efficient immune responses, and maintenance of systemic balance. Any disturbance in *Majja Dhatu* can lead to weakness, degeneration, and compromised immunity. Thus, preservation of *Majja Dhatu* is crucial for sustaining strength, immunity, and longevity.

Integrating Ayurvedic knowledge with modern science provides a more comprehensive understanding of its physiological and clinical significance.

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