



PHYSIOLOGICAL UNDERSTANDING OF *ASTHI DHATU* AND *ASTHIVAHA SROTAS*

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ABSTRACT

Introduction: *Shareera* is composed of *Dosha*, *Dhatu* and *Mala*. *Dhatu*s are the entities which supports our body and helps in performing proper physiological functions. *Asthi* is one among the *Sapta Dhatu*, which mainly involves in *Shareera Dharana* function. *Asthi Dhatu* is located in its *Srotas* as well as in the whole body. *Moolasthan*a of *Asthivaha Srotas* is *Meda* and *Jaghana*.

Aims and Objectives: To understand the *Asthi Dhatu* and *Asthivaha Srotas* and its possible physiological interpretations.

Materials and Method: Literature searches were conducted using classical text in *Ayurveda*, contemporary books, articles and many others.

Discussion and conclusion: *Asthi Dhatu* plays a vital role in maintaining the physical integrity of the body. The possible interpretation of the *Moolasthan*a of *Asthivaha Srotas* can be understood as fat or bone marrow adipose tissue and pelvic bone.

Key words: *Asthi, Asthi Dhatu, Asthivaha Srotas*

INTRODUCTION

Asthi is one among the *Saptadhatus*¹ which mainly involves in *Shareera Dharana* function². *Asthi* is defined as “*Asyate Iti Asthi*”³, it is some hard substance which present inside the soft mass i.e., *Mamsa* and it doesn't decompose as fast. It helps in providing a structural framework to the *Shareera*. Humans stand by the inner strength of *Asthi*, just as trees do with the support of *Sara's* inner strength⁴.

UTPATTI

Asthi Dhatu is formed by *Meda Dhatu* in the sequence of *Dhatu Nirmana*. *Meda Dhatu* becomes *Khara* with the combination of *Prithvi* and *Vayu Mahabhoota* and its own *Dhatwagni*. That *Khara* part is called as *Asthi*⁵. The *Sthayi Bhaga* will nourishes the *Asthi*, and *Poshaka Bhaga* flows through the *Asthivaha Srotas* and nourishes both *Upadhatu (Danta)* and the subsequent *Dhatu (Majja)*.

LOCATION OF ASTHI DHATU

Asthi Dhatu is located in its *Srotas* as well as in the whole body.

PANCHA MAHABHOOTA PREDOMINANCE

According to *Charaka Acharya*, *Prithvi*, *Agni*, and *Vayu* are predominant in *Asthi Dhatu*⁶, but *Sushruta Acharya* considers that *Prithvi* and *Vayu Mahabhuta* are predominant⁷.

GUNA AND KARMA

Asthi Dhatu is having the qualities such as *Guru*, *Khara*, *Kathina*, *Sthula*, *Sthira* and *Murtimanta*. It mainly does the function of *Deha Dharana* and *Majja Pushti*⁸. *Asthi Dhatu* provides structure to the body and supports the body by performing various functions like, protection of soft tissues and vital organs of the body(Protective function), supports the body and brings out various movements of the body by their attachment to the muscles and tendons(Mechanical function), plays an important role in the metabolism of calcium and phosphate in the body(Metabolic function), also red bone marrow in the bones is the site of production of blood cells(Hematopoietic function)⁹. *Prasada Bhaga* of *Asthi Dhatu* with the action of *Majja Dhatwagni* will help in the formation of *Majja Dhatu*.

PARINAMA KALA

Acharya Charaka states that, *Asthi Dhatu* is formed on sixth day from the *Ahara Rasa*¹⁰. However, *Sushruta* opines that, *Asthi Dhatu* is formed in a time span of twenty days¹¹. In modern science it is mentioned that Osteogenesis begins between the sixth and seventh weeks of embryonic development and continues until about age twenty-five¹².

TYPES OF ASTHI¹³

There are five types of *Asthi* in human body

Table No.1: Types of *Asthi*

Sl. No	AYURVEDA TYPE	MODERN TYPE	SITES
1	<i>KAPALA</i>	FLAT BONES	<i>Janu</i> (knee), <i>Jaghana</i> (pelvic), <i>Amsa</i> (shoulder), <i>Ganda</i> (cheek), <i>Talu</i> (palate), <i>Shankha</i> (temples), <i>Shira</i> (skull)
2	<i>RUCHAKA</i>	TEETHS	<i>Danta</i> (teeth)
3	<i>TARUNA</i>	CARTILAGE	<i>Ghrana</i> (nose), <i>Karna</i> (ear), <i>Griva</i> (neck), <i>Akshikosha</i> (orbit of the eye)
4	<i>VALAYA</i>	RIBS	<i>Parshuka</i> (ribs), <i>Prushtha</i> <i>Kasheruka</i> (vertebrae)
5	<i>NALAKA</i>	LONG BONES	All other long bones

NUMBER OF ASTHI^{14,15,16}**Table No.2: Number of *Asthi* according to different *Acharyas***

Sl. No	OPINION OF	NUMBER OF BONES
1	<i>CHARAKA SAMHITA</i>	360
2	<i>SUSHRUTA SAMHITA</i>	300
3	<i>ASTANGA SAMGRAHA</i>	348
4	MODERN SCIENCE	206

UPADHATU AND MALA^{17,18,19}**Table No.3: *Upadhatu* and *Mala* of *Asthi Dhātu* according to different *Acharyas***

ACHARYA	CHARAKA	SUSHRUTA	SHARANGADHARA	BHAVAPRAKASHA
UPADHATU	-	-	<i>DANTA</i>	-
MALA	<i>KESHA, LOMA</i>	<i>NAKHA, ROMA</i>	<i>NAKHA</i>	<i>NAKHA, LOMA</i>

ASTHI VRIDDHI LAKSHANA^{20,21}

Acharya Sushruta and *Vagbhata* have mentioned that, *Asthi Vriddhi* causes overgrowth of bones and extra teeth. Commentator *Dalhana* adds excess growth of hair.

ASTHI KSHAYA LAKSHANA

As stated by *Acharya Charaka*, due to *Kshaya* of *Asthi Dhatu* falling of scalp hair and body hair, nail, beard and teeth is observed. These symptoms are accompanied by an increase in joint looseness²². According to *Sushruta Samhita*, *Asthi Kshaya* is characterized by extreme bone pain, brittle nails and teeth, and dryness. *Dalhana* adds, the entire body becomes dry, including the nails and teeth²³. Given the link between *Vata* and *Asthi Dhatu*, this makes sense. The same kind of *Lakshanas* are explained by *Ashtanga Hridaya*²⁴.

ASTHIDHARA KALA

Acharya Sushruta has not mentioned about *Asthidhara Kala*. But *Acharya Dalhana* opines that *Purishadhara Kala* is same as *Asthidhara Kala*. It can be explained through various examples like: *Asthi Dhatu* is fifth amongst *Sapta Dhatus*. According to *Acharya Sushruta*, *Visha Vegas* are seven because they take the *Ashraya* in the *Sapta Kala* and exhibits *Vishavegantara Lakshanas* accordingly. In the fifth *Visha Vega*, when the *Visha* is in fifth *Kala* i.e., *Purishadhara Kala*, there is *Parvabheda* which is related with *Asthi*²⁵. Both *Pakwashaya* and *Asthi* are important sites of *Vata Dosha*. *Basti Karma* which is considered as *Ardha Chikitsa* is given through rectal route, so in this way *Basti* nourishes the *Asthivaha Srotas* and thereby treats *Vataja Vikaras* and *Asthi Dhatu Kshaya*. In *Asthi Pradoshaja Vikara* like *Asthi Kshaya*, *Asthi Vidradhi*, *Katishoola*, *Sandhi Vata* etc. *Panchatikta Ksheera Basti* is advised²⁶.

ASHRAYA-ASHRAYI BHAVA

Ashrayi is *Adheya*, or the ground for support, and *Ashraya* is *Adhara*, or support. *Dosha* and *Dushyas* are having *Ashraya Ashrayi Sambandha*, they stay together. *Asthi* is *Ashraya* to *Vata Dosha*. Because of its *Laghu Guna*, *Vata* keeps the bone light. The reflection of the *Vridhhi* of *Dushya* is the *Vridhhi* of *Dosha*. This law only applies to the signs of *Kapha* and *Pitta*. *Asthi* is a part of *Vata*; if *Vata* rises, *Asthi* falls and vice versa²⁷. *Brimhana Chikitsa* is indicated for *Vata Vridhhi*. Decreased state of *Asthi Dhatu* is to be treated with *Basti* using *Ksheera*, *Ghrita* and *Tikta Rasa Dravyas*²⁸.

ASTHI SARA PURUSHA

Acharya Charaka explains that *Asthi Sara Purusha* has large and stout-heel (*Parshni*), ankle (*Gulpha*), knee joint (*Janu*), forearm (*Aratni*), scapula (*Jatru*), chin (*Chibuka*), head (*Shira*), joints of finger (*Parva*), bone (*Asthi*), nail (*Nakha*) and teeth (*Danta*). Such persons are very enthusiastic, active, bear strain, have excellent and durable bodies and live for long²⁹. *Sushruta Acharya* states that *Asthi Sara* individual has huge head, shoulder, tooth, chin, nail, and bones³⁰.

ASTHIVAHA SROTAS

Srotas are the Channels meant to carry *Dhatus* during the process of transformation from one *Dhatu* to another *Dhatu*³¹. *Asthivaha Srotas* helps to transport the materials needed to make the bone tissue in the body. It has been only explained by *Acharya Charaka*.

MOOLASTHANA:**Table No.4: Moolasthanana of Asthivaha Srotas according to different Acharyas**

CHARAKA SAMHITA³²	SUSHRUTA SAMHITA	ASTANGA SAMGRAHA³³	ASTANGA HRIDAYA³⁴
<i>MEDA AND JAGHANA</i>	-	<i>MEDA AND JAGHANA</i>	<i>MEDA AND JAGHANA</i>

ASTHIVAHA SROTODUSHTI KARANA

The *Asthivaha Srotodushti* is caused by, *Vyayama* (indulgence in excessive exercise), *Ati Sankshobha* (excessive irritation), *Asthi Vighattana* (bones being crushed and subjected to repeated trauma), *Vatala Ahara* (excessive consumption of *Vata* aggravating food)³⁵.

ASTHI PRADOSHAJA VIKARAS

Asthi Pradoshaja Vikaras are, *Adhyasthi* (bone overgrowth), *Atidanta* (extra teeth), *Dantabheda* (crack in the tooth), *Asthibheda* (splitting pain in the bone), *Danta Shula* (pain in the tooth), *Asthishula* (pain in the bone), *Asthi Toda* (pricking pain in the bones), *Vivarnata* (discoloration of the body), *Kesha Dosha* (disorders of hair), *Loma Dosha* (disorders of body hair) *Shmashru Dosha* (deformities of moustache) and *Kunakha* (infection of nailbed)³⁶.

ASTHI AS THE MOOLASTHANA OF MAJJAVAHA SROTAS

Asthi is considered to be one among the *Moolasthanas* of *Majjavaha Srotas*. During the formation of *Asthi*, *Vayu Mahabhuta* makes space in the *Asthi Dhatu*, later these spaces get occupied by the *Meda Dhatu*, is referred to as *Majja*³⁷.

DISCUSSION**STHAYI AND ASTHAYI ASTHI DHATU**

Sthayi Bhaga of a *Dhatu* will nourish itself whereas *Asthayi Bhaga* has the ability to transport and nourish the next *Dhatu* and *Upadhatu*. In case of *Asthi Dhatu*, the *Sthayi Dhatu* can be considered as the Osseus tissue which is the specialized rigid connective tissue that forms the skeleton. The *Asthayi Asthi Dhatu* can be considered as the bone minerals or bone salts such as Calcium, Magnesium, Phosphorous etc. which helps to strengthen the bone.

MEDA AS MOOLASTHANA

According to *Dhatuposhana Nyaya*, the origin of *Asthi Dhatu* takes place on account of the specific action of *Asthi Dhatwagni* and *Asthi Poshakamsha* which is formed during the time of *Medo Dhatu Utpatti*. Here *Meda* can be understood as the fat or bone marrow adipose tissue.

Both bone and adipose tissue are having the same origin i.e., Mesenchymal stem cells. BMAT (bone marrow adipose tissue) is a heterogeneous tissue, found mostly in the medullary canal of the long bones (tibia, femur and humerus), in the vertebrae and iliac crest. This adipose tissue is also known as marrow adipose tissue (MAT) or yellow adipose tissue³⁸. Functionally, marrow adipocytes secrete adipokines, such as adiponectin, and cytokines, such as RANK-ligand and stem cell factor. These mediators can influence bone remodelling by promoting bone resorption. In addition, marrow adipocytes can secrete free fatty acids, acting as an energy supply for bone³⁹.

Fats are an essential part of a balanced diet. Saturated fatty acids (SFAs) improve bone health by enhancing osteoclast survival and promotes calcium absorption or excretion. Omega-3-long-chain polyunsaturated fatty acids (W-3 LCPUFA) mediate bone metabolism via lipid oxidation, calcium absorption and prostaglandin synthesis. It helps in promoting the functions of bone marrow mesenchymal stem cells and osteoblasts⁴⁰.

Fat facilitates fat soluble vitamins. Vitamin D is one among the fat-soluble vitamins which is essential for the calcium absorption. As a result, as indicated by all of these facts, they are crucial for maintaining bone health.

PANCHATIKA KSHEERA BASTI AND BONE HEALTH: THE ROLE OF FAT

Acharya Charaka has advised *Panchatikta Ksheera Basti* for the *Asthi Pradoshaja Vikaras*. *Basti* is the best treatment for pacifying *Vata Dosha*. As *Vata* is having *Ashraya- Ashrayi Bhava* with *Asthi*, *Basti* will help to control *Vata Dosha* as well as nourishing *Asthi Dhatu*. Studies shows that fatty acids might serve as potential therapeutic and nutritional agents in managing metabolic bone disorders⁴¹. All the ingredients of this *Basti* like, *Guduchi* (*Tinospora cordifolia*), *Nimba* (*Azadirachta indica*), *Vasa* (*Adhathoda vasica*), *Kantakari* (*Solanum xanthocarpum*), *Patola* (*Luffa acutangula*), *Ksheera* (Milk), *Goghrita* (Ghee), *Madhu* (Honey) contain fatty acids which might improve absorption as well as bone health.

JAGHANA AS MOOLASTHANA

The Pelvic region is intimately associated with *Pakwashaya*, the source of *Vata*. Applied through *Guda Marga*, *Basti Chikitsa* acts on *Pakwashaya* and is the principal treatment for *Vataja Vikara*. Any issue with *Jaghana* causes a disruption in the living body's upright posture. This is the area where *Asthivaha Srotas* vitiation is most commonly seen in old age.

Pelvic bone forms the central axis of the skeletal framework of our body. Its primary role is to support the weight of the upper body while sitting and to transfer this weight to the lower limbs while standing. It

serves as an attachment point for trunk and lower limb muscles, and also protects the internal pelvic organs. Thus, pelvic bone plays a vital part in skeletal system.

CONCLUSION

All the *Dhatus* have its own importance in sustaining the life of an individual. *Asthi Dhatu* plays a vital role in maintaining the physical integrity of the body. It is present all over the body, and is superior in *Deha Dharana*, despite the fact that it is the primary function of all *Dhatus*. *Sthayi Bhaga* of *Asthi Dhatu* can be correlated to the osseous tissue whereas *Asthayi Bhaga* can be correlated as the bone minerals like calcium, phosphorous, magnesium etc. As the *Moolasthan* of *Asthivaha Srotas*, *Meda* can be understood as the fat or bone marrow adipose tissue, while the pelvic bone can be understood as *Jaghana*.

REFERENCES

1. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukhamba Orientalia; reprint ed., 2023, Sutra Sthana 1/12, P.10
2. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukhamba Orientalia; reprint ed., 2023, Sutra Sthana 11/ P.183
3. Shabdakalpadruma by Raja Radhakant Deva, Chaukhamba Sanskrit Series Office, Varanasi, Part two, ed., 1961.
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,Shareera Sthana5/21, P.366
5. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Chikitsa Sthana 15/ 30,31 P. 515
6. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Chikitsa Sthana 15/ 30, P. 515
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,Sutra Sthana15/8, P.68
8. 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,Sutra Sthana15/4, P.67
9. Essentials of medical Physiology, By Dr. Sembulingum and Prema Sembulingum, Jaypee Brothers and medical publishers New Dehli, 8th edition, Chapter no.68,P.409

10. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Chikitsa Sthana 15/21 P. 515
11. 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,Sutra Sthana, 14/14, P. 62
12. Breeland G, Sinkler MA, Menezes RG. Embryology, Bone Ossification. [Updated 2023 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing;2024Jan.<https://www.ncbi.nlm.nih.gov/books/NBK539718/>
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,Shareera Sthana5/20, P.366
14. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Shareera Sthana 7/6 P. 337
15. 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,Shareera Sthana5/18, P.365
16. Astanga Samgraha of Vrddha Vagbhata with Sasileka Sanskrit commentary by Indu, Ed. Dr. Shivprasad Sharma, Chaukhamba Sanskrit series office; Ed. 6, 2022, Shareera Sthana5/61
17. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Chikitsa Sthana 15/19 P. 515
18. 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,Sutra Sthana46/529, P.253
19. Sarangadhara Samhita Prof. K R Srikantha Murthy, Chaukambha Orientalia, Reprint edition.2017, Poorva Khanda 5/16-17, P.22
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,Sutra Sthana15/14, P.70
21. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, Sutra Sthana 11/11 P.184
22. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Sutra Sthana 17/ 67 P. 103

23. 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,Sutra Sthana15/9, P.69
24. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, Sutra Sthana 11/19 P.185
25. 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,Kalpa Sthana 4/39, P.573
26. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Sutra Sthana 28/27, P.180
27. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, Sutra Sthana 11/27-28 P.186
28. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, Sutra Sthana 11/31, P.187
29. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Vimana Sthana 8/107 P. 278
30. 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,Sutra Sthana35/16, P.152
31. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Vimana Sthana 5/3,P. 249
32. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Vimana Sthana 5/8 P. 251
33. Astanga Samgraha of Vrddha Vagbhata with Sasileka Sanskrit commentary by Indu, Ed. Dr. Shivprasad Sharma, Chaukhamba Sanskrit series office; Ed. 6, 2022, Shareera Sthana6/25, P.314
34. Ashtanga Hrudaya with Sarvangasundara commentary of Arunadatta and Ayurvedarasayana commentary of Hemadri. Varanasi (India): Chaukambha Orientalia; reprint ed., 2023, Shareera Sthana 3/41, P.392
35. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Vimana Sthana 5/17 P. 251

36. Charaka Samhita of Agnivesa with Ayurvedadeepika commentary by Sree Chakrapanidatta, ed. Yadavji Trikamji Acharya, Chaukhamba Surbharati Prakashan, Re print. 2023, Sutra Sthana 28/16 P.179
37. Charaka Samhita of Agnivesa with ayurvedadeepika commentary by sree chakrapanidatta, ed. yadavji trikamji acharya, chaukhamba Surbharati prakashan, Re print. 2023, Chikitsa Sthana 15/31-32,P. 515
38. Piotrowska K, Tarnowski M. Bone Marrow Adipocytes-Role in Physiology and Various Nutritional Conditions in Human and Animal Models. *Nutrients*. 2021 Apr 22;13(5):1412. doi: 10.3390/nu13051412. PMID: 33922353; PMCID: PMC8146898.
39. Veldhuis-Vlug AG, Rosen CJ. Clinical implications of bone marrow adiposity. *J Intern Med*. 2018 Feb;283(2):121-139. doi: 10.1111/joim.12718. Epub 2018 Jan 15. PMID: 29211319; PMCID: PMC5847297.
40. Fang Z-B, Wang G-X, Cai G-Z, Zhang P-X, Liu D-L, Chu S-F, Li H-L and Zhao H-X (2023) Association between fatty acids intake and bone mineral density in adults aged 20–59: NHANES 2011–2018. *Front. Nutr*. 10:1033195. doi: 10.3389/fnut.2023.1033195
41. Bao M, Zhang K, Wei Y, et al. Therapeutic potentials and modulatory mechanisms of fatty acids in bone. *Cell Prolif*. 2020;53:e12735. <https://doi.org/10.1111/cpr.12735>

