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Research Article

AN OBSERVATIONAL STUDY OF ASTHI DHATU WITH CLINICAL APPROACH

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ABSTRACT

Asthi of the hardest morphological components of Human Body except Teeth. The main function of Asthi i.e., Dharana can be understood along with the action of osseous tissue where it acts as framework of Human body. It is made from the medodhatu in combination with asthidhatvagni (sausma) and Prithvi, Agni etc. Developmentally it of Pitrijabhava and structurally, Danta is considered to be the upadhatu of Asthi dhatu. In relation to osseous tissue, asthidhatu, enumeration of asthi, asthisanghata, asthiguna, asthi vaha srota, asthi marma, asthi as pratyanga, asthidharakala etc will come under consideration. The morbidity related to asthi dhatu is found in context of Asthikshaya, Asthivridhhi, Asthi pradosaja vikar. The present work includes maximum abnormality mentioned in relation to Asthi including Asthi Sausirya and also tried to evaluate its applied aspect. Dissection and histological interpretation are also tried to highlight the present work.

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INTRODUCTION

Asthi is one among the essential component of the Human Body. It is the fifth dhatu present in the Human Body. It is the hardest substance which remains even after decomposition of other body parts. Asthi is a body component which bears identical characteristic to osseous tissue. Osseous tissue is a specialized form of connective tissue which is composed of organic (33.33%) and inorganic (66.77%) matter called bone matrix or collagen matrix along with 3 progenitor cells. The important function of Asthi i.e., deha dharana can be understood with the function of Bone or osseous tissue i.e., formation of framework of Human Body.

The main configuration of Asthi is related to Prithvi Mahabhuta and its ashrayi dosha is Vata dosha. The different aspects of Asthi such as nomenclature, types, functions, morbidity etc and its detailed knowledge can be traced in the Ayurvedic Literature.

The morbidization of asthi can be understood under the term Kshaya, Vriddhi and Pradoshaja Vikar. As it forms the skeletal framework its abnormality causes a wide range of alteration in bodily function. The present work includes maximum abnormality mentioned in relation to Asthi including Asthi Sausirya and also tried to evaluate its applied aspect. Dissection and histological interpretation are also tried to highlight in the present work.

Objectives

1. Evaluation of Asthi Dhatu.

2. Assessment of Clinical Aspect of Asthi Dhatu.

METHODS

1. The concept of asthi dhatu is evaluated from textual references and its modern perspective is assessed through osseous tissue.
2. Asthi understood under fundamental and clinical aspect.
3. Application of Histology and dissection point of view is also tried.

RESULT

The study is carried out under the following aspects:

1. Fundamental.
2. Dissection.
3. Histology.
4. Clinical.
5. Therapeutic.

Fundamental Aspect

Derivation

Asthi is formed by 2 sanskrit words – “as” and “kthin” the words together mean stability¹. Amarkosh says it as “हृदइतिभाषा” and bears 3 synonyms i.e. kikasam, Kulyam and medajam¹.

Definition

It is the fifth dhatu which stays for a long time (i.e., Ashyatay) and take part in movement (i.e., khipatey) along with muscle².

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Synonyms: Kikasham, Kulyam, Medajam.³

Types & Number

There are 5 types of Asthi viz. Kapala (flat), Ruchaka (teeth), Taruna (cartilages), Valaya (irregular) & Nalaka (Long)⁴.

The total no. of Asthi is counted 360 according to Acharya Charaka⁵ & Bhagbhat⁶, while Acharya Susruta counted it 300⁷. Basically, they considered all the hard structure as Asthi. In Anatomy it is counted 206⁸.

Utpatti

Charaka opines, Asthi develops as precursor of medo dhatu. Nourishing portion of medo dhatu undergoes processing through asthidhatvagni (sausma) and in combination with Prithvi, Agni etc. attains kharatwa and form Asthi Dhatu⁹.

Importance

Susruta quotes, as trees are dependent on its inner core for its sustenance (dharana) likewise the body is dependent on Asthi. To highlight Asthi's importance Susruta added the persistence of Asthi even after the degeneration of skin, muscle tissue and other body parts. Muscles by attaching strongly to the bones by siras and snayus keep the Human Body in proper position¹⁰.

Asthi also termed as the extract of body (deha sara) which remain even after the destruction of other body component¹¹.

Panchabhautik constituents

According to, Charaka- Prithvi, Anila and Teja¹², prithvi mahabhut predominance.

Bhagbhat I & Bhagbhat II - Prithvi¹³.

Asthi Vaha Srota

Charaka & Bhagbhat I quotes, the moolasthan of asthivahasrotato be meda (fats) and jaghan (buttocks)¹⁴.

Sarangadhar & Bhav Mishra defines srota as the structure which carries asthi dhatu along with other dhatu, upadhatu, upadhatu mala, mana, prana, anna, jala, dosha, mutra etc¹⁵.

Asthi Sanghata

The 14 Asthi Sanghata according to Susruta, & Bhav Mishra are located one each in gulpha (ankle joint), janu (knee joint) and vangshanapradesh (inguinal region) in lower limb and similarly located in upper limbs too. Trik (sacral region) and shira (head) has one each sanghat¹⁶.

Bhagbhat I quotes each in gulpha (ankle), janu (knee), vangshana (groin/pelvis), manibandha (wrist), kurpura (elbow), kaksha (axilla), trik (sacral region) and shira (head)¹⁷.

Time duration for Asthi formation

Susruta mentions the time duration of rasa dhatu formation is 3015 kala, and transform to veerya in male and artava in female in 30 days. He further says, the rasa takes 18090 kala for sukra dhatu formation and in this aspect Asthi formation takes 12060 kala¹⁸.

Asthi Sara Purush Lakshana

A person with asthi sara has prominent parshni (heels), gulpha (ankle), janu (knee), artani (forearm), jatru (clavicle), chibuk (chin), shira (head), parshva and nakha (small joints of hand and feet, nails), danta (teeth). Such person are always

enthusiastic, very active, enduring, having strong and firm body as well as longevity as quoted by Charaka¹⁹.

Similarly, Susruta quotes the person has prominent Shira (head) and kandha (shoulder) and also have firm danta (teeth), hanu (mandible), asthi (bones) and nakha (nails)²⁰.

Functions:

Susruta - dehadharana and majjapusti²¹.

Bhagbhat II - dharana²².

Guna:

Asthi is predominantly formed by Prithvi mahabhut hence its characteristics (guna) can be incorporated to be same for asthi dhatu i.e., guru, khara, kathina, sthula, sthira, murtimanta etc²³.

Upadhatu:

Sarangadhar - danta (teeth) is the upadhatu of asthi dhatu²⁴.

Mala:

Charaka - kesha (hairs) and loma (body hairs)²⁵.

Bhagbhat I - Sweda (sweat)²⁶.

Bhagbhat II - nakha (nails) and roma (body hairs)²⁷.

Asthidhara kala: In the context of visavega, Dalhan gives a glimpse of Asthidhara kala.

Susruta opines, in 5th visavega the visa reaches the asthi and exhibits symptoms *parwabhedha, hikka & daha*²⁸. Dalhan further explains the visavega which exhibit its symptoms based on their respective ashaya of saptakala. According to enumeration of kala, purishadhara kala is the 5th kala, located in the Pakwasaya. Pakwasaya and asthi are the main seats of vata dosha. Also in Basti therapy, which is the specific treatment for vata dosha is administered through the guda to reach the pakwasaya. From these contexts, purishadhara kala is also identified as asthidhara kala²⁹.

Asthi Marma:

Asthi mentioned as marma by all the Acharyas except Acharya Charaka³⁰.

Asthis Pitrija bhava:

Asthi is derived from Pitrija bhava as per Charak³¹.

Asthi as Pratyanga:

Susruta considered asthi as one of the Pratyanga³².

Dissection Aspect

In Cranium dissection, Skull is cut and separated into 2 parts viz. calveria and cranial fossa. Skull is formed by 22 no. of flat bones that come together via cranial sutures. Flat bones are also known as diploe bone as it has a spongy layer between 2 layers of compact bone³³.

Histological Aspect

The osseous tissue cells are surrounded by matrix called bony matrix or collagen matrix which has organic and inorganic elements. The organic elements (33.33%) are formed by dense bundles of collagen fibres embedded in an amorphous ground substance composed of hyaluronic acid and protein-polysaccharides. While the inorganic matter (66.77%) consists of Calcium phosphates (85%), Calcium carbonate (10%) and small amount of calcium fluoride and magnesium chloride.

Bone is of 2 types

Compact Bone: Its lamellar structure is the main characteristics. It is traversed by longitudinal channels, the

haversian canals which anastomose with each other. Volkmann's canals connect blood vessels of periosteal and endosteal surface with Haversian canals. Haversian canals are surrounded by concentric lamellae and accompanying bone cells in the lacunae.

Spongy Bone: Here, the lamellae are irregularly arranged. Haversian system is relatively few or absent, marrow spaces contain haemopoietic cells with fat cells and are traversed by bony trabeculae. The matrix contains osteoblasts which are trapped by calcified matrix and known as osteocytes. It is placed in the spaces called lacunae possessing long processes which project into delicate tunnels known as canaliculi³⁴.

Clinical Aspect

The morbidity of asthi dhatu can be understood under the following headings:

1. Vriddhi
2. Kshaya
3. Pradosajavikara
4. Asthivahasrotadusti lakshana.

Morbidity	Charak ³⁵	Susrut ³⁶	As.Hridaya ³⁷	As.Sangraha ³⁸
Asthi Vriddhi	-	<i>Adhasthi Adhidanta (Iasha, nakhaatvridhi as per Dalhana)</i>	<i>Adhasthi Adhidanta (over growth of bone & extra tooth)</i>	<i>Adhasthi Adhidanta (increased size/no. of bone & teeth)</i>
Asthi Kshaya	<i>Kesha Loma Nakha Samshru Dvija Prapatana (falling of hairs, nails, beard & teeth) Sandhi saithilya (looseness of joints)</i>	<i>Asthisoola (bone pain) Danta & nakhabhanga (breaking of teeth & nails) Raukshyam (roughness)</i>	<i>Asthitoda (bone pain) Danta Iasha and nakha sadanam (prematurely falling of teeth, hairs, nail)</i>	<i>Danta nakha roma keshasatan (falling of teeth, hairs, nails, beard & teeth) raukshya (roughness) parushya sandhisaitilya (looseness of joint) asthitoda (joint pain) asthibadhamamsaabhilasha (desire to eat flesh with bone)</i>
Asthi Pradoshaja Vikar^{39,40}	<i>Adhasthi Adhidanta (increased size/no. of bone & teeth) Asthibheda (cracking sensation of bone) Asthisoola (pain in bone) Danta asthivaivarna (discoloration of teeth & bone) Kesha, loma, nakha, samshru dosha (morbidity in hairs, body hairs, nails & beard).</i>	<i>Adhasthi (extra growth of bones) Adhidanta (eruption of extra teeth) Asthitoda (pricking pain in the bones) Asthisoola (constant pain) Kunakha (distorted shape, texture of nails)</i>	-	-

Apart from the above aspects the clinical condition also can be highlighted as below: -

1. **Marma** – Bhagbhat II mentioned the symptom of as thimarmaviddhalakshanato be *Majjaanweto-acchovic chinasrava* and *ruk* i.e. When there is injury in asthimarma there is discharge of thin fluid mixed with bone marrow alongwith intermittent pain⁴¹.
2. **Vrana Vastu**-There are 8 vranavastu as mentioned by Susruta and asthi is one among them. It is further clarified by Dalhana, which can be identified in 2 ways:
 - Vrana chinna (scar)
 - Adhistan (site)⁴².
3. **Vrana Sthan**- There are 8 vranasthan as mentioned by Charaka and asthi is one among them⁴³.
4. **Asthi Granthi**- As mentioned by Bhagbhat II, when there is injury due to fracture or even if any morbidity in bone leadsto development of irregular swelling termed as Asthi Granthi⁴⁴.

It is also mentioned by Sharangadhar as one among the 8 types of granthi⁴⁵.

1. Pranasta Shalya-Susruta mentioned the characteristic of pranastashalya which are *Vividhavedana, Sopha* and when there *Asthgatavivara* there is *asthipurnata, Asthitoda, samharshabalwan*
2. (संहर्षइतिमारुतोपद्रवोरोमाञ्जप्रायोवेदनाविशेषःसंहर्षःसङ्घटनम्इत्यन्ये) which means severe pain- according to Chakrapani⁴⁶.
3. And as per Bhagbhat I, the symptoms are *Vividha- vedana, sopha*⁴⁷.
4. Vidradhi- The symptoms of vidradhi in asthi as mentioned by Susruta are Swelling anywhere in bone with *jwalandaha, vat vedana, Asthimajjagatdaha, Kleshyadaturamchiram, Medaprabham, snigdha, sukla, sitam, guru* (srava) as puya. It is of sarva dosha yukt and causes Ruja hence it is considered to be Asadhya⁴⁸.
5. Majja-Asthigatadustavayulakshan- As per Charaka the symptoms of majja-asthigatadusta vatare *Asthibheda, Parwabhedha, Sandhisoola, Mamsa -kshaya, Balakshaya, Aswapan, Santataruk*⁴⁹.
6. Asthigatkupitvayulakshan- As per Bhagbhat II the symptoms are *Sakthi Sandhya asthisoolam, Tivrabalakshayam*⁵⁰.
7. Asthyaavritvayulakshan- The symptoms as per Charaka are *Sparshasthaavriteyushnapeedanamabhinandati* (Pt feels comfort after application of hot substances and compression), *Sambhajyateysidati, Suchirbhiivatudhyate* (pricking pain)⁵¹.
8. According to Bhagbhat II, *Atyaushnasparshanpeedanamad hinandati* (Pt feels comfort after application of hot substances and compression), *Suchyatudhyate atyaarthamangam* (pricking pain), *Sidattisoola* (laxity in the body)⁵².
9. And as per Bhagbhat IS *parshanatyaushnapeedanabhinandan* (Pt feels comfort after application of hot substances and compression), *succhitudhyateyarthamangam* (pricking pain) and *Sidattisoola* (laxity in the body)⁵³.
10. Kustha in Asthi-majjalakshana– As per Susruta the symptoms are *Nasabhanga, Akshirag, Krimiyukt -vrana, Swarabhanga*. It is asadhya in nature⁵⁴.
11. Mamsa-sira-snayu-asthi-sandhi marmavranalakshana- According to Madhavkar symptoms seen are *bhram, pralap, patina, pramoha, vichesta, glani, sharirushnata, stastr-a-angata, murcha, urdhvavata, vatajanyativravedana and mamsaodakavamrudhiramsrava*. A person who has severe pain day and night which do not subside on any way should be understood that the person has Asthividhh Vrana⁵⁵.
12. FakkaRoga: As mentioned by Kashyap, FakkaRoga in Children, a child is unable to stand even after completion of 1 year⁵⁶.

DISCUSSION

1. The function of *Asthi* i.e., *DehaDharana* can be understood as normalcy of framework which facilitates it's underneath structure to remain in its proper position.
2. *Danta* (teeth), the *upadhatu* of *asthi* is the hardest structure after bone.
3. *Asthi* and *Vata* are inversely proportionate to each other especially in relation to increase and decrease as vata takes the asraya in asthi.

4. The characteristics of Asthi i.e., *guru, khara, kathina, sthula,sthira,murtimanta* etc clearly shows the identity of bone as it is hard, rough, gives strength and gives the shape (murtimanta) and forms the framework of Human Body.
5. *Asthikshaya* is described by all the Acharyas of BrihatTrayee .The word *Kshaya* means loss, decline, and diminished etc.
6. Dalhana quotes here,

‘क्षयःस्वप्रमाणात्...’

This means quantitative and also may be qualitative deficiency of that dhatu. Charaka mentioned 18 types of *kshaya* these *kshaya* can be understood due to *Vataprakopaka*. These again may influence through:

- Dhatukshaya
- MargaAvaran.

Charaka & Astanga Samgraha quoted *Sandhi Saithilya* as a characteristic of *Asthikshaya* including falling of *kesha, loma* along with teeth where weakness is also found.

The word *saithilya* is further clarified by chakrapani in sharir sthan quoting:

‘...शैथिल्यमनिबिडसंयोगता...’

It means the separation of structures which are closely attached to each together.

Sandhisaitihilya is seen due to morphological alteration of structures of joints such as synovial capsule when gets morbidized causes functional alteration i.e., altered range of motion seen in Osteoarthritis.Also seen in clinical feature of genetic disorders such as Achandroplesia and Osteogenesis Imperfecta type I.

Adhyasthi and *Adhidanta*are the characteristics of both Asthi vriddhi and Asthi Pradoshaa vikar mentioned by Charak⁷⁶&Susruta⁷⁷.The term is further described by Commentator Dalhana as:

‘अध्यस्थीनिअधिकास्थीनि अधिदन्तानितिअधिकान्दन्तान्;’

Where the meaning of the terms is clarified and can be understood under 2 context i.e.,

- Excess no.
- Abnormal size of bone and teeth. For e.g.,

In certain osteological diseases such as calcaneal spur there is a calcium deposit causing a bony protrusion on the underside of the calcaneus caused often by strains on foot muscles and ligaments. This can be correlated with condition known as Vatakantak or Padakantak which shows formation of thorn like “kantak” causing pricking pain due to vitiated Vata. These may be considered as *adhyasthi*. (sus/nid/01/79)

Again, in Bunion there is a bony bump that forms on the joint at the base of big toe. Basically, it occurs when some of the bones in the front part of our toe move out of place. This causes tip of big toe to get pulled towards the smaller toes and forces the joint at the base of big toe to stick out. It can be correlated with the causes of Vayu involvement where due to the increased movement of big toe from its own place.

Also in developmental disorders, such as Marfan’s Syndrome symptoms of *adhyasthi* such as disproportionately long arms, legs and fingers due to excess bony tissue formation is seen.

Paget’s disease is characterised by localized increased number of osteoclast which causes excessive osteoclastic bone resorption that is followed by compensatory increased osteoblastic activity leading to unstructured, fibroblastic and biomechanically unstable bone. As a result, there is deformity and enlargement of the bone with a defective and disorganized pattern. Here, the increased and abnormal size of osseous tissue is identical with *adhyasthi*.

In similar way in case of some morbidity of teeth such as Hyperdontia there is extra tooth present in the dental arch. In one of the *dantamoolagataroga* by Susrut viz. *Vardhana*⁸⁴ symptom of origination of excess tooth due to *vataprakopa* is observed and can be considered as sharing the same resemblance with the characteristic of *adhidanta*.

Also in some of the developmental disorders such as Osteogenesisimperfecta where there is tooth discolouration which can be understood as danta vaivarna seen in asthi pradoshaja vikar. Also there is constriction of cervical portion of tooth, which gives the crown a bulbous appearance which looks like increased size of tooth and resembles *adhidanta*.

In Marfan’s Syndrome, symptom of crowded teeth is seen which can be considered as a characteristic of *adhidanta*.

Cleidocranial Dysplasia involves oral manifestation specifically in maxilla which is underdeveloped and is shorter than the mandible. There is complete failure of eruption of permanent teeth as well as root of the teeth are shorter and thinner than usual also shows relation⁸⁷ of asthi and danta thus hypothesizing asthi kshaya and asthi pradosaja vikar Lakshana.

The features such as *asthisoola, asthitoda, asthiveda* are seen in both *asthikshaya* as well as *asthipradoshajavikar* which are different types of pain as quoted by Charak & Susruta. It is also seen in *roga* as like *asthigatadustavayu, asthikupitvayu* and *pranastashalya*.

In the similar way, due to environmental influence the most common bone disorders where the types of pain mentioned above are observed in the following disorders viz. Osteoporosis, Osteoarthritis, Osteomyelitis, Osteonecrosis, Osteomalacia, Rickets, Fibrousdysplasia and Bone cancer.

1. In order to highlight the gradation of vitiation of one particular *dhatu Pradoshajavikar* is emphasized. The characters that are mentioned against each dhatu show its extreme vitiation. When *asthidhatu* is extremely vitiated they produce *asthipradoshajavikar*. Here, the structural abnormality of bone are highlighted such as *adhiasthi, asthiveda, asthisoola, asthivivarnata*. Here, the morbidity of its *upadhatu* i.e., *danta* along with the *mala* i.e., *nakha, kesha, loma, roma* are also mentioned such as *adhidanta, dantavivarnata, kunakha etc*.
2. Commenter Dalhan, explains *Pradoshajavikar* in two regards: -
 - *Chikitshavisheshvignyanartha*-management of disease.
 - *Sukhasadhyatwa*- prognosis.

AcharyaCharaka mentioned involvement of danta, kesha, loma, shamashru and nakha apart from morbidity of asthi.

1.In relation with characteristic of Asthi pradosaja vikar similarities are seen both in Charak & Susrut as *Asthisoola, Adhyasthi, Adhidanta* in common. While morbidity, *kunakha*

by Susrut and Nakha dosha by Charak is stressed. Discolouration of teeth is also mentioned by Charak.

Puranam is the function of *majjadhatu* which indicates its location in bone. Bone is nourished through Nutrient foramen and Juxtamedullary apparatus. This nourishment again goes to Haversian canal of Volkmann's canal. Volkmann's canal connect blood vessels of periosteal and endosteal surface with Haversian canal.

Abnormality of *majjavahasrota* will impair the *asthidhatu* too leading to *Asthidhatukshaya*.

Available study shows bone weakness and lowered BMD affecting the body ridges that holds the dentures in the proper position resulting in poor-fitting dentures.

Osteoporosis has a major impact on the part of the jaw bone supporting the teeth. Loss in this bone is most likely to cause tooth loss or increased mobility. Hence, osteoporosis patient experiences difficulties linked to ill-fitting or loose dentures. It clearly shows the relation between the dhatu kshaya effecting on its upadhatu i.e., danta.

In bone modelling and remodelling the key cellular components are the 3 bone cells: Osteoclast which causes bone resorption, Osteoblast causes formation and later new bone is deposited by Osteocyte. The remodelling depends on a fine tuned crosstalk between these 3 protagonists to ensure that the amount of bone resorped by osteoclast equals the amount of bone formed by osteoblast and thereby to ensure the maintenance of bone mass.

The major mechanism of bone loss is increased bone resorption resulting in decreased bone mass and micro architectural deterioration. It mainly affects cortical (compact) and trabeculaer (cancellous/spongy) bone. Decrease in Cortical thickness, number and size of trabeculae results in increased porosity. Trabeculae may be disrupted or entirely absent. Trabecular bone loss occurs more rapidly than cortical bone loss as trabecular bone is more porous and bone turnover is higher.

In *Asthisausirya* mentioned as a symptom in *mazzadhatukshaya*. *Sausirya* is further described by Commentator Hemadri to be Sa-randhratva which means "with pores". Hence, *Asthisausirya* can be understood as porous bone which is the primary symptom of Osteoporosis.

Asthi is predominantly formed by Prithvi mahabhut and it diminishes due to the involvement of vayu and Akasha. Normally porosity can be understood as deficiency in structure which occurs here due to less amount of prithvi mahabhut which is caused by vayu and its persistence through akash.

In Osteogenesis Imperfecta, the context of woven to lamellar bone formation by Mesenchymal osteoblasts (MOBLs) and Surface osteoblasts (SOBLs) respectively demonstrate lamellar on woven bone synthesis as an obligate self-assembly mechanism and bone synthesis following the normal developmental pattern but showing variable delay in maturation caused by structurally abnormal or insufficient amounts of collagen matrix.

CONCLUSION

Asthi dhatu forms the hardest component of Human Body. Hence, Dharana considered as its function. Apart from osseous time cartilage, nail and teeth also comes in the whole scenario.

As it is the location of vayu causes morbidity in asthi dhatu. Structural and qualitative increase leads to abnormality defined as Adhyasthi. Enumeration as 5th in visa vega obviously relate to purishadhra kala present in intestine. Congenital abnormality like paget's disease include abnormality of asthi kshaya character. Vata vriddhi relate to dhatu kshaya, marga avarodh lead to structural abnormality like porosity in periosteum can be understood.

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