

Critical Analysis of the Concept of Asthi Kshaya vis-a-vis Osteoporosis

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ABSTRACT : 'AYURVEDA', "THE SCIENCE OF LIFE" is a time tested treasure of knowledge which explains human body as a congenial homeostasis of Dosha, Dhatu and Mala. The function of dhatus is dharana of the Sharira. Among the dhatus, Asthi dhatu is blessed with the function of sharira dharana. It gives shape to the body and protects the vital organs. Equilibrium of dhatus is health and their disequilibrium is disease. This disequilibrium may either be increase or decrease. Asthi kshaya (decrease in bone tissue) is a condition explained in Ayurveda, under the heading of ashtadasha kshayas. In Asthi kshaya there is diminution of Asthi dhatu. Similar to this, there is a condition known as Osteoporosis in western medicine which means 'Porous bones' or "the brittleness of the bones due to increased porosity from loss of mineral substance" causing decrease in the bone tissue & leading to increased risk of fractures. According to the principles of Aashrayaashrayee bhava, Asthi dhatu is the seat of Vata dosha and Asthi & Vata are inversely proportional to each other regarding increase and decrease. Increase of Vata leads to decrease of Asthi. Here, an effort is made to critically analyse the concept of Asthi kshaya mentioned in Ayurveda with special reference to Osteoporosis.

Key words : Asthi, Kshaya, Osteoporosis, Osteopenia, Aashrayaashrayee bhava, Bone density, Brittleness, Homeostasis.

INTRODUCTION

Ayurveda explains human body as a 'congenial homeostasis' of Dosha, Dhatu and Mala; "Dosha dhatu mala mulam hi Shariram"¹. This can be substantiated by the Sushruta's definition of health i.e. equilibrium of dosha (psycho-biological rhythm), agni (digestion & metabolism), dhatu (body tissues), malakriya (excretory function) and well being of Soul, senses and mental faculty². The function of dhatu is dharana of the Sharira. Asthi is blessed with the function of Sharira dharana, which gives shape to the body and protects the vital organs. Man without Asthi would have been an amorphous bolus of soft tissues. Hence Asthi dhatu can precisely be termed as the edifice bars, on the systematic framework of which man stands tall and handsome. The state of equilibrium of dhatus is health and its disturbance is termed as disease³. This disequilibrium may either be vridhhi (increase - qualitative or quantitative) or kshaya (decrease - qualitative or quantitative).

Generally bones are considered as Asthi. There are two types of dhatu, i.e. sthayi and poshaka dhatu. Asthi or bone can be considered as sthayi dhatu and not the whole Asthi dhatu. Chakrapani commenting on Charaka vimana sthana 5/8 mentions that Asthi dhatu is also in liquid form called as poshaka Asthi that flows

through the Asthivaha srotas and nourishes the sthayi Asthi dhatu⁴. According to recent advances, the osseous tissue can be taken as the sthayi Asthi dhatu and the nutrients that are responsible for the nourishment of the bone tissue such as calcium, phosphorus, magnesium etc. can be considered as the poshaka Asthi dhatu⁵.

Asthi kshaya is a condition in which there is decrease in the Asthi dhatu (Bone tissue) leading to many undesirable effects. It can be compared with Osteoporosis in which there is decrease in the Bone Mineral Density (BMD) leading to increased risk of fractures. Two conditions mentioned in Ayurveda may be discussed in this regard. One is Asthi kshaya and the other is Asthi saushirya. Asthi saushirya is not mentioned as a separate condition but, as a symptom of Majja kshaya whereas, Asthi kshaya is mentioned as an independent condition. There are no signs and symptoms of Asthi saushirya but, the signs and symptoms of Asthi kshaya are mentioned separately. The treatment of Asthi kshaya is also mentioned separately. Moreover, the important point to be noted is that, the signs and symptoms of Asthi kshaya i.e. Asthi-sandhi shula, kesha, roma, nakha, danta vikara/pata and daurbalya are exactly the same as the updated signs and symptoms of osteopenia/osteoporosis mentioned in the contemporary science. Recently, modern scientists have agreed that there is definite association between hair, nails and teeth pathology and osteopenia/osteoporosis. Hence, it may be understood that Asthi kshaya is more suitable condition than Asthi saushirya to be correlated to osteopenia and osteoporosis. Asthi

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kshaya is 'decrease in the bone tissue' and Asthi saushirya means 'porous bones'. Hemadri has commented on the word 'Saushirya' as 'Sarandhratvam' which means 'with pores'⁶. This condition is explained in the context of Majja kshaya⁷. Osteoporosis means the decrease in the bone tissue and not the bone marrow. More over there is another condition termed as Osteopenia, which is a pre stage (Purvarupavastha) of Osteoporosis in which there is decrease in the Bone Mineral Density too. But in this condition, the decrease is not so remarkable as compared to Osteoporosis. Majja is the next Dhatu of Asthi. Hence in the process of kshaya, Majja kshaya occurs when there is no proper supply of nutrients from Asthi dhatu. Thus Majja kshaya may occur after Asthi kshaya as per the basic principles of anuloma kshaya. Since there is decrease of bone tissue in both the conditions i.e. Osteopenia and Osteoporosis, they may be commonly compared with Asthi kshaya.

Asthi Dhatu Guna & Karma :

Asthi is guru, khara⁸, kathina, sthula, sthira and murtimad. Its function is deha dharana⁹, Majja pushti & it is the seat of Vata.

Etymology of Asthi Kshaya :

The word Asthi Kshaya is composed of two words Asthi and Kshaya. The word Asthi is derived from the root 'As' + 'Kthin' meaning "To Stay" or in the sense of "Stability"¹⁰.

The definitions of Asthi are 'Asyate Kshipyate yat'; 'Asyate iti Asthi'; 'Mamsabhyantarasthah - Sharirastha Sapta Dhatvantargata Dhatu Visheshaha'¹¹. That which is present in its own state for a long time is called Asthi. Sushruta mentions that twacha, mamsa etc. tissues gets destroyed soon (after death), but Asthi persists in its own state for a long time. Hence it is called as the sara of the Sharira¹². Similarly the

definitions of Kshaya are 'Kshiyate anena iti Kshaya'; 'Kriya kshayakarawat tu Kshaya ityucyate budhaihi'; 'Kshaya vyadhi visheshaha'¹³. That which decreases is called as Kshaya or the kriya which causes the decrease either qualitative or quantitative is termed as Kshaya and it is a vyadhi vishesha. Hence the combined meaning of Asthi kshaya is decrease in bone tissue.

The term "Osteoporosis" was coined by Pommer in 1885 which literally means "porous bones". The word Osteoporosis is comprised of two words i.e. 'Osteo' and 'Porosis'. 'Osteo' is derived from the Greek word 'Osteon' means the 'bone tissue' and 'Porosis' is derived from the Latin word 'Porosus' which means 'full of pores'. Thus combined meaning of the word Osteoporosis is 'Porous bones'. In 1994 World Health Organization (WHO) defined Osteoporosis operationally to be femoral neck Bone mineral density (BMD) value 2.5 standard deviations or more below the mean for normal young white women, or t-score of -2.5. In other words Osteoporosis is defined as "a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue leading to enhanced bone fragility and a consequent increase in fracture risk"¹⁴.

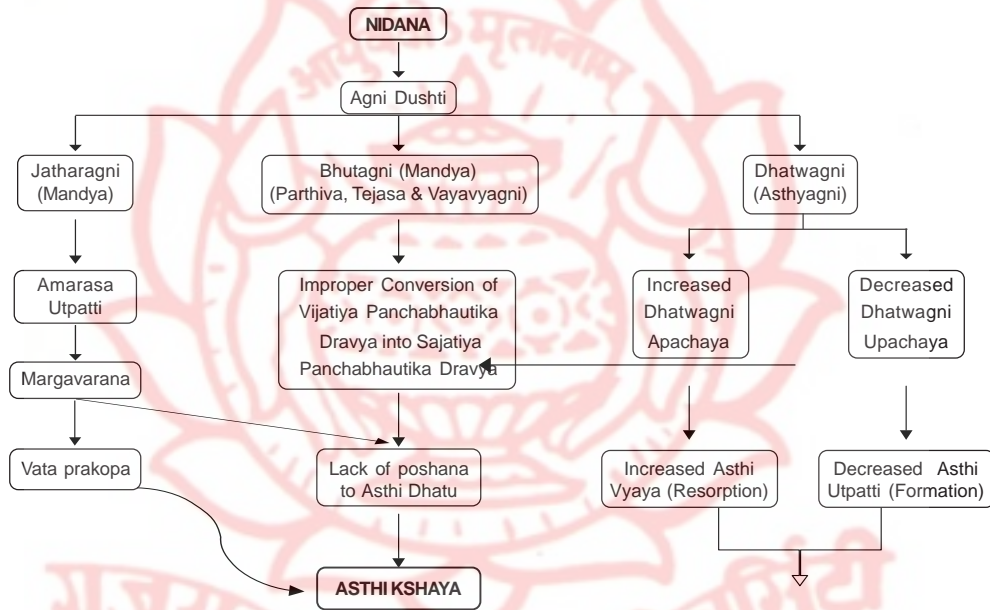
The etiological factors for Asthi kshaya are not mentioned separately in the texts. However, one should assess the etiological factors for Asthi kshaya on the principles of ashrayashrayi Bhavas¹⁵. Accordingly, Asthi is the main seat of Vata. Vagbhata explains that increase or decrease of Asthi and Vata are inversely proportional to each other i.e. when Vata increases, Asthi decreases and vice-versa. Hence, the factors which cause increase of Vata will cause decrease of Asthi. Charaka has explained the samanya nidanas which lead to the kshaya of 18 types¹⁶. The etiological factors can be classified as Aharaja (dietary), Viharaja (lifestyle), Manasika (mental) and Anya (others).

TABLE NO. 1 : THE COMMON ETIOLOGICAL FACTORS OF ASTHI KSHAYA :

Etiological factors that increase Vata ¹⁷			
Dietary	Lifestyle	Mental	Others
Excessive intake of; Dry vegetables. Dry meat. Pungent, Bitter, Astringent substances. Dry, light, cold, rough, porous substances. Alcohol having dry property. Improperly cooked food. Fasting. Dieting & limited food. Irregular dietary habits. Excess of eating.	Excess of; Fighting with stronger person. Exercise. Reading. Walking / Running. Jumping. Swimming. Lifting heavy weights. Falling from fast moving vehicles. Sexual intercourse. Waking at nights. Exposure to wind & sunlight. Suppression of natural urges. Using uneven seats & beds. Day sleep.	Excess of; Worry. Grief. Fear. Anger.	Trauma. Injury to vital organs. Improper treatment. Letting out excess of blood, dosha, dhatu & mala. Overuse of Panchakarma. Loss of body tissues.

TABLE NO. 2 : SROTO DUSHTI HETU OF MEDOVAHA, ASTHIVAHA, MAJJAVAHA AND PURISHAVAHA SROTAS :

Medovaha sroto dushti hetu ¹⁸			
Dietary	Lifestyle	Mental	Others
Intake of fatty food, Varuni.	Lack of exercise, Day sleep.	----	----
Asthivaha sroto dushti hetu ¹⁹			
Following Diet & lifestyle leading to increase of Vata.	Exercise, crushing of bones.	----	Irritation.
Majjavaha sroto dushti hetu ²⁰			
Intake of abhishyandi and viruddha ahara.	---	---	Crushing. trauma. Compression.
Purishavaha sroto dushti hetu ²¹			
Excessive eating, over eating during indigestion, weak digestion, lean built	Suppression of urge of defecation.		

SCHEMATIC REPRESENTATION OF SAMPRAPTI OF ASTHI KSHAYA :**TABLE NO. 3 : THE SYMPTOMS OF ASTHI KSHAYA ACCORDING TO DIFFERENT SAMHITAS :**

No.	Symptoms	Charaka	Sushruta	Ashtanga Sangraha	Ashtanga Hridaya	Harita Samhita
01	Asthi bheda	+	-	+	-	-
02	Asthi toda	-	+	+	+	-
03	Ruja	-	-	-	-	+
04	Asthi shula	+	+	-	-	-
05	Kesha vikara & paata	+	-	+	+	-
06	Loma/Roma vikara and paata	+	-	+	+	-
07	Nakha vikara & paata	+	+	+	+	-
08	Smashru vikara & paata	+	-	-	-	-
09	Danta vikara & paata	+	+	+	+	-

Contd....

10	Shrama	+	-	-	-	-
11	Sandhi shaithilya	+	-	+	-	-
12	Rukshata	-	+	+	-	-
13	Parushya	-	-	+	-	-
14	Asthi baddha	-	-	+	-	-
15	Mamsabhilasha	-	-	+	-	-
16	Anga bhanga	-	-	-	-	+
17	Ati manda cheshta	-	-	-	-	+
18	Bala kshaya	-	+	+	+	-
19	Meda kshaya	+	-	-	-	+
20	Viryasya mandya (Utsaha Hani)	-	-	-	-	+
21	Vikampana	-	-	-	-	+
22	Vamana	-	-	-	-	+
23	Visangnata	-	-	-	-	+
24	Shosha	-	-	-	-	+
25	Kathorata	-	-	-	-	+
26	Shopha	-	-	-	-	+

TABLE NO. 4 : BIO-CHEMICAL MARKERS OF BONE FORMATION⁴⁸ :

No.	Marker	Tissue of Origin	Specimen	Method
01	Calcium	Bone, liver, intestine kidney	Serum	Colorimetric
02	Total alkaline phosphatase (total ALP)	Bone, liver, intestine, kidney, placenta	Serum	Colorimetric
03	Bone specific alkaline phosphatase (BALP)	Bone	Serum	Colorimetric, electrophoretic, precipitation, IRMA, EIA
04	Osteocalcin	Bone, platelets	Serum	RIA, ELISA
05	Carboxy-terminal propeptide of type-I procollagen (PICP)	Bone, soft tissue, skin	Serum	RIA, ELISA
06	Amino-terminal propeptide of type-I procollagen (PINP)	Bone, soft tissue, skin	Serum	RIA, ELISA

TABLE NO. 5 : BIO-CHEMICAL MARKERS OF BONE RESORPTION⁴⁹ :

No.	Marker	Tissue of Origin	Specimen	Method
01	Hydroxyproline, total and dialyzable	Bone, cartilage, soft tissue, skin	Urine	Colorimetry, HPLC
02	Pyridinoline	Bone, cartilage, tendon, blood vessels	Urine, Serum	HPLC, ELISA
03	Deoxypyridinoline	Bone, dentin	Urine, Serum	HPLC, ELISA
04	Carboxy terminal cross-linked telopeptide of type-I collagen (CTX-MMP)	Bone, skin	Serum	RIA
05	Amino terminal cross-linked telopeptide of type-I collagen (NTX-I)	All tissues containing type-I collagen	Urine, Serum	ELISA, CLIA, RIA
06	Carboxy terminal cross-linked telopeptide of type-I collagen (CTX-I)	All tissues containing type-I collagen	Urine, Serum	ELISA, RIA
07	Hydroxylysine-glycosides	Bone, soft tissue, skin, serum complimen	Urine	HPLC
08	Bone sialoprotein	Bone, dentin, hypertrophic cartilage	Serum	RIA, ELISA
09	Tartrate-resistant acid phosphatase (TRACP)	Bone, blood	Plasma Serum	Colorimetry, RIA, ELISA

TABLE NO. 6 : PATHYAPATHYA IN ASTHI KSHAYA :

Pathya	Apathya (Avoid in excess)
Sweet taste dominant substances; Rice; Black gram; Milk Whey; Butter milk; Butter; Ghee; Meat soup; Anti Vata oils; Regular exercise; Exposure to early morning sun rays.	Pungent, bitter, astringent taste dominant substances; Dry, cold, light, porous, etc. property predominant substances; Madya (Alcohol); Shushka Mamsa (Dry meat); Shushka Shaka (Dry vegetable); Excessive eating; Fasting; Heavy exercise; Excessive sexual intercourse; Fighting with stronger person; Day sleep; Night; awakening; Suppression of natural urges; Medicines like Cortico-steroids etc.); Smoking and other etiological factors.

Apart from these the sroto dushti hetu of the Medovaha, Asthivaha, Majjavaha and Purishavaha srotas can also be taken as the nidana for Asthi kshaya. (Table 1).

Kala (time) is the age factor. Old age is the time of aggravation of Vata. The symptoms of ageing like loss; of vigor, functioning of sense organs, courage etc. are related to degenerative changes in the body tissues. Sushruta says that the Anna Rasa can not nourish the old aged persons due to senile degeneration; “*Sa evannaraso vriddhanam jaraparipakwa shariratwat aprinano bhavati*”²².

Etiological factors for Osteoporosis: Osteoporosis is one of the metabolic bone disorders, which is caused by many factors. It may be seen as a consequence from the involuntional losses associated with aging and, in women, additional losses related to natural menopause. This condition is called as the ‘Primary Osteoporosis’. Osteoporosis that is caused or exacerbated by other disorders or medication exposures is referred to as ‘Secondary Osteoporosis’.

The risk factors and etiological factors of Primary Osteoporosis are as follows;²³ Advanced age, history of fracture as an adult, history of fracture in an immediate relative, low body mass index (BMI) <19, female gender, caucasian race (White Americans of Asian origin), menopause/andropause, surgical menopause (radical hysterectomy or oophorectomy in early age), low calcium diet, magnesium and vitamin-D deficiency, smoking or tobacco in any form, alcoholism, lack of exercise (Sedentary life style), astronauts (living in low gravity areas).

Some of the causes of secondary Osteoporosis are;²⁴ Elher Danlos syndrome, premature menopause, osteogenesis imperfect, anorexia nervosa/bulimia, androgen insensitivity, Turner’s and Klinefelter’s syndrome, diabetes mellitus, hyperparathyroidism (1° and 2°), Cushing’s syndrome, gastrectomy & celiac disease, malabsorption, Protein Calorie Malnutrition (PCM), Rheumatoid arthritis, glucocorticoids etc.

Samprapti (Pathogenesis): Though the samprapti of Asthi kshaya has not been explained directly

in Ayurvedic classics, keeping in mind all the etiological factors explained under Vata vyadhi an attempt has been made here to formulate and explain the pathogenesis of Asthi kshaya. Even though factors responsible for increase in Vata are the main factors in the manifestation of Asthi kshaya, the etiological factors responsible for the vitiation of Medovaha, Asthivaha, Majjavaha and Purishavaha srotas play a definite role directly or indirectly in the pathogenesis of Asthi kshaya. Hence these factors should not be neglected.

Proper nourishing process of Dhatu²⁵ is very much essential in maintaining the qualitative and quantitative normalcy of the dhatu. Proper functioning of Jatharagni, Bhutagni and Dhatwagni is essential in performing this important function. Any functional deformity in any of these Agni especially the dhatwagni leads to the deformity in the transformation of poshaka dhatu (Dhatu specific nutrients) into poshya/sthayi dhatu, resulting in dhatu vikriti. The role of Manas in the causation of a disease is very well explained in the classics. Mental factors also play a vital role in the pathogenesis of Asthi kshaya. Thus, there is no single pathogenetic mechanism leading to Asthi kshaya. Samprapti of Asthi kshaya is therefore a complex mechanism. These multiple pathways of Samprapti of Asthi kshaya may be explained as Samanya and Vishsha samprapti as follows;

Samanya Samprapti: Increase in Vata leads to decrease in Ashti. Dhatu kshaya and margavarana are the causative factors for aggravation of Vata²⁶. Hence the causes of vitiation of Vata may be further classified into sakshat dhatu kshayakaraka and margavaranakaraka nidana. Chakrapani has explained dhatu kshaya as sara kshaya and margavarana as vega pratibandha leading to Vata prakopa²⁷.

By the over indulgence in these nidana the srotas become rikta (devoid of unctuousness) because of decrease of body tissues and obstruction in the channels. This leads to vitiation of Vata prakopa and this vitiated Vata fills in the channels which are devoid of unctuousness and vitiates them further leading to the stronger provocation of its own. Commenting on the word ‘rikta’ Chakrapani says;

“Riktani Tucchyani, Snehadi Guna Shunyani Ityarthaha”²⁸.

Charaka has quoted that due to the obstruction in the path of Vata, it aggravates and causes dryness in Rasadi dhatu²⁹. Due to obstruction there will be blockage in the normal movement of Vata, especially Vyana Vata. By this the circulation of ahara rasa (Rasa Samvahana), Arrangement of body tissues and digestive fire stimulating functions of Vyana are affected. As a result of this, the ahara rasa containing the nutrients to the body tissues will not be able to reach and nourish the sthaya dhatu, dhatu vyuhana i.e. specific arrangement and permeation of the nutrients inside the sthaya dhatu³⁰ will not be possible and the functions of the dhatwagnis are also affected. As a combined effect of these factors dhatu kshaya occurs.

Hence in a nut shell it can be said that, due to the sakshat dhatu kshayakaraka and margavaranakaraka nidana sevana, the prakrapita Vata fills in the rikta asthivaha srotases which are devoid of snehadi gunas and cause Asthi kshaya.

Vishesha Samprapti: Asthi kshaya may also be seen in patients of sthaulya (obesity). It may be surprising to hear about Asthi kshaya in persons with increased Meda, because Asthi is the very next tissue to Meda and Meda nourishes the Asthi, hence there should be increase of Asthi in persons of increased Meda. But Charaka and Chakrapani both have clarified that, the snigdha, guru, etc. ahara taken by the person suffering from obesity is directed towards the nourishment of Meda dhatu only, and predecessor and subsequent tissue nourishment will not be possible³¹. Medovaha srotas is vitiated due to its provoking factors. This leads to Medo dhatwagni (pachakamsha) mandyata, which causes Meda vriddhi. Due to hypofunctioning of medo dhatwagni, instead of sthaya Meda dhatu, ama Meda (ill formed fatty tissue) or abaddha Meda is formed. Excessive accumulation of such ama Meda causes obstruction in the channels nourishing the subsequent tissue i.e. Asthi leading to Asthi kshaya. In later stages decrease of Majja, Shukra and Oja may also be seen as complications.

Asthi and Majja are very closely related to each other, as Majja fills the Asthi. Charaka explains that, there is a metabolic co-operation between the dhatus i.e. “Paraspara Upasamsthabdha Dhatu Sneha Parampara”. Asthi and Majja also perform this function of mutual nourishment. The factors responsible for the vitiation of Asthivaha and Majjavaha srotas are also responsible for Asthi kshaya. The dietary factors such as intake of abhishyandi and incompetent foods of

Majjavaha sroto dushti provokes Vata due to obstruction and the indulgence in dietary and lifestyle factors leading to vitiation of Vata explained as causes of vitiation of Asthivaha srotas directly leads to provocation of Vata, resulting in Asthi kshaya. The other etiological factors responsible for vitiation of both the srotas are specific to trauma causing provocation of Vata and leading to Asthi kshaya. Dalhana commenting on the visha vega explained by Sushruta says that Purishadhara kala and Asthidhara kala are one and the same. Hence involvement of the causative factors of vitiation of Purishavaha srotas in the pathogenesis of Asthi kshaya should not be neglected³². The causative factors of vitiation of Purishavaha srotas are suppression of urge of defecation, excessive eating, overeating during indigestion, weak digestive power and thin body constitution. Suppression of urge of defecation leads to udavarta & ultimately to provocation of Vata. Thin body constitution is the main feature of Vata prakriti. Hence the provoked Vata causes Asthi kshaya. According to medical science, lean built and low body mass index (BMI) is the risk factors of osteoporosis. Excessive eating, overeating during indigestion and weak digestive power leads to formation of ama, which provokes Vata due to obstruction and obstruction in the channels nourishing the Asthi leading to nutritional deficiency to the bone tissue, finally resulting in Asthi kshaya.

In the pathogenesis of Asthi Kshaya the role of Jatharagni, Bhutagni and Dhatwagni can be explained as follows:

The vitiation of Jatharagni leads to improper digestion of the food resulting in the production of ama rasa, which contains very less nutrients or may totally be devoid of nutrients leading to improper nourishment of the Asthi resulting in Asthi kshaya. The derangement of Bhutagni especially Parthivagni, Tejasagni and Vavyagni affects the conversion of heterologous panchabhautika dravya to homologous (Asthi specific) panchabhautika dravya which leads to nutritional deficit resulting in Asthi kshaya.

The chief function of any Agni is metabolism and metabolism is comprised of Upachaya (anabolism) and Apachaya (catabolism). Similarly Asthi dhatwagni also has anabolic and catabolic functions. The anabolic part is controlled by the Jatharagni and the catabolic part is the moiety of Jatharagni. The hypofunctioning (sada) and hyperfunctioning (atidipti) of the upachaya part results in the kshaya and vriddhi of the asthi dhatu respectively where as, the hypofunctioning and hyperfunctioning of the apachaya part of Asthi dhatwagni leads to the vriddhi and kshaya of the Asthi dhatu respectively. Hence the factors which cause the hypofunctioning of Jatharagni

also causes the hypofunctioning of Asthi dhatwagni and results in improper conversion of poshaka Asthi dhatu into sthaya Asthi dhatu leading to Asthi kshaya. Similarly factors responsible for the hyperfunctioning of apachaya, leads to the Asthi dhatu paka (excessive bone resorption) leading to Asthi kshaya.

Hence to summarize, when anabolic function of Asthi dhatwagni becomes manda and catabolic function becomes tikshna, Asthi vyaya (bone resorption) over powers Asthi utpatti (bone formation) leading to Asthi kshaya (Osteoporosis). In some cases even though there is hypofunctioning of catabolic dhatwagni we observe dhatu kshaya. This is because of the dosha prabhava as explained by Chakrapani³³.

The involvement of the psyche can not be ruled out in the pathogenesis of disease, because body and mind have close association with each other. Asthi kshaya is not an exception to it. Charaka opines that the sharirika roga (somatic diseases) and manasika roga (psychic diseases) have inter-relationship³⁴. Chakrapani clarifies that; this relationship may be in four ways; i) Shariranam Sharirena, ii) Manasanam Manasena, iii) Shariranam Manasena and iv) Manasanam Sharirena³⁵.

Psychic factors explained in Vata vyadhi such as worry, fear, grief and anger leads to both dhatu kshayajanya and margavarajananya Vata prakopa. These factors produce ama resulting in obstruction³⁶. Charaka says that, even though food is taken in proper quantity and quality and is wholesome, it is not digested properly if a person is afflicted by worry, fear, grief and anger etc³⁷. Hence these psychological factors have direct influence on functioning of agni and also results in provocation of Vata leading to Asthi kshaya. Thus, Vata prakopaka nidana along with the sroto pradushaka nidana of Meda, Asthi, Majja and Purishavaha sotas, agni dushti i.e. Jatharagni, Parthivagni, Tejasagni, Vayavyagni & Asthyagni and Manasika Nidanans altogether form a complex mechanism of pathogenesis of Asthi kshaya. (Table No. 2).

Pathogenesis of Osteoporosis : The specific pathogenetic mechanisms in Osteoporosis are poorly understood. There are multiple pathways that can lead to bone fragility and hence there are likely to be many different ways that Osteoporosis can develop. In essence, Osteoporosis is the failure to maintain the physiological balance of the skeleton similar to the age related degeneration processes in other systems (CVS, CNS, Renal etc.)³⁸. Changes in bone mass are brought by an imbalance between bone resorption and bone formation processes that are normally coupled. In children and

adolescents, rate of bone resorption are high, but bone formation is even higher, with the net result being skeletal accretion. Once peak bone mass (PBM) has been reached in the third decade of life, bone resorption generally outstrips bone formation and there is loss of skeletal mass.

There are three major pathogenetic reasons for low bone mass. Each can have genetic and environmental causes.

1. Failure to achieve optimal peak bone mass. This is largely genetically determined, but can be substantially affected by lifestyle, particularly calcium intake and physical activity during skeletal growth.
2. Increased bone resorption has been reported in most Osteoporotic patients. Estrogen deficiency is a major factor in women, especially after menopause, and apparently in men as well. Calcium and vitamin-D deficiency and reduced calcium absorption in older individual, leading to parathyroid hormone excess, also contribute. Endocrine abnormalities (e.g. primary hyper parathyroidism or hyper thyroidism etc.), cytokines, and other local factors that are possibly influenced by reduced mechanical function may play a critical role.
3. Inadequate bone formation. This may be due to complete loss of skeletal elements by excessive resorption, so that there is no template on which to form new bone; to age related impairment of osteoblast function, or to changes in local and systemic factors that regulate bone formation³⁹.

Prodromal symptoms : As we have discussed Asthi kshaya is a disease caused by the increased Vata. It is a general rule that the purva rupa are in unmanifested (avyakta) stage in any Vata vyadhi. Here avyakta can be taken as ishat or alpa vyakta or asampurna lakshana, so to say mildness in the symptoms, as clarified by Chakrapani⁴⁰. In the initial stage of the disease the mild symptoms can be taken as the premonitory symptoms of Asthi kshaya like dull aching in the bones, joints, and mildness of other symptoms etc. can be considered as the premonitory symptoms of Asthi kshaya. Osteoporosis is totally asymptomatic in the initial stage, because low bone mass itself doesn't cause any symptoms and it is called as the "silent thief".

Symptomatology : Pain in the bones and joints is the main symptom of Asthi kshaya. Generally, when dhatu is affected its upadhatu and mala is also affected; hence dental deformity/fall, falling of; hair, body hair, moustache and nail deformity are seen in Asthi kshaya.

Teeth are considered as upadhatu of Asthi by Sharangdhara. The other symptoms seen in Asthi kshaya are either due to the anatomical or physiological alteration of the Asthi dhatu and its waste products.

Recent advances in the study of Osteoporosis have shown that the deformity in the nail and teeth is a definite indicative of risk of Osteoporosis. There is increasing evidence that osteoporosis and the underlying loss of bone mass characteristic of this disease, is associated with periodontal disease and tooth loss. Periodontitis has long been defined as an infection-mediated destruction of the alveolar bone and soft tissue attachment to the tooth, responsible for most tooth loss in adult populations. Current evidence including several prospective studies supports an association of osteoporosis with the onset and progression of periodontal disease in humans. The majority of studies have shown low bone mass to be independently associated with loss of alveolar crestal height and tooth loss⁴¹. Brittle nails are also indicative of Osteoporosis. Both fingernails and bones contain a crucial bonding substance which helps give them strength. The team, including University of Limerick experts, says low levels in the fingernail indicate low levels in bone. In Osteoporosis, the first clue the fingernail could play a role in diagnosing the disease came when a doctor noticed his osteoporosis patients had floppy nails. It was found that levels of disulphide bond - needed to bind one protein molecule to another - were lower in people with osteoporosis. In nails, the disulphide bond is needed to bind keratin - which gives them strength. For bones, the protein collagen needs disulphide bonds to stick together⁴².

Symptomatology of Osteoporosis : Symptoms of Osteoporosis include: 1) Pain (due to fractures), 2) Tenderness, 3) General debility, 4) Muscular weakness, 5) Abdominal distension, 6) Insomnia, 7) Loss of appetite, 8) Osteo-arthritis, 9) Constipation and ileus and 10) Kyphosis and Scoliosis. The gradings for assessing pain, tenderness and general debility have been mentioned in previous works⁴³ but, for the assessment of hair fall, dental deformity/fall and nail deformity the following gradings have been developed.

Investigator's gradings to assess hairfall, dental deformity/fall and nail deformity (Sanjay Kadlimatti, Chandola H. M. 2009) :

1. Hair fall :

Grade 0 - No hair fall

Grade 1 - Hair fall once in the morning while washing / combing

Grade 2 - Hair fall on every time of combing

Grade 3 - Hair fall even without combing & raised hairline in the frontal region (mild baldness)

Grade 4 - Visible or significant baldness in frontal / vertex region (caput).

2. Dental deformity/fall :

Grade 0 - No dental deformity

Grade 1 - Occasional dental pain with dental caries or loosening of at least one tooth.

Grade 2 - Dental pain that don't responds to analgesics along with caries / loosening / loss of 2-4 teeth.

Grade 3 - Loosening / loss of 4-8 teeth.

Grade 4 - Loosening / loss of more than 8 teeth.

3. Nail deformity :

Grade 0 - No Nakha Vikara (nail deformity)

Grade 1 - Mild loss of natural texture & elasticity of nails

Grade 2 - Moderate loss of natural texture & elasticity of nails

Grade 3 - Visible brittleness of nails

Diagnosis : Compared to the last decade an enormous progress has been made in the field of osteoporosis related bio-chemistry. Various bio-chemical markers are available now for the diagnosis of Osteoporosis. These bio-chemical markers are again specifically divided into the bio-chemical markers of bone formation and markers of bone resorption (Table No. 4).

Radiological assessment : The radiological assessment is very much helpful for the diagnosis of Osteoporosis. A couple of decades back X-ray was the only method for the assessment of the bone quality and quantity. But as the bio-technology advanced more sophisticated and accurate methods of measuring the bone mineral density have been developed. Such recent techniques used to assess the bone quantity and quality of bone in Osteoporosis are; Bone mineral density (BMD) measurements; Quantitative computed tomography (QCT), MRI and Ultrasound.

X-Ray : X-rays were the first and foremost method used to diagnose Osteoporosis. The first milestone achieved in diagnosing Osteoporosis by X-rays was by the Indians. Dr. Singh. M, Dr. Maini. P.S. et al. were the first to grade Osteoporosis on the basis of X-rays. This was popularly known as the 'Singh's Index'⁴⁶. Dr. Singh, et al. introduced a method of determining the degree of Osteoporosis by the X-ray evaluation of trabecular patterns of the proximal femur. He graded the degree of

Osteoporosis from I-VI, with Grade-I being severely Osteoporotic and Grade-VI being normal bone. The grading is as follows;

- ◆ Grade-VI : All the normal trabecular groups are visible and the upper end of the femur seems to be completely occupied by the cancellous bone.
- ◆ Grade-V : The structure of the principal tensile and principal compressive trabeculae is accentuated. Ward's triangle appears prominent.
- ◆ Grade-IV : Principal tensile trabeculae are markedly reduced but can still be traced from the lateral cortex of the upper part of the femoral neck.
- ◆ Grade-III : There is a break in the continuity of the principal tensile trabeculae opposite the greater trochanter. This grade indicates definite Osteoporosis.
- ◆ Grade-II : Only the principal compressive trabeculae stand out prominently; the others have been more or less completely resorbed.
- ◆ Grade-I : Even principal compressive trabeculae are markedly reduced in number and are no longer prominent.

Many studies have proved the increased risk of inter-trochanteric fracture in patients with Singh's index grade-III or below.

Measurement of Bone Mass or Bone Mineral Density) (BMD)⁴⁷ :

Clinical application of bone densitometry has been one of the advances in Osteoporosis that has led to the increased patient awareness of this increasingly prevalent disease. With bone densitometry it is possible for clinician to diagnose Osteoporosis before the first fracture has occurred; predict risk for fracture in post-menopausal women; men and in patients receiving gluco-corticoids. Three reasons clinicians do bone mineral density measurements are 1) Diagnosis using the WHO criteria for Osteoporosis, 2) Fracture risk prediction and 3) Monitoring the natural progression of diseases that effect BMD or monitoring the therapeutic response to Osteoporosis specific treatments.

Several non-invasive techniques are now available for estimating skeletal mass or bone mineral density. These include Dual Energy X-ray Absorptiometry (DEXA), Single Energy X-ray Absorptiometry (SEXA or SXA), Quantitative Computed Tomography (QCT), Ultrasound (US) and Magnetic Resonance imaging (MRI).

As per the W.H.O criteria, depending upon the 't'-score bone health can be graded as follows :

1. Normal : A value of BMD (t-score) within 1 standard deviation of young adult reference mean, i. e., 't'-score > -1
2. Osteopenia: A value of BMD (t-score) more than 1 and less than 2.5 standard deviation below the young adult reference mean, i.e., -1 > 't'-score > -2.5.
3. Osteoporosis: - A value of BMD more than 2.5 standard deviation below the young adult reference mean i.e. 't'-score < -2.5.
4. Severe Osteoporosis: - A value of BMD more than 2.5 standard deviation below the young adult reference mean i.e. 't'-score < -2.5 and presence of at least one or two fragility fractures.

Prognosis : Asthi Dhatu is the fifth among the metamorphic chain of Dhatu. Therefore it is a deep seated Dhatu. It is said in classics that deep tissue seated disorders are Yasya⁴⁸ in the initial stages and become Pratyakhyeya in the later stages, as the condition worsens.

Treatment of Osteoporosis :

The basic principle "Prevention is better than cure" is the first step in the management of Osteoporosis. Attaining the good bone mass at the adolescent prevents the risk of Osteoporosis. Once Osteoporosis becomes established then treatment becomes inevitable which includes: Calcium and Vitamin-D, Hormone replacement therapy (HRT), Bisphosphonates, Selective Estrogen Receptor Modulators (SERMs), Phytoestrogens, Calcitonin, Anabolic Steroids. The treatments such as HRT, Bisphosphonates, SERMs and Anabolic steroids have serious adverse effects.

Ayurvedic Management : The *modus operandi* formulated in the treatment of Asthi Kshaya includes: 1) Nidana Parivarjana (Avoidance of etiological factors), 2) Shodhana (Biopurification), 3) Shamana (Palliative treatment), 4) Rasayana (Rejuvenation) and 5) Pathyapathya (Proper diet).

1. Avoidance of etiological factors : Avoiding the indulgence in the causative factors is of prime importance in Ayurveda. The person suffering from Asthi kshaya must avoid the excessive indulgence in etiological factors responsible for provocation of Vata, vitiation of Medovaha, Asthivaha, Majjavaha & Purishavaha srotas and also the psychic factors which are mentioned above. The physician also has a role to play in this avoidance by not prescribing the tikshna drugs (cortico-steroids etc.). Moreover, excess of biopurification and injury to vital organs should also be prevented along with contradictory treatment leading to Asthi Kshaya.

2. Biopurification : It is indicated in bahu doshavastha of a disease. There is direct mention of chikitsa sutra in Ashtanga Sangraha⁴⁹ and in Ashtanga Hridaya⁵⁰ for Asthi kshaya. Charaka has mentioned the similar line of treatment for Asthi pradoshaja vikara⁵¹.

* *Asthi Kshayajan Bastibhihi Tiktakopahitaischa Kshira Sarpibhihi* || (A.S.Su.19/15)

* *Asthi Sankshayat Jatan Kshira Ghrithaihi Tikta Samyutaihi Bastibhistatha* || (A.Hr.Su.11/31)

* *Asthyashrayanam Vyadhinam Pancakarmani Bhesajam* |

Bastayaha Kshira Sarpishi Tiktakopahitani Cha || (C.Su.28/27) ||

All these quotations mention the same line of treatment for Asthi kshaya and Asthi pradoshaja vikara i.e. Panchakarma, especially Basti which contains kshira, ghritha and tikta dravya. It is a well known fact that among the Panchakarma, for diseases caused by the Vata, basti is the ultimate treatment of choice.

Here a question may arise in the minds of the scholars that, why tikta dravya, which are said to be Vata prakopaka are used in the treatment of Asthi kshaya, which is the result of increased Vata. Arunadatta in his Sarvanga Sundara teeka on Ashtanga Hridaya (11/31) has raised the same question and he himself has given an efficient answer to it. He says that, there is no justification in using Vata provoking drugs i.e. tikta dravyas in the treatment of Asthi kshaya, which itself is caused by increased Vata. This may worsen the condition. But it is said that drugs having snigdha and shoshana properties produce kharatwa in Asthi dhatu and increases Asthi dhatu, because Asthi is also having khara property as its main character. We can not find a single drug which has both snigdha and shoshana properties. Therefore combination of kshira, ghritha and tikta dravya is indicated. Here snigdha property is contributed by kshira and ghritha and shoshana property by tikta drugs, because shoshana is the main property of tikta drugs⁵². Asthi which possess the khara guna is nourished by the combination of kshira, ghritha and tikta dravya, which also produce khara guna when combined. This again works on the samanya siddhanta. Hence use of basti prepared with tikta dravya along with kshira and ghritha in the treatment of Asthi kshaya is substantiated.

3. Palliative treatment : Sushruta has described the principles of treatment for Asthi kshaya along with the treatment of 18 types of kshaya, as follows;

* *Tatra Swayoni Vardhana Dravya Prayogaha Pratikaraha*⁵³.

The swayoni dravya i.e. similar to the respective dhatu is to be used for the treatment of the respective dhatu kshaya. Here, in Asthi kshaya dravya similar to Asthi dhatu should be used. This is based on the samanya siddhanta. This samanya is of three types: 1) dravya samanya, 2) guna samanya and 3) karma samanya. Among these, dravya samanya is considered the best for the treatment of dhatu kshaya. In case of dhatu, samanya is described as;

* *Dhatavaha punaha shariraha samana gunaihi samana guna bhuyishthairva api ahara vikaraihi abhyasmanaihi vridhdhim prapnuvanti* ||

For the treatment of decreased dhatu, the use of drugs which are similar to dhatu, or the food and transformation having similar qualities of dhatu which has undergone diminution will bring about the increase of that particular dhatu. Ashtanga Sangraha has mentioned the same shloka but instead of vikara he has used the word vihara. The similar dravya for Asthi as explained in classics "*Asthi Tarunasthna*"⁵⁴. Dalhana commenting on Sushruta samhita sutra sthana - 15/10 has said the same thing i.e. "*Asthi Taruna Sangnakena Asthnam*".

The use of taruna Asthi increases Asthi dhatu. Similarly use of Asthi in its transformations i.e. bhasma (ash) will also increase Asthi dhatu. Keeping this principle in mind many preparations are used in Ayurveda & Indian folklore medicine, such as : 1) Ajasthi bhasma, 2) Asthi bhasma of other animals and 3) Kacchapa prishthasthi bhasma etc. Some other closely related transformations of similar dravyas are : 1) Pravala bhasma, 2) Pravala pishti, 3) Kukkutanda twak bhasma, 4) Shankha bhasma, 5) Shukti bhasma, 6) Kapardika bhasma etc. The samana guna bhuyishtha dravya of Asthi should possess the qualities similar to the Asthi such as guru (heavy), kathina (hard), khara (rough), sthula (bulk), sthira (remains for a long time) and murtimad (having shape) etc. Such drugs are milk, ghee, bitter substances combined with milk and ghee, black gram, meat/meat soup, rice and other drugs which possess the above mentioned properties of Asthi. In addition, Charaka, Vagbhata, Chakradatta, Bhavamishra, Authors of Yogaratnakara and Bhaishajyaratnavali etc. have mentioned the use of external and internal oleation therapy for the treatment of Asthi Majjagata Vata. Following unctuous preparations may be used in the management of Asthi kshaya, externally and internally.

Oil : Kshirabala taila, Chandana bala lakshadi taila, Dhanvantara taila, Bala guduchyadi taila, Balashwagandhadi taila, Lakshadi taila, Mahalakshadi taila, etc.

Preparations of Ghee : Pancha tikta guggulu ghrita, Patoladi ghrita, Mahatiktaka ghrita, Pancha tiktaka ghrita, Tiktaka ghrita, Indukanta ghrita.

Guggulu Kalpa : Various Guggulu formulations mentioned in the treatment of fractures and disorders of Vata can be given to the Asthi kshaya patients who suffer from different types of pain. These preparations are: Abha guggulu, Mahayogaraja guggulu, Lakshadi guggulu, Adityapaka guggulu, Yogaraja guggulu etc.

Kshira paka : Arjuna kshirapaka (Arjuna is known to be rich in calcium), Ashwagandha kshira Paka.

Rasayana : Various Rasayana preparations are useful in Asthi kshaya like: Dwitiya Brahma Rasayana, Chaturtha Triphala Rasayana, Chyavanaprasha Rasayana and Shilajatu Rasayana with milk.

Pathyapathya : The healthy dietetics and lifestyle to be followed in Asthi Kshaya can be summarized as under: (Table No. 4, 5).

CONCLUSION

Osteopenia & Osteoporosis can be covered under Asthi kshaya. The etiological factors responsible for the vitiation of Vata are responsible for the kshaya of the Asthi dhatu. The symptoms of Asthi kshaya and osteoporosis are almost same. Management of Asthi kshaya can be done by administering the basti containing ksheera, ghrita & tikta dravya and by the oral use of samana dravya and Rasayana. The above mentioned dietetics and lifestyle should be followed strictly to avoid the incidence of Osteoporosis.

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हिन्दी सारांश

अस्थिक्षय एवं ओस्टियोपोरोसिस-एक आलोचनात्मक विश्लेषण

संजय कडलीमट्टी, के. एस. महेश्वरी. एवं एच. एम. चन्दोला

आयुर्वेद शास्त्र के अनुसार मानव शरीर दोष, धातु और मल का मूल है। धातु, शरीर को धारण करती हैं। धातुओं में अस्थि धातु शरीर को आकार प्रदान करती है और मुख्य अंगों की सुरक्षा करती है। धातु साम्यता आरोग्य है और विषमता ही रोग है। यह विषमता, वृद्धि या क्षय हो सकता है। अस्थि क्षय एक ऐसी व्याधि है जिसमें अस्थि धातु का क्षय हो जाता है। आधुनिक मतानुसार ओस्टियोपोरोसिस अस्थि क्षय की समान अवस्था है जिसमें अस्थि का क्षय होने से हड्डियां कमजोर होकर टूटने का डर रहता है। आश्रयाश्रयी भाव के अनुसार जब वात की वृद्धि होती है तब अस्थि का क्षय हो जाता है। प्रस्तुत लेख में अस्थिक्षय को ओस्टियोपोरोसिस के संदर्भ में समझने का प्रयास किया गया है।

गुजरात आयुर्वेद युनिवर्सिटी