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ANATOMICAL CHANGES IN *ASTHIVAHA SROTAS* IN RELATION TO OSTEOPOROSIS

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ABSTRACT

Osteoporosis has been described as *Asthikshya* or *Asthishoshirya* and *Asthidoshaja vikar* in *Ayurvedic* texts. It is a Bone Metabolic Disease usually associated with strength, mass, density and structure of bone. Osteoporosis is a skeletal metabolic disorder where quantitative reduction of bone takes place due to abnormalities in mineral deposition due to insufficient mineral supply in diet. Reduction of bone is the normal phenomenon of ageing process but some individuals lose bone tissue much faster than normal process. This leads to fragile skeleton associated with high risk of fracture. *Ayurveda* mentioned the *lakashna* of *asthikshya* such as *praptana* of *kesh, loma, nakha, smshru, sandhisthilaya, asthishula, danta-nakha bhanga, rukshta* etc. *Asthivaha Srotas* are the channels which are transporting the bone tissue. Bone tissue comprises mainly four cells i.e. osteoproginator cells, osteoblasts, osteocytes and osteoclasts; and a homogenous matrix with organic and inorganic components. The inorganic component mainly consists of hydroxyapatite. Effect on trabecular and cortical architecture leads to bone fragility. Further anatomical aspect of *Asthivaha srotas* in relation to *srotodusti* of osteoporosis will be described in full paper.

KEYWORDS: *Asthivaha Srotas, Asthikshaya, Asthidoshaja vikar*, Osteoporosis.

INTRODUCTION

Osteoporosis is a common clinical syndrome involving multiple bones in which there is quantitative reduction of bone tissue mass but otherwise the bone tissue mass is normal.[1]

Osteoporosis has been described as *Asthikshya*[2] or *Asthishoshirya*[3] and *Asthidoshaja vicar*[4] in *Ayurvedic* texts. *Ayurveda* mentioned the *lakashna* of *asthikshya* such as *praptana* of *kesh, loma, nakha, smshru, sandhisthilaya, asthishula, danta-nakha bhanga, rukshta* etc.[5] The *Asthipardoshaja vikar* are included in *Asthivaha Srotas*[6] and occurred due to the *dusti* of the particular *srotas*. It will be either *Asthivridhi*[7] or *Asthikshya.*[8] So Osteoporosis comes under the *Asthipardoshaja vikar* occurred due to the some disturbance in trabecular and cortical architecture of bone that ultimately leads to bone fragility. Bone is a rigid modified form of connective tissue which consists of bone cells or osteocytes and the extracellular matrix is impregnated with inorganic salts, mainly calcium phosphate and carbonate, that provide hardness.[9] In developing bone, two additional types of cells are also present. These are osteoblasts[10] and osteoclasts[11] which are bone producing cells and bone removing cells respectively. The other cells present in bone tissue are osteoproginator cells[12] (stem cells of mesodermal origin), that proliferate and derive the osteoblasts and osteocytes. Any change in the normal anatomical structures and normal chemical composition of bone that ultimately leads to reduction in bone tissue mass are responsible for occurring osteoporosis which is related to *Asthivaha Srotas.*

Composition of *Asthivaha Srotas* in relation to hardness

The channels which carries the bone tissue are considered as the *Asthivaha Srotas*. The *mula*[13] are *meda* and *jaghana*. *Asthidhatu* takes its nutrition[14] from the *medodhatu* and *Jaghana* or pelvic girdle is responsible for the upright position of the body, it follows that *jaghana* takes part in *dharana karma*[15] of the body. So due to *poshana* and *dharana karma* of body, these two are considered as the *mula* of *Asthivaha Srotas*. The *mala of Asthidhatu* are nails and hair. These help in the removal of toxins from the body and bones. The bone stores the inorganic salts or minerals which are responsible for the weight of the bone. The bones are *panch-bhoutika* but there is predominance of *prithivi* and *vayu mahabhuta.*[16] The *prithivi mahabhuta* responsible for the building of bones and the increased amount of *vayu mahabhuta* is responsible for fragility of the bone. *Ayurveda* also mentioned the *lakashna* of *asthikshya* such as *praptana* of *kesh, loma, nakha, smshru, sandhisthilaya, asthishula, danta-nakha bhanga, rukshta* etc. If there is bone fragility then there is also the fragility of nails and teeth; ultimately leads to the hair loss. It is due to the reason that the chemical composition of nails, teeth and hair is the same as the bone and the chemical which is responsible for maintaining the hardness of bone is also the same but in nails, the hardness is due to the arrangement of disulphide bonds. If there is improper arrangement of disulphide bonds, then

it will leads to the brittleness of the nails. Osteoblasts[17] are responsible for laying down the organic matrix of bone including the collagen fibres and also responsible for calcification of matrix. It is assumed that osteoblasts are also responsible for shedding off matrix vesicles that serve as points around which formation of hydroxyapatite crystals takes place.

Osteocytes[18] generally maintain the integrity of the lacunae and canaliculi and help in maintain the channels for diffusion of nutrition through bone; and play a significant role in deposition or removal of matrix and of calcium when required. The ground substance[19] consists of an organic matrix in which mineral salts or inorganic ions (calcium, phosphate, magnesium, carborate, hydroxyl, chloride, fluoride, citrate, sodium and potassium) are deposited. The ions such as calcium, phosphate and hydroxyl are in the form of needle shaped crystals and collectively called as hydroxyapatite. Approximately 65% of dry weight of bone is carried by inorganic salts and 35% by organic ground substance and collagen fibres. These percentage is accounted only for the dry bones and in living bone about 20% weight of bone is carried by water. It means that the inorganic ions and organic matrix is responsible for bone tissue mass probably. If there is any quantitative reduction in mass of constituents of bone matrix, then it leads to osteopenia which ultimately leads to osteoporosis. About 97% of total calcium of the body is located in the bone and about 3% carried by blood. When the level of calcium in blood rises then the calcium is deposited in the bones and when the calcium level falls in blood then the calcium is withdrawn from the bones under the influence of hormones.

Anatomical Changes in Osteoporosis

Osteoporosis is classified into two categories broadly: primary and secondary. The exact mechanism of primary osteoporosis[20] is not known but it is assumed that it is a result of an excessive osteoclastic reabsorption and slow bone formation which are stimulated by various factors such as oestrogen deficiency in women as in postmenopausal osteoporosis and androgen deficiency in men; combined deficiency of calcitonin and oestrogen; hyperparathyroidism; deficiency vitamin D and some genetic factors. Secondary Osteoporosis[21] results with an underlying disease (immobilisation, chronic anaemia, acromegaly, hepatic disease, hyperparathyroidism, hypogonadism, thyrotoxicosis and starvation) or medication (hypercortisonism, administration of anticonvulsant drugs and large dose of heparin). Histologically, Osteoporosis may be active or inactive type. Active Osteoporosis[22] characterised by accelerated turnover i.e. increase in number of osteoclasts

with increased resorptive surface as well as increased quantity of osteoid with increased osteoblastic surfaces. Inactive Osteoporosis[23] characterised by reduced turnover i.e. decreased number of osteoclasts with decreased resorptive surfaces and normal or reduced amount of osteoid with decreased osteoblastic surface.

Role of inorganic salts in bone strength[24]

The inorganic and organic constituents of bone matrix can be removed by weak acids and heat respectively. The process of removing the inorganic salts called decalcification and thus it reduce the rigidity of bone by softening the bone tissue. When treated with heat, the bone becomes brittle and breaks easily. This also shows the reduction of bone tissue mass.

Osteoporosis in hair[25]

The hair is composed of carbon (45%), oxygen (28%), nitrogen (15%), hydrogen (6.7%) and sulphur (5.3%). These all elements represent the *panch-mahabhuta* in which the *prithivi mahabhuta* provide strength and rigidity. Here sulphur is responsible for rigidity. The other elements constituting the hair are keratin, lipids, minerals (iron, magnesium, copper, zinc and lead), pigments and water; and keratin is the main constituent of hair. It is composed of 18 amino acids and provides strength to the hair through maintaining sulphur to sulphur covalent bonds. Alpha keratin, a hair protein which is fibrous and containing sulphur in low quantity; has about 45000 molecular weight and insoluble in water find in highest quantity in hair. The keratinization process depends upon various factors such as genetic, hormonal, metabolism and dietary factors etc. the dietary factors leads to improper or irregular keratinization results in anatomical defects in hair. Any quantitative reduction in chemical constituents of hair that are responsible for providing rigidity and any disturbance in maintaining the normal calcium level in blood and bones leads to osteoporosis.

Osteoporosis in nails[26]

The main chemical component of nail is also keratin, containing highest quantity of sulphur. The rigidity of nail depends upon the arrangement of cells (keratinocytes), their adhesions and the orientation of keratin fibres apart from its chemical composition or calcium content. The nail plate is the hard visible part composed of keratinized, squamous cells that are loosely adherent to the germinal matrix but strongly adherent to sterile matrix. The matrix produce the cells which form the nail plate contain nerves, lymph and blood vessels. In osteoporosis, changes can be seen in disulphide bonds. It is also the diagnostic test which have the same accuracy as the current gold standard- DEXA scanning.

Osteoporosis in teeth

Tooth is composed of three calcified tissues- enamel[27], dentine.[28] and cementum.[29] The enamel is the hardest material in the body. It consists of about 96% of inorganic salts. These inorganic salts are mainly in the form of hydroxyapatite which is a complex structure of bone containing calcium phosphate and calcium carbonate. The crystals are arranged in the form of rod-shaped prisms that run from deep surface to superficial surface. Prisms are separated by interprismatic material. The difference between prism and interprismatic material is differing orientation of the hydroxyapatite crystals in them. Dentine is made up of glycosaminoglycans which is calcified ground substance and numerous collagen fibres are embedded in it. The calcium salts in the form of hydroxyapatite and these inorganic salts carried about 70% of weight of dentine. The cementum has the same composition as the bone. So any reduction in the constituents of inorganic ions or salts leads to osteoporosis in teeth.

CONCLUSION

The *mula Jaghana* explains that the *Asthivaha Srotas* is responsible for the upright position of the body and provides strength or hardness. Basically, the hardness of bone is due to the organic and inorganic constituents that form the bone matrix. Inadequate formation of bone matrix leads to osteoporosis that effect the normal architecture of bone, mainly the cortical and trabecular architecture. The cortical architecture of bone appears more thinner and porous as compared to the trabecular architecture. Osteoporosis effect the normal *panch-bhotika* level also. As *Prithivi mahabhuta* provides rigidity or hardness whereas the increased amount of *vayu mahabhuta* leads to fragility or osteoporosis.

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