



Review Article

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AN ANALYTICAL STUDY OF MUSCULOSKELETAL COMPONENT IN AYURVEDA: A REVIEW

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ABSTRACT

Ayurveda describes various components of body starting from micro to macro level. Musculoskeletal components are macroscopic or gross structures which include Bones, Muscles, Cartilages, Tendons, Ligaments, Joints and other connective tissues that support and bind tissues and organs together. In Ayurveda Peshi, Asthi, Sandhi, Snayu, Kandara along with Jala, Kurcha, Mamsarajju, Sevani, Sanghata and Simanta can be considered as identical components of these structures. Scattered references are available regarding certain aspects of these components which are necessary to be analyzed and correlated from modern anatomical concepts. To highlight the concept of muscular tissue as well as its structural and functional entities are identified in terms of various terminologies like mamsavahasrota, mamsadhara kala, mamsavahasrotamoola and Peshi etc. Different types Peshi like bahala, pelava, sthula, anu, prithu, vritta, hrishwa, dirgha, sthira, mridu, slakshna, karkasa etc are also interpreted with modern Anatomical point of view. All the broad muscles like Trapezius, Rectus abdominis, Diaphragm etc are discussed under bahala, Brevis muscles can be understood with hrishwa, vritta comes under Teres muscles of the body. Skeletal elements are discussed under Asthivahasrota, Asthidhara kala, along with its functional aspect. Likewise other components viz. Sandhis, Snayu, Kandara along with related structures are discussed in relation to morphophysiological aspect. The present study thus analyzes all the structures available in classics relating to musculoskeletal components with logical interpretation and correlates them with most nearest identity.

Keywords: Musculoskeletal component, Peshi, Asthi, Sandhi, Snayu, Kandara

INTRODUCTION

The musculoskeletal system includes- Bones, Muscles, Joints, Ligaments, Tendons and other connective tissues for supports and binds tissues and organs together. They are responsible for movements, supports, stability and protection of the body¹. Observing all these aspects as well as structural identity, the Peshi, Asthi, Sandhi, Snayu and Kandara can be considered under musculoskeletal components in Ayurveda. Apart from these structures some other anatomical components viz. Jala, Kurcha, Mamsarajju, Sevani, Sanghata and Simanta also come under this system. Histologically, muscle develops from muscular tissue while bone and cartilage develop from osseous tissues and chondroblasts respectively, which are mesenchymal in origin. The white fibro-elastic tissues form tendons, ligaments and fascia etc. The components like Mamsa, Asthi, Snayu, Kandara etc. exhibit all these aspects Ayurveda and they can be interpreted accordingly. Thus the present work carried out in following way-

- Available references regarding musculoskeletal components from Brihatrayee, Laghyatrayee along with related text books in Ayurveda and modern Anatomy along with recent electronics databases were taken and studied.
- Morpho-physiological aspects of musculoskeletal components were studied and analyzed from both Ayurvedic as well as modern anatomical point of view.

DISCUSSION

Peshi

Peshi is the compact form of mamsa dhatu formed by the action of vayu². It exhibits with lengthy and fleshy appearance^{2,3}. The main functions of Peshi are to give strength and support to the body, and coverto protect the internal structures along with vessels, nerves and bones^{4,5}. Bhavaprakasha mentioned that Peshi responsible for movements of different parts of the body⁶. These references make it clear that Peshi means muscle which is made up of muscle tissues that constitute by elongated, cylindrical muscle fibres and the main function of muscle is to provide movements of the body along with maintenance of posture and body position. Histologically mamsadhara kala⁷can be understood along with intermuscular septum, as well as epimysium, perimysium, endomysium which are covering of a muscle, fasciculi, and individual muscle fibre respectively. Three terminologies namely visamrinala, pankaudaka and bhumi are mentioned relating to mamsa where visamrinala exhibit ramification of veins, pankaudaka can be identified with specific muscle, while bhumi place for lamina of muscle tissue⁷.Mamsavahasrotamula is mentioned as snayu, twacha and raktavahi dhamani⁸. As the nerves innervate the myotome, the blood vessels are the suppliers of protein, calcium and other nutrients to the muscles, whereas the skin gives supports and protects the skeletal muscles. Therefore, these three structures are directly related to developments, nourishment and maintenance of the muscles. In certain congenital disorders like neuromuscular disorder, myasthenia gravis, there is involvement of vessels and nerves which can be considered as the involvement of mamsavaha srota⁸. In classics, Peshi are

enumerated as 500 in number with 20 extra in female. However, in modern Anatomy there is no such specific enumeration available yet. Recent data correlated it as 600 to 850, mostly as 640. Hence interpretations of muscles from the numerical aspect in both sciences are difficult. Different characteristics and types of Peshi mentioned in Ayurveda can be understood along with the modern view as follows-

Bahala (broad and large) - all the broad and large muscles are included here under⁹. Example -Diaphragm, Rectus abdominis, Trapezius etc. However Dalhana concept i.e. bahutara indicate as muscles layers of wall like external, intermediate and internal muscles layers of thoracic wall. In relation with Pelava (small)-all the minor muscles can be considered here under⁹. Dalhana comment as Alpa (little) in this regard which exhibit the small muscles like platysma, pyramidalis etc. Regarding Sthula(big)-it can be understood along with all the heavy, large and big muscles of the body⁹. Dalhana comment as tadviparita (opposite of) indicates opposite to Anu (very small) which mean for large muscles of the body. For example- gluteus maximus, pectoralis major, diaphragm etc. Anu (very small)-Dalhana mentioned as sukhshma (minute), both the concept indicate the very small muscles like stapedius, pyramidalis, subclavius etc. Pritu (flat)-Dalhana comments as vistirna⁹. Analyzing both the concepts the flat and broad muscles which covered a large area can be considered hereunder. Examples- latissimus dorsi, trapezius, external oblique etc. Vritta (round)-Dalhana comments as vartula, this can be understood along with the round shape (teres) muscles of the body⁹. Example- teres major, teres minor etc. Hrswa (short)-Dalhana mentioned as adirgha⁹. All the short muscles (brevis) can be considered here. Examples- adductor brevis, extensor hallucis brevis etc. Dirgha (long)-means the long muscles, for example, longus colli, longus capitis, Sartorius (longest muscle of body). However, Dalhana's concept i.e. Ayata means rectangular in shape. Sthira (firm)-mentioned as kathina⁹ by Dalhana. Both concepts indicate all the firm and stable muscles like deltoid, rectus femoris etc. mridu (soft)-kumala word is mentioned by Dalhana⁹. All the soft muscles of the viscera like cardiac, muscles of stomach etc. can be correlated in this regard. Slakshna (smooth)-is mentioned as sparsasukha by Dalhana which indicate mucosal and sub mucosal membrane of viscera. Dalahana's concept in this regard indicates the functional aspect of muscles exposed externally which are rich by nerve supply as well as vascular supply. It can also be understood with muscles of lip and labial muscles. Karkasha (rough) - in relation with karkasha, Dalhana mentioned the word tatviparita i.e. opposite to slakshna⁹. Rough, serrated and border having with irregular muscles can be considered here under.

Asthi

Embryologically, Asthi are derived from pitrija bhava i.e. paternal origin^{10, 11}, which are hard and heavy in nature (kathina, gourava¹²).

Asthi are predominantly formed by the prithvi mahabhuta^{13, 14}, where vayu cause porosity (soushirya) in them¹⁵. In relation with mahabhoutic composition (basic body elements), prithvi mahabhuta predominance can be understood along with organic as well as inorganic compositions of bone like calcium phosphate, calcium carbonate, calcium fluoride and magnesium phosphate which are responsible for the rigidity and hardness of bone. With the action of Vayu i.e. bibhajana, the three types of cells viz. Osteoblast, Osteocyte and Osteoclast get differentiated. Here osteogenic cells differentiate and develop into Osteoblast which in turn are responsible for forming new bones where the excess growth is prevented by Osteoclast, while

the Osteocytes are stable cells in bone. In the subsequent development of bones i.e. ossification, governed by two processes, i.e. membranous and cartilaginous ossification. Here in both processes, bony plates called lamellae are formed, followed by trabeculae and finally, by different canals like lacunae, canaliculars etc. inside the whole bone. These growths, differentiations, and developments are exclusively governed by vayu. The character soushirya¹⁵ indicate porosity which is a special character in this tissue, influenced by ruksha (dryness) and sukhshma guna (minuteness) of vayu. These porous spaces can be understood along with various channels and spaces like haversian canal, lacunae, canaliculars as well as medullary canal. In relation to embryological origin the whole hard structures like nails, teeth, bones, ligaments, vessels, hair etc. are mentioned as of paternal origin. In modern embryology also, there is some similarity regarding these elements where they are derived from a single germinal layer i.e. mesoderm. It is observed that ligaments and tendons are white fibrous tissues, while elastic layer present in tunica media of vessels develop from yellow elastic tissues. In all these tissues protein and collagen play a major role. Cartilage is formed by chondroblasts along with presence of albuminoids which are of three types. Among them hyaline and fibro consist of excess cartilage cell. All these impart rough appearance of ligaments, tendons, cartilage, artery etc. which seem logical by placing them under a single source of origin i.e. pitrija bhava. Asthi are mentioned as strongest structures of body, which remain undestructed (navinachyanti) even after the decay of all the structures like muscles, skin etc.^{10, 11, 13, 15, 17}. It is mentioned as adharasyatotha, sarakaye asthini¹⁸ and responsible for deha (body), dharana (support), by providing attachment of muscles, vessels as well as other structures of body^{16, 17, 18, 19, 20, 21}. All these references can be incorporated directly by the functions of bone which constitute the framework of body and gives shape and form to the body. It supports, gives strength and transmit weight of the body. Caraka mentioned Asthivahasrota which can be understood along with the nutrient foramen and canals present in bones which are extended into the modularly cavity⁴¹. Asthidhara kala can be understood as periosteum as well as endosteal layers of bone. Observing all these references, the word Asthi can be directly correlated with bone. Other references regarding Asthi are available in relation with distributions as well as enumeration. The distribution and numeration of bone in Ayurveda and modern anatomy are differing due to various causes. For example, Ayurveda considered all the hard structures along with teeth, teeth sockets, nails, cartilages of trachea, nose ear etc. They also counted each rib separately in three different parts as like arbuda, sthalaka and parshuka which increased the total numbers. Extended or protruded parts in bones like transverse processes of the vertebra are counted separately.

Sandhi

The concept of joint according to modern and Ayurveda is different. According to Ayurveda joints are the places of junctions of any two or more parts (anga) of the body. It may be joints between bones (asthi sandhi), joints between muscles (peshi sandhi), joints between vessels (sira sandhi) etc²². But in modern science joints are the region of the skeleton where two or more bones meet, articulate and they are supported by varieties of connective tissues. From numerical aspect also there is no similarity in both the sciences. In modern science, there are no specific numbers mentioned but recent data shows that the number varies from 340 to 360. In Ayurveda, the total number of joint is mentioned as 210. However in classics only the asthi sandhis i.e. bony joints are described in details where some similarities with modern science regarding the types with characteristics are noticed. From the aspect of action i.e.

movements of joints, Ayurveda mentioned two types of joint viz. Chestavanta²³ which can be understood along with movable or Diarthrosis joints and Sthira²⁴ can be understood along with immovable or Synarthrosis joints. Apart from these two joints slightly movable or amphiarthrosis joint is also mentioned in

modern anatomy which is not mentioned in Ayurveda under this classification.

Another classification made on the basis of structural as well as distributions can be understood as below shown in table.

Table 1: Interpretation of types of Sandhi along with modern anatomy

Types of joints according to Ayurveda	Modern interpretation	Examples
Kora sandhi	Hing joint	Joints of fingers(anguli), ankle(gulpha), knee(janu), elbow(koorpora)
Ulukhala sandhi	Ball and sockets joints	Hip joints(vangsana), glenohumoral joints (kakshya),
Samudga sandhi	Amphiarthrosis	Symphysis pubis(bhaga), joints in anal region (guda), and buttocks(nitambha)
Pratara sandhi	Amphiarthrosis	Vertebral column (Parhwavangsha) , joints of neck (greeva)
Tunnasevani sandhi	Suture	Suture of skull bone (Sirakapalasthi)
Vyashatunda or kakatunda	Amphiarthrosis	Mandibular joint (hanu)
Mandala sandhi	They are not actual joints	Found in throat can be understood with tracheal rings (kantha nadi), joints of the eyes (netra), kloma
Sankhavarta sandhi	They are not actual joints	Joints in ear (srotas) are not actual joint.

Mandala and Sankhavarata are not considered as joints in modern anatomy, tunnasevani can be understood as immovable joints while the remaining 5 joints can be included in movable joints.

Snayu

From the different characteristic as well as functional aspect, snayu can be correlated with fascia, ligaments, tendons and nerves cord. The specific characteristics of Snayu like sanakara, dhanushi^{26, 27}etc clearly indicate snayu is a fibrous structure which is exhibit like rope of bow. The term pratana bhavanti²⁴ can be understood along with reticulated network like distributions of white fibrous tissue. Sarangadhara mentioned that snayu are the structures that bind the muscles, bones etc together which clearly indicate as ligaments and tendons of the body²⁸. The types of snayu are²⁹. Pratanawati snayu can be understood with ligaments or tendons, Vritta snayu can be understood with yellow elastic tissue as the characteristic mentioned as vritta indicates as round. Prithu means for flat and broad which can be understood along with flattened or ribbon shape tendons and aponeurosis. Susirasnayu can be understood with sphincter of pylorus from its character. In relation to applied aspect, Susruta mentioned that the injury of the snayu causes severe pain due to which hamper the activities of the body. This can be understood along with the sprain of ligaments of joints. The main sign and symptoms of a sprain are pain, swelling, and spasm combination of which causes difficult to use the injury parts leading to obstruct or hindrance of normal activities.

Kandara

Kandara can be understood along with the big (mahaty, mahasnayu) and round shape (vrittasnayu) tendons³⁰⁻³². Susruta mentioned the word nakhaagrapraroха for the tendons (kandara) which can be understood as insertion of the tendons. He mentioned about the insertion of tendons of hand and feet as the nakhaagra praroha which can be understood along with the flexor and extensor tendons of the digits which are extensions of the forearm muscles. In case of feet also the extended tendons of the leg muscles like extensor digitorum longus, extensor hallucis brevis and longus etc to the phalanges can be understood in this regard. In relation with tendons bind to neck and heart (greevahridayanibandhani) is difficult to correlate where the insertion mentioned as media which can be understood as pubic

regions rather than considered it as penis. Kandara mentioned in relation with back (sronipristhataganam) vimba is mentioned aspart of insertion which can be understood as sacrum. Tendons of back can be understood along with the anterior longitudinal ligament, posterior longitudinal ligament and ligamentum flavum. Regarding murdha, it is mentioned as uruvakshyapindadigatanam, which is difficult to understand with Susruta's view, but from Dalhana's comment, it can be understood as tendons (kandara) related to neck (greeva) that are attached with the head. This can be considered as ligamentum nuchae which is a fibro elastic intermuscular septum extended from external occipital protuberance to the spine of C7 i.e. seventh cervical spine.

Jala

The word jala can be understood along with the network like structures of the body in general while in specific it can be understood along with retinaculum of the hand and feet. For example flexor and extensor retinaculum of the hand, and flexor retinaculum, peroneal retinaculum, superior as well as inferior extensor retinaculum of foot. From the verse "parasparanibaddhaniparaspara gavakshitani"³³, can be understood along with "anastomosis" around the joint where muscles, bones, ligaments, vessels etc are anastomoses each other.

Kurcha

Kurcha formed by the sannipata (combinations) of mamsa, asthi, sira and snayu^{3,35}. They are brush like structures which can be understood along with the aponeurosis. From the distribution of kurcha in classics, plantar and palmar aponeurosis of hand and feet, ligamentum nuchae in neck and suspensory ligament of penis can be incorporated here.

Mamsarajju

The word Rajju means rope like structures. Therefore mamsarajju can be understood as rope like structures related to muscles. From the location (pristhavangshaubhayat) as well as functional aspect (peshinibandhanarthe) mamsarajju can be correlated with longissimus, spinalis, and iliocostalis muscles of the back^{36, 37}.

Sevani

Sevani can be understood along with suture and raphe of the body. 5 numbers of sevani mentioned in relation with sira can be understood along with coronal, sagital, lambdoid and two squamous sutures of the skull. The sevani present in sepha can be understood as the raphe of the scrotum. Sevani in the jihwa can be correlate with frenulum linguae of the tongue³⁸.

Sanghata

Distribution of sanghatas are mentioned in relation with ankle, knee, hip, wrist, elbow and shoulder, along with pelvis and head, which are the big joints of the body where more than two bones take part to form the joints. Therefore sanghata can be said as the big joints of the extremities including the joint of the head³⁹.

Simanta

In classics simanta are counted as similar with Sanghata i.e 14 in number. However Ashtanga Sangraha and Hridaya mentioned 18 numbers of Simanta, where the total number is increased due to consideration of 5 numbers of sutures present in the skull instead of considering the head as single. These Simanta can be understood with articulates parts of the bonesthat participate in mentioned joints viz. ankle, knee, hip, wrist, elbow, shoulder, pelvis and head⁴⁰.

CONCLUSION

After going through this study we conclude that Musculoskeletal components are observed in terms of Peshi, Asthi, Sandhi, Snayu, Kandara along with Jala, Kurcha, Mamsarajju, Sevani, Sanghata and Simanta by observing their composition, characteristics as well as functional aspect. Peshi formed by mamsa dhatus can be understood with muscle, and muscle tissue. Sometime the aponeurosis, or fascia or even small ligaments are also considered as Peshi. Asthi are the hardest and strongest components of the body, formed by osseous tissue i.e. Asthi dhatus, which is the main framework as well as strength giver of the body. The growth, differentiation, and developments of bone can be understood along with action of vayu i.e. vibhajana. Numerically Asthi are counted more in Ayurveda due to inclusion of all the hard structures of the body including cartilages, protruded parts of bone which are similar in appearance. Sandhi mentioned as articulations of any two or more structures, but only the Asthi Sandhi are described elaborately in classics which can be understood with bony articulations. They are mainly classified according to their movements as well as from morphological aspect. Snayu are the fibro-elastic, white fibrous tissue, like ligaments to bind, support and sustain the joints. Sometime it is also meant for tendons; fascia as well as cartilage too. Kandara is identical terminology for tendon in specific, while sometime it can also be understood as ligaments and intermuscular septum. Other relating musculoskeletal components like jala, kurcha, mamsarajju, sevani, sanghata and simanta represent Retinaculum, Aponeurosis, rope shape muscles, Raphe and Sutures, and joints of the extremities respectively by considering from their morphological as well as physiological aspects.

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