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A STUDY ON SANDHI SHAREERA WITH MODERN CONTEMPRARY SCIENCE

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ABSTRACT

The meaning of word Sandhis is "the meeting of two or more structure" According to modern joint is a point where two or more bones are articulates with each other. Acharya Sushruta has quoted that although there are numerous Sandhi in our body which cannot be counted so only Asthi Sandhi should be considered while enumerating Sandhi. There are two hundred ten sandhi in the human body. Sushruta has classified the Sandhis. This article emphasis on the etymology, synonyms, Utapatti, functions of Sandhis its correlation with joint, with references to anatomical and physiological aspect, description of Sandhi(joint) in present in both sciences, so an attempt is made in this article to brief look on the Sandhi.

Key words- Sandhi. Joints,

INTRODUCTION

Ayurvedic classics like Bruhatreyee & Laghutreyes are impact a whole some knowledge of Shareera , Nidana and Chikitsa. To treat a disease the thourough knowledge about the disease and Shareera of it related Part should be Known well. Every aspect of Shareera is well explained & given through knowledge in Samhitas, so the person one who knows shareera Rachana and Shareera kriya indetail. He can only know and understand Ayurveda which can makes pleasure to the Universe. In our Ayurvedic classics different Acharyas have mentioned different number of Sandhi.

अस्थनां तु सन्धयो ह्येते केवलाः परिकीर्तिताः ।।

पेशीस्नायुसिराणां तु सन्धिसंख्या न विद्यते ।। २८ । (Su. Sh. 5/28)

The Sandhis are innumerable so Acharya sushruta counted only the Asthisandhi. He couldn't counted the other sandhis like peshisandhi(joint between muscles), joint between Snayusandhis(joint between nerves), sirasandhi(joint in between arteries,vein and capillaries)[1].

So acharya Sushruta explained Sandhis are 210 in number, which are responsible for various movement and are distributed thoughout the body like walking, standing, sitting, lifting etc.

In ayurvedic Samhitas the descrption of anatomy of Sandhi in detail is not found. It is observed that the incidence of Joints disorders are incresing in today's world. It is the burning problem in the current scoiety. A thorough knowledge of the structure and function of the joint is requried to diagnose and treat the joint diseases.

Ayurvedic review on SANDHI:

1) Etymology

In this study it is very essential to know the meaning of the word sandhi, it"s origin, literal meaning so it is essential need to know the meaning origin,derivative of word. So etymologically the word sandhi is taken from sanskrit root Shadbhakalpadruma and sanskrit – hindi kosha, Originated by **'Dha' dhatu. „ki' pratyaya** is applied. So in this order **Sam+Dha+Ki** are forming the root **word "sandhi"** which means „ to unite" or „meeting point". [2]

2) Definition of Sandhi

" अस्ति संयोग स्थानम् ||

Sandhi is defined as a place of union of bones.[3]

सन्धयश्चाङ्गसन्धानाद् देहे प्रोक्ता कफान्विता । (Saar.I. 5.37)

According to Sharangadhara samhita qoutes that the joints combine the bone and are with kapha.[4]

सन्धिसंश्लेषाच्छ्लेषकः सन्धिषु स्थितः । (A.H.Soo.12.18)

Incidentally it may be remembered that the term sleshmaa (kapha) means to embrace (श्लिष् आलिङ्गने।) and there is a special faction of kapha lodged in the joints named sleshaka- kapha.[5]

According to acharya sushruta only asthi sandhi"s should be taken into account where as other sandhis of peshi,sira and snayu are innumerable and are also explanined. So according to shareera Rachana the definition of sandhi can be taken as union of two or more bones.

3) Synonyms Various Ayurvedic and non Ayurvedic literatures have given following synonyms to the word sandhis are sandhi, slesha, samyoga, bhaga, bheda, sandhana, avakasha, sammilana, sangama, maitrikarana.[6]

4**) Embryological development**: In the third month of foetal life five pindakas or lump like protuberances appears to give rise to five parts i.e two upper limbs, two lower limbs and the head. According to Garbhopanishad the padapradesha develops in third month and Gulpha along with jathara and kati pradesha develops in the fourth month.[7]

5) Sandhi Rachana: Anatomically two separate entities constitute a joint, from the mobility and dislocation point of view sushruta has considered only bony joints, while from the point of establishing the equilibrium of internal environment the dosha, dhatu etc

Bones play vital role in the dharan karma of sharira and bones are joined to each other with the help of mamsa, sira, snayu binding together to form joints hence the mamsa.sira,snayu and asthi binding each other are collectively can be considered as sandhi.

Acharya susruta described the importance of sandhi and snayu as man built a ship by to many bindings and then the ship can able to float with various types of weight.[8]

6) Sandhi and Garbha bhava's: Acharya charaka has described the garbhaja bhava in sharirasthana while describing pitruja bhavas of garbha, Acharya illustrated pitruja bhavas such as asthi, sira, and snayu which are also constituents of joint.[9]

7) Panchabhoutikatwa of sandhi:

Table no.1

Panchamahabhoota	Structures in Sandhi
1) Akasha mahabhoota	Space between articular surface
2) Vayu mahabhoota	Various movements like prasaran, akunchana, gamana etc
3) Agni mahabhoota	Warmness seen after movements in joints
4) Jala mahabhoota	Synovial fluid (shleshaka kapha)
5) Pruthvi mahabhoota	Meeting points of sandhi

8) Sandhi and Dosha: The kapha is responsible for sthiratva,snigdhatwa and sandhi bandana.[10]The sleshma that resides in sandhi named as sleshaka kapha. It facilitates free movements of the sandhi and lubricates it as well.[11]

9) Sandhi and prakruthi: Person of vata prakruti is krush and his sandhi becomes sashabda[12]. The joints of person having pitta prakruts are shithila and binded by mamsa.[13] Joints of kapha prakruti persons are stable, snigdha and shlistha and binded by muscle ie, goodha.[14]

10) Sandhi and kala The fourth kala is known as shlesmadhara kala lies within the sandhi. It lubricates the joint and allows free movement of area of the bones and lines the fibrous capsule of the elbow joint.[15]

12) Sandhi Swaroopa: Two or more athis are not only sufficient to form a sandhi. It requires other structures which connect the asthi to one another to maintain, stabilize, bear weight and facilitate the gati in them. Structures that constitute a sandhi are a follows

1)Asthi 2) Snayu 3) Shleshmadhara kala 4)Shleshma 5) Peshi 6) Sira 7) Dhamani

Some of the author opines that formationof sandhi takes place in garbhakala along with formation of other dhatus, ashaya,kala and marma.[16]

11) Sandhi Sankhya : According to Acharya Caraka there are 200 sandhi.[17] Acharya sushruta explains that the Sandhi"s are 210 in number.[18]

" सङ्ख्यातस्तु दशोत्तरे द्वे शते; तेषां शाखास्वष्टषष्टिः, एकोनषष्टिः कोष्ठे, ग्रीवां प्रत्यूर्ध्व त्र्यशीतिः ।" (S.Saa.5.26)

According to Susruta-samhitaa there are 210 bony joints. Among them there are 68 joints in saakhaa (the limbs), 59 are in koshtha (the trunk) and 83 joints are in siras (head) and greevaa (neck).

एकैकस्यां पादाङ्गुल्यां त्रयस्त्रयो, द्वावङ्गुष्ठे, ते चतुर्दश । (S.Saa.5.26)

In each paadaanggulee (toe) there are three joints. In the paadaanggushgha (big toe) there are two joints. This excludes the proximal joint with the wrist. Thus there are 14 joints in the toes.

जानुगुल्फवङ्क्षणेष्वेकैकः, एवं सप्तदशेकस्मिन् सक्ति भवन्ति। (5 Sax.5.26)

In each janu (knee), gulpha (ankle) and vamkshaana (loin) there are one joint each. Thus in each lower limb there are 17 joints.

एतेनेतरसक्थि बाहू च व्याख्यातो। (S. Saa.5.26)

Similarly there are 17 joints in the other lower limb and in each upper limb. This makes a total of 68 joints in all the four limbs.

त्रयः कटीकपालेषु चतुर्विंशतिः पृष्ठवंशे तावन्त एव पार्श्वयोः, उरस्यष्टोः तावन्त एव

ग्रीवायां त्रयः कण्ठे, नाडीषु हृदयड्रोमनिबद्धास्वष्टादश... [1] (5.Sam.5.26)

There are three joints in katee-kapaala (the pelvic flat bones). In prshtha-vamsa (the vertebral column) there are 24 joints. Similarly there are 24 joints in the flanks, On the uras (chest) there are eight joints Eight joints are there in greevaa (the neck) also. Three are in kantha (the throat). In the naadees (ducts) of hedaya (the epigastrium) and kloma (trachea) there are 18 joints.

दन्तपरिमाणा दन्तमूलेषु एकः काकलके नासायां च द्वो वर्त्ममण्डलजो नेत्राश्रयी, गण्डकर्णकः, हो हनुसन्धो, द्वावुपरिष्टाद्भुवोः शङ्खयो, पञ्च शिरः कपालेषु, एको मूर्ध्नि। (5 Sax.5.26)

In dantamoola (the gums) there are as much joints as there are dantaah (teeth) (32), one each is in kaakalaka (the palate) and naasa (nose). Two joints depend on the eyes. They are in the vartma mandala (the lids). In ganda (the cheek), karna (ears) and samkha (temples) there are one each. There are two joints with hanu (the mandible). There are two joints above bhroo (the eyebrows). So are above the samkha (temples) too. There are five joints on sirah-kapaala (the upper part of cranium). One is at the moordhaa (vertex).

13) Classification of sandhi: Mainly the Sandhis are classified into two types

1) On the basis of Kriya (movements of joints)

2) on the basis of Rachana (Structure of joints)

1)on the basis of kriyaanusara (movements of joints)[19]

शाखास्वधोहनौ कट्यां चेष्टावन्तस्तु सन्धयः ।
ग्रीवायां बाहुचेष्टाश्च पृष्ठोरस्यल्पचेष्टकाः ।।
शेषास्तु सन्धयः सर्वे विज्ञेया हि स्थिरा बुधैः । (su.sha 5/25)

Chestavanta sandhi (Depending on Movement) The chestavanta means movable joints.

The Chestavanta sandhi are again classified into 2 types

a) Alpa Chesthavanta (slightly movable)

b) Bahu Chestavanta (freely movable) So the chestavanta sandhis usually present in shakha and hanu pradesha

.Alpa chala sandhi presents in the kati pradesha (intervertebral joint region). The sthira sandhi present in the shiras.

1) on the basis of Rachananusara(structure of joints)[20]

त एते सन्धयोऽष्टविधाः - कोरोलूखल- सामुद्ग- प्रतर- तुन्नसेवनी- वायसतुण्ड-मण्डल- शङ्खावर्ताः। (S.Saa.5.27)

On the basis of the structure totally eight types of sandhis explained as follows:

1. Kora sandhi: According to Harachandhra in commentary on Sushmille sombita, Kapat is taken for Nibandhana Special devise called Korce that is Kabja (hinge). The movement of Kapeil is considered as Kora. which moves in only one direction. Kora Sandhis are Seen In Anguli, manihandha (interphalangial) gulpha (Ankle joint); Janu (kneejoin & Kurpara (elbow joint).

2. Ulukhala: It resembles the shape of mortar i.e. a stone and grinder. These type of Sandhi look like motor & pestle of stone grinder were used in the Kitchen in olden days it is named as ulukhala by shape comparing with motor and pestle. The ulukhala variety of joints found at Kaksha (shoulder joint), Vankshana (hip joint) and Dashana.

3. Samudga: It resembles like a covered base fit into one another. Those joints are in Amsapeetha(Scapula),Guda(anal region),Bhaga(symphysis pubis) and Nitamba(buttcoks).

4. Pratara:this variety of joints are flat in nature and floating supported by cushion and friction is seen in between articular surfaces. These joints are in Greeva(neck) and Prusthavansha(vertebral column).

5. Tunnasevani: it resembles like suture, The articulating surfaces resembles dentate edges which are supported and sticked together or embedded into one another. Those joints in kapala asthi(skull) and kati(hip)

6. Vayasatunda: it resembles like a crows beak.Those joints are in the Hanu(mandible , temperomandibular joint).

7. Mandala: It resembles like circular or oval or round in nature. Those joints are in nadi of kantha(tracheal rings)

8. Shankhavarta: These are circular in nature resembles spiral shaped like snell of common snail. Those joints are in srotra (ear ossicles) and shrungataka (sinus).

Modern Review on Joints

Bones are rigid organs that constitute part of the endoskeleton of vertebrates. They support and protect the various organs of the body, produces red and white blood cells and store minerals. A joint or articulation (articulate surface) is the location at which bones connect. They are constructed to allow movement (except for skull bones) and provide mechanical support and they are classified structurally and functionally. Structurally to definehow bones connects to each other while functionally is to determine by the degree of movement between the articulating bones.

Definition: Joints are meeting places of bones.[21] Joint is a point of contact between bones and cartilage or bone and bone or between teeth and bones.[22]

CLASSIFICATION OF JOINTS

Basically the joints are classified both structurally and functionally…

1) Structural classification: structurally joints are classified into

a) Fibrous joints

b) Cartilaginous joints

sc) Synovial joints

a) **Fibrous joint** – Absence of synovial cavity in fibrous joint, If there is no synovial cavity and the bones are held together by fibro connective tissue.

Fibrous joints are sutures, syndesmosis and interosseous membranes.

Ex: suture of skull, teeth and jaw, interosseous between tibia and fibula and radius and ulna.

b) **Cartilaginous joint** -Like fibrous joint there is no synovial cavity and the bones are held together cartilages and allows little or no movements. The articulating bones are tightly connected by hyaline cartilage or fibrocartilage.

There are two types of fibrocartilaginous joints

a) primary cartilaginous joints
b) secondary cartilaginous joints

c**) Synovial joints**: Synovial joints have some specific characterstics features from other joints. The most unique characterstic feature of synovial joint is presence of space called synovial joint cavity between the articulating bones which allows the joints to move freely. A synovial joint joins bones or cartilage with a fibrous joint capsule that is continous with the periosteum of the joined the bones, constitutes the outer boundary of a synovial cavity and surrounds the bones articulating surfaces. This joint unites long bones and permits free bone movements and greater mobility. The synovial cavity/joint is filled with synovial fluid. The joint capsule is made up of an outer layer of fibrous membrane, which keeps the bones together structurally , and inner layer, the synovial membrane, which seals in the synovial fluid.

The bones at synovial joints are covered by hyaline cartilage layer called as articular cartilage. The cartilage covers the articulating surface of the bones with a smooth slippery surface but does not bind them together. Articular cartilage acts as a shock absorber and also reduce friction between bones during movements. All synovial joints are classified fuctionally as diarthrosis.[25]

Ex: shoulder joint, hip joint, knee joint..

Synovial fluid: The synovial membrane also known as secrets synovial fluid also known as synovia, which is viscous, clear or pale yellow in nature. The principal role of synovial fluid is to reduce friction between the carticular cartilage of synovial joints during movements. Synovial fluid is a small component of the transcellular fluid component of extracellular fluid.[26]

2) Functional classification : It is based upon the degree of mobility of the joints. They are of three types [27]

a) Synarthrosis (Immovable joints)

b) Amphiarthrosis (Slightly movable joints)

c) Diarthorsis (Freely movable joints

1) Synarthrosis (Immovable joints)

a) Sutures: These are immovable joints found only in between the bones of skull, articulating bones united by a thin layer of dense fibrous connective tissue.

Ex. Suture-Frontal suture 2 Gomphosis- Roots of teeth with sockets of the alveolar processes of the maxilla and mandible. 3. Synchondrosis-joint connects the epiphysis and diaphysis of growing bone.

b) Gomphosis: cone shaped peg fits into a socket where articulating bones united by periodontal.

Ex. Rootss of teeth (teeth socket)

c) Syndesmosis: Articulating bones united by dense fibrous connective tissue

2) Amphiarthrosis (slightly movable joints)

These are slightly movable joints. it is of 2 types.

a) Synchondrosis: are primary cartilaginous joint connecting material is hyaline cartilage.
Ex. Distal articulation between the tibia and fibula.
b) Symphysis: are secondary cartilaginous joint connecting material is broad, flat disc shaped of cartilage.
Ex. pubic symphysis and intervertebral disc.

2) Diarthrosis (Freely movable joints)

All synovial joints are diarthrosis are similar in structure, the shapes of the articulating surface vary, thus many types of movements are possible. Diarthrosis are classified as follows.

a) **Gliding joint (Arthrodial joint)** : The articualting surface of bones in a planar or flat or slightly curved. The gliding joints usually permits back and forth and side to side movements between the flat surface of bones.
Ex: Intercarpel and intertarsal joints

b) **Hinge joint (Ginglymus joints) :** The convex surface of one bone fits into the concave surface of another bone. As the name implies, hinge joints produces on angular opening and closing motion like that of hinged of door

Ex: knee, elbow, ankle and interphalenges joints.

Hinge joint between lower end of femurbone and upper end of tibia and also trochlea of humerus and troch of ulna at the elbow.

c) **Pivot joint :** the rounded or pointed surface of one bone articulates with ring formed partly by another by another bone and partly by ligament.

Ex: Atlas rotates around the dense of axis.

Pivot joint between head of radius and radial notch of ulna.

d) **Condyloid joint:** or ellipsiodal joint the convex oval shaped projection of one bone fits into the oval shaped depresssion of another bone.

Ex: Temporomandibular joint and metacarpophalangeal joint.

e) **Saddle joint:** the articular surface of one bone is saddle shaped and the articular surface of the other bone fits into saddle, as a sitting rider would sit.

Ex: the joint between trapezium of the carpal and metacarpal of thumb

f) **Ball and socket joint**- In this joint, Ball like surface of one bone fitted into a cup like depression of another bone.

Ex: shoulder and hip joints.

DISCUSSION

In ayurvedic classics Sandhis have been classified into eight types by taking account of shapes of Sandhis mainly movement of Sandhis has been considered where as in modern science the classification of Sandhis has been done by taking account of both structure and functions (movement).

Kora sandhi (Hinge Joint)

मणिबन्धगुल्फजानुकूपरेषु कोराः सन्धयः Su. Sh. 5/27)

Kora Sandhi is like Gatra (Pit). According to modern Anguli Sandhi (Interphalangeal Joint), Gulpha Sandhi (Ankle joint), Koorpara Sandhi (Elbow joint) are hinge variety of Synovial joint. This joint can be compared with hinge joint because the motion is similar to that of a hinged door.

In a hinge joint the convex surface of one bone fits into the concave surface of another one. Hinge joint includes the knee, elbow, ankle and interphalangeal joint. Movement is primarily in a single plane, and the joint is therefore known as monaxial or uniaxial.

Ulukhala sandhi (Ball and socket Joint)

कक्षावङ्क्षणदशनेषूलूखला (Su. Sh. 5/27)

A ball and socket joint consists of a ball-like surface of one bone fitted into a cup like depression of another bone. The only examples of ball and socket joints are the shoulder joint and up joint. Because head of the humerus (Which is ball-shape) is articulated with glenoid cavity of the scapula (which is cup- shape). Hip joint - joint formed by the head of femur (ball shape) and the acetabulum of the hip bone (cup-shape)

Their two joints are said to be triaxial because they permit movement in three planes.

1. Flexion-Extension

2. Abductions-Adduction

3. Rotation and circumfusion

Samudga sandhi (saddle joint)

अंसपीठगुदभगनितम्बेषु सामुद् गाः । (Su. Sh. 5/27)

These Sanshis have articulating ends which look like a Samputa (box) or an enclosed shell. Ansapeetha (Acromicroclavicular joint) and Nitamba (Sacroillac joint) are palne joints. Guda (Sacrococcygeal joint) and Bhaga (pubic Sympysis) are Secondary Cartilaginous joints.

In a saddle or sellaris joint, the articular surface of one bone is saddle-shaped and the articular surface of the other bone is shaped like the legs of a rider sitting in the saddle. The joint between the trapezium of the carpus and metacarpal of the thumb is an example of a saddle joint.

Movements at a saddle joint are side to side and back and forth

These saddle joints are biaxial and also permit circumduction. In circumduction, the thumb is moved in a circle.

The Pratara Sandhi (Gliding Joint)

ग्रीवापृष्ठवंशयोः प्रतराः । (Su, Sh. 5/27)

In ayurvedic classics has mentioned that these types of joints are formed from articulation of Samatala or falt part of slightly movable bony parts Greevvansha and Pruhthavansha are Intervertebral joints. The joints between the vertebral bodies is secondary cartilaginous joint.

The articulating surface of bones in a gliding joint are usually flat. A gliding movement is the simplest kind that can occur at a joint. Only side to side and back and forth movements are permitted.

The heads and tubercles of ribs glide on the bodies and transverse processes of vertebra. Also, the clavicle glides on the sternum and the scapula. Twisting and rotation are prevented at gliding joints.

Tunnasevani Sandhi (Suture)

शिरःकटीकपालेषु तुन्नसेवन्य: । (Su. Sh. 5/27)

A Suture is a fibrous joint composed of a thin layer of dense fibrous connective issue that unites bones of the skull. An example of a suture is the coronal suture between the frontal and parietal bones. The irregular, interlocking edges of sutures give them added strength and decrease their change of fractures.

Tunna Sevani is a suture type of joint. Shirokapala and Katikapala have sutural joints so sutures can be included in Tunnasevani sandhi.

Tunnasevani are present in cranium, flat bones and in the hipbone before pubis.

Vayusatunda Sandhi(Condylar joint)

हन्वोरुभयतस्तु वायसतुण्डा: 150, Sh. 5/27)

Where sandhi is like beak of crow is regarded as vyastunda Sandhi. Hanu Sandhi (Temo-romandhibular joint) is the condylar joint. So condylar joint can be included in Vayastunda sandhi.

Vayusatunda are the two mandibular joint. In a condyloid or ellipsoidal joint an oval shaped condyle of one bone fits into an elliptical cavity of another bone. The joint at the wrist between the radius and carpals condyloid.

The movement is biaxial (Flexion-extension, abduction - adduction)

Mandala sandhi's

कणठनेत्रहृदयक्लोमनाडीषु मण्डला: I (Su. Sh. 5/27)

Sushruta classified Sandhi into two types. Those which can be counted and are between the bones and another types of joints are counnt-less as these are the joints or junctions between Peshi (muscle), Snayu (tendons) Sira (vessels) Later type of junction is present in Kantha (larynx), Hrudaya (Heart), eyes and Kloma Nadi (trachea) as Sandhi In Netra joints between five Mandalas from six Sandhis.

Mandala sandhi's are present in trachea, heart,eyes .kloma and nadi. The shape of this sandhi just look like a conch-shell.

Shankhavarta

शोत्रश्रृङ्गाटकेषु शङ्खावर्ता: । (Su. Sh. 3/27)

Shankhavarta sandhis are present in cochlea and nose where sringataka marmas are situated.

Here the manning of Shankhavarta should be taken as irregular strcture . By Shankharvart Sandhi it sholud be consider a joint of irregular structures (or irregular form) The word Sandhi in Ayurvedic clasics do not focus on joints of bones only it may be joints between two cartilages or between two peshi (muscle) Snayu (tendon) and Sira (Vessels). Shrotra is mentioned in classics as a Shankha varta sandhi. So on going through the anatomy of the ear it is found that the joint of ear ossicles along with cohlea can be considered as Shankhavarta Sandhi in Shrotra.

CONCLUSION

As per various classical texts of Ayurveda the Sandhi is meeting menting point of two or more Asthis. Ayurveda and modern science both are same classification basis on the structural and function.Understanding the Joint diseases with this type of detailed study of Sandhi Shareera (anatomy and physiology) of joint from both ayurvedic and modern science is significantly resourceful. Kora Sandhi can be consi-dered as hinge joint, Ulukhala Sandhi may include ball and socket variety of synovial joint and gomphosis variety of fibrous joint. Ansa-peetha, Guda, Bhaga, Nitamba has Samudga Sandhi can be considered as acromioclavicular, sacrococcygeal, pubic symphysis, and sacroiliac joint respectively. In Pratara, Greeva and Prushtavansha may include intrevertebral joint. Sutures as Tunnasevani and Hanu in Vayasatunda may be taken a temperomandibular. Sankhavartha include Shrota and Shringa-taka can be correlated with cochlea and region of nasal conchae.

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