

**A COMPREHENSIVE STUDY OF SANDHI SHARIRA WITH SPECIAL REFERENCE TO
JANU SANDHI**¹**Dr. Rutuja S. Chavan,** ²**Dr. Premanand Bhalerao**¹MD (Sch) Sharir Rachana Faculty, PG Scholar., Dr GD Pol Foundation YMTAMC Kharghar Navi Mumbai.²PHD MD(Sharir Rachana), Associate Professor, Dr. GD Pol Foundation YMTAMC Kharghar Navi Mumbai.***Corresponding Author: Dr. Rutuja S. Chavan**

MD (sch) Sharir Rachana Faculty, PG Scholar., Dr GD Pol Foundation YMTAMC Kharghar Navi Mumbai.

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ABSTRACT

According to modern text joint is a place 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. Total two hundred and ten Sandhi are present in human body. Every bone is unite by joints and covered by muscles and gets blood supply by different Sira and Dhamani. These bones unite to form Asthi Sandhi. In Ayurveda the main Sthana of Kapha Dosha is all joints in human body. Janu Sandhi (knee) is the largest and most complex synovial joint of the body and is of great importance because it plays great role in movements like walking and stability, including maintenance of the erect posture and the transmission of the body weight. Sandhi can be taken as union of two or more bone in Ayurvedic Samhitas the description of anatomy of Sandhi in detail is not found. It is observed that the incidence of joints disorders is increasing day by day. It is burning problem for families and society. A thorough knowledge of the structures and functions of the joint is required to diagnose and treat the disease of joints.

INTRODUCTION

Ayurveda is one of the oldest systems of medicine, originating from the ancient Indian medical tradition. It is traditionally regarded as an Upaveda of the Atharvaveda. The classical Ayurvedic texts, including the Sushruta Samhita, Charaka Samhita, and Ashtanga Sangraha, emphasize the importance of Sharira Sthana in understanding human anatomy and supporting the diagnosis and management of diseases. Among these texts, the Sushruta Samhita provides a detailed description of the structure and organization of the human body.

The term Sandhi refers to a junction or union, particularly the articulation between bones. In Ayurveda, Sandhi plays an important role in connecting skeletal components and maintaining the structural integrity of the body. Shleshaka Kapha is described as being located in the joints, where it facilitates smooth movements and supports the functional integrity of the articulating surfaces. The term Sayoga is also associated with the concept of union or connection. The development of skeletal structures involves mesenchymal tissue, which

contributes to the formation and differentiation of various components of the musculoskeletal system. Different Ayurvedic Acharyas have described the number and classification of Sandhi in their respective texts. Acharya Sushruta classified Sandhi according to mobility into two categories: Cheshtavanta Sandhi, which permits movement, and Sthira Sandhi, which provides stability with little or no movement. Janu Sandhi (knee joint) belongs to the category of Cheshtavanta Sandhi and is essential for locomotion, weight-bearing, and maintaining postural stability. Therefore, the detailed study of Sandhi Sharira, with special reference to Janu Sandhi, is important for understanding its Ayurvedic principles and correlating them with modern anatomical knowledge.

The articulation of bones requires the support of various associated structures that connect the Asthi (bones), maintain joint integrity, provide stability, withstand weight-bearing forces, and facilitate movement (Gati). A comprehensive understanding of Sandhi Sharira is essential for studying the anatomical structure and functional characteristics of joints.

Sandhi plays a crucial role in locomotion and various bodily movements, including flexion, extension, abduction, and adduction, depending on the type and location of the joint.

Sandhiyo Ki Vividhata (Types of Sandhi)

The term Sandhi refers to the union or junction of anatomical structures within the human body. Based on the structures involved, different types of Sandhi can be described, such as Asthi Sandhi (articulation between bones), Sira Sandhi (junction of vessels), and Peshi Sandhi (association or junction of muscular structures). Among these, the classical Ayurvedic texts provide a more detailed description of Asthi Sandhi, including its classification, anatomical features, and functional significance.

Number of Sandhi

According to the classical Ayurvedic description of the joints of the human body, the total number of Sandhi is stated to be 210, distributed across the major anatomical regions as follows:

- Four limbs: 17 joints in each limb, accounting for a total of 68 joints ($17 \times 4 = 68$).
- Madhya Sharira (middle portion of the body): 59 joints.
- Shira and Griva (head and neck): 83 joints.

Total number of Sandhi = $68 + 59 + 83 = 210$.

Classification and Distribution of Sandhi According to Acharya Sushruta

Acharya Sushruta has described a total of 210 Sandhi (joints) in the human body, distributed among the limbs, trunk, head, and neck. The regional distribution is outlined below.

1. Sandhi of the Limbs (Shakha Sandhi)

The limbs contain 17 joints each, accounting for a total of 68 joints in all four limbs. Their distribution is as follows:

Anguli Sandhi (joints of the fingers and toes): $3 \times 4 = 12$
 Angushtha Sandhi (joints of the thumbs and great toes): 2
 Janu Sandhi (knee joint): 1

Gulpha Sandhi (ankle joint): 1

Vankshana Sandhi (hip joint): 1

Total: 17 joints per limb $\times$ 4 limbs = 68 Sandhi.

2. Koshtanga Sandhi (Joints of the Trunk)

The joints of the trunk account for 59 Sandhi, distributed as follows:

Katikapala/Shroni Sandhi (joints of the pelvis): 3
 Prishtavansha Sandhi (joints of the vertebral column): 24
 Parshva Sandhi (joints of the sides of the trunk): 24
 Uras Sandhi (joints of the chest): 8

Total: 59 Sandhi.

3. Urdhvajatru Sandhi (Joints of the Head and Neck)

According to the classical description, the head and neck region contains 83 Sandhi, distributed as follows:

Greeva Sandhi (joints of the neck): 8

Kantha Sandhi (joints of the throat): 3

Hridaya/Klomanadi Sandhi (as described in the classical enumeration): 18

Dantamula Sandhi (articulations associated with the roots of the teeth): 32

Kakalaka Sandhi: 1

Nasa Sandhi (nasal articulation): 1

Vartmamandala Sandhi (articulations of the orbital or eyelid region): 2

Ganda Sandhi (articulations of the cheek or maxillary region): 2

Karna and Shankha Sandhi (ear and temporal regions): 4

Hanu Sandhi, Bhru Sandhi, and Shankhopari Sandhi (mandibular, eyebrow, and supra-temporal regions): 6

Shirah Kapala Sandhi (cranial sutures): 5

Murdha Sandhi (joint associated with the crown of the head): 1

Total: 83 Sandhi.

Comparative Description in Ayurvedic Classics

The number of Sandhi varies among the classical Ayurvedic authorities. Acharya Charaka and Acharya Vagbhata describe 200 Sandhi, whereas Acharya Sushruta enumerates 210 Sandhi in the human body. These differences reflect variations in anatomical classification and enumeration among the classical texts.

Classification of Sandhi Based on the Range of Movements^[1]

According to the range of movement, Acharya Sushruta classifies Sandhi into two major categories: Cheshtavanta Sandhi and Sthira Sandhi.

1. Cheshtavanta Sandhi or Cheshta Yukta Sandhi (Movable Joints)

Cheshtavanta Sandhi refers to joints that permit movement between the articulating structures. These joints facilitate different types and ranges of movement, depending on their anatomical structure and functional requirements. They are primarily found in the Shakha (limbs), Hanu (mandible), and Kati (pelvic region).

Cheshtavanta Sandhi can be further classified into two subtypes

- a) Bahu-Cheshtayukta Sandhi: These joints permit a comparatively wide range of movements and facilitate various functional activities. Examples include the shoulder, elbow, and knee joints, as well as the temporomandibular joint of the mandible.
- b) Alpa-Cheshtayukta Sandhi: These joints allow only a limited range of movement compared with Bahu-Cheshtayukta Sandhi. The articulations of the Prishtavansha (vertebral column) are examples, as they permit restricted movements that collectively contribute to the flexibility of the spine.

2. Sthira Sandhi or Acheshta Sandhi (Immovable or Relatively Fixed Joints)

Sthira Sandhi refers to joints that provide structural stability and permit little or no movement. Their primary function is to maintain the integrity of the skeletal framework and provide support to the body. According to the classical Ayurvedic classification, joints that are not included under Cheshtavanta Sandhi are considered Sthira Sandhi.

This classification highlights the relationship between joint mobility and stability and provides a foundation for understanding the functional characteristics of Janu Sandhi (knee joint), which is categorized as a Cheshtavanta Sandhi.

Classification of Sandhi According to the Structure of Joints

Based on their structural characteristics, shape, and anatomical configuration, Sandhi are classified into eight types in Ayurvedic literature.^[2] The following types describe the morphological features of joints and their possible correlation with modern anatomical classifications.

1. Kora Sandhi (Hinge Joint or Ginglymus Joint)

Kora Sandhi is characterized by a hinge-like configuration that primarily permits movement in one plane, particularly flexion and extension. This arrangement provides directional mobility while maintaining stability during movement. Examples described in the Ayurvedic context include Anguli Sandhi (interphalangeal joints of the fingers and toes), Manibandha Sandhi (wrist region), Gulpha Sandhi (ankle joint), Janu Sandhi (knee joint), and Kurpara Sandhi (elbow joint). These joints are correlated with hinge-type articulations in modern anatomy, although the wrist joint permits movements that are more complex than those of a typical hinge joint.^[3]

2. Ulukhala Sandhi (Ball-and-Socket Joint)

Ulukhala Sandhi derives its name from its resemblance to a traditional mortar and pestle or grinding apparatus used in earlier times. In this type of articulation, a rounded articular surface fits into a corresponding socket, allowing movement in multiple directions. The Ayurvedic descriptions associate this type of Sandhi with the Kaksha (shoulder region), Vankshana (hip region), and Dashana (tooth-related region).^[4] The shoulder and hip joints are commonly correlated with ball-and-socket joints in modern anatomy.

3. Samudga Sandhi (Saddle-Type Joint)

Samudga Sandhi is described as having an arrangement resembling a box, receptacle, or bowl-like structure. Its articular surfaces are understood to have complementary shapes that facilitate movement while providing stability. Classical descriptions associate this type of joint with the Amsapeetha (scapular region), Guda (anal or coccygeal region, according to the cited interpretation), and

Nitamba (iliac or pelvic region).^[5] Its precise correlation with modern joint classifications requires reference to the original Ayurvedic text and commentary.

4. Pratara Sandhi (Gliding or Plane Joint)

Pratara Sandhi refers to articulations in which relatively flat or slightly curved surfaces of adjacent bones come into contact and permit limited gliding movements. These joints contribute to flexibility and coordinated movement while maintaining structural stability. Examples are described in relation to the Greeva Vamsha (cervical vertebral region) and Prishtha Vamsha (thoracic vertebral region), particularly the articulations between adjacent vertebrae.^[6] This type is broadly comparable to plane or gliding joints in modern anatomy.

5. Tunna-Sevani Sandhi (Sutural Joint)

Tunna-Sevani Sandhi describes a type of articulation in which two bones are joined closely along interlocking or seam-like margins, resembling stitches used to unite two pieces of material. These articulations provide firm structural connections and allow little or no movement. Examples include the Shirah Kapala Sandhi (cranial sutures) and the articulations described in relation to the Kati Kapala (pelvic bones).^[7] Cranial sutures are directly comparable to fibrous sutural joints in modern anatomy.

6. Vayasa-Tunda Sandhi (Condylod Joint)

Vayasa-Tunda Sandhi is described as a joint whose shape resembles the beak of a crow, from which it derives its name. In Ayurvedic literature, this type of articulation is associated with Hanu Sandhi (temporomandibular joint). The structural features of this joint have been compared with condylod or condylar articulations in modern anatomy.^[8] However, the temporomandibular joint has a complex structure and is more appropriately classified as a modified hinge or ginglymoarthrodial joint in modern anatomical terminology.

7. Mandala Sandhi (Annular Joint)

Mandala Sandhi is described as having a circular or ring-like configuration. According to the cited Ayurvedic description, this type of Sandhi is associated with structures in the Kantha (throat), Hridaya (heart), Netra (eye), and Klomanadi (tracheal region).^[9] These articulations are traditionally described as relatively fixed in nature and associated with cartilaginous structures. Their precise correlation with modern anatomical joint classifications requires careful interpretation of the original Ayurvedic reference.

8. Shankhavarta Sandhi (Conch-Shaped or Spiral Joint)

Shankhavarta Sandhi is characterized by a configuration resembling the spiral coils of a conch shell. Classical descriptions associate this type of Sandhi with the Srotas (ear region) and Shringataka region. It has been interpreted in relation to certain fixed, membranous, or cartilaginous articulations.^[10]

In modern anatomy, cartilaginous joints are broadly classified into two categories. Synchondroses are joints in which bones are connected by hyaline cartilage; many are temporary and gradually ossify during growth. A common example is the epiphyseal plate of a growing long bone, which typically closes after skeletal maturity. Symphyses, in contrast, are joints in which bones are united by fibrocartilage and generally persist throughout adulthood. The pubic symphysis and intervertebral discs are common examples.

These comparisons provide a framework for exploring similarities between Ayurvedic descriptions of Sandhi Sharira and contemporary anatomical concepts. Nevertheless, the proposed correlations should be interpreted cautiously because the classical categories do not always correspond directly to modern structural classifications.

Arthrology

Arthrology is the branch of anatomy concerned with the study of joints and articulations, including their structure, functions, movements, disorders, and clinical management. The prefix arthro- is derived from the Greek word arthron, meaning joint. Joints are classified according to their structural characteristics and the degree of movement they permit.

Structural Classification of Joints

The structural classification of joints is based primarily on two criteria

The presence or absence of a space between the articulating bones, known as the synovial cavity.

The type of connective tissue that holds the articulating bones together.

Based on these characteristics, joints are classified into three major categories

a. Fibrous Joints: In fibrous joints, the articulating bones are connected by dense fibrous connective tissue rich in collagen fibres. A synovial cavity is absent, and these joints generally permit little or no movement. Examples include the sutures of the skull and the distal tibiofibular syndesmosis.

b. Cartilaginous Joints: In these joints, the articulating bones are connected by cartilage, and a synovial cavity is absent. Depending on their structure, they may permit limited movement or remain relatively immobile. Examples include the pubic symphysis and the epiphyseal plate of a growing long bone.

c. Synovial Joints: Synovial joints are characterized by the presence of a joint cavity between the articulating surfaces. The bones are enclosed within an articular capsule consisting of an outer fibrous layer and an inner synovial membrane. Accessory ligaments may provide additional support and stability. These joints permit a wide range of movements, depending on their shape and anatomical arrangement.

Functional Classification of Joints

Functionally, joints are classified according to the degree of movement they permit. Synarthrosis: An essentially immovable joint. The plural form is synarthroses. Amphiarthrosis: A slightly movable joint. The plural form is amphiarthroses.

Diarthrosis: A freely movable joint. The plural form is diarthroses. These joints generally correspond to synovial joints and permit movements ranging from gliding to extensive angular and rotational movements.

Characteristic Features and Types of Joints

1. Complex Joint

A complex joint is one in which an intra-articular disc or meniscus made of fibrocartilage divides the joint cavity into two compartments, either completely or incompletely. The knee joint is an example because its medial and lateral menisci partially divide the joint cavity and improve the congruity between the femoral and tibial articular surfaces.

2. Synovial Joint

Synovial joints possess distinctive structural features that facilitate movement while maintaining stability.

a. The articulating surfaces of the bones are covered by articular cartilage, which is usually hyaline cartilage. The surfaces are not directly connected to each other, allowing movement between them.

b. A joint cavity separates the articulating surfaces. Under normal physiological conditions, this is a potential space containing a small quantity of synovial fluid.

c. The joint is enclosed by an articular capsule consisting of an outer fibrous capsule and an inner synovial membrane.

d. The synovial membrane lines the internal surface of the capsule, except over the articular cartilage. It produces synovial fluid, which lubricates the joint, reduces friction, and supplies nutrients to the avascular articular cartilage.

e. Synovial joints permit different types of movement, including gliding, flexion, extension, abduction, adduction, and rotation, depending on their anatomical configuration.

3. Compound Joint

A compound joint is one in which more than two bones participate in the articulation. The knee joint is an example because the femur, tibia, and patella contribute to its articular arrangement. The femorotibial and patellofemoral articulations together form the knee joint complex.

4. Condylloid Joint

Condylloid joints are characterized by an oval or ellipsoidal convex articular surface that fits into a corresponding concave surface. They generally permit movement around two axes, including flexion, extension, abduction, and adduction. Circumduction may also occur through the combination of these movements. A typical example is the radiocarpal joint of the wrist.

5. Saddle Joint

In saddle joints, the opposing articular surfaces are reciprocally concave and convex, resembling a saddle. These joints generally permit movement around two axes, including flexion, extension, abduction, and adduction. A limited component of rotation may accompany certain movements. The first carpometacarpal joint of the thumb is a typical example.

6. Hinge Joint

Hinge joints primarily permit movement around a single transverse axis, allowing flexion and extension, similar to the movement of a door on its hinges. Typical examples include the interphalangeal joints and the humeroulnar articulation of the elbow.

The knee joint is classified as a modified hinge joint because, in addition to flexion and extension, it permits a limited degree of medial and lateral rotation when flexed. Small accessory movements also occur due to the complex arrangement of its articular surfaces, ligaments, menisci, and surrounding muscles. These features enable the knee to combine mobility with the stability required for weight-bearing and locomotion.

Janu Sandhi Sharira

1. Nirukti (Etymology)

The term Janu refers to the knee, an important anatomical region of the lower extremity involved in locomotion and movement. The word Sandhi denotes a junction or union between anatomical structures and is associated with the concept of joining, connecting, and binding. Thus, Janu Sandhi refers to the articulation located in the knee region, which enables movement and provides support to the body.

2. Sandhi Lakshana (Definition of Sandhi)

In Ayurveda, Sandhi refers to the junction between bones (Asthi). It serves as a connecting structure that maintains the continuity and integrity of different parts of the body. Sandhi is also considered a site of Shleshaka Kapha, which facilitates smooth joint movements and helps maintain the functional relationship between the articulating surfaces.

3. Sankhya (Number)

There are two Janu Sandhi in the human body, one situated in each lower extremity. These joints play an essential role in weight-bearing, maintaining posture, and facilitating locomotion.^[11]

4. Prakara (Classification)

According to Ayurvedic classification, Janu Sandhi is categorized as Kora Sandhi, traditionally correlated with a hinge-type joint. This category is described in relation to the joints of the fingers, wrist, ankle, knee, and elbow.

Janu Sandhi is also classified as Cheshtavanta Sandhi, which refers to movable joints. These joints are present in the extremities and other regions, such as the jaw and

waist, where mobility is necessary for performing various bodily functions.^[12] In modern anatomy, the knee is classified as a modified synovial hinge joint because it primarily permits flexion and extension, along with limited rotation when flexed.

5. Pramana (Measurement)

According to the description attributed to Acharya Charaka, the length of Janu is four Angula, while its circumference measures sixteen Angula.^[13] Angula is a traditional unit of measurement based on the breadth of a finger and is used in Ayurvedic literature to describe body dimensions.

6. Sandhi Rachana (Anatomical Structure)

The formation of a functional Sandhi involves more than the articulation of two or more Asthi (bones). Several associated structures are necessary to connect the bones, maintain joint stability, withstand weight-bearing forces, and facilitate movement (Gati).

According to the classical Ayurvedic description, fourteen Sanghata (assemblages or unions of bones) are recognized in the body. Among these, three are described in relation to the ankle, knee, and inguinal regions, with corresponding structures present in the opposite lower limb and the upper extremities.^[14]

The principal structures associated with the formation and functioning of Sandhi are as follows:

1. Asthi
2. Snayu
3. Shleshmadhara Kala
4. Shleshma (Shleshaka Kapha)
5. Peshi
6. Sira
7. Dhamani

Structures Involved in the Formation of Janu Sandhi

1. Asthi (Bones)

Asthi is one of the principal structural components involved in the formation of Sandhi. The bones associated with the formation of Janu Sandhi are described as follows:

Janghasthi – bone of the leg, corresponding primarily to the tibia in the modern anatomical context.

Janvasthi – bone associated with the knee region.

Urvasthi – bone of the thigh, corresponding to the femur.

Acharya Charaka has separately described Janu Asthi and Janu Kapalika Asthi. According to this interpretation, four bony components are associated with the knee region, including Janu Kapalika. The principal function of Asthi is Dharana, which refers to supporting and maintaining the structural framework of the body.

2. Snayu (Ligamentous Structures)

Snayu refers to the supporting structures that bind and stabilize Asthi (bones), Mamsa (muscles), and Meda (adipose tissue). Acharya Sushruta compares the role of

Snayu to ropes that securely bind the planks of a boat, enabling it to carry the weight of passengers safely across a river. Similarly, ligaments and related supporting structures maintain the integrity of joints and enable the body to withstand weight-bearing forces.^[15]

Among the different varieties of Snayu, Pratanavati Snayu, characterized by a branched arrangement, is described in association with joints. According to the cited Ayurvedic reference, ten Snayu are present in the knee region.^[16] These structures contribute to joint stability and help maintain the proper relationship between the articulating bones.

3. Shleshmadhara Kala

Shleshmadhara Kala is described as the fourth Kala in Ayurvedic literature and is considered to be present in the joints of living beings. It is associated with the retention and functioning of Shleshma within the joints. Its role in facilitating smooth joint movements is explained through the analogy of a well-lubricated wheel axle, which allows the wheel to rotate freely with minimal friction. Similarly, the proper functioning of joints is associated with the action of Kapha, which supports smooth and coordinated movement.^[17,18]

4. Shleshma (Shleshaka Kapha)

The Kapha located within the joints is known as Shleshaka Kapha. According to Ayurvedic principles, it lubricates the articulating surfaces, reduces friction, and facilitates the smooth movement of Sandhi. It also contributes to joint stability and functional integrity.

Shleshaka Kapha is therefore considered important for maintaining the proper functioning of Janu Sandhi. Its traditional description can be discussed alongside the lubricating role of synovial fluid in modern anatomy, although the two concepts are not exactly equivalent.

Together with the bones, supporting tissues, and muscles, these components contribute to joint mobility, stability, and load-bearing capacity.

5. Peshi (Muscles)

Peshi refers to the muscular structures that surround and support different anatomical components, including Sira, Snayu, Asthi, Parva, and Sandhi. Muscles provide strength to the joints and assist in maintaining their stability during movement and weight-bearing activities.

The muscles surrounding a joint also protect underlying structures and contribute to coordinated movement. According to the cited Ayurvedic description, five Peshi are present in the knee region. These muscles may be correlated broadly with the muscular support of Janu Sandhi, which is essential for walking, standing, and other lower-limb activities.

6. Sira (Vascular Structures)

In Ayurveda, different types of Sira are described according to their functions and the substances they carry.

Kaphavaha Sira: These are described as channels carrying Kapha and are associated with maintaining the unctuousness, firmness, and strength of the joints.

Raktavaha Sira: These channels carry Rakta and are associated with tissue nourishment, complexion, and the perception of touch.

Asthivaha Sira: These are described in relation to the nourishment and maintenance of Asthi Dhatu.

These descriptions emphasize the importance of tissue nourishment and structural maintenance. In modern anatomical terms, blood vessels supply oxygen and nutrients to the tissues surrounding the knee, including the synovial membrane, joint capsule, ligaments, and adjacent bones. Articular cartilage itself is avascular and receives nutrients primarily through diffusion from synovial fluid.

7. Dhamani (Channels)

According to Ayurvedic descriptions, Adhogata Dhamani are associated with the distribution and maintenance of Vata, Pitta, Kapha, Rakta, and Rasa throughout the lower regions of the body. These regions include structures below the umbilicus, such as the Pakwashaya (large-intestinal region), Kati (pelvic or lower-back region), urinary bladder, anus, genital organs, and lower extremities, including the knee joint.

These descriptions highlight the traditional understanding of the role of Dhamani in maintaining bodily functions and supporting the tissues of the lower limbs. In modern anatomy, the arterial supply to the knee is provided through a network of vessels, including branches of the popliteal artery and the genicular anastomosis, which help maintain blood circulation around the joint.

DISCUSSION

The concept of Sandhi Sharira is described in detail in the classical Ayurvedic texts. Acharya Sushruta has enumerated 210 Sandhi, whereas Acharya Charaka and Acharya Vagbhata have described 200 Sandhi each. In contemporary anatomy, the total number of joints in the human body varies according to age and the criteria used for defining and classifying a joint. During growth and skeletal maturation, certain cartilaginous joints undergo ossification, resulting in changes in the number of distinct articulations. The classification of joints in Ayurveda is primarily based on their structural characteristics, mobility, and functional significance, providing a foundation for comparison with modern anatomical concepts.

The anatomical features of Janu Sandhi described in Ayurveda can be correlated with contemporary

anatomical knowledge to a certain extent, as discussed below.

1. Correlation of Kora Sandhi with Modern Joint Classification

According to Ayurvedic literature, Janu Sandhi is classified as Kora Sandhi. This category is traditionally associated with joints that permit a comparatively restricted range of movement. Examples include the interphalangeal joints, wrist, ankle, knee, and elbow. In modern anatomy, the knee is classified as a modified hinge-type synovial joint, primarily permitting flexion and extension, with limited rotation when flexed. The concept of Kora Sandhi may therefore be compared broadly with certain hinge-type articulations. However, it does not correspond precisely to all hinge, ellipsoid, saddle, or condyloid joints, as these modern categories differ in their articular structures and ranges of movement. Unlike ball-and-socket joints, which permit movement around multiple axes, the knee has a predominantly uniaxial movement pattern with additional accessory movements.

2. Correlation of Cheshtavanta Sandhi with Movable Joints

Acharya Sushruta classified Cheshtavanta Sandhi as joints that permit movement and are found in the extremities and other mobile regions of the body. Janu Sandhi falls under this category because it facilitates flexion, extension, and limited rotational movements. In modern anatomy, the knee is a freely movable synovial joint that plays an essential role in locomotion, weight-bearing, and postural stability. Thus, the concept of Cheshtavanta Sandhi can be correlated functionally with movable joints, particularly synovial joints.

3. Correlation of Janu Asthi and Janu Kapalika Asthi

Acharya Charaka has described Janu Asthi and Janu Kapalika Asthi separately in the knee region. The term Kapala refers to a plate-like or shell-like structure. Based on the description of Kapala-type bones in the Janu region, Janu Kapalika Asthi has been interpreted as corresponding to the patella, a sesamoid bone located within the quadriceps femoris tendon. The patella protects the anterior aspect of the knee and improves the mechanical efficiency of the extensor mechanism. This proposed correlation provides a basis for examining similarities between classical Ayurvedic descriptions of the knee and contemporary osteology.

4. Correlation of Snayu with Ligaments

According to the cited Ayurvedic description, ten Snayu are present in Janu Sandhi. Snayu are described as structures that bind and stabilize the bones and other tissues. In modern anatomy, the knee joint is supported by several ligaments, including the anterior and posterior cruciate ligaments, medial and lateral collateral ligaments, patellar ligament, and other capsular and supporting ligaments. Depending on the method of

enumeration, approximately twelve ligamentous structures may be identified when smaller ligaments are included. This numerical comparison suggests a possible functional similarity between the Ayurvedic concept of Snayu and the ligamentous support of the knee, although the two classifications are not directly equivalent.

5. Correlation of Peshi with Muscles

Ayurvedic literature describes five Peshi in the knee region. Peshi provide strength and support to the joint and facilitate movement. In modern anatomy, several muscles contribute to knee movement and stability. These include the gastrocnemius, sartorius, semitendinosus, semimembranosus, and plantaris muscles, which are associated with the knee region. Other important muscles, such as the quadriceps femoris, biceps femoris, gracilis, and popliteus, also contribute to knee function through their muscular or tendinous attachments. Some tendon-like structures may be discussed in relation to the Ayurvedic concept of Kandara. However, the five Peshi should not be assumed to correspond exactly to these five modern muscles without further textual and anatomical evidence.

6. Correlation of Shleshmadhara Kala with the Synovial Membrane

Shleshmadhara Kala is described in Ayurveda as a membrane associated with the joints and the maintenance of Shleshma. Its role in facilitating smooth joint movements may be compared functionally with that of the synovial membrane in modern anatomy. The synovial membrane lines the inner surface of the joint capsule, except over the articular cartilage, and produces synovial fluid. This fluid lubricates the articulating surfaces and supports the physiological environment necessary for normal joint function. Nevertheless, Shleshmadhara Kala and the synovial membrane represent concepts from different anatomical frameworks and should be regarded as a functional comparison rather than an exact structural equivalence.

7. Correlation of Shleshma (Shleshaka Kapha) with Synovial Fluid

According to Ayurvedic principles, Shleshaka Kapha is located within the joints and contributes to lubrication, smooth movement, and maintenance of joint integrity. The classical analogy of a wheel moving smoothly when its axle is properly lubricated illustrates this function. In contemporary anatomy, synovial fluid reduces friction between articular surfaces, assists in distributing loads, and provides nutrients to the avascular articular cartilage. It also contributes to the maintenance of a suitable environment within the joint cavity. Therefore, Shleshaka Kapha may be compared functionally with the lubricating and supportive roles of synovial fluid, although the two are not identical concepts.

8. Correlation of Sira and Dhamani with Neurovascular Structures

Ayurvedic texts describe different types of Sira, including Kaphavaha, Raktavaha, and Vataavaha Sira, as well as Adhogata Dhamani, in relation to the nourishment and maintenance of body tissues. Their descriptions may be examined alongside the vascular and neural structures supplying the knee region. In modern anatomy, the knee receives its arterial supply primarily through branches of the popliteal artery, including the genicular arteries, while venous drainage occurs through accompanying veins and communicating vessels. The joint and surrounding tissues also receive sensory and motor innervation from branches of the femoral, tibial, common fibular, and obturator nerves. These structures contribute to tissue nourishment, sensation, proprioception, and coordinated movement. However, Ayurvedic Sira and Dhamani cannot be directly equated with individual arteries, veins, or nerves without specific textual evidence.

CONCLUSION

The Ayurvedic description of Sandhi Sharira demonstrates several functional and structural similarities to the anatomical understanding of joints in modern science. Janu Sandhi, or the knee joint, can be correlated with Kora Sandhi, which broadly resembles a hinge-type joint. Shleshmadhara Kala may be functionally compared with the synovial membrane, while Shleshma, particularly Shleshaka Kapha, may be compared with synovial fluid due to its role in facilitating smooth joint movements. Similarly, Adhogata Dhamani, Kaphavaha Sira, Raktavaha Sira, and Vata-vaha Sira may be understood through their functional associations with the vascular supply, venous drainage, and neural structures of the knee region, although these correlations are not exact anatomical equivalents.

The present study aims to interpret classical Ayurvedic concepts in the context of contemporary anatomical knowledge while preserving their fundamental principles and traditional significance. A comprehensive understanding of Sandhi Sharira, particularly Janu Sandhi, is essential for understanding the structural and functional changes that occur in joint disorders and deformities. Thus, this study brings together the Ayurvedic and modern anatomical perspectives to develop a clearer and more clinically relevant understanding of joint anatomy.

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