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STRUCTURAL EVALUATION OF JANU SANDHI ACCORDING TO AYURVEDA AND MODERN TEXTS

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ABSTRACT

Ayurveda is the treasure of knowledge which was developed and discovered by our great ancestors. To understand and to properly execute this knowledge we must have the knowledge of Sharira. In *ayurvedic* classics to understand the proper structure of *sharir*, whole body divided into six major parts known as *shadanga sharir*.[6],[7] Means parts of *shadanga sharir* is four *shakha* i.e two *bahu* and two *sakthi*, *antaradhi* (trunk) and *shir* (head). The extremities are meant to perform physical activities and take part in locomotion. The joining part of *jangha* and *uru (parts of adhosakha)* is known as *janu sandhi*. *Janu sandhi* is one of the important *sandhi* amongst them and also *vaikalyakar marma* and *sandhi marma*.[8] When this *janu marma* get injured it leads to *khanjata*.[9] *Ayurveda* also described the different structures present in *janu sandhi* like *peshi*, *kala*, *snayu*, *ashthi* etc. with their functions. *Acharya Susruta* told 5 *peshi* present in janu sandhi.[12] The aim of this article is to evaluate the *janu sandhi* and its related structures in terms of modern science.

KEYWORDS:- *Janu Sandhi, Peshi, Kala, Snayu, Asthi, Janu Marma* etc.

INTRODUCTION

Ayurveda is a science of life with holistic approach to health and personalized medicine. It is

one of the oldest medical systems, which comprises thousands of medical concepts and hypothesis. In *ayurveda* the *sharir* is given prime importance. According to *Sushrut* this complete knowledge about *sharir* at all times is very much essential for a physician as well as a surgeon in order to provide a healthy life for mankind. *Sharir rachana* is fundamental division of ayurveda which is essential for treatment. Although *ayurveda* is very much old by the time frame, it's principles are applicable today as like it's earliest era. Our life is evolved on the 'art of locomotion'. Locomotion/ movements are only possible due to our joints, in *ayuverda* these are called *asthi sandhis*. *Acharya susruta* in *sharir sthan* explained about the *asthi sandhi* (total no. 210) and their function of *sandhan* in *anga* and *sandhi.* In *ayurvedic* classics to understand the proper structure of *sharir*, whole body divided into six major parts known as *shadanga sharir*.[6],[7]

Means parts of *shadanga sharir* is four *shakha* i.e two *bahu* and two *sakthi*, *antaradhi* (trunk) and *shir* (head). The extremities are meant to perform physical activities and take part in locomotion.

The joining part of *jangha* and *uru (parts of adhosakha)* is known as *janu sandhi*. *Janu sandhi* or knee joint is the most important joint in body and this joint archives large range of movement required to daily work. If this sandhi gets affected, our regular work also gets affected. The knee joint is the largest, most complex and weight bearing joint in the body. It is a hinge joint that connects the rounded bony ends (condyles) of the femur, tibia and bounded in front by the patella. *Ayurveda* also described the different structures present in *janu sandhi* like *peshi, kala, snayu, ashthi* etc. with their functions. *Acharya Susruta* told 5 *peshi* present in janu sandhi.[12]

Various ligaments, muscles and tendons help to confine joint motion with in safe limits, while the menisci and cartilage cushion the joint against considering force that bears on the knee.

AIM AND OBJECTIVES

To study about the structures of *janu sandhi* according to *ayurveda* and it's co-relation with modern texts.

Review of literature

1. Nirukti of *sandhi*

The word *Sandhi* is derived from the *mula `Du`-Dha-Jn'* with `*Sama*' prefix which is used in meaning of `*Dharana*' and '*Poshana*'.

Definition of *sandhi*

According to *Acharya Dalhana* '*Asthi Samyoga Sthanam'* the union of two or more bone is called as '*Sandhi'*.

Classification of *sandhi*

- *Sankhya Sharira:*

1. *Sushruta* and *Vagbhata* – 210 *Sandhi*
2. *Charak* -200 *Sandhi*

- Distrubution of *Sandhi*:

1. *Shakha* – 68
2. *Kostha*-59
3. *Urdhva Jatru*-83

Sushruta has mainly classified the *sandhi* into two *chashtavanta* and *sthira*. *shakha, hanu, kati* are *cheshtavanta* while others are *sthira*.

The structure which is present between the sakthi (thigh) and the jangha (leg) is referred as janu, which is supposed to be the knee.

- Praman - 4 Anguli
- Approximately 3- 4.5 cms

- **Relations of *janu sandhi***

1. No. of *sandhis* present at *jaanu* – 1

As per *susruta* in *gulph, janu, vankshan* 1 join is present.

2. No. of *asthis* present at *jaanu*- 1

As per *sushruta* in *janu* 1 *asthi* is present.

3. Number of *snayu* present at *jaanu*-

As per *sushruta* – 10 *snayu* are present at *janu*.

4. No. of *peshee* present at *jaanu*-

As per *sushruta* – 5 *peshee* are present at *janu*.

5. *Seemanta* present at *jaanu*

As per *sushruta* and *bhava prakash* - 14 in no. and places are same as *sanghata*.

6. *Sanghata* present at *jaanu*

Total 14 in no., in lower extremity 3 – at *gulph*, *janu* and *vankshan* as per *sushruta*, *sarangadhar* and *bhoj*.

MATERIALS AND METHODS

1) Type of study:- It is an Observational study.

2) Study design

a) Literature study of janu Sandhi and Knee joint

↓

Structural comparative study with ayurvedic texts & modern science

↓

Dissection of knee joint and evaluation

❖ MATERIALS

Specification of instruments & related measurements:

- Knee region of cadaver
- Scalpel blade with handle
- Surgical scissor
- Plain and tooth forceps
- Retractor
- Camera
- Gloves
- Mask

❖ METHOD: Conceptual study

- Considering the aim of literary study of *Janu sandhi*, refrences are collected from various *Ayurvedic samhitas* including *bruhtrayi* and *laghutrayis* and their concerned commentaries.
- References of knee joint are collected from modern literatures.

OBSERVATION

Knee joint

Dissection was carried out by cutting the knee region above at the level of lower 1/3rd of thigh and below at upper 1/3rd of the leg.

Back of the knee (Popliteal region)

- A vertical incision is taken posteriorly joining the midpoints of Upper and Lower borders of the part taken for dissection.
- Skin was reflected on either Side and Superfacial fascia was removed.

❖ **Structures seen under superficial fascia**

1) Veins

a) Short saphenous vein

b) Long saphenous vein- posteromedially

2) Cutaneous nerves

a) Branches of terminal part of posterior cutaneous nerve of thigh.

b) Posterior division of medial cutaneous nerve of thigh.

c) Peroneal or sural communicating nerve.

Boundaries of the fossa

- The deep fascia over the fossa was cut along the Bicep femoris i.e. superolaterally.
- A similar incision was made over superomedial side i.e. along the Semitendinosus and Semimembranosus.
- The muscles were identified and they were followed upto insertion.
- The Gracilis and Sartorius muscles were found on superomedial aspect and their tendons were traced upto insertion.
- The deep fascia from the posterior surface of the fossa was striped and fat in the fossa was removed to visualize its contents.
- Fascia from the heads of the Gastrocnemius was removed to expose the inferomedial and inferolateral boundaries and the plantaris muscle was separated from posteromedial surface of lateral head.

Structures seen after cutting deep fascia

Structures forming boundaries of popliteal fossa are,

- Superolaterally- Biceps femoris
- Superomedially- Semitendinosus and semimembranosus supplemented by Gracilis, Sartorius and adductor magnus
- Inferolaterally- Lateral head of Gastrocnemius supplemented by plantaris
- Inferomedially- medial head of Gastrocnemius

Contents seen in the popliteal fossa

1) Popliteal artery and its branches
2) Popliteal vein and its tributaries
3) Tibial nerve and its branches
4) Common Peroneal nerve and its branches
5) Posterior cutaneous nerve of thigh
6) The Genicular branch of obturator nerve
7) Popliteal lymph nodes
8) Fat

Bursae found at popliteal region

1) Bursa deep to lateral head of gastrocnemius.
2) Bursa deep to biceps femoris (between biceps femoris and fibular collateral ligament).
3) Bursa deep to medial head of Gastrocnemius.
4) Bursa between semitendinosus and semimembranosus.
5) Bursa deep to semimembranosus
6) Anserine bursa which separates the tendons of Sartorius, Gracilis and semitendinosus from one another and from tibial collateral ligament.

❖ Contents of the fossa were removed. The floor of the fossa was observed to be formed from following structures (from above downwards),

1) Popliteal surface of femur
2) Capsule of knee joint and the oblique popliteal ligament
3) The strong popliteal fascia covering the popliteal muscle

Knee joint

❖ Skin from front of the knee is removed.

Structures seen under skin

Patellar plexus

It is a plexus of fine nerves situated infront of the patella, the ligamentum patellae and the upper end of the tibia. It is formed by contributions from-

1) Anterior division of lateral cutaneous nerve.
2) Intermediate cutaneous nerve.
3) Anterior division of medial cutaneous nerve.
4) Infrapatellar branch of saphenous nerve.

Bursae

1) Subcutaneous suprapatellar
2) Subcutaneous infrapatellar

❖ The deep fascia was removed from front of the knee,

The structures seen after removing deep fascia are,

1) Quadriceps tendon enclosing the patella.
2) Ligamentum patellae attached to tibial tuberosity.

❖ The structures surrounding the knee joint are removed; leaving behind the fibrous capsule, collateral ligaments and part of the muscles or their tendons so that their connection with ligaments may be seen.

It was observed that the joint capsule is deficient anteriorly and strengthened by medial and lateral patellar retinacula.

❖ The quadriceps tendon was cut across; immediately proximal to the ends of patella, the ends of this incision were carried downwards to the tibial condyles passing 2-3 cm on either side of the ligamentum patellae.

❖ After turning the patella downwards the cavity of the knee joint was exposed.

Structures seen after turning the patella downwards

1. Suprapatellar bursa extending deep to the quadriceps tendon.
2. Deep infrapatellar bursa.
3. Infrapatellar pad of fat.
4. Infrapatellar synovial fold extending backwards from pad of fat to the intercondylar fossa of femur.
5. Alar folds: diverging on each side from the median fold to reach the lateral edges of the

patella.

6. Anterior cruciate ligaments.

❖ The Tendons and Muscles on the lateral and medial side of knee joint are retracted.

Structures seen on the lateral side of knee joint

1) Biceps femoris muscle
2) Fibular collateral deep to biceps tendon
3) Inferior lateral genicular vessels and nerves
4) Tendon of origine of Popliteus
5) Bursa between the fibular collateral ligament and tendon of popliteus.
6) Bursa between tendon of popliteus and lateral condyle of tibia.

Structures seen on medial side of knee joint

1) Tendons of Sartorius, Gracilis and semitendinosus.
2) Semimembranosus and inferior medial genicular nerves and vessels
3) Great saphenous vein with saphenous nerve and vessels
4) Tibial collateral ligament
5) A bursa deep to tibial collateral ligament

Structures on the posterior of the knee joint

1) Oblique popliteal ligament
2) Arcuate popliteal ligament
3) Middle genicular artery and nerve

❖ Posterior part of the capsule was removed,

Structures seen after removing fibrous capsule on posterior part

1) Anterior cruciate ligament
2) Posterior cruciate ligament

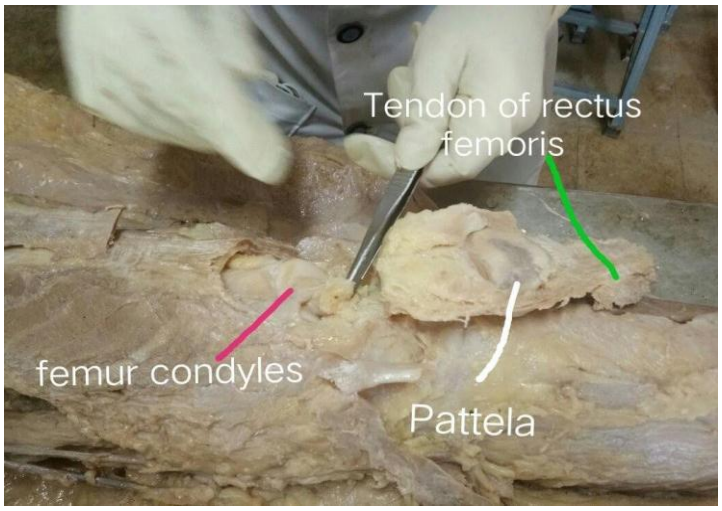
❖ The remains of fibrous capsule, fibular collateral ligament and the cruciate ligaments were cut.

Structures seen on the superior surface of upper end of tibia

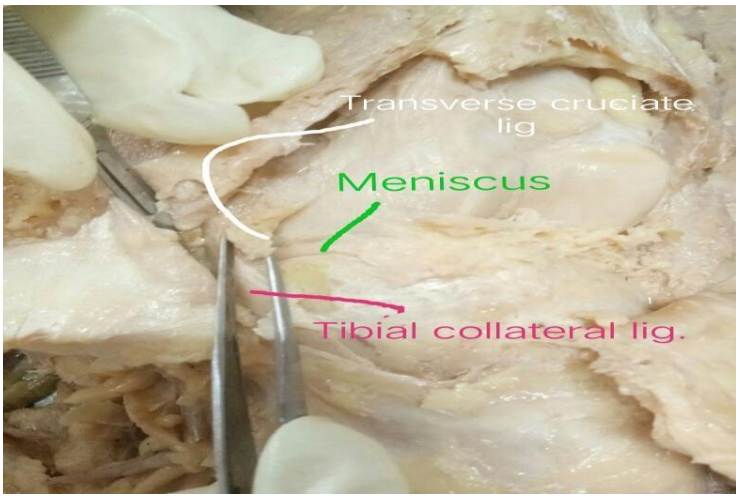
1. Medial Meniscus
2. Lateral Meniscus
3. Origines of anterior and posterior cruciate ligaments on inter condylar area.

1. **Knee joint after removing Skin and Superfascial fascia**

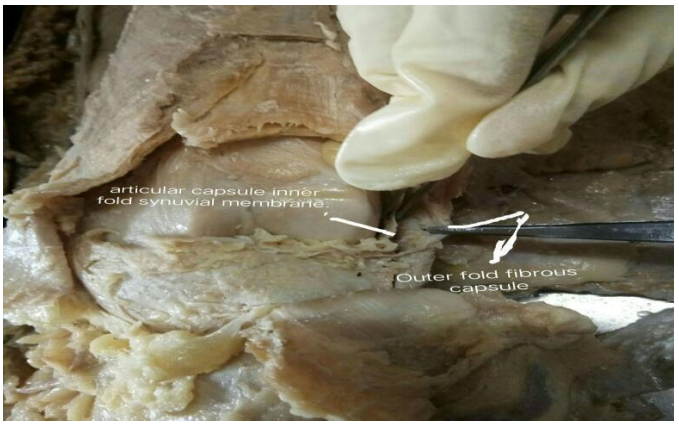
2. **Knee joint after reflecting ligamentum patellae**



3. **Ligaments – transverse ligament, Menisci, Tibial collateral ligament**



4. Showing fibrous capsule's membrane



5. Showing menisci of knee joint

DISCUSSION

Janu sandhi is major joint in lower limb. This is a type of *cheshtavanta* & *kora sandhi* so there are many structures present which help it in function, stability and strength like - *snayu, sira, peshee, shleshmadharakala* and *asthi*. These *snayu, sira, peshee, shleshmadharakala* and *asthi* can be correlated with ligaments, vessels, muscles, synovial membrane and bone respectively in modern science.

Snayu

Sr. no.	*Pratanavati snayu*	Sr. no.	*Vritta snayu*
1.	Ligamentum patellae	1.	Medial meniscus
2.	Tibial collateral ligament	2.	Lateral meniscus
3.	Fibular collateral ligament		
4.	Oblique popliteal ligament		
5.	Arcuate popliteal ligament		
6.	Anterior cruciate ligament		
7.	Posterior cruciate ligament		
8.	Transverse ligament		

Function

- The function of *snayu* is stated as *sandhibandhan* by giving example of a boat.
- *Sandhibandhan* function of *snayu* can be explained as, Ligaments- joining bones at joints Aponeurosis/ tendons- joining muscles with bones
- Another function of snayu is to prepare skeleton to bear weight i.e. *bharakshamatva*.
- The forces developed by skeletal muscles are transferred to bones by these connective tissue structures i.e. tendons, aponeurosis and ligaments. They passively stabilize joint and help in guiding joints through their normal range of motion, when a tensile load is applied.

Counting

The number of *snayu* present in *janu* according to *ayurvedic* texts are 10. The ligaments present in the knee joint according to textbooks of anatomy are 11.

- The total no. of tendons present at the knee joint are 7.
- ***Sira*:-** These are said as binding agent of *sandhi* by different *acharyas*. There is no description of *sira* at the place of *janu* in any *ayurvedic* texts.
- ***Peshee*: -** *Acharya sushruta* and *Dalhan* described 5 *peshees* at the place of *Janu*, 20 *peshees* at *uru*, 20 between the *gulf* and *janu*.

  Counting - As per *ayurveda* there are 5 *peshees* at the place of *janu* according to different *acharyas.*

- Principal muscles producing movements at the knee joint are –

1) Biceps femoris
2) Semitendinosus
3) Semimembranosus
4) Quadriceps femoris
5) Popliteus

Movement	**Principal muscles**	**Accessory muscles**
a)Flexion	1) Biceps femoris 2) Semitendinosus 3) Semimembranosus	1) Gracilis 2) Sartorius 3) Popliteus
b)Extension	Quadriceps femoris	Tensor fasciae latae
c)Medial rotation of flexed leg	1) Popliteus 2) Semimembranosus 3) Semitendinosus	Sartorius Gracilis
d)Lateral rotation of flexed leg	Biceps femoris	-

But in above muscles Quadriceps femoris and Hamstrings muscles are group of muscles which include 4 muscles separately.

Quadriceps femoris

A) Rectus femoris
B) Vastus lateralis
C) Vastus medialis
D) Vastus intermedius

❖ These muscles are extensor of the knee joint.

Hamstrings muscles

A) Semitendinosus
B) Semimembranosus
C) Long head of Biceps femoris
D) Ischial head of Adductor magnus

❖ These muscles share the following characters-

a) Origin from the Ischial tuberosity
b) Insertion into one of the bones of the leg
c) Nerve supply from the tibial part of the sciatic nerve
d) The muscles act as flexors of the knee

➢ As these 2 grp muscles have many common things so can be counted as two peshees.
➢ Remaining 3 muscles (Gracilis, Sartorius and Popliteus) are counted as three peshee.

1) *Shleshmadhara kala*

Shleshmadhara kala is very important amongst all *kala* which is situated in all *sandhis* (joints). Thus the *shleshmadhara kala* in all *sandhis* facilitates their proper functioning.

This *shleshak kapha* act as lubricant in *janu sandhi* and helps in protection as well as movement these all function are same like synovial memebrane and synovial fluid in the knee joint (*janu sandhi*). *Shleshmadhara kala* can correlate with the synovial membrane.

2) *Sanghaat*

Where more than two bones make joint at one place, these places are called as *sanghaat.* In *janu sandhi* there is meeting of *uru, janu* and *jangha asthi*. These places can be correlated as compound joints. Knee joint is also one of them, here femur, tibia and patella makes the joint.

3) *Seemant*

These places are associated with *sanghata*, so their places and numbering are same.

4) *Asthi*

Janu sandhi is said to be joining part of *uru* and *jangha asthi*. *Jangha asthi* are 2 in no. in each lower limb, *uru asthi* is 1 in no. in each lower limb. So we can correlate them as tibia-fibula to *jangha asthis* and femur to *uru asthi*. At the place of *janu sandhi* there is description of *janu asthi* which is a type of *kapalasthi*, so can be correlated with patella bone which is a type of flat bone.

CONCLUSION

The *asthi* at *janu pradesh* (*janvasthi* – type of *kapalasthi*) is patella (flat bone).

1. *Sandhi* at *janu* is the meeting point of *uru* and *jangha asthi* in *ayurveda* is meeting point of femur and tibia in modern science.
2. Knee joint is a complex joint and of condylar (in between femur and tibia) and saddle joint (between femur and patella) type. This condylar joint in *ayurveda* is called *kora sandhi*, but there is no term for saddle joint in *ayurveda*.
3. 10 *snayu* at *janu pradesh* can be considered as Ligamentum patellae, 2 collateral ligament, 2 menisci, 2 arcuate ligament, 2 cruciate ligament in modern science.
4. *Shleshmadhara kala* which secrete *shleshaka kapha* can be considered as *synovial membrane* which secretes synovial fluid in modern science. They both act as lubricant and make movement smoother. Synovial membrane forms fibrous capsule filled with synovial membrane in knee joint.
5. 5 *peshee* at *janu* can be considered as quadriceps femoris, hamstring muscles, Sartorius, gracilis and popliteus in modern science, which are responsible for different movements at knee joint.
6. *Tvacha* can be considered as skin in modern science, but there is no term in ayurveda for superficial fascia, deep fascia, bursae, patellar retinaculla like structures.

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