Review of literature.
REVIEW OF LITERATURE

Following aspects are covered in this chapter –

1] PREVIOUS WORK CARRIED OUT – This topic reveals the previous work done in various Universities and Colleges regarding this topic.

2] ĀYURVEDIC LITERATURE – In this, following topics are covered:
   • Vāta sthāna and relation with Sandhi.
   • Sandhi Śārīra — covering the etymology, types, movements etc general and knee joint.
   • Sandhigata Vata characteristics.
   • Preparation of Kṣirabalā oil.
Basti — Anuvāsana Basti it apparatus and procedure etc.

3] MODERN LITERATURE – Knee joint, its Anatomy and movements, Osteo-arthritis etc.

1] PREVIOUS WORK CARRIED OUT:

Previous work done in various Universities and Colleges is included under this heading.


9. Shripathi R – Evaluation of Trayodashanga Guggulu forte in osteoarthritis Faculty of Ayurveda Institute of Medical Sciences Banaras Hindu University, Varanasi 1987.


**RESEARCH WORK CARRIED OUT ON OSTEOARTHRITIS:**

(2) Zatsiorsky VM. Kinematics Branch of physics concerned with the geometrically possible motion of a body or system of bodies, without consideration of the forces involved. Champaign, Ill: Human Kinetics; 1998.


(7) Escamilla RF, Fleisig GS, Zheng N, et al. Biomechanics of the knee during closed kinetic chain and open kinetic chain exercises Open Kinetic Chain Exercises (OKCE); these exercises are performed typically where the hand or foot is free to move. These exercises are typically non-weight bearing, with the movement occurring at the elbow or knee joint. Med Sci Sports Exerc. 1998;30:556-569.


(10) Stuart MJ, Meglan DA, Lutz GE, et al. Comparison of intersegmental tibiofemoral joint forces and muscle activity during various closed kinetic chain exercises Closed Kinetic Chain Exercises (CKCE) are physical exercises performed where the hand (for arm movement) or foot (for leg movement) is fixed and cannot move.

2. REVIEW OF ĀYURVEDIC LITERATURE:

A] VĀTA STHĀNANI AND THEIR RELATIONS WITH SANDHI -

Following reference states the locations of Vāta doṣa -

tेषां त्र्याणामपि दोषानां शरीरे स्थाननिबाग उपदिल्यते। तद्भथा —

बर्ति: पुरीषाधानं कटि: सक्षिप्ती पादों अस्थिनि च वातस्थानानि।

अन्यापि पक्वश्यो विशेषण वातस्थानम्। . च.सू 20.9

Čaraka-Samhitā describes division of body as related to location of three doṣah.

It states, Bladder, Rectum, Waist, Thighs, Lower limbs, and Colon are the locations of Vātadoṣa, amongst which, Colon is chief one. Lower part of Colon is where Basti (Medicated enemata) is administered.

Suśṛt-Samhitā forwards almost same information. It quotes:

dोषस्थानानि अत ऊर्ध्व कक्षयाः। तत्र समासेन वातः श्रोणिगुदसंश्रयः

तदुपरि अधो नामे: पक्वशयः, पक्वशयमध्य पिल्लस्य, आमाशय:

श्लेष्यस्य। . सु-सू 21.6
Aṣṭāṅga-Hṛdaya seems to be in agreement with locations suggested by Čaraka-Samhitā. He adds - Ears in locations of Vāta; Umbilicus, Eyes and skin in location of Pitta; Kloma, Nose, Tongue in locations of Kapha.

Purishavaha Srotas has principle organs as Pakwāśaya and Guda or anus. Pakwāśaya is interpreted as Large Intestine is justified over here. Large intestine begins from Caecum. Following references will support the justification.

While describing ‘Kalā’, Suśrta states reference given above. He states that this is fifth ‘Kalā’ which helps to divide Mala or excretory products. It is located in Pakwāśaya.

Pakwāśaya is the place for origin of Fissure-in-ano, severe thirst, and obstruction in anus.
Kośtha is around Liver and Intestine is located here. At the level of Caecum, ‘Kalā’ called ‘Maladharā’ gets distinguished from other ones.

Movements and secretions of Large intestine are not clearly mentioned in Āyurveda’s compendia. However, following references can draw idea about the movements and functions of Large intestine in Āyurveda concept:

पक्वाधानालयोपान: काले कर्षति चायम्।
समीरण: शाक्रूमूत्रशुकगमर्तवायप्याध्यू। . सुनि. 1.19

This concept spells out that expulsion of various kinds of excretion, urination; defecation, expulsion of baby, etc. are dependent on the proper functioning of Large intestine due to its intimate relationship with Apana Vayu.

वलय: प्रवाहीं तासामन्तर्मध्ये विशर्जनी।
बाह्या संवरणी तत्स्या गुदोष्टौ बहिरंगुलै।। वास्मत

This quote also indicates Defecation Reflex.

All these references collected together strongly interrelate bones, thighs, (lower end of thighs involved in Knee joint), with chief location of Vāta as Pakwāsaya or Large Bowel.

It is for this reason, that Basti must be the prime and basic treatment in all Vāta-vyādhi.

In the verse mentioned above, it is noted that water (and dissoluble particles) are absorbed from colon; however oil is not supposed to get
absorbed as there is no such mention in Āyurveda nor it is read in Modern Medicine.

Lipid absorption is extremely slow or almost nil here. New researches however suggest typical lipids with specific molecular weight can be very slowly absorbed.

B) SANDHI ŚĀRĪRA :

Etymologically the word Sandhi is taken from Sanskrit root Shabdakalpadruma.

सन्धि – सं + धा + कि=– संधानमिति

(शब्दकल्पद्रुम– page no 240)

जन् – To be produced walking or motion(शब्दसागर–page no 288)

The meaning of the word Sandhi is ‘to unite’ or a ‘meeting point’.

Definition of Sandhi :-

Sandhi can be taken as union of two or more bones.

अस्थनां तु सन्धयो हेतुते केवल्य: परिकीर्तिता:।। चु.शा.

The Rigveda defines Sandhi as union

सन्धिता सन्धि:।ऋग्वेद

The Atharvaveda defines Sandhi as Parva.

अस्थियांसं परमेस्मास्मितं हृदयामयम्।।

बलासं सर्व नाशायाहेष्ट यश्च पर्वसु।। – अर्थवं वेद– 1330.

Synonyms :-

Various Ayurvedic and non Ayurvedic literatures have given following synonyms to the word Sandhi .

In Amarakośa – Sandhi , Śleṣma.
In Anekarthasamgraha – Samyoga, Śleṣma.
In Abhinava paryāyavaśīkoṣa – Samyoga, Bhoga, Bheda, Sadhana and Avakāśa.
In Ādarśa Hindi Sanskrit koṣa – Sammilana, Sangama, Maitrikarana.

PancaMahābhaūtic composition of Sandhi :-

Each object in the universe is composed of five basic elements i.e. PancaMahābhūta. Even Sandhi Utpatti is based on the principle of PancaMahābhūta.

1. As the Sandhi is the meeting place of two Asthis, so Asthis are dominated by Prthviguna, so indicates the involvement of Prthvi Mahābhūta.

2. The space which is seen in the Sandhis and in between the articular surfaces indicates towards the presence of Ākāśa Mahābhūta.

3. Synovial fluid which is present in between the articular surfaces shows the presence of Jala Mahābhūta.

4. The rise of temperature which is seen after articulation between bony ends indicates the presence of Agni Mahābhūta.

5. The various movements and functions of sandhi are because of Vāta. This indicates the presence of Vāyu Mahābhūta.

Number of Sandhis :-

Compendia show difference of opinions regarding number of joints present in bodies due to various reasons.

<table>
<thead>
<tr>
<th>Compendia</th>
<th>No. of Sandhi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Čaraka-Samhitā</td>
<td>200</td>
</tr>
<tr>
<td>Suśrta-Samhitā</td>
<td>210</td>
</tr>
</tbody>
</table>
Classification of Sandhis :-

1. Movement
2. Shape

Suśṛta-Samhitā is considered as the best for anatomical approach hence the other Āyurvedic compendia have followed his opinion regarding the classification.

1. Kriyā (Movement)
2. Raćanānusar(Shape)

Classification with movements of Joints :-

Suśṛta-Samhitā has made the classifications of the joints based on their range of movements as

1. Čeṣṭāvanta (joints with movements)
2. Sthira (joints with no movements)

Suśṛta-Samhitā quotes the joints situated in the Śākhā (Extremeties), Hanu (Mandible), Kati (pelvic& vertebral region) are joints with movements whereas remaining joints are not movable.

शाखासु हन्वोः कटयां चेष्टावन्तस्तु सन्ध्यः । - सु.शा .५/२५.

The movable sandhi are again classified into

1. Bahućala (freely movable)
2. Iṣatéala (slightly movable)
The joints of extremities, mandible and neck are freely movable joints and the joints of back and chest are slightly movable.

**Anatomical classification of Joints:**

Suśruta-Samhitā classifies the joints as:

1. Kora
2. Udukhala
3. Sāmudga
4. Pratara
5. Tunnasevani
6. Vāyasatunda
7. Mandala
8. Śankhavarta

Bhavamisra classifies joints in the same fashion. Tunnasevani is replaced by Tūnasevani and Vāyasatunda replaced by Kakatunda.

1) **Kora sandhi** :-

   तेषां अड़ुलि मणिबन्ध गुल्फ जानु कूपरेरु कोरः सन्धयः।
   सु.शा.५/२७।

   कोरः कलिका तदाकृत्य इत्यन्ते । डल्हण।
This Sandhi looks like a flower bud when seen in flexed condition of the joint from a distance that is why; it may be called as Kora sandhi. Kora means a Bud.

In the opinion of Harana Čandra the Kora sandhi is a hinge type of joint. The Sandhi looks like hinge, seen in the doors and windows which hold the arms tightly. The movements seen are flexion and extension.

The Kora sandhis are found in the places Anguli (Inter phalengial), Manibandha (Wrist), Gulpha (Ankle), Janu (Knee), and Kurpara (Elbow). This is Hinge joint according to modern science.

2)Udukhala Sandhi -

कक्षाक्षणदशाऎश्लूखला:। । सु.शा. 5.27
उदुखलस्तण्डूलकण्ठनोपपोगी — डल्हण
This Sandhi is shaped just like a traditional stone grinder which is used in kitchen, that is why, it is called as Udukhala sandhi. One articulating end is round and the other articulating end is having a groove in which the head fixes.

Kaksha (shoulder) Vankshana (Hip), Dasana (Dents) are Udukhala sandhi. Of these Dasana are fixed joint but other two are movable with greatest range of movement. This is Ball and socket type of joint in modern science.

3] Sāmudga Sandhi :-

This Sandhi looks like a Box. The articulating end is having a fossa or cavity and the other end is slightly elevated so that they can articulate. It is included in Iṣatcāla sandhi variety.
The Samudga sandhis are found at Amsakuta (sternoclavicular joint) Guda (sacrococcygeal joint), Bhaga (symphysis pubis), and Nitamba (sacroiliac joint). It is compared with Saddle joint in modern science.

4] Pratara Sandhi :-

This joint is Bow shaped that is why, it is called "Pratara". According to Dalhana the articulating surface of this variety of joint are flat in nature and floating supported by cushion. Friction is seen in between the articulating surfaces. According to Susruta, these joints are found at Greeva and Prushtavamsa (Inter vertebral joints). This can be compared with gliding joint in modern science.

5] Tunnasevani Sandhi :

Figure 4 : Pratara Sandhi.

~ 21 ~
This joint is shaped just like two cut edges sutured together by overlapping one another. This is clearly mentioned by Gananath sen. He opined that articulating surfaces resembles dentate edges which are supported and jammed together to embed into one another.

In Tunnasevani joints the articular edges are dentated and embedded into one another. These are found at sutures of the cranial vault. These are immovable joints. It is compared with Sutural joints in modern classification.

6] Vāyasatunda Sandhi :-

The Sandhi is in the shape of Beak of a crow is called Vayasatunda.

According to Dalhana the Hanu which is situated with in shankhasthi is considered as Vayastunda sandhi. It is situated beside the Bahyakarna vivarana on both sides.

It resembles the Kakatunda (Beak of a crow); so it is named as Vayasatunda. Even Susruta has quoted similar opinion about Vayasatunda.
sandhi. The Temporomandibular joint is the typical example of Vayasatunda sandhi.

7] Mandala Sandhi :-

कणठपद्यनेत्रक्ष्वलोक्षनाकाश्रु मण्डला:। . सू.शा. 5.27
मण्डलो मण्डलाकृति। उत्त्हगण

Figure 7 :- Mandala Sandhi.

As the shapes of these Sandhi are round or oval, these are called mandala sandhi. According to Dalhana the sandhi which are round and oval are called as Mandala sandhi.

These are sthira sandhi made up of cartilages. These sandhis are present in Kantha, Hrudaya and Netra. These sandhis can be compared with Cartilaginous or Membranous joints, a variety of fixed join.

8] Śankhavarta Sandhi :-

श्रोत्रश्रृंगातकेषु शंखावर्त। . सू.शा. 5.27

Figure 8 :- Shankhavarta Sandhi.
The shape of this Sandhi is in resemblance with the circles of snail or śankha. According to Haranaśandra these are circular in nature which resemble with circles of a snail or śankha.

According to Susruta they are found in Śrotra (Internal ear) and Śṛṅgataka (At the base of nose).

Tables showing the Sandhi and their locations

1) Kora

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anguli</td>
<td>Inter Phalangeal joint</td>
</tr>
<tr>
<td>2</td>
<td>Manibandha</td>
<td>Wrist joint</td>
</tr>
<tr>
<td>3</td>
<td>Gulpha</td>
<td>Ankle joint</td>
</tr>
<tr>
<td>4</td>
<td>Janu</td>
<td>Knee joint</td>
</tr>
<tr>
<td>5</td>
<td>Kurpara</td>
<td>Elbow joint</td>
</tr>
</tbody>
</table>

2) Udukhala

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kaksha</td>
<td>Shoulder joint</td>
</tr>
<tr>
<td>2</td>
<td>Vankshana</td>
<td>Hip joint</td>
</tr>
<tr>
<td>3</td>
<td>Dasana</td>
<td>Alveolar sockets of teeth</td>
</tr>
</tbody>
</table>

3) Samudga

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amsapeetha</td>
<td>Sterno claviclar</td>
</tr>
<tr>
<td>2</td>
<td>Guda</td>
<td>Sacro coccygeal</td>
</tr>
<tr>
<td>3</td>
<td>Bhaga</td>
<td>Symphysis pubis</td>
</tr>
<tr>
<td>4</td>
<td>Nitamba</td>
<td>Lumbo sacral</td>
</tr>
</tbody>
</table>
4) Pratara

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Greeva Prushta</td>
<td>Intervertebral</td>
</tr>
</tbody>
</table>

5) Tunnasevani

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sira,kati,kapala</td>
<td>Sutural joints</td>
</tr>
</tbody>
</table>

6) Vayasatunda

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hanu Sandhi</td>
<td>Temporomandibular joint</td>
</tr>
</tbody>
</table>

7) Mandala

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kantha</td>
<td>Tracheal rings</td>
</tr>
<tr>
<td>2</td>
<td>Hridaya, Netra, Kloma, Medhra</td>
<td>Vomeronasal, Sphenoido-temporal</td>
</tr>
</tbody>
</table>

8) Shankavartha :-

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Sandhi</th>
<th>Anatomical Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shrotra</td>
<td>Cochlea</td>
</tr>
<tr>
<td>2</td>
<td>Shringataka</td>
<td>Base of Nose</td>
</tr>
</tbody>
</table>

**DESCRIPTION OF JĀNU SANDHI SHARIR :-**

Jānu means the Knee.

Jan means to be produced (walking, motion).

Sandhi word is derived from the root Sam + Dha+ Ki which means Sandhanamiti - Holding together, joining, and binding.
Characteristics of JĀNU SANDHI :-

Sandhis are the junctions of Bones and are seat of Kapha; they help to keep the Body parts Together.

Samkhyā :-

Janu Sandhi’s are 2 in number present in lower extremities.

Dimensions :- Circumference of the middle portion of knee is 14 Angulas.

Length of Jānu is 4 Angula and its circumference is 16 Angulas.

Two or more Asthis are not sufficient to form a Sandhi. It requires other structures which connect the Asthis to one another, maintain, stabilize, bear weight and facilitate the gati in them.

Structures that constitute a Sandhi are quoted below-

1. Asthi
2. Snāyu
3. Śleṣma dhara kala
4. Śleṣma
5. Peśi
6. Sirā
7. Dhamani

1) ASTHI :-

Asthi is the Primary Structure of any sandhi.
Asthis taking part in formation of JANU SANDHI are:

1. JANGHASTHI
2. JANVASTHI
3. URVASTHI

Ācaraka-Samhitā has explained Jānu Asthi and Jānu Kapālika asthi’s separately.

द्वे जानुनिः द्वे जानुकपालिकेः - च.शा.७/६

This view presents four bones in the joint including Janu Kapalika.
The main function of Asthi is dharana of sarīra.

अस्त्यिनि देहार्सां मनः: पुष्पः च सु-सू.१५/५

Vāta has its abode in Asthidhatu. Living of similar entities together is Āṣrayāṣrayi bhāva in simple words.

आश्रयमिति समानगुणस्थानम्। चक्रपाणि, च.सू. १२

Doṣa system is controlling and commanding for living body. Three of them are located in various organs. When doṣāḥ find similar qualities, they tend to remain there comfortably. This is Āṣrayāṣrayi bhāva.

It is explained as follows:

तत्त्रास्थनि स्थितो वायुः पित्तं तु स्वेदरक्तयोः।
श्लेष्या शोषेषु तेनेषामात्रयाश्रयिणः सिद्धः।
यदेकस्य तदन्यस्य वर्धनक्षपणोषधम्।
Asrayasrayi bhāva is described by Aṣṭāṅga-Hṛdaya for the purpose of explaining the relation between doṣa and duṣya. It has two-fold meaning. One supplements pathological investigation and other adds to management of disease or Čikitsā.

Aṣraya is ādhāra or support and āṣrayi is ādheya or ground for support. Doṣa stays tuned with duṣya i.e. other body constituents. The vrddhi of doṣa is reflected as vrddhi of duṣya. This law is applicable to śleśmā and Pitta.

Vāta vrddhi indicates bṛhaṇa Čikitsā. It brings vāta vrddhi in control. Čaraka-Samhitā Sūstrasthāna suggests basti (enema) of milk and ghṛta with tikta dravya as treatment of asthipradosaja disease. This is samana of vitiated vāta. This point out that Čarakācārya considers Āṣrayāṣrayi bhāva of Asthi and vāta.

In Sandhigata Vāta the vitiated Vāta results in Asthi Kṣaya. Vāta, based on sthāna and karma attains five different names viz. Prāna, Udāna, Samāna, Vyāna, Apāna. Out of these five there is no direct reference regarding the Vāta residing in the Sandhi. Vyāna Vāyu is said to be kṛtsna deha carah i.e., it moves all over the body. However, based on its function of gati or movement it can be considered that Sandhi is one of its sites.
2) SNĀYU :-

Snāyu is a structure that binds Asthi, māmsa and meda.

स्नायवो बन्धनं प्रोक्ता देहे मांसास्थियमेदसाम् ।— शाप्र.५/३६

As a boat consisting of planks becomes capable of carrying load of passengers in river after it is tied properly with bundle of ropes. All joints in the body are tied with many ligaments by which persons are capable of bearing load.

नौर्थथा फलकास्तीर्था बन्धनेवर्धिनियुः ।
भार्स्त्रमा भवेदप्सु नृयुक्ता सुसमाहिता ॥
एवमेव शरीरद्विगुन्य वावतः सान्त्यः स्मृतः ।
स्नायुविद्विधमेकः भारस्सा नरः ॥ सु.श.५/३३,३४

Out of the different types of Snāyu, the pratanavati [branched] Snayu is present in the Sandhi.

Samkhya -

Ten Snayus are present in Knee.

दश जानुनि — सु.श.५/२९

3) ŚLEŚMA DHARĀ KALĀ :-

Fourth Kala is Śleṣmadhara (Kapha supporting) which is situated in all joints of living beings.
As a wheel moves on well by lubricating the axis, joints also function properly if supported by Kapha.

चतुर्थी शलेष्ठताः सर्वसन्धिः प्राणभृतां भवति ॥
सनेहस्यके वथा बक्षे चच्रां साधु प्रवत्ति ॥
सन्धयः साधु चरतन्ते संश्लिष्यः शलेष्मणं तथा ॥

सु.शा.४/१४, १५.

4) ŚLEŚMĀ :-

The Śleśmā that resides in Sandhi is named as Śleśaka Kapha. It facilitates free Movements of the Sandhi and lubricates it as well.

सन्धि संश्लेष्यः शलेष्कः सन्धिः स्थितः । - अ.हृ.सू.१२/१८

Above mentioned structures are directly involved in the formation of Sandhi.

The structures which help in movements & supporting and supplying nutrition to Knee joint are

5) PEŚI :-

The Peśi covers the different structures of the Body such as Sirā, Snāyu, Asthi parva and Sandhi and imparts strength to these structures including the Sandhi. Five Peshi (muscles) are present in Knee.

सिरा स्नायु अस्थि पर्वाणि सन्ध्यास्त्वः शरीरिणाम् ॥
पेशीभिः संवृतान्तः बलवत्ति भवन्ति ॥ - सु.शा.५/३८.

6) SIRĀ :-

Kaphavaha siras carrying Normal Kapha produces the unctuousness, firmness in joints, and increases its strength.
3Rakta vaha siras carrying normal Blood does dhatu purana bring
complexion and helps in positive sensation of touch.

स्नेहंगोषु सन्धीनां स्थैर्यं बलमुदीर्णताम् ॥
करोत्यन्यानं गुणाभापि बलासं स्वा: सिराश्रान् ॥

- सु.शा.७/१२.

Asthi is a dhātu hence this function is applicable for Asthi Dhatu
poṣana also.

7) DHAMANI :-

Adhogata Dhamanis carrying Vata, Pitta, Kapha, Rakta and Rasa
sustains and maintains parts below umbilicus-

Pakwashaya, Kati, urine, faeces, anus, urinary bladder, pennis & legs
(Knee joint).

एताभिरधोनाभि: पक्वाशय कटी मूत्र पुरी गुद् बलसि मेछ्र सक्षीनि
धार्यन्ते यायन्ते च ॥ - सु.शा.२/७.

C] SANDHI GATA VĀTA :-

Sandhi gata Vāta is one of the Nānātmaja Vāta Vyadhi. Vitiated Vāta,
when occupies locations, which are not under its jurisdiction, it triggers
pathogenesis in that location. Sandhigata Vāta comes under this category of
Sthāna gata Vāta Vyādhi. Here vitiated Vāta gets located in the Sandhi and
results in the disease, Sandhigata Vāta.

NIDĀNA PANČAKA -
NIDANA :-

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Nidana for Sandhigata Vata has not been given separately. General Nidana mentioned for Vata Vyadhi is applicable.

They are classified into:

a. Āhāratah – Katu, Kaśāya, Tikta, Ṛkśa, laghu, Śīta, Anāśana, Vishamāśana, Adhyaśana, Alpāśana.


c. Mānasika – Čintā, Śoka, Bhaya, Krodha.


e. Vaidyakṛta – Viṣama upācāra, Ati doṣa asṛk srāvana.

f. Vyādhijanya – Roga ati karśana, Āma, Marmāghāta.

रूक्ष शीत अल्प लघु अन्न व्यवाय अतिप्रजागृः ।

विषमादुपचारश्र दोषासृक स्रवणादिति ॥

लघन प्लवन अत्यधव्यायाम अति विचेषिते।

धातुनां संक्रमयाधिन्ता शोकयोग अति कर्षणात् ॥

धुःखश्यासनात् ऋद्धाहिवस्वपनाध्यादिपि ॥

वेगसंधारणादृ आमादृ अभिघतात् अभोजनात् ॥

मर्माघातात् गज ऊष्ट्र अश्रुशीप्रध्यानापतंसनात् । (च.चि.२८/१५–१८)

PURVARŪPA :-

Specific purvarūpa are not mentioned for Sandhigata Vata. Avyakta Lakshanas of the disease itself will be purvarupa.

अव्यक्तं लक्षणं तेषां पूर्वरूपम् इति स्मृतम् ॥ - च.चि.२८/१९.
Rūpa :-

Symptoms seen in Sandhigata Vata according to different Authors are as follows.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>S.S</th>
<th>C.S</th>
<th>A.H</th>
<th>M.N</th>
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<tr>
<td>HANTISANDHI</td>
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<td>-</td>
<td>MADHUKOŚA</td>
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<tr>
<td>STAMBA</td>
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<td>-</td>
<td>MADHUKOŚA</td>
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<td>-</td>
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</tbody>
</table>
The references are as follows:

हन्ति सन्धिगतः सन्धीनः शूलशोभौ करोदति च। - सु.नि.१२/२८।
हन्तीत्यादि एतेनाकुञ्चनप्रकाशर्योभाव उक्तः डल्हण।
वातपूर्णद्रवशपर्णुः शोधः सन्धिगते अनिले।
प्रसारणाकुञ्चनयोः प्रवृत्तिः सवेदना॥ - च.चि.२८/३७॥
वातपूर्णद्रवशपर्णुः शोठः सन्धिगते अनिले।॥
प्रसारणाकुञ्चनयोः प्रवृत्ति च सवेदनाम्। - अ.दु.नि.१५/१४
हन्ति सन्धिगतः सन्धीनः शूलारायणः करोदति च।
(सा.नि.२२/२१)
हन्ति सन्धिगतः सन्धीनिति सन्धिविश्लेषं सत्तमादिकं वा करोदति
(मथुकोश)
आटोपम् इष्टसशब्दम् अध्यायम्। (सु.सू.१५/१५)
हन्ति सन्धिगतः सन्धीनः शूल शोभौ करोदति च।
(भा.प्र. म. २४/२५४)
हन्ति सन्धिगतः सन्धीनः शूल शोभौ करोदति च।
(यो.र. वातव्यायी निदानय/ २५)

UPAŚAYA – Vāta Śāmaka Āhara and Vihāra.

SAMPRĀPTI -
Samprāpti for Vāta Vyādhi is applicable to Sandhigata Vāta as well.
Due to aetiological factors aggravated and vitiated Vayu invades the channels with some space or channels which have become weak due to ill nourished Dhātu and snehādi gunas and leads to production of various Sarvāṅga or ekāṅga roga. In this context it is ekāṅga roga as only Jānu Sandhi is taken up for the study.

Samprapti of Sandhigata Vata can be shown in the form of a flow chart as follows –

1] Hetu sevana.
2] Increase in Chala and Ruksha Guna at local level.
7] More friction within the joint cavity.
8] Stimulation of Nerve endings.
9] Pain and associated manifestations.

FACTORS INVOLVED IN SAMPRĀPTI :-

1) Hetu – Vāta Prakopaka Nidāna
2) Doṣa – Vyaāna Vāta, Śleṣaka Kapha
3) Dūṣya – Asthi, Majjā
4) Srotas – Asthivaha & Majjāvaha

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5) Duṣṭi - Prakopa

6) Mārga - Madhyama (Marma asthi sandhi)

7) Udbhava – Pakwāśaya

8) Adhishtāna – Sandhi

9) Pratyātmalinga – Vātapūrnadṛtisparṣa

10) Upadrava – Khanjatva

Sandhi as Marma :

<table>
<thead>
<tr>
<th>Marma</th>
<th>Place</th>
<th>Upadrava</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulpha</td>
<td>Ankle</td>
<td>Vedana , Khanjatwa</td>
</tr>
<tr>
<td>Janu</td>
<td>Knee</td>
<td>Khanjatwa</td>
</tr>
<tr>
<td>Kukundara</td>
<td>Lumbosacral region</td>
<td>Suptatwa ,</td>
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<tr>
<td></td>
<td></td>
<td>Pakshaghata</td>
</tr>
<tr>
<td>Krukatica</td>
<td>Junction of neck and head</td>
<td>Chalamurdha</td>
</tr>
<tr>
<td>Avarta</td>
<td>Above eyebrows</td>
<td>Andha , Drushtiheena</td>
</tr>
<tr>
<td>Seementa</td>
<td>Skull bone sutural joint</td>
<td>Unmada , Bhaya chit , Marana</td>
</tr>
<tr>
<td>Adhipati</td>
<td>Bregma</td>
<td>Marana</td>
</tr>
</tbody>
</table>

D] PREPARATION OF KŚĪRABALĀ OIL :

This preparation is as per Sahasrayoga published by Government of India 1st edition on page no 292 and is given below with reference:

श्लामूलं पञ्चपलं क्षीरं पिष्टं च योजयेत्।
क्षीरे चतुर्गुणं तैलं प्रसं मृदगन्निनां पचेत्॥
Root of Balā (Botanical name) is weighed 5 tolas or 240 Gms and is ground in milk. Volume of milk is taken 4 times volume of ground root. Prastha of Sesame oil is added to the mixture while boiling the milk and as per text rules and regulations the mixture is boiled till oil is appropriately medicated.

**Anuvāsana Basti**

Basti is one of the very powerful procedures in Āyurvedic Panca karma. Anuvāsana Basti is a kind of Snehabasti by Suśrta-Samhitā. अनुवासनिणि न दुष्ट्युदिवसं वा दीयते इत्युपासतः | सुशृङ्ग

This basti remains harmless even if it is retained in the body. It is only of oil. Niruha Basti, which is given in dose of 96 tola; sneha basti is given in the dose of 24 tola and anuvāsana is given in the dose of 12 tola. Mātrā basti is given in the half dose of anuvāsana basti i.e. 6 tole.

Avoided in Āmāvaṣṭhā, Santarpanottha Vyādhi, Kapha Meda Pradhāna Prameha; Abhyantara snehapāna etc

Performed after meal; at day time in Śiśira, Vasanta and Hemanta; at night time in Śarad, Varṣā and Hemanta; 9th day after Virecana (Caraka) and 7th day after Virecana (Suśrta); in Vāta Vyādhi perform Anuvāsana regularly

- Preparatory phase for Basti – Abhyanga, swedana etc
- Always after meal
- Instruct the patient not to walk or exercise
- Perform on left lateral position of the patient; keep in supine for some time, Sphik Mardana
- Post phase – pratyāgamana of basti up to 12 hours is appropriate – wait till 24 hours – Śunthi dhane siddha jala, Yūṣa

All other rituals of basti as per directions of compendia are observed here. Apparatus is used for adults hence Netra basti was 12 angula.

REVIEW OF MODERN LITERATURE

A) ANATOMY OF KNEE JOINT :-

Knee joint is the largest and more complex joint of Body. Complexity is the result of fusion of 3 joints i. e. Lateral femoro-tibial, medial femoro-tibial and femoro patellar joints.

Type – Compound Synovial joint, Two Condylar joint between Condyles of femur and Tibia and one Saddle joint between Femur & Patella.

Sub Type – Modified Hinge variety.

Characteristic features of Synovial joint are as follows:

COMPLEX JOINT - Complex joint is one in which the cavity is divided completely or incompletely into two parts by an Intra-articular disc of fibro cartilage. In Knee Joint, the menisci divide the joint cavity incompletely.

SYNOVIAL JOINT-

a) Contiguous bony surfaces are covered with articular cartilage, hyaline in nature and not directly connected with each other.

b) Joint presents a joint cavity which is reduced to a potential space in normal healthy condition.

c) It is surrounded by an articular capsule which consists of outer fibrous capsule and inner Synovial membrane.
d) Synovial membrane lines whole of interior of joint except the cartilage covered ends of articulating bones. Thus forms a cavity filled with Synovial fluid which acts as a lubricant and provides nourishment to articular cartilage.

e) Movements in this joint are always possible from simple gliding to wide range.

**COMPOUND JOINT** - When there is more than pair of articular surfaces in a joint, it is termed a compound joint. In Knee joint there are Articular surfaces of femur, tibia and patella.

**HINGE JOINT** - Movements are like those of a door on a hinge forward and backward movement is permitted but side to side movement or rotation is not possible. Knee joint is a modified hinge joint because typical hinge joint is always uniaxial but the Knee joint permits movements of flexion, extension in addition there is rotational, abduction and adduction movements in semi flexed position.

**BONES TAKING PART IN KNEE JOINT :-**

1) The condyles of Femur
2) The condyles of Tibia
3) Patella

The femoral Condyles articulate with the Tibial Condyles below and behind and with Patella in front. Articular surfaces are obviously not congruent. The femoral Condyles are convex from side to side and from before backwards, in profile they are both spiral in shape with the curvature
greatly accentuated Posteriorly but the lateral condyle flattens from back to front more rapidly than the medial one.

Articular surfaces in condyles of femur :-

It is in the shape of inverted U for articulation with the patella above and Tibia below. Patellar surface is separated from Tibial surface by 2 faint grooves which cross condyles obliquely. Lateral groove is better marked; it runs laterally and slightly forwards from the front part of the intercondylar fossa and expands to form a faint triangular depression, which rests on anterior edge of the lateral meniscus in full extension of knee. Medial groove is restricted to the medial part of the medial condyle and like wise rests on the anterior edge of the medial meniscus in full extension of knee.

Patellar Surface of Femur extends over anterior surface of Both Condyles, but larger part on the lateral Condyle. It is transversely concave, vertically convex & grooved proximodistally to accommodate posterior surface of Patella. Its upper border is oblique and runs downwards and medially. Where the medial groove ceases this surface is continued backwards onto the lateral part of the medial condyle as a semi lunar area adjoining the anterior part of the intercondylar fossa. This area articulates with medial vertical facet of the patella in full flexion of knee joint. Since the whole patellar surface of the femur is concave transversely and convex in parasagittal plane it can be regarded as an asymmetrical Saddle shaped (Riders seat on a Horse) surface.

Tibial Surface of Femur – is divided into medial and lateral parts by inter Condylar fossa. Anteriorly each Part is directly continuous with Patellar surface. Tibial surfaces are convex from side to side and from before backwards. They cover the convex inferior and posterior surfaces of
Condyles. Lateral Tibial surface is broader and passes straight backwards where as Medial Tibial surface is gently curved with the convexity of curve directed medially. Anteroposterior curvatures of both surfaces are not uniform, being much sharper in both Posteriorly than it is in front. Medial Tibial surface is longer than the lateral Antero Posteriorly, and shows a slight curve, which is concave to the lateral side. These differences are important determinants of the rotatory (spin) movements both adjunct and conjunct.

Tibial articular surface of femur on lateral condyle is 1.25 cm less than that of medial condyle.

ARTCULAR SURFACE OF LEFT FEMUR

Tibial art}

Both Condyles separated 

Articular surface is oval in out line & concave in all diameters with its long axis Antero Posteriorly and is perceptibly longer than the lateral. Lateral articular surface is circular in out line slightly hollowed in central part. Articular surface of medial condyle

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is related around its anterior, medial and posterior margins to medial meniscus and the area of contact is flattened. Articular surface of lateral condyle is related to lateral meniscus around its anterior, lateral and posterior margins and bears its flattened imprint.

ARTICULAR SURFACES OF RIGHT TIBIA

Articular Sur of patella in its upper part
has a smooth,
ridge which corresponds to the groove on the patellar surface of femur. Lateral facet is broader than the medial one. Articular surface along with ridge are covered by articular cartilage. Articular surface of patella is further divided by two faint horizontal ridges which with the vertical ridge, map out 3 pairs of facets. On the medial side a second vertical ridge cuts off a narrow elongated semi lunar strip from the medial border of the surface. This strip comes in contact with the lateral part of the anterior end of the medial femoral condyle in full flexion and in that position the uppermost lateral facet on the patella is in contact with the anterior part of the lateral condyle. As the knee is extended the middle facets of the patella make contact with the lower half of the femoral patellar surfaces. In full extension only the lowest patellar facets are in contact with the femur.
ARTICULAR SURFACES OF RIGHT PATELLA

Features of Articular cartilage are as follows
1) It covers the articular surface of bone.
2) It is hyaline in type.
3) It has no perichondrium.
4) It has no vascular, nerve or lymphatic supply.
5) It is not covered by Synovial membrane.
6) Deep part of it becomes calcified and attached to bone and that region of bone is known as articular lamella.
7) Nutrition of cartilage is obtained from
   a) Vascular network at the periphery of Synovial membrane.
   b) Blood vessels in the medullary cavity.
   c) Synovial fluid which lubricates the joint.

LIGAMENTS OF KNEE JOINT
1) Fibrous capsule
2) Ligamentum patellae
3) Tibial collateral ligament
4) Fibular collateral ligament
5) Oblique popliteal ligament
6) Arcuate popliteal ligament
7) Anterior cruciate ligament
8) Posterior cruciate ligament
9) Transverse ligament
10) Anterior Menisco femoral ligament
11) Posterior Menisco femoral ligament
12) Menisco fibular ligament

**Fibrous capsule** is very thin and is attached \( \frac{1}{2} \) to 1 cm beyond articular margins of femur and tibia.

**FEMORAL ATTACHMENT :-**

a) Anteriorly – Articular margin except the margins of Patellar Articular surface.

b) Posteriorly – Along the margins of Condyles of femur and inter Condylar area.

c) Laterally – Lateral surface of lateral condyle just above the groove for the origin of Popliteus.

d) Medially- Medial surface of the medial condyle just beyond Articular margins.

**TIBIAL ATTACHMENT –**

a) Anteriorly – Attachment extends downwards in a Triangular manner from medial and lateral part converging to the margins of Tibial tuberosity.

b) Posteriorly – Posterior Articular margins of Condyles of tibia and inter Condylar area.

c) Laterally – Articular margin of lateral condyle of tibia except posterior part where tendon of Popliteus descends.

d) Medially-Articular margin of medial condyle of tibia.
ATTACHMENTS OF FIBROUS CAPSULE :-

Deficient part- Anteriorly particularly in the upper part where the Synovial membrane protrudes as Suprapatellar bursa, in the region of patella and also in region of Ligamentum patella.

Weakest part- On the lateral aspect part of the capsule lying deep to fibular collateral ligament. Because fibular collateral ligament is not adherent or blended with the capsule but separated by lateral inferior genicular vessels and nerves.
**Reinforcing and strengthening of the capsule**

Anteriorly-Medial and Lateral Patellar retinaculum which are extensions from Vastus medialis and Lateralis.

Posteriorly-In centre by Oblique popliteal ligament, On sides by corresponding head of Gastrocnemius.

Medially- Tibial collateral ligament, Semimembranosus and expansions from Sartorius.

Laterally- Ilio Tibial tract.

Fibrous capsule is attached to periphery of menisci.

**Coronary ligament**— Part of the capsule between the menisci and Tibia is called coronary ligament.

Part of the capsule from femur to menisci and part of capsule from menisci to tibia are called Long and Short Coronary ligaments respectively.

**Ligamentum Patellae**

This is the Central portion of the common tendon of insertion of the quadriceps femoris. It is 7.5 cm long and 2.5 cm broad.

Attachments

Above – Margins & rough posterior surface of the apex of patella.

Below – Smooth upper part of Tibial Tuberosity.

Ligamentum patella blends with lateral and medial patellar retinaculum at sides. Posterior surface of Ligamentum patellae is separated from Synovial membrane by infra patellar pad of fat and from tibia by a bursa.
RIGHT KNEE JOINT- LIGAMENTUM PATELLAE & TIBIAL COLLATERAL LIGAMENT

This is a Broad, flat long band of great strength.

Attachments :-

Superiorly – Medial epicondyle of femur just below the adductor tubercle.

Inferiorly – Divides into Anterior & Posterior parts.

Anterior Superficial Part – 10 cm long, 1.25 cm broad Attached below to medial border and posterior part of the medial surface of shaft of Tibia.

Posterior Deep Part – is short blends with capsule and with medial meniscus attached to medial condyle of Tibia above the groove for semi membranous.

Morphologically- Tibial collateral ligament represents degenerated tendon of adductor magnus muscle. 71

FUNCTIONS -

1) Stability in extension and medial stability of Knee joint.

2) Strengthens the medial part of capsule.

3) Anterior part of ligament prevents hyper flexion. 72
**Fibular Collateral Ligament**

This is a strong, rounded cord like structure, 5 cm long.

**Attachments**

Superiorly – Lateral epicondyle of femur just above popliteal groove.

Inferiorly – embraced by tendon of biceps femoris and is attached to head of fibula in front of its apex.

It splits the tendon of insertion of Biceps femoris. Ligament is not attached to lateral meniscus and is separated from it by tendon of Popliteus & from capsule by inferior lateral genicular vessels and nerve.

Morphologically – Represents the femoral attachment of peroneus longus.

**Functions:**

1) Stability in extension.

2) Lateral stability of Knee joint.

3) Limits hyper flexion

**RIGHT KNEE JOINT - FIBULAR COLLATERAL LIGAMENT, CRUCIATE LIGAMENTS & CORONARY LIGAMENT**
This is an expansion from Tendon of the Semimembranosus close to its insertion into tibia. Runs upwards and laterally blends with posterior surface of the capsule. Attached – To lateral part of inter Condylar line and lateral Condyle of femur. It forms the floor of popliteal fossa and popliteal artery is in contact with it

It is pierced by-
1) Middle genicular vessels & nerve.
2) Posterior division of Obturator nerve (genicular branch).

Functions:
1) It strengthens the posterior part of the capsule.
2) Responsible for maintaining lateral stability and stability in extension of Knee joint.

**RIGHT KNEE JOINT- OBLIQUE POPLITEAL LIGAMENT & ARCULATE POPLITEAL LIGAMENT**

**Arcuate Popliteal Ligament**

Consists of y-shaped capsular fibers, stem of it is attached to head of fibula. Posterior limb arches medially over the emerging Tendon of Popliteus to be attached to posterior border of Inter Condylar area of Tibia.
Anterior limb extends to lateral epicondyle of femur, where it is connected with lateral head of Gastrocnemius. This limb is often termed short lateral ligament.

**Cruciate Ligaments** Thick, strong ligaments connecting Tibia to Femur and they lie with in the capsule but outside the Synovial membrane of knee joint, They are called cruciate because they cross each other, and anterior and posterior from their attachment position to the Tibia.

**Anterior Cruciate Ligament** -
- Tibial Attachment – To medial part of the anterior inter condylar area, being partly blended with anterior end of lateral meniscus.
- Course – Passes upwards, back wards and laterally twisting on itself and fans out.
- Femoral attachment – Posterior part of Medial surface of lateral condyle. It lies anterolateral to posterior cruciate ligament.
- Average dimension – length 38 mm, width 11 mm.

**Posterior Cruciate Ligament** is stronger but shorter and less oblique.
- Tibial attachment – Posterior inter Condylar area and to posterior extremity of lateral meniscus.
- Course – Passes upwards, forward and medially broadening out.
- Femoral attachment – Lateral surface of medial condyle of femur.
- Average dimension – length 38 mm, width 13 mm.

**Functions of cruciate ligaments**
- 1) Act as direct bonds of union between Tibia and femur.
- 2) Maintains the antero posterior stability of the joint.
- 3) Prevents hyperextension of knee joint.
- 4) Prevents side to side displacement.
5) Anterior cruciate ligament becomes tense in extension and prevents forward gliding of Tibia on femur.

6) Posterior cruciate ligament becomes tense in flexion and prevents backward gliding of Tibia on femur.

7) In lateral rotation of leg both ligaments are relaxed.

8) In medial rotation of leg both ligaments are taut.

Nerve supply – Middle genicular nerve a branch of Tibial nerve & Posterior division of Obturator nerve.

Arterial supply – Middle genicular artery a branch of popliteal artery.

**Transverse Ligament** Connects anterior convex margin of lateral meniscus to the anterior end of medial meniscus. Also called Menisco – meniscal ligament.

**LEFT TIBIA–TRANSVERSE LIGAMENT,TIBIAL ATTACHMENT OF CRUCIATE LIGAMENTS, POSTERIOR MENISCOFEMORAL LIGAMENT & LATERAL & MEDIAL MENISCUS**

**Anterior Menisco Femoral Ligament**
Connects posterior end of lateral meniscus to medial Condyle of femur. It passes in front of posterior cruciate ligament.
Posterior Menisco Femoral Ligament (ligament of Wrisberg).
Extends from posterior attachment of lateral meniscus and passes behind posterior cruciate ligament to medial condyle of femur.

Functions – Two Menisco femoral ligaments control the mobility of posterior horn of lateral meniscus specially during rotatory movements of Knee joint and thus prevents lateral meniscus from injury.

Menisco fibular ligament – is observed in 80% of knee joints.

Synovial membrane It is more extensive and complex of all joints.

REFLECTIONS OF SYNOVIAL MEMBRANE (SAGITTAL, TRANSVERSE & CORONAL VIEWS)

Histological structure of Synovial membrane
Synovial membrane consists of a Cellular intima made up of Synovial cells which rests upon a vascular fibrous Subintimal lamina called Subsynovial tissue.

Structurally Synovial membrane is classified

  a) Fibrous type- This is Subsynovial consists of fibrous tissue and is intimately related to deep surface of Intra capsular tendons and ligaments. It possesses finger like processes known as Synovilli Two types of Synovilli are there

  1) Absorptive for absorption of Synovial fluid.
2) Secretary for secretion of Synovial fluid.

b) Fatty type- Here Subsynovial tissue contains fat cells and the membrane becomes folded. The folds contain fat and known as Articular pad of fat. They fill up the irregularity of the joint cavity and make it stable.

c) Areolar type -Here the Subsynovial tissue is composed of loose areolar tissue and traversed by collagen and elastic fibres.

Functions of Synovial membrane are

a) Secretion of Synovial fluid.

b) Removal of particulate matter and transference to cells of deeper zone.

c) Absorption of cartilaginous debris formed as a result of wear and tear.

**Synovial fluid** is a clear, pale yellow, viscous fluid of slightly alkaline pH at rest. It resembles Egg albumin therefore named Synovia. Composition – Protein - about 0.9 mgm / 100 ml, mucin (hyaluronate containing glucuronic acid), cells mainly monocytes, lymphocytes, macrophages free Synovial cells & leucocytes.

Functions

1] Provision of a liquid environment, with a narrow pH range for joint surfaces.

2] A nutritive source for the articular cartilages discs, and menisci.


**Menisci or Semilunar Cartilages** - are two fibro cartilaginous discs. They are shaped like Crescents (Shape of moon in its first quarter). They divide the joint cavity into upper and lower compartments.
Differences between the two semi lunar cartilages are as follows -

**Functions of Menisci** -

1] It deepens the articular surfaces and makes them congruent or well adaptable with each other. Because of their flexibility they can adapt their contour to the varying curvatures of the different parts of the femoral condyles.

2] Menisci serve as shock absorbers.

3] They help in lubricating joint cavity.

4] Because of their nerve supply they also have a sensory function. They give rise to proprioceptive impulses.

5] Distributes weight over a larger surface.

6] Protects edges of articular surface.

7] Limits the Translation movements.

8] Facilitates the combined movements.

9] It facilitates the rolling, sliding and spinning movements.

10] Acts as a cushion in extremes of flexion and extension.  

Menisci meet a functional need is demonstrated by fact that they are reformed following excision provided that their whole breadth is removed since regeneration can only occur from vascular fibroareolar tissue around their periphery.

**Relations of Knee Joint** :-

Anteriorly -


Anteromedially -

1] Medial patellar retinaculum.

Anterolaterally -
1) Lateral patellar retinaculum.

Posteriorly -


Postero laterally.


Postero medially

1)Gracilis tendon 2) Sartorius.

LEFT KNEE JOINT- RELATIONS OF KNEE JOINT

Blood Supply is supplied by Anastomoses around it.

Chief sources of Blood supply are:

1] Five genicular branches of popliteal artery.

2] Descending genicular branch of femoral artery.

3] Descending branch of lateral circumflex femoral artery.
5] Circumflex fibular branch of posterior tibial artery.

Five genicular branches are as follows
a) Medial superior genicular artery.
b) Lateral superior genicular artery.
c) Middle genicular artery.
d) Lateral inferior genicular artery.
e) Medial inferior genicular artery.

Two recurrent branches are Anterior and Posterior Tibial recurrent artery.

Anastomoses around the Knee joint is a complicated, arterial network situated around the Patella and around the lower end of the Femur and the upper end of the Tibia.

The arterial network is divisible into a superficial and a deep part. The superficial part lies partly in the superficial fascia around the patella and partly in fat behind the Ligamentum patellae. The deep part lies on the femur and tibia all around their adjoining articular surfaces, supplying the bone, the articular capsule and Synovial membrane.

**Nerve Supply :-**
1) Posterior division of femoral nerve (through branches to the Vasti).
2) Tibial nerve
3) Common peroneal nerves.
4) Obturator nerve, through its posterior division.

All these nerves follow Hilton’s law.

Hilton’s law- The motor nerve of a muscle which moves the joint also supplies that joint and the skin over the joint. The object is to immobilize the joint because the whole area including skin will be painful in case of
affection of the joint.

**MOVEMENTS OF KNEE JOINT :-**

Mainly occurs in two joints

1) Femoro patellar joint 2) Femoro tibial joint

Movements in Femoro patellar joint Mainly takes place in two axis Transverse axis & Vertical axis.

Movements along Transverse axis consist of Gliding and adaptation. These movements are associated with movements of femoro tibial joints and in different positions of joint.

1) In full extension Quadriceps is in contracted condition and patella lies at proximal part of patellar surface of femur, so inferior pair of facets of patella come in contact with femur.

2) In semi flexed position Quadriceps will be in semi contracted condition. Patella moves distally and middle pair of facets come in contact with femur.

3) In full flexion Quadriceps will be in relaxed condition so superior pair of facets of patella will be in contact with femur. Thus patella moves downwards in a Transverse axis.

Rotational movement of patella – This movement takes place around a vertical axis during flexion of knee joint, Patella is fixed against the condyles of femur. So if hyper flexion occurs a movement of rotation of patella around the vertical axis will occur and the medial vertical facet of patella will come in contact with Semi lunar area on the lateral margin of the medial condyle of femur.

Movements in Femoro tibial joint

Flexion and extension take place in upper compartment of joint, above the menisci. They occur in Transverse axis.

Rotatory movements at Knee take place around a vertical axis and are permitted in lower compartment of joint below the menisci. Rotatory movements can occur independently in partially flexed Knee or called adjunct rotation. Rotatory movements may be combined with flexion and extension or called conjunct rotation.

They differ from ordinary hinge movements in two ways.

1) Transverse axis around which movements take place is not fixed. During extension the axis moves forwards and upwards and in reverse direction during flexion.

2) These movements are invariably accompanied by rotations and conjunct rotation. Medial rotation of femur occurs during the last 30 degrees of extension and lateral rotation of femur occurs during initial stages of flexion. When foot is off the ground, the tibia rotates instead of femur in opposite direction.

**LOCKING & UNLOCKING OF KNEE:**

Locking is a mechanism that allows Knee to remain in position of full extension as in standing without much muscular effort. Conjunct rotations are of value in locking and unlocking of Knee. Locking occurs as a result of medial rotation of the femur during last stage of extension. Antero posterior diameter of lateral femoral condyle is less than medial condyle. As a result when the lateral articular surface is fully 'used up' by extension, part of medial condylar surface remains unused. At this stage lateral condyle serves as an axis around which the medial condyle rotates backwards i.e. medial rotation of femur occurs. This movement locks the Knee joint. Unlocking
occur by a reversal of medial rotation i.e. by lateral rotation of femur. Movements of flexion and extension in between Femur and Tibia are in real composite movements of rolling, gliding and rotations occurring around an obliquely Transverse axis.

**Condition of ligaments and Menisci in following movements**

**IN EXTENSION** -

Both Cruciate ligaments, Tibial collateral ligament, Fibular collateral ligament, Posterior aspect of Capsule, Oblique popliteal ligaments all are taut. In act of extending knee Ligamentum patellae is tightened by quadriceps femoris but in erect attitude it is relaxed. Anterior parts of the menisci are compressed between femoral condyles and the Tibia.

**IN FLEXION** -

Fibular collateral ligament, Posterior part of Tibial collateral ligament are relaxed. Cruciate ligaments and anterior part of Tibial collateral ligament remain taut. Posterior parts of the menisci are compressed between the femoral condyles and Tibia.  

**Range of movements:**-

Range of extension is 5 to 10 degree beyond a vertical axis. Flexion can be carried to about 120 degree with the hip joint extended, to 140 degree when hip joint is flexed and to 160 degree when a passive element such as sitting on heels is introduced. Passive rotation is about 60 to 70 degree in range. Conjunct rotation between Tibia & femur is limited to 20 degree.
**MUSCLES PRODUCING MOVEMENTS**

<table>
<thead>
<tr>
<th>Movement</th>
<th>Principal muscles</th>
<th>Accessory muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Semi tendinosus</td>
<td>4. Gastrocnemius</td>
</tr>
<tr>
<td></td>
<td>3. Semi membranosus</td>
<td>2. Sartorius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Plantaris</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Popliteus</td>
</tr>
<tr>
<td>B. Extension</td>
<td>Quadriceps femoris</td>
<td>Tensor fasciae latae</td>
</tr>
<tr>
<td>C. Medial rotation</td>
<td>1. Popliteus</td>
<td>1. Sartorius</td>
</tr>
<tr>
<td></td>
<td>2. Semi membranosus</td>
<td>2. Gracilis</td>
</tr>
<tr>
<td></td>
<td>3. Semi tendinosus</td>
<td></td>
</tr>
<tr>
<td>D. Lateral rotation</td>
<td>Biceps femoris</td>
<td>Tensor fasciae latae</td>
</tr>
<tr>
<td>E. Locking of Knee</td>
<td>Quadriceps femoris</td>
<td>Biceps femoris</td>
</tr>
<tr>
<td>F. Unlocking of Knee</td>
<td>Popliteus</td>
<td></td>
</tr>
</tbody>
</table>

**RADIOGRAPHIC APPEARANCE OF NORMAL KNEE JOINT**

Antero posterior view :-

Taken in full extension following features are noted

1) Articular ends of Femur and Tibia are demarcated by thin white lines of cortical bone.

2) Head and Styloid process of Fibula are seen considerably below the knee joint space on the lateral side and are superimposed by Tibia.

3) Inter condylar eminence of Tibia presents a spinous appearance on the upper surface of Tibia.
4) Inter condylar notch of Femur is variable and super imposed by Patella.

5) Knee joint space is normally a 0.5 cm gap cast due to radiolucency of the articular cartilage.

Lateral view

1) Inter condylar eminence of Tibia is slightly overlapped by Femoral condyles. The Spine lies somewhat behind the midpoint of the superior surface of Tibial condyles.

2) Knee joint space is obscured by overlapping bone shadows.

3) Medial and Lateral Femoral condyles anterior and posterior margins are not super imposed due to difference in their diameters.

4) Patella is seen in front of the condyles of Femur.

RADIOLOGICAL APPEARANCE OF KNEE JOINT

B) OSTEO-ARTHRITIS OF KNEE JOINT:

OSTEOARTHRITIS -

Definition:
It is defined as a degenerative non inflammatory joint disease characterized by destruction of articular cartilage and formation of new bone at the joint surfaces and margins.

Two main varieties of osteoarthritis are recognized.

1) Primary osteoarthritis
2) Secondary osteoarthritis

Primary osteoarthritis is always in elderly people.

Etiology – Obesity, Genetics, occupation involving prolonged standing, sports, endocrinal factor & metabolic disorders and old age. Increased muco polysaccharide in articular cartilage and diminished hyaluronic acid in Synovial fluid develop in old age which is noticed to cause osteoarthritis.

Pathology -

Changes in Articular Cartilage and Bone
Cartilage becomes soft and irregular at pressure points.
Minute flecks of cartilage called 'detritus' are shed into joint.
Fibrillation of cartilage occurs.
Followed by complete loss of articular cartilage.
This puts enormous pressure on under lying bone which causes sclerosis and later eburnation.
Cysts may develop in subchondral area due to micro fractures that degenerate.
New bone formation takes place in non pressure areas at periphery of Joints results in osteophyte formation.

Changes in Synovial Membrane
Synovial membrane shows changes when Lipping of articular cartilage
starts. Membrane hyper trophies and thickens it becomes shaggy (rough haired) Villi become enlarged.

Detritus deposits on Synovial membrane gradually penetrates into the sub Synovial layer & induces fibrosis.

Many tags appear particularly at places of attachment with capsule and may detach giving rise to loose bodies in joint called ' Joint mice'.

**Changes in Capsule and Ligaments**

Fibrous tissue of capsule becomes dense.

Transforms into fibro cartilage at point of attachment to articular cartilage.

Some times nodules appear at these places.

These changes restrict mobility of Joint.

Ligaments show gradual process of dissolution causing disorganization of joint.

**Changes in Neighboring tendons and Peri articular Tissues**

Neighboring tendons show attrition (abrasion).

Wasting of surrounding muscles is often noticed.

Overlying tissue becomes oedematous.

Skin looks pale, tight and shiny.

Knee joint Osteoarthritis may involve predominantly medial femoro tibial, lateral femoro tibial or patellofemoral compartment. It is usually unilateral but becomes bilateral over a period of time.

**SYMPTOMS OF OSTEO-ARTHRITIS :**-

**1. Pain**

a) Occurs after a night's rest and gradually disappears after use.

b) As disease progress pain becomes more severe and more constant and disturbs sleep. At this time pain gets more severe as joint is used.
Pain at night is an important symptom.

c) As pain increases joint gradually loses movement due to spasm.

2. Stiffness

a) Beginning it is noticed only after the joint has been immobile for some time.

b) Later on stiffness gradually increases and becomes constant.

3. Deformity — Genu varus (bow leg) is the deformity observed in Osteoarthritis of Medial Compartment and Genu valgus (knock knee) deformity in Osteoarthritis of lateral compartment.

4. Swelling of Joint

5. Limping.

6. Locking — Terminal movements of knee are restricted. Inability to extend the knee for last few degrees.

Physical Signs

 Inspection

Swelling and deformity of Joint.

Palpation

Joint may be mildly tender but it is not warm. Synovial thickening may be felt in superficial joints, so also swelling due to effusion. Osteophytes may be felt. Typical 'crepitus' — a sensation of grating may be felt when joint is moved.

Movements become more & more restricted as disease progress.

Muscle weakness & Muscle wasting may be present.

Symptoms of Osteoarthritis and cause beyond it are as follows:
1) **Pain**

<table>
<thead>
<tr>
<th>Source</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Synovium</td>
<td>Inflammation</td>
</tr>
<tr>
<td>2) Sub chondral bone</td>
<td>Micro fractures, Medullar hypertension caused by distortion of Blood flow by thickened Sub chondral bone.</td>
</tr>
<tr>
<td>3) Osteophytes</td>
<td>Stretching of periosteal nerve endings.</td>
</tr>
<tr>
<td>4) Ligaments</td>
<td>Stretch</td>
</tr>
<tr>
<td>5) Capsule</td>
<td>Inflammation and Distension</td>
</tr>
<tr>
<td>6) Muscle</td>
<td>Spasm</td>
</tr>
</tbody>
</table>

2) **Stiffness** – Restriction of movement at the beginning is due to muscle spasm, gradually fibrosis of the capsule and formation of Osteophytes restrict the movement of joint.

3) **Deformity** – It is due to Capsule shrinkage due to fibrosis and muscle imbalance.

4) **Swelling** - Swelling may be due to effusion, Synovial thickening or Osteophytes.

5) **Limping** – This is due to pain, stiffness and deformity of the joint.

6) **Locking** – is due to loose bodies.

Radiological examination of Knee joint is the most important diagnostic tool.

**FOLLOWING ARE THE RADIOLOGICAL FEATURES SEEN IN OSTEOARTHРИTIS OF KNEE.**

1] Loss of Joint space

2] Sub chondral Sclerosis
3] Sub chondral cysts
4] Osteophytes
5] Bony collapse
6] Loose Bodies
7] Deformity and malalignment

Radiological Anatomy variations of knee OA and the pathology beyond it is as follows

1] Joint space narrowing more common in Medial femorotibial compartment

The width of a joint space seen radiologically is due to radiolucent cartilage, joint space narrowing is therefore the result of cartilage destruction. This change characteristically occurs in areas of excessive weight bearing.

A normal knee joint is never straight. It has an average 7° valgus (Men 3 to 5°, Women 5 to 7°) So the weight bearing axis passes through the medial femoro tibial compartment more prone to joint space narrowing.

2] Sub chondral Sclerosis –

This occurs due to increase cellularity and bone deposition. Remodeling and hypertrophy of Bone occurs. Appositional bone growth occurs in subchondral region leading to Bony Sclerosis. Localized increase in density is presumably due to a) Stress induced new bone formation & b) Trabecular collapse.

3] Sub chondral cysts –

happens due to Synovial fluid intrusion into the bone.

4] Osteophytes –

Joint space narrowing due to cartilage destruction is followed by loss
of underlying bone in stressed areas and formation of new bone and cartilage in non stressed areas and at joint margins so that joint alignment alters. New bones formed at joint margins are called Peripheral Osteophytes or with in the joint are called Central Osteophytes. Osteophytic new bone is formed in response to new lines of force and prevents further malalignment.

6] **Loose Bodies**- Arises from 4 Sources.

1) Osteo Chondritis dissecans in which a fragment of bone is separated from the femoral condyle and less commonly from other parts of articular surfaces.

2) Osteoarthritis of knee with detachment or fracture of marginal Osteophytes from the patella, femoral condyles or Tibial condyles.

3) Chondrification of the Synovial membrane with formation of large number of loose bodies. (Osteo chondromatosis)

4) Injuries producing Osteo chondral fracture.

**STIFFNESS OF THE JOINT :-**

The viscosity of the synovial fluid changes with weather. i.e. fall or rise in temperature.

![Figure Shows Stiffness of Joint](image)
Fall in temperature leads to increased viscosity, leads to stiff joint and with rise in temperature the viscosity reduces.

**SPECIAL INVESTIGATION FOR A JOINT**

1. X-ray – Plain, Digital
2. Magnetic Resonance Imaging
3. C T scan
4. Arthroscopy

**CLINICAL SURVEY OF DISEASES PERTAINING TO THE JOINTS**

For the first time the clinical based survey is conducted in Lathwia in the year 1992. After that in the year 1999 for the first time the clinical survey is conducted by a society, by name – Network on occupational health and safety on total number of persons 851 randomly. The survey is done based on

1. Occupational
2. Geriatric (age based)
3. Pathological

**1. Occupational :-**

In the occupational survey they considered the persons who are doing their jobs in a sitting posture. Basing on this they have given their analysis as

a) Problems to the cervical part of vertebra effecting the vertebral disks needs to disk prolapse, compress , indentation of theca giving pressure to spinal nerves in 18 persons.

b) Problems to the lumbar part with the same effect in 15 persons.
They have given the symptoms exhibited by that persons as
1. Pain at corresponding joints
2. Numbness to the muscles which are supplied by the corresponding nerves under compression
3. Hand power during flexion of the hands is reduced
4. SLR is +ve for the lumbar problem patients
The investigations supporting the above complaints are also given
1. The X-ray shows - Osteophytes
   Reduced joint space
2. The MRI shows – Osteophytes
   Prolapsed disc
   Reduced and leak out nucleus pulposus
   Tissue disturbance

2) Geriatric (age based) :-

The age based problems are observed in both male and female during the survey.

In females the most common cause is menopause. Due to menopause the osteoporosis causes damage to the dependent bones which may broke when a situation arise. The broken bones after healing with treatment never come to the absolute normal condition. This leads to the change in gait of the patient. Due to change in gait the joints undergo osteoarthritic changes during wear and tear mechanism. These cases are found to be 23 in number in the survey.

In males age based osteoporosis is the main cause which leads to same pathological change in the bones giving the same result of osteoarthritis.
These cases are found to be 18 in number in the survey. The X-ray, MRI findings are just like the common osteoarthritic changes. So basing on this we can understand that the osteoporosis do not directly effect the joint. The effect on the bones indirectly gives the impact on the joints.

3) Pathological Survey :-

The age limit is taken as 15 - 60 years for the survey based on pathological causes.

1. Infectious - a) Rheumatoid Arthritis  
   b) Gouty Arthritis

2. Endocrinal dysfunction –  
   a) Obesity  
   b) Diabetes

4) Infectious :-

Rheumatoid Arthritis is mostly related with genetical factor. In the age group between 15 – 20 yrs juvenile rheumatoid arthritis is attacking. These cases are not at all found in occupational related survey. Only infectious related rheumatoid arthritis is present.

The gouty arthritis is most prevailed in females than in males .The age group is also between 25 – 45 yrs. The number of persons attacked are found to be 2 in the survey.

2. Endocrinal dysfunction

The thyroid problem causes obesity which in turn leads to osteoarthritis. Stress factor causes diabetes in 85 % of the cases in the centers where the software and business is more. The fluctuations in the levels of glucose cause the diabetic complications. One of those complications is diabetic arthropathy.