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REVIEW OF GULPHA SANDHI (ANKLE JOINT) ACCORDING TO AYURVEDA AND MODERN SCIENCE

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ABSTRACT

Sandhi means the meeting Point of 2 or more structure, according to modern - Tt is a point where two or more bones articulate with each other. Sandhi is essential for locomotion and various movements of body, there are 210 Sandhi's in human body, injury to these structures may lead to many locomotory disorders. Amongst all of the sandhi Gulpha sandhi is most prone to be injured. it is complex, hinge variety of synovial joint, injury that commonly occur during sport, exercise, running, jumping, pedaling etc. In Ayurveda Gulpha is explained under Marma sharir as Gulpha Marma, it is Adhoshakhagat sandhi of 2 in number, it comes under kora variety of Chesthavat sandhi. it is most vulnerable to damage due to exerted stress, which may produce severe Pain, stiffness, swelling, sprain, fracture. In order to treat all these deformities, one should have the knowledge of anatomy of joint, to understand its exact anatomical position, its locomotion, internal structure vital point involve in it, it is an attempt to present a guideline about ankle joint according to Ayurveda and modern literature.

KEYWORD: Gulpha sandhi, Gulpha marma, Ankle joint, Talocrural joint.

INTRODUCTION

The purpose of Ayurveda is to safeguard health while enhancing the longevity of life, human body has a complex system of different type of bones, muscles, ligament, tendons, organ, Tissue etc. each component and system play an important role in function of body. These structures may be subjected to disease and injuries from overuse and overload.

Sandhi (joint) are essential for locomotion and various movement of the body and to balance our body weight. The word Gulpha means where the Pada (foot) and Jangha meet to gather or the part of body where the foot is connected with the lower limb. The Gulpha are two in number which is situated in Pada Jangha sandhana. According to Amarkosh Gulpha means Padasya granthi.[1]

The word Gulpha is categorized under various concepts like as a sandhi (Joint), Marma (Vital point of the body), Asthisanghat (Union of more than 2 bones) & jaala (Plexus or network).[2] In ayurveda gulpha is explained under Marma Sharir as Gulpha Marma, it is adhoshakhagat sandhi of 2 in number, it comes under kora variety of chesthavat sandhi.[3]

Ankle joint is one of the most frequently injured areas of the body since being the connecting link between stable leg bone and the mobile foot and subjected to great varieties of forces in walking, running, standing etc. If there is any trauma or injury at Gulpha Marma region it will directly affect the (Gulpha Sandhi) ankle joint. The ligaments, tendons and bones have an important role in maintaining the stability of ankle joint and some clinical and pathological aspects of these are reviewed. Various traumas on ankle joint or Gulpha Marma leads to the biomechanical dysfunction of the joint.[4]

Comparison of Gulpha Sandhi as given in various Ayurvedic Samhita's.[5]

Veda kala

Vedas are the first written documentation of Indian civilization. In Atharva Veda references are available about Gulpha Sandhi. There is a query regarding how have the ankle's articulations been planned and formed.

Marma in Upanishad

Following references can be consider regarding Marma and associated subject available in different Upanishad.

- ★ Description of vessels and blood circulation
- ★ Vascular injuries
- ★ Characteristics of Sira and Dhamani.
- ★ Marma,
- ★ Dhamani,
- ★ There are 107 Marma mentioned in Garbhopanishad.
- ★ In Yogopanishad 18 Marma has been explained and Gulpha is one among them.

Charaka Samhita.[6]

Acharya Charaka has explained about Sandhi's in Charaka Shareera sthana 7th chapter.

Sushruth Samhita.[7]

Acharya Sushrutha has mentioned Gulpha Sandhi as Kora sandhi among the eight types of Sandhi's', Acharya Sushruta gave much importance to marma, he gives description on Marma, their types, numbers, locations, viddha lakshana in Shareera sthana 6th chapter.

Ashtanga Sangraha and Ashtanga Hrudaya.[8]

Reference of marma and Sandhi marma is available in both the Grantha's, Vruddha Vagbhat mentions in 7th chapter and Laghu Vagbhata in 4th chapter.

Bava prakasha Samhita.[9]

In Bavaprakasha Gulpha Sandhi and Gulpha marma has been explained in the Purvakanda, Garbha prakarana adhyaya.

Saranghdara Saamhita.[10]

Explanation about Sandhi and can be seen in Saranghdara Samhita Purvakanda (5^{th} chapter)

GULPHA AS MARMA.[11]

Aachrya Sushruta has described the Gulpha Marma which is a Rujakara Marma and its location is as follows. (su.sh-6/11)

The joint between Paada (foot) and Jangha (Leg) is said to be Gulpha and symptoms of aghat over Gulpha marma are:

According to Dr. Ghanekar**,** Gulpha is ankle joint includes tibio-fibular and talocrural articulation, when there is any injury on Gulpha there may be symptoms like

1. Ruja (Pain)
2. Stabdha Paadata (Stiffness of leg)
3. Khanjata (Functional Deformity)

Gulpha Marma

Type of Marma - Sandhi Marma.

Type of Sandhi - Kor sandhi.

According to Aghat lakshana - Rujakar Marma.

Sadanganusar - Adhoshakhagat Marma,

Position - Padajangha sandhana. |

Pramana - Two Anguli.

Number of Gulpha Marma - Two (one in each Gulpha Sandhi)

Marmabhighata lakshan.[12]

Manmabhigata result in sudden onset of pain, irregular pulsation, numbness, heaviness, unconsciousness, affinity to cold, sweating, vomiting and] dyspnoea. Convulsions, weakness of body, vertigo, shivering, tachycardia, heartbum and restlessness indicate a bad prognosis.

Acharya Susrutha in Sutrasthana, mentioned about the lakshanas of Sandhi kshata as increased swelling, severe pain, Slitting type of pain in the srrall joints, Loss of strength, Oedema loss of function of joints.

Shortening and debility of body parts, pain and delayed wound healing are the consequences of injury to the Snayu. Acharyas have mentioned the Gulpha Marmakshatha lakshanas according to the table as follows.

Table 1: Lakshana of Gulpha Marma kshata.

Sushrut samhita	Ashtang Samhita	Ashtang Hridaya
Ruk	Ruk	Ruk
Stambha	Stabda Sakthi	Stambha
Khanjatwa	Shantata	Mandhyakrith

Indu, the famous commentator of Astangsamgraha describes that Shantata means ‘Ayoshithyogyathwam’ (sexual inability). This is not mentioned in any of the other Brihatrayees.

Gulpha as sandhi.[13]

Synonyms- Padagranthi, Guthika, Charanagranthi, Ghuntakaha, khudaka, khallaka ,khulaka, khuduka.

It is sandhi of lower limb helps in various movements and bears 50% weight during locomotion. It is situated at the junction of foot and leg allowing movements, structurally it is kora and functionally bahuchala.it is also called Kallkorasandhi. Here more than two articular bones are involved. Medial and lateral malleolus, tibiofibular ligaments make deep socket for

the body of the talus, so structurally, it is strong joint and stability is due to interlocking of articular surfaces.

Gulpha as jaala

Jaala means network either formed by sira, snayu, mamsa and asthi.

a) Sira-Gulphajaala is formed by the blood vessels. Anterior medial malleolus and anterior lateral malleolus branches are anastomosis around ankle joint. The veins of lower limb are three group i.e superficial, deep and perforating superficial veins.

b) Mamsa-Jaala is tibialis anterior, ext. hallucis longus, ext. digitorum longus, peroneus tertius are anteriorly whereas posteriorly tibialis, flexor digitorum longus, flexor halluces longus, peroneus brevis and longus.

c) Snayujaala is fibrous capsule, medial and lateral ligaments, medial ligaments are 3 superficial Tibionavicular ligament, Tibiocalcaneal ligament and Posterior tibiofibular ligament and 1 deep ligament i.e., Anterior tibiotalar ligament whereas lateral ligament are Anterior tibiofibular ligament, Posterior tibiofibular ligament and Calcaneofibular ligament.

d) Asthijaala is formed by articulation with lower end of tibia with its medial malleolus and lateral malleolus of fibular inferior transverse tibiofibular ligament, body of talus.

7 tarsal bones are arranged in two rows as proximal and dorsal row. The talus, calcaneum in proximal row, medial, intermediate, lateral cuneiform, cuboid and navicular interposed medially between the head of talus and 3 cuneiform bones are in dorsal row.

Gulpha As Asthi Sanghata

The articulation of two or more bones forms as joints. Such joint region may be known as Asthisanghata and form the complex joint in the body in one each Asthisanghata is present in Gulpha pradesha.

MODERN REVIEW ANKLE REGION.[14]

The ankle or the talocrural region Is the region where the foot and the leg meet the ankle and formed the joint-The Ankle joint or talocrural joint.

The Subtalar joint and the Inferior Tibiofibular joint

The movements produced at this joint are: - a) dorsiflexion b) planter flexion of the foot.

In medical terminology ankle can refer specifically to the Talocrural joint.

The main base of the ankle region is the talus (in the foot) and the Tibia and Fibula (in the leg) .The Talus is also called the Ankle bone. The articulation between the Tibia and the Talus bears more weight than that between the shorter Fibula and the Talus.

The Ankle joint (talocrural joint) is a Diarthrodial articulation involving the distal Tibia and Fibula and the body of the Talus; it is the only example in the human body of a "true mortise joint" .The human foot is a complex structure adapted to allow Orthograde bipedal stance and locomotion and is the only part of the body which is in regular contact with the ground .There are 28 separate bones in the human foot, including the Sesamoid bones of the first meta Tarso phalangeal joint and 31 joints, including the Ankle joint.

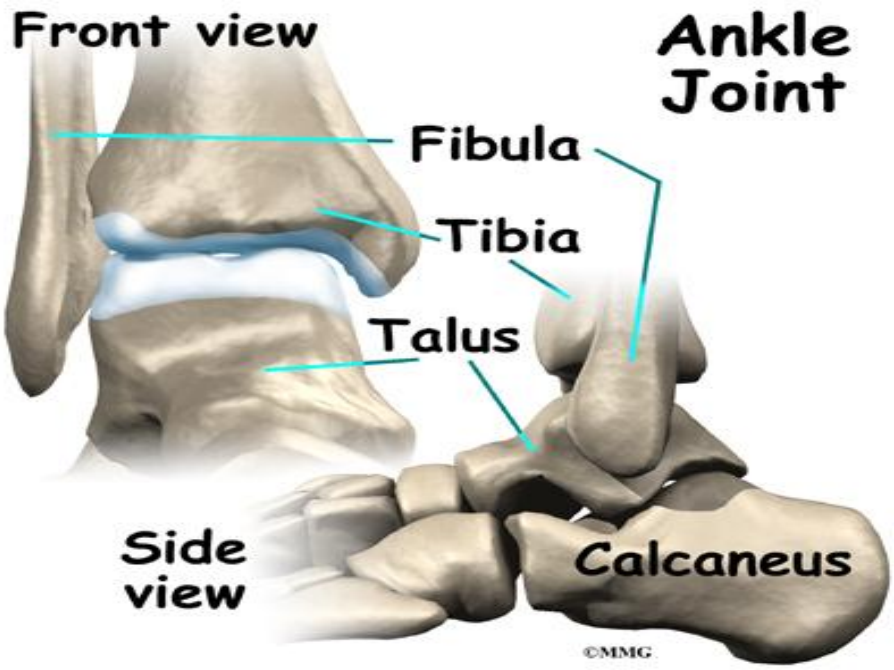

Fig 1: Ankle joint.

Articular Surfaces

The upper articular surface is formed by;

i) The lower end of the Tibia including the medial Malleolus

ii) The lateral malleolus of the Fibula

ii) The Inferior transverse Tibio fibular ligament. These structures form a deep socket.

The inferior articular surface is formed by articular areas on the upper, medial and lateral aspects of the Talus.

Structurally, the joint is very strong. The stability of the joint is ensured by

i) Close interlocking of the articular surfaces

ii) Strong collateral ligaments on the sides

iii) The tendons that cross the joint, four in front, and five behind, the depth of the superior articular socket is contributed by- i) The downward projection of the medial and lateral malleoli, on the corresponding sides of the Talus; and ii) By the inferior transverse tibiofibular ligament that bridges across the gap between the tibia and the fibula behind the talus. The socket is provided flexibility by strong tibiofibular ligaments and by slight movements of the fibula at the superior tibiofibular joint.

There are two factors, however that tend to displace. The tibia and fibula forwards over the Talus. These factors are:

a) The forward pull of tendons which pass from the leg to the foot; and

b) The pull of gravity when the heel is raised. Displacement is prevented by the following factors.

The talus is wedge shaped, being wider anteriorly. The malleoli are oriented to fit this wedge

I) The posterior border of the lower end of the tibia Is prolonged downwards.

ll) The presence of the inferior transverse tibiofibular ligament.

III) The Tibiocalcaneal, posterior Tibiotalar, Calcaneofibular and posterior Talofibular ligaments pass backwards and resist forward movement of the Tibia and Fibula.

Ligaments

The joint is supported by

i) Fibrous capsule

ii) The deltoid or medial ligament

iii) Lateral ligament.

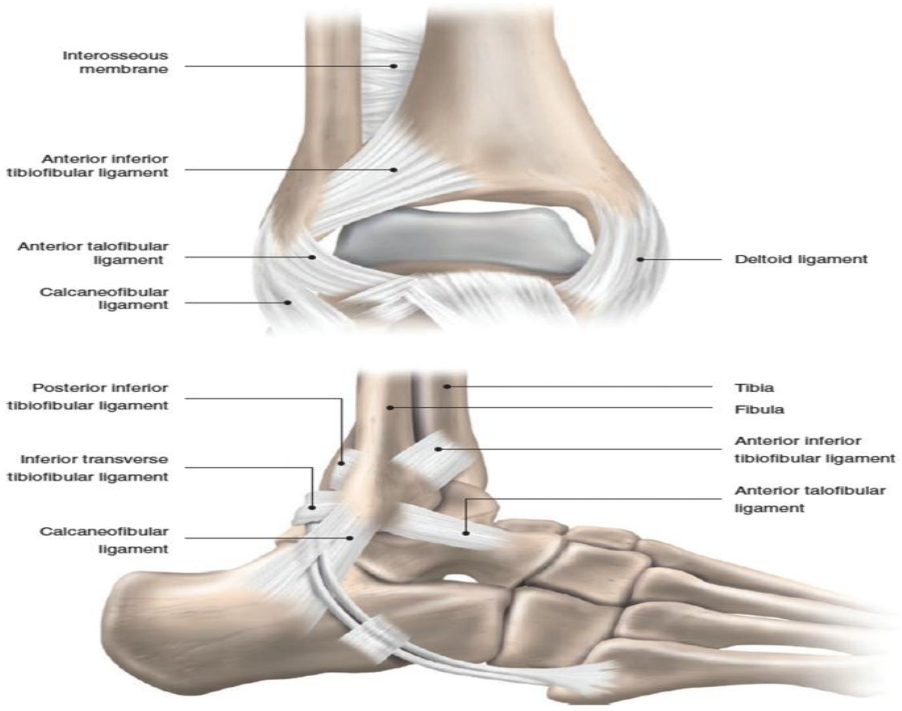

Fig. 2: Ankle joint ligament.

i) Fibrous Capsule: - It surrounds the joint and is attached all around the articular margins with two exceptions. 1) Postero-superiorly, it is attached to the inferior transverse tibiofibular ligament; and 2) Antero-inferiorly, it is attached to the dorsum of the neck of the talus at some distance from the trochlear surface.

The anterior and posterior parts of the capsule are loose and thin to allow hinge movements. On each side, however, it is supported by strong Collateral ligaments.

The synovial membrane lines the capsule. The joint cavity ascends for some distance between the tibia and the fibula.

ii) The Deltoid Or Medial Ligament

This is very strong triangular ligament present on the medial side of the ankle. The ligament Is divided into a superficial and a deep part, both parts have a common attachment above to the apex ang margins of the medial malleolus. The lower attachment Is Indicated by the name of the fibers.

a) Superficial part-

i) Anterior fibers or Tibionavicular ligament are attached to the tuberosity of the Navicular bone and the medial margin of the spring ligament.

ii) The middle fibers or Tibiocalcaneal are attached to the medial tubercle or posterior Tibiotalar are attached to the medial tubercle and to the adjoining part of the medial surface of the talus.

b) Deep part

Anterior tibiolateral is attached to the anterior part of the medial surface of the talus. The deltoid ligament is crossed by the tendons of the Tibialis posterior and flexor digitorum longus.

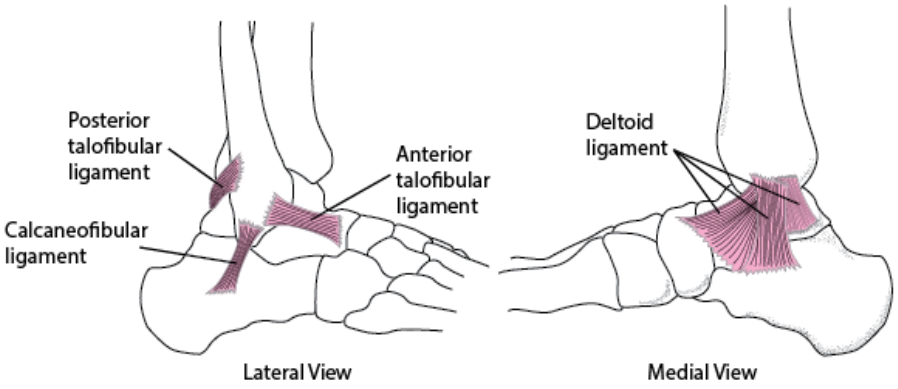

Fig. 3: Medial & lateral side of ankle joint showing deltoid & lateral ligament.

iii) Lateral Ligament

a) The anterior talofibular ligament is a flat band which passes from the anterior margin of the lateral malleolus to the neck of the talus, just in front of the fibular facet.

b) The posterior Talo fibular ligament is a flat band which passes from the lower part of the malleolar fossa of the fibula to the lateral tubercle of the talus.

c) The Calcaneo fibular ligament is a long-rounded cord which passes from the notch on the lower border of the lateral malleolus to the tubercle on the lateral surface of the Calcaneum. It is crossed by the tendons of the Peroneus and Brevis.

Relations of The Ankle Joint (Transverse section of the ankle joint).[15]

Anteriorly: Anteriorly from medial to lateral side, the ankle joint is related to the following structures:

1. Tibialis anterior
2. Extensor Hallucis longus
3. Anterior Tibial Artery
4. Deep Peroneal nerve

5. Extensor Digitorum longus
6. Peroneus tertius.

Posteriorly: Posteriorly medial to lateral side, Ankle joint is related to following structure:

1. Tibialis posterior
2. Flexor Digitorum longus
3. Posterior Tibial Artery
4. Posterior Tibial nerve
5. Flexor hallucis longus

Muscles.[16]

Muscles give shape to the body by holding the bones in position. It expands and contract to impart movement. The muscles act on the ankle through three separate compartments such as:-1) Anterior 2) Posterior and 3) Lateral compartments

Anterior compartment muscles cross the ankle joint anteriorly to act as dorsiflexors. The muscles of posterior and lateral compartments cross the ankle joint, posteriorly to form plantar flexors.

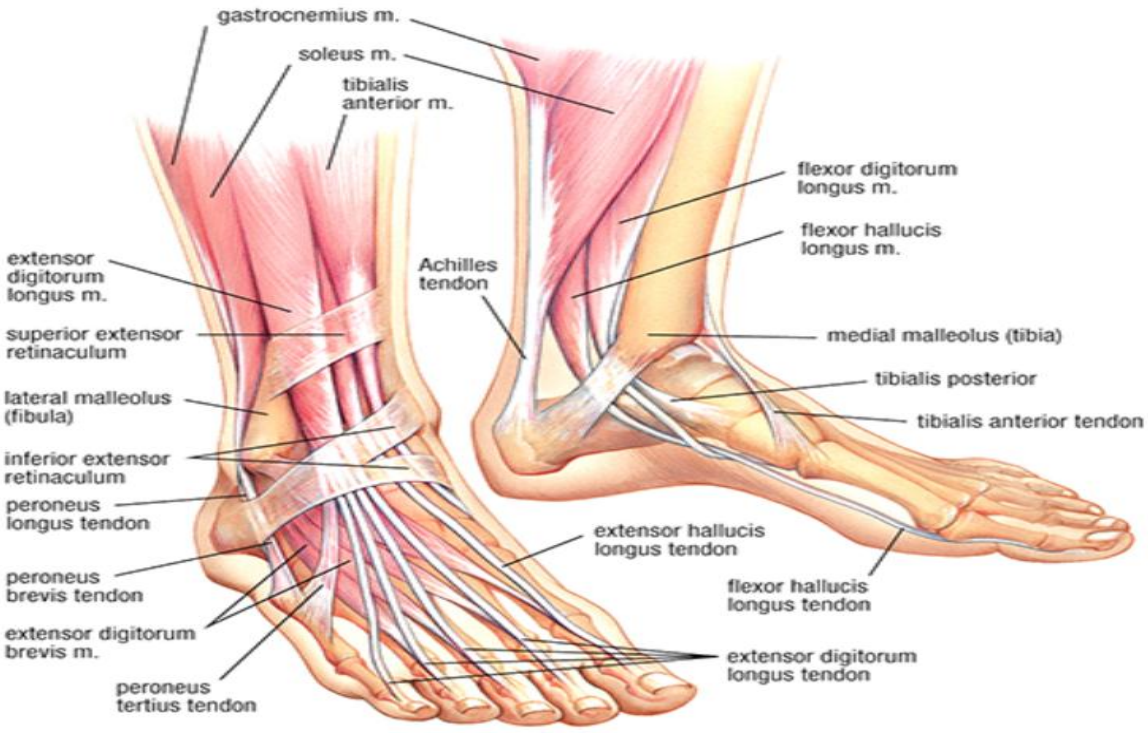

Fig. 4: Muscles & tendons of ankle joint.

Tendons

Ends of muscles are attached to bone, cartilage or ligaments by a cord of fibrous tissue called tendon. They vary in length and thickness according to the site within the body.

A tendon may be enclosed in a sheath to prevent friction and may be separated from neighboring structures by a bursa. They are very strong structures and so are rarely ruptured but injuries occur at the attachment to bone or the tendomuscular junction. The forces applied to a tendon may be more than five times of body weight.

Table no. 2: Muscles contributing to foot and ankle movement.

Dorsiflexion -	Extensor digitorum longus Extensor hallucis longus Peroneus tertius Tibialis anterior
plantar flexion-	Flexor digitorum longus Flexor hallucis longus Gastrocnemius Peroneus longus Peroneus brevis Plantaris Soleus Tibialis posterior
Inversion-	Extensor hallucis longus Flexor digitorum longus Flexor hallucis longus Tibialis posterior
Eversion	Extensor digitorum longus Peroneus brevis Peroneus longus Peroneus tertius

Movements.[17]

Active movements are dorsiflexion and plantar flexion.

1) In dorsiflexion the forefoot is raised, and the angle between the front of the leg and the dorsum of the foot is diminished. It is a close-pack position with maximum congruence of the joint surfaces. The wider anterior trochlear surface of the talus fits into lower end of narrow posterior part of the lower end of tibia. There are no chances of dislocation in dorsiflexion.

2) In plantar flexion, the forefoot is depressed, and the angle between the leg and the foot is increased. The narrow posterior part of trochlear surface of talus loosely fits into the wide

anterior part of the lower end of tibia. High heels cause plantar flexion of ankle joint and its dislocations....

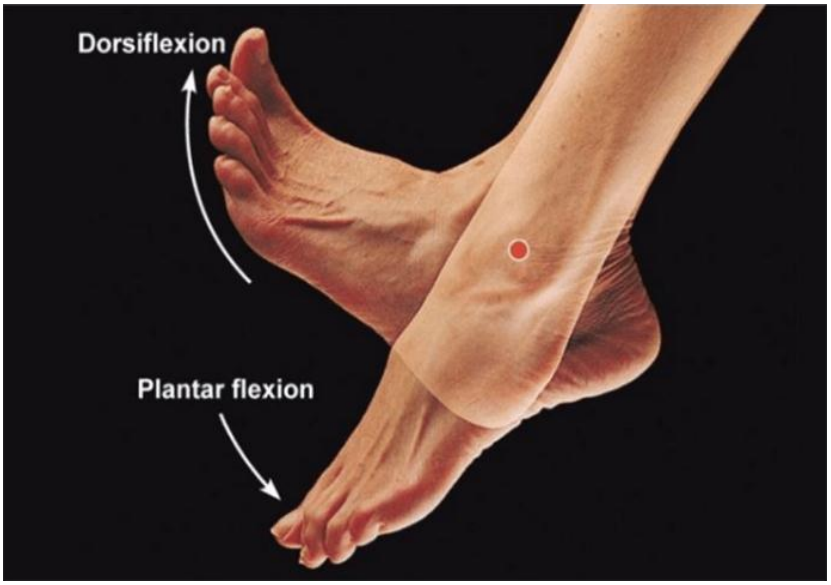

Fig. 5: Movements of ankle joint.

Blood Supply.[18]

Anterior medial malleolar and anterior lateral malleolar branches take part in the anastomoses around the ankle joint or malleolar networks.

- Lateral malleolar network

Lies just below the lateral malleolus. It is formed by anterior lateral malleolar branch of anterior tibial artery, lateral tarsal branch of dorsalis pedis artery, perforating branch of the peroneal artery, calcaneum or terminal branch of the peroneal artery and twigs from lateral plantar artery.

- Medial malleolar network

Lies just below the medial malleolus. It is formed by anterior medial malleolar branch of anterior tibial artery, medial tarsal branch of dorsalis pedis artery, medial malleolar branch of posterior tibial artery, calcaneal branches of posterior tibial artery and twigs from the medial plantar artery.

Nerve Supply: Branches of deep peroneal nerve and tibial nerves.

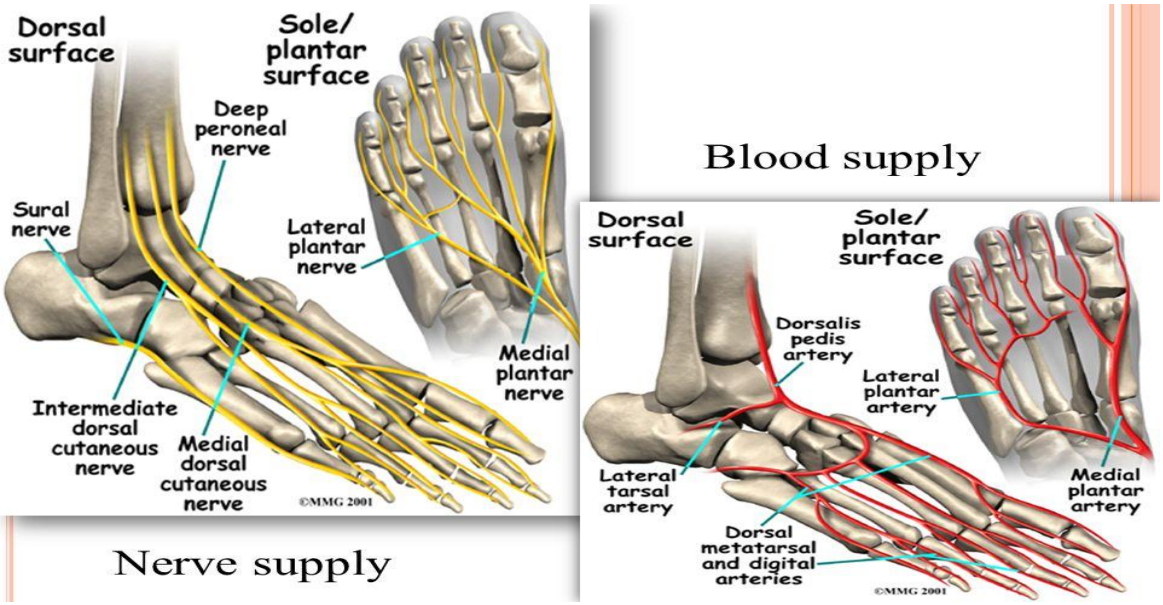

Fig. 6: Blood supply & nerve supply of ankle joint.

Clinical Anatomy.[19]

1) **The sprains of the ankle** are almost always abduction sprains of the subtalar joints, although a few fibers of the deltoid ligament are also torn. True sprains of the ankle joint are caused by forced plantar flexion, which leads to tearing of the anterior fibers of the capsule. The joint is unstable during plantar flexion.

2) **Dislocations of the ankle** are rare because joint is very stable due to the presence of deep tibiofibular socket. Whenever dislocation occurs, it is accompanied by fracture of one of the malleoli. Acute sprains of lateral ankle occur when the foot is plantar flexed and excessively inverted. The lateral ligaments of ankle joint are torn giving rise to pain and swelling.

3) **Acute sprains of medial ankle** occur in excessive eversion, leading to tear of strong deltoid. ligament. These cases are less common.

4) **The optimal position of the ankle** to avoid ankylosis is one of slight plantar flexion.

5) **For injections into the ankle joint,** the needle is introduced between tendons of extensor hallucis longus and tibialis anterior with the ankle partially plantar flexed.

6) **During walking,** the plantar flexors raise the heel from the ground. When the limb is moved forwards the dorsiflexors help the foot in clearing the ground. The value of the

ankle joint resides in this hinge action, in this to and fro movement of the joint during walking.

7) **Pott's fracture** is a fracture affecting one or both of the malleoli. During activities such as landing from jump (volleyball, basketball) or when rolling on ankle, a cetain amount of stress is placed on the tibia and fibula and ankle joint.[20]

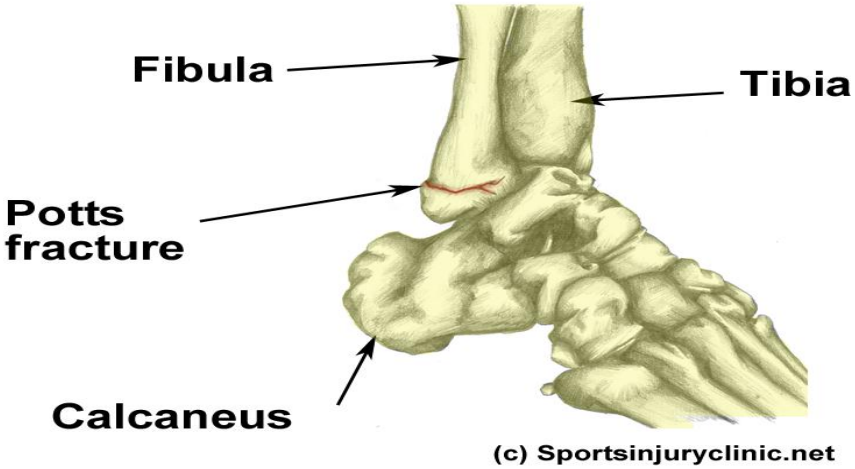

Fig no. 7: Pott's fracture.

DISSCUSSION

After detail study of Ayurvedic and modern literature it is concluded that Gulpha Marma which is a Sandhi Marma is situated at the junction of Pada (foot) and Jangha (leg) is called Gulpha or Ankle joint.

According to modern literature the ankle, or the talocrural region, is the region where the foot and the leg meet. The ankle includes three joints:-Talocrural joint, Subtalar joint, and Inferior tibiofibular joint. The movements produced at this joint are dorsiflexion and plantar flexion of the foot. The talocrural joint is a synovial hinge joint that connects the distal ends of the Tibia and Fibula in the lower limb with the proximal end of the Talus. The articulation between the Tibia and the Talus bears more weight than that between the smaller Fibula and the talus, So after Aghata Over ankle joint maximum chances of injury in lateral side, tibiotalar joint is more stable than fibulotalar joint and lateral collateral ligament is weaker than medial collateral ligament So the Ruja on the lateral side is more than medial side.

As we know Gulpha Marma is a Sandhi Marma and Rujakar marma so this Marma is a Sandhi predominant Marma, but other structures are also (Mamsa, Sira, Snayu and Asthi)

involved in the Marma. Structural study of Gulpha Marma show 5 compositions is correlated as:

MAMSA Fibularis (peroneus) longus, fibularis brevis, superior fibular(peroneal) retinaculum.

SIRA Perforating branch of Fibular (peroneal) artery, Fibular nerve.

SNAYU Lateral ligament of the ankle which consists of three separate ligaments.

1. Anterior talofibular ligament, a flat weak band
2. Calcaneofibular ligament
3. Posterior talofibular ligament.

ASTHI - Tibia, Lateral malleolus of Fibula.

SANDHI - Joint between Tibia, Fibula and Talus.

Injury to Gulpha marma cause
(viddha lakshan)

1) Stabhdata- Rigidity, stiffness
2) Khanjata- Deformity of foot or lower limb
3) Ruja- pain

CONCLUSION

As per Ayurveda Gulpha Marma located between pada and jangha compared with modern anatomy, it is found out that it is lies in ankle joint. The Gulpha Marma abhigata leads to Ruja and Stambha, further if it is not treated that may leads to the disability of the joint i.e., Vaikalyata. The Khanjata means disability, the Khanjata is due to the deformity of structures involved in the Gulpha Sandhi Marma. We need to take care of ankle joint and do regular exercise and oleation for its smooth functioning, based on above review and discussion, we can conclude that ankle joint is vital part of body, hence it is vulnerable, which need to be protected from trauma or injury.[18]

REFERENCES

1. Dwivedi S, Shukla D, “An Observational study to find location of Gulpha Marma wsr to Ankle sprain”, Int. J. ayu. Alt Med., 2015; 29.

2. Kulkarni P S et.al. World journal of pharmaceutical research, Jaysingpur, Maharashtra, study on- "Study of different aspect of Gulpha with special reference to tarsal tunnel syndrome, 2018; 7(17): 638. (www.wipr.net)
3. Jyothi V, Rajiv Gandhi University of health science, Bangalore, Karnataka," Comprehensive study on Gulpha sandhi Shareer wsr to its structural changes in Aamvaat, 2009-2012; 1.
4. Aneesh T et. al., Karnataka, international journal of Ayurveda & Pharma research, "An Ayurvedic understanding of biomechanical dysfunction of ankle joint wsr Gulpha Marma Abhighat", 2016; 4(7): 74-77.
5. Vipin P.C, Rajiv Gandhi university of health science, Bangalore, Karnataka, "A Comprenhsive study on Gulpha sandhi Shareer wsr to sport injuries", 2010-2011; 4, 5.
6. Ravi Datta Tripathi, translated by Vijay kale, Charak Samhita, publish by Chaukhamba Sanskrit Pratishtan (2013) edition-1, vol-1, Sharirsthana - 7/6, pg-764.
7. Shastri A.D, Sushrut Samhita, vol-1, reprint-2012, Chaukhamba sanskrit sansthan (2013), Sharirsthan-6; 6, 8.
8. Garde G, translated commentary on Ashtang Hridaya, published by Chaukhamba surbharti prakashan (2014), 4/5, pg-143
9. Sitara B. Translated commentary on Bhavprakash of Bhavmishra, Chaukhamba Orientalia Varanasi, edition-1 (2010) vol- 2, Madhyamkhanda-24; pg-160
10. Acharya Radhakrishna Parashar et.al, Sharangdhar Samhita, published by Baidya Nath Ayurveda Bhavan Ltd (1994), edition-4, purvakhanda-5/55; pg-88
11. Dwivedi S, Shukla D.; "Observational study to find location of Gulpha Marma wsr to ankle sprain"; Int. J. ayu. Alt Med., 2015; 29.
12. Vipin P.C, Rajiv Gandhi University of health science, Bangalore, Karnataka,- " A Comprehensive study on Gulpha sandhi sharer wsr to sport injuries", 2010-2011; 41.
13. Mulimani N.G, et. all, ISSN-2456-4354, Karnataka (2017) PIJAR, vol-1, issue-4; pg-68,70
14. Dwivedi S, Shukla D.; "Observational study to find location of Gulpha Marma wsr to ankle sprain"; Int. J. ayu. Alt Med., (2015); 56, 60.
15. Gangal J. et.al; "Concept of Gulpha Pradesh in Ayurveda" IJTSRD, April 2020; IV (3): 1030.
16. Vipin P.C, Rajiv Gandhi University of health science, Bangalore, Karnataka (2010-2011), -"A Comprehensive study on Gulpha sandhi sharer wsr to sport injuries', 2010-2011; pg-29, 30, 31.

17. Chourasia B.D, Human Anatomy -Regional & Applied Dissection & Clinical, 6th edition vol-2 CBS publishers & distributors, New Delhi-2013; 152.
18. Jyothi V, Rajiv Gandhi University of health science, Bangalore, Karnataka," Comprehensive study on Gulpha sandhi Shareer wsr to its structural changes in Aamvaat, 2009-2012; 26.
19. B. D Chourasia, Human Anatomy -Regional & Applied Dissection & Clinical, 6th edition vol-II, CBS publishers & distributors, New Delhi; 150.
20. https://www.physio-pedia.com.