

**THE BIOMECHANICS OF HIGH HEELS ON THE ANKLE JOINT AND GULPHA MARMA****Dr. Pallavi Waghmare<sup>1\*</sup>, Dr. Rita Marwaha<sup>2</sup>, Dr. Shiba Datta Panda<sup>3</sup>, Dr. Pankaj Gupta<sup>4</sup> and Dr. Swatantra Chourasia<sup>5</sup>**<sup>1</sup>Post Graduate Scholar, Final Year, PG Department of Rachna Sharir, Pt. Khushi Lal Sharma Govt. Ayurveda College, Bhopal, Madhya Pradesh, India.<sup>2</sup>Professor & HOD, PG Department of Rachna Sharir, Pt. Khushilal Sharma Govt. Ayurveda College, Bhopal, Madhya Pradesh, India.<sup>3</sup>Assistant Professor, PG Department of Rachna Sharir, Pt. Khushilal Sharma Govt. Ayurveda College, Bhopal, Madhya Pradesh, India.<sup>4</sup>Professor, PG Department of Rachna Sharir, Pt. Khushilal Sharma Govt. Ayurveda College, Bhopal.<sup>5</sup>Assistant Professor, PG Department of Rachna Sharir, Pt. Khushilal Sharma Govt. Ayurveda College, Bhopal, Madhya Pradesh, India.**\*Corresponding Author: Dr. Pallavi Waghmare**

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**ABSTRACT**

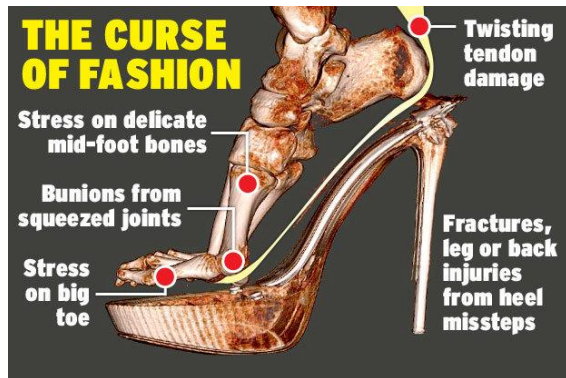
Although high heels provide a striking aesthetic enhancement, their widespread use extends beyond just fashion trends. They hold cultural and social significance, often being seen as a symbol of empowerment and femininity. Many women wear high heels as a form of self-expression or to convey confidence and authority in both professional and social settings. From red carpets to office corridors, high heels remain a powerful statement in the ensemble of contemporary fashion, underlining their enduring popularity in modern society. High-heeled shoes, although very common for cosmetic reasons, subject the ankle joint, or *Gulpha Sandhi* in *Ayurveda*, to major biomechanical stress. This joint is also the site of the *Gulpha Marma*—*Snayu Marma* (ligament-related vital point) in traditional *Ayurvedic* literature such as the *Sushruta Samhita* and *Ashtanga Hridaya*. This article critically reviews the influence of high heels from the perspectives of contemporary biomechanics and *Ayurvedic marma* theory. The plantar flexion produced by high heels moves the body's center of gravity and destabilizes the ankle, making ligament injury and loss of balance more likely. *Ayurvedic* accounts of *marma viddha lakshanas* are close observations, listing pain, swelling, and functional disability as resulting from trauma to *Gulpha Marma*. Integrative therapy approaches—such as *marma chikitsa* and *Panchakarma*—are described as effective for high heel-associated injuries. The article promotes clinical biomechanics to promote improved preventive and curative approaches to ankle joint health.

**KEYWORDS:** Plantar flexion, Gulpha marma, snayu marma.**INTRODUCTION**

High-heeled shoes are frequently linked to style and beauty; they significantly modify the lower extremities biomechanics, especially the ankle joint. These modifications affect muscle activation patterns, load distribution, posture, and gait dynamics, which may cause discomfort and long-term musculoskeletal issues. The effect of these modifications on the *Gulpha Marma*, a crucial vital point around the ankle area. According to contemporary anatomy, the ankle joint, also known as the talocrural joint, is a hinge-type synovial joint made up of the articulation of the talus, fibula, and tibia. It is essential for maintaining body weight and enabling motions like plantarflexion and dorsiflexion. Wearing

high heels increases plantarflexion at the ankle joint by moving the center of gravity of the body anteriorly. This change leads to decreased stability, changed proprioceptive feedback, and increased strain on the posterior muscles and connective tissues. According to studies, wearing high heels on a regular basis shortens the fascicles of the gastrocnemius muscle and stiffens the Achilles tendon, which decreases the ankle's active range of motion. *Gulpha Marma* is classified as a *Sandhi Marma* (joint-related vital point) and is one of the 107 essential *Marma* points in the *Ayurvedic* system. It includes the ankle joint's anatomical components, such as bones, ligaments, tendons, and related soft tissues, and is situated where the foot (*Pada*) and leg (*Jangha*)

converge.<sup>[1]</sup> It encompasses the anatomical structures of the ankle joint, including bones, ligaments, tendons, and associated soft tissues. Injury or excessive strain to this area—such as that induced by high-heeled footwear—may disrupt the physiological and energetic equilibrium of the lower limb, potentially leading to pain, stiffness, and functional impairments.



## ANATOMY OF ANKLE JOINT AND GULPHA MARMA

*Gulpha Marma* corresponds anatomically to the talocrural (ankle) joint, where the distal tibia and fibula articulate with the talus. The ankle joint, also known as the talocrural joint, is a synovial hinge-type joint that permits movement primarily in one plane—dorsiflexion and plantarflexion of the foot.

### Articulating Bones<sup>[3]</sup>

The ankle joint is formed by

- The distal end of the tibia, including the medial malleolus.
- The distal end of the fibula, including the lateral malleolus.
- The body of the talus, particularly its superior (trochlear) surface.

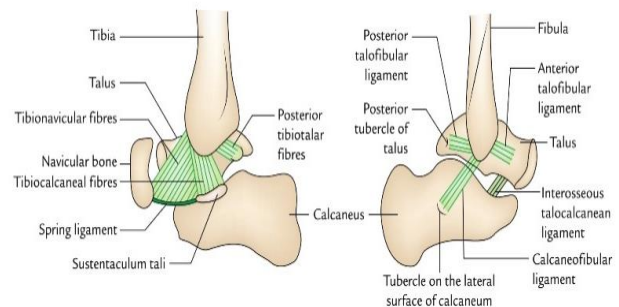
### Ligaments of the Ankle

The ankle joint is stabilized by a dense network of ligaments that support the joint during movement and protect against over-eversion or over-inversion. They are divided into medial and lateral ligament complexes.

### MOVEMENTS OF ANKLE JOINT<sup>[5]</sup>

Movement	Description	Primary Muscles Involved
<b>Dorsiflexion</b>	Upward movement of the foot toward the shin.	Tibialis anterior, extensor hallucis longus, extensor digitorum longus, fibularis tertius
<b>Plantarflexion</b>	Downward movement of the foot away from the shin.	Gastrocnemius, soleus, flexor hallucis longus, flexor digitorum longus, tibialis posterior
<b>Inversion</b>	Movement of the sole medially (toward midline)—mainly subtalar joint.	Tibialis anterior, tibialis posterior
<b>Eversion</b>	Movement of the sole laterally (away from the midline)—mainly the subtalar joint.	Fibularis longus and brevis

Medially, the deltoid ligament is a strong, fan-shaped band that extends from the medial malleolus of the tibia to the talus, calcaneus, and navicular bones. It is composed of four separate parts, which include the tibionavicular, tibiocalcaneal, anterior tibiotalar, and posterior tibiotalar ligaments. The ligament primarily has the responsibility of resisting eversion in the ankle joint.<sup>[4]</sup>

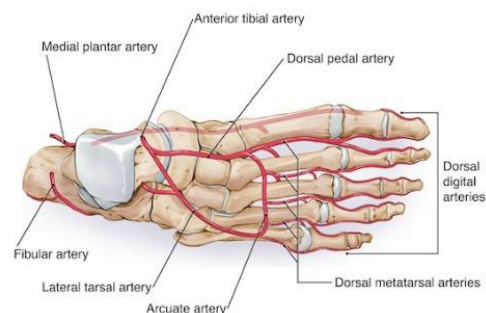


### Lateral Ligaments

Located on the lateral side of the ankle, these are at greater risk of injury (especially with inversion sprains). Composed of 3 large ligaments: Anterior talofibular ligament (ATFL)—most commonly affected Calcaneofibular ligament (CFL) Posterior talofibular ligament (PTFL).

Function: Inhibits inversion (inward rolling) of the foot.

Arteries: Anterior tibial, posterior tibial, and fibular (peroneal) arteries.



Nerves: Deep fibular (anterior compartment), tibial (posterior compartment)

## GULPHA MARMA

Acharya Sushruth structurally classified it as Kora sandhi and functionally have classified it as *bahuchal sandi*. And have explained that *gulphasandhi* is present in a region between *paada* and *janghapradesha*.<sup>[6]</sup>



- **Number:** 2 (one in each ankle)
- **Category:** Sandhi Marma (joint type)
- **Size:** 4 Angula (approx. 7–8 cm in diameter)
- **Prognosis of Injury:** *Vaikalyakara Marma* (causing disability upon injury).<sup>[7]</sup>
- **Therapeutic importance** – This marma point is very potent for relieving various painful conditions of lower back and legs. The regular stimulation of this marma helps in improving the balance in profession like dancing, running and other sport activities.<sup>[8]</sup>

## EFFECTS OF INJURIES

### Ayurvedic Interpretation of High Heel-Induced Injuries

According to Ayurveda, high heels are an *aggravating factor* for *Vata Dosha*—responsible for movement and nerve function. Constant stress on the *Gulpha Marma* can lead to:

- *Gulpha Shotha* (ankle swelling)
- *Rujā* (pain)
- *Bhramsha* (dislocation or misalignment)
- *Sandhigata Vata* (degenerative joint disease)

## EFFECT OF HIGH HEELS ON ANKLE JOINT MECHANISM

The impact of high heels on ankle joint mechanics is a significant concern when discussing the broader implications of wearing such footwear. High heels cause notable alterations in posture and gait, which can place additional stress on the ankle joints. When wearing high heels, the foot is positioned in plantar flexion, which elevates the heel and shifts the body's center of gravity forward.

## AYURVEDIC UNDERSTANDING OF PAIN AND ITS TREATMENT BY MARMA CHIKITSA

Pain is a psychic response of an essential protective reflex with imperative necessity. Pain results from above-threshold intensity stimuli to sensory nerve endings. The nervous impulses arise due to stimulation of peripheral receptors, which is sensed as pain in the higher cerebral centers. This type of nervous activity can be produced by a variety of physical phenomena, i.e.

pressure, squeezing, tension, tearing, histamine-like substances, bradykinin, serotonin and other polypeptide compounds.

In *ayurveda*, *Vedana*, *Dukha*, *Pida*, *Sula*, *Ruka*, *Ruja*, *Beda*, *Sadana*, *Avasada*, are the words applied to pain. *Sushruta Samhita* states that the main causative factor of pain is *Vata*. The seat of pain is *Mana* (psyche) and *Sharira* (body). Pain to be relieved instantly is the goal of *Marma Chikitsa*. Stimulation of *Marma* may lead to analgesia by releasing a sequence of prostaglandin inhibitors, endorphins, interferon, and other opioid-like compounds which are hundreds of times stronger than opium. Pain can be relieved instantly within no time.

पादजंघयोः संधावे गुल्फो नाम, तत्र रुजः स्तब्धपादता खञ्जता वा ।  
"(सु०शा० ६/२४)

According to *Sushruta Samhita*, injury to a *Marma* like *Gulpha* leads to *Vaikalyata* (disability). Management focuses on restoring function, reducing inflammation,

## Marma chikitsa

Gulpha marma is one of the most important, potent, and tender marma of the body. it is situated at the ankle joint (junction below the leg and foot).

**Technique** The thumb is placed at the dorsal part of the ankle, and the index finger is kept at the groove postero-inferior to the malleolus. A hook-like shape is formed between the index finger and thumb now, the marma point is stimulated by striking or pushing it towards the malleolus. This is to be done 10-15 times. similar technique is applied on the other side.

## IMPACT OF HIGH HEELS ON ANKLE JOINT BIOMECHANICS

High heels cause the foot to bend into plantar flexion, lifting the heel above the toes and shifting the body's center of gravity forward. This position places undue strain on the Achilles tendon, calf muscles, and posterior capsule of the ankle joint, resulting in muscular shortening, reduced dorsiflexion, and compensatory responses that alter gait and posture.<sup>[9]</sup>

- **Altered Joint Dynamics:** Wearing high-heeled shoes can lead to increased plantarflexion of the ankle, which affects the overall biomechanics of the lower extremities. This altered position can reduce the ankle's range of motion (ROM) and affect the stability of the joint during walking.
- **Increased Muscle Activity:** Studies indicate that high-heeled shoes require greater muscle activation around the ankle to maintain balance and stability. This increased demand can lead to muscle fatigue and discomfort, particularly in the gastrocnemius and soleus muscles, which are placed in a shortened position while wearing heels.
- **Pressure Distribution:** The pressure exerted on the forefoot is significantly higher when walking in high-heeled shoes compared to flat shoes. This increased pressure can lead to various foot



deformities, such as hallux valgus and other musculoskeletal injuries.

- **Risk of Injuries:** The biomechanics of walking in high heels can increase the risk of ankle sprains and other injuries. The instability caused by elevated heels can lead to falls and other accidents, particularly in inexperienced wearers.
- **Long-term Effects:** Prolonged use of high heels may result in chronic issues such as tendonitis, inflammation of the bursa, and progressive

stretching of the ligaments around the ankle joint. These conditions can lead to long-term mobility issues and pain.

**Recommendations for Wearers:** To mitigate the negative effects of high heels, it is advisable for wearers to limit the duration of use, choose lower heel heights, and incorporate exercises that strengthen the ankle and improve flexibility.



## DISCUSSION

High heels drastically change the lower limb's biomechanics, especially the ankle joint and the area known as Gulpha Marma in Ayurveda. Weight transmission and movement depend heavily on the ankle joint, a synovial hinge joint made up of the tibia, fibula, and talus. Wearing high heels causes the body's center of gravity to move anteriorly, which alters posture and joint loading patterns to compensate.

This forward shift causes the ankle joint to become more plantarflexed, which puts unnecessary strain on the leg's posterior structures, such as the calf muscles and Achilles tendon. Increased compressive forces over a smaller area result from the changed alignment, which decreases the contact area between the talus and tibial plafond. Joint degeneration, diminished proprioception, decreased stability, and an increased risk of falls or injuries like ankle sprains can all result from this over time.

As a Sandhi Marma (joint-related vital point), Gulpha Marma is significant from an Ayurvedic standpoint because it is linked to both physiological processes and structural integrity. Regular wearers of high heels often report experiencing ruja (pain), stabdhata (stiffness), and movement impairment as a result of injury or prolonged stress to this Marma. The persistent strain and misalignment, which primarily affects the joint's Snayu (ligament) and Asthi (bone), can be interpreted as vitiation of Vata dosha.

Long-term use of high heels also shortens the muscle-tendon units, alters gait kinetics, and reduces dorsiflexion range, according to contemporary gait analysis. These biomechanical abnormalities are associated with the Ayurvedic concepts of Dosha-Prakopa (vitiation) and Marma-abhighata (trauma to vital areas). These side effects have the potential to impair the Gulpha Marma's

energetic and physiological properties, which can lead to both systemic and localized discomfort.

## CONCLUSION

The habitual wearing of high heels has profound effects on the ankle joint's biomechanics and the integrity of the Gulpha Marma. The altered foot mechanics, increased stress on the forefoot, and changes in muscle and tendon structures can lead to discomfort, pain, and potential long-term musculoskeletal issues. From an Ayurvedic perspective, the disruption of the Gulpha Marma's energy flow further underscores the importance of cautious high heel use. To mitigate these effects, it is advisable to limit the duration and frequency of high heel wear, choose shoes with lower heel heights and better support, and incorporate regular stretching and strengthening exercises for the lower limbs. Understanding these impacts is crucial for management and prevention. In order to restore balance and lessen pain in the Gulpha region, people should be educated about proper footwear, incorporate ankle-strengthening exercises, and think about Marma therapy. A multidisciplinary approach that combines traditional Marma science with contemporary biomechanics may provide useful insights into the overall health and well-being of joints.

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