

CADAVERIC AND CONCEPTUAL STUDY OF JANU SANDHI WITH SPECIAL REFERENCE TO SNAYU AND SANDHI BANDHANA

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ABSTRACT

Janu Sandhi (knee joint) represents one of the most structurally complex and functionally demanding joints in the human body. It plays a central role in locomotion, weight transmission, and postural stability. Classical Ayurvedic literature describes this joint in detail, emphasizing the role of *Snayu* (ligamentous structures) and *Sandhi Bandhana* (joint-binding mechanisms) in maintaining its integrity. The present study aims to analyze the anatomical and functional aspects of Janu Sandhi through cadaveric dissection and a conceptual review of Ayurvedic texts, followed by correlation with contemporary anatomical understanding. Cadaveric observations demonstrate that the structural stability of the knee joint is primarily maintained by cruciate and collateral ligaments, menisci, joint capsule, and surrounding musculature. These structures closely correspond to *Snayu* and *Sandhi Bandhana* described in Ayurveda. Classical texts mention approximately ten *Snayu* in the Janu region, which aligns well with the ligamentous and supportive elements identified in modern anatomy. Furthermore, the concept of *Shleshaka Kapha* is functionally analogous to synovial fluid, contributing to lubrication and nourishment of the joint. This integrative analysis highlights that Ayurvedic anatomical concepts are not merely theoretical but reflect a precise understanding of structural and functional anatomy. The study provides a scientific basis for interpreting clinical conditions such as *Sandhigata Vata* and ligament injuries, thereby supporting an integrative approach in musculoskeletal research and practice.

KEYWORDS: Janu Sandhi, Snayu, Sandhi Bandhana, Knee Joint, Cadaveric Study, Ayurveda Anatomy.

INTRODUCTION

Janu Sandhi is an important joint described under *Sandhi Sharira* in Ayurveda and is essential for movement, stability, and weight-bearing functions. It represents a classical example of a *Cheshtavat Sandhi* (movable joint), designed to allow controlled motion while maintaining structural integrity.

In Ayurvedic literature, *Sandhi* is defined as the junction (*Sandhana Sthana*) of two or more *Asthi* (bones), facilitating both mobility and support. Beyond simple articulation, Sandhi encompasses a dynamic system involving multiple structural and functional components that ensure coordinated movement and stability.

From a modern anatomical perspective, the knee joint is a synovial hinge joint formed by the articulation of the femur, tibia, and patella. It is stabilized by a complex arrangement of ligaments, cartilage, capsule, and muscles. The requirement for both mobility and stability make it biomechanically unique and clinically significant.

Ayurveda emphasizes the importance of *Snayu* as binding elements that maintain joint stability and prevent dislocation. The broader concept of *Sandhi Bandhana* includes ligaments, muscles, and other supporting structures that collectively maintain joint integrity.

Modern anatomy identifies key stabilizing ligaments such as the anterior cruciate ligament (ACL), posterior cruciate

ligament (PCL), medial collateral ligament (MCL), and lateral collateral ligament (LCL). These structures show strong conceptual similarity to *Snayu* described in classical texts.

The present study aims to integrate these two perspectives through cadaveric observation and textual analysis, thereby providing a comprehensive understanding of Janu Sandhi.

AIMS AND OBJECTIVES

1. To study the anatomical structure of Janu Sandhi through cadaveric dissection
2. To analyze the concept of *Snayu* and *Sandhi Bandhana* in Ayurvedic literature
3. To correlate Ayurvedic descriptions with modern anatomical structures
4. To evaluate the functional significance of *Snayu* in maintaining knee stability

MATERIALS AND METHODS

Study Design - An observational cadaveric study combined with a conceptual literary review.

MATERIALS

- Preserved human cadavers (lower limb specimens)
- Standard dissection instruments
- Classical Ayurvedic texts including: Sushruta Samhita, Charaka Samhita, Ashtanga Hridaya

METHODOLOGY

Cadaveric Study - The dissection of the knee joint was carried out in a systematic, layer-wise manner:

- Removal of skin and superficial fascia
- Exposure of muscular structures
- Identification of ligaments and joint capsule
- Observation of intra-articular structures such as menisci and synovial membrane

Conceptual Study - A detailed review of Ayurvedic literature was conducted focusing on:

- Classification and functions of *Snayu*
- Concept of *Sandhi Bandhana*
- Structural description of Janu Sandhi.

Comparative Analysis - Findings from cadaveric dissection were correlated with Ayurvedic descriptions to establish structural and functional parallels.

Review of Literature

Ayurvedic Perspective - In Ayurveda, Sandhi is described as *Asthi Samyoga Sthana*, indicating the site of union of bones. Janu Sandhi is classified as a *Kora Sandhi*, which allows flexion and extension movements. It is also categorized as a *Sandhi Marma*, highlighting its clinical and surgical significance.

Structural Components of Sandhi - A movable joint (*Cheshtavat Sandhi*) consists of the following:

- **Asthi**: Forms the structural base of the joint

- **Sandheya Tarunasthi**: Covers articulating surfaces and facilitates smooth movement
- **Sandhi Chakrika**: Acts as a cushioning and aligning structure
- **Sandhi Kosha**: Encloses the joint and is composed of *Snayu*
- **Shleshmadhara Kala**: Inner lining responsible for secretion of lubricating fluid
- **Supporting structures**: Include *Snayu*, *Mamsa*, *Sira*, and *Majja*
- **Snayu** - *Snayu* are fibrous structures responsible for binding and stabilizing joints. They:
 - Maintain alignment
 - Prevent excessive movement
 - Provide tensile strength

Ayurveda describes approximately ten *Snayu* in the knee joint, which reflects the presence of multiple ligamentous and supportive elements.

Sandhi Bandhana - *Sandhi Bandhana* refers to the mechanism responsible for maintaining joint stability. It includes: *Snayu* (ligaments), muscles and joint capsule

Shleshaka Kapha - This subtype of *Kapha* is responsible for lubrication, nourishment, and smooth functioning of joints. It prevents friction and degeneration.

Modern Anatomical Perspective - The knee joint is a synovial hinge joint formed by: Femur, Tibia, Patella. It consists of tibiofemoral and patellofemoral articulations.

Structural Components

Articular Surfaces - The femoral and tibial condyles and patella form the articulating surfaces, which are incongruent and require menisci for proper alignment.

Articular Cartilage - Hyaline cartilage covers the bone ends and provides a smooth, low-friction surface.

Joint Capsule - A fibrous capsule encloses the joint and is reinforced by ligaments.

Synovial Membrane and Fluid - The synovial membrane secretes synovial fluid, which: Lubricates the joint, nourishes cartilage and reduces friction.

Menisci - Medial and lateral menisci: Improve congruency, absorb shock and enhance stability

Ligaments - Major stabilizing ligaments include: ACL and PCL, MCL and LCL and Patellar and popliteal ligaments. These structures prevent excessive movement and maintain stability.

Muscles - Muscles crossing the joint provide dynamic stability and facilitate movement.

Observations (Cadaveric Study)

The following observations were made:

1. The knee joint was enclosed within a strong fibrous capsule
2. Cruciate ligaments (ACL and PCL) were identified within the joint
3. Collateral ligaments (MCL and LCL) were observed externally
4. Menisci were present between femoral and tibial surfaces
5. Synovial membrane and fluid were evident
6. Muscles such as quadriceps contributed to joint stability

These components collectively ensure both mobility and structural stability.

DISCUSSION

Correlation of Snayu with Ligaments - Snayu described in Ayurveda closely resemble ligaments in both structure and function. Both are fibrous tissues responsible for binding and stabilizing joints. The classical description of ten Snayu in the knee correlates with multiple ligamentous and capsular structures observed in modern anatomy.

Concept of Sandhi Bandhana - Sandhi Bandhana encompasses all structures contributing to joint stability,

Comparative Analysis

Ayurvedic Concept	Modern Equivalent	Function
Asthi	Bones	Structural support
Tarunasthi	Articular cartilage	Smooth movement
Sandhi Chakrika	Menisci	Shock absorption
Snayu	Ligaments	Stability
Sandhi Kosha	Capsule	Protection
Shleshaka Kapha	Synovial fluid	Lubrication
Mamsa	Muscles	Movement

CONCLUSION

The study establishes a clear correlation between Ayurvedic and modern anatomical concepts of the knee joint. The concept of *Snayu* aligns closely with ligaments, while *Sandhi Bandhana* represents the overall stabilizing system of the joint.

Cadaveric findings validate classical descriptions, demonstrating that Ayurvedic scholars possessed a detailed understanding of joint anatomy. This integrative perspective enhances clinical understanding and supports the development of holistic approaches in the management of joint disorders.

Future Scope

- Histological analysis of Snayu
- Radiological correlation using MRI
- Clinical studies on Snayugata Vata
- Biomechanical evaluation of joint stability

including ligaments, capsule, and muscles. This aligns with modern understanding of joint stabilization mechanisms.

Functional Integration - The knee joint requires a balance between:

- Stability (provided by ligaments and capsule)
- Mobility (enabled by articulation and muscles)

Ayurveda recognizes this balance through the interaction of Snayu and Kapha.

Clinical Correlation - Injury to Snayu corresponds to ligament tears such as ACL injury

- Results in instability, pain, and restricted movement
- Interpreted as *Snayugata Vata*

Degenerative conditions such as osteoarthritis correspond to *Sandhigata Vata*.

Role of Shleshaka Kapha - Shleshaka Kapha provides lubrication similar to synovial fluid, preventing wear and tear.

Marma Significance - Janu Sandhi is a vital point where injury can lead to functional impairment, emphasizing its clinical importance.

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