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Correlating Majjadhara Kala with the Gut-Brain Axis: An Ayurvedic-Contemporary Interface A Conceptual Review Bridging Kala Sharira and Modern Gut-Brain Neuroscience

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Abstract: *Ayurveda describes the human body as being held together by seven Kalas — subtle membranous partitions that separate and support the Dhatus. Among these, Majjadhara Kala occupies a unique conceptual position: Acharya Sushruta, in the context of Sarpadamshta Visha Vijnaniya of the Kalpa Sthana, uses the term Majjadhara Kala interchangeably with Pittadhara Kala, the seat of Grahani, thereby linking the gut mucosa with Majja Dhatu, the tissue that also constitutes Mastulunga (brain and nervous tissue). This textual equivalence anticipates, in principle, what modern neuroscience now formally describes as the gut-brain axis (GBA) — a bidirectional communication network linking the gastrointestinal tract and the central nervous system through neural (vagal), endocrine (HPA axis), immune (cytokine), and microbial (short-chain fatty acid, neurotransmitter) pathways. This article undertakes a conceptual and comparative review of Majjadhara Kala vis-à-vis the gut-brain axis, drawing upon classical Ayurvedic sources and contemporary peer-reviewed literature on the microbiota-gut-brain axis. Grahani Agni, Majjavaha Srotas, and the Visha-Vega pathway of toxin translocation across Kalas are shown to offer a physiologically coherent classical parallel to vagal signalling, intestinal permeability, and neuro-immune crosstalk described in modern gastroenterology and neuroscience, opening avenues for integrative research into functional gastrointestinal, neuropsychiatric, and autoimmune disorders.*

Keywords: Majjadhara Kala, Gut-Brain Axis, Grahani, Majja Dhatu, Kala Sharira, Vagus Nerve, Gut Microbiota, Ayurveda

I. INTRODUCTION

Ayurveda envisages the sharira as a continuum of Dhatus held in structural and functional integrity by seven Kalas — Mamsadhara, Raktadhara, Medodhara, Shleshmadhara, Purishadhara, Pittadhara, and Shukradhara — each described as the subtle interface that contains a Dhatu and mediates its interaction with adjoining tissues **[1] (Su. Sha. 4/17-27)**. While Pittadhara Kala is conventionally correlated with the intestinal mucosa and identified with Grahani, the same functional zone is, in a specific classical context, referred to as Majjadhara Kala.

In the Kalpa Sthana, while describing the pathogenesis of Sarpa Visha, Acharya Sushruta states that the sixth Vega of Visha penetrates Majja Dhatu through Majjadhara Kala, deranging Grahani and producing Gaatra Gaurava, Atisara, and Hritpeeda **[2] (Su. Ka. 4/40)**. The commentator Dalhana clarifies that Asthidhara and Majjadhara are used synonymously with Purishadhara and Pittadhara respectively, since the symptoms on vitiation of these Kalas overlap **[3] (Dalhana on Su. Ka. 4/40)**. This nuance implicitly links the gut lining with Majja Dhatu, the tissue that also constitutes Mastulunga, the brain **[1] (Su. Sha. 4/31)**.

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Contemporary biomedical science has arrived, independently, at a structurally similar proposition. The gut-brain axis (GBA) is now defined as the bidirectional communication system linking the enteric and central nervous systems through neural, endocrine, immune, and humoral pathways, with the vagus nerve and gut microbiota as central mediators **[4,5] (Carabotti 2015; Cryan 2019)**. The conceptual convergence between an eighteen-centuries-old surgical treatise and current gastro-neuro-immunology forms the rationale for the present review.

II. AIM AND OBJECTIVES

The aim of this article is to critically review and correlate the classical Ayurvedic concept of Majjadhara Kala with the contemporary understanding of the gut-brain axis.

Objectives: (1) To compile classical references pertaining to Majjadhara Kala, Majja Dhatu, Majjavaha Srotas, and Grahani. (2) To review contemporary literature on the anatomical and functional basis of the gut-brain axis. (3) To draw a conceptual correlation between the two systems of understanding, with clinical and research implications.

III. MATERIALS AND METHODS

This is a conceptual, non-experimental review. Classical references were collected from Sushruta Samhita (Sharira Sthana and Kalpa Sthana with Dalhana's Nibandhasangraha commentary), Charaka Samhita, and Ashtanga Sangraha/Hridaya. Contemporary literature was retrieved from PubMed, ScienceDirect, and Springer Nature databases using the terms "gut-brain axis," "microbiota-gut-brain axis," "vagus nerve," and "enteric nervous system." Material was synthesized thematically to permit side-by-side conceptual comparison.

IV. CONCEPTUAL REVIEW

A. Majjadhara Kala — Classical Perspective

Kala, as defined by Sushruta, is a subtle membranous structure that separates one Dhatu from another while nourishing and protecting it **[1] (Su. Sha. 4/17)**. Majjadhara Kala appears explicitly in the Kalpa Sthana's Sarpadamshta Visha Vijnaniya chapter as the site through which Majja Dhatu is invaded during envenomation, and is clarified by Dalhana to be synonymous with Pittadhara Kala — the seat of Grahani, located between Amashaya and Pakwashaya **[2,3] (Su. Ka. 4/40)**.

Grahani is described as the principal site of digestion, sustained by Jatharagni and responsible for Bhukta Avasthapana — retention of ingested food until adequately processed **[6] (Cha. Chi. 15/56-57)**. Grahani Dushti is described as producing not only gastrointestinal manifestations but also systemic and mental symptoms, echoing the broader classical understanding that Agni Dushti disturbs Dhatu Poshana at every subsequent level, including Majja.

Majja Dhatu is described as being formed on the sixth day from Ahara Rasa, filling the Asthi and lending unctuousness, strength, and voice quality to the individual **[7] (Cha. Chi. 15/20-21)**. Sushruta identifies Mastulunga, the brain, as a form of Majja **[1] (Su. Sha. 4/31)**. The Visha-Vega doctrine — describing sequential penetration of poison from Twak through successive Dhatus and Kalas until it reaches Majja and Hridaya — is itself a classical model of a toxin traversing a gut-associated membrane to affect the nervous system, providing the direct textual bridge between Majjadhara Kala and neuro-visceral pathology **[2] (Su. Ka. 4/38-41)**.

B. Gut-Brain Axis — Contemporary Perspective

The gut-brain axis refers to the continuous, bidirectional communication between the gastrointestinal tract, its resident microbiota, and the central nervous system **[4] (Carabotti 2015)**. The enteric nervous system, often termed the "second brain," contains an estimated 200-600 million neurons embedded in the gut wall and operates with a degree of autonomy while remaining in constant communication with the CNS **[5] (Cryan 2019)**.

The vagus nerve, comprising approximately 80% afferent and 20% efferent fibres, is the principal direct neural conduit of this axis **[8] (Berthoud 2000)**. Gut microbiota and their metabolites, notably short-chain fatty acids such as butyrate,

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propionate, and acetate, modulate vagal afferent activity and regulate serotonin synthesis, of which over 90% occurs in enterochromaffin cells of the gut **[9] (O'Riordan 2022)**.

A second pathway is immune-mediated: dysbiosis and increased intestinal permeability permit translocation of bacterial lipopolysaccharide into systemic circulation, triggering pro-inflammatory cytokine release that crosses the blood-brain barrier and drives neuroinflammation, implicated in depression, anxiety, and neurodegenerative disease **[10] (Margolis 2021)**. A third pathway operates through the hypothalamic-pituitary-adrenal axis, wherein early microbial colonization programs stress reactivity, and psychological stress in turn alters gut permeability and microbial composition **[5,11] (Cryan 2019; Xu 2024)**.

Vagus nerve stimulation, an established therapy for drug-resistant epilepsy and depression, has been shown to modulate gut microbial composition, while microbial metabolites feed back to regulate vagal tone — reinforcing the concept of the gut lining as a bidirectional signalling interface rather than a passive digestive boundary **[12] (Bonaz 2018)**.

V. CORRELATING MAJJADHARA KALA WITH THE GUT-BRAIN AXIS

Placed side by side, the classical and contemporary models display a striking structural correspondence, summarized in Table 1.

Table 1: Correlation between Majjadhara Kala and the Gut-Brain Axis

Ayurvedic Concept	Modern Correlate	Shared Functional Basis
Majjadhara Kala / Pittadhara Kala (Grahani)	Intestinal mucosa; gut-associated neuro-immune interface	Site of digestion, absorption, and barrier function between lumen and internal tissue
Majja Dhatu / Mastulunga	Central and enteric nervous tissue	Nervous tissue nourished/affected via the gut-associated Kala
Grahani Agni	Digestive enzymes, gut microbial metabolism	Determines quality of nutrient transformation reaching Majja
Visha Vega crossing Kala to reach Majja/Hridaya	LPS/endotoxin translocation via increased intestinal permeability	Pathological transfer of harmful substance from gut lining to nervous system
Majjavaha Srotas	Vagal afferent/efferent fibres, neuro-humoral channels	Conduit for bidirectional gut-Majja communication
Grahani Dushti causing systemic/mental symptoms	Dysbiosis-associated anxiety, depression, cognitive change	Gut dysfunction manifesting as neuro-behavioural disturbance

The act of naming the Grahani-Pitta interface as Majjadhara Kala in a toxicological context indicates early recognition that pathology at the gut-lining level has direct consequences for Majja Dhatu — anticipating the modern observation that intestinal barrier compromise permits neuroactive and inflammatory substances to influence the CNS **[10] (Margolis 2021)**.

Grahani Agni parallels the functional role of gut microbiota and its enzymatic output. Just as Manda or Vishama Agni is said to generate Ama capable of vitiating distant Dhatus and Manas, dysbiosis-driven microbial metabolites and endotoxin are shown to alter mood, cognition, and behaviour through vagal and immune signalling **[9,10] (O'Riordan 2022; Margolis 2021)**.

The bidirectionality that defines the modern GBA is mirrored in classical descriptions where Manasika factors such as Chinta, Bhaya, and Shoka are held to vitiate Agni and precipitate Grahani Roga, while Grahani Dushti in turn produces

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Chittodvega — a reciprocal causation conceptually equivalent to the stress-microbiome-brain feedback loop **[5,13] (Cryan 2019; Longo 2023)**.

VI. CLINICAL AND RESEARCH IMPLICATIONS

Recognizing Majjadhara Kala as a classical precursor to the gut-brain axis has practical relevance. Ayurvedic management of Grahani Roga through Deepana-Pachana, Agni-balancing diet, and Manasika Chikitsa may be reappraised as an early template for microbiota-targeted and vagal-modulation therapies now explored for irritable bowel syndrome, functional dyspepsia, anxiety, and depression **[12,14] (Bonaz 2018; Wang 2022)**. Conditions with a suspected gut-mediated neuro-immune component, including Amavata, where Agni Dushti and Ama formation are central to pathogenesis, may similarly benefit from integrative research examining Grahani/Majjadhara Kala status alongside intestinal permeability and inflammatory markers.

Future research directions include: assessment of Grahani Dushti Lakshanas alongside validated intestinal permeability markers (zonulin, LPS-binding protein); evaluation of Deepana-Pachana and Rasayana interventions for their effect on gut microbial diversity and inflammatory cytokine profiles; and Prakriti-stratified studies examining whether constitutional variation in Agni correlates with baseline vagal tone or heart-rate-variability, a recognized proxy for vagal activity in gut-brain axis research.

VII. LIMITATIONS AND FUTURE SCOPE

This review is conceptual rather than experimental; the correlation drawn rests on textual analogy and functional parallelism rather than direct empirical validation. The term Majjadhara Kala appears in a narrow textual context rather than as an independent member of the sevenfold Kala scheme, and its equivalence with Pittadhara Kala, though explicitly stated by Dalhana, should be interpreted with due philological caution. Future work should combine Ayurvedic clinical assessment tools with validated biomedical markers of gut-brain axis function in prospective, sufficiently powered study designs.

VIII. CONCLUSION

The classical identification of Majjadhara Kala with the Grahani-Pittadhara interface offers a coherent anticipatory framework for what contemporary science now describes as the gut-brain axis. Both systems converge on a shared insight: the gut lining is not merely a digestive boundary but a critical neuro-immune interface whose state directly influences Majja Dhatu, and vice versa. Integrating classical Kala Sharira concepts with modern microbiota-gut-brain axis research may enrich both Ayurvedic clinical reasoning and integrative neuro-gastroenterology, and merits further structured, evidence-based exploration.

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