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Original Researcher Article

AN INTEGRATIVE EXPLORATION OF THE BRAIN-GUT AXIS WITH SPECIAL REFERENCE TO PITTADHARA KALA SA EVA MAJJADHARA KALA

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Abstracts: 'Kala Sharir' represents a distinctive concept in Ayurved Rachana Sharir, primarily described in Sushrut Sharir Sthan, Kalpa Sthan and Ashtang Hridaya Sharir Sthan, with emphasis on functional roles and limited description about its location. Traditional texts lack descriptions of Kala in preventive or clinical contexts and pathophysiological references like, Acharya Dalhan in his commentary had stated that the Purishdharakala is same as Asthidharakala, while the Pittadhara is similar to the Majjadharakala. However, no elaborative explanation is provided in this regard by the Acharyas. Few articles have tried to establish the relation between the above said kalas on logical grounds analyzing the concepts of Ayurveda. The present chapter will provide an insight into the aspect of "Pittadharasaevamajjadharakala" considering the modern perspective. Few efforts have been taken to establish this correlation in Ayurved perspective considering the Majja to be present in the Asthi (bone marrow). However, in this chapter Majjadhara Kala is thought to be associated with the nervous system and the relation of Pittadhara and Majjadhara can be established through the modern anatomy and physiology.

Keywords: Ayurveda, Kala Sharir, Pittadhara kala, Majjadhara kala, Gut – Brain Axis.

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INTRODUCTION

The concept of Kala in *Ayurved* first described by Acharya Sushruta in Shareer Sthan where he defined Kala as the membranous layers or sheaths that separate and encase the Dhatu and Ashayas akin to woods stratified structure revealed by cutting. just as a trees pith marks the innermost core kala delineates boundaries in dhatus. These Kalas are extensively supplied with *Snayus* bathed in *Jarayu* and encased in *Sleshma*. Thus, the three Basic principles in the formation of kala are *Snayu*, *Jarayu* and *Sleshma*. Anatomically it separates different systems whereas physiologically it does the *dharan*(sustain) of its respective *dhatu*(tissues). *Acharya Sushruta* classified it in seven types viz. *mamsadhara, raktadhara, medodhara, sleshmadhara, purishdhara, pittadhara and shukradhara kala*. Any anatomical or physiological disruption in *kala* may lead to pathology, therefore its study is essential for the purpose of diagnosis and treatment.

MATERIALS AND METHODS

1. Classical Review: Primary Ayurvedic texts—Sushruta Samhita, Charaka Samhita, Ashtanga Hridaya were reviewed for references on *Kala Sharir*.

2. Literature Search: Modern research articles were sourced from PubMed and Google Scholar databases.

3. Analytical Approach: A comparative and integrative analysis was conducted to correlate Ayurvedic concepts with modern scientific findings.

REVIEW OF LITERATURE

Pittadharakala:

Pittadharakala is the sixth *kala*, which holds the four types of food (*ashita*, *khadita*, *peetam*, *leedha)* as it moves from the *Amashaya* (stomach) to *Pakvashaya* (intestine), with the function of *Pachana* within the gastrointestinal tract.

Acharya Dalhan in *Kalpasthan*, equates *Pittadhara as Majjadharakala*, though classical texts offer limited direct explanation. Very few arguments are made in this regard on the basis of core concepts of Ayurveda. These interpretations are based on Ayurvedic principles and linked with modern science to explain the phrase "*Pittdharasaevamajjadharaiti*".

Majjadharakala:

***MajjaDhatu and Mastulunga* (Brain):** According to *Induteeka*, *Medodhatu,* transforms into *Mastulunga*, which then becomes *Majjadhatu* from *Medodhatu* as a *Sadyahpranahara marma*. *Mastulunga* resides within the flat bones of skull. *AstangaSangraha* identifies *Mastulunga* as a *Majja Dhatu*, resembling solidified ghee (*Avilina Ghrta*).

Majja is considered as marrow as in bone marrow (*asthi – majja*). Yet it increasingly aligns with the nervous system, housed protectively like marrow inside bone. Considering the skull as the casing of the brain and the vertebrae as the casing of the spinal cord, *Majja* can be associated with the nervous system. In context of the above the *Majjadharakala* is associated with the meninges of brain

Everyday experiences show how tension ignites stomach upset, while bowel troubles intensify

nervousness. That nervous flutter before a big event or pain from worry are widespread sensations. Our intestines respond sharply to feelings such as happiness, dread, annoyance, or sadness. Its enteric nervous system forms an independent network governing the GI tract.

Neurogastroenterology is the study of the enteric nervous system, a subdivision of the autonomic nervous system (ANS) that directly controls the gastrointestinal system. The ENS is capable of autonomous functions such as the coordination of reflexes. The ENS consists of some 100 million neurons far fewer than the brains but a tenth of the spinal cord. The enteric nervous system is embedded in the lining of the gastrointestinal system.

Ganglia of the ENS

The enteric nervous system (ENS) comprises two main ganglia: the myenteric (Auerbach's) plexus between muscularis externa layers and the submucosal (Meissner's) plexus in the submucosa. Myenteric plexus forms longitudinal neuron chains that boost gut tone, contraction velocity, and intensity for motility across the gut, while easing sphincters for material passage. Submucosal Plexus located in the submucosa, it regulates local secretion, absorption, and muscle activity based on mucosal sensory input. Signals reach the myenteric plexus, sympathetic ganglia, spinal cord, and brainstem.

Function and Structure of the ENS

The enteric nervous system has been described as a second brain. There are several reasons for this. For instance, the enteric nervous system can operate autonomously. It normally communicates with the central nervous system (CNS) through the parasympathetic (e.g., via the vagus nerve) and sympathetic (e.g., via the prevertebral ganglia) nervous systems. However, vertebrate studies show that when the vagus nerve is severed, the enteric nervous system continues to function. In vertebrates, the enteric nervous system includes efferent neurons, afferent neurons, and interneurons, all of which make the enteric nervous system capable of carrying reflexes and acting as an integrating center in the absence of CNS input. For instance, the sensory neurons report mechanical and chemical conditions, while the motor neurons control peristalsis and the churning of intestinal contents through the intestinal muscles. Other neurons control the secretion of enzymes.

The enteric nervous system also makes use of more than 30 neurotransmitters, most of which are identical to the ones found in the CNS, such as acetylcholine, dopamine, and serotonin. More than 90% of the body's serotonin is in the gut, as well as about 50% of the body's dopamine, which is currently being studied to further our understanding of its utility in the brain. The enteric nervous system has the capacity to alter its response depending on factors such as bulk and nutrient composition. In addition, the ENS contains support cells that are similar to the astroglia of the brain, as well as a diffusion barrier around the capillaries that surround the ganglia, which is similar to the blood–brain barrier of the cerebral blood vessels.

Regulation of ENS Function

The parasympathetic nervous system enhances enteric nervous system activity by stimulating enteric neurons, thereby promoting gastrointestinal functions. Parasympathetic enteric fibers play a crucial role in defecation and provide extensive innervation to the sigmoid colon, rectum, and anal canal. In contrast, sympathetic nervous system activation suppresses enteric activity by inhibiting neurotransmitter release and exerting a direct inhibitory effect on the enteric plexuses. Additionally, when the gastrointestinal tract undergoes irritation or distension, sensory (afferent) nerves transmit signals to the medulla for central processing.

Innervation of the GI Tract

The gastrointestinal tract receives both intrinsic and extrinsic neural innervation. The intrinsic innervation, known as the enteric nervous system, is situated within the gut wall and is primarily organized into the myenteric and submucosal plexuses. This system regulates gastrointestinal motility, secretion, digestion, and absorption. Communication between the gut and the brain occurs largely through vagal afferent pathways, which convey information regarding the contents of the gastrointestinal tract. Extrinsic innervation is provided mainly by the vagus nerve and the spinal cord.

Vagal Afferent Feedback Signals

There are three types of vagal afferent endings, each providing a different type of information to the brain: (1) intramuscular array (providing "stretch" information) as the stomach begins to fill and food enters the small intestine, the presence of that food causes a stretch in the surrounding muscle fibers that activates vagal

afferent neurons with intramuscular array endings, (2) intraganglionic laminar endings (providing "tension" information) which are found primarily in the stomach and in the proximal duodenum, have been hypothesized to measure tension, and (3) mucosal terminals (providing "nutrient" information) is located mainly in the intestine, with the endings in close proximity to where nutrients are being absorbed and where various kinds of endocrine cells are releasing their products. The vagus nerve enters the brain in an area of the brain known as the caudal medulla, with the vagal afferents and vagal efferents entering structures that are immediately adjacent to each other: the vagal afferents enter nucleus tractus solitarii (NTS), while the vagal efferents enter the dorsal motor nucleus. The NTS receives not only information from vagal afferents from the stomach and intestine, but also vagal inputs from the liver and from taste receptors in the oral cavity.

Microbial Activity on the Gut-Brain Axis

Apart from direct interaction between nerves and immune cells, (stress-induced) changes to the microbiome may affect the brain and behavior. Studies suggest that inflammatory cytokines disrupt brain neurochemistry and make people more vulnerable to anxiety and depression, possibly explaining the observation that relatively more of IBD or IBS patients also suffer from anxiety and depression.

DISCUSSION

As indicated above, the gut–brain axis is a two-way communication system connecting the gut and the brain through neural, hormonal, and immune pathways. It allows the brain to control gut functions such as movement, secretion, and mucus production, while gut bacteria and their metabolites can influence brain function and behavior. Although the exact mechanisms are not fully understood, this interaction plays an important role in health and disease. Emotional factors like stress and depression affect disorders such as IBD and IBS through this axis, and these conditions are often associated with changes in gut microbiota (dysbiosis). Stress worsens disease by damaging the gut lining, altering gut movement and secretions, and changing the environment of gut bacteria, leading to microbial imbalance. Stress also releases catecholamines in the gut, which significantly affect intestinal immunity and immune cell responses to microbes.

Stress and Intestinal Immunity: Activation of the HPA Axis

The central nervous system (CNS) interacts with the intestine through the brain-gut axis; comprising of the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS). In turn, the ANS consists of the parasympathetic and sympathetic nervous systems and the ENS located within the intestinal wall. Both vagal and spinal sensory neurons terminate at various points within the gut wall including the muscularis and the mucosal epithelium and play an important role in the transfer of information from the CNS to the ENS.

The neuroendocrine system and the immune system have been considered as two autonomously acting networks. The neuroendocrine system responds to external stimuli such as temperature, pain, and stress, whereas the immune system responds to exposure to bacteria, viruses, and tissue trauma. It is now increasingly recognized that these two systems act in close synergy; the immune system is regulated by the CNS, in response to environmental stress, either directly by the ANS or via activation of the HPA axis. This intimate bidirectional network is based on the fact that the immune and neuroendocrine systems share ligands such as neuropeptides, hormones, cytokines, and the respective receptors. Various neuropeptides are released at the peripheral endings of sensory and efferent nerves in response to various invasive and inflammatory stimuli. Neuropeptides, such as opioids released during inflammation, possess anti-inflammatory and antinociceptive properties, which render them potential candidates to treat the unwanted immune responses that occur in inflammatory and autoimmune disorders, by tuning immune homeostasis in a cytokine-like manner. Gut Inflammation and Mental Health affected by chronic digestive inflammation is associated with depression, anxiety, and cognitive decline.

CONCLUSION

Considering modern Neurogastroenterology, *Pittadhara Kala* may be understood as a functional expression of *Majjadhara Kala*, reflecting an integrated gut–brain–immune interface. Diet and Mental Health nutritional interventions improving gut health show benefits in mental clarity and emotional stability. The above description regarding the brain gut connection is helpful in establishing

the fact stated by *Dalhan* about the relationship between *Pittadharakala* and *Majjadharakala*.

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