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ANATOMY OF EXCRETORY SYSTEM (RENAL SYSTEM) WITH SPECIAL REFERENCE TO PATHOPHYSIOLOGY OF RENAL CALCULUS.

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ABSTRACT

The field of Ayurveda is considered the "science of life" and a subset of Atharvaveda. Within Ayurveda, comprehensive descriptions are offered concerning various bodily systems, encompassing their anatomical, physiological, and pathological aspects. Among these systems, the Mutravaha Samsthana (Urinary system) holds significance, as it governs the creation and expulsion of urine. Unfavorable conditions within this system can give rise to numerous ailments concerning the Basti (Bladder). Ayurvedic texts contain depictions of several disorders that manifest similarly to urinary problems, yet are distinct in their underlying causes. Examples of Mutra Roga (Urinary disorders) encompass Mutraghaat (Obstruction), Mutrakricchra (Urinary tract infection), and Ashmari (Urolithiasis or kidney stones). Notably, renal calculi stand out as the most widespread and persistent ailment within the urinary tract system. This recurring and excruciating disorder ranks as the third most prevalent urinary ailment, inflicting intense pain and discomfort.

Key-words – Ashmari, Ayurveda, Renal stone, Basti, Excretory system

Introduction

Ayurvedic methods concentrate on attaining a harmonious equilibrium among the three primary energies known as Vata, Pitta, and Kapha. According to Ayurveda, good health is the outcome of maintaining this equilibrium within these energies, whereas their imbalance leads to illnesses and poor health. Factors such as an irregular lifestyle, prolonged physical and mental stress, improper dietary patterns, consumption of incompatible foods, and the misuse of senses can disrupt this balance. In Ayurvedic teachings, the body is composed of seven fundamental tissues known as "dhatus," which support its functioning. These dhatus encompass various organs and bodily components, namely Rasa (Plasma), Rakta (Blood), Mamsa (Muscles), Meda (Fatty tissue), Asthi (Bones), Majja (Bone marrow), and Shukra (Semen and Reproductive tissue). Another critical concept is "Mala," representing the waste products

generated during physiological and metabolic processes within the body. The primary types of Malas include Purish (Faeces), Mootra (Urine), and Sweda (Sweat). These waste products are essential for maintaining vital bodily functions. The body's circulatory channels are referred to as "Srotas," carrying great physiological significance. According to Charakacharya, Srotas play a crucial role in facilitating various vital physiological functions. These channels are responsible for the circulation of essential products. In terms of physiology, tissues fulfill significant roles by ensuring their own nourishment and providing nutritional elements for the development of corresponding tissues. Among waste products, Mootra (urine) holds importance in the human body. The Mootravaha Srotas, the urinary channels of circulation, originate from the Vrikka (kidneys) and Mootrashaya (urinary bladder).

Anatomy of urinary system in Ayurveda:



Renal calculi stand as the oldest and most widespread ailment within the

urinary tract system. This ailment demonstrates a recurring pattern and

ranks as the third most prevalent disorder among urinary conditions. Research indicates that over 10% of the population in developed regions across the globe suffer from urinary stone tract disease. In India, approximately 12% of the populace is known to experience urinary stone issues. Epidemiological studies have unveiled that this condition affects men (12%) more than women (6%), with the highest occurrence falling within the age range of 20 to 40, followed by a decline in incidence after the age of 50. The causative factors encompass a range of influences including hot climates, dietary choices, metabolic irregularities, heightened urinary citrate levels, immobility, and insufficient urinary drainage. Concerning kidney stones, those composed of calcium constitute the most prevalent type (75-90%), trailed by magnesium ammonium phosphate (struvite) stones (10-15%), uric acid stones (3-10%), and cystine stones (0.5-1%).

Excretory System Development:

Embryologically, as per Ayurvedic principles, the human body takes form based on the amalgamation of the Panchbhautika (Five elements) and the Tridosha (Three Bio-elements) during the union of Shukra (Sperm) and Shonita (Ova). These eight factors collectively contribute to the creation of each organ during fetal development. The Basti (Bladder), a hollow structure, takes shape through the combination of Vayu (Airy bio-element) with the essence of Rakta (Blood), Kapha (Watery bio-element), and Pitta (Fiery bio-element). Various Acharyas (Saints) have concurred that the Basti (Bladder) originates from Matrija Bhava, the maternal constituents.

Vrikka structure : The depiction of the excretory system's anatomy and

functioning in Ayurvedic texts is quite basic and concise. The term "Vrikka" is derived from "vrikkadane," which translates to "to take." While discussing the urinary system, Sushruta does not associate the term "vrikka" with the "basti." Instead, there's a description of "mutravaha nadis" or channels that transport fluid waste ("drava mala") from the "pakwashaya" to the "basti," where it trickles down as drops into a pool of urine. Both Charak and Sushruta mention that "Vrikka" are internal organs, numbering two. The connection between "vrikka" and "mutrashaya" is explained when discussing the seven "ashayas" (compartments) and the organs linked to them. It's specified that there are two "vrikka" in the human body, one on each side. These "vrikka" are described as nearly round in shape. Signs of "vrikka vidradhi" indicate that these organs are positioned in the posterior abdomen within the lumbar region. The "vrikka" are said to serve as the source of the "medovaha srotas," responsible for nourishing abdominal fat. This is possibly due to the proximity of the adrenal glands to the upper poles of the kidneys. The secretion of cortisol by the adrenal glands promotes the release of fatty acids from adipose tissue. Excessive cortisol secretion is linked to a unique form of obesity characterized by fat accumulation in the chest and head regions.

Despite being located outside the renal capsule, the suprarenal glands are enclosed with the kidneys in the perirenal fascia. There are two "mutravahi nadis," which are said to branch into an extensive network numbering in the millions, in correspondence with the

approximately one million nephrons found in each kidney.

Basti structure : The "basti" is described as a reservoir for urine, akin to the term "mutrashaya." This equates the "basti" to the urinary bladder in modern anatomy, which temporarily holds urine. In Ayurvedic texts, the "basti" is linked to various areas such as "nabhi," "prishtha," "kati," "mushka," "guda," "vankshana," "shepha," and "pourush granthi." Correspondingly, the apex of the urinary bladder in modern anatomy is connected to the umbilicus via the median umbilical ligament. The upper portion is separated from the rectum by the rectovesical pouch, while the lower part is related to the seminal vesicles and the terminal segment of the vas deferens. In males, the urinary bladder is contiguous with the base of the prostate. The "basti" is described as having a shape resembling that of an "alabu," which is ovoid. This shape mirrors the distended urinary bladder. There is a single outlet for the "basti," just as the urinary bladder has a solitary urethral orifice. Ayurvedic texts state that the "basti" is encircled by "sira" (veins) and "snayu" (ligaments). Modern anatomy also recognizes the presence of various true and false ligaments around the bladder. True ligaments encompass the lateral true ligament, lateral puboprostatic ligament, medial puboprostatic ligament, median umbilical ligament, and the posterior ligament. False ligaments include the median umbilical fold, medial umbilical fold, lateral false ligament, and the posterior false ligament. According to Sushruta, the "basti" is "adhomukha," meaning its opening points downward. This aligns with the urinary bladder, where

the urethra is connected at the lower end or neck.

Gavini Structure (Ureters): There are two ureters, situated on either side of the bladder known as "Basti". They receive urine from the digestive tract and transport it to the urinary bladder.

Mutrapraseka Structure (Urethra): The urethra is one of the eight vital organs, requiring protection during surgery for bladder calculi. It serves as the outlet from the bladder, measuring two angulas in females and twelve angulas in males. In males, it carries both urine and semen, while in females, it carries only urine.

Mutravaha Srotas Structure (Nephrons): According to Charaka, "Srotas" refers to channels from which substances flow. The channels transporting urine are considered as nephrons. These nephrons originate from the bladder and the inguinal region, with differing opinions from Charaka and Susruta about their roots. Trauma to these nephrons can lead to urinary retention, bladder distension, and painful erections, potentially resulting in patient death.

Mutravaha Dhamanis Structure (Arteries of the Urinary System): Susruta describes "Adhogami Dhamanis," arteries moving downward, responsible for dividing nutrients and waste, including urine, feces, semen, ova/menses, and flatulence. These arteries are subdivided into ten groups, totaling thirty, with two specifically involved in nourishing and holding urine in the urinary bladder.

Mutravaha Siras Structure (Veins of the Urinary System): Charaka and Susruta's texts lack descriptions of urinary system veins. Ashtanga Hridaya introduces the concept of "Mutravaha Sira," tiny channels carrying urine to the bladder.

These veins continuously filter and fill the bladder with urine.

On basis of characteristics of kidney stones:

Classification of Ashmari

Type	Incidence	Crystal shape	X-ray findings
Calcium oxalate-dihydrate & monohydrate (mulberry stone)	75%	Envelope & dumb-bell shaped	Radio-opaque Spherical, brown colour with sharp projection
Phosphate stone (staghorn calculus)	10-15%	Amorphous	Radiopaque, spherical, smooth with white color. It is either Ca phosphate or Ca, mg, ammonium phosphate
Uric acid	10%	Diamond Rhomboid	Radiolucent, smooth, hard, yellowish,
Struvite of cystine from renal tubules.	10%	Coffine –lid	Radiopaque, stag horns common Defective absorption
Cystine	1%	Hexagonal	Faintly radiopaque

On basis of Doshic varieties :

- Kaphaj Ashmari: The presence of Kapha dosha leads to compactness and enlargement, causing an obstruction in the urine flow. This results in symptoms such as a tearing pain in the bladder, a sense of heaviness in the bladder, and a feeling of coldness. The Ashmari resembles the size of a hen's egg, has a pale-white color, a smooth texture, and is relatively large. Its appearance is akin to that of the madhuka flower.
- Pittaj Ashmari: When both Kapha and Pitta doshas are involved, there is compactness leading to urine blockage. This results in discomfort, including a burning sensation in the bladder-penis

region and a sensation of hot air emanating from the bladder. The Ashmari appears in shades of red, yellow, and dark colors, resembling the seed of the Bhallataka tree.

- Vataja Ashmari: The combined action of Vata and Kapha doshas obstructs urine flow, causing intense pain. This pain is so severe that the individual clenches their teeth, presses their navel, external genitals, and anus, often vocalizing their distress through shouts. Urination requires exertion. The resulting Ashmari is hard, irregular, and rough in texture, resembling the Shyava stone and containing thorn-like structures similar to those found on the Kadamba Pushpa flower.

Etiopathogenesis

Ashmari holds a significant position in Ayurveda as one of the notable surgical conditions. Vagbhata referred to it as "Maharoga," while Susruta, a pioneer in surgery, provided an extensive account of Ashmari, covering its origins, symptoms, prognosis, complications, and both medical and surgical treatments. In the text Madhava Nidana, Kapha is identified as the fundamental Dosha responsible for Ashmari. It is explained that Ashmari forms when Vata dries up semen, urine, Pitta, or Kapha accumulated in the urinary bladder, much like how bile solidifies in a cow. All types of Ashmari are attributed to the combination of the three Doshas.

According to Susruta, individuals who neglect proper cleansing practices (asamshodhana) and have improper dietary habits (apathya karina) experience an aggravation of their Shlesma Dosha. This aggravated Dosha mixes with urine and enters the Vasti (urinary bladder), leading to the formation of calculi. Charaka, in the Mutrakrichra chapter, elaborated on Ashmari. He outlined factors such as excessive physical activity, harsh and potent medications (tikshna - ausadhi), riding swiftly on horses or vehicles, excessive consumption of dry wine, eating aquatic and marshy animals, consuming food before the previous meal is digested (adhyasana), as the underlying causes for the eight types of Mutrakrichra and eventually Ashmari.

In the course of treatment, Charaka cautioned patients against engaging in exercise, consuming rough and dried foods, suppressing natural urges, eating baked foods, exposing oneself excessively to wind and sun, and consuming foods that disturb Vayu (like

lotus rhizomes, Jambu, etc.). Unlike Susruta, Charaka emphasized the contribution of Vayu Dosha as a factor. Kashyapa attributed the etiology of Mutrukrichra and Ashmari to the carrying of heavy loads on the loins (kati) and shoulders (skandha). This load-bearing leads to the vitiation of Pitta, which then combines with Kapha and Vayu before entering the Vasti and affecting it.

Discussion

Based on our current understanding of the anatomy of this system, we are aware that the primary components involved include the Kidneys, Ureters, Urinary Bladder, and Urethra. However, Ayurvedic insights into the anatomy of these structures are limited and fragmented. The physiological aspects of this system are also not clearly elucidated in Ayurvedic texts. While the Kidneys and Urinary Bladder are explicitly mentioned as "Vrikka" and "Basti" respectively, there is no specific reference to the Ureters and Urethra. Terminologies such as "mutravahi nadi" and "dhamani" are present, yet the descriptions provided are inadequate for a comprehensive understanding of the anatomy and physiology of this system.

In Ayurveda, Vata is situated in the "Pakvashaya" (large intestine), which plays a crucial role in the elimination and retention of waste products like "mala," "mutra," and other toxins. An aggravated Vata is held responsible for generating "ashmari" or stones. The deranged Vata leads to desiccation of "Shukra," "Mutra," "Pitta," and "Kapha" in the "Basti pradesh" (region of the bladder), culminating in the gradual formation of stones. Sushruta's perspective suggests that "Mutra" enters the "basti" through "Mutravahak nadies," analogous to how "mutra-Vata," "Pitta," and "Kapha" also

enter the "basti." With the application of "Upsneha nyaya," the process of stone formation, or "Ashmari," transpires.

The symptoms of calcium oxalate stones closely resemble those of "Vataja Ashmari," exhibiting traits like an amber hue reminiscent of lac or resin, a coarse surface, irregular contours, and a visual semblance to the kadamba flower. Uric acid stones, known as "Urate Calculus," display a yellowish-brown tint in comparison to the color profile of "Pittaja Ashmari." The color transformations of cystine stones, initially yellow and green upon exposure to external conditions, correspond to the fundamental hues attributed to "Pitta," such as red, yellow, or black. These stones share a size similarity with a bhallataka seed and occasionally exhibit a honey-like color.

Phosphate stones manifest as white formations with a smooth exterior and larger dimensions, causing comparatively less discomfort than other types of calculi. These characteristics align with the classical attributes of "Kaphaj Ashmari," which are characterized by a white, glossy texture, large and oval shapes resembling hen's eggs, and a color akin to the madhuka flower. In light of these observations, renal stones can be identified as "Ashmari" as outlined in Ayurvedic foundational texts.

Conclusion

Ayurveda provides a comprehensive account of the Mutravaha Samsthana, which refers to the urinary system responsible for producing and expelling urine. Urine formation is a vital physiological process that eliminates waste and supports the body's detoxification. The process involves the conversion of Aahar Rasa, obtained from digestion and metabolism, into urine. The

majority of waste fluids are expelled through the urinary system, and any dysfunction in this process can lead to various health issues. Essential components like Basti, Mutravaha Srotansi, Vrikka, Mutravaha Nadies, Mutravaha Dhamanis, and Mutravaha Sira are integral to urine formation within the body. From a modern medical standpoint, the kidney, nephrons, urinary bladder, and urethra play pivotal roles in the urine formation process. Familiarity with this process aids physicians in understanding the underlying causes of urinary system-related illnesses.

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