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CORRELATION OF MEDODHATU IN MODERN PHYSIOLOGY: A REVIEW

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ABSTRACT

In Ayurveda, medodhatu is the fourth among the fundamental tissues of the body. It is the sneha dhatu of the body which resembles sandra sarpi. It is having ap- prithvi predominance. Kapha dosha and medodhatu have ashraya- ashrayi bhava. The most important function of medodhatu is snehana (unctousness). Dridhatva and asthipushti are the other functions of medodhatu which provide structural stability and firmness to the body. It also nourishes the succeeding asthidhatu. Medodhatu is formed from the metabolic transformation of mamsadhatu with the help of agni which yields the sukshmabhaga, the poshaka medodhatu. The dhatvagni converts it to poshya medodhatu as the sthulabhaga, sweda as the malabhaga and poshaka asthidhatu as the sukshmabhaga. Medovahasrotas are the channels for internal metabolic pathways of physiological, pathological and pharmacological action of medodhatu. In modern physiology, this aligns with the role of body- lipid system. It includes the adipose tissue and the circulating lipids. The poshaka medodhatu is correlated to cholesterol and lipids present in the circulating blood. Poshya medodhatu is gativivarjita. So it can be correlated to the body's fat depot. It functions as an energy reserve and provides protection and support to the body. The fat cells regulate insulin resistance and lipid metabolism by secreting hormones. The applied aspect of this phenomenon extends to various metabolic and lifestyle disorders. This paper explores the correlation between medodhatu and fat tissue and lipids, examining their role in health, disease and metabolism, and thus draws the comparison between traditional Ayurvedic knowledge and contemporary physiology.

Keywords: Medodhatu, Adipose Tissue, Lipid, Snehana

INTRODUCTION

Ayurveda, the ancient system of medicine considers doshas, dhatus and malas as the basic trinity of life. The human body depends on dhatus for its structural integrity. Medodhatu is the sneha predominant dhatu, occupies the slot between the mamsadhatu and asthidhatu. It is categorised as both the body's fat tissue- the adipose tissue and the body's circulating lipids in blood including cholesterol, lipoproteins, chylomicrons, VLDL, LDL, apolipoproteins, and HDL. Modern physiology recognises adipose tissue as an important endocrine organ that plays a key role in homeostasis and is involved in the pathogenesis of a variety of diseases. Circulating lipids are essential for metabolism and organ function.

CONCEPT OF MEDODHATU

The snehana or unctuousness of the sharira is largely dependent upon the presence of medas. It is called so, as it oleates the body Medhyati snihyati anena iti medah[1].

Synonyms

- Mamsaja, mamsateja- as medodhatu is formed from mamsadhatu by dhatwagni
- Asthikrita- formation of asthi is from medas
- Vasa - the fatty substance which locates in mamsa is called as vasa. Acharya Dalhana comments that vasa is mamsa sneha and medodhatu is sarva sareera sneha.[2]

Panchabhautika composition

The main constituents of medodhatu are prithvibhuta (earth) and apbhuta (water). The prithvibhuta provides the guru guna (heavy) to medas. Medas is sneha guna predominant drava dhatu. The apbhuta is responsible for drava (fluid) constitution. As medas is formed from its precursor mamsadhatu, agnibhuta is responsible for the origin of drava medodhatu from sthira (stable) mamsadhatu.

Ashraya- ashrayi bhava of medodhatu

Kapha dosha and medodhatu has reciprocal relationship, called as ashraya- ashrayi bhava. Kapha and medas are similar in terms of the guna like guru, drava, sheeta (cool), snigdha, pichila (slippery), mridu, manda (slow in action) etc. When vitiated kapha dosha undergoes sthanasamsraya (stage of localisation) and dosha- dushya sammurchana in medodhatu, diseases like prameha (diabetes) and sthaulya (obesity) etc. occur.

Comparison of the Functions of Medodhatu with Modern Perspective

Snehana is the important function of medodhatu.

Table 1: Functions of Medodhatu as per acharyas

Functions	Acharya Vagbhata	Acharya Sushruta
Netrasnigdhata	+	-
Gatrasnigdhata	+	-
Snehana	+	+
Asthipushti	+	+
Swedapravarthana	-	+
Dridhatvam	+	+

According to Bhavaprakasha, medas is guru and snigdha and gives bala (strength) and is atibrimhana (over nutritive).

Snehana
Medodhatu imparts lubrication to all structural units of the body. It helps in the binding of tissues. Snehana property is due to predominance of prithvibhuta and jalabhuta, soumya guna and sheeta virya. Owing to the sneha guna, medas imparts compactness and strength to the body. It forms a protective cushion around the various internal organs of the body against mechanical injuries. It includes the lipid layer of the cell membrane, lipids in the blood such as triglycerides, cholesterol, fatty acids and stored lipids like adipose tissue and secretions of sebaceous glands.

Netrasnigdhata
Snigdhata is needed for the normal functioning of the eye. The tear film keeps the conjunctiva and cornea moist.[3]

Gatrasnigdhata
Medodhatu provides a smooth shape to the limbs and body. Sebaceous layer of skin protects it from excessive dehydration and growth of microbes, and keeps the softness of the skin. Adipose tissue of the body acts as a good insulator and helps to reduce the heat loss through the skin. It serves as an energy reserve and provides protection and support to the body.

Asthipushti
Asthi, the succeeding dhatu of medodhatu forms the skeletal frame work of the body. Vitamin D has got an important role in bone deposition and absorption. Vitamin D is a cyclopentanoperhydrophenanthrene (CPP) ring containing compound. CPP ring is the basic structure for cholesterol like compounds. Vitamin D is also responsible for Calcium absorption from GIT as well as Calcium reabsorption from renal tubules. The bone density is due to the presence of Calcium compounds.

Dridhatvam
By the karma of dridhatva and asthipushti, medas provides the structural stability and firmness to the body.

Swedapravarthana
Medas is responsible for the formation of sweda. According to Charaka Samhita, sweda is the mala of medodhatu. In medovriddhi, swedadhikya is an important clinical feature. The vishyandana of swedavahisiramoola causes swedadhikya. It is the combination of kapha with medas. The individuals having sthaulya, sweat more.

Medovahasrotas
The channels are the pathway for the metabolism of medodhatu

Table 2: Different opinion regarding the moolasthana of Medovahasrotas

Acharya	Moolasthana
Acharya Charaka	Vrikka and Vapavahana
Acharya Sushruta	Vrikka and Kati
Acharya Vagbhata	Vrikka and Mamsa

Vrikka, a koshtanga is unanimously considered by all the three Acharyas as the moolasthana. It is formed from sara of rakta and meda. According to Acharya Sharangdhara, vrikka nourishes the medodhatu inside of the jatara.[4] It has been held that the Acharyas might have included supra renal gland situated at the top of each kidney under term vrikka. It has a very important role in the fat metabolism through its hormones like cortisol and adrenalin. The supra renal gland helps in mobilisation of fat, increase the concentration of fatty acids in blood, increased utilisation of fat for energy and decreased utilisation of glucose. Also obesity or sthaulya is associated with changes in adrenal function. The adipose tissue hormones or adipokines have direct effects on the adrenal gland and interact with adrenal hormones at several levels.[5] Hyperlipidemia is a common feature in nephrotic syndrome, and is characterised by increased levels of total cholesterol, low density lipoprotein (LDL), triglycerides (TG), very low density lipoprotein, (VLDL), lipoprotein (a) levels . This might have made them to call vrikka as the root of medovahasrotas. Vapavahana is one of the roots of medovahasrotas by Charaka Samhita. It is also known as tailavartika.[6] It can be correlated to the omentum. Greater and lesser omentum stores a large amount of fat. Triglycerides are stored around kidneys and omentum. Kati is said to be one of the moolasthana of medovahasrotas by Acharya Sushruta. Adipose tissues of hip region store large quantity of fat. Also in medokshaya, kati swapa (numbness along hips) is a clinical feature. Mamsa, a moolasthana by Acharya Vagbhata is based on the theory of uttara dhatu formation from poorva dhatu. Also it can be correlated with the vasa (mamsagata sneha) below the skin.

Madhava Nidana considers udara and asthi as the chief depot of meda.[7] According to pratyaksha shareera, medodhatu is the snehadhatu which is similar to sandrasarpi located inside udara and below tvak.

Dr. C. Dwarkanath considers the channels through which nutrition to the adipose tissue is transported as medovahasrotas.[8] Dr. B.G. Ghanekar considers the capillaries of the perinephric tissue and omentum as medovahasrotas.[9] As per Gray's Anatomy the fat cells are held together by the network of capillary vessels. The channels carrying the digested fats from the gastrointestinal tract to blood and sites of storage can also be considered. The chylomicrons enter the intestinal lacteals and circulate through the blood and lymph channels- systemic capillaries, thoracic duct and left subclavian vein.

Medovahasrotodushti Nidana
Avyayama, divaswapna, excess intake of medyabhakshana and varunimadya forms the nidana for the vitiation of medovahasrotas.

Avyayama means the lack of exercise, which causes the body to store excess energy from food as fat manifesting as overweight and obesity. While contraindicating individuals with divaswapna, Acharya Charaka has included the individuals with medodushti. When a person does profound sleep without reducing the intake of food, the excess calorie is stored in the form of fat. The hormone serotonin secreted during sleep increases the small intestinal motility and absorption. It also contributes to increase of medas. As per samanya vishesha siddhanta, medya bhakshana increases the medas in the body. Medyanna sevana means the eating of fat rich, fried and high caloric value food in excess. Medyanna may result in condition like fatty liver, a manifestation of medodushti. Varuni madya is guru, snigdha and increases medas, rakta, sthanya and kapha of the body.

Fat cells, residing in the adipose tissue depots, are adapted to store excess energy efficiently as triglyceride and, when needed, to release stored energy as free fatty acids for use at other sites. This physiologic system is orchestrated through endocrine and neural pathways, But in the presence of nutritional abundance and a sedentary lifestyle, and influenced by genetic endowment, this system increases adipose energy stores and produces adverse health consequences.[10]

Diseases from Medodhatu Vikruti
Medodhatu vikruti happens mostly due to dushti of medovahasrotas. Premonitory signs and symptoms of prameha

are seen in vitiated medodhatu. The fat cells or adipocytes secrete interleukin 6 (IL-6) in response to inflammatory and catabolic stimuli. IL-6 improves the glucose tolerance by stimulating the release of leptin and glucagon – like peptide- 1 (GLP-1), and by inducing insulin secretion from pancreatic β- cells. Elevated IL-6 levels are an independent predictor of type 2 diabetes.[11]

Vitiated medodhatu also produces tumours, scrotal enlargement, galaganda, arbuda, oshtaprakopa, sthaulya etc.

Medodhatu Vriddhi

In medodhatu vriddhi, the body becomes over-unctuous and sthaulya develops due to deposition of adipocytes with the increase in size and sagging of the gluteal region, flanks, breasts and abdomen. Also the individual develops cough, dyspnoea and bad odour of the body. The body develops increased fatigue on exertion and symptoms of vitiated kapha, rakta and mamsa.[12]

Medodhatu Kshaya

Kahaya of medodhatu produces enlargement of spleen (plihavridhi), feeling of emptiness of joints, dryness of body and craving for fatty food. Also there will be katisvapa (numbness along hips) and krishangata (emaciation).[13]

Formation of Medodhatu

Medodhatu is formed from mamsadhatu when medoposhakamsha is acted upon by medodhatvagni. The mamsadhatu gets digested by the dhatvagni and stirred up by the agni, made snigdha by apguna, finally gets converted to medodhatu. The medodhatvagni acts upon the sukshmabhaga (poshaka medodhatu); and converts it to poshya medodhatu as the sthulabhaga, sweda as the malabhaga and poshaka asthidhatu as the sukshmabhaga. The medodhatu gets nourishment from annarasa, which has fatty substances.

The poshaka medodhatu is gatiyukta (mobile). It can be correlated to cholesterol and lipids present in the circulating blood. Poshya medodhatu is gativivarjita (immobile). Fat depots are mainly seen in subcutaneous tissue and omentum. Medodhatvagni may include glucocorticoids, insulin, glucagon etc. If glucagon levels are excess, lipolysis occurs which is equivalent to medokshaya.[14]

Upadhatu of Medodhatu

Most acharyas consider snayu as the upadhatu of medodhatu.

Table 3: Different opinion on the upadhatu of Medodhatu

Charaka Samhita	Dalhana Tika	Ashtanga Sangraha	Sarangadhara Samhita	Sarangadhara Deepika Tika
Snayu	Snayu and sandhi	Snayu, Sandhi and Asthi	Sweda	Sweda, Snayu and Sandhi

Medosara Purusha

Individuals with the excellence of medodhatu are having the abundance of good complexion, pleasant voice, and unctous body parts. Such individuals are of big size and unable to tolerate exertion. But they are endowed with wealth, power, happiness, enjoyment, charity, simplicity and diplomatic niceties.[15]

ADIPOSE TISSUE

Adipose tissue is a dynamic connective tissue that forms the storage depots of fat in the form of triglycerides.[16] It is composed of adipocytes, also called fat cells or lipocytes. The major function of adipose tissue is to store triglycerides until they are needed for energy elsewhere in the body. A secondary function of adipose tissue is to provide insulation for the body. Large quantities of lipases are present in adipose tissue. Some of these enzymes catalyse the deposition of triglycerides derived from chylomicrons and other lipoproteins. Others, when activated by hormones cause splitting of the triglycerides in fat cells to release free fatty acids. Because of the rapid exchange of fatty acids, triglycerides in the fat cells are renewed approximately once every 2 to 3 weeks, making fat a dynamic tissue.[17] Body adipose tissue is of two types- white and brown. White adipose tissue (WAT) - It represents the biggest store of energy in the body. It helps in the maintenance of FFA, free fatty acid concentration in the blood. It is scattered throughout the body.

Brown adipose tissue (BAT) - It is found in infants. It has high metabolic rate. It contains numerous mitochondria with high cytochrome content. It has very rich sympathetic supply. On stimulation, sympathetic nerve releases nor-epinephrine which acts via β- adrenergic receptors to activate a lipase. This results in the breakdown of triglyceride, and increased fatty acid oxidation in the mitochondria increases the heat production.[18]

Adipose tissues can also be categorised by anatomical location as visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT). The adipose tissues are a source of several hormones including leptin, adiponectin, resistin, proinflammatory cytokines such as tumor necrosis factor -α (TNF α), C- reactive protein (CRP), interleukin -6 (IL-6). These adipokines play roles in regulating systemic energy homeostasis, body weight, inflammation, and glucose and lipid metabolism. In lipid metabolism, IL-6 has a housekeeping role. IL-6 stimulates lipolysis and unlocks the thermogenic competence of adipocytes. The thermogenic adipocytes increases energy expenditure and reduce body adiposity. IL-6 is related with insulin sensitivity in humans. NEFA (non- esterified fatty acids) also known as free fatty acids (FFA) act as vehicle for transporting triglycerides from adipose tissue to where it is used. NEFA level in the blood indicates an individuals' metabolic state and function of hormones like insulin. Elevated NEFA levels are associated with metabolic disorders like obesity, type 2 diabetes etc.

LIPIDS

Lipids are the fatty compounds in the body, which includes neutral fat or triglycerides, phospholipids, and cholesterol. Chemically, the basic lipid moiety of triglycerides and phospholipids is fatty acids, which are simply long- chain hydrocarbon organic acids. Although cholesterol does not contain fatty acids, its sterol nucleus is synthesised from degradation products of fatty acid molecules, giving it many of the physical and chemical properties of other lipid substances.

Triglycerides are mainly used in the body to provide energy for various metabolic processes. Some lipids, especially cholesterol, phospholipids, and derivatives of these compounds, are used throughout the body to perform other intracellular functions.

Transport of Lipids

Chylomicrons transport lipids from the gastrointestinal tract to the blood via lymph. Essentially all fats in the diet are absorbed into lymph in the form of chylomicrons. Chylomicrons are transported in the thoracic duct and emptied into venous blood. They are removed from the plasma as they pass through the capillaries of adipose and liver tissue. The membrane of these tissues contains large quantities of the enzyme lipoprotein lipase; these enzymes hydrolyse triglycerides of chylomicrons into fatty acids and glycerol. The fatty acids immediately diffuse into the cells, once inside, they are resynthesised into triglyceride. When the fat that has been stored in fat cells is to be used elsewhere in the body, it must be transported to other tissues. The fat is mainly transported in the form of free fatty acids.[19] The free fatty acids released from adipose tissue are transported in the blood in combination with albumin. Lipoproteins transport cholesterol, phospholipids and triglycerides. The three major classes of lipoproteins are very low density lipoproteins (VLDL), which contain high concentrations of triglycerides and moderate concentrations of both phospholipids and cholesterol; low density lipoprotein (LDL), which contain relatively few triglycerides but a very high concentration of cholesterol; and high density lipoproteins (HDL) which contain 50% protein with smaller concentration of lipids. Thus the principal function of various lipoproteins in the plasma is to transport a specific type of lipid throughout the body.[20]

DISCUSSION

The physiology of the human body is related to doshas, dhatus and malas. Dhatus are basic structural elements of the body. Medodhatu is the fourth dhatu among the seven dhatus. It is derived from mamsadhatu from dhatwagni. It is the sneha predominant dhatu made up of prithvibhuta and jalabhuta. It gives unctuousness, lubrication and insulation to the body parts. In contemporary medicine, it can be correlated with loose connective tissue made up of fat cells or adipocytes, as well as circulating lipids in the blood. Fat is recognised as adipose tissue, the lipid depot in the body that stores energy, regulates metabolism, and plays a significant role in endocrine function. When the different body tissues need energy, triglycerides stored in adipose tissue are hydrolysed as free fatty acids and transported through blood. Medovahasrotas is the pathway for the metabolism of adipose tissue. The applied aspect of this extends to various metabolic and lifestyle disorders, such as sthaulya, medoroga, krishangata and prameha.

CONCLUSION

The concept of medodhatu in Ayurveda correlates well with the modern physiological understanding of adipose tissue and circulating lipids. Bridging the knowledge of ancient Ayurveda with modern physiology provides a balanced perspective on the functions and disorders of the fat tissue in both systems of health. Further exploration may pave the way for integrative medical approaches for treating metabolic and adipose- related disorders.

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