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RESEARCH ARTICLE

IMPORTANCE OF REGULATION OF DAILY WATER INTAKE TO PREVENT DIABETIC EYE DISEASE

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ABSTRACT

Diabetic eye disease comprises a group of conditions include diabetic retinopathy, diabetic macular edema (DME), cataract, and glaucoma. Polydipsia is one of the cardinal symptoms of diabetes mellitus (Prameha) so that the intake of water will be comparatively more when compared with normal person. The chronic exposure to the over hydration in diabetic patients may gradually results in constant decreased osmolality of the ECF. The condition may lead to alter the permeability of cells and increase the inflow of water in to the cells cause oedema. The oedematous changes are more evident in brain tissues. As eye is the forward extension of prosencephalon this is remarkably expressed as retinal edema and subsequent vision impairment. In Yogaratnakara, the regular intake of more liquid food (dravaannapanathi nishevana) is considered as an etiology of eye diseases. Ashtangahrudaya advised minimum water intake as a life style modification to be adopted in prameha and eye diseases. As diabetes mellitus is a life style related disorders some life style modification in the form of diet, diet style, habit is necessary to prevent the advanced complications of the disease. As per classical reference the intake of water more than the required quantity in diabetic patients will cause the special pathological condition called abhishyandha (microvascular changes) in the eyes. This article emphasizes on the importance of water intake regulation in patients with diabetic eye disease to prevent the advancement of pathology in eyes and to preserve the vision.

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INTRODUCTION

Diabetes Mellitus is a life style related metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia is associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart and blood vessels. Symptoms of marked hyperglycemia include polyuria, polydipsia, weight loss, polyphagia, and blurred vision (Association, 2011). India is set to emerge as the diabetic capital of the world. According to the WHO, 31.7 million people were affected by diabetes mellitus (DM) in India in the year 2000. This figure is estimated to rise to 79.4 million by 2030, the largest number in any nation in the world (Seema Abhijeeth Kaveewar, 2014). Almost two-third of all Type 2 and almost all Type 1 diabetics are expected to develop diabetic retinopathy over a period of time (Salil *et al.,* 2016).

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A systematic review of 35 population based global studies (2012) showed that the prevalence of diabetic retinopathy, proliferative diabetic retinopathy, diabetic macular oedema, and vision threatening diabetic retinopathy among individuals with diabetes are 34.6%, 7.0%, 6.8%, and 10.2% respectively (Yingfeng Zheng *et al.,* 2012). In India diabetic retinopathy is emerging as an important cause out of 4.7% cases of blindness due to posterior segment disorders (Khurana, 2017). Diabetic retinopathy is the most common cause of vision loss among people with diabetes and a leading cause of blindness among working-age adults. Diabetic eye disease comprises a group of conditions include diabetic retinopathy, diabetic macular edema (DME), cataract, and glaucoma. The internal environment of human body can be defined as the composition of the fluid that bathes the cells. All the water in the human body is summarized under the concept of total body water (TBW). It constitutes 55-60 % of body weight in adults. Total body water is divided into two basic groups – intracellular and extracellular fluid. Intracellular fluid (ICF) contributes 2/3 of adult TBW while extracellular fluid (ECF) contributes the remaining 1/3 TBW. Extracellular fluid is further divided into the liquid stored in the blood vessels – intravascular fluid (IVF, plasma + lymph), contributing 1/4

ECF, and the interstitial fluid (tissue fluid) contributing 3/4 ECF. Polydipsia is one of the cardinal symptoms of diabetes mellitus so that the intake of water will be comparatively more when compared with normal person. The chronic exposure to this habit may gradually results in constant decreased osmolality of the ECF. The process of water exchange happens in connection with transport of sodium ion [Na+] between ECF and ICF. The change in osmolality between the ECF and ICF may alter the permeability of cells and increase the inflow of water in to the cells cause oedema. The oedematous changes are more evident in brain tissues. As eye is the forward extension of prosencephalon this is remarkably expressed as retinal oedema and subsequent blurred vision. In Ayurveda classic, Yogaratnakara, there is statement about the regular intake of more liquid food (dravaannapanathi nishevana) can cause eye diseases (Madhan Shetty and Suresh Babu, 2008). From the light of above mentioned contemporary scientific data, this causative factor may be underlined. In Ashtangahrudaya Matraseetaya chapter, excess intake of water is restricted in Prameha and eye diseases. As diabetes mellitus is a life style related disorders some life style modification in the form of diet, diet style, habit is necessary to prevent the complications of the disease.

Method of data collection

Details related to the review article are collected from Ayurvedic classical text books, contemporary medical books, recent publications and internet.

Cellular level changes in diabetes mellitus

Diabetes mellitus is a chronic disease caused by inherited and/or acquired deficiency in production of insulin by the pancreas, or by the ineffectiveness of the insulin produced. Such a deficiency results in increased concentrations of glucose in the blood, which in turn damage many of the body's systems, in particular the blood vessels and nerves. There are two principle forms of diabetes:

Type 1 diabetes (formerly known as insulin-dependent) in which the pancreas fails to produce the insulin which is essential for survival. This form develops most frequently in children and adolescents, but is being increasingly noted later in life.

Type 2 diabetes (formerly named non-insulin-dependent) which results from the body's inability to respond properly to the action of insulin produced by the pancreas.

Type 2 diabetes is much more common and accounts for around 90% of all diabetes cases worldwide. It occurs most frequently in adults. The complications of diabetes mellitus are divided into microvascular and macrovascular. Retinopathy, nephropathy and neuropathy are classified in microvascular complication and cardiovascular disease is included under macrovascular complication. Diabetic retinopathy is associated with damage to the small blood vessels in the retina, resulting in loss of vision.

a). Changes in eye in diabetes Mellitus: Diabetic retinopathy is predominantly a microangiopathy in which small blood vessels are particularly vulnerable to damage due to high glucose levels. Direct hyperglycemic effects on retinal cells are also likely to play a role.

Diabetic maculopathy (foveal oedema, exudates or ischaemia) is the most common cause of visual impairment in diabetic patients, particularly type 2. Diffuse retinal oedema is caused by extensive capillary leakage, and localized oedema by focal leakage frommicroaneurysms and dilated capillary segments. The fluid is initially located between the outer plexiform and inner nuclear layers; later it may also involve the inner plexiform and nerve fibre layers, until eventually the entire thickness of the retina becomes oedematous. Excessive intake of water will reduce the osmolality of IVF in the body. If the osmolality of IVF of retina is less, in addition to microvascular damage there is a chance of excessive fluid leakage from IVF to ECF. The difference in osmotic gradient will subsequently result in retinal oedema (Kanski, 2016). It can logically have interpreted that the fluctuation in the osmotic gradient in body fluid will increase the cellular level damage. So diabetic condition with fluctuating blood glucose level is more alarming.

Water metabolism

a). Water intake: Rise in vascular tonicity even without any change in blood volume or fall in blood volume even when unaccompanied by a rise in osmolality followed by subsequent stimulation of thirst receptors determine the water intake. Presumably the initial sensation of thirst depends on blood volume and osmolality changes when appropriate amount of water has been drunk, the sensation vanishes because of the activity of oral and gastric receptors. The thirst centre is situated in the midhypothalamic region near the paraventricular nucleus (caudal to the osmoreceptors). Water balance is said to be positive (intake exceeds loss) in growing age. Here as a part of metabolism water retention takes place and the balance becomes positive. Water balance is negative (loss exceeds intake) under the following conditions**:** (a) When the subject is thirsty,(b) When a pre-existing oedema is clearing up due to diuresis, and(c) When diet is changed from high carbohydrate to high fat.In any condition of increased water loss, the relative proportion of Na and K content of the fluid excretion will indicate whether the water is coming chiefly from the extracellular or intracellular sources. High Na+ content will indicate extracellular source, whereas high K+ content will indicate intracellular source, provided intake remains constant.

b). Water excretion: The kidneys maintain our body's water balance by controlling the water concentration of blood plasma. The kidneys also control the salt levels and the excretion of urea. Water that is not put back into the blood is excreted in our urine. As the blood passes through the kidneys, all the small molecules are filtered out of the blood. This includes molecules of water, salt, glucose and urea (a waste product from the breakdown of proteins). The kidneys then reabsorb all of the glucose and as much water and salt as the body needs, putting them back into the blood. This leaves some water and salt, and all of the urea, which is called urine. The urine passes from the kidneys to the bladder, where it is stored prior to being excreted from the body.

c). Regulation of water balance: The major water regulatory factors of human body are the hormones(aldosterone, vasopressin) and renin-angiotensin system. When osmolality of plasma rises, the osmoreceptors of hypothalamus are stimulated, resulting in vasopressin(ADH) secretion. This will increase the water reabsorption form renal tubules.

Therefore, proportionate amounts of water and sodium are retained to maintain the osmolality. When osmolality decreases, ADH secretion is inhibited results in increased urine output. Sodium (Na+) and Potassium(K+) play major role to regulate the osmolality balance between ECF and ICF in the body. Normally kidney primed to conserve Na+ and excrete K+. Aldosterone increases the Na+ reabsorption form distal tubules (Vasudevan *et al.,* 2016). When there is a fall in the ECF, renal plasma flow decreases and this would result in the release of renin by juxtaglomerular cells. Renin is an enzyme, which catalyses the conversion of plasmatic angiotensinogen to angiotensin I. Angiotensin I is then converted by angiotensin converting enzyme to angiotensin II, which stimulates aldosterone synthesis and causes vasoconstriction. Aldosterone production is also stimulated by increased levels of serum Potassium, retains Na^+ and water in the body, increases blood pressure by increasing in extracellular fluid volume, increases urine excretion of K^+ and H^+ in distal tubuli. Natriuretic peptides like ANP (atrial natriuretic peptide) and BNP (brain natriuretic peptide) produced from heart have significant vasodilating effects, increase natriuresis (increase in Na^+ losses to the urine) and dieresis.

Table 1. Normal range of Na+ and K+ in the body (Vasudevan *et al.*, 2016)

Name of ion	Normal level in Plasma(mEq/L)	Normal level in cells (mEq/L)
Sodium	136-145	12
Potassium	3.5-5.2	160

Table 2. Water balance in the body (Vasudevan *et al.*, 2016)

Intake of water per day		Output of water per day	
Water in food	1250 ml	Urine	1500 ml
Oxidation of food	300 ml	Skin	500 ml
Drinking water	1200 ml	Lungs	700 ml
		Feces	50 ml
	2750 ml		2750 ml

Ayurvedic view of water balance

Ayurveda narrated the pivotal role of water metabolism in the existence of life. Jala (water), one among the panchamahabhootha (five basic elements of life) is considered as the major constituent of Kaphadosha (one among the three humors of the body). Kaphadosha is involved in the formation of structural entities of the life. The balance between thri-doshas(three humors; Vata, Pitta and Kapha; representing the bio-fundamental adaptations of the body) is very important in regulating bodily activities. kaphadosha tends to be cool, moist, stable and heavy. In the body these qualities manifest as dense, heavy bones, lustrous, supple skin, low metabolism, and large, stocky frames. When out of balance, Kapha individuals are prone to have santharpanajanya (disease due to improper food, food habits and life style) diseases like Prameha(non-insulin dependent diabetes mellitus). As per Ayurveda, water metabolism happens in the following manner as sthoolabhava (big part) into muthra (urine), sookshmabhava (small part) into raktha(blood) and athisookshmabhava(very small part) into prana(air). In Ashangahrudhaya, Vagbhata suggested that minimum water intake is required in all seasons except Greeshma (May-June- summer) and Sarath (September-October- Autumn). In these two season, one can take enough quantity of water considering the digestive fire.

Ayurvedic view of role of excess water intake in pathogenesis

In Ayurvedic classics, intake of water is restricted in Prameha (Diabetes mellitus), Pleeha (Spleen disorders), Vrana(Ulcer), Kushta(skin disorders), Pandu (Anaemia), Jatara(Liver disorders), Peenasa (Rhinitis), Athisara (Diarrhoea), Sopha (edema), Swasa (Bronchial asthma), Agnimadhya (low digestive fire) and Akshiroga (eye diseases) (Vagbhata, 2011). Out of this here we are giving special importance to diabetes and eye diseases. As we know diabetic eye disease is characterized by microangiopathy, localized exudation, leakage of fluid from retinal vessels and hypo perfusion. The whole changes in diabetic eye is represented by a hypotheticalclinical concept abhishyandha (term related with vascular pathology of the eye). Over hydration in body especially in diabetes may change the osmolality of body fluid which in turn vitiate srothas (microvascular channels). The changes in osmotic gradient is due to the intake of water more than the prescribed quantity which in turn derange the vascular tronsport between ECF and ICF. This pathological situation causes the vascular transduction followed by oedema in the tissues.

DISCUSSION

Diabetic eye disease is characterized by diabetic retinopathy, diabetic macular edema (DME), cataract, and glaucoma. These conditions are most alarming due to the vision impairment. Pathology in diabetic eye disease may not be reversible but it can be arrested and manage the vision threat by means of some preventive aspects. The avoidable blindness management is planned by considering the changes in the nature of food, food habits and life style since it is a life style related disorder. Out of which the important instruction considering the Ayurvedic literature review is the regulation of water intake. The water regulation in human body is carried out by neuro-endocrinal support. This peculiar and important regulatory mechanism maintain the osmolality of ECF and ICF and thereby stabilize the ionic balance in the body. As per classical reference, the intake of water more than the required quantity in diabetic patients will cause a special pathological condition called abhishyandha (microvascular changes) in the eyes. This review article emphasizes on the importance of regulation of water intake in patients with diabetic eye disease to prevent the advancement of pathology in eyes and to preserve the vision.

Conclusion

The review article put forwarded a new idea based on a logical and scientific interpretation of Ayurvedic literature. The information from Ayurvedic literature explained by using contemporary scientific methods to be propagated as evidence based Ayurvedic knowledge among the common people and to prevent the blindness due to diabetic eye disease. The intake of water is to be regulated to arrest the progress of pathology in diabetic eye disease. The statement is to be clinically evaluated by means of appropriate scientific tools to facilitate translational research.

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