

Sorry !!

Salt is not meant to be added in the diet routinely, but to be used as "Medicine" when needed

Introduction

Common salt, also known as cooking salt, edible salt and table salt, or simply as 'Salt' is the oldest, and the most widely used food additive for its two unique properties. One is, its magical property of preserving food in higher concentrations. This magical property, when salt was scanty in the past, made it a very precious article of commerce that people used to buy it by paying an equal weight of gold - an ounce of salt for an ounce of gold - and they were also very particular to receive it as their salary, if not in full, at least a portion of it. The Greek word for salt is 'Salarium' and the word salary derived from that. The other one is, its unmatched property as taste enhancer. This property of salt is so alluring that people who are accustomed to taking salted diet, when advised to go on unsalted food, they find it terribly miserable as if they are already addicted to it. No doubt, salt is an addiction. It is, perhaps, the worst form of all addictions, and this might be the reason why it is almost universal. The fiscal effect of such addiction is so strong that salt production has stabilised the economy of many countries and the main revenue of some of the countries depends on their salt production. Currently, the annual production of salt for culinary purpose across the world, has exceeded 12 million tonnes. While salt is doing so well on the economics of almost all the countries in the world, what about its impact on human health? Is it only high blood pressure (the principal, and perhaps the lately recognised manifestation of salt toxicity)? Or is it much more in which high blood pressure presents just as the tip of the iceberg?

Salt and Human Life



Our predecessors, during the last 85 million years (70 million years of mammalian and primate evolution, and 4 to 15 million years of hominoid, hominid and Homo Sapiens evolution), ate a diet to which no salt was added. This was also true for all the modern humans diverged from a common Homo Sapien ancestor who lived in Eastern Africa, about 2 million (2000,000 years) years ago. Such a diet contained fruit as the main constituent until 7.5 to 4.5 million years ago. Later, in addition to the plant based products, our ancestors including Homo Habilis and Homo Erectus started eating the meat of the grazing animals, which were in large numbers in the areas where they lived. With the emergence of modern humans (Homo Sapiens) subsequently, and with the development of better tools meant primarily to process the game caught, these hunter - gatherers ate a great deal of meat which eventually resulted in their diet to contain 50 % each of plant and animal based products. This went on, until the advent of agriculture . With the increase in population and better civilisation, agriculture became the leading way of life about 8 to 13 thousand years ago . As the wave of agriculture crept across Europe and rest of the world from Middle East, at about 1 kilometer per year, the intake of meat got reduced, and once again the main constituent of human diet was one of plant based, to the tune of 90 %. However, in spite of all these changes, the amount of salt in the diet remained in the range of 0.05gm to 1.75gm per day with an average of less than 1gm, in most of the

populations, all through. During all these many million years, our predecessors relied on the very small amounts of salt present naturally in food for their survival. Thanks to the human design which has been genetically programmed to eat such a low salt diet, but blessed with a powerful mechanism to conserve it. In spite of this meagre amount of salt, our ancestors were physically more fit and energetic than the present day populations. Very recently (in evolutionary terms), salt made an accidental entry in the kitchen, about 8065 (BC -6050) years ago, when people in Romania appreciated the preservative property of salt as they immersed meat in brine. They started extracting salt by evaporating salt - laden spring water. Following this, a salt - work (yet another earliest evidence in the history of salt), was started in Xiechi Lake near Yuncheng in Shanxi, China, in BC -6000. Sooner, ' salting ' became a very important method of food preservation as it eliminated the dependence on the seasonal availability of foods and allowed long distance travels. Salt, not only played its role as food preservative, but also made the preserved food more delicious which induced people to add salt to the unsalted food also, only to make it as tasty as that of the preserved food. Starting with just 50mg (0.05gm) a day, millions of years ago, salt intake eventually reached 5000 mg (5gm) a day, 1000 years ago, particularly in the civilised populations. And it did not stop with that. Dietary salt intake continued to rise due to its increasing availability, change in life style from nomad to agriculturist, change in food preparation, etc. It went upto 100 gm per day in the sixteenth century in Sweden, but to 18 gm per day in Europe in the nineteenth century. With the introduction of modern techniques of food preservation such as refrigeration, canning, etc, during the twentieth century, it got reduced to a worldwide average of 10gm per day - an amount still 20 times more than what paleolithic ancestors took. Incidentally, it is also 20 times more than the physiological requirement of an acclimatised most modern human adult - Homo Sapiens Sapiens.

Having accustomed to very low salt diet for the last 85 million years, humans, suddenly (in evolutionary terms), during the last eight thousand and odd years have been exposed to massive amounts of salt. Such a high intake of salt, undoubtedly, is toxic, and the people are bound to undergo physiological stress. This stress expresses itself as pressure, as well as non-pressure related problems, as the physiological requirement (metabolic need) of salt has not changed throughout the entire period of human evolution.

The Importance of Salt and Its Requirement

Life without salt is impossible. When salt is added as "food additive" for its taste enhancing property, it brings luxury to one's eating as it makes the dishes most enjoyable. But, such an addition, as far as health and survival are concerned, is not a must, and is undoubtedly, superfluous. On the contrary, salt as a "nutrient" is absolutely essential as it is the "volume maker" of the most important body fluid called the extra-cellular fluid which includes the fluid portion (plasma) of the blood too. This fluid functions as "The Supplier" of all the nutrients such as oxygen and glucose to all the cells in the body, "The Receiver" of all the waste materials such as carbon-dioxide and urea from all these cells and "The Transporter" carrying all these waste materials to the organs of excretion concerned such as the lungs and the kidneys. Thus, so important is this fluid that life without it is simply not possible. The making of this vital fluid is vested only with salt in view of its inherent ability to attract and hold water along with it. Salt is made up of 40 % sodium and 60 % chloride. Starting prenatally, making of this fluid increases in volume proportionate to one's body weight and age, as the individual grows, reaches a steady state which is maintained as per the metabolic demands of the bodily tissues. For example, the volume of this fluid is 14 litres in a 70 kg adult, ie, 20 % of the body weight. In addition, a very small amount of sodium is required on daily basis for making evaporative sweat by the skin to maintain the body temperature, especially in an arid environment. The amount of sodium required for this purpose, can again easily be met with, from less than one fourth of the salt coming naturally from the food in which there is no added salt. Of course, the remaining three fourth, which is in excess of the physiological requirement, gets excreted by the kidneys, even if they are small with poor excretory capacity due to low birth weight, ie, less than 2.5 kg.

The daily need for sodium (salt) is the amount required for making evaporative sweat which is meant for maintaining the body temperature. This sweat is produced by about 3 million eccrine type of sweat glands, spread out all over the skin. Each sweat gland, like the nephrons in the kidney, has a glomerulus and a tubular system and functions at the command of "The Central Control - The Hypothalamus", the neuroendocrine organ situated at the base of the brain. They are biologically designed to conserve sodium in the face of limited intake of salt, especially during more physical activities and hot climates. In other words,

they behave like "miniature nephrons" contributing their share in the maintenance of sodium balance. In day today life, sodium requirement, for other than the purpose of sweat formation, is almost nil . The daily requirement of salt ranges from 287.5 mg to 1150 mg (5 to 20 mmol or 115 mg to 460 mg of sodium). This wide range is because of wide variations in physical activity, climatic condition, age, weight, body surface area and acclimatisation among the populations. However, most of the people will require not more than 575 mg of salt (10 mmol or 230 mg of sodium) per day. This amount can easily be met with from any food - vegetarian or non vegetarian - in which no salt is added, but having adequate calories, as it will be containing upto 1750 mg (1.75 gm) of salt . Any amount of salt taken in excess of the daily need (physiological / metabolic requirement), needs to be excreted to keep the sodium in balance. Otherwise, because of its water holding property, there will be inexorable accumulation of fluid, and people will die of fluid toxicity in a matter of few days.

Salt Overdose and Toxicity

The current intake of dietary salt, with an average of 10 grams (10,000 mg) per day, is 20 times more than the physiological requirement of the human body. This excess salt, unless excreted, will lead to immediate death. Kidneys, which come in as " Saviour of Life ", excrete this excess salt. Unfortunately, this excretion is not a simple task for most of the kidneys. In fact, in the vast majority of the population, especially in people with smaller kidneys due to low birth weight and advancing age, there is an absolute need for the kidneys to generate extra - pressure (called 'Pressure Natriuresis' in medical terms) to push this excess salt out. This extra - pressure, exhibits itself as high blood pressure in every part of the body, and that is the reason why it is called as 'Systemic Hypertension', in medical terms. This high blood pressure is very slow in progression and takes decades to reach the peak. It is the most common, and the principal manifestation of salt toxicity, affecting billions of people across the world. In addition to this, with high intake of salt, there is also one more phenomenon happening , ie, continuous exposure of all the bodily organs to a very high salt environment, an event occurring before salt gets excreted. This long term exposure, though appears benign, damages many vital organs in the body including the heart, brain, kidneys, blood vessels, stomach, etc. This damage caused by salt toxicity is direct and insidious.

Mankind, thus, is facing two major problems related to high intake of salt. One is, 'Indirect Salt Toxicity' and is pressure-related due to the excretion of salt by the kidneys. The manifestation of this toxicity is the development and maintenance of high blood pressure with its complications such as heart attack, stroke, kidney failure, blindness, osteoporosis, kidney stones, etc. The other one is, 'Direct Salt Toxicity' which is independent of blood pressure, but related to high salt environment. This direct toxicity of salt is responsible for increasing the risk of many illnesses including stomach cancer, other cancers, asthma, Meniere's disease, etc. Of course, people also develop ailments due to the combined effects of both pressure and non-pressure related problems (indirect & direct salt toxicity) causing millions of death across the world every year.

Salt Toxicity and High Blood pressure

Long ago, stiffening of pulse ('Hard Pulse Disease' - the original name for High Blood Pressure) was attributed to high intake of dietary salt. The earliest evidence, relating dietary salt to BP appeared in an article written by a Chinese doctor (Huang Ti Nei Ching Su Wen) in a medical 'journal' - 'The Yellow Emperor's Classic of Internal Medicine' during BC - 2698 to 2598. Then, in 1904, Ambard and Beaujard, after the first ever scientific study linking dietary salt to BP, concluded that it was salt, primarily responsible for high blood pressure. Since then, a large number of studies, (including the well conducted, most scientific ones such as 'INTERSALT', 'INTERMAP', etc) confirmed that excess salt, taken more than the normal excretory capacity of the kidneys, is the single most important cause of high blood pressure. These studies not only established the direct, positive, linear and the dose dependent relationship of salt to blood pressure, but also confirmed this relationship being steeper and stronger with advancing age. Interestingly, they also confirmed the incidence of high blood pressure being zero in populations who add either a little or no salt in their diet. These " No Salt " populations which currently account for more than 12 crore of the world population (representing different ethnicity, geographical regions, varying lifestyle factors such as hunting, gathering, pastoral, peripatetic, nomadic, etc, included communities like Yanomamo Indians in Brazil, the resident Alaskans of US, the Inuit, the Kalalit, the other communities in the centripolar regions of the North, about 500 different groups in different pockets of India comprising 8

crore people, etc), do not record rise in blood pressure and therefore, no pressure related problems of whatsoever in them, despite aging.

Blood pressure at birth is 60/40 (Systolic / Diastolic) mm of Hg. With the maturation of the Circulatory System getting completed at the age of 12, it becomes 110-120/70-80. This pressure at the age of 12 is the most ideal pressure one can have throughout his / her life, because, at this pressure there is no occurrence of heart attack, heart failure, stroke, kidney failure and other pressure related problems, despite aging. Unfortunately, this pressure with aging is maintained in about 10 % of the world population only, but not in all. This population do not develop high blood pressure with aging because of two reasons. One is, either they do not add salt in their diet, or, add a little. The other is, they probably have the best number of nephrons in their kidneys having the ability to excrete the excess salt without generating ' extra - pressure ' (Pressure - Natriuresis). In the remaining 90 % of the population, however, with the current intake of 10 gm of dietary salt per day, the blood pressure rises with aging. It also increases, even in those at 65 with normal BP, by about 90 % chance, during the rest of their life. Simple aging is not the cause of high blood pressure, but excess salt intake with aging is.

Currently, about 2.5 billion (250 crore) people in the world have high blood pressure (>120 / 80). This accounts for more than one third of the world population, making it the biggest and the most common of all the illnesses, in human beings. Starting from 110/70 mm of Hg , the risk of developing morbidity and mortality gets doubled for every increase of 20 mm of Hg, systolic pressure (the pressure during left ventricular contraction), and 10 mm of Hg, diastolic pressure (the pressure during left ventricular relaxation), leading approximately to 3/4th of stroke, 2/3rd of heart attack and 1/3rd of kidney failure. High blood pressure, also causes blindness, diseases of the aorta, etc, in a very significant number of patients . The result of all these, is loss of 92 million years of productive life, and 7.6 million death, every year, world wide. Fiscally, to treat all the people with high blood pressure with all its complications, it would cost more than the annual budget, in every country, every year.

Salt Toxicity : Heart Attack, Heart Failure, Stroke and Kidney Failure

Increase in salt increases blood (plasma) volume and this increased blood volume goes on unnoticed, and results in more blood flow, more perfusion and better feeding of all the individual cells in the body. With further increase in salt on regular basis, there is a continuous over feeding of all these cells, and these cells refuse to accept this over feeding, once the threshold is reached . This refusal, called ' autoregulation ' in medical terms, restores the blood flow, but at the cost of constricting the blood vessels, particularly the arterioles and the capillaries. This constricted and narrowed blood vessels offer resistance to the blood flow, coming from the pumping action of the heart. To overcome this resistance (peripheral resistance), heart increases its pumping capacity, but in vain, as the blood vessels are unyielding to accommodate (dilate) this excess blood flow . At this juncture, kidneys come for rescue as saviour of life, and generate extra - pressure to push this salt laden excess volume out, and thus restore the blood volume back to normal. But, in the bargain, there are two clinically important events, take place . One is, in the heart itself, the other in the blood vessels all over. Heart, to increase its pumping capacity, increases in size ('The Big Heart') - what is called ' hypertrophy ' in medical terms. This hypertrophied 'big heart', ultimately, leads to heart failure - more it is big, earlier and severe would be the heart failure. Blood vessels, experience the jet effect of the over working and over beating heart at every single point along their entire length and undergo wear and tear, leading to either partial or total occlusion, resulting in dysfunction/ death of those cells which were at the mercy of these blood vessels for their survival. The occlusion of these blood vessels happens universally, but its impact is critical in the heart, brain, kidneys, nerves, eyes, etc.

Increase in salt, as shown by the recent studies over the past two and half decades, also increases the cell volume and stiffness of the blood vessels all over the body independent of blood pressure, whether it is high or normal. These effects of salt are not surprising as it has both prohypertrophic (tendency to increase the size of the cells) and profibrotic (tendency to replace the normal functioning cells by non - functioning stiff fibres) properties. These non-pressure related effects of salt are much appreciated in the heart, brain & Kidneys. The outcome of these non-pressure related effects are, increase in heart size leading to heart failure, decrease in blood flow & reduction in capillary density (decrease in the number of capillaries per unit volume of the organ) leading to heart attack,

stroke, vascular dementia, decline in cognitive function, proteinuria (protein leak from the kidneys), worsening of kidney function, end stage kidney failure, etc. Added to this, there can be major contribution coming from the pressure - related (high blood pressure) toxicity of salt, making all these illnesses really severe and more prevalent. Thus, both the non-pressure related and the pressure related toxicity of salt cause the most major public health problem in terms of cardiovascular morbidity and mortality across the world.

Salt Toxicity: Cancer stomach and other Cancers

Salty, and salt preserved foods such as cured meat, fish, pickles, etc, and diets with high content of salt, taken regularly for long, are associated with the development of cancers which include cancer of the stomach, nose, throat, colon, rectum, breast, ovary and pancreas. Of these, the most studied is stomach cancer. Growing body of evidences indicate that a strong association exists between the intake of salt and the incidence of stomach cancer and this association seems to be dose dependent. A recent study, involving 270,000 individuals followed up for 6-15 years, showed 68 % higher risk of developing stomach cancer in those with high intake of salt than in those with low intake. Another study, done in 2007, found, for every one gram of salt taken daily an increase of 8 % risk, in developing stomach cancer . Also, stomach cancer deaths, linking salt intake, have been reported in 39 populations from 24 countries with high rates being noted in Northern China, Japan and Korea where the consumption of salt is high. In Japan, where stomach cancer is the most common cancer, steps are being taken to cut salt drastically as a public health measure. Salt induces cancer stomach at least in three ways 1) It promotes the growth and the action of Helicobacter pylori - the major risk factor for cancer stomach. 2) Salt, being an irritant, directly damages the inner lining of the stomach, making it atrophic and exposing it to the chemical carcinogens - substances capable of inducing cancer. 3) Salt increases the endogenous production of N-nitroso compounds derived from methionine, having the potential to act as carcinogens. In conclusion, about 25 % of all stomach cancers are directly attributable to high salt intake.

Salt Toxicity : Brittle Bones (Osteoporosis) and Kidney Stones

Calcium is so important for the bones that 99.3 % of the total body calcium deposits are in the bones. Calcium ensures normal mineralisation for making

the bones stronger and prevents fractures in most occasions. However, its content in the bones depends upon the balance between the intake and the excretion (excretion by the kidneys). The average intake of calcium in the general population is low, often requiring supplementation. Excretion of calcium by the kidneys is proportional to the excretion of sodium (salt) by them. This obligatory loss of calcium through the kidneys is in the order of 1.4 mmol for every 100mmol of sodium excreted. This loss of calcium, which is an equivalent of 1000 mg, unless additionally replaced in the diet, will result in bone resorption with leaching of calcium, leading to additional 1% of bone loss every year. With the current intake of excessive salt, the development of bone weakness (osteoporosis) is almost universal in adults, more so in populations with physical inactivity, postmenopausal age and the elderly. With high intake of salt leading to higher excretion of sodium by the kidneys, resulting in more calcium passing through them, people, especially with high blood pressure (the victims of high salt intake) also develop kidney stones. It is not a wonder to note that more than 80 % of all the kidney stones contain calcium as the main constituent as most of us are in the habit of taking excessive salt . By keeping ourselves on diet without added salt / reduced salt, we will be able to, apart from other problems, prevent osteoporosis, kidney stones and, of course, calcium deficiency to a larger extent.

Salt Toxicity: Obesity and Diabetes

Obesity (Body Mass Index > 30) has already emerged as a huge health burden, particularly in the developed and developing countries. Adult female obesity is more common than adult male obesity, but, childhood obesity skyrockets. Obesity predisposes an individual to high blood pressure, diabetes, cardiovascular diseases, sleep apnea, shortness of breath, etc . Increase in dietary salt increases thirst which forces the individual to take more fluids. Nearly 1/3 rd of the fluids drunk is rich in calories as they are mostly sugary soft drinks. Studies, conducted in the age groups of 4 to 18 years, confirm, every one gram reduction in salt reduces fluid intake by 100 ml/day, in which 27 % is sugar sweetened soft drinks. Therefore, cutting back on salt will reduce the risk of developing overweight and obesity and thus, the related illnesses including diabetes, high blood pressure, heart attack, stroke, etc. Increase in salt increases the incidence of diabetes through its direct (non-pressure related), indirect (pressure related), and other effects. 1) It increases insulin resistance 2) It increases the incidence of

obesity which is the common risk factor for diabetes. 3) It increases, as we know, the blood pressure and people with high blood pressure are prone to develop diabetes by more than 2.5 times compared to people with out high blood pressure. Salt, excess in diet, thus, is not only responsible for the development of high blood pressure, but its role in the development of obesity and diabetes (the two major components of 'Metabolic Syndrome') is very significant.

Salt Toxicity: Water retention, Asthma and Meniere's Disease.

With high intake of salt, there is an increase in the body fluid (extracellular fluid). Kidneys get rid of this excess fluid. However, in the chase, at any point of time, there is always a minimum of 1.5 litres of excess fluid in the body. This excess fluid may prove to be a dangerous accumulation, causing morbidity and mortality in fluid retaining illnesses such as heart failure, kidney failure, liver failure, protein deficiency states, idiopathic and cyclic odema in women, etc. High intake of dietary salt is also associated with increase in the incidence, as well as, severity of bronchial asthma (an airway disorder with difficulty in breathing and wheezing), as it increases the reactivity in the bronchial tree - the respiratory tract. In addition, the recent studies indicate that increase in salt intake is associated with imbalance in the sodium content and fluid volume in the inner ear, predisposing the individuals to Meniere's disease - a disease with features of severe giddiness, loss of balance, palpitation, profuse sweating, etc.

Conclusion

The role played by salt in human life is equal to that of oxygen in human survival. The amount of salt present in the human food as natural ingredient is much more than what is required for physiological purposes. This is also true for those acclimatised individuals with intense physical activities. Therefore, under normal circumstances, it nullifies the need for adding salt in the diet. With the current intake of 8 to 12 grams of dietary salt per day, as seen in most of the countries around the world (181 out of 186 countries studied), the deleterious effects of salt on human health are enormous. Regular high intake of salt leading to chronic salt toxicity is largely responsible for devastating human life by causing heart attack, heart failure, stroke, kidney failure, etc, through the development and maintenance of high blood pressure - the mega hit of salt toxicity. Salt toxicity is also very much responsible for the occurrence of a number of illnesses such as

osteoporosis, kidney stones, cancer stomach, cancer of other organs including oesophagus, pancreas, colon, rectum, naso-pharynx, breast & ovary, vascular dementia, decline in cognitive function, asthma, Meniere's disease, etc, through direct and non-pressure related mechanisms, as seen in a very significant number of the population across the world. Whilst high blood pressure represents only the tip of the iceberg of salt toxicity, the other newly diagnosed diseases of salt toxicity are getting recognised more and more with the ongoing epidemiological, clinical, research and other studies. Undoubtedly, salt, in excess, is toxic. Taking diet with salt restricted to less than 2 gms per day will ensure most of the benefits of the diet in which no salt is added (“No salt diet”) , as this excess salt can be handled by most of the kidneys easily with little scope for salt toxicity to manifest - both pressure and non pressure related. Switching over to “ No Salt Diet “ / Salt Restricted Diet (< 2gms per day) from high intake of salt, at any stage of life, will also ensure most of the benefits during the rest of the life . However, taking diet without added salt (“ No Salt Diet “) from childhood is ideal, not only to eradicate high blood pressure once and for all from this planet , but also to wipe out all other illnesses related to salt toxicity, too. Therefore, we human beings across the world are bound to join hands to say, “Good Bye” to Salt to make not only a “ Hypertension Free World”, but also a world entirely free from salt toxicity.

Dr.N.Murugesan

Chief Nephrologist, East Coast Hospitals Ltd

drnamurugesan@gmail.com

-dedicated to my mentor Dr.K.S.Ramalingam, Chief Nephrologist,

Coimbatore Kidney Centre, Coimbatore

&

my Guru Dr.M.K.Mani, Chief Nephrologist, Apollo Hospitals, Chennai