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- **Beyond Currently Available Therapeutic Strategies: The Potential Role Of Carnitine And Nicotine As Anti-cachexia Agents**
- **Multidimensional Assessment Of Obstructive Sleep Apnea In Adults: An Appraisal Of The Symptoms, Role Of Nutrition And Its Treatment**

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To Our Readers

The current issue (34) of the Update Series of the Centre for Research on Nutrition Support Systems features two very interesting articles.

The first of these discusses the potential role of carnitine and nicotine in counteracting cachexia observed in many chronic diseases and their possible application as future therapeutic tools in the treatment of chronic cachexia. The article also offers us an insight into the biochemical pathways involving carnitine and nicotine and their utility in modulating the inflammatory response.

The second article explores the very important and interesting association between dietary energy intake, obesity and obstructive sleep apnea – a disorder that is characterized by decreased availability of air into the lungs with the possibility of resulting hypoxia and hypoxemia. The latter may indirectly affect day-to-day physical and mental functions. Obstructive sleep apnea, which is an important cause of loud snoring, has been observed in many individuals across the world and deserves appropriate attention.

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Beyond Currently Available Therapeutic Strategies: The Potential Role Of Carnitine And Nicotine As Anti-cachexia Agents

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ABSTRACT

The clinical course of most chronic diseases is associated with the onset of declining appetite and energy intake and increased muscle proteolysis leading to impaired function. This syndrome, generally termed as the anorexia/cachexia syndrome, is frequently observed among patients suffering from chronic diseases, and is clinically relevant since it reduces quality of life, and increases morbidity and mortality. The currently available pharmacological treatments may only partially counteract the damaging effects of the anorexia/cachexia syndrome, and more effective treatments are still investigated. There is good experimental and clinical evidence that chronic systemic inflammation, largely sustained by cytokines, and increased oxidative stress contribute to the development of the anorexia/cachexia syndrome. Thus, anti-inflammatory and anti-oxidant agents might modulate inflammation and protect against reactive oxygen species. Carnitine and nicotine have been recently tested as immunomodulating and anti-oxidant agents. In particular, carnitine supplementation has been shown in humans to reduce chronic inflammation and oxidative stress in haemodialysis patients as well as in neoplastic patients. These results are paralleled by reduced fatigue and improved outcome. Nicotine is more selective than acetylcholine in triggering the vagus nerve mediated anti-inflammatory effects. In animal models of sepsis and cancer, nicotine-induced activation of the nicotinic anti-inflammatory pathway resulted in improved survival. As part of a continued effort to develop a more efficacious strategy against the anorexia/cachexia syndrome, carnitine and nicotine may represent an interesting therapeutic approach, yet to be tested in larger and randomized clinical trials.

INTRODUCTION

One of the most debilitating features of almost any chronic disease is the progressive, involuntary and apparently inevitable loss of body weight, resulting from reduced energy intake, increased lipolysis of adipose tissue and wasting of skeletal

muscles[1,2]. This clinical syndrome, termed as anorexia/cachexia syndrome, is highly prevalent among patients suffering from chronic diseases, negatively influences their outcome, and impinges on their quality of life[1].

Supportive therapy, specifically nutritional-metabolic support, may counteract the detrimental effects of anorexia-cachexia syndrome, and clinical data seem to suggest that it may positively influence quality of life[3], reduce morbidity[4] and prolong survival[5]. In some cases, including hematologic malignancies in which parenteral/enteral nutrition is permissive to high-dose chemotherapy and bone marrow transplantation[6], nutritional support enhances the chances to completely recover from the disease.

Nutritional-metabolic support is an important part of palliative care, but it should not be considered only for patients with advanced disease. Rather, as per the definition issued by the World Health Organization, some aspects of palliative care, including nutritional support, are critical also for those patients in the curative phase of their disease. Therefore, nutritional-metabolic support should be initiated from the beginning of patients' clinical history, possibly in conjunction with either medical or surgical strategies.

Unfortunately, clinical trials investigating the effects of different nutritional and metabolic regimens yielded conflicting results[7,8]. The lack of unequivocal efficacy could be attributed at least in part to the pathogenesis of the anorexia/cachexia syndrome, which involves many different factors[9]. Therefore, therapeutic targeting of a specific physiological pathway may not result in a complete response to the syndrome. Indeed, enhancement of appetite and food intake without inhibition of proteolysis and lipolysis may lead to increased mortality[10]. Similarly, inhibition of proteolysis without provision of energy substrates with the diet may paradoxically lead to accelerated protein catabolism[11]. The contribution of human polymorphisms of some critical genes to the confounding results should not be overlooked[12].

Experimental and clinical evidence seems to suggest that the anorexia/cachexia syndrome characterizing the clinical course of different chronic diseases could be due to the chronic inflammatory condition and/or increased oxidative stress[13]. Therefore, an effective, yet not-immunosuppressive, anti-inflammatory therapeutic strategy could lead to an almost complete resolution of reduced appetite and muscle wasting. Carnitine and nicotine have been shown to exert anti-inflammatory and anti-oxidant properties which might be used in the treatment of the anorexia/cachexia syndrome.

CARNITINE ACTIVITY

L-carnitine is a trimethylamine molecule with vitamin-like properties, which is synthesized in different tissues, including liver, brain and kidney, via the conversion of two essential amino acids, lysine and methionine[14]. The carnitine system, which include carnitine, carnitine esters (acetylcarnitine, propionylcarnitine), several specific intracellular enzymes and membrane transporters, plays an essential

role in cellular homeostasis. Indeed, beta-oxidation, the major process by which long-chain fatty acids are oxidized in mitochondria, is ubiquitously dependent on this system.

Mitochondrial beta-oxidation is a major source of reactive oxygen species, and it has been suggested that increased oxidative stress due to reduced efficiency of cellular bioenergetic processes contributes to the development of metabolic alterations[15]. Reduction/oxidation (redox) state contributes to an inflammatory signal associated with oxidative stress, triggering the release of proinflammatory cytokines[16]. The use of carnitine to optimize mitochondrial function may result in reduction of the oxidative stress and inflammatory status, possibly leading to increased appetite, preserved lean body mass and reduced morbidity. Further supporting the rationale for the use of carnitine in wasting diseases, it should be considered that carnitine is important for the control and regulation of fuel partitioning within skeletal muscle, which may contribute to muscle structure and function phenotype[17].

CARNITINE AND UREMIA

The anti-oxidant and anti-inflammatory properties of carnitine have been well investigated in experimental models. Among other data, carnitine supplementation has been shown to restore the chemotactic and phagocytic activities of aged inflammatory cells[18], protect astrocytes against oxidative stress and inflammatory cytokine damage[19] and thus, in association to vitamin E and folate, may be useful in preventing Alzheimer's disease[20].

In humans, research interest has been focussed on patients with renal failure undergoing haemodialysis treatment. In these patients, the rationale for the use of carnitine as a supplement is demonstrated by studies suggesting a causal connection between increased oxidative stress, reduced carnitine concentrations, increased inflammatory status, skeletal muscle wasting, and increased morbidity and mortality[21]. To ascertain the clinical relevance of carnitine as an anti-inflammatory agent, patients on maintenance hemodialysis were studied and randomly assigned to receive intravenous injections of L-carnitine (20 mg/kg) or placebo three times weekly at the end of each hemodialysis treatment for a duration of six months[22]. At the end of the study, the carnitine group showed a statistically significant decrease in serum C-reactive protein and increase in serum albumin and transferrin, blood haemoglobin, and body mass index[22]. The positive effects of carnitine supplementation on haemoglobin have been further supported by a study involving patients on maintenance hemodialysis[23]. All patients received recombinant human erythropoietin (rHuEPO) therapy as needed, but only the carnitine-treated group received 1 gram of L-carnitine intravenously three times a week for four months, while the control group received placebo. At the end of the study, blood haemoglobin levels in the carnitine-treated group were significantly higher than in the placebo group, despite a significantly lower weekly requiring dose of rHuEPO therapy[23].

It must be acknowledged that the available clinical intervention studies are biased by the relatively small number of patients involved, and would not be sufficient to propose the routinary supplementation of carnitine to hemodialysis patients. However, stronger evidence, although not conclusive, for significant clinical benefits of carnitine administration is available from the retrospective study by Kazmi *et al*[24]. Using a dialysis database, almost 3,000 adult patients who received carnitine for at least 3 months, and had at least 3 months of pre-carnitine follow-up, were included in the study. Hospitalization and hospital day rates were compared before and during carnitine therapy, and with a matched population. Results obtained showed that carnitine therapy was associated with a significant reduction in hospital utilization, particularly for those patients with cardiovascular disease. The study, unfortunately, did not assess the possible mechanisms explaining the clinical benefits observed. However, considering the role of improved nutritional status, and in particular of preserved lean body mass, in improving outcome, it could be inferred that carnitine supplementation might contribute to the amelioration of end-stage renal disease/ hemodialysis induced anorexia/cachexia syndrome.

Although intriguing, the available evidence is not conclusive. Carnitine supplementation in hemodialysis patients is still controversial[25, 26]. However, preliminary results are encouraging and larger clinical intervention trials are eagerly needed to confirm the benefits associated with carnitine utilization and/or ascertain whether specific subsets of patients exist which are more likely to derive positive effects.

CARNITINE IN CANCER PATIENTS

In cancer patients, chemotherapy is associated with increased oxidative stress which may worsen chronic inflammation responsible for muscle wasting. Chemotherapy may also cause urinary loss of carnitine and is frequently associated with the onset of fatigue, independently from the concentrations of blood haemoglobin. To better elucidate the potential role of carnitine administration in this clinical setting, non-anaemic cancer patients undergoing chemotherapy received 4 g daily of oral L-carnitine for 7 days[27]. At the end of the study, fatigue ameliorated in almost all treated patients and maintained the improved functional assessment of cancer Therapy-Fatigue score until the next cycle of chemotherapy. Similar results have been previously reported by Cruciani *et al*, who showed that 1 week of carnitine supplementation in cancer patients with fatigue and carnitine deficiency resulted in improved symptoms of fatigue, reduced depression and sleep disruption[28]. Gramignano *et al* supplemented cancer patients undergoing chemotherapy with 6g daily of oral carnitine for 4 weeks, and reported a significant amelioration of fatigue[29]. More importantly, they reported that in their patients lean body mass and appetite increased significantly following carnitine supplementation. Levels of reactive oxygen species decreased and glutathione peroxidase increased, although not significantly. No change was observed in the plasma concentrations of cytokines. These data should be carefully interpreted, considering the small sample studied,

but they suggest that carnitine supplementation in cancer patients may result in reduced oxidative stress and chronic inflammation, leading to improved appetite and nutritional parameters. Of particular interest is the finding of improved appetite following carnitine supplementation[29]. Similar results have been observed by our group in an animal model of cancer-associated anorexia/cachexia syndrome, in which carnitine administration resulted in a dramatic increase in food intake, better preserved lean body mass and reduced circulating levels of interleukin-1 (Laviano *et al*, submitted).

The anorexigenic effects of carnitine are of particular interest, since they may help to understand better the pathogenesis of cancer-associated anorexia, whose etiology is complex and involves many different factors, including those related to lipid metabolism[30]. Under physiological conditions, in the hypothalamus (the key area regulating food intake), increased malonyl-CoA concentrations inhibit carnitine palmitoyltransferase (CPT)-dependent fatty acid oxidation and reduce food intake[31]. In cancer, CPT activity is depressed[32]. In the hypothalamus, this functional defect may lead to increased malonyl-CoA concentrations further inhibiting beta-oxidation. Therefore, restoring or enhancing hypothalamic fatty acid oxidation via carnitine supplementation may result in improved appetite in addition to its anti-inflammatory and anti-oxidative effects.

CARNITINE IN OTHER CLINICAL SETTINGS

In patients with distal ulcerative colitis, propionyl-L-carnitine enemas resulted in significantly improved disease activity index and amelioration of histologic features, including mucosal erosion, distortion of crypt architecture, inflammation and lamina propria gap[33]. However, no significant changes were observed in levels of pro-inflammatory cytokines.

In elderly subjects with rapid muscle fatigue, L-carnitine supplementation (2 g twice daily for 30 days) vs placebo resulted in significant improvements of total fat mass and total muscle mass, as well as significant reduction of physical and mental fatigue[34].

THE NICOTINIC ANTI-INFLAMMATORY PATHWAY

A large pool of data exists showing that brain's activity is influenced by cytokines (or in broader terms by inflammation). In the brain, the hypothalamus, however, not only integrates immune response to adjust metabolism and behaviour, but modulates the immune response as well. There is good evidence that the brain, via the vagus nerve, is able to control systemic inflammation in animal models[35,36] by activating the Jak2-STAT3 signaling pathway[37]. In particular, it appears that acetylcholine, the main neurotransmitter of the vagus nerve, can inhibit the production of pro-inflammatory cytokines by signalling through nicotinic receptors of macrophages[38]. Consequently, this mechanism has been called "the nicotinic anti-inflammatory pathway", since acetylcholine exerts its anti-inflammatory effects

via the α7-nicotinic-acetylcholine receptor (α7nAChR; 39). Interestingly, nicotine is more efficient than acetylcholine at inhibiting cytokine production since nicotine is a more selective cholinergic agonist. This evidence may explain the clinical knowledge that Crohn's disease, which can be described as a chronic inflammatory status of the intestine mediated and sustained by cytokines, is less prevalent and less severe among smokers than among non-smokers.

The molecular mechanisms responsible for the anti-inflammatory effects of nicotine are currently under investigation. It appears that nicotine prevents the endotoxin-induced activation of the nuclear factor-κb (NF-κb) pathway, which is critical for the production of pro-inflammatory cytokines[40], via α7nAChR mediated Jak2-STAT3 activation[37, 39].

EFFECTS OF NICOTINE IN EXPERIMENTAL MODELS

The potential anti-inflammatory effects of nicotine are currently being tested in animal models. In models of experimental sepsis, nicotine administration has been shown to reduce mortality[39], decrease neutrophils influx, proinflammatory cytokine levels, and liver damage[41]. The data, although preliminary and obtained from animal models, are encouraging and suggest the translation of these premises into the clinical setting.

Another important feature of nicotine administration is its ability to reduce oxidative stress and inflammation also in the brain[42-44]. This evidence suggests that nicotine could be used as a therapeutic tool in those neurodegenerative diseases characterized by increased brain inflammatory status, including HIV-related dementia, Alzheimer's dementia, and spinal cord injury. However, taking into consideration the fact that increased hypothalamic production of proinflammatory cytokines and increased oxidative stress are features of cancer associated anorexia/cachexia syndrome[9,29], it could be postulated that nicotine administration may result in decreased systemic and brain inflammation leading to improved appetite and amelioration of skeletal muscle wasting. Infact, it has been shown previously that nicotine-induced reduction of food intake is mediated via derangement of brain neurochemistry[45] in normal rats. Therefore, we hypothesized that nicotine administration may improve food intake in anorectic tumor bearing rats working through the nicotinic anti-inflammatory pathway. To test this hypothesis we used the Fischer rat/methylcholanthrene-sarcoma model, since this animal model of cancer-induced anorexia serves very well to the hypothesis that anorexia is mediated by systemic and central hyperproduction of TNF-α and IL-1[46], and pharmacological inhibition of these two cytokines has been demonstrated effective in ameliorating food intake[47, 48]. Preliminary data seem to show that repeated nicotine administration improves food intake in anorectic tumor bearing rats and prolongs survival. These data should be considered preliminary and more studies are needed to explain the mechanism for a possible utilization for cancer associated anorexia/cachexia syndrome, related chronic inflammation, metabolic abnormalities and myopathy.

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Multidimensional Assessment Of Obstructive Sleep Apnea In Adults: An Appraisal Of The Symptoms, Role Of Nutrition And Its Treatment

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ABSTRACT

The present study deals with the multidimensional assessment of adults suffering from obstructive sleep apnea (OSA) by critical evaluation of its effects on health and its treatment. OSA is a debilitating and often life-threatening condition that occurs when tissue in the upper airways blocks the breathing passages. The National Institute of Health estimates that 2 percent of women and 4 percent of men over the age of 35 have sleep apnea with excessive daytime sleepiness. In normal conditions, the muscles of the upper part of the throat allow air to flow into the lungs. However, when a person with OSA falls asleep, these muscles are not able to keep the air passage open all the time. When the airway closes, breathing stops, oxygen levels fall and sleep is disrupted in order to open the airway. The disruption of sleep usually lasts only a few seconds. However these brief arousals disrupt continuous sleep and prevent OSA sufferers from reaching the deep stages of slumber, which the body needs in order to rest and replenish its strength. Once breathing is restored, obstructive sleep apnea sufferers fall asleep only to repeat the cycle throughout the night. Most of the patients of this order are obese. Reduction of fats in the diet can help in obtaining the desirable weight. Continuous Positive Airflow Pressure (CPAP) is the most common non-surgical treatment for obstructive sleep apnea, Surgical treatment includes techniques like somnoplasty, uvulopalatopharyngoplasty, mandibular maxillary advancement and nasal surgery.

INTRODUCTION

The exact cause of OSA has remained unclear. Generally, sleep apnea happens when enough air cannot move into our lungs while sleeping. When a person is awake, and normally during sleep, the throat muscles keep the throat open so that air can flow into the lungs. But with OSA, the throat briefly collapses, causing pauses in the breathing. This decreases the oxygen level in the blood. Ingestion of alcohol and sleeping pills may increase the frequency and duration of breathing pauses in people with sleep apnea. Diagnosis of OSA is done with the help of a physician, pulmonologist, neurologist or other physician with specialty training in

sleep disorders. The diagnostic procedures for OSA may include a sleep history and evaluation of the upper airway. Polysomnography is the most common test used to determine if OSA is present. The patient is made to sleep in a laboratory overnight. Electrodes are attached to the scalp, on the outer edge of the eyelids and to the skin on the chin. Belts are placed around the chest and abdomen. A cannula is placed in the nose to measure the airflow and a probe is placed on the finger to measure the blood oxygen level. While the patient sleeps, the polysomnography records body functions such as eye movement, muscle activity, heart rate, respiration, blood oxygen levels, airflow and the electrical activity of the brain. This information is then gathered and evaluated. The multiple sleep latency test (MSLT) measures the speed of falling asleep. In this test, patients are given several opportunities to fall asleep during the course of a day when they would normally be awake. For each opportunity, time to fall asleep is measured. Individuals who fall asleep in less than 5 minutes are likely to require some type of treatment for sleep disorders. The MSLT may be useful to measure the degree of excessive daytime sleepiness and to rule out other types of sleep disorders. A number of non-surgical and surgical procedures are followed to treat OSA. Under non-surgical techniques, continuous positive airflow pressure (CPAP) is the most common treatment for OSA. It involves wearing a mask that supplies a steady stream of air through the nose during sleep. The airflow keeps the nasal passages open sufficiently to prevent airway collapse and apnea. Weight loss, changing sleep habits, avoiding alcohol and sedatives decrease sleep apnea significantly. The surgical approaches include somnoplasty, a surgical procedure that uses radio frequency energy to reduce the soft tissue in the upper airway; uvulopalatopharyngoplasty (UPPP) a procedure that removes soft tissue on the back of the throat and palate which increases the width of the airway at the throat opening; mandibular maxillary advancement, a procedure that corrects facial abnormalities or throat obstructions that lead to sleep apnea. Nasal surgery consists of the procedures that correct nasal obstructions such as a deviated septum, which may obstruct sleep.

MATERIALS AND METHODS

Duration of the study: The data was collected for a period of one year from May 2005 to May 2006.

Study setting: A total of 150 men suffering from OSA were selected for the study from cities of Delhi, Gurgaon and Chandigarh. For selection of subjects various hospitals at Delhi and Chandigarh were visited repeatedly to interact with the patients under treatment in the departments of ENT and respiratory diseases. All the patients belonging to Gurgaon were treated at hospitals in Delhi.

Selection of subjects: Purposive sampling was used to select the respondents. Subjects selected for this study were men suffering from OSA and belonging to various professions. A meeting was arranged with the selected respondents to confirm their participation in the study. In some cases, the respondents had to be

convinced to actively participate in the research work. They were assured that their identity would not be disclosed and any information pertaining to them would be confidential. The age of the subjects ranged between 40-60 years.

TOOLS AND TECHNIQUES

General information: A questionnaire technique was used to collect the general information. A questionnaire was designed to collect information from each subject about their age, profession, dietary practices like eating out pattern, likes and dislikes and their lifestyle. The respondents were asked to fill the questionnaire before they went for OSA treatment.

Anthropometric measurements: Anthropometry refers to obtaining physical measurements of an individual and relating them to the standards that reflect the growth and development of an individual. These measurements constitute a method to assess the nutritional status of an individual. In the present study, the anthropometric measurements used were weight and height and using these body mass index (BMI) was calculated. Using the normogram for determining BMI, categorization of subjects was done[1, 2]. The classification of BMI used is tabulated.

BMI (kg/m^2) classification	
Underweight	<18
Normal	18.1-24
Overweight & Obese	>24

Dietary survey: A dietary survey forms an important part of all the nutritional assessments and surveys. The methods most frequently used include retrospective or food recall methods and prospective or food record methods. Each of these methods has its own advantages and drawbacks. Ultimately, all survey methods are dependent on motivation, compliance and ability of subjects to report accurately their habitual food intake.

In the present study, 3-day recall method was used. The subjects were asked to recall all the foods eaten and the amounts of different food items consumed during the reference time period. Three-day diet recall of subjects was obtained. The subjects were shown different standardized common household measures like spoons, glasses, *katoris, karchis*, tablespoons to record the quantity of foods and beverages consumed.

The intake of foods and nutrients was computed for each day separately and then mean daily intake was derived. The energy, proteins, fats, fibre, calcium iron, β-carotene, vitamin C, thiamine, riboflavin, niacin were calculated with the help of food composition tables from the Nutritive value of Indian foods and adequacy of intake was determined by comparing the mean daily intake of nutrients with the ICMR recommended dietary allowances (RDA) for adult men[3].

RESULTS AND DISCUSSION

The data collected was analyzed to find out the deleterious effects of OSA on the subjects.

Profile of subjects: A total of 150 men suffering from OSA were enrolled for the study. Table 1 shows the distribution of subjects belonging to the selected cities

according to their profession. The highest number of patients was from Delhi followed by Chandigarh and the lowest number of patients was from Gurgaon. Responses filled in the questionnaire showed that all the subjects were sedentary workers and led an active social life. Most were non-vegetarians and enjoyed eating out at least 4-5 times a week.

Table 1: Distribution of subjects from selected cities

Profession	Delhi	Gurgaon	Chandigarh
Marketing executive	10	-	3
Engineer	9	6	8
College lecturer	5	3	6
Computer Professional	6	7	4
Lawyer	10	7	3
Businessman	25	18	20
Total	65	41	44
Grand Total	150		

Diagnosis of OSA: OSA was diagnosed in all the 150 subjects by a physician with the help of polysomnography and/or multiple sleep latency test. A total of 123 subjects were diagnosed of OSA using polysomnography while 84 underwent the multiple sleep latency test for confirmation of OSA.

Symptoms due to OSA: The diagnosis of OSA may include a sleep history and evaluation of the upper airway. Table 2 shows various symptoms associated with OSA. It was seen that loud snoring, breathlessness as well as weight gain were observed in most of the subjects. Abnormal daytime sleeping was also affecting many respondents. Such patients often feel very sleepy during the day, which has a negative impact on their concentration and daytime performance. Long-term effects of OSA include depression, irritability, sexual dysfunction, learning and memory difficulties, and falling asleep while at work, on the phone or driving. In fact, studies show that sleep deprivation can lower a person's quality of life and increase the risk for accidents.

Table 2: Symptoms arising due to OSA

Symptoms present	Number of patients
Loud snoring	139
Periods of gasping for breath	140
Abnormal daytime sleeping patterns	119
Headaches	46
Weight gain	122
Lack of concentration	98
Memory loss	109
Depression	67
Personality changes	115
Lethargy	110
Hypertension	99

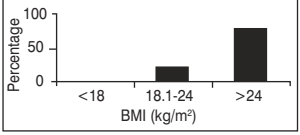
Blood lipid profile: There is growing research evidence for an independent association between OSA and cardiovascular disease (CVD). Also, chronic sleep deprivation has been shown to change metabolic function in a way that promotes weight gain and diabetes, two risk factors for heart disease[4,5]. Hence blood lipid profile of all the subjects was checked from their records to find out if the patients were suffering from hyperlipidemia by observing the total cholesterol level, low-density lipids (LDL), high-density lipids (HDL) and total triglyceride level (Table 3).

Table 3: Clinical diagnosis of hyperlipidemia in male subjects suffering from OSA

Blood parameter	Level of lipid	Number of patients (%)	Range	Mean ± SD
Total cholesterol mg/dl				
High	240 or more	68 (45.3)	256.0-264.0	261. 7 ± 72.8
Borderline-high	200-239	45 (30)	199.0-238.0	217.5 ± 12.1
Desirable	Below 200	37(24.7)	100.0-197.0	153.5 ± 26.5
LDL mg/dl				
High	160 or above	56 (37.3)	182.0-190.0	186.0 ± 2.6
Borderline	Below 139	33 (22)	136.7-129.0	135.3 ± 3.6
Normal	Below 130	50 (33.3)	105.0-130.0	117.8 ± 9.5
Desirable	Below 100	11 (7.3)	57.5-96.0	76.5 ± 11.8
HDL mg/dl				
High	60 or more	32 (21.3)	60.3-69.0	62.5 ± 2.9
Normal	35-39	80 (53.3)	35.0-38-0	32.2 ± 6.7
Low	Below 35	38 (25.3)	32.0-39.0	34.8 ± 4.6
Triglycerides mg/dl				
High	400-1000	63 (42)	235.0-296.0	256.4 ± 26.9
Borderline	200-399	41 (27.3)	152.0-196.0	172.9 ± 17.2
Normal	Below 200	46 (30.7)	56.0-131.0	97.9 ± 26.1

It is seen from Table 3 that 45.3% of the patients suffered from hypercholesterolemia and 30% had borderline high values of cholesterol. Only 7.3% had desirable value of cholesterol whereas 37.3% had high levels of LDL in blood and and 42% had high triglyceride levels, respectively. The low HDL-C values were observed among 25.3% of the subjects. Thus most of the subjects suffering from OSA had a deranged lipid profile.

Figure 1: BMI of subjects with OSA



Body mass index: It is a well-known fact that obesity is an important factor influencing sleep apnea, and is often listed as one of the main causes. However, that appears to be a two-way process. Once a person becomes a victim of sleep apnea, without very strict dietary control, even more pounds pile on. Weight and height of all the subjects was measured and BMI was calculated. The subjects were then categorized into various BMI ranges[1]. It is evident from Figure 1 that none of the subjects was underweight and only 20.7% had a normal BMI. In fact 79.3% were either overweight or obese which is an important factor contributing to OSA.

Dietary data: The dietary intake of the patients was calculated after visiting their homes and helping them to recall the foods eaten in the last three days. The energy and nutrient content in the diet consumed by the subjects was calculated

and compared with the RDA[3].

The subjects were taking a diet high in energy and fats. The recommended amount of visible fats is 20 g and the patients were taking more than double the amount[3]. When questioned about the type of fat consumed, most of them stated frequent use of butter and ghee and relatively less frequent use of refined oils. They were also eating out frequently which could have contributed to increase in energy intake. The businessmen were consuming largest amount of energy rich foods and maximum number of the subjects suffering from OSA were businessmen (Table 1). The amount of dietary fibre consumed was not even 50% the RDA. They were consuming eggs, foods that are rich in iron, calcium and may also contribute to hypercholesterolemia (Table 4). It was observed that due to consumption of non-vegetarian food, the amount of vitamin A was more than the RDA in all subjects. As most of the respondents consumed juices, the amount of thiamine, riboflavin and vitamin C was higher than the RDA (Table 5). Dietary modification was indicated in all subjects, as it is an important causative factor for development of obesity, which could contribute to OSA.

Treatment: The patients of OSA were treated using various techniques dependant on the availbility, trained medical practitioners and the financial status of the patients. Among non-surgical techniques, continuous positive airflow pressure (CPAP) (n=105) was the most common treatment, which the subjects opted for. Weight loss, changing sleep habits, avoiding alcohol and sedatives decrease sleep apnea significantly. The surgical approaches used were somnoplasty (n=11), uvulopalatopharyngoplasty (UPPP) (n=4) and nasal surgery (n=32). None opted for mandibular maxillary advancement as a treatment procedure. In 32 subjects nasal surgery had to be performed to remove the polyps/follicles in the nose, which

Table 4: Intake of nutrients by the subjects

Profession	Energy (kcal)	Proteins (gm)	Fats (gm)	Fibre (gm)	Calcium (mg)	Iron (mg)
RDA	2425	60	20	30	400	28
Marketing executive (n=13)	3200.56 ± 372.42	48.53 ± 14.78	54.34 ± 18.56	12.32 ± 0.89	678.45 ± 301.27	32.13 ± 4.18
Engineer (n=23)	3632.12 ±235.98	34.75 ±13.65	43.61 ±12.94	14.72 ±1.62	567.09 ±274.13	28.14 ±3.98
College lecturer (n=14)	3216.07 ±394.13	54.97 ±20.24	42.86 ±11.64	13.43 ±1.08	509.76 ±235.90	27.65 ±4.06
Computer Professional (n=17)	2786.04 ±287.21	47.82 ±13.94	45.09 ±13.81	19.76 ±2.08	632.67 ±299.76	27.71 ±3,43
Lawyer (n=20)	3076.13 ±302.64	46.92 ±12.87	50.14 ±14.98	20.31 ±4.62	568.42 ±245.97	26.74 ±3.18
Businessman (n=63)	3490.35 ±227.71	56.14 ±22.53	67.23 ±16.32	12.83 ±0.98	564.08 ±231.03	35.31 ±5.17

Table 5: Intake of nutrients by the subjects					
Profession	**Vitamin A (μg)**	**Vitamin C (mg)**	**Thiamine (m)**	**Riboflavin (mg)**	**Niacin (mg)**
RDA	600	40	1.2	1.4	16
Marketing executive (n=13)	789.23 ±14.13	113.65 ±23.90	1.45 ±0.09	1.89 ±1.23	12.56 ±2.04
Engineer (n=23)	674.14 ±12.16	143.09 ±21.06	1.30 ±0.07	1.92 ±1.07	15.97 ±3.54
College lecturer (n=14)	723 ±12.09	121.56 ±20.91	1.76 ±0.04	1.62 ±0.96	14.65 ±3.07
Computer Professional (n=17)	876 ±18.06	135.04 ±18.03	1.66 ±1.02	1.91 ±1.06	13.54 ±4.04
Lawyer (n=20)	651.81 ±15.32	112.98 ±17.65	1.64 ±0.03	1.95 ±1.56	12.04 ±3.92
Businessman (n=63)	788.91 ±17.63	108.17 ±13.08	1.09 ±0.98	1.13 ±0.87	11.73 ±3.82

were obstructing the passage of air.

Following a few days of treatment, the patients were provided with nutritional counseling. The foremost step to be taken was to reduce body weight. As many were severely obese, their diet was planned in consultation with them in such a way so that there was decrease in their energy and fat rich foods without compromising on proteins and micronutrients as the latter have been shown to help in recovery, especially after nasal surgery. They were advised to consume small meals at regular intervals. Emphasis was also laid on using skimmed milk and margarine. Owing to the fact that most subjects had to be in bed while undergoing treatment, their attendants were counseled to modify their diet. As they started feeling better and could sleep well, they were advised to go for regular walks especially in the morning.

CONCLUSION

OSA is a debilitating and often life-threatening condition that occurs when tissue in the upper airways blocks the breathing passages. A large number of patients suffering from OSA were obese or overweight with sedentary lifestyles and erratic dietary patterns. Most of them showed symptoms like loud snoring, gasping for breath and abnormal sleeping daytime patterns.

Proper diet and exercise are very important for a healthy lifestyle. It is well documented that weight loss has a notable ameliorative impact on the occurrence of OSA. Thus patients with OSA should consume a nutritious diet consisting of skimmed milk and its products, cereals, whole pulses, vegetables and fruits, which helped to reach and maintain desirable weight. Consuming a wide variety of foods

from all food groups and eating in a relaxed and pleasant atmosphere would ensure an adequate supply of all nutrients. Light exercise and walk everyday would help in reducing weight and will also help the person to feel fresh and less sleepy especially during the daytime.

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