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Sporadic Goitre Prevalence and its Association with Iodine Deficiency in Drinking Water of Plain Areas of Hyderabad and Adjoining Areas, Pakistan

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ABSTRACT

The enlargement of thyroid gland which is located in the human neck is known as goitre. When the supply of iodine to the thyroid gland is inadequate for the formation of sufficient quantities of thyroid hormones, goitre appears. In the present study prevalence and epidemiological risk factors of goitre in Hyderabad city and adjoining areas has been studied. The important findings of this study are summarized as follows: Females were seen to be more prone to develop goitre than males, with an overall female to male ratio of 5:1. In both sexes, the prevalence of goitre was the maximum in 15-25 year age group. Family history was positive in 22.45% cases. Of the goitre patients 77.22% belonged to Hyderabad city and 84.85% were sedentary by occupation. Goitre was more prevalent in surface water drinkers (80.75%) than in ground water consumers (19.25%), in the consumers of mine salt (67.54%) than that of sea salt (32.46%). The screening of goitre patients by blood chemistry revealed that 5.17% and 2.50% cases had hyperthyroid and hypothyroid respectively. Nodular non-toxic goitre was found in 6.71% cases, nodular toxic in 0.28% cases and solid adenoma/cyst in 24.41% cases were found. It seemed essential to examine iodine concentration in water of this area to ascertain whether the iodine deficiency is the cause of sporadic goitre. Iodine concentration in water is usually taken as an index of the iodine intake, therefore 100 water samples were collected and analyzed by ion selective electrode method. Water analysis results showed that iodine contents are within permissible limit i.e. not lower than 3µg/L. This indicates that iodine deficiency in water of study area is not an isolated epidemiological phenomenon for goitre genesis.

1. Introduction

Iodine deficiency is one of the most important and well-known global nutritional problems of the humans [1-5].The dietary iodine plays a vital role in the thyroid function management [6, 7]. The great arc of Himalayas from Pakistan across Nepal and India, into Northern Thailand and Vietnam and into Indonesia, is one of the most common regions of the world for iodine deficiency [8].

Iodine deficiency is the general cause of preventable mental retardation and brain damage in the world [9, 10]. It also causes goitres, decreases child survival, and impairs growth and development. In pregnant women, iodine deficiency can cause stillbirths, miscarriages and other complications. Children with Iodine Deficiency Disorder (IDD) grow up mentally retarded, apathetic and unable of normal movements, hearing or speech [11-13].

Globally, 2.2 billion people are living in iodine deficient areas which is 38% of the world's population [14]. Iodine deficiency has adverseeffects on the health of human community. Children with severe iodine deficiency are mentally and physically retarded. The mental retardation ranges from mild blunting of intellect to cretinism. A large part of the iodine deficient population may have some intellectual impairment leading to decrease in mean IQ level [15]. Iodine deficient Individuals have Low economic productivity and low educability causing serious economic and educational impact on the whole community. [16]. Various investigations of goiter in different parts of the world show that thyroid enlargement occurs more repeatedly when the iodine concentration of drinking water is lower than 3µg/L [17, 18]. The iodine concentration in water is normally taken as an indicator of the iodine intake. It is believed that food grow on iodine rich water is expected to have more iodine than food grow on iodine deficient water. These findings suggest that water may also affect the availability of iodine to the bio system.

A clinical survey was conducted In Nuclear Institute of Medicine and Radiotherapy, Jamshoro, Pakistan. There were 1100 patients which were enrolled for goiter assessment. Thyroid scanning was performed for

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anatomical assessment [19-21] while physiological assessment [22-26] was done by measuring thyroid hormones in the blood. Both anatomical and physiological assessment confirmed that goiter prevalence was common in study area. As deficiency of iodine in water is one of the causes of goiter. To get the status of iodine in potable water, drinking water of urban and rural areas was analysed.

There is low concentration of iodine in drinking water, which needs an accurate and sensitive method for the assessment of iodine. There are number of techniques available like ion exchange, solvent extraction and Ion selective electrode method which are used for the analysis of iodine in water [27, 28]. However, Ion selective electrode method due to its high sensitivity is one of the most appropriate techniques which were used for determination of iodine concentration in water [29, 30].

2. Methodology

2.1 Sampling

Total of 1100 patients were selected for clinical assessment and laboratory diagnosis. The patients belonged to high, low and middle class families. The sign and symptoms of goitre were observed in all categories of the patients belonging to both urban and rural areas, assuming that the cause of goitre is iodine. For hormonal estimation 5ml of blood was drawn from ante-cubital vein of each patient with all aseptic measures. The plunger was drawn carefully and the syringe put in a rack gently to allow the blood cells to settle down. After 2-3 hours the serum was separated in a polystyrene tube and centrifuged for 10 minutes at 3000 revolutions per minute for the removal of rest of blood cells. After that the samples were used for hormone analysis. Samples were stored at 2-8ºC in the refrigerator and the assays were performed within two weeks after the collection of samples. Repeated freezing and thawing was avoided as it may affect the sample results. Lipaemic and haemolysed samples were discarded and the test repeated with another fresh serum sample. For the determination of iodine concentration, 100 clear and transparent drinking water samples were collected in 1L bottle. All samples were clearly labelled by site and locality. Bottle was rinsed twice with the sample waterprior to filling and closing.

2.2 Analysis

Instruments and chemicals used in experimental work.

2.2.1 Equipment

Gamma scintillation counter from Amersham, England was used for the counting of ^{125}I in the sample blood serum. Thyroid scanning of the patients was performed with gamma camera. ORION model meter and double junction reference electrode were used for iodine determination in water, Magnetic Stirrer for stirring the solution, semi-logarithmic 4 cycle graph paper for plotting the calibration curve.

2.2.2 Reagents

For the estimation of thyroid hormones, FT_4, FT_3 and TSH kits from Amersham, England were used using I-125 as a tracer. To adjust ionic strength of the samples and standards, 5M $NaNO_3$ was used as ionic strength adjustor. 10% KNO_3 solution was used as reference electrode filling solution. 0.1 M NaI was used as a stock standard.

2.3 Procedure

For hormonal estimation, radioimmunoassay technique was used which is based on the antigen-antibody reaction in which tracer amount of the radio-labelled antigen competes with endogenous antigen for limited binding sites of the specific antibody against the same antigen. Amount bound is inversely related to the concentration of unknown antigen in blood serum. To get the information about the shape, size and overall activity of the thyroid gland, thyroid scanning was performed. It was performed in the nuclear medicine wing of the Nuclear Institute of Medicine and Radiotherapy at Jamshoro in the Sindh province of Pakistan. Intravenous injection of the ^{99m}Tc radiopharmaceutical was given to each patient. Scanning was performed under gamma camera and the images were processed on computer. A nuclear medicine specialist reviewed and interpreted the images together with patient.Gamma scan of normal and abnormal thyroids are shown in Fig. 1.

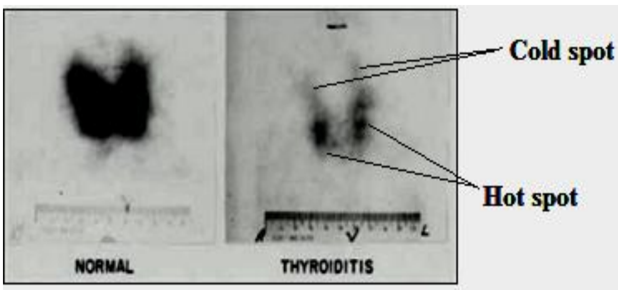

Fig. 1: Image of a normal and abnormal thyroid scan

A normal scan shows a thyroid of normal shape, size and position. The amount of radionuclide uptake by the thyroid is normal. It seems no area to have increased or decreased radionuclide uptake. An area of increased radionuclide uptake is seen in case of abnormal scan called as a hot spot or hot nodule. This means that a benign growth is overactive. Increased radionuclide uptake is indicative of hyperthyroidism.

An area of decreased radionuclide uptake is observed which is called a cold spot or cold nodule. This shows that this area of the thyroid gland is inactive. A variety of conditions, including cysts, hypothyroidism, non-functioning benign growths, cancer or localized inflammation, may produce a cold spot.

An electro-analytical technique (potentiometry) was used for monitoring of iodine in water samples. In this technique a pair of electrodes was immersed in a solution and there potential difference was measured. One of the electrodes is called reference electrode, which has a known potential independent of analyte solution. The other electrode is called indicator electrode, which has a potential that varies in a known way with changes in analyte concentration. The third requirement for a potentiometric cell is a salt bridge. This salt bridge prevents the components of analyte solution from mixing with the reference electrode.

A potential is developed across liquid functions at each end of salt bridge. These two potentials tend to cancel each other if nobilities of anions and cations in the bridge solutions are approximately equal. The nobilities of K^+ and Cl^- were nearly equal; therefore KCl was nearly ideal electrolyte for the bridge. The potential of the cell is given as:

$$E_{CELL} = E_{ind} - E_{ref} + E_j$$

where$E_j$is the liquid–junction potential; $E_j$may be positive or negative.

A calibration curve was plotted. Electrode potential of standard solutions was measured and plotted on the linear axis against their concentration on the log axis. The typical Iodide electrode calibration curve is shown in Fig. 2.

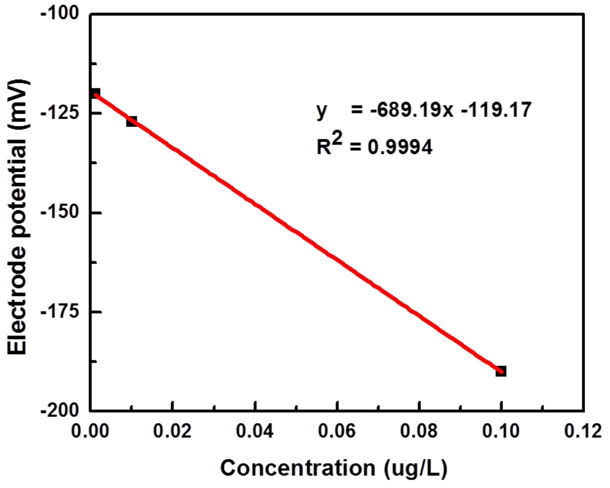

Fig. 2: Calibration Curve for the Iodide concentration

3. Results

The prevalence of goitre with respect to various parameters is given in Table 1. It was high in 16-20 year age group while minimum in < 9 years. Females were found to be more susceptible to goiterthan male, having female to male ratio as 5:1. 22.45% cases were found to have goitre in their families. 77.22% patients were residing in urban area like Hyderabad city, while 84.85 % were sedentary by occupation. Goiter was present in 80.75% patients utilizing surface water as compared to those 19.25% patients consuming ground water. There was no goiter in 32.46% patients who were using sea salt as compared to 67.54% patients who were goitreous as they were using mine salt.

Thyroid hormonal profile revealed that 21.22% cases were physiologically normal or euthyroid, 5.18% were thyrotoxic and 2.25% were hypothyroid. Through thyroid scanning as shown in Fig. 3, it was found that anatomically, 14.08% cases were suffering from puberty goitre, 0.28% nodular goiter and 6.76 % nodular non toxicgoiter. Cyst or solid adenoma was present in 24.41% cases while 25.82% having simple goiter.

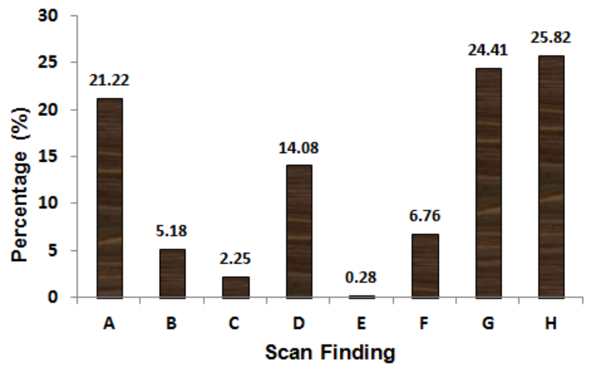

Fig. 3: Percentage wise Physiological and anatomical abnormalities in patients suffering from goiter; A: Eutyroid, B: Thyrotoxicosis, C: Hypothyroidism, D: Puberty goiter, E: Nodular goiter, F: Nodular non-toxic goiter, G: Solid adenoma/Cyst, H: Simple goiter

Analysis of water samples as shown in fig.4 revealed that iodine contents were 0.07, 0.03, 0.02, 0.05 and 0.04 µg/L respectively. Water analysis report shows that these areas are not iodine deficient as values are above the recommended range of 0.01-0.03 µg/L.

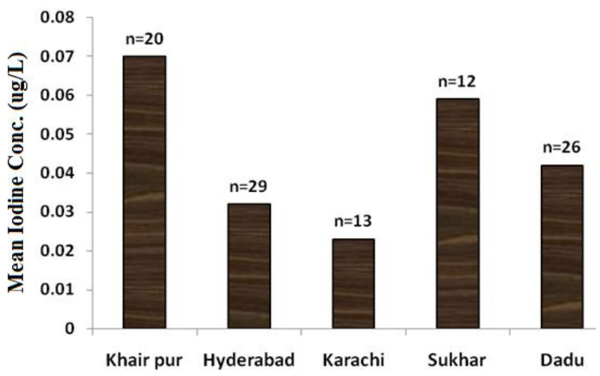

Fig. 4: Mean iodine concentration in drinking water samples collected from Hyderabad and its adjoining plain areas, where n = number of samples

Table 1: Various parameters and percentage of goitre

No.	Parameter								
	Age (year)	>9	10-15	16-20	21-25	26-30	31-40		
1	No.	23	118	240	152	138	191		
	%	2.1	15.3	21.9	13.8	12.6	17.4		
	Language	Urdu	Sindh	Other					
2	No.	453	368	279					
	%	41.16	33.49	25.35					
	Sex	Male	Female						
3	No.	186	914						
	%	16.89	83.13						
	Profession	Household	Students	Labourers	Servants				
4	No.	714	249	75	63				
	%	64.88	22.6	6.78	5.75				
	City	Hyderabad	Latifabad	Jamshoro	Badin	Sukhar	Dadu	Nawabshah	Mirpurkhas
5	No.	850	163	17	12	01	29	14	12
	%	77.30	14.86	1.55	1.06	0.12	2.67	1.31	1.12
	Family history	+ve	-ve						
6	No.	247	853						
	%	22.45	77.55						
	Water source	Water supply		Hand pump		Well	Canal		
7	No	854		199		13	35		
	%	77.60		18.10		1.15	3.15		
	Cooking oil	Dalda	Sunflower	Pakwan	Surson oil	Desi Ghee	Tallo	Habib	
8	No.	687	51	110	25	33	135	59	
	%	62.43	4.65	9.96	2.28	3.04	12.24	5.41	
	Table salt	Mine salt	Sea salt						
9	No.	357	743						
	%	67.54	32.46						

4. Discussion

It is recommended fact that goiter exist in hilly areas [31, 32]. The main theme of this study was to figure out that if study area is not the hilly area then why more than 70% patients visited NIMRA had thyroid disease just like different types of goiter (Fig. 3). Possible reasons may be (i) deficiency of iodine in water (ii) less intake of iodine through iodised salt (iii) Ingestion of goitrogenic food.

We selected iodine deficiency parameters in drinking water and assessed the iodine contents in drinking water.

It was found that water samples were not iodine deficient (Fig. 4) having values within permissible limit of 0.03 μg/L.

It must be emphasised that iodine deficiency may not be an isolated epidemiological phenomena. Therefore further study of other relevant factors is required to investigate the possible reason of iodine deficiency and prevalence of goiter.

Some interesting results have been found in our study. Firstly, it has been seen that goiter was more common in females than males specifically in teen age (Table.1).). The probable reasons may be (i) repeated stimulation of thyroid tissues due to rise in circulating hormones before each menstrual cycle (ii) sex hormones (LH & FSH) have some structural analogy with thyroid stimulating hormone (TSH) (iii) due to raised metabolic activities in teen ages , there is increased demand of extra iodine intake [33].

Secondly, Urdu speaking patients residing in Hyderabad city using mine salt were more prone to goitre than sindhi speaking patients residing in rural areas of Hyderabad using see salt. Possible reason may be that iodine contents of rock salt are so low that they have little or no value as a source of iodine [34, 35]. In addition this salt may contain unidentified goitrogens.Ingestion of goitrogens by daily food is one of the causes to prevail goitre.

Other possible reason of goitre may be the imbalance use of iodine and selenium contents in diet.

Iodine is the integral part of thyroid hormones which increase the production of hydrogen peroxide which is the electron acceptor for the thyroid peroxidase reaction. If thyroid hormone production is excessive, there is excessive production of hydrogen peroxide which is toxic for thyroid cells. Selinium on the other hand is the integral part of thyroid glutathione peroxidase and protects thyroid cells from hydrogen peroxide damage. Thus balanced amount of iodine and seliniun is important for proper functioning of thyroid gland and protection for oxidative damage.

5. Conclusions

In present study we have seen that study area is not iodine deficient area. It means that iodine is not an independent risk factor for the development of goiterbut other factors like sex, goitrogenic diet and imbalance selenium to iodine ratio may have contributing factors to prevail the goiter. Goiter can be prevented/ cured by proper education to the people about the contributing factors of the disease. Assessment of selenium in water may provide better picture about goitre.

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