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Thyroid Disorders Correlated with Serum (Calcium, Phosphate and Magnesium)

A Thesis Submitted in Fulfillment for the Requirements of the master Degree in medical laboratory sciences (Clinical chemistry)

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الآية

بسم الله الرحمن الرحيم

﴿ وتوكل على الله وكفى بالله وكيلا ﴾

صدق الله العظيم

سورة الأحزاب الآية (٣)

Dedication

To my family

To my beautiful mother

To my dear father,

Who gave me love and respect.

To my beloved wife,

To my brothers and sister.

Acknowledgements

First of all I thank the Almighty Allah who helped me to complete this study.

I would like to express endless thanks to my supervisor,

Dr.Mosab Omer Khalid

for his great efforts and guidance.

I would like also to thank

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For his great helps and endless support.

Abstract

This study was conducted in Shendi locality north of Khartoum, to assess the relationship between Thyroid diseases and serum electrolytes(calcium, phosphorous and magnesium), (80) participants Were involved in the study divided into test group (50) and control group (30)

Then serum sample collected then thyroid hormones (T4, TSH), and serum calcium, phosphorous and magnesium are measured. The obtained data were analyzed using SPSS (20) to get the statistical results.

The obtained results indicate that the mean of serum calcium in thyroid disease patients was (7.8) and in control group was (9.1) with (P.value 0.00) also it shows that the mean of serum phosphorous was (6.3) in case group and (3.2) in control with (P.value 0.00), this insure the presence of correlation between thyroid disorders and serum calcium and phosphorous.

the serum magnesium mean was (2.0) in case compare with (2.0) in control with (P.value 0.585).

The above results insure that there is no correlation between thyroid diseases and serum magnesium.

Also the present study indicate that there is no effect of treatment ,age of thyroid disease patient and their sex on serum calcium and phosphorous.

The study revealed that there was no effect of sex of patients and duration of thyroid disease but effect of age and treatment on mean of magnesium.

ملخص البحث

أجريت هذه الدراسة بمحلية شندي شمال الخرطوم وكان الهدف منها التحقق من وجود علاقة بين أمراض الفوسفات والمغنيزيوم في مصل الإنسان، الغدة الدرقية وتركيز كل من الكالسيوم

أجريت الدراسة على عدد ثمانين مشارك خمسون منهم مصابون بأمراض الغدة الدرقية وثلاثون غير مصابين بعدها تم جمع عينات المصل وأجريت عليها الدراسة حيث تم قياس هرمونات الغدة الدرقية وكل من الكالسيوم الفوسفات والمعنيزيوم وتم تحليل النتائج المتحصل عليها بواسطة برنامج التحليل الإحصائي المحوسب.

يكون تركيزه بينما ٧,٨ أشارت النتائج إلى أن متوسط تركيز أملاح الكالسيوم عند الأشخاص المصابين هو عند الأصحاء ٣,٢ بينما لا يتعدى ٦,٣ كما وجد أن تركيز الفوسفات عند المصابين ٩,١ عند الأصحاء **mg/dl 2.0** أما تركيز المغنيزيوم فلم يختلف بين المصابين وغير المصابين حيث لم يتعدى تركيزه.

مما سبق أثبتت الدراسة وجود علاقة بين أمراض الغدة الدرقية وتراكيز الكالسيوم والفوسفات كما انه لا توجد علاقة مع تركيز المغنيزيوم.

كما أن الدراسة أشارت لعدم تأثير كل من العلاج العمر والجنس علي تركيز الكالسيوم والفوسفات.

كما أنها أشارت لعدم تأثر المغنيزيوم بالجنس وفترة المرض.

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List of abbreviations

abbreviation	Full mane
ATP	Adenine triple phosphate
CKD	Chronic kidney disease
cl^-	Chloride
D_1	Deiodinases 1
D_2	Deiodinases 2
D_3	Deiodinases 3
DNA	Deoxyribonucleic acid
ECF	Extra celluer fluid
fT3	Free Triiodothyronine
fT4	Free Thyroxine
Hco_3	Bicarbonate
I^0	Iodine
ICF	Intra celluer fluid
MDI	Monodeiodinases
Mg^+	Magnesium
Na^+	Sodium
PTH	Parathyroid hormone
RNA	Ribonucleic acid
RT_3	Reverse Triiodothyronine
T_3	Triiodothyronine
T_4	Thyroxin
TBG	Thyroid-Binding Globulin
TH	Thyroid hormone
TPO	Thyroid peroxidase
TRH	Thyroid releasing hormone
TRs	Thyroid hormone receptor
TSH	Thyroid Stimulating Hormone
TSHR-Ab	Thyroid Stimulating Hormone receptor antibodies
ICU	Intensive care unit

abbreviation	Full mane
K^+	Potassium
Na/I	Sodium -iodide
Spss	Statistical Package for the Social Sciences
Tg	Thyroid globulin
Units	
ng/ml	Nanogram per mellilitter
mg/dl	Milligrams per deciliter
MIu/ml	Microgram per mellitter

CHAPTER ONE

Introduction

Rationale

Objectives

Chapter one

1.1. Introduction

The thyroid gland is responsible for the production of two hormones: thyroid hormone and calcitonin, Once released from the thyroid gland, thyroid hormone circulates in the bloodstream where leads to production of proteins that influence metabolism and development. Effects of thyroid hormone include tissue growth, brain maturation, increased heat production, increased oxygen consumption. [1]

Disorders of thyroid gland are among the most abundant endocrine disorders in Sudan**.** The interactions between kidney and thyroid functions are known for years. Thyroid hormones are necessary for growth and development of the kidney and for the maintenance of water and electrolyte homeostasis. On the other hand, kidney is involved in the metabolism and estimation of thyroid hormone. From a clinical practice viewpoint, it should be mentioned that both hypothyroidism and hyperthyroidism are accompany by remarkable alterations in the metabolism of water and electrolyte, as well as in cardiovascular function.[2]

The effect on thyroid hormones on electrolytes and minerals has not been well established and the underlying mechanisms are not well understood. Only few data on the association between thyroid function and electrolyte disorders exists. Thus our aim was to assess the levels of serum electrolytes and minerals in the patients with thyroid disorders. Thyroid hormones are essential for normal growth and maturation of skeletal system. Thyroid dysfunction is frequently associated with disturbances of calcium and phosphorous homeostasis. Thyroid disorders are important cause of secondary osteoporosis. Few studies show normal serum calcium and phosphorous levels while others show decreased levels in *hypothyroidism*. Even though the changes in the calcium and

magnesium may be slight in thyroid disorders, these disturbances will be important for patient in the long run. In *hypothyroidism* there is a depressed turnover due to impaired mobilization of calcium into the bone than leads to decrease the blood calcium level. In *hyperthyroidism* there is poor mobilization of calcium than leads to increases the blood calcium level. In *hypothyroidism* increased production of thyroid calcitonin can promote the tubular reabsorption of phosphate and also favors the tubular excretion of calcium. In *hyperthyroidism* decreased production of thyroid calcitonin. Can promote the tubular excretion of phosphate and also favors the tubular absorption of calcium. In many literatures different electrolyte disorders are associated with thyroid dysfunction. In severe *hypothyroidism* and myxoedema hyponatremia is described to be a consequence of enhanced renal water retention mediated by vasopressin. On the other hand, *hypokalaemia*, *hypomagnesaemia* and *hypocalcaemia* were mentioned in patients with thyrotoxicosis. Thus the present study was undertaken to assess the alterations in the levels of serum electrolytes in hyperthyroid, hypothyroid & euthyroid patients. [2]

1.2. Rationale

The prevalence of spontaneous hypothyroidism is between 1 and 2%, and it is more common in older women and 10 times more common in women than in men. The condition occurs in women overall incidence is about 3% of the general population.

Studies in Northern Europe, Japan and the USA have found the prevalence to range between 0.6 and 12 per 1000 women and between 1.3 and 4.0 per 1000 in men investigated.

The prevalence is higher in surveys of the elderly in the community. Overt hypothyroidism was found in 7% of 558 subjects aged between 85 and 89 years in Leiden, Netherlands.

A lower prevalence is seen in areas of iodine deficiency.

1.3. Objectives

1.3.1. General objective:

- To identify the relationship between thyroid diseases and serum electrolytes (calcium, phosphate and magnesium).

1.3.2. Specific objectives:

- To determine the effect of age and thyroid disease on the electrolyts.
- To identify the effect of thyroid disease duration on electrolytes.
- To determine the affect of treatment of thyroid disease on the electrolytes balance.

CHAPTER TWO

Literature Review

Chapter two

2. Literature review

2.1. Thyroid gland:

2.1.1. Anatomy of thyroid gland:

The thyroid gland is positioned in the lower anterior neck and is shaped like a butterfly. [1]

The thyroid gland is a very vascular structure that consists of two large lateral lobes connected by a broad is thymus. It is Located just below the larynx one either side and anterior to the trachea. The gland is specialized to remove iodine from the blood. [3]

The thyroid gland is one of the largest endocrine glands in the body, weighing 2-3 grams in neonates and 18- 60 grams in adults, and is increased in pregnancy. This gland is found in the neck inferior to the thyroid cartilage (also known as the Adam's apple in men) as shown in. It is a butterfly-shaped organ and composed of two one- like lobes: right lobe and left lobe, connected with the isthmus. The organ is situated on the anterior side of the neck, lying against and around the larynx and trachea, reaching posteriorly the oesophagus and carotid sheath. [4]

The fetal thyroid develops from an out pouching of the foregut at the base of the tongue and migrates to its normal location over the thyroid cartilage in the first 4–8 weeks of gestation. By week 11 of gestation, the thyroid gland begins to produce measurable amounts of thyroid hormone. [1]

2.1.2 Physiology of thyroid gland:

The thyroid gland plays a vital role in the overall body function during all stages of life. Although relatively small, it produces hormones that regulate the body's overall metabolism, the rate at which the body produces energy from nutrients.

Thyroid hormones influence growth and development, oxygen consumption and heat production, nerve function, and metabolism of lipids, carbohydrates, proteins, nucleic acids, vitamins, and inorganic ions. They also have important effects on other hormone actions. [4]

The thyroid gland secretes two hormones, T_4 and T_3. The thyroid hormones are the only iodine-containing compounds with established physiologic significance in vertebrates. T_4 is the predominant form of thyroid hormone. It's called T_4 because it contains four iodine atoms for each hormone molecule. When one specific iodine atom is removed from the T4 molecule, it becomes RT_3 or T_3. [5]

Thyroid function is regulated by thyrotropin (TSH) secretion from the pituitary gland .TSH secretion in turn is largely regulated by hypothalamic thyroliberin (TRH) secreted into the pituitary portal vascular system to stimulate pituitary gland TSH release, and by a feedback-inhibiting loop where by free thyroxine (VT'_4) acts at both the pituitary and hypothalamic levels where it is converted to the active hormone triiodothyronine (T_3) to inhibit TSH and TRH production, respectively. TSH stimulates the synthesis and secretion of the prohormone T_4, which circulates bound to binding proteins in serum. The most important of these binding proteins is thyroxine-binding globulin (TBG), but transthyretin (prealbumin) and albumin play secondary roles. T_4 is distributed to peripheral tissues, where it is metabolized by deiodination to T_3 by the iodothyronine monodeiodinases (MDIs) type I and type II. Most of the circulating Tı appears to be derived via hepatic monodeiodination of T_4 by type I MDI. Type II MDI produces T_3 for local action in brain, pituitary, and brown adipose tissue. T_4 also is deiodinated to inactive "reverse" T_3 (ri'3) by a type III MDI in most non hepatic tissues, and T_4 can be sulfoconjugated, glucuronide conjugated, and (or) deaminated to the thyroacetic and thyropropionic acid derivatives. Of all the metabolites,only T_3 and triiodothyroacetic acid manifest bioactivity. All of the

hormones can be measured in peripheral blood. However, measurements of TRH, the sulfate and glucuronide conjugates, and triiodothyroacetic acid have little or no clinical application at the present time. The most important in vitro measurements for routine clinical use include TSH and a direct or indirect measurement of FT_4. The latter include the T_3 resin uptake and variations. Other measurements include T_3, free T_3 *(VT3),* rT_3, TBG, and thyroglobulin. [6]

Thyroid hormone is made primarily of the trace element iodine, making iodine metabolism a key determinant in thyroid function. Iodine is found in seafood, dairy prod ucts, iodine-enriched breads, and vitamins. Significantly, iodine is used in high concentrations in the contrast medium used in computed tomography scans and to visualize arteries during heart catheterization. It is also present in amiodarone, a medication used to treat certain heart conditions. The recommended minimum daily intake of iodine is 150 g, although most individuals in developed countries ingest far more than this amount. If iodine intake drops below 50 g daily, the thyroid gland is unable to manufacture adequate amounts of thyroid hormone and thyroid hormone deficiency hypothyroidism results. Thyroid cells are organized into follicles. Follicles are spheres of thyroid cells surrounding a core of a viscous substance termed *colloid*. The major component of colloid is thyroglobulin, a glycoprotein manufactured exclusively by thyroid follicular cells. Thyroglobulin is rich in the amino acid tyrosine. Some of these tyrosyl residues can be iodinated, producing the building blocks of thyroid hormone. On the outer side of the follicle, iodine is actively transported into the thyroid cell by the Na_/I_ symporter located on the basement membrane. Inside the thyroid cell, iodide diffuses across the cell to the apical side of the follicle, which abuts the core of colloid. Here, catalyzed by a membrane-bound enzyme called thyroid peroxidase. This same enzyme also aids in the coupling of two tyrosyl residues to form triiodothyronine (T_3) or

thyroxin (T_4) these are the two active forms of thyroid hormone. This thyroglobulin matrix, with branches now holding T_4 and T_3, is stored in the core of the thyroid follicle. *Thyroidstimulating hormone (TSH)* signals the follicular cell to ingest a microscopic droplet of colloid by endocytosis. Inside the follicular cell, these droplets are digested by intracellular lysosomes into T_4, T_3, and other products. T_4 and T_3 are then secreted by the thyroid cell into the circulation , concentrated iodide is oxidized and bound with tyrosyl residues on thyroglobulin. This results in production of monoiodothyronine and diiodothyronin. [1]

The nuclear thyroid hormone receptors are products of the TRα and TRβ genes. These receptors are members of the ligand-dependent transcription modulator family. This implies that upon intra-nuclear binding of T_3 to a TR and via interaction with several co-factors, the complex binds to a thyroid hormone responsive element in the promoter region of a TH-responsive gene, ultimately affecting gene transcription. Many actions of TH can be explained by this transcriptional mechanism of action. TH transport across the cell membrane is required, since both deiodinases and TR are located intracellularly. In recent years, several specific TH transporters have emerged, such as the monocarboxylate transporters and the organic anion transporting polypeptide family. [7]

Peripheral thyroid metabolism is mainly regulated by the iodothyronine deiodinases D_1, D_2, and D_3. D_1 is present in the thyroid, liver and kidneys and converts T_4 to T_3. In addition, it plays a role in the breakdown of reverse T_3. D_2 enhances local T_3 production in various tissues. It is expressed in brain, skeletal muscle, thyroid, pituitary, brown adipose tissue, aortic smooth muscle cells, osteoblasts and the heart . In the brain, D_2 is expressed mainly in astrocytes in the cerebral cortex, hippocampus and amygdala. D_3 inactivates T_3 and T_4 and

thus regulates the clearance of T_3 and T_4. It is present in the brain, skin, placenta and fetal tissues. [8]

2.1.3. Hypothalamic – Pituitary –Thyroid Axis:

The thyroidal secretion of T_3 and T_4 is controlled by the thyroid-stimulating Hormone or thyrotropin (TSH), a peptide produced by endocrine cells in the anterior pituitary named thyrotrophs. TSH production is regulated by two interacting systems

- Open-loop neural control by hypothalamic hypophysiotropic factors
- Negative feedback by thyroid hormones

The neural control is mainly exerted by the thyrotropin-releasing hormone (TRH), a peptide produced by the paraventricular neurons of the hypothalamus that binds to specific receptors on the plasma membrane of the thyrotrophs, stimulating their production of TSH . TSH secretion is also influenced by other hormones including oestrogens, glucocorticoids and possibly growth hormone, while it is inhibited by cytokines in the pituitary and hypothalamus. Thyroid hormones, both T_3 and T_4, exert their negative feedback control on both the pituitary and the hypothalamus, determining a reduction in TRH and TSH release. Circulating T_3 and T_4 are transported inside the brain, where T_4 is converted into T_3 by type II deiodinase and then T_3 interacts with thyroid hormone receptors. [9]

2.1.4. Thyroid diseases:

2.1.4.1 Hypothyroidism:

Thyroid disorder is a general term representing several different diseases involving thyroid hormones and the thyroid gland. Thyroid disorders are commonly separated into two majorcategories, *hyperthyroidism* and *hypothyroidism*, depending on whether serum thyroid hormone levels (T_4 and

T_3) are increased or decreased, respectively. Thyroid disease generally may classified based on etiologic factors, physiologic abnormalities. [10]

Hypothyroidism is a clinical entity resulting from the deficiency of thyroid hormones or from their impaired activity. *Hypothyroidism* is a common metabolic disorder in the general population. [2]

Decreased thyroid hormone synthesis and low levels of circulating thyroid hormones result in biochemical and/or clinical *hypothyroidism*. This condition occurs more frequently in women; the overall incidence is about 3% of the general population. The clinical presentation, particularly in elderly patients, may be subtle; therefore, routine screening of thyroid function tests is generally recommended for women more than 50 years of age. *Hypothyroidism* is classified as primary or secondary. Primary hypothyroidism results from defective hormone biosynthesis resulting from Hashimoto's or autoimmune thyroiditis (most common), other forms of thyroiditis (acute thyroditis, subacute thyroiditis), endemic iodine deficiency, or antithyroid drug therapy (goitrous hypothyroidism); and congenital defects or loss of functional thyroid tissue due to treatment for *hyperthyroidism* including radioactive iodine therapy or surgical resection of the thyroid gland. [10]

Because of the diffuse distribution of thyroid hormone receptors and the many metabolic effects of thyroid hormone, *hypothyroidism* can lead to a variety of other abnormalities. *Hyponatremia* can occur due to inappropriate levels of antidiuretic hormone and significant degrees of *hypothyroidism* can also lead to myopathy and elevated levels of creatine kinase. Anemia can also be seen, either as a result of a decreased demand for oxygen carrying capacity or through an associated autoimmune pernicious anemia. *Hypothyroidism* may also lead to hyperlipidemia, most notably when the TSH is greater than 10 mU/L. One study documented more than half of those with *hypothyroidism* who were studied had

hypercholesterolemia, while another study showed 4.2% of patients with hyperlipidemia had hypothyroidism. In the presence of these clinical abnormalities (hyponatremia, unexplained elevation of creatine phsophokinase , anemia, or hyperlipidemia), evaluation for *hypothyroidism* as a potential secondary cause should be considered. [1]

Neonatal *primary hypothyroidism* may be caused by a congenitally absent, atrophic, or dysfunctional thyroid gland, a disorder that occurs once in every 3500 live births. As mentioned earlier, thyroid function is necessary for neurological development; therefore, untreated neonatal hypothyroidism results in profound impairment of growth and mental development. This disorder was formerly termed cretinism. Hypothyroidism is common; *(5-15%)* of women older than age *(*65*)* have this condition. For this reason, several organizations have recommended routine periodic assessment of thyroid function in women. [1]

Decreased thyroid hormone synthesis and low levels of circulating thyroid hormones result in biochemical and/or clinical hypothyroidism. This condition occurs more frequently in women; the overall incidence is about 3% of the general population. The clinical presentation, particularly in elderly patients, may be subtle; therefore, routine screening of thyroid function tests is generally recommended for women more than 50 years of age. *Hypothyroidism* is classified as primary or secondary. Primary hypothyroidism results from:

- Defective hormone biosynthesis resulting from Hashimoto's or autoimmune thyroiditis (most common), other forms of thyroiditis (acute thyroditis, subacute thyroiditis), endemic iodine deficiency, or antithyroid drug therapy (goitrous hypothyroidism).
- Congenital defects or loss of functional thyroid tissue due to treatment for hyperthyroidism including radioactive iodine therapy or surgical resection of the thyroid gland. [11]

Hypothyroidism can be divided into primary, secondary, or tertiary disease, dependent on whether the defect is located in the thyroid gland, pituitary gland, hypothalamus, respectively. The most common cause of *hypothyroidism* in developed countries is chronic lymphocytic thyroiditis, or Hashimoto thyroiditis. This is an autoimmune disease of the thyroid gland, which is often associated with enlargement of the thyroid gland *(goiter). (TPO)* antibody testing will be positive in 80-90%of patients with chronic lymphocytic thyroiditis. Other common causes of *hypothyroidism* include iodine deficiency, thyroid surgery, and radioactive iodine treatment. Certain drugs can cause *hypothyroidism*. Occasionally, patients will experience transient hypothyroidism associated with inflammation of the thyroid gland. Example of transient *hypothyroidism* includes recovery from non thyroidal illness and the hypothyroid phase of one of several forms of subacute thyroiditis (painful thyroiditis, postpartum thyroiditis, and painless thyroiditis). [1]

The most common cause of *hypothyroidism* in adults is autoimmune thyroid disease where autoimmune thyroiditis is one of the entities. Autoimmune thyroiditis can begin suddenly or it can develop slowly over the years. The most frequent forms are Hashimoto's thyroiditis and atrophic thyroiditis .

The second frequent cause is a thyroid ablation as a consequence of surgical removal of part or all of the gland in case of thyroid nodules, thyroid cancer, or Graves' disease. If part of the gland is left, it may be able to make enough thyroid hormone to keep blood levels normal. It is necessary that at least 90% of the gland be destroyed in order to develop *hypothyroidism*. Another cause of thyroid ablation is the radiation treatment during radiotherapy of neck for patients with Hodgkin's lymphoma, or cancers of the head or neck, or the use of radioactive iodine in some patients with Graves' disease, nodular goiter, or thyroid cancer. Third most common are all causes of congenital hypothyroidism

(in newborns), where one could find newborns without a thyroid (aplasia) or with only a partly formed one (hypoplasia). There are also babies with partial or all thyroid tissue in the wrong place (ectopic thyroid) or in some cases the thyroid is in place, but biosynthetic enzymes are defective. [12]

2.1.4.2 Hyperthyroidism:

Hyperthyroidism is a thyroid gland hyperfunction framework characterized by increased synthesis and secretion of thyroid hormones. This condition can occur at any age but is more common in adults. In elderly, the excess of thyroid hormones particularly impacts on quality of life and life expectancy because of high cardiovascular mortality and morbidity and increased risk of osteoporosis and bone fractures. The prevalence of *hyperthyroidism* as well as of subclinical hyperthyroidism is increased in subjects over 60 years of age. Overt *hyperthyroidism* has been reported. Subclinical hyperthyroidism, defined as serum TSH levels below the lower limit of the normality range when serum FT_4 and T_3 concentrations are within the normality range, has been reported. The most common forms of *hyperthyroidism* include diffuse toxic goiter *(Graves' disease)*, toxic multinodular goiter and toxic adenoma (Plummer disease). Together with subacute thyroiditis, these conditions constitute 85-90% of all causes of thyrotoxicosis. However, it is not uncommon in elderly that TSH concentrations are below the normality range due to a decreased clearance or to an altered hormonal set-point of the hypothalamic-pituitary-thyroid axis. Toxic multinodular goiter is the most frequent cause of spontaneous *hyperthyroidism*. Toxic multinodulare goiter and toxic adenoma represent about 60% of cases of *hyperthyroidism* in areas of iodine deficiency. Toxic multinodulare goiter increases by age and is more prevalent in women. This condition can be characterized by the coexistence of normal-hypo-and/or hyperfunction in nodules, with gradual suppression of TSH over the years. Often, it emerges

insidiously from nontoxic multinodular goiter. Toxic thyroid adenoma is a benign tumor of the thyroid gland and represents the most common cause of *hyperthyroidism* in women and middle age. Graves' disease is another frequent cause of thyrotoxicosi especially in iodine replete areas. *Graves' disease* is an autoimmune disease where the thyroid is overactive, producing an excessive amount of thyroid hormones. This is caused by autoantibodies (TSHR-Ab) that activate the TSH-receptor, there by stimulating thyroid hormone synthesis and secretion, and thyroid growth. About 25- 30% of people with Graves' disease will also suffer from Graves' ophthalmopathy with variable degree of inflammation of the eye muscles. [13]

2.1.4.3. Thyroiditis:

Inflammation of the thyroid, or thyroiditis, may be due to infection usually viral or autoimmune disease. In viral *thyroiditis*, associated with coxsackie, mumps and adenovirus, the inflammation results in a release of preformed colloid and there is an increase in the concentration of thyroid hormones in the blood. Patients may become transiently, and usually only mildly, thyrotoxic. This phase persists for up to six weeks and is followed by a similar period in which thyroid hormone output may be decreased, but not sufficiently to cause symptoms. There after, normal function is regained. *Hashimoto's thyroiditis*, an autoimmune condition, has been mentioned as a cause of hypothyroidism. Autoantibodies are present in high titre, and the disease is associated with the presence of other organ-specific autoimmune diseases. Very occasionally, transient hyperthyroidism may occur early in the course of the disease due, as in viral thyroiditis, to increased release of preformed colloid. [14]

2.1.4.4. Goitre and thyroid cancer:

Goitre, or enlargement of the thyroid, can occur in patients with *hyperthyroidism* (e.g. in Craves' disease, toxic multinodular goitre or a thyroid

adenoma), *hypothyroidism* (e.g. in Hashimoto's disease or iodine deficiency) and in euthyroid individuals with benign or malignant tumours of the gland. Physiological enlargement of the thyroid may occur during adolescence, unaccompanied by any change in function, but, otherwise, thyroid function tests should be performed even in apparently euthyroid patients presenting with *goitre* since the results may provide a clue to the cause. The biochemistry laboratory has no part to play in the diagnosis of thyroid cancer, with the exception of calcitonin-secreting medullary carcinoma. When patients with thyroid cancer are treated by ablative doses of radioactive iodine and put on replacement thyroxine, the efficacy of the treatment can be assessed by measuring plasma thyroglobulin concentrations. Since small amounts of thyroglobulin are normally released from the gland together with thyroid hormones, persistent thyroid activity can be inferred if thyroglobulin is present in the plasma. [14]

2.2. Electrolytes:

Electrolytes are dividing into anions that are ions with negative charge which move toward the positive electrode or cations that are ions with positive charge that move toward a negative electrode. The major electrolytes are Na^+, K^+, Cl^- and HCO_3^- which are found primarily as free ions, compared to Ca^+, Mg^+, and other trace elements which are mainly protein bound. In a healthy person, 60 % of the body weight is body water. Body water is of two types namely ECF and the ICF, with a cell membrane in between. With the help of Na, K ATPase pump, equilibrium between the two compartments is maintained, where by Na^+ being the main extracellular cation and K^+ the main intra-cellular cation. The capillary membrane divides the ECF into intravascular and interstitial compartments. The membrane pore size, the relative concentration and oncotic pressure of proteins decides the equilibrium between the compartments. [15]

2.2.1. Calcium:

Calcium is essential to many cell functions, such as the contraction of muscles, nerve impulses and the release of important substances from different cells. The calcium concentration in the blood is normally very carefully regulated. About 50 % is protein-bound in the blood, mainly to albumin, 45 % is free, physiologically active calcium, known as ionised calcium, and about 5 % is bound as calcium citrate or calcium phosphate, The body□s calcium content is about 1 kg, 99 % of which is bound to the bones. The daily intake of calcium for an adult should be at least 800 mg. The most common sources of calcium are dairy products, which account for more than 60 % of the daily intake. Other calcium sources include cereals, seeds and fresh vegetables. The uptake of calcium occurs primarily in the proximal part of the small intestine. [16]

2.2.1.1. Calcium regulation:

The blood calcium level is primarily regulated by the parathyroid hormone (PTH). PTH increases the calcium concentration in the blood by reducing the excretion of calcium though the kidneys and increasing the influx of calcium from the skeleton. Intact PTH has a half-life in the circulation of about four minutes. PTH stimulates the formation of active vitamin D in the kidney, which, in turn, increases the absorption of calcium from the small intestine. Normally, at falling calcium concentrations in the blood, more PTH is released, which causes an increase in the calcium level. Thus, adequate kidney function is essential for a normal concentration of serum calcium. [16]

2.2.1.2. Hypercalcaemia:

Disturbances of the calcium metabolism lead to high or low calcium concentrations in the blood. *Hypercalcaemia* occurs when the flow of calcium from the skeleton and gastrointestinal tract into the blood exceeds the kidneys□ excretion ability. *Hypercalcaemia* is seen in 1−4 % of outpatients and in 0.2−3

% of hospital patients. Primary hyperparathyroidism is the most common cause of *hypercalcaemia* in outpatient care, whereas malignancies constitute 30–50 % of the *hypercalcaemia* cases among hospital patients. There are several other, less common causes of hypercalcaemia. *Hypercalcaemia* may also be caused by various medications, such as lithium and thiazides.The hereditary benign familial hypocalciuric *hypercalcaemia*. In sarcoidosis, the hypercalcaemia is caused by the production of active vitamin D, which increases calcium absorption in the intestine**.** [17]

2.2.1.3. Hypocalcaemia:

Hypocalcaemia may have several causes; with iatrogenic *hyperparathyroidism* after thyroid surgery being the most common cause. *Hypocalcaemia* may also occur due to calcium or vitamin D deficiency caused by malnutrition and lack of sunlight. Other causes of low calcium concentrations might be kidney and intestinal disease or malignancies lead to low albumin concentrations. Several studies from intensive care units have shown that low calcium concentrations are associated with increased mortality without any specific underlying cause. [16]

2.2.2. Phosphorus:

Phosphorus is the second most abundant essential mineral in the human body after calcium. It not only plays a role in numerous biologic processes, including energy metabolism and bone mineralization, but also provides the structural framework for DNA and RNA. It is synthesized through various biochemical pathways such as glycolysis and beta oxidation. Approximately 80% to 90% of phosphorus is present in the bones and teeth in the form of hydroxyapatite. The remainder is present in extracellular fluid, soft tissues and erythrocytes. Serum and plasma contain only a small fraction of total body phosphorus in the form of inorganic phosphate, lipid phosphorus, and phosphoric ester phosphorus. [17]

2.2.2.1. Phosphorus regulation:

Phosphate is filtered freely across the glomerulus-about 13 mg/ kg/day in a normal adult-and 60% to 70% of filtered phosphate is reabsorbed in the proximal tubule (with 10% to 15% reabsorbed in the distal tubule). This transport is mediated via a sodium-gradient dependent process and sodium-phosphate co-transporterson the luminal brush border membrane of the proximal tubules. Parathyroid Hormone (PTH) and a diet high in phosphate result in the endocytosis of these transporters, thus leading to decreased absorption and phosphaturia. This PTH-Vitamin D axis has been used to explain the renal regulation of phosphate, but it fails to explain the mechanism behind isolated renal phosphate wasting syndrome as seen in tumorinduced osteomalacia, autosomal recessive hypophosphatemic rickets, autosomal dominant hypophosphatemic rickets, and x-linked hypophosphatemia, disorders characterized by normal PTH levels, the absence of hypocalcemia, and low or normal calcitriol levels. Thus, these disorders do not increase calcitriol levels to cause hypophosphatemia. [17]

2.2.2.2. Hyperphosphatemia:

A serum phosphate concentration of more than 5mg/dl is considered *hyperphosphatemia*. In this state, the body induces a physiologically significant down-regulation of serum phosphate by reducing intestinal absorption of dietary phosphates and decreasing re-absorption of phosphate from glomerular filtrate. Unless there is a significant deterioration of renal function, the phosphate homeostasis is maintained by the action of PTH, Vitamin D3, and phosphatonins. The main underlying causes for hyperphosphatemia are decreased renal function, defective phosphatonin and other phosphaturic factors, a large efflux of intracellular phosphates, and/or a dietary increase in phosphate. *Hyperphosphatemia* accelerates renal tubulointerstitial disease, renal

osteodystrophies and cardiovascular disease. Other causes of decreased phosphate excretion include parathyroid dysfunction as seen in pseudohypoparathyroidism, abnormal Plasma PTH, and hypoparathyroidism; calcium excess; pseudotumoral calcinosis; bisphosphate therapy; and metabolic alkalosis. Secondary hyperparathyroidism in CKD increases mortality by causing cardiovascular disease and renal osteodystrophy and accelerating renal tubulo-interstitial damage. Mineral homeostasis in CKD patients on dialysis is a very crucial part of treatment and Increased dietary phosphate. [17]

2.2.2.3. Hypophosphatemia:

Hypophosphatemia is defined as a serum phosphate concentration less than 2.5 mg/dl and severe *hypophosphatemia* as less than 1mg/dl. Physiologically significant and symptomatic. Inadequate dietary intake alone is rarely responsible for profound *hypophosphatemia*, especially since the body compensates with rapid renal adaptation and decreased urinary phosphate excretion in such situations. Is the most common cause of *hypophosphatemia* in ICU patients. Carbohydrate refeeding in malnourished patients stimulates endogenous insulin release, which results in stimulation of glycolysis and formation of phosphorylated carbohydrate compounds in the liver and skeletal muscle. The "hungry bone syndrome" is another cause of *hypophosphatemia* that can develop in patients who undergo parathyroidectomy after long-standing hyperparathyroidism .This is due to a massive deposition of calcium and phosphorus in the osteopenic bone in the post-operative period. [17]

2.2.3. Magnesium:

Magnesium (Mg^{+}) is the most abundant divalent cation in cells. Chemically, Mg^{+} prefers the hexa-coordination and forms complexes with octahedral geometry. Moreover, its preponderance of oxygen as its ligand offers unique chemical and structural platforms that are utilized in structure-function biology;

Mg^{+} is woven into many enzymatic reactions in nearly all metabolic pathways. In particular, it acts as a cofactor for every reaction that generates energy from ATP hydrolysis. Also, Mg^{+} is alloyed into various biological structures, such as chlorophyll, RNA/ DNA, and proteins, and stabilizes their biologically active forms. Although small fluctuations of Mg^{+} concentration in the cell may be tolerated, a balance of Mg^{+} within a certain range is vital for healthy cellular functions. Lipid membranes are impermeable to divalent cations. Therefore, cell membranes require transmembrane channels or transporters that allow Mg^{+} to pass through in a controlled fashion. [18]

Magnseium is an important cation, necessary in a large number of metabolic processes, including oxidative phosphorylation, enzymatic reactions involving adenosine triphosphate (ATP), deoxyribonucleic acid and ribonucleic acid metabolism and function, protein synthesis, among others. Because of its importance in metabolism, deficiency or excess of magnesium can have serious clinical consequences. Magnesium is available widely in food, and its concentration in the body is regulated by renal and gastrointestinal function. Therefore, disorders of magnesium metabolism in the absence of a predisposing factor are quite rare. Magnesium disorders are most often a consequence of a number of other conditions. Attention tends to be focused on the primary disease, so that the accompanying deficiency or excess of magnesium may go unrecognized and, thus, untreated, to the potential detriment of the patient. [19]

2.2.3.1. Hypomagnesemia:

Hypomagnesemia is common. It was found in 10% ($Mg2^{+}$ <1.6 mg/dL of patients admitted to a geriatric facility. When present, hypomagnesemia is usually undetected. In a prospective study, 47% of patients undergoing clinical blood testing for electrolyte concentrations had *hypomagnesemia,* but physicians ordered Mg^{+} levels in only 10% of these hypomagnesemic patients. [20]

Hypomagnesemia is a common electrolyte imbalance in critically ill patients; yet it is frequently overlooked. It has been aptly said that "The eyes cannot see what the mind does not know." *Hypomagnesemia* is easily mistaken for potassium deficit, a condition with which it is often associated. Serum magnesium is a poor indicator of total body magnesium stores due to its major intracellular distribution and may be normal in the presence of total body magnesium depletion is described as the most under diagnosed electrolytes abnormality in current medical practice. [21]

2.2.3.2. Hypermagnesemia:

Hypermagnesemia is a rare complication caused by intravenous or oral administration of magnesium (Mg^{+}) as an antacid, cathartic, or antiarrhythmic; however, when the serum Mg concentration exceeds 9 mg/dL, potentially fatal symptoms can occur such as severe bradycardia, cardiac arrest, paralysis, and respiratory failure. Although symptomatic *hypermagnesemia* usually occurs in patients with renal dysfunction, people with normal renal function can develop Mg toxicity after therapeutic doses of Mgcontaining medications. Here, we report the case of a patient who developed fatal *hypermagnesemia* after mechanical bowel preparation for surgery. [22]

2.3. Previous studies:

2.3.1. Thyroid function and serum electrolytes: does an association really exsite?

CONCLUSION: An association between thyroid function and electrolyte disorders seems to exist, although it is probably only relevant in marked hypo-/hyperthyroidism. [23]

3.2.2. Assessment of serum minerals and electrolytes in thyroid patients:

Conclusion: Thyroid patients should be regularly checked for serum electrolytes. Early detection and treatment can prevent the further complications and will be helpful during the management of thyroid patients. **[24]**

2.3.3. Serum Electrolyte and Bone Mineral Status in Sudanese Patients with ThyroidDysfunction

In conclusion:

Hypothyroidism cause significant increase in serum potassium and phosphours, with significant decrease in serum calcium and magnisum, In contrast hyperthyroidism caused slight increased in serum sodium and calcium, with significant increase in serum magnesium. **[2]**

2.3.4. A CORRELATIVE STUDY OF THYROID PROFILE AND MINERAL STATUS IN PATIENTS WITH HYPOTHYROIDISM - A HOSPITAL BASED CASE CONTROL STUDY :

Conclusion: The direction of effect of overt hypothyroidism on the blood levels of calcium, magnesium, and phosphorus is inconsistent affecting the various metabolisms and clinical manifestations; in these patients, hence all patients with overt hypothyroidism need to be evaluated for mineral status to provide individualized holistic disease management strategies to these patients.

3.2.5. CHANGES IN ELECTROLYTE AND LIPID PROFILE IN HYPOTHYROIDISM:

ABSTRACT:

TSH values and serum sodium, potassium and calcium levels. From this study, we were able to conclude that higher the TSH levels, higher will be cholesterol, triglyceride, LDL, HDL, magnesium and phosphorus levels in blood, and lower will be the values of serum calcium, sodium and potassium levels. [25]

CHAPTER THREE

Materials and Methods

Chapter three

3. Materials and Methods

3.1. Study design:

This was descriptive Cross – sectional community based study.

3.2. The study area and period:

Shendi locality (River Nile State-Sudan) is located north of Khartoum, about (176) km, the study carried out (from March to august 2018).

3.3. Study population and population criteria:

Eighty participants were included in this study, as:

- Hyperthyroidism patients (14 subjects) .
- Hypothyroidism patients (36 subjects)
- Healthy (30) subjects without thyroid diseases are matched with study groups.

3.4. Exclusion criteria:

- All individuals with renal diseases.
- Any patient with liver diseases.
- All patients with bone diseases.
- Patients have minerals supplements.

3.5. Data collection:

Structured questionnaire was used to collect the following data; personal data, social customs, food habits, water source , medical history, other chronic disease ,type of thyroid disorder , duration of the disease, treatment.

3.6. Sample collection and sampling technique:

Random sampling was used to select suitable sample size**.**

Venous blood samples (3ml) were drawn in heparinized blood collection tubes, using sterile syringes and centrifuged 1500 r.p.m for five minutes to obtain

heparinized plasma for analysis of thyroid hormones profile (TSH, T_4, ca^+, mg^+, P^-) Samples were obtained from the thyroid disease patients and healthy group as control.

3.7. Material and instruments:

3.7.1. Materials:

Syringes, cotton, plane containers, lithium heparin containers, alcohol swap, automatic pipettes, tips, glass tubes, distal water, sodium kite reagent, phosphorous kite reagent. Centrifuge, TOSOH AIA 360, mindray ba 88a.

3.7.2. Instruments:

- **TOSOH AIA 360:**

  General principles:

  It based on the enzyme-linked immunosorbent assay Antibody that has specificity to thyroxine is added to the patient sample along with enzyme-labelled thyroxine labelled with *(glucose-6-phosphate dehydrogenase)*. The binding of the antibody to the enzyme-labelled thyroxine inhibits the enzyme activity by interfering with the enzyme's active site for the substrate. When substrate (glucose 6-phosphate and NAD) is added to the system, it is catalyzed by any (leftover) unbound enzyme-labelled thyroxine to form product and (NADH). This reaction is measured spectrophotometrically at (340nm). The rate of product formation is directly proportional to the concentration of thyroxine in the patient sample Fluorogenic substrate–labelled TSH is competing with patient TSH for antibody in this homogeneous assay. Only unbound (leftover) labelled TSH reacts with the enzyme to form fluorescent product. There is a direct relationship between fluorescence and the amount of TSH present in the test sample. In other words, the highest fluorescence is emitted by the sample or standard with the highest levels of TSH.see appendix (1).

- **Mindray BA-88-A (spectrophotometer):**

Spectrophotometers are instruments that send electromagnetic radiation into a target and measure the resulting interactionof the energy and the target. You will use a UV/VIS spectrophotometer (one that operates in the ultraviolet and visible regions of the electromagnetic spectrum) to measure the absorption spectra of three substances in the 340–600 nanometer wavelength region of the spectrum. The type of reaction may be Fixed time , End point, Kinetics and Absorbance .see appendix (2)

- 7. 0 " TFT touch screen & popup keypad are applied
- Up to 200 tests can be programmed
- Testing modes: flow cell and cuvett

- **Thyroxine (Total T_4):** by TOSOH AIA 360 .

  Normal values: 63.2 – 141.0 ng/ml

- **Serum TSH:** by TOSOH AIA 360.

  Normal values: 0.4 – 4.2 MIu/l.

- **Phosphorus by mindray BA-88**

Principle of the method:

Inorganic phosphate in the sample reacts with molybdate acid medium forming a phosphomolydate complex that can be measured

Procedure:

	Reagent Blank	Sample Blank	Sample	standard
Distilled water	0.01 ml			
Sample		0.01 ml	0.01 ml	
Phos. STD				0.01 ml
Reagent A		1.0 ml		
Working Reagent	1.0 ml		1.0 ml	1.0 ml

- Mix thoroughly and stand for 5 minutes at room temperature.

Read the absorbance A of sample lank at 340 nm against distilled water, sample and standard against the reagent blank

Calculation:

$$\frac{\text{A sample} - \text{A sample blank}}{\text{A standard}} * \text{C standard} = \text{C sample}$$

- Reference values : 2.5 – 4.5 mg/dl
- **Calcium by mindray ba 88a.spectrophotometer:**

Principle:

Calcium in the sample reacts with methylthymole blue in alkaline medium forming a colored complex that can be measured.

Procedure:

	Blank	Standard	Sample
Working reagent	1.0 ml	1.0 ml	1.0 ml
Calcium standard		0.01 ml	
Sample			0.01 ml

Mix thoroughly and stand for 2 minutes at room temperature .read the absorbance (A) of standard and sample at 610 nm against the blank.

Calculation:

$$\frac{\text{A sample}}{\text{A standard}} * \text{C standard} = \text{C sample}$$

- Reference values: 8.6 – 10.3 mg/dl.

Magnesium by mindray ba 88a.spectrophotometer:

Principle:

Magnesium in the sample reacts with xylidyl blue in alkaline medium forming a colored complex that can be measured.

Procedure:

	Blank	Standard	Sample
Working reagent	1.0 ml	1.0 ml	1.0 ml
Magnesium standard		0.01 ml	
Sample			0.01 ml

Mix thoroughly and stand for 2 minutes at room temperature .read the absorbance (A) of standard and sample at 520 nm against the blank

Calculation:

$$\frac{\text{A sample}}{\text{A standard}} * \text{C standard} = \text{C sample}$$

- Reference values: 1.7 – 2.4 mg/dl.

3.8. Ethical considerations:

The study was approved by ethical committee of the College of Graduate Studies &Scientific Research (Institute Research Board) of the Shendi University, before conducting the study permission was taken all participants after explaining the research aims and benefits, all of them agreed to participate, and they have the right to refuse any time during the study.

3.9. Data analysis:

The collected data was analyzed by computer, using the statistical programs software Statistical Package for the Social Sciences (SPSS) version (20).

The following statistical measures were used:-

- Mean, Standard SD, frequency, for quantitative data.
- T-test and correlation were used for qualitative data (significance level were set at $P \leq 0.05$).
- The data was presented in form of tables.

CHAPTER FOUR

Results

4. Results

Table (4.1) Shows Comparison of serum calcium, phosphorus and magnesium between case group and control:

Electrolytes	Frequency of control	Frequency of case	Mean of case	Mean of control	P.value
Ca	30	50	7.8	9.1	0.000
P	30	50	6.3	3.2	0.000
Mg	30	50	2.0	2.0	0.585

Table (4.2) Shows the mean of serum TSH between case group and control:

	Hypothyroidism		Hyperthyroidism	
	Frequency	**Mean**	**Frequency**	**Mean**
Case	36	6.2	14	0.9
Control	30	2.1	30	2.1
P.value	**0.000**		**0.000**	

t- test P <0.05 is significant.

Table (4.3) Shows the comparison of serum T_4 between case group and control:

	Hypothyroidism		Hyperthyroidism	
	Frequency	**Mean**	**Frequency**	**Mean**
Case	36	63.7	14	172.8
Control	30	93.1	30	93.1
P.value	**0.000**		**0.000**	

t- test P <0.05 is significant.

Table (4.4) Shows the comparison of serum calcium, phosphate and magnesium between test group in hypo and hyperthyroidism patients:

Electrolyte	Hypothyroidism		Hyperthyroidism		P.value
	Frequency	Mean	Frequency	Mean	
Ca	36	7.7	14	8.1	0.241
P	36	6.4	14	6.3	0.948
Mg	36	2.0	14	1.9	0.209

t- test P <0.05 is significant.

Table (4.5) shows the mean of calcium, phosphate and magnesium with duration of thyroid diseases:

Electrolytes	Duration of diseases/ year	Frequency	Mean	P.value
Ca^{+}	1-3	36	7.8	0.814
	4-6	14	7.9	
P^{-}	1-3	36	6.3	.589
	4-6	14	6.5	
Mg^{+}	1-3	36	1.1	.130
	4-6	14	1.0	

t- test $P < 0.05$ is significant.

Table (4.6) Shows the mean of calcium, phosphate and magnesium with age of case:

Electrolytes	Age/year	Frequency	Mean	P.value
Ca^{+}	20 – 35	21	7.5	0.143
	36 – 50	21	8.1	
	51 – 60	8	7.9	
P^{-}	20 – 35	21	6.5	0.090
	36 – 50	21	6.0	
	51 – 60	8	6.9	
Mg^{+}	20 – 35	21	2.1	0.023
	36 – 50	21	1.8	
	51 – 60	8	1.9	

t- test $P < 0.005$ is significant.

Table (4.7) shows the means of calcium, phosphate and magnesium with presence or absence of treatment in case group:

Electrolytes	Treatment	Frequency	Mean	P.value
Calcium	No	12	7.8	0.727
	Yes	38	7.9	
Phosphorus	No	12	6.6	0.474
	Yes	38	6.3	
Magnesium	No	12	2.2	0.010
	Yes	38	1.9	

* t- test P <0.05 is significant.

Table (4.8) Shows compression between electrolytes and sex in case group:

Electrolytes	Sex	Frequency	Mean	P.value
Calcium	Male	28	8.0	0.106
	Female	22	7.6	
Phosphorous	Male	28	6.4	0.475
	Female	22	6.2	
Magnesium	Male	28	2.0	0.801
	Female	22	1.9	

t- test $P < 0.05$ is significant.

CHAPTER FIVE

Discussion

Conclusion

Recommendations

5.1 Discussion

This study was conducted in Shendi locality in the period of (March – August 2018). The study included (50) thyroid diseases patients, divided into two groups, group 1 hyperthyroidism(14) patients, group 2 hypothyroidism(36) patients and compared with (30) healthy volunteers as a control group .To determine thyroid disorder correlate with serum calcium, phosphorous and magnesium.

Our study showed a lower serum level of (calcium and phosphorous) and no effect on magnesium when comparing with the control group, the mean of $\mathbf{Ca}^{+}$ is lower in case group than control. The mean of case was (7.8) and in control group was (9.1), with (P.value of 0.000), agree with Arvind Bharti and Shaizalza Shrestha in India (In our study there was significant decrease in serum calcium levels in hypothyroidism groups), and disagree withAbedelmula .M in Sudan (Hypercalcaemia was described in patients with hyperthyroidism).

This present study showed that the mean of $\mathbf{P}^{+}$ is higher in case group than control. The mean of $\mathbf{P}^{+}$ in case was (6.3) and in control group was (3.2) with (P.value of 0.000), which agree with study of Arvind Bharti and Shaizalza Shrestha in India (Our study also revealed significantly high phosphorous levels in patients with hypothyroidism ($p<0.01$).

The results of this study showed that there is no difference in the mean of $\mathbf{Mg}^{+}$ in both case and control.

the mean of case was (2.0) and in control group was (2.0) with P.value of (0.585), which disagree with Sussana. TY in India (magnesium levels in hypothyroid patients were significantly decreased) and abedelmula .M. in Sudan (In our study hypermagnesiumia which is present in hyperthyroidism patients) complete agreement with Christoph Schwarza in Switzerland (serum calcium

levels were significantly lower in patients with high TSH than with normal TSH).

This research prevailed that there were no effect of age, duration of thyroid disease and treatment on calcium and phosphate.

This recent study revealed that there was no effect of sex and duration of thyroid disease but effect of age and treatment on mean of magnesium.

5.2. Conclusion

- The means of calcium and phosphate was lower in case group than control group, but magnesium showed no difference between case group and control.
- The means of calcium and phosphate in case group were not affecting by the type of thyroid diseases (hypothyroidism hyperthyroidism), age, duration, sex and duration.
- The mean of magnesium in case group was affected by age and treatment of thyroid diseases, but not affected by sex and duration of thyroid diseases.

5.3. Recommendations

- Early detection and treatment of thyroid disease
- Thyroid function test follow up to avoid complications.
- Serum calcium phosphorous and magnesium should be measured repeatedly as follow up to minimize comlications
- Food and water rich with minerals are required.
- Further studies are recommended to be done for insuring the relationship between thyroid disorder and electrolytes imbalance.

CHAPTER SIX

References

Appendices

6. References

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Appendices

Appendix (1)

Shendi University

Faculty of graduate studies &scientific research

Thyroid disorders correlated with(calcium ,phsphate and magnesium)

(The information in this questionnaire is confidential and used only for scientific purpose.)

Personal data

Date:-……
Name:-……
Address:-……
Mobile No:- …….. ….. …… ……

Socio-demographic data

1. **Age: -** …….
2. **Gender** : Male ( ) female ( )
3. **Residency:** - City ( ) 2. Rural ( )
4. **Level of education:-** 1.No formal education ( ) 2. Primary ( )
   3. Secondary ( ) 4. University ( )
5. **Water source :** …….
6. **Vegitable intake : regular ( ) Moderate ( ) rare ( )**
7. **Freuts intake : regular ( ) Moderate ( ) rare ( )**
8. **Alkohol ubuse : yes ( ) No ( )**

Clinical data

9. Family history of thyroid dises: yes ( ) No ( )

10. Thyroid disorder : hypothyroidism ( ) hyperthyroidism ( ) other ( )

11. History of liver disease : yes ( ) No ( )

12. Other chronic disease and what: .....

Laboratory data

13. Serum T4 ……..…….

14. Serum TSH: ……..……..

15. S.calcium : ……..

16. S.phosphate :……..…….

17. S. S.magnesium :…….

Appendix (2)

Appendix (3)