

A STUDY ON MAGNESIUM, COPPER AND ZINC METABOLISM IN SERUM AND URINE OF HYPOTHYROID PATIENTS BEFORE AND AFTER THYROID MEDICATION

A THESIS

Submitted for Partial Fulfilment
of Master Degree in Medicine



By
RIZK HABEEB GIRGIS
(M. B., B. Ch.)



Supervised By

Prof. Dr.
AHMED MOHAMED GHAREEB
Professor and Chairman of
General Medicine Department
Ain Shams University

Prof. Dr.
MOHAMED FARID EL-ASMAR
Professor and Chairman of
Biochemistry Department
Ain Shams University

Dr. MOUGHAZI ALI MAHMOUD
Ass. Professor of Medicine
Dr. ELHAM EZELDIN ISLAM
Lecturer of Medicine

129-47

Ain Shams University
Faculty of Medicine
Endocrine Unit.

1982

A STUDY ON MAGNESIUM, COPPER AND ZINC METABOLISM IN SERUM AND URINE OF HYPOTHYROID PATIENTS BEFORE AND AFTER THYROID MEDICATION

A THESIS

Submitted for Partial Fulfilment
of Master Degree in Medicine

By

RIZK HABEEB GIRGIS

(M. B., B. Ch.)

Supervised By

Prof. Dr.

AHMED MOHAMED GHAREEB

Professor and Chairman of
General Medicine Department
Ain Shams University

Prof. Dr.

MOHAMED FARID EL-ASMAR

Professor and Chairman of
Biochemistry Department
Ain Shams University

Dr. MOUGHAZI ALI MAHMOUD

Ass. Professor of Medicine

Dr. ELHAM EZELDIN ISLAM

Lecturer of Medicine

Ain Shams University

Faculty of Medicine

Endocrine Unit.

1982



ACKNOWLEDGEMENT

I wish to express my deepest, sincere gratitude to Professor Dr. Ahmed Mohamed Ghareeb for providing me the opportunity to work with the research team of Endocrine Unit, and under his guidance of which I am most proud. I am also grateful to Professor Dr. Mohamed Farid El-Asmar for his kind guidance and help.

I am specially indebted to Ass. Professor Dr. Moughazi Ali Mahmoud and to Dr. Elham Ezeldin Islam for their kind and constant help, guidance and encouragement so that this study could appear.

I am also grateful to all the medical and laboratory staff in the Endocrine Unit.

CONTENTS

	<u>Page</u>
AIM OF WORK	1
REVIEW OF LITERATURE	3
- Magnesium Metabolism	3
- Calcium and Phosphorus Metabolism in hypothyroidism	20
- Renal and Electrolyte Changes in hypothyroidism	23
- Copper Metabolism	27
- Zinc Metabolism	42
- Magnesium, Copper and Zinc contents of various food stuffs	58
MATERIAL AND METHODS	62
RESULTS	69
DISCUSSION	99
CONCLUSION	108
SUMMARY	110
REFERENCES	114
ARABIC SUMMARY.	

A I M O F W O R K

AIM OF THE WORK

The mitochondrion is mainly responsible for the energy production in the cell, and thyroxine has a direct action on the mitochondrial function. 60 % of the cellular magnesium is found in the mitochondrial component of the cells. Williams (1974).

Hypomagnesaemia can lead to muscle tremors, twitches and bizarre movements, a picture similar to hyperthyroidism, while hypermagnesaemia produces muscle weakness and somnolence which simulates the picture of hypothyroidism. Flink et al. (1957).

Copper has been recognized as an essential dietary element. It is necessary for promotion of homeostasis. Elvehjem (1935).

Several proteins and enzymes require copper as part of their molecular structure. These copper proteins include e.g. cytochrome oxidase, ceruloplasmin, tyrosinase, as well as histaminase. Prasad (1976).

Zinc is a component of a number of enzymes particularly carbonic anhydrase, carboxypeptidase A and the

dehydrogenases. It is also important in man for growth and sexual development, and it seems important for the synthesis of RNA and DNA, and for cell division. Varley et al. (1980).

The aim of this work is to study magnesium, copper, and zinc metabolism in hypothyroid cases, and the changes which occur in serum and urinary magnesium, copper and zinc before and 2 weeks after thyroxine therapy, and to demonstrate the role of these changes in hypothyroid manifestations.

REVIEW OF LITERATURE

MAGNESIUM METABOLISM

Normal Distribution and Turnover of Magnesium in Man

Magnesium body contents :

The total body content of magnesium is 200 m.mols (in a 70 kgm.man). It is about 21 gm of magnesium.

About 70 % is combined with calcium and phosphorus in the complex salts of bones, the remainder is in the soft tissues and body fluids. Harper (1973).

The range obtained by atomic absorption spectrophotometry for whole blood magnesium is 1.4 - 2.5 m eq./liter (average 2.0) (1.7 - 3.0 mg/100 ml). Lanter (1975). The levels of magnesium in serum of healthy people are remarkably constant, remaining on the average at 1.7 m.eq./liter, and varying less than 15 % from this mean value. Wacker and Parisi (1968).

Serum magnesium measures 0.7 - 0.95 m.mol./liter (1.8-2.3 mg/100 ml.). Price (1978).

About 80 % of serum magnesium is in a diffusible state, the nondiffusible fraction being probably combined with serum proteins. Lanter (1975).

In the cerebrospinal fluid, magnesium level is higher than that of blood (2.5 - 3.0 m.eq/liter) (3.0 - 3.6 mg/100 ml). Lanter (1975).

According to Fomon (1974) human breast milk contains about 4 mg/100 ml.

Requirements and intake :

The daily requirement of magnesium in the diet is 350 mg/day for adult men and 300 mg/day for adult women. Harper (1973).

For the newborn it is much lower, being 60 mg/day, and increases to 150 mg/day for children. Fomon (1974)

Biochemistry of Magnesium

Atomic composition of magnesium makes it able to capture and transport energy effeciently. Also, magnesium atom can hold reacting groups effeciently together. Magnesium atom has a chelating function which is necessary for all the photosynthetic processes. Prasad (1974).

Magnesium will prove to be another divalent cation with a messenger function as that of calcium in the mediation of hormonal functions. Rasmussen (1974).

Magnesium Metabolism

Absorption :

Ingested magnesium is mainly absorbed by the small intestine particularly the ileum, and the average daily absorption of magnesium from the gastrointestinal tract is 0.14 m.eq/kg. Fletcher et al. (1960).

There is an interrelationship between absorption of magnesium and calcium, as there is a common transport

mechanism for both cations across the intestinal Wall. Alcock and MacIntyre (1962).

The main factor controlling the amount of magnesium absorbed in a given time is the ionic concentration of magnesium in the digested food at the absorption site, apart from the small effect of the potential difference across the wall of the small intestine. High intake of phosphate, calcium and alkalies appears to diminish magnesium absorption, while high magnesium intake increases urinary calcium. Smith and Mc Allan (1966).

Secretion of magnesium :

Magnesium is secreted through the liver and pancreas into the bile and pancreatic juice which is followed by complete reabsorption. This explains hypomagnesaemia in patients losing high amounts of intestinal fluids. Lear and Cron (1968).

Urinary excretion of magnesium :

The urinary excretion of magnesium has diurnal variation, being lowest during the normal sleeping hours and

maximal in the late morning. Lanter (1975).

Most of absorbed magnesium is excreted by the kidney, and fecal magnesium represents largely the unabsorbed fraction. Aikawa et al. (1960).

Magnesium filtered by the glomeruli is reabsorbed by the renal tubules by an active process, and magnesium may be secreted by the renal tubules. It is noted that mercurial and thiazide diuretics as well as acidifying substances increase the urinary excretion of magnesium and calcium. Prasad (1976).

Magnesium is also excreted in sweat which can account for 25 % of magnesium lost daily. Consolazio et al. (1973).

Magnesium Homeostasis

It is the ionic fraction of magnesium which appears in the glomerular filtrate, while protein bound magnesium filtered is returned to the circulation through lymph. So, hypomagnesaemia can result from renal diseases with heavy proteinuria. There is always maximal tubular absorption of magnesium. So, magnesium deficiency does not occur even under low magnesium diets. Barnes et al. (1958).