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Original Article

# Why are serum magnesium levels lower in Saudi dialysis patients?

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**الملخص**

**أهداف البحث:** غالبا ما يتغير مستوى المغنيسيوم في الدم عند مرضى غسيل الكلى. أجريت هذه الدراسة للتأكد من اختلاف مستويات المغنسيوم عند المرضى الذين يعالجون بغسيل الكلى.

**طرق البحث:** أجريت هذه الدراسة الاستعادية في وحدة غسيل الكلى بمستشفى الملك خالد الجامعي، جامعة الملك سعود بالرياض، على المرضى الذين يخضعون لغسيل الكلى بانتظام. تم توثيق البيانات الديموغرافية للمرضى، بما فيها مؤشر كتلة الجسم، ومستوى الكالسيوم بالدم، والمغنيسيوم، وهرمون الغدة الجار درقية، والكوليسترول، والدهون الثلاثية.

**النتائج:** من بين ما مجموعه ١١٥ مريضا٧٠، (٦٠.٩٪) كانوا على غسيل الكلى الدموي و ٤٥ (٣٩.١٪) على غسيل الكلى البريتوني. من هؤلاء؛ ١٠ مرضى (٨.٧٪) كان مستوى المغنيسيوم <٠.٧ ممول/ ل، وكان لدى ١٣ (١١.٣٪) ٧،٠ممول/ ل، ولدى ٢٤ (٢٠.٩٪) ٠.٨ ممول/ ل، وعند ٢٦ (٢٢.٦٪) كان ٠.٩ ممول/ ل، وعند ١٦ (٩،١٣٪) ٠،١ ممول / ل، و ٢٦ (٢٣.٩٪) ظهرت المستويات ≥١،١ممول/ ل. تقريبا كان لدى ٩٣٪ من العينة ارتفاع مستويات هرمون الغدة الجار درقية، و٤٣ (٣٧.٤٪) انخفاض مستوى الكالسيوم بالدم، و ٢٤ (٢٠.٩٪) انخفاض مستوى الكوليسترول و ٦٠ (٢،٥٢٪) انخفاض الدهون الثلاثية بالدم. أظهر مرضى غسيل الكلى البيرتوني انخفاضا ملحوظا لمستويات المغنسيوم وارتفاعا لمستويات هرمون الغدة الجار درقية بالمقارنة بمرضى غسيل الكلى الدموي.

**الاستنتاجات:** يعتبر مرضى الكلى المزمن عموما معرضين لخطر الإصابة بزيادة مغنيسيوم الدم بسبب انخفاض تخلص الكلى. ولكن عددا كبيرا من مرضى غسيل الكلى في وحدتنا لديهم انخفاض في مستويات المغنسيوم بدلا من ذلك. بالإضافة إلى عوامل أخرى يتأثر إفراز هرمون الغدة الجار درقية بمستويات المغنسيوم في الدم. كما وجدنا علاقة مهمة بين مستويات المغنسيوم بالدم والكالسيوم وكذلك هرمون الغدة الجار درقية. بناء على ذلك، فإن تحسين تركيز المغنسيوم عند مرضى غسيل الكلى مهم لتقليل خطر اضطراب دهون الدم، وعدم انتظام ضربات القلب، وفرط إفراز هرمون الغدة الجار درقية أو أمراض انعدام الحركة العظمية.

**الكلمات المفتاحية:** المغنسيوم؛ هرمون الغدة الجار درقية؛ الكالسيوم؛ غسيل الكلى؛ مرض الكلى المزمن؛ الكوليسترول

## Abstract

**Objectives:** Serum magnesium (Mg) levels are often altered in dialysis patients. This study was conducted to ascertain the trends in Mg levels in patients on dialysis treatment.

**Methods:** A retrospective study was performed in the Dialysis Unit of King Khalid University Hospital, King Saud University, Riyadh, on patients undergoing regular dialysis. Patient demographic data, including body mass index (BMI), serum calcium (Ca), Mg, parathyroid hormone (PTH), cholesterol, and triglycerides were documented.

**Results:** Of a total of 115 patients, 70 (60.9%) were on haemodialysis (HD), and 45 (39.1%) were on peritoneal dialysis (PD). Of these, 10 patients (8.7%) had Mg levels of <0.7 mmol/L, 13 (11.3%) had 0.7 mmol/L, 24 (20.9%) had 0.8 mmol/L, 26 (22.6%) had 0.9 mmol/L, 16 (13.9%) 1.0 mmol/L, and 26 (23.9%) showed levels of ≥1.1 mmol/L. Approximately 93.0% had increased PTH levels, 43 (37.4%) had decreased serum Ca, 24 (20.9%) had low serum cholesterol, and 60 (52.2%) had low serum triglyceride. PD patients had significantly lower Mg and higher PTH levels compared to HD patients.

**Conclusion:** Patients with chronic kidney disease are generally considered at risk of developing hypermagnesaemia due to reduced renal excretion. However, a

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considerable number of dialysis patients in our unit had hypomagnesaemia (or low levels) instead. In addition to other factors, PTH secretion is affected by serum Mg levels. We found a significant correlation between serum Mg and Ca as well as PTH levels. Consequently, optimizing Mg concentration in patients on dialysate is essential to reduce risk of dyslipidaemia, arrhythmias, hyperparathyroidism, or adynamic bone disease.

**Keywords:** Calcium; Cholesterol; Chronic kidney disease; Dialysis; Magnesium; Parathyroid hormone



## Introduction

Magnesium ($Mg^{++}$) is the fourth most abundant cation in the body and is involved in various cell functions. In health, the kidneys, gastrointestinal tract, and bones are responsible for maintaining Mg balance and keeping serum $Mg^{++}$ concentrations in the normal range.[1] Dietary intake of magnesium-rich foods is one of the factors responsible for variations in Mg levels among the general population and also among dialysis patients. The local Arab or Saudi diet contains a number of Mg-rich foods, including nuts, seeds, dried fruits, and dairy products. In chronic kidney disease (CKD), the reduced renal excretion of $Mg^{++}$ and other ions leads to elevations in serum potassium, phosphate, and $Mg^{++}$.[2]

Patients with chronic renal failure often have increased body $Mg^{++}$ content because of reduced renal excretion of Mg leading to hypermagnesaemia.[3] CKD, and particularly end-stage renal disease (ESRD), is the only clinical condition where sustained hypermagnesaemia may occur with a positive net $Mg^{++}$ balance.[1] In dialysis patients, hypermagnesaemia is frequent; usually mild (serum $Mg^{++} < 1.5$ mmol/L) and asymptomatic, severe and symptomatic hypermagnesaemia can be seen with exogenous $Mg^{++}$ administration.[4] A literature search for the effects of Mg balance in ESRD patients suggests that hypermagnesaemia may have a suppressive effect on PTH synthesis and/or secretion. Therefore, elevated serum $Mg^{++}$ levels may play a role in the pathogenesis of adynamic bone disease.[4]

Conversely, hypomagnesaemia is also seen not infrequently in ESRD patients on dialysis. This can be attributed to dietary restrictions, use of loop and thiazide diuretics, and lower concentration of Mg in the dialysate, leading to loss of Mg from the body.[5] Hypomagnesaemia is correlated to dyslipidaemia, thus predisposing the individual to vascular calcification, atherosclerosis, and cardiovascular mortality.[6] Low $Mg^{++}$ levels have been associated with impairment of myocardial contractility, intra-dialytic haemodynamic instability, hypertension, and thickening of the carotid inner wall linings.[7] In addition, dietary limitations for ESRD patients limit the intake of Mg rich foods, thus increasing the potential for hypomagnesaemia. $Mg^{++}$ studies in dialysis patients remain controversial with regard to their therapeutic applications.[8–10] It has been reported that hypermagnesaemia can suppress PTH levels; however, it remains to be seen if the reverse is true; i.e., can Mg deficiency cause elevated serum PTH levels?

Both serum calcium and serum $Mg^{++}$ levels are important in the regulation of serum parathyroid hormone (PTH) levels. Calcium, vitamin D, and phosphorus play a key role in the control of parathyroid gland function in uraemic patients. There is a significant inverse correlation between serum PTH level and serum $Mg^{++}$ and calcium levels.[11,12] $Mg^{++}$ can modulate PTH secretion in a way similar to calcium.[13] Despite studies conducted on the relationship between $Mg^{++}$ and PTH, the effect of $Mg^{++}$ on PTH levels in dialysis patients is not well established. Whereas some studies have demonstrated that serum $Mg^{++}$ levels did not affect PTH in dialysis patients, several studies have reported a statistically significant inverse correlation between serum $Mg^{++}$ and PTH in dialysis patients. It is thought that early $Mg^{++}$ deficiency in humans is characterized by high PTH, since $Mg^{++}$ ions possess an effect on calcium-sensing receptors in the parathyroid glands similar to that of calcium.[14] Conversely, with more severe $Mg^{++}$ deficiency, PTH secretion has been reported to decrease.[15] The influence of serum $Mg^{++}$ levels on PTH secretion necessitates further investigation.

A number of our dialysis patients have hypomagnesaemia, or low normal Mg levels, rather than the expected hypermagnesaemia. To investigate this issue further, we designed this study to understand the prevalence of hypermagnesaemia and hypomagnesaemia in relation to serum parathyroid and calcium levels, diet, and lipid profile of our dialysis patients.

## Materials and Methods

This is a retrospective study (It is a cross-sectional study) performed in the Dialysis Unit of King Khalid University Hospital, King Saud University, Riyadh, KSA, covering patients seen between January 2011 and December 2011. All patients above 16 years of age, who were on regular haemodialysis (HD) (the magnesium content in the dialysate fluid in haemodialysis is 0.5 Mmol/L) or on peritoneal dialysis (PD) (the magnesium content in the peritoneal solution is 0.25 Mmol/L, as magnesium chloride) for more than three months, were included in the study. Patients with active infection or bone malignancy were excluded from the study. The serum $Mg^{++}$ was measured using standard kits®. The method used to measure serum magnesium is the Siemens Dimensions Assay, using FLEX® Reagent Cartridge. Intact serum PTH (iPTH) was measured by the RIA method using DSL-8000 of the USA. Other pertinent data included age, gender, weight and height for calculation of BMI, serum calcium, serum cholesterol, and serum triglyceride level. Normal values for serum $Mg^{++}$, serum PTH, serum calcium, serum cholesterol and serum triglycerides were considered as follows: serum $Mg^{++}$ (0.7–1.1 mmol/L), serum PTH (13–64 ng/L), serum corrected calcium (2.1–2.55 mmol/L), serum cholesterol (3.2–5.2 mmol/L) and serum triglycerides (0.4–1.48 mmol/L).