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CLINICAL RESEARCH

Serum Magnesium in Patients on Chronic Haemodialysis with a Standard Dialysate Magnesium - A Single Centre Study

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Introduction

Magnesium (Mg) is the second most abundant intracellular cation [1]. Despite the well-recognised clinical importance of magnesium, Mg is not included in routine laboratory assessments [2,3]. Therefore, Mg is sometimes referred to as the forgotten or neglected cation [4,5]. Magnesium plays a pivotal role in maintaining normal cell membrane functions [6], regulation of blood pressure and vascular resistance. Magnesium is needed as a cofactor in most enzymatic processes [7]. Deficiency of magnesium cause clinically significant effects. The cardiovascular impact of magnesium deficiency includes effects on cardiac electrical activity, myocardial contractility and vascular tone [8]. Hypomagnesemia is associated with cardiac arrhythmias and coronary artery disease [9-11].

Impact of magnesium deficiency in haemodialysis (HD) patients is increasingly recognised. It is recognised as a modifiable risk factor in haemodialysis patients who have high cardiovascular and all-cause mortality rate. Magnesium balance in a normal healthy subject is mainly depend on dietary intake, intestinal absorption and renal excretion. In advanced stages of chronic Kidney disease and in haemodialysis patients, the renal excretion is deficient. Further the haemodialysis patients will be constantly exposed to a standard level of magnesium in the haemodialyste solution which could become a major determinant of their magnesium level. This standard is 0.5 mmol/L of Mg in our centre, as it is the routine for majority of the centres in the UK. Hitherto, there is lack of consensus regarding the optimum level of magnesium in dialysate despite explorative research and heightened interest in recent times. Further, serum magnesium is not routinely monitored in most HD units and there is no agreed protocol regarding the frequency of monitoring and the population of patients who need frequent monitoring.

A previous study that examined pre and post HD serum magnesium concentrations over six dialysis sessions while dialysing against standard 0.5 mmol/L magnesium concentration in dialysate [1]. This study showed a decline in post HD magnesium concentration. We wanted to confirm the long term steady effect of standard dialysate magnesium (0.5 mmol/L) on serum magnesium level over a period of 4 years with annual monitoring. We intended to explore the incidence of hypomagnesemia in the chronic haemodialysis patients who were dialysed with standard dialysate magnesium of 0.5 mmol/L in our centre over the past 4 years.

In the cohort who developed hypomagnesemia, demographic features, clinical characteristics and associated risk factors were explored.

This is thought to be helpful in identifying the high risk population of HD patients who may need frequent monitoring targets.

Methods

Location and the population

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This study was performed in Queens Hospital, Romford, UK which is a satellite unit for chronic haemodialysis under Barts Health NHS Trust. This was a retrospective observational study analysing data over the period of 4 years from year 2020 to 2023. Ethical approval was not needed as the analysis was done by using routine lab data collected and no intervention was done.

125 patients on chronic maintenance haemodialysis were included in the study.

Inclusion criteria

1. Age > 18 years

2. On chronic haemodialysis for > 3 months

3. Haemodialysis with regular three times weekly dialysis schedule

4. Standard dialysate magnesium concentration of 0.5 mmol/L

Exclusion criteria

1. On HD < 3 months

2. Patient on HD due to AKI

3. Less than thrice weekly dialysis.

All the patients who fulfilled the inclusion criteria had an annual serum magnesium test over the period of four years. Blood was taken pre dialysis after a long dialysis interval for the analysis of serum magnesium. Blood was analysed in the Royal London Hospital, UK using the standard methods of analysis.

Reference range for serum total magnesium was 0.7 to 1.05 mmol/L. Hypomagnesemia was defined as serum magnesium less than or equal to 0.7 mmol/L. The magnesium concentration in dialysate was kept at a steady 0.5 mmol/L concentration for all the patients.

Results

The patients of chronic haemodialysis (n = 125) represented a heterogeneous population with an age range of 26 to 92 years and a male preponderance (Males = 113 [90.4%] and females = 12 [9.6%]) A total of 20 patients had hypomagnesemia which corresponded to a cumulative incidence of 16%. The characteristic of patients with hypomagnesemia are given in Table 1.

Majority of the patients with hypomagnesemia were in the 70 to 79 age group. Although most were male, the female proportion among patients with hypomagnesemia (35%) was higher when compared to the total population on chronic HD. A majority (60%) of those with hypomagnesemia have been on chronic HD for 2 to 4 years.

Within the duration of the study 12 deaths have occurred among patients with hypomagnesemia that corresponds to an incident mortality rate of 60%. Of the 12 deaths that registered, three have been attributed to COVID-19 infection.

Discussion

Over the follow up of four years only 20 patients (cumulative incidence 16%) developed hypomagnesemia after being dialysed with 0.5 mmol/L haemodialysate. All these patients had HD three times per week. Majority of patients (average 60%) maintained serum magnesium within the normal range over the four year period despite HD with 0.5 mmol/L dialysate . An average of 31% of patients had magnesium level above 1 mmol/L. Previous study [12] found 73% patients to be hypermagnesemic with HD with 0.5 mmol/L dialysate over one year. Both this and our study showed that majority of patients maintained normal or higher levels of magnesium with standard dialysate magnesium. This is contrast to the thought that relatively low dialysate magnesium leads to hypomagnesemia due to diffusive elimination of magnesium during the dialysis process. Leenders, et al. [13] suggested that commonly used dialysate magnesium concentration of 0.50 mmol/L generally induces a decline of plasma magnesium concentrations towards concentrations in the lower range of normal [13]. However, this effect is not seen in the population we analysed.

Table 1: Characteristic of patients with hypomagnesemia (n = 20).

	n (%)
Age (Years)	
< 50	1 (5)
50-59	2 (10)
60-69	5 (25)
70-79	9 (45)
80-89	3 (15)
Gender	
Female	7 (35)
Male	13 (65)
Ethnicity	
White British	14 (70)
Asian	1 (5)
European	1 (5)
Black Caribbean	1 (5)
Not stated	3 (15)
Duration of haemodialysis (Years)	
Less than 2	6 (30)
2-4	12 (60)
More than 4	2 (10)
Comorbidities	
Type 2 diabetes	12 (60)
Ischaemic heart disease	8 (40)
Peripheral vascular disease	2 (10)
Cardiac rhythm abnormalities	3 (15)

Most of the hypomagnesemic patients were over 60 years. Age 70-79 group had the highest incidence of hypomagnesemia. Only three patients were below 60. This may be explainable by the reduced nutritional reserve in the elderly population. Over 60-year-old HD patients may need more attention towards their magnesium balance.

Majority of the HD population in our centre were males and majority of hypomagnesemic patients were male. However when total HD cohort is considered, both male and female representation in the hypomagnesemia group was exactly the same (20% in each group).

Majority of patients with hypomagnesemia were white British. The impact of ethnicity on serum magnesium concentration is likely to be due to dietary effects.

Dilysis vintage is < 4 years in majority (90%) of patients. This is also in contrary to the thought that continuing HD with standard HD lowers serum Magnesium.

Most patients with hypomagnesemia had diabetes and cardiovascular disease.

There was considerably high mortality rate among the hypomagnesemia group. The death rate was 60%. It is difficult to draw a conclusion from this since the study period included the COVID pandemic where some of these deaths are due to COVID infection.

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