Section: General Medicine

Original Research Article

COMPARISON OF MAGNESIUM LEVELS IN HEART FAILURE WITH PRESERVED EJECTION FRACTION TO HEART FAILURE WITH LOW EJECTION FRACTION -A CROSS SECTIONAL STUDY IN SOUTH INDIA

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ABSTRACT

Background: Heart failure (HF) is a major cause of morbidity and mortality worldwide. Neurohormonal activation in HF contributes to electrolyte disturbances, among which magnesium imbalance is associated with arrhythmias and adverse cardiovascular outcomes. This study aimed to evaluate serum magnesium levels in patients with heart failure and their association with ejection fraction and disease severity.

Materials and Methods: A hospital-based cross-sectional observational study was conducted in the Departments of Cardiology and General Medicine at Pushpagiri Institute of Medical Sciences and Research Centre, Kerala, over 1.5 years. Fifty adults (>18 years) fulfilling Framingham criteria with elevated BNP/NT-proBNP levels were included. Patients receiving magnesium supplements and those with stage 5 chronic kidney disease were excluded. Serum magnesium levels were measured using a Beckman analyzer. Echocardiography was performed using the VIVID E system, and heart failure severity was assessed using the New York Heart Association (NYHA) classification. Data were analyzed using SPSS version 24.

Results: Among the 50 patients, 54% were males and most belonged to the 51–75-year age group. Twenty-six patients had heart failure with reduced ejection fraction (HFrEF) and 24 had preserved ejection fraction (HFpEF). Mean serum magnesium level was 1.62 mmol/L. Normal magnesium levels were observed in 48% of patients, while 22% had mild hypomagnesemia and 30% had significantly low levels. Serum magnesium levels were lower in HFrEF patients and in those with NYHA class III–IV compared with HFpEF and NYHA class II patients.

Conclusion: Lower serum magnesium levels are associated with reduced ejection fraction and increased severity of heart failure, highlighting the importance of routine magnesium assessment in HF patients.

Keywords: Heart failure, magnesium, ejection fraction, echocardiography, NYHA class, electrolytes.

INTRODUCTION

Heart failure is a clinical condition that occurs due to structural or functional impairment of ventricular ejection or filling of blood, which in turn causes the clinical symptoms like dyspnoea and fatigue and signs of HF, namely edema and crepitations.[1] The prevalence of heart failure is increasing due to the frequency of coronary artery disease and the growing elderly population. Heart failure is the leading cause of cardiovascular mortality and morbidity.[2]

Heart failure is considered as a progressive disorder that begins after an index event that either destroy

the heart muscle, with a resultant loss of functioning cardiac myocytes, or, that, disrupts the ability of the myocardium to generate force, and hence prevents the heart from normal contraction.[3] Coronary heart disease and hypertension account for the majority of the cases of heart failure.[4]

Other causes include valvular heart disease, cardiomyopathies, hyperthyroidism and anaemia.[5] Common symptoms of HF is due to volume overload with increase in pulmonary and systemic venous pressure. Most important symptom is shortness of breath. Other manifestations are dyspnoea on exertion, orthopnoea, paroxysmal nocturnal dyspnoea and pedal edema.[6]

Clinical signs include raised JVP, bilateral basal crepitations and S3 gallop. Diagnosis of HF is relatively straight when patient presents with typical signs and symptoms. And also cardiac biomarkers like BNP & NT pro-BNP will be elevated and these are released from ventricles and atria in response to stress increased on walls.[7]

After calcium, magnesium is the second most common electrolyte that plays role in metabolic processes and normal myocardial functioning.[8] Also regulation of myocyte and endothelial function.[9] The Clinical sequel of hypomagnesaemia includes development of various arrhythmias and thus attaining magnesium homeostasis is of major significance in HF.[10]

Magnesium is a cheap, widely available investigation, so in this study we intent to know the serum Magnesium levels in heart failure and also to compare the serum magnesium levels in heart failure with preserved ejection fraction to reduced ejection fraction.

MATERIALS AND METHODS

It was a Observational cross sectional study conducted at Department of cardiology and general medicine, pushpagiri institute of medical science and research centre, thiruvalla, kerala for 1.5 Years

Patients diagnosed with heart failure, satisfying the inclusion criteria, admitted general medicine or cardiology departments of Pushpagiri medical college. Consecutive sampling is done untill sample size attained

Sample Size: Assuming 99 % confidence interval and 5% relative precision based on the mean and standard deviation of serum magnesium level (reference study), the required minimum sample size is 46.

Inclusion criteria

Patients above 18 years fullfilling framingham criteria and serum BNP or NT-pro BNP levels elevated

Exclusion criteria

Patients on magnesium supplements and ckd stage 5

Study Tools

1. Patient consent form
2. Self-prepared proforma for obtaining data from the subjects
3. Patient informant sheet

Methods of data collection

The pre-tested, semi structured questionnaire shall be used for data collection. Clinical and relevant laboratory and radiological data shall be collected and shall be documented in the predesigned proforma. Serum magnesium levels shall be assessed in all the study patients using BECKMAN MACHINE. Severity of heart failure at the time of presentation shall be done using New York Heart Association Functional classification (NYHA I- IV). For standardisation, Echocardiography shall be done using VIVID E MACHINE by a trained echocardiographist or cardiologist with a miniumum experience of two years. Findings of echocardiography and Left ventricular ejection fraction shall be noted. The data collected through the questionnare will be entered using a data entry platform The data will be analysed using SPSS 24.00. All continious variables will be expressed as mean & median and all categorical variables will be expressed as proportion.

RESULTS

Table 1: Distribution of study population based on age and Gender

Age group (Years)	Frequency	Percentage
≤ 50 Years	11	22.0
51-75 Years	23	46.0
> 75 Years	16	32.0
Total	50	100.0

Patients aged 50 years or younger constituted 22% (11 patients) of the population. The largest age group, comprising 46% (23 patients), was between 51 and 75 years. Patients older than 75 years made up 32% (16 patients) of the study population. This distribution highlights that nearly half of the patients fall within the 51-75-year age range. The gender distribution of the study population shows a slight male predominance, with 54% of the patients being male and 46.0% being female.

Table 2: Distribution of study population based on cardiovascular disease status

Cardiovascular Disease	Frequency	Percentage
CAD	40	80
Valvular Heart disease	9	18

Cardiomyopathy	9	18
CVA	8	16

Coronary artery disease (CAD) was the most prevalent cardiovascular disease in the study population, affecting 80% (40 patients). Both valvular heart disease and cardiomyopathy were present in 18% (9 patients each). Cerebrovascular accidents (CVA) were observed in 16% (8 patients). This distribution highlights the high incidence of CAD among heart failure patients, with significant occurrences of valvular heart disease, cardiomyopathy, and CVA. Dyspnoea was the most common symptom, experienced by 70% (35 patients). Chest pain was reported by 20% (10 patients), while orthopnoea was present in 4% (2 patients). Other complaints accounted for 6% (3 patients).

Table 3: Distribution of study population based on S. Magnesium levels

S. Magnesium	Frequency	Percentage
1.8-2.5	24	48.0
1.2-1.7	11	22.0
<1.2	15	30.0
Total	50	100.0

Magnesium levels ranged from 0.90 to 2.40 mmol/L, with a mean of 1.6220 mmol/L and a standard deviation of 0.47307 mmol/L. Magnesium levels varied widely, with nearly half of the patients (48%) having normal levels, 22% having mildly decreased levels, and 30% having significantly low levels.

Table 4: Distribution of study population based on Serum sodium, Potassium & creatinine levels

Electrolyte		**Frequency**	**Percentage**
Sodium	Normal	47	94.0
	Low	3	6.0
Potassium	Normal	45	90.0
	Low	1	2.0
	High	4	8.0
Creatinine (mg/dl)	Normal (<1.1)	33	66.0
	1.2-2	12	24.0
	2-3	5	10.0

Most patients had normal sodium and potassium levels, with a small percentage exhibiting abnormality. Specifically, sodium levels were normal in 94% of patients, with 6% experiencing hyponatremia. Potassium levels ranged from 2.90 to 6.00 mmol/L, with a mean of 4.3660 mmol/L and a standard deviation of 0.597 mmol/L. Potassium levels were within normal limits in 90% of patients, while 8% had hyperkalaemia and 2% had hypokalaemia.

Table 5: Distribution of study population based on CAG findings

CAG findings	**Frequency**	**Percentage**
Single vessel disease	5	10.0
Double vessel disease	8	16.0
Triple vessel disease	11	22.0
Normal coronaries	4	8.0
Not done	22	44.0
Total	50	100.0

Coronary angiography (CAG) was conducted on 28 out of the 50 heart failure patients. Among the study population, 10% were found to have single vessel disease, 16% had double vessel disease, and 22% exhibited triple vessel disease. Additionally, 8% of the patients had normal coronary arteries. Notably, CAG was not performed on 44% of the study population, potentially limiting the comprehensive assessment of coronary involvement in a significant portion of the cohort.

Table 6: Comparison of Magnesium levels as per the type of heart failure

Type of Failure	**Mean(mmol/l)**	**SD(mmol/l)**
HFrEF (n=26)	1.2231	.25504
HFpEF(n=24)	2.0542	.17688

t=13.281, p<0.001 (Significant)

In comparing magnesium levels between different types of heart failure based on ejection fraction (EF), the study found significant differences. Patients with Heart Failure with Reduced EF (HFrEF), had a mean magnesium level of 1.2231 mmol/L with a standard deviation of 0.25504

mmol/L. Conversely, patients with Heart Failure with Preserved EF (HFpEF), exhibited a significantly higher mean magnesium level of 2.0542 mmol/L with a standard deviation of 0.17688 mmol/L. Statistical analysis revealed a t-value of 13.281 and a p-value of less than 0.001, indicating a highly significant difference between the groups. These findings suggest that magnesium levels vary significantly between HFrEF and HFpEF patients within the study population.

Table 7: Comparison of Magnesium levels as per the NYHA Class

NYHA Class	Mean (mmol/l)	SD (mmol/l)
Class 2	1.8172	.39103
Class 3/4	1.3524	.45013

t=3.894, p<0.001 (Significant)

When comparing magnesium levels according to the NYHA class, the study revealed significant differences. Patients in NYHA Class 2 had a mean magnesium level of 1.8172 mmol/L with a standard deviation of 0.39103 mmol/L. In contrast, patients in NYHA Classes 3 and 4 had a lower mean magnesium level of 1.3524 mmol/L with a standard deviation of 0.45013 mmol/L. Statistical analysis showed a t-value of 3.894 and a p-value of less than 0.001, indicating a highly significant difference. These findings suggest that higher NYHA class, indicating greater severity of heart failure, is associated with lower magnesium levels within the study population.

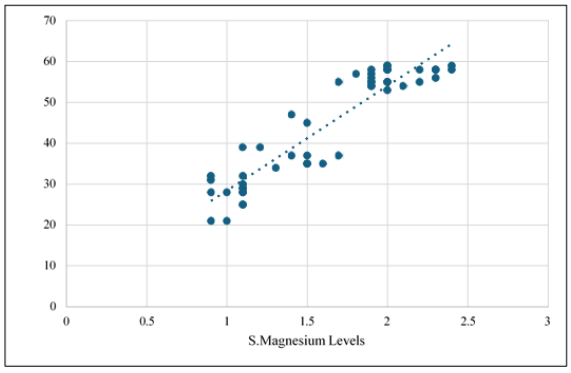

Figure 1: Scatter Plot Comparing Serum Magnesium Levels and Ejection Fraction

The correlation analysis between magnesium levels and ejection fraction (EF) yielded a Pearson correlation coefficient of 0.925, which is statistically significant with a p-value of less than 0.001. This strong positive correlation indicates that higher serum magnesium levels are associated with higher ejection fractions among the study population.

DISCUSSION

Patients with age more than eighteen years were included in the study. Out of fifty cases the most affected is between fifty-one and seventy-five years were 23 in number. Eleven patients were below fifty years. And 16 patients were seventy-five years and older. In a study conducted by kantikar,[11] et al in north india the majority age group is between sixty-one to seventy and followed by fifty-one to sixty. In both studies the majority lies sixty to seventy.

Coronary artery disease is the most prevalent disease among the fifty patient and CAD is seen in fourty of the patients. Second one is mainly due to hypertension and 37 patients had hypertension. Other etiologies include cardiomyopathy and valvular heart disease a small percentage of heart failure is caused by these nine patients each that is eighteen percentage. Study conducted by kantikar etal11noted that majority of patients were having coronary artery disease followed by hypertension. Then valvular heart disease and cardiomyopathy respectively. The result of the current study according to etiology also is concordant with the study.

The most common presenting complaints in the current study is dyspnoea in the total of fifty patients thirty-five patients presented with dyspnoea. Next common symptom was chest pain in ten patients. And other main symptoms include orthopnea in two patients. Study done by nancy,[12] et al has similar findings that most common symptom is dyspnoea nearly eighty percentage followed by orthopnea (forty percentage) and chest pain in eighteen percentage.

Twenty-four patients had normal serum magnesium levels, eleven patients had mildly decreased levels of magnesium and thirty patients of patients had significantly low serum magnesium level. Study done by kantikar,[11] et al found that thirty-six patient had normal serum magnesium levels and fourteen patients had hypomagnesmia that is only twenty eight percentage. In our study a total of fifty-two patients had hypomagnesmia. Comparing with the study we had more hypomagnesmia.

In our study ninety-four patients had normal sodium levels with six percent had hyponatremia. Normal potassium levels were seen in ninety percentage peoples.

Hyper and hypokalemia is seen in two and eight percentage respectively. Creatinine was normal in sixty-six percentage of patients and twenty-four, ten percentage patient's had mild to moderate and more severe renal dysfunction. We had already excluded the stage five chronic kidney disease patients. Studies done by Ceremuzynski,[13] et al has shown that seventy-eight percentage of people had normal potassium levels and fifteen percentage had hypokalemia.

Patients in NYHA class 2 had a mean serum magnesium level of 1.8172mmol/L with a standard

deviation of 0.39103 mmol/L. Patients in NYHA class 3 & 4 had a lower mean magnesium level of 1.3524mmol/L with a standard deviation of 0.45013mmol/L. Statistical analysis showed a t-value of 3.894 and a p-value of less than 0.001, which is significant. Higher the NYHA class lower the serum magnesium levels. Study by kantikar,[11] et al also has findings that serum magnesium levels decreased as class of heartfailure increases.

For analysis the HFmrEF is grouped under HFrEF resulting in 26 patients in HFrEF and 24 patients in HFpEF. In patients with heart failure with reduced EF had a mean magnesium level of 1.2231 mmol/L with a standard deviation of 0.25504mmol/L. HFpEF had a mean magnesium level of 2.0542 mmol/L with a standard deviation of 0.17688mmol/L. Statistical analysis revealed a t-value of 13.281 and a p-value of less than 0.001, which is significant. The current study has a strong positive correlation indicates that heart failure with reduced ejection fraction has lower serum magnesium levels and patients with heart failure with preserved ejection fraction had higher serum magnesium levels compared to the reduced ejection fraction. According to the study conducted by lynette,[14] et al serum magnesium levels are lower in heart failure with reduced ejection fraction. Both the studies have shown that HFrEF has lower serum magnesium levels.

CONCLUSION

Patients with heart failure encounter electrolytes derangement by action of neurohumoral mechanisms and magnesium is one of them. From the above results and discussion, we conclude that heart failure of NYHA class 3 & 4 has lower serum magnesium levels compared to class 2. Those patients with heart failure with reduced ejection fraction has lower serum magnesium levels compared to patients with heart failure with preserved ejection fraction.

REFERENCES

1. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2013;62(16):e147–e239.
2. Ghali JK, Cooper R, Ford E. Trends in Hospitalization for heart failure in the United States, 1973–1986: evidence for Increasing population prevalence. Arch Intern Med. 1990;150:769–773.
3. Douglas L. Mann, Murali Chakinala. Heart failure: Pathophysiology and Diagnosis. Harrison's principles of internal medicine.19th Edition. McGraw-Hill, New York:2015, 1503
4. Packer M. Evolution of the neurohormonal Hypothesis to explain the progression of Chronic heart failure. Eur Heart J. 1995;16:4–6.
5. Dzau VJ. Renal and circulatory Mechanisms in congestive heart failure. Kidney Int. 1987;31:1402–1415.
6. Kurmani S, Squire I. Acute heart failure: definition, classification and epidemiology. Curr Heart Fail Rep. 2017;14:385–392.
7. Enselberg CD, Simmons HG, Mintz AA. The effects of magnesium upon cardiac arrhythmias. Am Heart J. 1950;39:703–12
8. De Baaij JHF, Hoenderop JGJ, Bindels RJM. Magnesium in man: Implications for health and disease. Physiol Rev. 2015;95:1–46
9. Qu X, Jin F, Hao Y, Li H, Tang T, Wang H, Yan W, Dai K.Magnesium and the risk of cardiovascular events: a meta-analysis Of prospective cohort studies. PLoS One. 2013;8(3):e57720
10. Lutsey PL, Alonso A, Michos ED. Serum Magnesium, phosphorus, and calcium are Associated with risk of incident heart Failure: The Atherosclerosis Risk in Communities (ARIC) Study. Am J Clin Nutr. 2014;100:756–64.
11. Kanitkar SS, Baruch L, Kukin ML, Bernstein JL, Fisher ML, Packer M. Prognostic importance of the serum magnesium concentration in patients with congestive heart failure. Journal of the American College of Cardiology. 1990 Oct 1;16(4):827-31.
12. Albert N, Trochelman K, Li J, Lin S. Signs and symptoms of heart failure: are you asking the right questions?. American Journal of Critical Care. 2010 Sep 1;19(5):443-52.
13. Ceremuzynski L., Gebalska J., Wolk R., Makowska E. Hypomagnesemia in heart failure with ventricular arrhythmias. Beneficial effects of magnesium supplementation. Journal of Internal Medicine.
14. Lynette F, Özbeyaz NB, Algül E, Şahan HF. The Effect of Hypomagnesemia on Hospitalization in Preserved Ejection Fraction Heart Failure Patients. The European Research Journal. 2023;9:S43-4.