



A PROSPECTIVE STUDY OF ASSOCIATION BETWEEN SERUM MAGNESIUM LEVELS AND DIABETIC FOOT ULCER GRADES.

Surgery

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ABSTRACT

BACKGROUND: The background for choosing hypomagnesemia for my study in spite of many other electrolyte derangements encountered in Type II Diabetes is that hypomagnesemia is an important factor that alters diabetic foot related complications. Hypomagnesaemia has been described to occur with amplified incidence in patients with type II diabetes mellitus. Magnesium is well-known to be essential for nerve conduction; insufficiency is well-known to cause peripheral neuropathy symptoms and studies propose that a deficit in magnesium could deteriorate blood glucose control in type II diabetes. Researchers rely on that a deficit of magnesium interferes insulin excretion in the pancreas and upsurges insulin resistance in the body's tissues.

Methods: This study conducted in 105 patients who are admitted Department of General Surgery in Government Dharmapuri Medical College Hospital, Dharmapuri, Tamil Nadu in between JAN 2016 and DEC 2016 with Type II DM with diabetic foot are studied.

A detailed history and clinical examination is recorded in all study groups

Diabetic foot ulcers are graded using Wagner classification. Venous blood sample collected after overnight fasting in all diabetic foot patients for serum magnesium. Serum magnesium level done by using colorimetric method. Serum magnesium level correlated with various grades of diabetic foot ulcer.

AIM OF THE STUDY: The aim of this study is to find out the relationship between level of serum magnesium and diabetic foot ulcer grades.

RESULTS: Hypomagnesaemia is one of the most important contributing factors in diabetic foot patients. This study shows that there is a relationship between the level of magnesium and severity of diabetic foot ulcer.

KEYWORDS:

INTRODUCTION

India with approximately 42 million cases is ranked first in the list of the ten nations most affected with diabetes. India is fast emerging as the diabetes capital of the world. A study by the American Diabetes Association reports that India will see the greatest increase in people diagnosed with diabetes by 2030.

Foot ulceration is found to be most common complication among Diabetic patients, affecting almost 15% of diabetic patients in the course of their lifetime. This may be recognized that many social and cultural practices like barefoot walking, poor facilities for diabetes attention and education as well as poor Socioeconomic conditions. Limb amputation has a foremost impact on the individual, not only in changing body image, and likewise with regard to loss of productivity, increasing dependency, and amounts of treating foot ulcers if patients have need of inpatient care. Random qualitative research suggests that diabetic foot ulceration has a profound social impact with patients reporting dishonor, social isolation, loss of social role, and joblessness.

Hypomagnesaemia is well-defined as serum Magnesium concentration less than 1.6 mg/dl or more than two standard deviation- (SD) lower the mean of the overall population. Hypomagnesaemia possibly lead to reduced glycemic control, hypertension, coronary artery disease (CAD), nephropathy, neuropathy and foot ulcerations.

Probable reasons of Hypomagnesaemia in patients with type II Diabetes:

- Reduced intake
- Deprived oral intake
- Esophageal dysfunction
- Diabetic gastroparesis
- Higher gastrointestinal loss
- Diarrhea as consequence of autonomic dysfunction
- Greater renal magnesium loss
- Higher filtered load-Glomerular hyperfiltration
- Osmotic diuresis
- Volume expansion due to disproportionate volume replacement
- Diabetic ketoacidosis
- Hypo-proteinemia-Micro
- albuminuria and manifest proteinuria
- Reduced renal reabsorption Insulin insufficiency or resistance
- Diuretics
- Electrolyte abnormalities: Phosphate and K⁺ depletion

Magnesium is the most important intracellular cation and plays a very vital role in the complex carbohydrate metabolism. It plays a cofactor for greatest enzymatic reaction which needs kinases. It may lead to improved cellular glucose transport, diminished pancreatic insulin secretion, malfunctioning post receptor insulin signaling and changed insulin receptor interactions.

At cellular level, diminished Magnesium levels moreover lead to induction of pro-inflammatory and pro-fibrogenic reaction, reduction of enzymes protecting in contrast to oxidative stress, amplification or induction of micro-vascular modifications in type II diabetic patients. A latest trail showed that people with increased

dietary ingestions of Mg(whole cereals, dry foods ,spinach, coriander) have reduced risk of type II diabetes mellitus. Magnesium has many valuable effects in number of important phases of glucose metabolism and insulin metabolism. Dietary MAGNESIUM supplementation can avert insulin resistance in animal studies.

Many theories show that tissue hypoxia, hyperglycemia and reduced immunity associated with diabetes Mellitus are studied in detail. However, the electrolytic derangement behind development of diabetic foot development is studied less. Sakiro- zgurkeskek et al studied in detail about the association of serum magnesium with diabetic foot. But no other study has yet described the exact relationship between severity of hypomagnesaemia to severity of diabetic foot.

This study is indented to find out relationship between level of magnesium and severity of diabetic foot ulcer using wagners grading

AIM OF THE STUDY

The aim of this study is to findout the relationship between level of serum magnesium and diabetic foot ulcer grades.

OBJECTIVES

1. To assess the incidence of hypomagnesemia in diabetic foot ulcer patients with Type 2 DM.
2. To evaluate the relation of hypomagnesaemia to various grades of diabetic foot ulcer as per Wagner grading in patients with Type 2 DM

DESIGN OF STUDY : Prospective study

PERIOD OF STUDY : One year JAN 2016-DEC 2016

SELECTION OF STUDY SUBJECTS:

Age between 13 and 80 years in both Sexes with diabetic foot ulcers.

DATA COLLECTION: Data regarding history, clinical examination, investigation, outcome

ELIGIBILITY CRITERIA

INCLUSION CRITERIA:

Patients with Type 2 DM with foot ulcers who are admitted in surgery department.

Patients who are willing to participate in study.

EXCLUSION CRITERIA

- Patients <13 years and >80years
- Hepatic failure
- Hypertension
- Renal failure
- Heart failure
- Acute or chronic diarrhea
- Malabsorption syndrome
- Thyroid or Adrenal dysfunction
- Malignancies
- Sepsis

METHODS

This study conducted in 105 patients who are admitted Department of General Surgery in Government Dharmapuri Medical College Hospital, Dharmapuri, Tamil Nadu in between JAN 2016 and DEC 2016 with Type II DM with diabetic foot are studied.

A detailed history and clinical examination is recorded in all study groups Diabetic foot ulcers are graded using Wagner classification. Venous blood sample collected after overnight fasting in all diabetic foot patients for serum magnesium. Serum magnesium level done by using colorimetric method. Serum magnesium level correlated with various grades of diabetic foot ulcer.

STATISTICAL ANALYSIS

All data were entered in Excel 2007 and statistical analysis was performed using the statistical software SPSS 16.0. Data were expressed as frequency (with percentages), mean values (with standard deviations). ANOVA was performed to find the mean differences between groups and Pearsons Chi-square test was used to find the differences between proportions. Correlation co-efficient was used to find the relationship between serum magnesium level and other biochemical parameters. Results were defined as statistically significant when the P value (2-sided) was less than 0.05.

RESULTS AND ANALYSIS

Total number of cases enrolled =105

Number of cases excluded =3

Among three two case lost follow up & One case expired due to myocardial infection

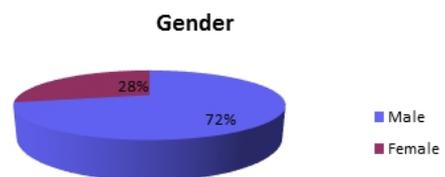
Total number of cases included in study =10

TABLE -1 DEMOGRAPHIC CHARACTERISTICS

	Wagner Classification of diabetic foot ulcer					p-value
	One (n=14)	Two (n=35)	Three (n=32)	Four (n=14)	Five (n=7)	
Age (in yrs)	48.6±8.9	49.9±9.5	57.0±8.5	62.6±5.3	68.4±2.9	<0.001
Gender						
Male	10 (71.4%)	25 (71.4%)	22 (68.7%)	10 (71.4%)	6 (85.7%)	0.937
Female	4 (28.6%)	10 (28.6%)	10 (31.3%)	4 (28.6%)	1 (14.3%)	
Duration of diabetic foot ulcer (in days)	6.7±4.0	9.4±4.9	13.2±4.4	18.4±6.1	19.8±6.3	<0.001

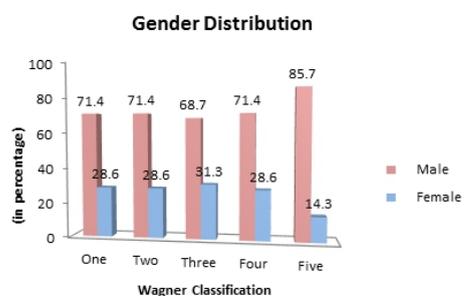
Table shows that relationship between diabetic foot grading with Age, Gender, Duration of diabetic foot. Totally 73 males and 29 female were included. 85.7% Males and 14.3% females have grade 5 diabetic foot. When duration of diabetic foot increases the severity of grading also increases.

CHART-1 GENDER DISTRIBUTION OF CASES



This Pie Chart shows 72% Male & 29% Female patients have participated in our study.

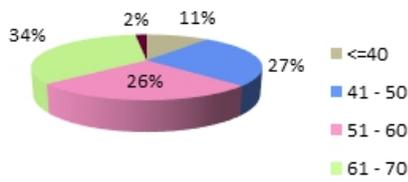
CHART-2 THE RELATION BETWEEN GENDER AND GRADING



This Coloumn Diagram shows increased dominance of Males in grade 5 as compared to other grades of Diabetic ulcers.

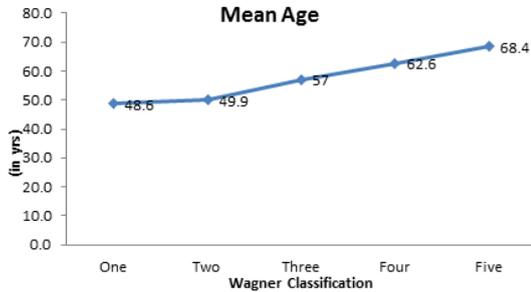
CHART3 AGEDISTRIBUTION

Age Group



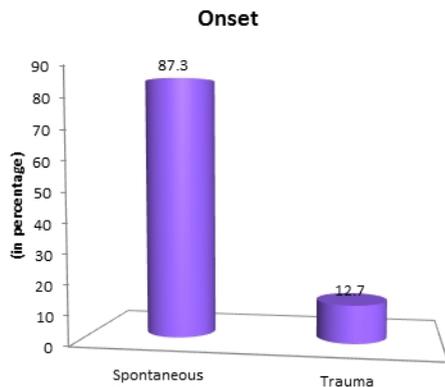
This Pie Diagram shows distribution of age group in our study, most of the cases belong to 61 to 70 years of age group, showing that Diabetic ulcers are more commonly seen in old age.

CHART 4 THE RELATION BETWEEN AGE AND GRADING



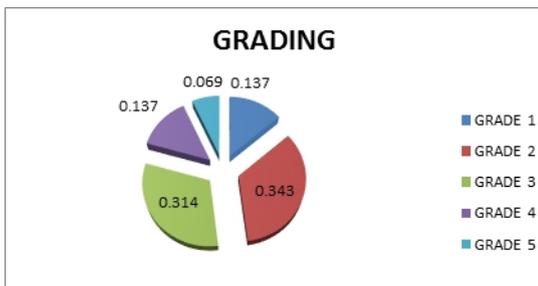
This Line Diagram shows the positive relationship of diabetic foot grading with age group. The above study implies that as the age increases the severity of grading also increases.

CHART 5 PRECIPITATING FACTORS



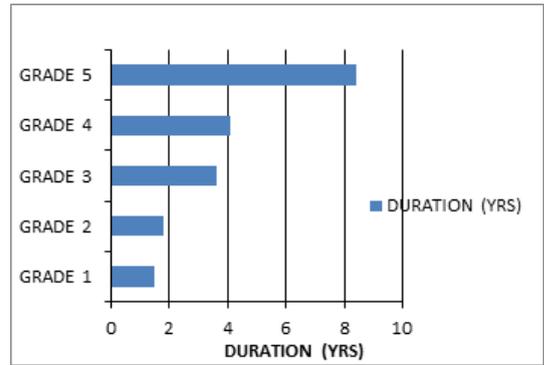
This graph shows that 87.3% patients developed diabetic foot spontaneously, 12.7% patients developed diabetic foot followed by traumatic injury, implying that most commonly Diabetic ulcers are of spontaneous origin rather than of traumatic origin.

CHART 6 FREQUENCY OF WAGNER GRADING



This Pie Diagram shows most of the cases belongs to have grade 2 Wagner classification of diabetic foot.

CHART 7 ASSOCIATION BETWEEN DURATION OF DIABETIC FOOT AND GRADING OF ULCER



Bar Diagram shows that Severity of diabetic foot increases with duration of diabetes.

TABLE 2 CLINICAL FEATURE

Symptoms of Peripheral Neuropathy

	Frequency	Percent
Yes	28	27.5
No	74	72.5
Total	102	100.0

Table shows 27.5% patients has symptoms of diabetic neuropathy.

TABLE 3 INVESTIGATIONS

Sugar

	Frequency	Percent
Nil	2	2.0
1+	32	31.4
2+	47	46.1
3+	21	20.6
Total	102	100.0

Table shows >98 % of cases have albuminuria at the time of examination.

TABLE 4

Albumin

	Frequency	Percent
Nil	9	8.8
1+	58	56.9
2+	31	30.4
3+	4	3.9
Total	102	100.0

Table shows 90.2% cases have albuminuria.

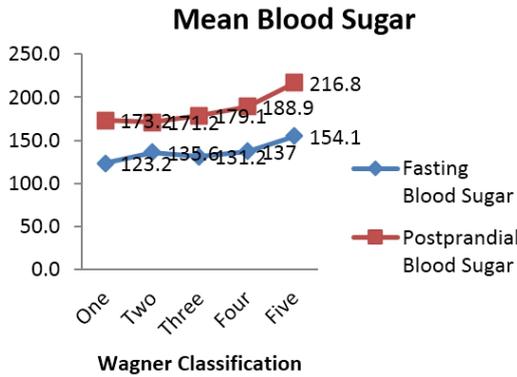
TABLE 5 BIOCHEMICAL MEASUREMENTS

	Wagner Classification of diabetic foot ulcer					p-value
	One (n=14)	Two (n=35)	Three (n=32)	Four (n=14)	Five (n=7)	
Serum Magnesium (in mg)	1.7±0.3	1.5±0.3	1.2±0.2	1.0±0.3	0.7±0.1	<0.001
Fasting Blood Sugar	123.2±14.2	135.6±12.7	131.2±18.1	137.0±20.8	154.1±8.8	0.001
Postprandial Blood Sugar	173.2±34.9	171.2±14.5	179.1±19.8	188.9±20.5	216.8±20.0	<0.001

Blood Urea (in mg)	30.2±6.5	34.3±6.8	35.5±7.2	40.7±6.4	45.1±10.2	<0.001
Serum Creatinine (in mg)	1.0±0.2	1.1±0.2	1.3±0.2	1.6±0.3	1.9±0.4	<0.001

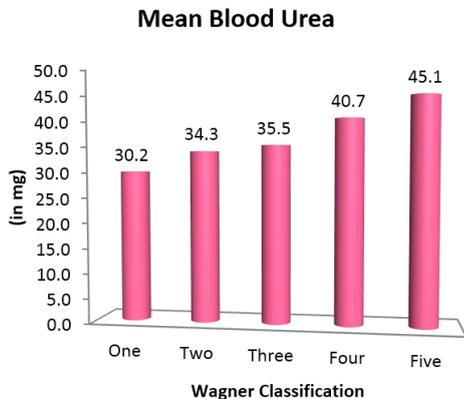
Table shows the relationship between wagner grading to blood sugar, urea and creatinine

CHART-8 RELATIONSHIP BETWEEN WAGNER GRADING AND BLOODSUGAR



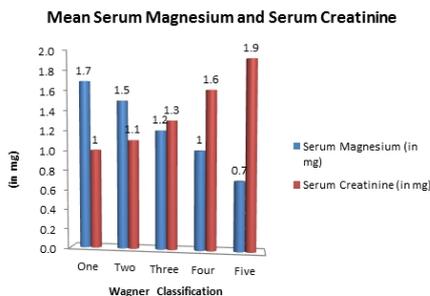
Grade 5 diabetic foot cases have high fasting and postprandial blood sugar than Grade 1 cases. Fasting and postprandial blood sugar have positive relationship with diabetic foot severity.

CHART 9 RELATIONSHIP BETWEEN WAGNER GRADING AND UREA



Column Diagram shows serum urea has positive relationship diabetic foot grade.

CHART 10 RELATIONSHIP BETWEEN WAGNER GRADING AND SERUM MAGNESIUM AND CREATININE



Column Diagram shows that serum magnesium has a NEGATIVE relationship with diabetic foot grading. Serum creatinine has positive relationship with severity of diabetic foot.

TABLE -6 SERUM MAGNSEIUM AND WAGNER GRADING

Serum Magnesium Level (in mg)	Wagner Classification of diabetic foot ulcer					p-value
	One	Two	Three	Four	Five	
<1	-	3 (8.6%)	1 (3.1)	4 (28.6)	7 (100.0)	<0.001
1 – 1.3	-	7 (20.0%)	19 (59.4)	9 (64.3)	-	<0.001
1.4 – 1.6	6 (42.9)	14 (40.0)	9 (28.1)	-	-	<0.001
>1.6	8 (57.1)	11 (31.4)	3 (9.4)	1 (7.1)	-	<0.001
Total	14 (100.0)	35 (100.0)	32 (100.0)	14 (100.0)	7 (100.0)	<0.001

Serum magnesium deficiency classified as Mild (1.4-1.6), Moderate (1-1.3), severe (<1). From table severe serum magnesium deficient cases have grade 5 diabetic foot. Serum magnesium level negative correlation with diabetic foot grade. It was statistically significant.

CHART 11 ASSOCIATION BETWEEN SERUM MAGNESIUM LEVEL AND DIABETIC FOOT

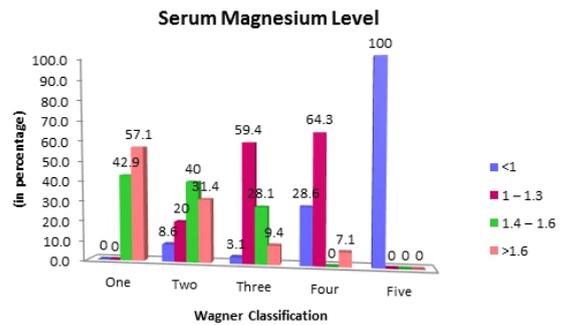


Diagram shows that all the cases with severe magnesium deficiency belong to Wagner grade 5. As the deficiency of Magnesium increases severity of Diabetic foot grade also increases.

TABLE - 7

	Frequency	Percent
Normal	85	83.3
Abnormal	17	16.7
Total	102	100.0

16.7% Patients has associated Peripheral Neuropathy.

TABLE 8

	Frequency	Percent
Normal	93	91.2
Abnormal	9	8.8
Total	102	100.0

8.8% Patients has associated Peripheral vascular diseases

DISCUSSION

105 cases were taken up for this study. Among them two cases lost follow up. One case died due to Myocardial infarction. So, as a whole 102 cases were studied and analyzed.

AGE

All cases included in the study are above 13 years of age. Most of the cases belong to age group of 61-70 years. The minimum age taken into consideration is 38 years and maximum age is 72 years. This study shows that diabetic foot severity increases with increasing Age group.

SEX

Among 102 cases studied 73 were Male and 29 were female. The study shows male cases are more prone for diabetic foot as compared to female cases.

DURATION OF DIABETES

Duration of diabetes (years) has negative correlation (correlation coefficient -0.644) with serum magnesium level. It has statistically significant <0.001.

DURATION OF DIABETIC FOOT

Duration of diabetic foot (days) has negative correlation with serum magnesium level (correlation coefficient -0.570). It has statistically significant <0.001. But, the Haquea et al. study concluded that the serum magnesium level has no direct relationship with the duration of DM.

PRECIPITATION FACTOR

87.3% patients developed diabetic foot spontaneously, 12.7% patients developed diabetic foot followed by traumatic injury.

SYMPTOMS OF PERIPHERAL NEUROPATHY

27.5% Cases has symptoms of peripheral neuropathy.

INVESTIGATIONS

More than 98% Cases has glycosuria, 91.2% cases has albuminuria. Osmotic diuresis associated with glycosuria and reduced renal absorption is the reason for hypomagnesaemia.

Fasting blood sugar has negative correlation (correlation coefficient -0.313) with serum magnesium. It is statistically significant (P value 0.001).

ŞakirÖzgür Keşkek et al observed that there was an inverse correlation between the magnesium levels and serum fasting glucose levels in diabetic foot cases (P value 0.001).

Postprandial blood sugar inverse correlation (correlation coefficient -0.331) with serum magnesium. It is statistically significant (P value 0.001).

Blood urea has inverse correlation (correlation coefficient 0.484) with serum magnesium. It is statistically significant (P value <0.001).

Serum creatinine has inverse correlation (correlation coefficient -0.482) with serum magnesium. It is statistically significant (P value <0.001).

HYPOMAGNESEMIA

In our study most of the cases with severe magnesium deficiency belong to Wagner grade 5. Serum magnesium has inverse correlation with severity of diabetic foot grade. It is statistically significant (P value <0.001).

ŞakirÖzgür Keşkek et al observed that serum magnesium levels of the patients with diabetic foot ulcers were lower than those patients, with diabetes without foot ulcers and in the healthy subjects (p<0.001).

Low magnesium levels were reported in cases with diabetic foot by the Srinivasan et al. Additionally, Rodriguez-Moran et al. reported low serum magnesium levels in diabetic foot cases compared to the controls; however, these results did not reach statistical significance.

In the Dasgupta et al. study, a high incidence of foot ulcers in patients with hypomagnesaemia was seen when compared to the controls (58.8% vs. 22.5%).

In a similar study Keskek et al noted a strong correlation between hypomagnesaemia and diabetic foot ulcer (P<0.001).

Our study reinforces the previous study results as hypomagnesaemia

in diabetic cases have strong relation to develop diabetic foot ulcer

LIMITATIONS

The nutritional levels of all of the subjects were not the same; therefore, we could not know how much magnesium each participant received daily. Control group were not included. It would have been beneficial if the sample size had been larger.

CONCLUSION

Hypomagnesaemia is a one of the most important contributing factor in diabetic foot patients.

This study shows that there is a relationship between the level of magnesium and severity of diabetic foot ulcer.

As available information suggests that prudent outcomes are associated with hypomagnesaemia, it is prudent that magnesium levels are to be monitored in diabetic foot patients.

Further studies on the role of magnesium supplementation in type 2 diabetes in wide population are recommended to avoid further amputations and limb impairment.

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