SHORT COMMUNICATION

Study of Serum Magnesium in Surgical Stress

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Abstract:

Background: A deficiency of magnesium is of clinical importance in hospitalized patients. The prevalence of hypomagnesaemia is high in critically ill patients. Knowing the important role of magnesium in surgical cases, it is necessary to anticipate and diagnose magnesium deficiency prior to surgery and in the immediate postoperative period to correct it. *Aims and Objectives:* The aim of this study was to analyse serum magnesium levels in patients undergoing emergency surgical procedures, planned surgical procedures and normal healthy matched controls and to compare the serum magnesium levels in all the three groups. *Materials and Methods:* The study participants were divided into three groups: i) Group I: patients undergoing emergency major surgery ii) Group II: patients undergoing planned major surgery iii) Group III: normal healthy controls. Serum Magnesium investigation was done by Xylidyl Blue Method using UV-1800/Shimadzu UV-Spectrophotometer. *Results:* The mean serum Magnesium in control group was found to be 2.16 ± 0.30 mg/dl. In patients undergoing planned surgery, pre-operative serum magnesium was normal (2.16 ± 0.22 mg/dl) but decreased significantly on postoperative day 3 (1.63 ± 0.27 mg/dl) and day 6 (1.97 ± 0.12 mg/dl) and returned to normal level by post-operative day 9 (2.14 ± 0.14 mg/dl) compared to controls. In patients undergoing emergency surgery, serum magnesium was decreased pre-operatively (1.90 ± 0.48 mg/dl).Further significant reduction was found at post-operative day 3 (1.38 ± 0.28 mg/dl), day 6 (1.59 ± 0.30 mg/dl) and day 9 (1.88 ± 0.46 mg/dl) compared to controls. Mean serum Magnesium overall in emergency surgery patients was reduced significantly compared to planned surgery patients. *Conclusion:* A transient fall in the serum Magnesium as compared to its pre-operative level was seen in every patient undergoing surgical procedure due to surgical stress. In patients undergoing emergency surgical procedure, the decrease was significant and continued post-operatively till 9th day compared to planned surgery patients.

Keywords: Emergency Surgery, Planned Surgery, Hypomagnesaemia, Oxidative stress

Introduction:

Electrolyte metabolism and its alteration, in relation to clinical features, is a subject of modern interest. Magnesium has an important role in the regulation of blood concentration of neuro-hormones, catecholamines. These neurohormones are part of the body's natural stress response. Unregulated release of these hormones due to hypomagnesaemia leads to a state of oxidative stress [1]. When the serum magnesium level of patient undergoing surgery is lower than normal, then a further decrease in the serum magnesium level induced by the surgical stress, may become enough to precipitate symptomatic magnesium deficiency, increasing morbidity and convalescence period [2-4]. Hypomagnesaemia has been associated with poor prognosis and increased mortality in the acutely ill [5-7].Thus knowing the importance of role of magnesium in surgical cases, it becomes necessary to anticipate and diagnose magnesium deficiency prior to surgery and in immediate postoperative period to correct it.

Material and Methods:

The present study was hospital based cross-sectional study, conducted by Department of Biochemistry and Department of Surgery, SMBT IMS and RC, Dhamangaon, Nashik, over a period of 6 months. The study was approved by Institutional Ethics Committee.

Sample size calculation:

With the help of statistician of PSM department of SMBT IMS & RC, the sample size was calculated by using the formula:

Sample size (n) = $4pq/E^2$

Where,

p=Prevalence rate/ Proportion = 0.015 (1.5%). Calculated according to the patients data obtained from SMBT Institute of Medical Sciences & Research Centre, Dhamangaon-Ghoti, situated in a rural area of Nashik district for serum Magnesium analysis.

q= 1-p: 1-0.015= 0.985

E= Allowable error 5% = 0.05

Sample size (n) = $4pq/E^2$

$= 4 \times 0.015 \times 0.985 / (0.05)^2$

$= 0.0591 / 0.0025$

$= 24$ (Approximate)

Participants of the study were divided into three groups.

1. Group I consisted of 30 patients in the age group of 20 to 59 years admitted in the department of surgery of SMBT IMS and RC, Dhamangaon for undergoing emergency surgical procedure.
2. Group II consisted of 30 patients in the age group of 20 to 59 years admitted in the department of surgery of SMBT IMS and RC, Dhamangaon for undergoing planned surgical procedure.
3. Group III included age and sex matched 30 healthy controls.

Inclusion Criteria:

Group I: Laparotomy for G.I. tract perforation/ intestinal obstruction, emergency appendicectomy, urinary tract complications, crush injury, amputation for gangrene of leg, infective gangrene of skin.

Group II: Subtotal thyroidectomy, prostatectomy, operations on urinary tract, planned appendicectomy, repair of hernias, stomach and duodenal complication surgery, cardio-thoracic surgery.

Group III: Normal healthy age and sex matched volunteers.

Exclusion criteria:

Hypoparathyroidism; malignancies; diabetics under treatment; chronic pancreatitis; severe starvation; malabsorption; Crohn's disease; ulcerative colitis; Patients on diuretics, proton pump inhibitors, digitalis, adrenergic; Human Immunodeficiency Virus (HIV) and Hepatitis B surface Antigen (HBsAg) positive.

Procedure:

5 ml venous blood sample was collected pre-operatively and on post-operative days 3, 6 and 9 from the patients and at one time from controls after taking valid consent. Blood samples were collected in a plain bulb for estimation of serum magnesium. Estimation was done by Xylidyl Blue Method [8] using UV-1800/Shimadzu UV-Spectrophotometer with the normal range 1.7 to 2.2 mg/dl.

Statistical Analysis:

Quantitative data was represented as Mean±SD. Statistical analysis was done using SPSS software version 17. $P < 0.05$ was considered statistically significant.

Result:

Table 1 and Table 2 represent the mean serum magnesium levels in patients undergoing various emergency and planned surgeries respectively.

Mean serum magnesium level in control group was found to be 2.16 ± 0.30 mg/dL. When mean serum Magnesium levels in emergency surgical cases were compared with the controls, no significant difference was observed between pre-operative levels (1.90 ± 0.48 mg/dl) and the control levels (p=0.057). However, the values at post-operative day 3(1.38 ± 0.28 mg/dl) (p=0.0001), day 6 (1.59 ± 0.30 mg/dl) (p=0.0001) and day 9 (1.88 ± 0.46 mg/dl) (p=0.0009) in emergency surgery group were decreased significantly as compared to controls (Table 3). Similarly when mean serum Magnesium levels in planned surgical cases were compared with the controls, no significant difference was observed between pre-operative levels (2.16 ± 0.22 mg/dl) and the controls (p=1.00). However, mean serum Magnesium levels at post-operative day 3 (1.63 ± 0.27 mg/dl) (p=0.0001) and day 6 (1.97 ± 0.12 mg/dl) (p=0.0021) were reduced significantly and returned to normal by day 9 (2.14 ± 0.14 mg/dl) (p=0.74) in planned surgery group when compared with the controls (Table 4).

Table 5 represents the comparison between pre-operative and post-operative mean serum Magnesium levels in emergency surgery group and planned surgery group. It was found that mean serum Magnesium levels at pre-operative (p=0.0091) and post-operative day 3 (p=0.0008), day 6 (p=0.0001) and day 9 (p=0.0044) were decreased significantly in patients undergoing emergency surgical procedures as compared to patients undergoing planned surgical procedure.

In the present study, out of 30 patients undergoing emergency surgery, 23 (76%) patients had decreased serum magnesium on post-operative day 3, 18 (60%) patients had reduced serum magnesium on day 6 and 10 (33%) patients showed decreased values on day 9. In comparison, out of 30 patients undergoing planned surgery, 18 (60%) patients had decreased magnesium levels at post-operative day 3, 11 (36%) patients showed reduced levels at day 6 and 2 (6%) patients had decreased levels at day 9.

At critical serum magnesium values below 1.2 mg/dL, symptomatic magnesium deficiency in the form of symptoms like mental confusion, muscular weakness, irritability, tremors and ataxia was observed. In our study, 8 (23%) cases in emergency surgery group had critical (symptomatic) magnesium deficiency and 4 (12%) cases in planned surgery group had critical magnesium deficiency.

Table 1: **Mean Serum Magnesium levels in Patients Undergoing Various Emergency Surgeries**

Surgery	**Pre-operative**	**Post-operative**		
Types	**Day 0**	**Day 3**	**Day 6**	**Day 9**
Laparotomy for GI complications (7)	1.93 ± 0.35	1.27 ± 0.26	1.43 ± 0.19	1.77 ± 0.19
Emergency appendicectomy (7)	2.85 ± 0.22	1.8 ± 0.38	2.1 ± 0.28	2.74 ± 0.25
Urinary tract complications (4)	1.8 ± 0.20	1.53 ± 0.12	1.83 ± 0.25	1.87 ± 0.31
Below knee amputation for gangrene of leg (4)	1.69 ± 0.09	1.42 ± 0.06	1.45 ± 0.05	1.38 ± 0.25
Crush injury (4)	1.58 ± 0.42	1.3 ± 0.14	1.4 ± 0.04	1.8 ± 0.42
Infective Gangrene of skin (4)	1.6 ± 0.07	0.95 ± 0.35	1.35 ± 0.35	1.7 ± 0.42

Number of cases is given in parentheses, Data expressed in Mean ± SD (mg/dl)

Table 2: Mean Serum Magnesium Levels in Patients Undergoing Various Planned Surgeries

Type of surgery	Pre-operative	Post-operative		
		Day 3	Day 6	Day 9
Subtotal thyroidectomy (4)	2.29 ± 0.71	1.93 ± 0.63	2.1 ± 0.63	2.1 ± 0.62
Prostatectomy (6)	1.79 ± 0.89	1.13 ± 0.71	1.69 ± 0.52	1.95 ± 0.47
Urinary tract complications surgery (5)	1.99 ± 0.50	1.49 ± 0.14	1.71 ± 0.11	1.98 ± 0.32
Stomach and duodenum complications surgery (5)	2.39 ± 0.56	1.83 ± 0.43	2.05 ± 0.55	2.21 ± 0.45
Planned appendicectomy (4)	2.2 ± 0.4	1.8 ± 0.35	1.67 ± 0.23	2.2 ± 0.35
Cardio-thoracic surgery (3)	2.37 ± 0.78	1.57 ± 0.21	1.88 ± 0.39	2.4 ± 0.4
Exploratory laparotomy (3)	2.12 ± 0.68	1.66 ± 0.59	1.64 ± 0.32	2.04 ± 0.61

Number of cases is given in parentheses, Data expressed in Mean ± SD (mg/dl)

Table 3: Comparison between Mean Serum Magnesium Levels in Patients Undergoing Emergency Surgeries and Controls

Group	Pre-operative	Post-operative		
	Day 0	Day3	Day 6	Day 9
Emergency surgery	1.90 ± 0.48	1.38 ± 0.28	1.59 ± 0.30	1.88 ± 0.46
Controls	2.16 ± 0.30	2.16 ± 0.30	2.16 ± 0.30	2.16 ± 0.30
P value	0.057	0.0001**	0.0001**	0.0009**

Data expressed in Mean ± SD (mg/dl), p<0.05- Statistically significant p<0.001**- Highly significant*

Table 4: Comparison between Mean Serum Magnesium Levels in Patients Undergoing Planned Surgeries and Controls

Group	Pre-operative	Post-operative		
	Day 0	Day 3	Day 6	Day 9
Planned surgery (II)	2.16 ± 0.22	1.63 ± 0.27	1.97 ± 0.12	2.14 ± 0.14
Controls (III)	2.16 ± 0.30	2.16 ± 0.30	2.16 ± 0.30	2.16 ± 0.30
P value	1	0.0001**	0.0021*	0.74

Data expressed in Mean ± SD (mg/dl), p<0.05- Statistically significant p<0.001**- Highly significant*

Table 5: Comparison between Pre-Operative and Post-Operative Serum Magnesium Levels in Emergency and Planned Surgical Cases

Group	Pre-operative	Post-operative		
	Day 0	Day 3	Day 6	Day 9
Emergency surgery (I)	1.90 ± 0.48	1.38 ± 0.28	1.59 ± 0.30	1.88 ± 0.46
Planned surgery (II)	2.16 ± 0.22	1.63 ± 0.27	1.97 ± 0.12	2.14 ± 0.14
	p=0.0091*	p=0.0008**	p=0.0001**	p=0.0044*

Data expressed in Mean ± SD (mg/dl), p<0.05- Statistically significant p<0.001**- Highly significant*

Discussion:

Magnesium is a vital cation in the body. Hence, when serum magnesium depletion occurs, its detection, confirmation and correction becomes necessary. In the present study, serum magnesium level was estimated in 30 patients undergoing emergency surgery (Group I), 30 patients undergoing planned surgery (Group II) and 30 healthy controls (Group III). Then the mean serum magnesium values were compared among the three groups.

Findings similar to the present study were also reported in the studies conducted by Cordova *et al.* [2], Purohit *et al.* [3], Kiran *et al.* [5], Djabletey *et al.* [6] and Hasan *et al.* [7].

Patients undergoing major surgery are under considerable stress, which is worse in emergency surgeries than planned surgeries. Secondly, in all these cases, stress involves the endocrine system which releases corticosteroid hormones [9]. Mineralocorticosteroids increase the renal excretion of magnesium [10] which may lead to the development of hypomagnesaemia. Magnesium serves to regulate the blood levels of catecholamines, epinephrine and nor-epinephrine. These hormones are a part of the body's natural stress response. In magnesium deficient patients, unregulated release of these hormones leads to further precipitation of oxidative stress [1]. Hence chances of developing symptomatic magnesium deficiency are increased in these patients. This development of symptomatic magnesium deficiency in these surgical patients increases the morbidity and convalescence period [2, 3]. Hypomagnesaemia has also been associated with poor prognosis and increased mortality in acutely illness [5, 6].

Conclusion:

A transient fall in serum magnesium level was seen in every patient undergoing major surgery, but a profound and continued reduction was seen in patients undergoing emergency surgery as compared to patients undergoing planned surgery. Therefore early detection of magnesium deficiency and prompt treatment of the deficiency becomes necessary to reduce the morbidity and duration of convalescence in surgically stressed patients Further studies are required in Indian scenario to deduce whether timely treatment of magnesium deficiency in such surgical stress patients can lessen the morbidity and mortality.

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