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"Observations of Serum Magnesium Levels in Major Burns"

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Abstract: *To observe the Serum magnesium levels in 25 cases of major burns. 25 cases of Major burn of varying degree from different ages & sex admitted in Burn ward of Rajendra Institute of Medical Sciences, Ranchi were taken up for study. Local assessment of percentage & depth of burn was done. General examination & Investigation of serum electrolyte (magnesium) was estimated on day 10. The type of intravenous fluid given, duration and other treatments were recorded. All patients were followed up for neuro-muscular and mental symptoms.*

Result: *Serum magnesium was estimated on 10th day and it was found to be low. Magnesium therapy was given either orally or intravenously. The effect of magnesium deficiency on the development of mental symptoms and gastrointestinal upset were noted and their responses to magnesium administration were also noted.*

Conclusion: *The range of serum magnesium in the present series was found to be 1.5 to 2 meq/l, and the mean 1.676±0.44 mEq/L. No variation was found to exist between different ages and different sexes. 48% cases had hypomagnesaemia and 32% had magnesium deficiency syndrome. All patients having serum magnesium levels between 0.5 to 0.75mEq/L and >80% of those having 0.75 to 1.0 mEq/L developed symptoms of magnesium deficiency.*

The treatment of hypomagnesaemia with magnesium in concentration of 5mEq/L in multi-electrolyte solution may be helpful in preventing hypomagnesaemia and magnesium deficiency syndrome.

Keywords: *Serum Magnesium levels, Major Burns, Hypomagnesaemia, and Magnesium deficiency syndrome.*

I. Introduction

A burn is a thermal injury from thermal application, or from the absorption of physical energy or chemical contact. Clinically the severity of the burn is estimated from the area of the burned surface and the depth of the burn wound, the age of the patient and associated medical problems. As a rule an adult with more than 20% or the child with 10% of the body surface area involved is major burn and will require intravenous fluid replacement (Bailey & Love's 2008). Burn is a Major form of physical as well as mental trauma which needs intensive management in specialized burn units. In spite of vigorous treatment with intravenous fluids, antibiotics, analgesics, antacids major burns cases have high mortality & morbidity. Burns have been classified by the American Burn Association and the American College of Surgeons Committee on trauma as Minor, Moderate, and Severe. Minor burns are superficial burns of less than 15 percent of total body surface area. Moderate Burns are defined as 15 to 25 percent of total body surface area in adults or 10 to 20 percent in children: full thickness burns of less than 10 percent total body surface area and burns not involving the eyes, ears, face, hands, feet, or perineum. Major Burns as described above and most full thickness burns in infants & elderly patients be treated in specialized care facilities.

Superficial burns heal themselves by epithelisation alone. Epidermal burns look red are painful, blisters are not present and heal rapidly without sequelae. Superficial dermal burns are blistered and painful they heal by epithelisation within 14 days without scarring. Deep burns have lost all adnexal structures and if left heal by second intention with scarring. They are blistered and have a blotchy red appearance with no capillary return on pressure and absent sensation to pin-prick. Full thickness burns have a white or charred appearance with absent sensation. This charred layer consists of denatured contracted dermis called an eschar.

Burns may be caused by hot water (scalds), fat burns, flame burns, electrical burns, friction burns, chemical burns, cold injury and ionizing radiation burns. On arrival, a major burn case should be treated like any trauma case with priorities in the following order.

A. Airway maintenance
B. Breathing and ventilation
C. Circulation
D. Disability-neurological status
E. Exposure and environmental control- keep warm
F. Fluid resuscitation

There is heavy fluid and electrolyte loss due to vomiting and exudation from burned skin surface. Therefore fluid replacement in the form of Ringer lactate or Hartmann's solution plays a sheet anchor role in the first 24 hour since the time of burn and later also. Among electrolyte Ringer lactate replaces cations like Na^+, K^+,Ca^{++}, ions and anions Cl^- and HCO^{3-} except Magnesium ions. Magnesium is an important cation and there is a fall in serum magnesium level in the first week or beginning of second week of major burn (Brezina and Zumen 1958). Broughton published his series on burn cases in 1968 in which he found significant fall in serum magnesium in 40% of his cases and 26% showed symptoms of magnesium deficiency. Low serum magnesium has been reported by various workers like Thomas (1971) & Tehrani et al (1974).

Since the beginning of the 19th century Humphrey Davy first pointed out the importance of magnesium for living beings. Magnesium is involved in diverse functions such as cell adhesion, metabolism of proteins, carbohydrates, and nucleoproteins. The total body count of Magnesium in the average adult varies between 21 to 29 grams, approximately 2000mEq, about half of which is bound to bones, 45 % occurs intracellularly and the rest is found in extracellular compartment. Serum Magnesium concentration normally ranges from 1.5 to 2.5 mEQ/L. (Christopher 1972). The normal dietary intake of Magnesium is approximately 20 mEq (240mgdaily). Magnesium deficiency is known to occur with starvation malabsorption syndrome, protracted losses of gastrointestinal fluid, prolonged intravenous fluid therapy with magnesium free fluids and during total parenteral nutrition with inadequate magnesium. Other causes include acute pancreatitis, chronic alcoholism, primary aldosteronism, amphotericin B therapy and protracted course of thermal injury.

The Magnesium ion is essential for proper function of most energy systems, and depletion is characterized by neuromuscular and central nervous hyperactivity. The signs and symptoms are similar to calcium deficiency including hyperactive tendon reflex, muscle tremors and tetany with a positive Chvostek's sign. Progression to delirium and convulsions may occur with severe deficit. Paroxysmal ventricular dysrthymias and repolarisation alternans may also occur. The diagnosis of magnesium deficiency depends on the awareness of the syndrome and clinical recognition of the symptoms. Laboratory confirmation is available. Magnesium deficiency is correctible hence serum levels should be investigated in burn patients and magnesium therapy started if found lower. Magnesium deficiency in burn patient is to be corrected by proper Magnesium therapy by oral and parental route in appropriate doses. If renal functions are normal, magnesium sulphate or magnesium chloride is given intravenous or intramuscular in a dose of 2 mEq per Kg of body weight per day. Oral magnesium chelates- glycinate, lysinate, or amino acid chelates can be given at divided doses of 200-400mg (Krispin Sullivan, 1997). Magnesium should not be given to oliguric patients or in severe volume deficit unless actual magnesium has been found.

Aims of Study:

- Study the serum magnesium levels in major burns and evaluate the outcome of treatment of burn patients in terms of morbidity & mortality.
- Study the varying se magnesium levels in the different stages of major burns,
- *Evaluate the effects of hypomagnesaemia in burn patients.
- To formulate a strategy for the supplementation of magnesium ions for a quick and better recovery of burn patients.

II. Material And Methods

The Method which was followed in this series of cases is that of calorimetric method using Titan yellow as precipitating agent. Neil and Nelly 1956 modified earlier method by using gum ghatti as the colour stabilizer and included calcium in the standard. Reading; reading of the standard and unknown serum were taken in calorimeter making the readings of the test blank to the be of zero density, using a green filter or with the calorimeter set at 520 mill microns.

Calculations : Magnesium (mg) per 100ml of serum

$$= \frac{\text{Reading of Unknown}}{\text{Reading of Standard}} \times 2.5$$

III. Results

Based on the observation the normal level of serum magnesium ranges from 1.5-2.0 mEq/L. All patients having serum Magnesium levels between 0.5-0.75 mEq/L and >80% of those having 0.75-1.0 mEq/L developed symptoms. None of the cases having values more than 1.25mEq/l developed magnesium deficiency syndrome. The treatment of magnesium deficiency was successful in most cases except in death

IV. Discussion

In the present study, 25cases of burn of which 60% of the cases were females and 40% were males as shown in Table 1. Besides the burn patients a control group of 20 patients have studied . McNeil (1976) has published a review of 1600 cases in which 60% were males and only 40% were females. The preponderance of females in the burn series in this study is because of the facts that in our country women are doing the cooking work over the traditional; open hearth, wearing loose flowing garments like saris. In western countries where cooking has become less hazardous due to the prevalence of gas or electric stoves, and the relatively tight dresses worn by the cooks.

The present study found that approximately 36% of the cases were children (9), 62% were young adults (13), and 2% were the age of 40 years (3) . McNeil (1976) found that most of his patients approximately 44% were children (1-14 years), 30% were young adults and the rest were on the wrong side of 40 years. The prominence of young adults in the present series is because of the fact that they are most active and hence more prone to such accidents. The excess of children in McNeil may be due to the negligence of parents in western families in early aged children and due to bound less curiosities and fascinations of crawling and walking child.

The range of serum magnesium in the present study was found to be 1.5 to 2.0 mEq/l, and the mean 1.676±0.44 mEq/L. No variation was found to exist between different ages and sexes as per the Table 6. A range of 1.8mEq/L to 2.5mEq/L has been mentioned by Harrison's (principles of internal medicine) however varying ranges have been reported in literature by various reporters, from as low as 1.4meq/l to as high as 2.5meq/L. In the author's series 52.9% of cases had serum magnesium levels in the normal range (mean being 1.67mEq/L) as per Table 6. 47.1% had significantly decreased se magnesium levels. 64% of those who had hypomagnesaemia. My observations are within standard limits. In the present study severity of burn was found to have no role in the production of magnesium deficiency syndrome. Of 12 cases where serum magnesium levels were low 50% were noted in 1^{st} week, 25% in 2^{nd} week, 16.6% in 3^{rd} week, and 8.34% in 4^{th} week as in Table 4.

In the present study the cases of hypomagnesaemia were treated as soon as they were detected. Magnesium levels returned to normal after 4-5 days of treatment. Maximum % (40%) was detected in 1^{st} week. By 4^{th} &5^{th} weeks many cases of severe burn died and good number of moderate burn were cured. Hence the consequent decrease of hypomagnesaemia as in Table 5. In contrast to the finding that the hypomagnesaemia predominates the 1^{st} two weeks after burn, the symptoms were noted to the most predominant in 2^{nd} (37.5%) and 3^{rd} weeks (37.5%) after burn. It goes therefore that depletion of magnesium to the extent of production of symptoms occur only after the lapse of some time. Thus in the present series the symptoms were more around third week as shown in Table 4. In the present study none of the burn cases having serum magnesium levels above 1.25 mEq/l exhibited any symptoms of magnesium deficiency. All the cases having values between 0.5 to 0.75 MEq/L had some or the other symptoms as per Table 2.

The present study showed dramatic improvement by magnesium therapy by oral (magnesium chelates-glycinate, lysinate or amino acid chelates or parenteral route (magnesium sulphate). Symptoms ameliorated and serum magnesium levels rose to normal following supplementation in 80% of cases. Result could not be assessed in 20% cases due to death of patients. The author is of the opinion that magnesium in serum estimations should be made in a routine way as other electrolytes in burn cases.

V. Conclusion

The range of serum magnesium in the present series was found to be 1.5 to 2 meq/l, and the mean 1.676±0.44 mEq/L. No variation was found to exist between different ages and different sexes. 48% cases had hypomagnesaemia and 32% had magnesium deficiency syndrome. All patients having serum magnesium levels between 0.5 to 0.75mEq/L and >80% of those having 0.75 to1.0mEq/L developed symptoms of magnesium deficiency. Table 4A. The treatment of hypomagnesaemia with magnesium in concentration of 5mEq/L in multi-electrolyte solution may be helpful in preventing hypomagnesaemia and magnesium deficiency syndrome. Serum magnesium levels should be monitored in burns and like conditions where parenteral alimentation is required for longer duration requiring magnesium therapy.

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Table 1: Age & sex distribution in cases of major burns (15-40%) in adults and 10-20 % in children

Age group (years)	Male		Females	
	No of cases	Percentage	No of cases	Percentage
0-12	6	13.34	2	4.45
12-25	2	4.45	8	17.78
25-40	2	4.45	2	4.45
40-60	-	-	3	6.67
Total	10		15	

Table2: Mean serum magnesium levels in normal cases & cases of burn (n=45)

Type of cases	Mean serum magnesium levels (mEq/L)
Normal	1.67
Normomagnesemia	1.50
Hypomagnesemia without symptoms	1.36
Hypomagnesemia with symptoms	0.94

Table 3: Details about cases where hypomagnesemia were associated with magnesium deficiency syndrome

Age/Sex	Days a after burn	% of burn	Serum Magnesium level (Meq/L)	Symptoms
35/M (Alcoholic)	8	25	0.6	Cramps, Depression
22/F	10	40	1.1	Cramps
35/F	10	70	1.0	Tremor
24/F	2	60	1.0	Delirium
40/F	20	70	0.9	Paralytic ileus
6 months/F	15	70	0.5	convulsions
45/F	16	65	0.6	Cramps, tremor
40F	15	70	0.5	Delirium

Table 4: Occurrence of hypomagnesemia & magnesium deficiency syndrome

Weeks after Burns	No. of cases	Percentage	No. of cases	percentage
1st week	6	50	1	12.5
2nd week	3	25	3	37.5
3rd week	2	16.66	3	37.5
4th week	1	8.34	1	12.5

Table 4A: Appearance of symptoms of magnesium deficiency syndrome at different magnesium levels

Serum magnesium levels (meq/l)	No. of cases	No of Cases having Symptoms	Percentage
0.5-0.75	4	4	100
0.75-1.00	9	7	77.78
1.00-1.25	8	5	62.5
1.25-1.50	1	-	-
1.50-1.80	3	-	-

Table 5: Cases where oral/parenteral magnesium therapies were given

	Types of cases	Total number	No of cases		Percentage	
Oral therapy	Hypomagnesaemia without symptoms	9	6		66.6	
	Hypomagnesemia with symptoms	16	3		18.75	
Parenteral therapy	Hypomagnesemia without symptoms	9	3		33.3	
	Hypomagnesaemia with symptoms	16	13		81.25	
Results of Magnesium Therapy	Hypomagnesemia without symptoms	9	7	2	28	8
	Hypomagnesemia with symptoms	16	13	3	52	12
		Total	20	5		

Table 6: Mean serum magnesium level (mEq/L) in normal cases and in burn having symptoms of magnesium deficiency

Types of cases	Range	No. of estimation	Mean	SD	't' Value	'p' value	Remarks
Normal	1.5-2.0	20	1.67	0.44	3.84	<0.01	Highly significant
Burn	0.5-2.0	25	0.94	0.82			