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CASE REPORT

Successful Treatment of Severe Iron Intoxication with Gastrointestinal Decontamination, Deferoxamine, and Hemodialysis

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Abstract

Acute iron poisoning is a common and potentially serious problem in the pediatric population. Early recognition and treatment is crucial for a better outcome and to prevent morbidity and mortality. An 18-year-old female, who had accidental ingestion of 50 tablets of ferrous sulfate (100 mg of elemental iron per 335 mg tablet), 100 mg/kg of elemental iron, developed acute gastrointestinal and neurologic signs of toxicity and severe anion gap metabolic acidosis. The patient had received gastrointestinal decontamination, deferoxamine (DFO) infusion, and hemodialysis (HD) resulting in a decrease in serum iron concentration from 2150 to 160 mcg/dL at 24-h post-ingestion and improved mental status. Our cases demonstrate that HD may assist in decreasing serum iron concentration and improving clinical status in patients with massive overdose and life-threatening toxicity.

Keywords: ferrous sulfate, hemodialysis, deferoxamine, iron intoxication

INTRODUCTION

Acute iron poisoning is a common and potentially serious problem.[1–5] Iron tablets attract the children because they are often brightly colored, sugar-coated, and have the appearance of candy.[4] Early recognition is crucial for a better outcome and to prevent morbidity and mortality. We reported successful treatment of severe iron intoxication with gastrointestinal decontamination, deferoxamine DFO, and hemodialysis (HD). We think it is a topic that is not well represented in the literature and would be of interest to nephrologists who, like me, are unlikely to know very much about acute iron toxicity and have not been exposed to such a case.

CASE REPORT

An 18-year-old female with no past medical or psychiatric illness was brought by her husband with a history of accidental ingestion of 50 tablets of ferrous sulfate (100 mg of elemental iron per 335 mg tablet), 100 mg/kg of elemental iron, approximately 8 h after ingestion. On examination, she was conscious but lethargic. Her pulse rate was 124/min, regular, and blood pressure was 120/80 mm Hg. She was afebrile and had no cyanosis/jaundice and oliguria.

The treatment was initiated with gastric lavage and DFO at a local hospital. Gastric lavage with a large-bore orogastric tube and whole bowel irrigation was used for gastrointestinal decontamination. She was transferred to our hospital for HD in view of severe symptoms (persistent vomiting, abdominal pain, and acute gastrointestinal signs of toxicity, lethargy, altered mental status, and neurologic manifestations of toxicity), severe anion gap metabolic acidosis, and history of ingestion of significant number of ferrous sulfate pills.

Investigations revealed hemoglobin 10.5 gm/dL, white cell count 15,300/cmm, and platelet 150×10^3. Her initial liver function and renal function tests were normal. The glucose level was 155 mg/dL. Approximately 6 h after ingestion, arterial blood gas (ABG) showed PaO_2 122 mm Hg, PCO_2 20 mm Hg, pH 7.16, bicarbonate 6.9 mmol/L, and base excess –21.5 mmol/L,

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potassium 2.3 mmol/L, sodium 150 mmol/L, chloride 97 mmol/L (partially compensated non-respiratory severe metabolic acidosis). Hyperkalemia was associated with electrocardiographic (ECG) changes (tall, peaked T-waves with a shortened QT interval). She was initiated on HD for worsening acute gastrointestinal, neurologic signs of toxicity, and severe anion gap metabolic acidosis despite gastrointestinal decontamination and DFO infusion. ABG was showing hypokalemia due to bicarbonate therapy given for acidosis. She underwent HD without any adverse events, bleeding, and hemodynamic instability. We performed continuous renal replacement therapies, continuous veno-venous hemodiafiltration, dialysate rate 1000 mL/h, replacement rate 1000 mL/h, blood flow rate 100–150 mL/h, and ultrafiltration rate 0 mL/h without anticoagulation. DFO was administered intravenously at a continuous rate of 10–15 mg/kg per hour based on the severity of clinical symptoms until resolution of clinical symptoms such as metabolic acidosis (24 h). A mild hypotension developed during the initial administration of DFO. It was managed by providing vigorous fluid resuscitation and slowing down the rate of the deferoxamine infusion. Repeated ABG revealed improved metabolic acidosis and normal ECG. The patient had received gastrointestinal decontamination, DFO infusion, and HD resulting in a decrease in serum iron concentration (SIC) from 2150 to 160 mcg/dL (reference range 40–150 mcg/dL) at 24-h post-ingestion and improved mental status. She improved gradually. She was discharged in good health after psychiatric consultation.

DISCUSSION

The Physiological Effects of Iron Toxicity

The free radical production and lipid peroxidation are the mechanisms involved in iron-induced tissue damage.[6] Direct vasodilation, inhibition of serum proteases, mucosal necrosis, impairment of capillary permeability, alteration of the lipid membrane of mitochondria, inhibition of enzymatic processes in the Krebs cycle, and uncoupling of oxidative phosphorylation are the toxic effects of iron on the cells.[7–10] The protective mechanisms of transferrin is rapidly exhausted with an acute intoxication.[11] Absorbed iron is rapidly cleared from the circulation and taken up by the cells of various tissues, where high concentrations of iron disrupt mitochondrial function.[10,12]

Use and Problems with Use of SIC in Diagnosis of Iron Overdose

SIC is useful to confirm diagnosis and predict severity of iron toxicity if the time of sample collection is appropriate (4–6 h from the time of ingestion). However, since it measures free iron in the blood, it may not always predict severity of iron intoxication. For slow-release iron, an SIC is recommended at 8 h.[6] Because iron is rapidly cleared from the serum, samples obtained after 8 h may be falsely low. SIC > 500–1000 mcg/dL indicated serious systemic toxicity.[5] SIC is not available at all hospitals. In such cases, the treatment can be initiated with aggressive GI decontamination and/or initiate DFO therapy according to the presence of systemic symptoms, total elemental iron intake, and findings on abdominal radiograph. An anion gap metabolic acidosis is an important, but non-specific, indicator of iron toxicity. The leukocytosis and hyperglycemia are reported with SIC > 300 mcg/dL.[13,14]

Management of Acute Iron Intoxication[5]

History should focus on total amount (mg/kg), timing, and form of iron ingested. There are five overlapping phases of clinical manifestations: (1) gastrointestinal phase (30 min to 6 h) manifest as abdominal pain, vomiting, diarrhea, hematemesis, melena, lethargy, shock (from capillary leak and third spacing), and metabolic acidosis, (2) latent phase (6–24 h) associated with improvement in GI symptoms, tachypnea, and tachycardia, and (3) shock and metabolic acidosis occurs from 4 h to 4 days due to hypovolemic or cardiogenic shock with profound metabolic acidosis, coagulopathy, renal failure, pulmonary failure, and central nervous system dysfunction, (4) hepatotoxicity occurs within 2 days and is associated with coma, coagulopathy, and jaundice. Severity is dose dependent, and (5) bowel obstruction occurs within 2–4 weeks and is associated with vomiting, dehydration, and abdominal pain, usually gastric outlet obstruction. Diagnostic evaluation should be carried out for all patients with systemic toxicity, those who have ingested >40 mg/kg of elemental iron and those who have ingested unknown amount of elemental iron. The clinical status of the patient is more useful than SIC to determine the severity of iron ingestion.

Diagnostic evaluation should include arterial or venous pH, abdominal radiograph for radiopaque pills, and measure SIC within 4–8 h after ingestion. Initial management included secure airway and breathing, treat volume depletion aggressively with isotonic infusion, whole bowel irrigation for all patients with a significant number of pills in stomach and small intestine on radiograph.

Intravenous DFO is the antidote for serious iron overdose. Indications for DFO treatment are severe symptoms like altered mental status, hemodynamic instability, persistent vomiting, diarrhea, anion gap metabolic acidosis, SIC > 500 mcg/dL, and significant number of pills on X-ray. Starting dose should be 15 mg/kg/h and is increased to 35/mg/kg/h during the first 24 h for severe ingestions. DFO should be given early in iron overdose because iron moves rapidly from the circulation into cells, where, in acute intoxication, it is not readily accessible for chelation. DFO binds with ferric iron (Fe3 +) in the blood to form water-soluble ferrioxamine, which is renally excreted.

Elimination Enhancement—Extracorporeal Methods of Iron Removal

Extracorporeal methods of iron removal (e.g., HD) are less useful because they only remove free circulating iron and must be started soon after ingestion, before intracellular iron transport occurs. Extracorporeal removal with exchange transfusion or continuous veno-venous hemofiltration is associated with better outcomes in severe iron toxicity and should be initiated after consultation with nephrologist. They are useful when clinical deterioration persisted and when SIC is high, despite the administration of DFO. The iron concentration in the ultrafiltrate is a better way than SIC and clinical resolution of signs to prove that substantial amounts of iron is removed by extracorporeal methods. In our case, iron level was not tested in ultrafiltrate samples, which is a better test to define the contribution of HD.

Carlsson M reported good outcome with two-thirds of blood-volume exchange followed by 5 h of plasmapheresis in an 18-month child with severe iron overdose. There was a significant reduction in SIC from 1362 to 40 mcg/dL and was associated with clinical improvement.[2] In another report, Milne C reported improved mental status and decrease in SIC from 3906 to 148 mcg/dL after deferoxamine infusion and continuous veno-venous hemofiltration in an 18-month child with systemic toxicity of ferrous sulfate.[3] These cases demonstrate that exchange transfusion or continuous veno-venous hemofiltration is useful in decreasing serum iron and improving clinical status in patients with severe iron intoxication. However, these modalities can cause complications such as bleeding and hemodynamic instability and should be regarded as last resort for iron poisoning.

CONCLUSION

We report successful treatment of severe iron intoxication with gastrointestinal decontamination, deferoxamine, and HD. Early recognition is necessary to ensure appropriate therapy and prevention of fatalities. Our cases demonstrate that HD may assist in decreasing serum iron and improving clinical status in patients with massive overdose and life-threatening toxicity.

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