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Case Report Open Access

A Survivor of Methyl Ethyl Ketone Peroxide (MEKP) Toxicity

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Abstract

Methyl ethyl ketone peroxide (MEKP) is a widely used catalyst in the hardening of ester resins. It is highly hazardous, since it is a highly reactive oxidizing compound. Thus, it's exposure results in chemical burns and release of free radicals. Previously reported cases of MEKP ingestion showed high morbidity and mortality as it caused severe metabolic acidosis, acute liver and renal failure, upper gastrointestinal ulceration, optic disc atrophy, myocardial damage, coagulopathy, and neurologic damage. A 42-year-old man accidentally ingested about 150 ml of MEKP 40% followed by ingestion of 100 ml olive oil. He was treated with stomach wash, free radical scavengers, and hemodialysis. Although he developed mild hematemesis, myocardial and hepatic impairment, coagulopathy, and papillitis, he neither developed renal impairment nor any gastrointestinal strictures after 4 weeks. Besides, his cardiac and hepatic functions, and coagulapthy were rapidly improved. Treatment with careful stomach wash, olive oil, free radical scavengers, and hemodialysis may be effective in reducing the morbidity and mortality of MEKP.

Keywords: MEKP; ingestion; Heamodialysis; Free radical scavengers

Introduction

MEKP is a colorless to yellow liquid with mint like odor. It is used as a hardening agent for fiberglass-reinforced plastics, in the manufacture of acrylic resins, and as a curing agent for unsaturated polyester resins. It acts through the formation of free radicals that catalyze the polymerization of the plastic monomer [1].

The pure chemical is an unstable peroxide, capable of releasing molecular oxygen. It is shock, sunlight, and heat sensitive, and undergoes explosive decomposition at 230°F. Commercial MEKP contains a mixture of peroxide, hydroperoxide, and active oxygen in dimethyl phthalate (DMP), which is used as a diluent to prevent decomposition and explosion of MEKP. Because of the high reactivity of MEKP, it is available only as a 40% to 60% solution in dimethyl phthalate or other phthalates. MEKP can undergo spontaneous ignition or decomposition if mixed with readily oxidizable organic or flammable materials or chemical reactants [2].

The toxic oral dose of MEKP in dimethyl phthalate was estimated to be 50 to 100 ml. It may lead to abdominal burns, gastrointestinal bleeding, necrosis, perforation of the stomach, stricture of the esophagus, severe metabolic acidosis, acute liver failure, rhabdomyolysis, respiratory insufficiency, toxic myocarditis, and temporary cardiac arrest [3-14].

The mechanism by which MEKP causes toxicity in the acute phase of exposure is by forming various alkylperoxyl radicals involving the decomposition into various organic acids (e.g., formic acid, acetic acid, propionic acid). This reaction is strongly accelerated by the heme group splitting the MEKP monomer into hydrogen peroxide (H2O2) and methyl ethyl ketone [15,16].

These free radicals cause deleterious effects on particularly the liver, and the digestive tract, in addition to the heart, kidney, and nervous system through inducing lipid peroxidation of these organs. Also, the organic acids may cause metabolic acidosis, local burns of skin and mucosa on contact, and induce neurologic lesions such as inflammation and ischemia of the optic nerve [17-19].

There are no guidelines for the treatment of MEKP toxicity after ingestion. All reviewed literature and case reports pointed to trials of gastrointestinal decontamination [5,11], administration of some physical antidotes as milk [4], in addition to supportive treatment [3-14]. In 2008, Van Enckevort et at published a case report that discussed the value of N-acetylcysteine,as free radical scavenger thus reversing or preventing the acute liver failure, which is the main cause of death. Additionally, it pointed to the effectiveness of hemodialysis in the removal of the formed organic acids, thus correcting the metabolic acidosis and reversing its deleterious effect on the optic nerve, kidney, and heart [13].

Case Report

A 42-year-old male car painter accidentally ingested about 150 ml of solution of 40% MEKP in dimethyl phtalate out of a glass while he was painting a car. He felt severe burning abdominal pain but he did not vomit. He immediately ingested about 100 ml of olive oil then he sought medical advice in a nearby hospital where nasogastric wash was provided using normal saline. He was then referred to Alexandria Main University Hospital. The patient arrived at the hospital after about 70 minutes of ingestion complaining of drowsiness, oral and abdominal pain. He had history of being a heavy smoker, and cannabis addict.

On examination, he was slightly confused with blood pressure 70/40, pulse 100 beat/min, temperature 37°C, respiratory rate 28/min, and oxygen saturation 99%. Oral examination revealed inflamed tongue, and free oropharynx. Abdominal examination showed slight tenderness on palpation. Nasogastric drain showed altered heamatemsis. Fundal examination revealed optic discitis. ECG showed ST segment depression in leads I, II, and AVL. The rest of examination was normal.

Laboratory investigations showed high anion gap metabolic acidosis, markedly elevated liver transaminases, slightly elevated creatinine, markedly prolonged activated partial thromboplastin time, markedly elevated cardiac enzymes, markedly elevated hemoglobin level, and severe leucocytosis (Table 1). Chest and standing abdominal X-rays were normal, ultrasound abdomen was free, but echocardiography revealed slightly decreased cardiac contractility with ejection fraction 45%.

Lab results	1st day 10pm	2nd day 8am	3rd day 8am	4th day 8am	5th day 8am	2nd week	4th week
Hb g/dl	15.2	14.8	14.4	12	11.4	12.5	12.7
WBC 103/ul	56.7	52.9	33.6	19.3	18.2	13.4	10.5
Plts 103/ul	384	300	229	220	195	315	370
PT sec	51.6		17	12.8			
PTT sec	>120		31	25			
INR	4.6		1.5	1.1			
SGOT U/l	1981	1617	1428	1254	1099	320	60
SGPT U/l	614	566	476	421	388	125	37
Urea mg/dl	58	45	34	29	18	32	38
Creatinine mg/dl	1.5	1.2	0.88	0.8	0.78	0.9	0.87
CK-MB ng/ml	29.5	22	15	12	10	10	
Troponin I ng/ml	7.64	3.3	1.3	0.09	0.007	<0.001	
PH	7.18	7.38	7.42				
HCO3 mmol/l	7	21	22				

Table 1: Laboratory results.

Immediate fluid restitution was given after inserting a central venous access in addition to the administration of low dose vasopressors intravenously until the patient became hemodynamically stable. Intravenous ondansetron and esmoprazole infusion were started. Oral rebamipide and antacid containing aluminum hydroxide were given on the second day.

N-acetylcysteine was given intravenously with a loading dose of 140 mg/kg and 70mg/kg maintenance for 17 doses, which is the same regimen used in acetaminophen toxicity. Also, oral vitamin C in a dose of 250 mg /day and vitamin E in a dose of 400 mg every 6 hours were given. A four-hour session of hemodialysis was provided within 60 minutes of admission, after which metabolic acidosis was corrected. On the second day altered hematemesis and melena stopped and vasopressors were weaned off. Follow up cardiac, renal, and liver enzymes started to slightly decline. Over the next three days his activated partial thromboplastin time, hemoglobin, and renal functions returned to normal but slight leukocytosis was still present. His echocardiography follow up was normal with ejection fraction 60%.

The patient was discharged to the ward after five days, where he stayed for another two days before being discharged home. He was prescribed esmoprazole tablets in a dose of 40 mg/day, rebamipide tablets in a dose of 100 mg/8 hours, oral N-acetylcysteine in a dose of 200 mg/8 hours, and oral vitamin E in a dose of 400 mg/day for two weeks (Table-2). Follow up examination in the outpatient clinic after two weeks showed that he had neither swallowing nor visual problems. His complete blood count, and renal functions were normal but his liver transaminases were slightly elevated.

Compound/Drug	Dose	Starting time	Duration
Olive oil	100 ml orally	Immediately after ingestion	Once
Lactated ringer solution	4 L intravenously	75 minutes after ingestion	Over the first 6 hours
Nor-epinephrin	3 microgram intravenously	100 minutes after ingestion	8 hours
Ondansetron	4 mg/12 hours Intravenously	80 minutes after ingestion	3 days
Esmoprazole	80mg loading Followed by maintenance infusion in a dose of 192 mg/day Intravenously	80 minutes after ingestion	4 days
N-acetylcysteine	140 mg/kg loading intravenously Followed by 70mg/kg maintenance for 17 doses/4 hours	120 minutes after ingestion	3 days
Vitamin E	400 mg capsule/6 hours	120 minutes after ingestion	7 days
Vitamin C	250 mg effervescent tablets/day	180 minutes after ingestion	7 days

Rebamipide	100 mg tablet/8 hours	Second day	Until the end of the second week
Esmoprazole	40mg tablet/day	Fifth day	Until the end of the second week
Vitamin E	400 mg capsule/day	Eighth day	Until the end of the second week
N-acetylcysteine	200 mg effervescent/8 hours	Fourth day	Until the end of the second week

Table 2: Compounds/drugs applied to the patient.

Four weeks later upper gastrointestinal endoscopy was performed revealing no signs of esophageal or stomach ulcerations or strictures. Complete blood count, and liver enzymes were normal.

Discussion

Although MEKP is a widely used hazardous substance that leads to high morbidity and mortality, there are no definite guidelines for treatment of its intoxication.

On reviewing the literature there were only few case reports regarding MEKP poisoning. They reported a variety of clinical presentations, treatment modalities, and outcomes. The reported clinical presentations and complications were esophageal and gastric ulcerations and strictures, mild impairment of liver functions to acute liver failure, renal failure, respiratory distress, coagulopathy, neurologic suppression, toxic myocarditis, rhabdomyolysis, and cardiac arrest. On the other hand, the reported treatment trials were mainly supportive and symptomatic. Different trials included the use of gastric wash, milk, H2-blockers, proton pump inhibitors and antacids for decontamination and reduction of local gastric effect and systemic toxicity. In addition to vitamins as B and K, mannitol, frusemide, steroids, peritoneal dialysis, hemodialysis, N-acetylcysteine, sodium bicarbonate, and inotropes were used to reverse the systemic effect [3-14].

In this case although the patient had ingested a large amount of MEKP, about 150 ml, fortunately he had rapidly ingested about 100 ml of olive oil which may have acted as a physical antidote. Also, a careful nasogastric wash, using normal saline, was done within a short period after ingestion that also may have reduced both the local and systemic effects of the ingested MEKP [20].

There were two main goals in the treatment plan of this case. The first was to treat and reduce local injury represented in the upper gastrointestinal inflammation, ulceration, and bleeding by administering a proton pump inhibitor through intra venous infusion in addition to giving oral antacid and rebamipide on the second day. Oral antacid was started on the second day for fear of any chemical reaction that may occur with the remaining MEKP in the stomach which can cause further injury. The second goal was to reverse and prevent any further systemic injury through preventing further lipid peroxidation by administering free radical scavengers as N-acetylcysteine, vitamin E, and vitamin C. In addition, the goal was to remove any accumulated organic acid, specially formic acid, via heamodialysis thus correcting the metabolic acidosis and reversing its deleterious effects on various body organs and preventing any further neurological damage. Also, supportive treatment using fluid resuscitation and vasopressors was very important to keep the patient vitally stable till regaining his normal cardiac functions. These two goals were successfully achieved using the previously mentioned treatment strategies, where upper gastrointestinal bleeding and ulcerations were treated without any later complications as documented by the upper gastrointestinal endoscopy that was performed four weeks later. Rapid correction of the metabolic acidosis, and the cessation of further neurologic damage were achieved following the removal of organic acids via hemodialysis. The administration of free radical scavengers as N-acetylcysteine, vitamin E, and Vitamin C stopped further liver damage as documented by the improvement of liver transaminases over the following four weeks (Tables 1 and 2).

Administering vitamin C and E orally in large doses during the period of hematemsis presented a great challenge. We had to give strong anti-emetics as ondansetron to prevent vomiting. Fortunately, it was absorbed without vomiting or any further gastrointestinal complications. In conclusion, although gastric wash is contraindicated in case of corrosive ingestion, careful nasogastric wash combined with physical antidotes as olive oil, milk, and egg white may be of benefit in case of MEKP ingestion. The use of free radical scavengers as N-acetylcysteine, vitamin E, and vitamin C can be good antidotes that stop and reverse further organ damage especially the liver. Heamodialysis is highly beneficial in removing any accumulated organic acids, particularly formic acid, thus correcting metabolic acidosis and stopping further neurologic and organ damage.

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