Ileal perforation by electrical shock. A case report

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Case report

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Background: Ileal perforation after electrical burn is a rare but serious complication that leads to high morbidity and mortality if there is a delay in diagnosis and management. We present a 50-year-old male who presented an electrical burn after having contact with high-voltage cables by means of a metal rod and a fall of 5 meters in height; Without losing consciousness, he was transferred to the nearest hospital. On admission he referred to generalized abdominal pain, on physical examination, burns on both palms of the hands, injury to the right foot, absence of peristalsis and data of peritoneal irritation. An focused assessment with sonography for trauma (FAST) was performed, which reported a positive study for heterogeneous free fluid, in addition to a tomography (CT) in which abundant free fluid was observed in the cavity. Arterial blood analysis showed metabolic acidosis, managed with crystalloids. He is assessed by the surgery service and later goes to the operating room to perform an exploratory laparotomy (LAPE) where a mesentery burn at the level of the jejunum and ileum, peritoneum, and intestinal injury in 50% of the circumference at 170 cm were observed. of treitz angle. An entire end-to-end manual anastomosis was performed in two planes with absorbable suture, the abdominal wall was closed by planes and the surgical act was considered finished.

Keywords: electrical burn, high voltage, perforation, intestinal injury, resection, anastomosis.

Electrical burn victims account for approximately 5% of admissions to major burn centers (1). Electrical injuries are generally divided into high voltage (>1000 V, 50 Hz), low voltage (<1000 V), arc burns (no current passing through the patient), and lightning burns (2). High-voltage current injuries are generally associated with occupational accidents in which the worker comes into direct contact with energy, or indirectly through conductive materials or equipment (3). The clinical manifestations can vary from the absence of apparent lesions to severe systemic damage. Abdominal visceral injuries are associated with high voltage injuries where the point of contact is directly over the abdomen. There may be serious consequences after the passage of electrical current through the abdominal viscera, being difficult to diagnose (4). During electrical contact, the victim is transiently included in a closed electrical circuit. Visceral damage depends on the intensity, duration of exposure to current, its path through the tissues and organ resistivity, in association with high voltage. Intraadominal injury associated with electrical injury is difficult to diagnose (3, 5).

Case report

A 50-year-old male who, while working, presented an electrical burn after having contact with high-voltage cables by means of a metal rod and a fall of 5 meters in height, without presenting an alteration in his state of consciousness or any type of apparent injury receiving primary care by paramedics, he was later sent to the general hospital 450 of the state of Durango. Upon arrival, he received the first intra-hospital care by the emergency department where he was reported active, reactive, with a 15-point Glasgow scale, without neurological alteration, without signs or symptoms of spinal cord injury, with a 2-cm cutting lesion at the right parietal level, central pupils, isochoric, normoreflective to light, without alteration of the cranial nerves; without cardiorespiratory alterations, with soft, depressible abdomen, not distended, peristalsis present, without data of peritoneal irritation. extremities with superficial second degree burn on both palms of the hands, being the entrance of the burn, with pulses present and adequate capillary refill; at the level of the right pelvic

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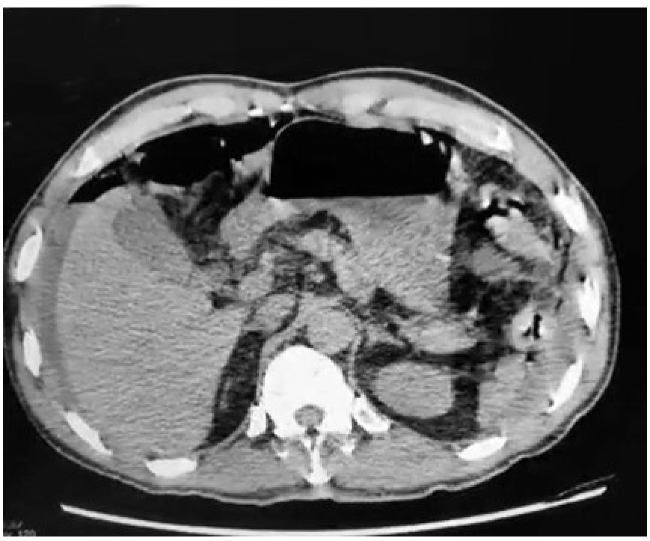

Figure 1. Computed tomography scans of the abdomen showing free air in the abdominal cavity.

limb in the second toe, burn lesion with changes in color, with decreased capillary refill, rest of the physical examination without alterations.

Hemodynamically stable, with vital signs with a blood pressure of 117 /73 mm Hg, heart rate 113, temperature 36.5 Celsius degrees, shock index 1.0 oxygen saturation 94%, urinary index 1.1 mL/h without alterations in the electrocardiogram; in his first hours he was started on fluid resuscitation and a shock protocol was requested; laboratory with hemoglobin, 16 g/L (references 14 – 17gr/dl); leukocytes count, 13 (reference 4.5- 11/10-3/mm3); platelets, 572x10-3 (reference 150 – 450 10-3/mm3); seric creatinin 0.7, (reference 0.7 to 1.5 mg/dL); BUN 14 mg/dL (reference 6 - 20 mg/dL); DHL 251 UI/L (reference 105- 333 UI/L); creatin-kinase (CK), 511 (reference 55- 150 UI/L), CK- fraction MB, 68 (reference <16 UI/L);

After, 2 hours after his arrival, he presented deterioration with generalized with abdominal pain. FAST was performed, which reported a positive study for heterogeneous abdominal free fluid. So, additional Computed Tomography (CT) scan in which abundant free fluid and free air were observed in the abdominal cavity (figure 1). Arterial blood analysis showed metabolic alkalosis, pH 7.48, pCO2 29 mmHg, pO2 75 mmHg, HCO3 24.2 mmol/l, lactate 2.3 mmol/l; Base excess, XX mmol; and managed with crystalloids. He was assessed by the surgery division and later goes to the surgery room to perform LAPE.

Previous to surgery anesthesia valoration, an agitated patient is found, with neurological deterioration, 13 points on the Glasgow scale. general anesthesia was decided; LAPE approach trough abdominal midline, it is dissected by planes until reaching the abdominal cavity where it is observed: 2000 mL of liquid free of intestinal characteristics, with was aspirated and first saline solution wash was

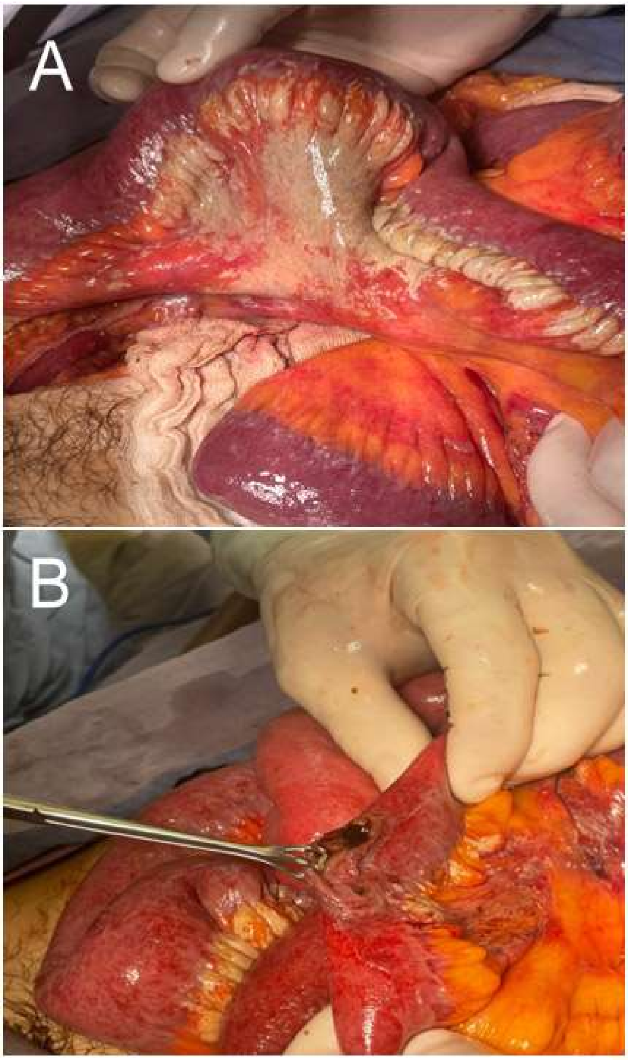

Figure 2. A. intraoperative image, showing burned mesentery. B. Bowel perforation grade III (AAST classification)

done posteriorly, a detailed abdominal structures was realized observed a mesentery burn at the level of the jejunum and ileum, peritoneum (figure 2A) and irregular intestinal lesion of 3 cm lengths by 2 cm in diameter (figure 2B) classified as grade 3 according to the AAST (6,7) at 170 cm of angle of Treitz; 10 centimeters of ileum were resected and a pathology was sent for study.

Cavity lavage is performed with solutions and an entire end-to-end manual anastomosis is performed in two planes with polygactin 910 type absorbable suture with 3 zero points from Connel – Mayo and with silk 3 zero points from Lembert respectively (figure 3). Saratoga-type drainage directed to the pelvic cavity and subsequent closure of the abdominal wall by planes and the surgical act is considered completed.

After the surgical event, the patient went to the intensive care unit, where he remained for 10 days, with a favorable evolution. Later he was sent to the general surgery floor.

During his hospitalization, acute fibrinopurulent enteritis, perforated secondary to an

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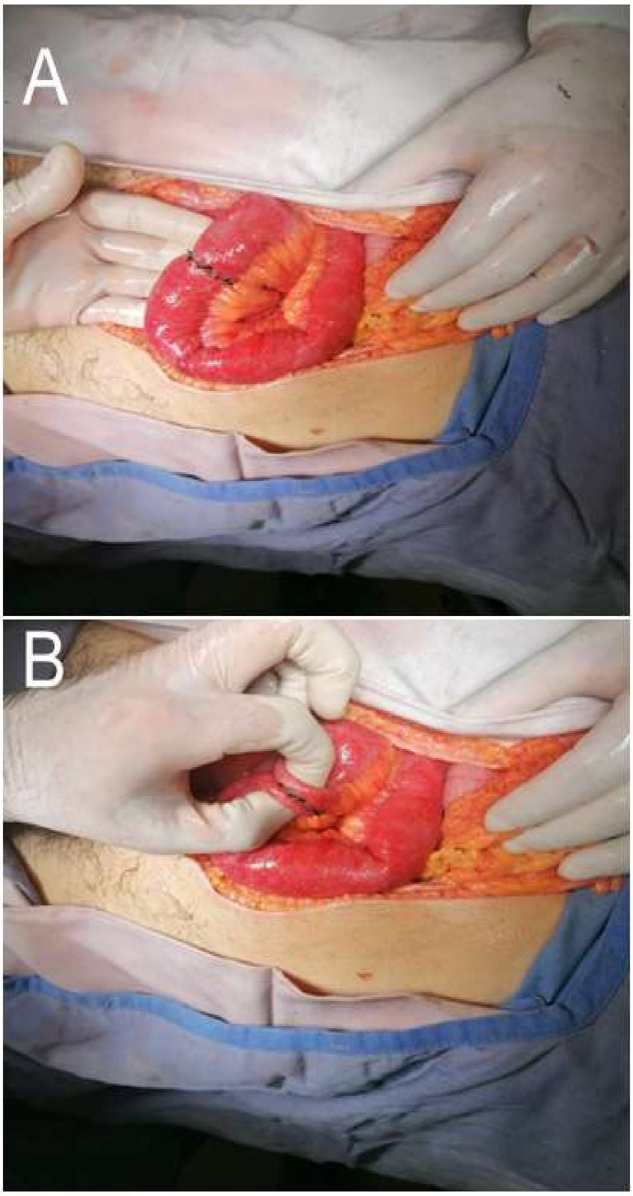

Figure 3. A. End-to-end anastomosis of the small intestine in two planes. B. Verification of adequate anastomosis.

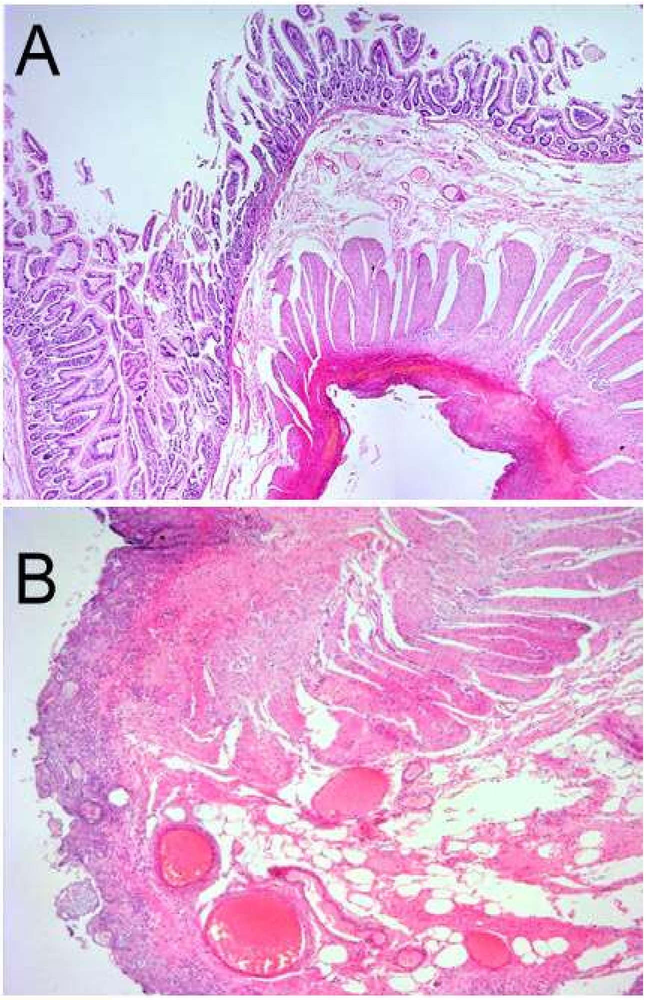

Figure 5. A. Histological section of the small intestine stained with H-E (50X) showing erosion of the mucosa, edema of the submucosa, in addition to changes due to autolysis of the muscularis propria and an area of cellular injury secondary to burn (arrows). B. Histological section of the wall of the small intestine stained with H-E (50X) showing acute and chronic enteritis, vascular congestion and edema of the submucosa.

electrical burn of a segment of the small intestine, was reported as part of his pathology (figure 4).

He was finally discharged from the hospital without complications.

Discussion

Intensive heat contact to the skin can cause burn injuries. In addition to thermal burns due to flames, scalding or hot vapors, electric-and chemical burns can lead to severe burn injuries needing a specialized and multidisciplinary therapy (8). Therapy of burn injuries can be divided in different stages of burn care. In the beginning acute life-saving procedures and if applicable intensive care reatment procedures are paramount. Electrical burn injuries are among the most devastating injuries. The lesions progress in time and space, during the days (8,9).

Proper initial care of patients with major burns is key to their clinical outcomes. The early identification and control of airway and breathing problems help prevent early deaths. Initiating proper fluid resuscitation avoids major complications. Recognizing and treating associated injuries are also essential (10).

Electrical injury has been called the “grand masquerader” of burn injuries because small surface wounds may be associated with devastating internal injuries. Electrical injuries account for approximately 4% of all burn center admissions and cause around 1,000 deaths per year in the United States (11). Frequently these are workrelated injuries and have a significant public health and economic impact. Electrical injuries are caused by direct or alternating current (DC or AC), and are arbitrarily divided into high (≥ 1,000V) or low (<1,000V) voltage (10). Electricity can cause injury by current flow, arc flash, ignition of clothing or concomitant physical trauma such as fractures or dislocations. Understanding these

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mechanisms may help to predict the severity of the injury and the potential sequelae (10,12).

In physics, the flow of electricity in an electrical circuit is analogous to water in a garden hose. The smaller the wire, the higher the resistance (measured in Ohms) and the less the current flows for any given pressure (measured in Volts). Ohm's Law defines this relationship, where current (I) is directly proportional to the voltage (V) and inversely proportional to the resistance (R): I = V/R. Heat creation by the Joule Effect (J = Current2 x Resistance x Time) highlights the importance of current, contact time and tissue resistance (13).

Humans are of course more complex than simple electrical circuits and damage is a reflection of the interaction of the electricity with tissues. Heat generation accounts for a significant portion of the damage observed. Thus, duration of contact, resistance and current flow are the primary determinants of heat injury. Contact duration is longer when the victim's hand cannot "let go" of an electrical source. Above a threshold current, tetanic contraction in the victim's flexor muscles are dominant over the extensor muscle. This can lead to extraordinarily long contact times and resulting extensive tissue damage similar to a high voltage injury even with relatively low voltage. Similar injuries can be found if the patient becomes unconscious in contact with the source of electricity (12,13).

Different tissues possess different resistance properties. Generally speaking, skin and bone are high resistance while nerves, muscle and blood vessels have the least resistance. The position of the limb (flexed or extended) compared to the direction of current flow can also change the dynamics of tissue damage (10,13).

Therefore, conceptualizing the body as a conduit with a resistance proportional to the cross-sectional area is an oversimplification. Dry skin has a resistance as high as 100,000 Ohms. Once this resistance is overcome, current flows through the underlying tissue, especially muscles, following a highly unpredictable path. On the other hand, wet skin has a much lower resistance. At the cellular level, multiple processes damage cell membranes including electroporation (electrical injury alters and damages cells at a microscopic level), which explains the damage that is not immediately apparent on physical exam and may lead to progressive cellular damage and tissue death (10,14,16).

Consequently, deep tissues may be severely injured even when superficial tissues appear normal or uninjured. Given this unpredictability, providers must suspect deep injury when examining the patient exposed to electrical current (16).

The Types of Injury, Based on Mechanism:

1. Body Conduction
When electrical current flows through a person. Low voltage electricity may cause few physical findings, but delayed onset of migratory pains, neurologic findings and psychological effects can be very debilitating (10).

2. Arc Flash and Arc Blast Injuries
When electrical current travels through the air between two conductors, the resulting arc has a temperature of up to 4000°C. The heat released can cause flash burns to exposed skin and even ignition of clothing or surrounding objects. The explosive force of the superheated air may cause associated blunt trauma from a fall (10).

3. Secondary Ignition
An arc flash releases sufficient energy as radiant heat to ignite clothing or surrounding flammable materials (10).

4. Thermal Contact Burns
As the electrical current passes through the body, heat is generated (10).

Subsequent evaluation of the patient with electrical injury is similar to other burn injuries. Extra effort must be taken to find all contact points and to detect evidence of blunt trauma or other associated trauma. In addition, cardiac monitoring should be initiated as soon as possible due to the high possibility of dysrthymias (17). Prompt initiation of fluid resuscitation to maintain a high urine volume is important, Initiate fluid resuscitation using Lactated Ringer's at 4ml/kg/percent surface burn area, sufficient to maintain a urine output of 30-50 ml per hour in an adult or 1 ml/kg/hour in a child (10,13,17)
If there is evidence of red pigment such as myoglobin, the urine output should be maintained between 75- 100 ml per hour until the urine grossly clears (10,17).

The exact incidence of colonic and intestinal perforation is unknown; electrical burn complications such as intestinal ischemia are reported in only 2.8% with a mortality rate of 78% (18,19).

Conservative treatment has become standard for all patients with non-severe blunt abdominal trauma. Immediate laparotomy after blunt injury is rarely based solely on clinical parameters (20).

Establishing the need for urgent laparotomy based on clinical criteria is particularly problematic in the patient with multiple blunt injuries. Possible indications include the following:
Unexplained signs of hemorrhage or hypotension in a patient who cannot be stabilized and in whom an intra-

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abdominal injury is suspected,Clear and persistent signs of peritoneal pain.

- Radiological evidence of pneumoperitoneum compatible with rupture of a viscera.
- Evidence of diaphragmatic rupture.
- Persistent and significant gastrointestinal bleeding through the nasogastric tube or vomiting (20).

The evaluation of patients with blunt abdominal trauma is one of the greatest challenges in emergency practice. Clinical examination is often unreliable. Focused abdominal ultrasound for abdominal trauma or FAST ultrasound is an accessible, portable, non-invasive and reliable tool for diagnosing the presence or absence of fluid in the abdomen (21).

With the advent of the Advanced Trauma Life Support (ATLS) courses, the care of polytraumatized patients has been systematized, confirming that the main preventable cause of death in closed abdominal trauma is undetected intra-abdominal bleeding. With the aim of identifying these hemorrhages, diagnostic peritoneal lavage (DPL) was initially developed, becoming the "Gold Standard" of abdominal evaluation for traumatized patients; however, it presented a complication rate of up to 10% (22).

During the 1980s, ultrasound began to be used in the emergency room to replace LPD. The ultrasound term FAST (Focused Abdominal Sonography for Trauma) was coined by Rozycki et al. in 1995, which has been used to bring together various ways in the use of ultrasound for the evaluation of patients with abdominal trauma, whose central axis is free liquid detection (23).

CT is an important tool in the management of closed abdominal and abdominopelvic trauma. It is reserved for hemodynamically stable patients (24). Oral and IV contrast medium should be used. It can determine the presence of injuries to solid organs, intra-abdominal fluid, blood, air, and injuries to retroperitoneal organs, which may have suffered from trauma and not caused hemoperitoneum, so they are not detected with ultrasound. as well as showing the extension of the lesion in structures such as the spleen and liver, as well as determining contrast extravasation, which implies active bleeding (24,25). Due to these characteristics, CT is very useful in deciding the therapeutic management of the lesion. CT has a sensitivity of 92% to 98% and a specificity of ~99% in detecting solid organ injury. It does not detect lesions of the diaphragm, intestine and some of the pancreas (24,25).

Abdominal visceral injuries are encountered by every surgeon who deals with trauma. It is simple and useful to divide abdominal visceral injuries into those caused by penetrating mechanisms of injury and those due to blunt mechanisms (26).
An initial laparotomy in closed abdominal trauma is necessary to assess the extent of the injury and repair the viscera as deemed necessary (27).

A midline incision is the standard approach to abdominal visceral injuries because of its ease and versatility. Abdominal exploration should be consistent and systemic so as not to miss significant injuries. Hollow viscus injury is most common after penetrating injury, while blunt injury most often results in injury to solid viscera (26).

Here is currently not enough data regarding the management of bowel injury and the results of primary repair or resection and anastomosis in high-risk trauma patients. Lolis ED, Theodoridou E et al in their study aimed to determine whether there were any short-term (30 days) postoperative complications relevant to the primary reconstruction of such bowel injuries and suggests that primary reconstruction is feasible and can provide a good outcome (28).

Primary repair of bowel injuries should be the preferred option in trauma patient, regardless of the site—small bowel or colon—of the injury. Stoma creation is an important factor for postoperative morbidity, which should be weighed against the risk of an intestinal suture or anastomosis (29).

Conclusion

In our case, the patient was initially evaluated as polytraumatized and a victim of electrical burns. The general surgery team opted to perform an exploratory laparotomy due to the findings presented in the physical examination, in addition to the free fluid and free air that was observed in the CT, considered closed trauma of the abdomen. Until then, these injuries could be explained by the passage of electrical discharge or by biomechanical mechanisms related to trauma.

The suspicion of visceral damage due to the electric current was supported by the intraoperative findings of carbonization of the small intestine mesentery, as well as the macroscopic changes in the edges of the perforation site; All this was confirmed by the anatomopathological analysis.

The adequate approach of patients with electrical burns requires the availability of a multidisciplinary team that includes an adequate surgical team, radiologists, emergency physicians, intensivists, among others, to provide adequate care to all these patients.

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After the initial resuscitation, a shock protocol and a correct assessment by the surgery service must be established and carried out. After this case presentation, Visceral injuries should always be suspected in polytraumatized patients with electrical burns.

A correct physical examination supported by imaging methods and laboratory tests allow early diagnosis, which reduces morbidity and mortality by allowing early intervention. The passage of electrical current through the body cannot be determined with precision, and the detection of some type of abdominal visceral injury can only be corroborated by exploratory laparotomy

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To all our teachers and fathers.

Conflicts of interests

The authors declare no conflict of interest.

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