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Accidental High Voltage Electrocution Leading To Abdominal Wall Blow Out With Omental Evisceration And Auto Amputation Of Right Upper Limb: An Unusual Presentation

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Abstract:
Electricity is the backbone for modern industrialization, development and day to day needs. Electrical Injuries are among the most devastating of burn injuries. High voltage electrical injuries result in extensive deep tissue damage and are associated with multiple complications and a high mortality rate. The passage of electric current through the body, produces wide range of effects, varying from insignificant localised spasm, little or no contact burns, or extreme severe burns. We describe the case of a 6-year-old child who suffered high voltage electric injury leading to anterior abdominal wall blow out with omental evisceration and auto amputation of right forearm. He was initially resuscitated in emergency room followed by emergency exploratory laparotomy was done with primary repair of ileal perforation along with right arm 4 quadrant amputation. This paper also emphasizes the safety measures to be taken at work place pertaining to high voltage cable.

Keywords: *abdominal wall blow out , high voltage electrical injury , fore arm auto amputation , burns.*

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I. Introduction:

The incidence of electric burn in India is unknown . Male are mostly affected, reflecting the occupational exposure to electric hazard. Tissue damage is determined by intensity of voltage and current, duration of contact, resistance of tissue, area of contact, and pathway of flow through the body until the point of exit of current. The energy generated at entry and exit point results in tissue vaporization, especially, at the exit site due to the resistance of the tissue to the exiting current. This resulted in an outward orientation of the tissue by this explosive force of the current leaving the body causes a blow out of the exit point and in case of abdomen causing evisceration of bowel. [1]The entry point of electricity is usually the upper extremities with resultant exit through the lower extremities. ***The exit point through the abdominal wall with resultant abdominal wall loss is rare with evisceration of bowel and omentum.***

Thermal burns, arrhythmias and myonecrosis are commonly known and monitored compilations of electrical injuries. [2] Direct thermal trauma to internal viscera is also known and almost all internal organs have been reported to be affected, bowel being the most common. [3], [4], [5] However, bowel perforation occurring is rare, dreaded and erratic complication of electrocution, making it a dangerous pitfall if missed.

We report our experience of a similar case, where patient presented to emergency with abdominal wall blow out and evisceration of omentum through it along with auto amputation and gangrene of right fore arm. exploratory laparotomy was done and perforation was managed f/b amputation of right arm. patient was managed well in time. However, this could be detrimental, especially in our setup where neither follow-up nor access to tertiary care is robust.

II. Case Report:

A 6Y O boy presented to emergency after sustaining high tension electrocution. Electrocution occurred while playing on the terrace when he accidently took support of nearby high tension electric wire going through the terrace. The entry point for the current was through the right upper limb with exit wound over right lower abdomen resulting in full thickness abdominal wall blow out with evisceration of omentum through it.

On examination, the patient was conscious, oriented with blood pressure of 110/58 mm of Hg in left arm and pulse of 110/min. His right upper limb was dried, shrivelled, and blackened cold till axilla, marbling of veins present, no sensation to touch , pain, temperature , tense, with auto amputation of distal 1/3 of forearm including hand. There was 9 cm x 6 cm wound over right lower abdomen 5 cm diagonal to the umbilicus in the mid clavicular line involving full thickness of abdominal wall including peritoneum through which omentum prolapsed [Figure 1] . Rest of examination was normal, and there was no myoglobinuria.

Figure 1a: prolapsed omentum with perforation through abdominal wall defect.

Figure 1b: auto amputation of right Fore arm.

On laboratory evaluation his haemoglobin was 10.1 gm/di, TLC of 8000/mms and platelets of 1,33,000/mms. His Kidney function test and electrolyte profile were deranged (urea-121 mg%, creatinine-1.5 mg%, and K*~5.6 meq/L). Coagulation profile was normal. electrocardiogram (ECG) revealed the features of hyperkalaemia. Burn TBSA was 18% acc. To Wallace rule of 9 (i.e. 9% for the entire right upper limb + 9% for the lower abdomen). *however burn damage to the internal organs could not be assessed in Wallace rule of nine*.

USG arterial Doppler of right upper limb ; flow noted in right axillary artery, however no flow was noted in the arteries distal to it .

Patient was immediately prepared for exploratory laparotomy after initial resuscitation . Emergency explorative laparotomy done with resection of gangrenous omental segment. Intra-operatively findings : 2x1cm of perforation [Figure 2] seen at the distal ileal segment 20cm from the IC Junction along with 2 impending perforations adjacent to it , ? contact of bowel with exit wound , lymphatic channels over the messentry prominent seen as whitish streaks . primary repair of the perforation done with 2-0 vicryl (sero muscular) . Gangrenous omental segment resected out. Vascularity around the perforation checked and it was satisfactory. rest of the bowel was healthy. No other solid organ injury seen.

Orthopaedic and paediatric surgery opinion was taken in the operating room and we proceeded with 4 quadrant amputation of the right am at the shoulder joint. [Figure 3] .

Figure 2: Intraoperative images showing 2x1 cm ileal perforation , 20cm from the ICJ .

Figure 3: Right shoulder disarticulation

Post operative period- Patient was initially housed in intensive care unit, multiple blood transfusions were done. Regular dressing of the abdominal wound were done , gradually healed by secondary intention [Figure 4] leaving a fibrous scar at the wound site .patient passed flatus on post op day 4 and stool on post op day 6 . however he developed sepsis on post op day 10 with high grade fever (101 F) along with rising TLC (20,000) and hypotension BP:60/40mmhg . NORAD support was started with escalation of antibiotics and blood cultures sent . Fever settled after 5days and patient became hemodynamically stable . He finally was discharged on POD 24 .

Figure 4: wound healed by secondary intention .

III. Discussion:

Electric burns are intricate injuries that can impact multiple organ systems, presenting significant challenges for clinical management [6]. Electric injuries are typically categorized into two groups based on voltage: low-tension and high-tension, with 1,000 volts serving as the dividing line. There are three primary types of electric injuries [6]:

1. **Entry and Exit Wounds**: The entry point, where contact occurs, is often charred, depressed, and may be blistered due to vaporization of tissue water. In contrast, the exit point tends to be dry and circumscribed, often exhibiting an outward orientation caused by the explosive force of the current as it leaves the body.
2. **Arc Burns**: These occur when electricity arcs from a contact point to a ground point, typically associated with alternating current, leading to muscular contractions.
3. **Flame Burns**: Resulting from the ignition of clothing or surrounding materials due to heat generated by electric current.

Common entry points include the skull and upper extremities, with exit points generally found in the lower extremities. Once the skin is penetrated, the electric current typically follows the path of least resistance, which may not align directly between the entry and exit wounds.

Electricity can cause severe damage to human tissue by generating heat as it flows through. The extent of heat production is explained by Joule's law [7]:

$H=0.24I2\times R\times TH=0.24I2\times R\times T$

There are limited reports of electric burns resulting in full-thickness abdominal wounds. For instance, JY Yang et al [8]. described a high-tension electric injury with a full-thickness exit wound in the left abdomen, managed by early debridement and exploratory laparotomy, followed by split skin grafting on the fifth post-burn day; however, the patient later developed a gastrocutaneous fistula. Similarly, Wang Xuewei et al [9]. reported a high-tension injury with severe burns to the head, chest, abdomen, and both upper extremities, which involved a 3 cm defect in the abdominal wall with intestinal prolapse due to perforation. This was addressed through early debridement, exploratory laparotomy, and restoration of gastrointestinal continuity. Takashi Honda et al [10]. also documented a case of high-voltage electric injury leading to a full-thickness abdominal wound, which was managed with early debridement and exploratory surgery, temporarily reconstructed with a fascial prosthesis; this patient later developed a duodenocutaneous fistula.

Abdomen is usually not affected as it has a greater cross-sectional area and low resistance to electricity. All these factors may dissipate the energy of electricity, thus making an abdominal blow-out due to electrocution a rare phenomenon.[11] Management of abdominal blow-out can be done following principles, as reported by Stone *et al*.[12] :

1. Insertion of synthetic prosthesis to bridge any sizable defect in the abdominal wall rather than closure under tension via primarily mobilized flap.
2. Use of end bowel stomas rather than exteriorized loops for primary anastomosis in the face of active infection, significant contamination and/or massive contusion.
3. Delay in final reconstruction until all intestinal vents and fistulae have been closed by prior separation.

In our case, patient sustained high tension electric injury which flows through the right upper limb resulting in auto amputation of right distal forearm and charring with abdominal wall blow out involving full thickness at exit point over the right lower abdomen with prolapsed of omentum.

IV. Conclusion:

This case highlights the fact that the abdominal wall blow-out following electrocution is a rare phenomenon, and the underlying mechanism of such cases is not completely understood. It aso highlights the importance of considering visceral injuries in cases of high-voltage electrical injuries, even if initial evaluations appear normal. Contrast-enhanced computed tomography (CECT) of the abdomen can aid in the diagnosis of visceral injuries and could be considered as a routine imaging modality in high-voltage electrical injuries. These patients are at risk of developing abdominal wall hernia which should be repaired, if it becomes evident at later stage.

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