Electrocution Death: Exit Mark Injury use in the Suggestion of Body Posture during Forensic Investigation

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Abstract: Since then, electrocution and forensic investigation of electric death associated with criminal offenses have established the importance of mark injuries. The marks (entry and exit) came into significance as they were/are used to establish fatality and extent of electric power electrocuted. Unlike entry, exit injury has presented attention to scientists on its adequate and vital use in explaining forensic incident despite being infrequent. To enrich forensic understanding and make use of this "silent witness – exit mark", this study used four cases of related scenario. Three of the four cases were literature-based cases and one case involved in investigation. By interpreting the cases, this paper argued that exit injury contains useful information that can be related to posture of the body before electrocution. This paper thereby suggested the presence of the exit injury to be related to body posture, sole plantar exit injury in particular (stood position). This would help investigators and scientists to determine the immediate probable position and state of victim before electrocution. Furthermore, the suggestion would assist reconstruction processes that seek to find out the event originality through responding to fundamental and core principle tools of incidence investigation, CoPRRR, and the 6Ws.

1 BACKGROUND

Exit marks as to entry injury marks are common and crucial findings to establish electrocution associated deaths (Kumar et al. 2015; Kuhtic et al. 2012). On the occurrences of these injuries, together with mark entry and exit of encountered electric flow, the energy is converted in burning or shocking to the body. Location of occurrence is indefinable as depending on contact of conduction but palm and sole (plantar) are the common parts found with these marks, exit being on sole and entry primarily on palm. Though these two marks occur together, still there are some affirmations which have been established that exit injury can occasionally occur without the presence and occurrence of entry marks (Guntheti et al. 2012). That is, only exit injury mark observation is found in just few cases that are rare to meet in electrocution scenario. Its fatality in appearance may present similar to entry but its peculiarity is on a more tissue damage, skin splits and raising (Rao n.d.).

Apart from establishing fatality of the event occurred due to electrocution, a possibility of understanding body positioning or gesture during electric conduction may be suggested and explored. This is from the fact of potential resistance provided at particular body surface. According to (Manigandan et al. 2014), the amount current expected for passage depend on the resistance provided by the body or body part. Thus, in return, the extent of injuries to be caused proportionate the magnitude passed. Body positioned in standing while contacting ground or non-standing with free contact dictate the electric conduction to formation of exit wounds in plantar. This approach might reveal and ease the reconstruction of events in forensic investigation.

1.1 Justification and Purpose

Despite that exit marks in electrocution are discussed to have substantial use in establishing fatality forensic proof, limited studies have

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enumerated the sign and even yet related to body posture sustained before electric accident. This study, therefore, suggested the posture/gesture of the body before the electrocution in relation to exit injury in order to help reconstruction during forensic investigation. Also, to contribute on the knowledge of rare occurring exit injury marks.

2 METHOD

The study reviewed three previously published cases and presented an analysis of the encountered case to make a discussion of four cases in total. Both reviews of the cases and the encountered case in place were analysed to generate suggestive findings. Findings presented are based on; external examination of the dead body, internal observation, post-mortem, and autopsy findings, and also crime scene study findings focusing on exit marks and body gesture relation.

3 ELECTROCUTION AND MARK INJURIES REVIEW

The term electrocution is referred to death caused by electric shock. This is a sudden violent response to electric current flow to any part of a person's body. That violent response causes either primary electrical injury - tissue damage produced directly by electrical voltage or secondary injuries, such as thrown falls, are common (Fish & Geddes 2009). Death occurs when a sufficient amount of current passes through body parts by contact with electric equipments, frayed cords, poorly insulated wires, ungrounded electric instruments, and working in electric posts without any protective guard (Fish & Geddes 2009). The damages or burns caused due to contact are generally referred to as entrance and exit wounds. The kind of injuries according to (Fish & Geddes 2009; Kuhtic *et al.* (2012) sometimes get misleading interpretation to gunshot wounds by absence of bullet exit wound due to logging.

As pointed out earlier, these marks are essential to the establishment of electrocution deaths and become serious in forensic investigation where criminal offence is inquired from the scenario. The encountered obstacle in investigation might be interrupted by a poor definition or absence of those mark as explained in (Parakkattil *et al.* 2017). The study institutes that the difficult of investigating electrocution fatality cases are dependant of voltage. That is, high voltage electrocution burns resemble burns caused by other sources, especially if the person survives for few days. In that case, circumstantial evidence in correlation with the autopsy findings helps in determining the cause and manner of death. Crime scene findings also help to explain the pattern of injuries observed at autopsy in addition to contact-related features together with clinical signs that rule out current flow (Fish & Geddes 2009).

The literature discussion has also considered skin resistance (impedance), internal body resistance, current path through the body, the let-go phenomenon, skin breakdown, electrical stimulation of skeletal muscles and nerves, cardiac dysrhythmias, arrest, and electric shock drowning. From which, the high-voltage burns include ground faults, ground potential gradient, step and touch potentials, arcs, and lightning remain essential. As whole, incorporate the mechanism of electric current in the body; how and why specific accidents occur and what medical and surgical problems might be expected in reaching the manner and cause of death (Fish & Geddes 2009; Guntheti *et al.* 2012). However; the occurrence of deaths due to electrocution continue to be infrequent and so to incidence of the injury marks. This lowered tendency continues to qualify the virtual accidental nature of these kind of death from self-execute, suicides nature, and homicides to those executed entirely by alternating current (Wick & Byard 2009).

The lowered prevalence and incidence occurrence is also perpetuated by general preventive measures taken with time for electric safety usage. Remained fatalities occasion according to (Guntheti et al. 2012) with other literature still continue to reveal palmer as the commonest site for entry wound and crease fold of hands. The inference is that the commonest site of exit wound is feet, the sole. The study also concludes to four patterns of electrical injuries: entry wound alone, exit alone, both and flash burns, and no external typical signs with accidental nature and manner of electrocution. In this study; four cases are discussed. Three from literature and compared to one involved in investigation making a total of four. The analysis was made according the purpose of the aimed benefit above.

3.1 Literature Selected Case Presentation

The discussion of case one and two was obtained from the study named “Fatal High Voltage

Accidental Electrocution – Two Case Reports" where the author discussed cases of high voltage (Manigandan *et al.* 2014). With other danger encountered the two cases, this article narrated and discussed sustained injuries of whether presence or absence of exit injury marks;

3.1.1 Case Presentation 1

According to the article; the first case victim was a 14 years old boy who was referred to hospital casualty after sustaining electric shock while bird-nesting in an electric pole 20 feet higher from the ground. In hospital, the boy survived for 6 hours only after. The investigations reported biochemical within normal ranges. Autopsy reveal reported multiple burnt and punched out lesions on left half of the trunk, inner aspect of left upper limb and inner aspect of both thighs including the genital region as presented in Figure 1. Head dissection reported fracture of left temporal and parietal bones. Underlying the fracture extradural haemorrhage with blood clot weighing around 20 grams was also reported. Brain below the extradural haemorrhage was depressed with contusion of the left side temporal lobe (Figure 1).

Figure 1: Multiple burnt and punched out lesions involving trunk and genitalia (accessed from (Manigandan *et al.* 2014))

3.1.2 Case Presentation 2

Case reported a victim of 40 years old lineman who sustained electric shock and burn injuries while repairing high tension wires. The report narrates that; the victim was wearing a cotton shirt, and it caught fire during the incident. Autopsy revealed that burn injuries over front of chest, abdomen and anterior aspect of both thighs. A charred and deeply scorched electric mark was found over the lateral aspect of the right index finger that suggested entry wound. Multiple exit wounds reported on both feet and over the pulps of all toes of the right foot. Also, burn area of size 6x3.5 cm was on plantar aspect of the right foot due to tissue heating up as appears in figure 2, keratin dissolution and separation of epidermal layers. The report continued with a deeply scorched wound over the medial aspect of left foot (Fig 3). Cranial cavity examination reported extradural haemorrhage on left parieto-temporal area, diffuse subarachnoid haemorrhage in the left cerebral hemisphere along with contusion of the temporal lobe without any fracture of the skull.

Figure 2: Multiple exit wounds on right foot (accessed from (Manigandan *et al.* 2014))

3.1.3 Case Presentation 3

Report case three is obtained from the study named "Electrocution Method to Conceal Homicide: A Rare Case Report" where the author discussed a homicidal death with post-mortem electrocution injuries concealment (Jambure et al. 2012). The paper reported a case of male victim, 45 years old with history of accidental electrocution while ironing.

3.1.3.1 External Autopsy Examination;

External examination reported moderate built body, 56 kilograms of weight, 158 centimeters height with congested face. Conjunctivae petechial haemorrhage with bleeding on left ear. Neck found with multiple finger tip contusions and nail scratch abrasions on thyroid region over anterior and both lateral aspect, reddish in colour. Irregular, reddish, and abraded contusion over left forehead and burn injury over right forearm dorsal aspect. Electric burns over dorsum little finger, middle finger and dorsum of left hand. Two electric burns over right palm (Figure 3).

Figure 3: Electric burns over right palm (accessed from (Jambure *et al.* 2012))

3.1.3.2 Internal Autopsy Examination;

In the neck, there was found contusion over strap muscles on sides, thyroid and cricoid cartilage fracture, blood infiltration in fractured margins, epiglottis petechial haemorrhages. Under-scalp contusion was found under left fronto-temporal region with underlying subarachnoid haemorrhage and petechial haemorrhage in white matter of brain. Investigative tests reported alcohol in blood and in stomach. The report concluded by crime scene findings of iron press on table with outer coat of wire partially burnt, and inner coat intact also candle was on the table near iron press suggested to burn the outer coat of the wire of the iron press.

3.2 Encountered Case Presentation

3.2.1 Case Presentation 4

It is based on experience of participated investigation of electrocution death case in Surabaya. The victim was 33 years old male, 120 kilograms, and 173 centimeters. He was brought by police to Dr. Soetomo Hospital Forensic Department for Autopsy and Post-mortem examination under police request. The body was evacuated dead after consecutive persisted two days door lock with foul smell information from neighbours.

3.2.1.1 External post-mortem inspection;

On external inspection, the body was found greenish brown skin, skin peeling almost whole body, and a continued corpse decaying process. Burns and injuries on left hand - left thumb, finger (1,2,3), back of left hand (2 cuts); right hand - fingertips 1,3,4,5; six chest cut wounds and electrical burns wounds; stomach - 8 electrical burn wounds (Figure 4 a & b).

Figure 4: Multiple entry wounds on fingers

Figure 5: No encountered signs of exit injuries found on feet sole

3.2.1.2 Internal post-mortem inspection;

Found bleeding spots on the heart and tongue, neither laboratory test investigation revealed a positive toxicological test of the contents of the stomach and anatomical pathology nor substances test consumption. Summary report revealed that electrocution encountered death due to electrical trauma that caused cardiac arrest resulting in suffocation over 48 hours.

3.2.1.3 Visitation to Scene of Crime;

The crime scene of incidence was visited by a team of Forensic experts, police crime scene detective, and an investigator. The scene found to happen in a room of size 3.5x3 meter, in which an extension cable found open with dry decomposed fluids on surface (Figure 6b). Wire of the extension cable was burnt with blackish colour of contacted tissue during electrocution (Figure 6a). The cable was an extension from wall socket electric supply to television set and radio. The room was also found un-tidy with displayed staff, decomposed fluids with foul smell draining near exit door.

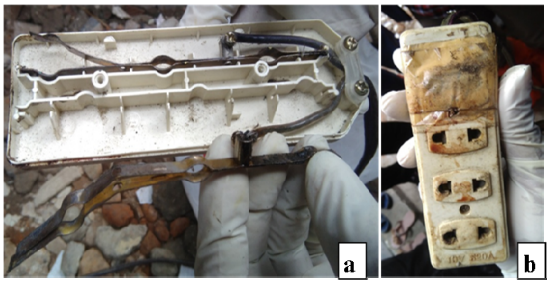

Figure 6: Extension cable with burnt wire and decomposed fluids found open in crime scene

4 DISCUSSION

In electrocution for death to occur, the human body must become a part of an active electrical circuit having current capable of over stimulating the nervous system or causing damage to internal organs. The basic physics of electric current can be expressed by the formula: Ampere=Voltage/Resistance. The extent of injuries received depends on the magnitude of the current (measured in Amps), pathway of the current and duration of current flow and the resistance offered by the body. Of the three; the amperage or the amount of current flow stand as most important factor in electrocution at constant voltage (V) with determination of resistance offered by the body against the current passage. The minimal amount of amperage perceptible to a human as a tingle is 1 milliamp, whereas 5 milliamperes produces tremors, and 15-17 milliamperes causes contracture of the muscles which prevents the victim from releasing the live conductor. Ventricular fibrillation occurs between 75 and 100 milliamperes or ventricular arrest at extremely high currents. Most fatalities occur with the domestic voltage between 110 and 380 Volts, which is the voltage range of houses and industrial electricity.

Skin offers higher resistance to the passage of current than internal tissues. The resistance (R) varies greatly according to thickness of the keratin covered epidermis. Thus, palms, soles and calloused skin provide more resistance than the thin skin elsewhere. Electric current takes the path of least resistance and creates heat, causing thermal damage to various tissues along its passage. Most of the deaths from electricity are from cardiac arrhythmias, usually ventricular fibrillation leading to cardiac arrest. It is due to passage of current through the myocardium and possible dislocation of pacemaking nodes. Death may occur as a result of respiratory arrest, due to paralysis of intercostal muscles and diaphragm or rarely by affecting the brain stem when the current enters through the head. But it must always be remembered that non-electrical trauma is quite common. With electric source of greater than 300 Volts, current might be transmitted by means of arcing, caused by formation of conductive plasma between the source and the ground. The blast effect of high-voltage arcing can throw the victim away from the source, causing fatal injuries. The distance to which an electric arc can jump is proportional to the voltage. The current can arc up to 35 cm in 100000 V or may be as little as few mm in 1000 V.

Referring to the four cases presented above; case 1 experienced a no entry or exit wounds. The sustained burn injuries were due to arcing of the current, giving rise to the appearance of ‘crocodile skin’. The victim suffered non-electrical injuries from being thrown to the ground. Case 2, both the entry and exit wounds were seen. In this case the exit wounds were multiple and much severe in nature compared to one entry (Figure 2). This extremely high voltage current causes the epidermal keratin to melt and, and after cooling, it leaves a raised brown or yellow nodule of fused keratin surrounded by an areola of pale skin. Case 3, though it was executed as concealment to homicide performed, still, conduction resulted into palm mark as entry injuries (Figure 3). Case 4 that happened in Surabaya evidenced no exit mark injuries (Figure 5 a & b) despite of multiple electric entry marks (Figure 4 a & b). Formation of marks as electric conduction pathway are associated to resistance as explained above. Furthermore, its presence suggests and nearly proofs the death of electric source. To all four, however, that case presented multiple exit wounds still case four behaved differently similar to case one, and case three that despite of electric passage with no exit injury mark were evidenced. The question is how the electric passage and conduction progress in these three cases is: case one, three and four? Because as to what is known, exit injury marks would have appeared on sole reciprocating the palm entry but also as the second tough skin surface apart from palm.

This presentation is a deviate to expectations but it gives a significant contribution on the scenario of electric conduction through the body. Here the scenario is on the position and gesture of the body to support passage and out flow of current during conduction. Visiting back to case one, the scenario tells that the victim was electrocuted while on electric pole – from such event, the body present a

no feet or sole contact with ground or any object (Figure 1). The absence of direct sole contact minimizes or removes the factor of increased resistance that would resist electric to path through similar to soft tissue. Case three presents an individual whose death was found to be primarily not of electrocution source instead a strangulation then concealment to hide evidence. In this too, the reconstruction of event might result in a victim laid down for intended or homicide electrocution after either homicide or weakened from alcohol and strangulation. The possibility of having exit marks is minimized because the body wasn't on its weight or stood position against ground. Thus, no resistance too restricted electric current to flow through. Case four likewise, the victim is presented with a possible reconstruction of a sustained death while repairing electric cable that was found open as presented in the scene of event. The possible position of the victim during repairing that cable is a down seated position. The position make the body sole in no contact similar to case one and three hence no resistance to current flow electrocuted. Discussing together with case two, body position suggests differences between the cases. The victim is presented as an individual electrocuted while repairing a high tension electric wire. The suggestion is drawn that the repair happened outside on high electric power line that transmits high tension electricity. While attending that, the victim was in stood position on ground contact, hence creating high pressure and tension on sole that resulted into resistance of electric flow to cause multiple exit injuries.

5 CONCLUSION

As thoroughly explained above on the importance of exit injuries in establishing fatality sign of electric executed death, this study adds on the provision of determining position and posture of the victim during electrocution. Summarizing from the four cases studied altogether, three cases: one, three and four are cases that suggest that their victims' sole were not in contact with ground (not in stood position) during the electric flow contrary to case two. This new suggestion influences occurrence of exit wounds which is vital to fatal establishment due to resistance encountered. Apart from such establishment of exit wounds injuries, the position suggests on the probability that help to attend the principle of reconstruction with easy that – the exit wound formation is in direct relation with body position during electrocution. The formed sole exit wound the tensed/pressured the sole contact – suggesting a stood position and vice versa. Significantly, adding to figure knowledge of exit injury formation. Specifically when attending to answer the last R (reconstruction) of CoPRRR (Control, Preserve, Record, Recover and Reconstruct) and 6Ws (What? Where? How? Who? When? and Why?) fundamental and core principle tools of forensic incidence investigation.

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