CASE
REPORT

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Contribution of medico-legal autopsy to the investigation of fatal occupational accidents: case report

Contribuição da autopsia médico-legal para a investigação do acidente de trabalho fatal: relato de caso

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ABSTRACT | Work accidents are a major public health problem. Although they are understood to be unintentional events, they are both predictable and preventable. Medico-legal institutes play a key role in the investigation of fatal work-related accidents (FWRA) because all cases of violent or suspicious death must be subjected to forensic autopsy. The present is a report of a case of FWRA in which autopsy contributed to a better understanding of the event's dynamics. The case concerns a 34-year-old man believed to have suffered a fall at the workplace. Examination revealed reddish and purple bruises on the chest, upper limbs and the occipital area, and hardened, partially detached epidermal lesions on the fingers, with the characteristic macro- and microscopic appearance of passage of electric current while alive. Fractures on the left parietal and occipital bones were found, as well as diffuse traumatic subarachnoid hemorrhage and laryngeal, subpleural and subepicardial petechiae. Blood alcohol and toxicology tests were negative. The cause of death was blunt head trauma, with signs of contact with electric current while alive. The autopsy therefore allowed for a better understanding of the mechanism of death, and ruled out the possibility of the worker having been under the effect of psychoactive substances at the time of event. Autopsy might be relevant to determine the sequence of events, thus contributing to the implementation of preventive measures.

Keywords | accidents, occupational; electric injuries; head trauma; forensic medicine; occupational medicine.

RESUMO | Os acidentes de trabalho são um importante problema de saúde pública. Embora entendidos como eventos não intencionais, podem ser previsíveis e preveníveis. Os institutos médico-legais desempenham importante papel na investigação de acidentes de trabalho fatais (ATF), pois todos os casos de morte violenta ou suspeita devem ser submetidos à necropsia forense. Este trabalho é um relato de caso necroscópico de ATF em que os dados obtidos na necropsia poderão contribuir para a melhor compreensão da dinâmica do ocorrido. Tratava-se de indivíduo do sexo masculino, com 34 anos de idade e suspeita de ter sido vítima de queda em ambiente de trabalho. Havia equimoses avermelhadas e arroxeadas no tórax, nos membros superiores e na região occipital do periciado. Na epiderme dos dedos das mãos foram observadas lesões cutâneas endurecidas, com destacamento parcial, que apresentavam aspectos macro e microscópico característicos de passagem de corrente elétrica em vida. Evidenciou-se fratura de crânio nos ossos parietal esquerdo e occipital, hemorragia subaracnoidea difusa, além de petéquias laríngeas, subpleurais e subepicárdicas. A pesquisa de alcoolemia e o exame toxicológico foram negativos. A causa do óbito foi traumatismo cranioencefálico contuso, tendo sido observados no periciado indícios de contato com corrente elétrica em vida. A autopsia permitiu melhor entendimento do mecanismo de morte e eliminou a possibilidade do trabalhador estar sob efeito de substâncias psicoativas no momento da ocorrência. Isso pode ser importante para a determinação da sequência dos eventos, auxiliando na implantação de medidas de prevenção.

Palavras-chave | acidentes de trabalho; traumatismos por eletricidade; traumatismos craniocerebrais; medicina legal; medicina do trabalho.

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INTRODUCTION

Work accidents (WA) are trauma events related to work activities that cause immediate or potential harm to the health of workers. They represent a significant public health problem as a function of their considerable morbidity and mortality, being death the worst possible outcome[1]. Although they are understood to be non-intentional, WA are predictable and preventable, which fact denies the fortuitous or causal connotation usually attributed to them. The best approach to avoid WA is to understand their mechanisms in order to plan preventive strategies.

The traditional sources for study of WA in Brazil are provided by the Department of Informatics of the Unified Health System (DATASUS) — System of Information on Mortality (Sistema de Informação sobre Mortalidade – SIM) and System of Information on Notifiable Diseases (Sistema de Informação de Agravos de Notificação – SINAN) — and the Social Security Technology and Information Company (Empresa de Tecnologia e Informações da Previdência Social – DATAPREV) — Single System of Benefits (Sistema Único de Benefícios – SUB) and Work Accidents Reports (Comunicação de Acidentes de Trabalho – CAT) database. All these sources have individual limitations, and one strategy to avoid them is to integrate traditional databases with other sources of information, as e.g., medico-legal reports[2].

A total of 3,242 deaths by WA were reported in Brazil in 2015[3], and the National Institute of Social Insurance (Instituto Nacional do Seguro Social – INSS) granted 368 death pensions related to WA[4]. Medico-legal institutes play a relevant role in the investigation of fatal work accidents (FWA), because in Brazil all cases of violent death must be subjected to forensic autopsy[5].

The aims of the present report are to emphasize the relevance of forensic autopsy for the understanding of FWA and to characterize medico-legal reports as a potential source of additional information for investigation of FWA.

CASE REPORT

The case concerns a 34-year-old male industrial electrician transferred to the Medico-legal Institute of Belo Horizonte, Minas Gerais, Brazil (Instituto Médico Legal de Belo Horizonte – IML-BH). The cadaver was dressed with a company uniform and synthetic boots, none of which exhibited signs of burns. According to the autopsy request form, the suspected diagnosis was WA at the workplace involving fall from a height, but there was no mention of any previous contact with electricity. The worker received urgent medical care, but was pronounced dead still at the site of the event.

External examination revealed reddish ecchymosis on the anterior chest, left arm and subscapular area and the occipital region. There were puncture wounds on the anterior side of both forearms. Hardened lesions with partially detached epidermis, compatible with thermal action, were found on the fingers (Figure 1).

Internal examination revealed localized fractures on the fifth costal cartilages and body of sternum. Subpleural and subepicardial petechiae were observed (Figure 2). The heart, lungs, kidneys, liver and intestines had normal size and no macroscopic sign of chronic disease. There was no bleeding inside the chest or abdomen.

Following removal of the scalp, diffuse bleeding was evidenced on the occipital area (Figure 3). On skull examination, a sagittal linear fracture was found extending from the left parietal bone to the foramen magnum (Figure 3) in addition to diffuse subarachnoid hemorrhage (Figure 3). The cerebral arterial circle and main branches were dissected, but no aneurysms or arteriovenous malformations were found. The brain tissue, subcutaneous tissue and neck muscles did not show signs of bleeding. Neither foreign bodies or luminal secretion were seen in the larynx and trachea. There were diffuse petechiae across the laryngotracheal mucosa (Figure 2). Neither fractures nor dislocations were found on the cervical spine.

Samples of urine, stomach tissue and content and liver were collected for toxicology investigation, and blood samples for alcohol measurement and toxicology investigation. All the toxicology tests were negative. Fragments of all the burns on the hands were analyzed; the results were compatible with lesions by antemortem passage of electric current (presence of vital reaction). Based on the autopsy findings, the cause of death was attributed to blunt traumatic brain injury (TBI) while the lesions on the hands denoted antemortem passage of electric current.

DISCUSSION

Whenever a violent or suspicious death occurs, a police inquiry is launched to establish whether it involved a crime and who was eventually responsible for it. IML-BH, a part of the Minas Gerais Police Department, is charged of performing medical legal examinations for cases in which crime left traces[5]. In the case of deaths by external causes, as is the one of FWA, the cadaver is the body of crime and must be

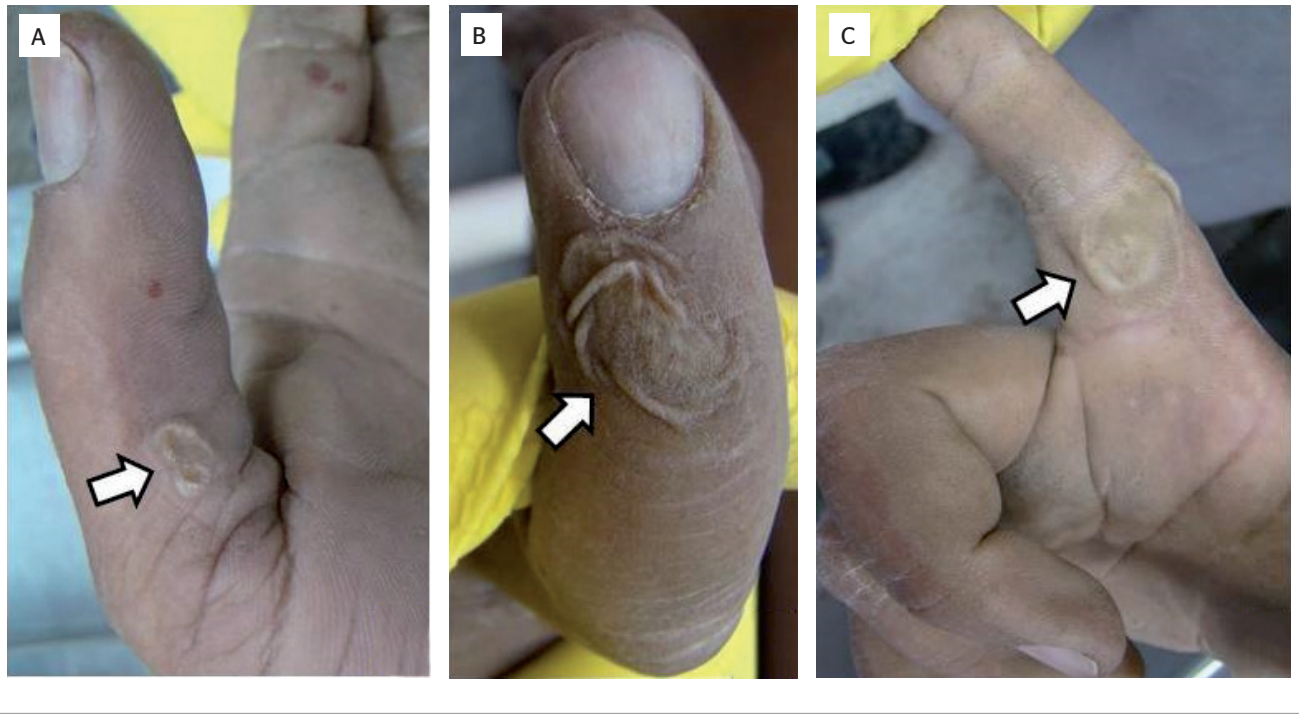


Figure 1. Lesions on the cadaver's hands. White arrows point to wounds compatible with passage of electric current on the first finger of the left hand (A), third finger of the left hand (B) and second finger of the right hand (C). The lesions had raised margins and exhibited partial detachment of the epidermis. Microscopic examination revealed epidermal coagulative necrosis in association with palisade-like distribution of the epidermal cells and cell vacuolization.

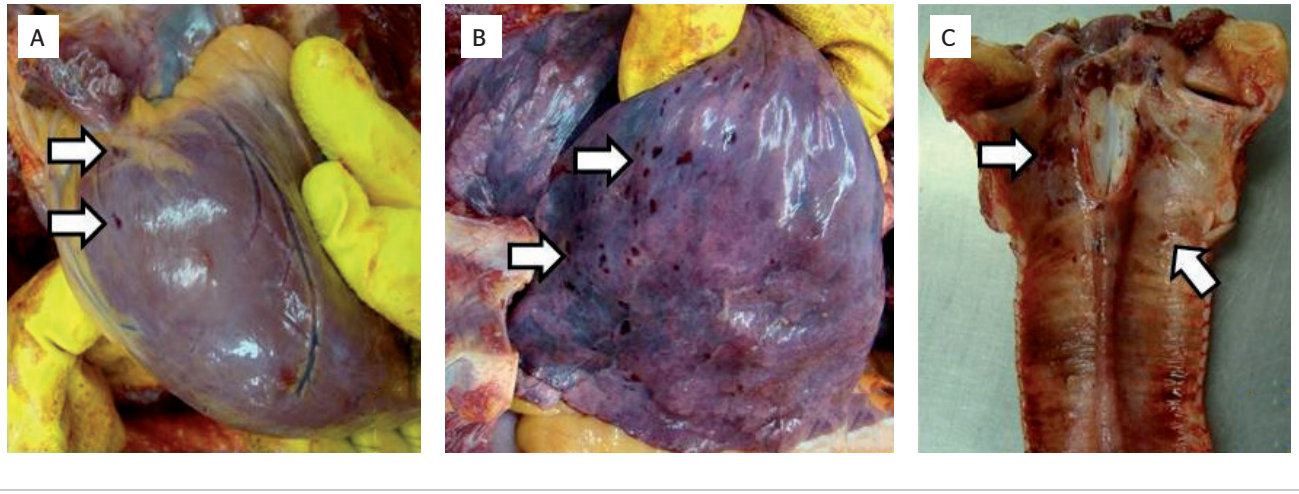


Figure 2. Heart (A), right lung (B) and laryngotracheal mucosa (C) in detail. White arrows point to petechiae (pinpoint bleeding).

examined as such. Therefore, all victims of FWA must be subjected to medico-legal autopsy, even when death occurred at a later time provided there is causal relationship between death and trauma.

FWA might have criminal, civil, social security, administrative and labor repercussions, and employers might be accountable as a function of their part in the occurrence of events. Yet, for employers to be held accountable there must be causal relationship between their actual behavior and harmful outcome (natural causation) or between harmful outcome and the behavior they should have had adopted (normative causation)[6]. Forensic autopsy might play a crucial role in the determination of causation.

In the case reported here, death was due to TBI, which is the main cause of death by trauma worldwide[7], and accounts for 22% of FWA in the United States. Falls, as occurred in the present case, are the main cause of FWA in Japan since 2005[8], and account for 91% of severe WA-related TBI in the United Arab Emirates[9]. Most workers with TBI after falls are male and under 40 years old[9], as was the case described in the present report. Predominance of males and younger workers are also the epidemiological characteristics of most of the other subtypes of FWA[10].

Although falls result in a wide variety of injuries[7], usually patterns are identifiable in the ensuing wounds[11]. Transfer of energy to the head causes injuries predominantly located on the occipital, frontal and temporoparietal areas[7]. The occipital area is particularly affected in falls; when individuals fall "on the back", energy is transferred to areas of considerable functional relevance, such as the brainstem, which might cause death even in the absence of fracture[7]. As a rule, the external occipital protuberance, on the medial part of the occipital bone, is the thickest part of the cranial vault[7]. As a result, energy transferred to this region tends to cause fractures on adjacent thinner areas. The morphological profile of the fracture found in the cadaver described in the present report was the one commonly found in victims of falls with impact on this area[7].

Pelvic and rib fractures are common findings in cases of falls followed by death. Hip bone injuries occur when a large amount of energy is transferred, and thus usually occur in falls from heights[11]; this type of injury was not found in the present case. Some hints indicate that the bilateral/symmetric fractures on the (fifth) costal cartilages and sternum were not caused by the fall, because in such cases unilateral (asymmetric) involvement of the first and second costal arches is more common[11]. In addition, rib/costal cartilage or sternum fractures are found, respectively, in up to 35 and 45% of autopsies of individuals subjected to external cardiac massage[12]. The main mechanism involved in the production of sternum injuries is transfer of energy to the anterior part

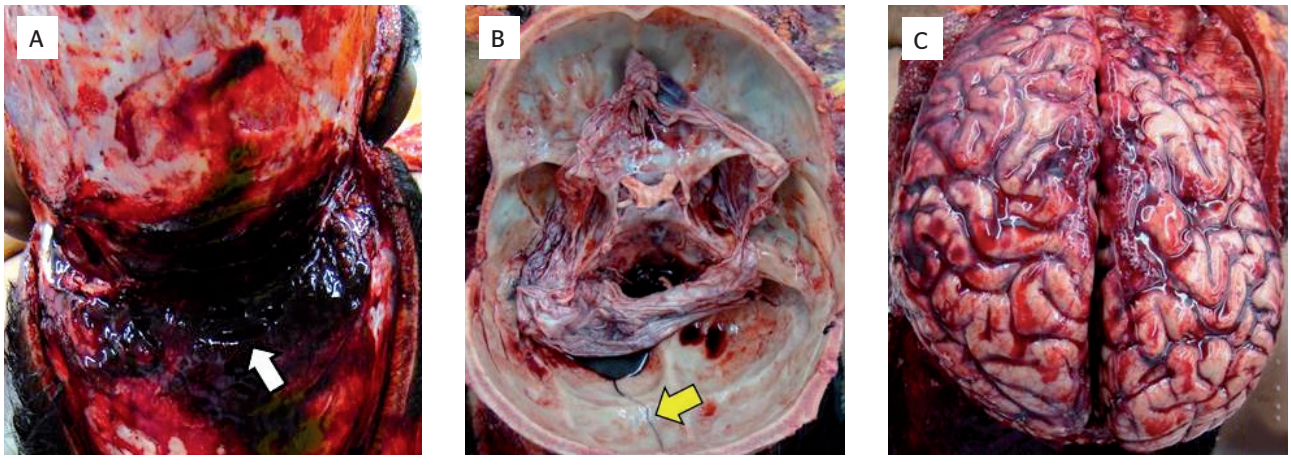


Figure 3. Head injuries. The white arrow points to subcutaneous hemorrhage all across the occipital area of the scalp (A). The yellow arrow points to a linear fracture on the left side of the occipital bone (B). Diffuse traumatic subarachnoid hemorrhage (C).

of the chest, resulting in anterior-posterior compression[12]. Most such injuries involve the body of sternum, have transverse direction (as in the present case) and are located on the point of energy transfer[12]. In the present case, the rib and sternal fractures, as well as the subepicardial and a part of the subpleural petechiae were very probably caused by the chest compression performed as a part of the medical care delivered following the accident[12]. Also the puncture wounds on the forearms were a result of medical care.

The diffuse subarachnoid hemorrhage (SAH) found on autopsy was attributed to blunt TBI after the most common causes of this type of bleeding were ruled out, such as ruptured arterial aneurysm, arteriovenous malformations and intraparenchymal hemorrhage secondary to systemic arterial hypertension and other chronic diseases[7]. Ruling out such conditions is relevant, because ruptured aneurysms might account not only for SAH, but also for falls, motor vehicle accidents and even sudden death[7].

Possible involvement of electricity must be investigated in every case of FWA based on the elements present at the site of the accident and the autopsy findings. The skin is the main barrier that opposes the passage of electric current across the body, and where it is thicker (pulp of fingers and soles) it offers greater resistance compared to the internal organs, which might give rise to burns through the Joule effect. However, presence of such burns does not allow inferring conclusions on the direction of the electric current, and thus neither on its points of entry and exit[13]. In addition, such burns are unspecific, and might occur also in other situations in which heat is transferred to the skin[13]. Confirmation of the mechanism of these burns is provided from analysis of all the available medico-legal data, including the ones relative to the site of the accident. It should be noticed that the body parts that more often enter in contact with electricity sources are the hands, feet and head[13]. In the present case, while burns were indicative of contact with electric current, the findings on the head showed that the immediate cause of death was TBI.

The distribution of FWA per occupation or economic sector varies among the various studies. The reason is that studies were performed in various geographical regions, which differ in productive profile (and consequently also on exposure to hazards), vulnerable groups and proportion of informal workers[14]. Falls at the workplace do not only derive from factors directly related to the type of occupation, but also from individual and environmental characteristics[8]. Electrical workers, as in the present case report, are at particularly high risk for injuries caused by contact with electricity and falls[10].

In the present case, blood alcohol testing and toxicology investigation were negative. Nevertheless, we stress the medico-legal relevance of these tests to understand the context of death. Alcohol and psychoactive drugs increase the frequency of WA by interfering with the motor coordination, critical judgment and attention, among other effects[15]. Nevertheless, alcohol and drug use have been scarcely studied as risk factors for WA, for which medico-legal reports are relevant sources of information.

Although the relationship of FWA with work is more obvious than the one of work-related diseases, there is still imprecision in the corresponding data. SINAN records severe, even fatal WA since 2004, and thus is a universal source of information on these events[2]. SINAN also provides categorized information on deaths, such as economic activity developed by the involved company and time when death occurred relative to the working hours, in addition to the sociodemographic profile of workers[14]. However, Ministry of Health Ruling no. 104[16] states that FWA should be mandatorily reported by Sentinel Units only; since such units miss in several locations, a considerable part of FWA are not reported[14]. Crosschecking of SIM and SINAN data on FWA that occurred in Belo Horizonte in the period from 2008 to 2010 revealed that 54.6% of the cases missed in SINAN[2]. Within this context of underreporting, medico-legal reports play a relevant role in the recovery of unreported cases.

Medico-legal autopsy affords a better understanding of the mechanism of death, which might contribute to the definition of the following sequence of events, as well as to the implantation of preventive measures by identifying where they are inefficient. Thus it represents a relevant source of information for occupational health.

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