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The pathology of torture

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ABSTRACT

Detainees may be subjected to torture and extra-judicial execution by State actors and terrorists. But, the pathology of torture has not been well-described. This is due to the lack of autopsies performed on victims of torture, mostly due to the disposal of the bodies of the victims by their torturers. On this basis, the cause of death of detainees subjected to torture is often a matter of speculation or remains obscure. This paper provides an overview of the pathology of torture based on the authour's experience with the autopsies of torture victims. At autopsy, many different types of inflicted injuries may be observed, often ranging in severity. However, three recurrent patterns of trauma that are the hallmarks of torture were recognized by the authour: (1) blunt impact trauma characterized by bruises, patterned injuries, and internal injuries; (2) electrical and thermal injuries; and (3) injuries from stress positions that occur from prolonged suspension. The most under-recognized form of fatal torture are the complications of stress positions related to suspension of the victim's body by the upper, or lower extremities. For example, prolonged suspension by reverse hanging (suspension of the victim's body by the wrists or forearms with the arms extended backward at the shoulder joint) can cause over-stretching and necrosis of the muscles of the shoulder, resulting in fatal myoglobinuric renal failure. It is essential that autopsies be performed on all detainees who die in custody, to determine if torture played a role in death. Furthermore, the true nature of the injuries sustained often remains obscure unless a musculocutaneous dissection is performed. Specifically, dissection of the back, limbs and the soles of the feet, as well as the shoulders and knees is essential to determine if specific forms of torture have been applied. This is especially true for fatal complications of stress positions. Seeking the truth about the medical consequences of fatal torture will raise awareness about torture-related injuries, assist in rehabilitation of torture survivors, and strengthen forensic humanitarian action.

1. Introduction

Torture, ill-treatment, and extra-judicial execution of detainees by State actors, terrorists, and other militants have occurred over human history. However, the medical investigation of torture has only recently been described [1–3]. Most of the published contributions in the medical literature on torture are retrospective studies on the aftermath of torture in living survivors. These studies are typically conducted on asylum seekers [4,5]. Very few studies have addressed the medical aspects of torture in active field investigations, while torture is occurring. Thus, virtually nothing has been published about torture as a clinicopathological entity. No systematic pathological studies have been published and only isolated case reports have described the postmortem findings in cases of torture [6–10]. This paucity of information is largely explained by the lack of access to dead bodies of torture victims. Most often, torturers dispose of the bodies of their victims shortly after death occurs. On this basis, autopsies are seldom performed. Furthermore, if autopsies are performed, the examinations are often incomplete and have limited documentation of physical findings. This knowledge gap contributes to impunity, and a lack of awareness about the detailed medical aspects of torture. In many ways, this situation mirrors the growth and development of knowledge, over the 20th century, of child abuse and neglect. Only through the systematic medical, radiological and pathological examination of children who had suffered abuse and neglect did the classical signs of child abuse become defined.

In recent years, humanitarian forensic science has emerged as a growing forensic discipline. This platform applies the various forensic disciplines to seek the truth about the injury, death, and disappearance of people, during times of war, internal armed conflict and terrorist action. This knowledge in turn helps to improve humanitarian action to prevent recurrence. Autopsies conducted in cases of torture, death in custody, and extra-judicial execution have expanded the evidence-base about the nature of

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injuries and cause of death for people who killed in those circumstances.

In this paper, I will explore the forensic pathology of torture. Due to the limits imposed by field work in this area of forensic medicine, much of the information in the paper is based on experience with casework, rather than systematic study. The experience is mostly based on cases that I have personally encountered on international missions during times of active conflict, or in post-conflict societies. Therefore, the specific types of torture reported in this paper may not be observed in all contexts. However, the framework for the approach to the autopsy on torture cases is generally applicable, i.e., the classification and descriptions of the signs of torture are unlikely to vary extensively between countries. In addition, torture cases are sometimes encountered in usual domestic death investigation systems at times of political stability, particularly in certain criminal circumstances. Hopefully, these data will catalyze additional clinical and scientific studies on torture and increase the interest in publishing case series on the autopsy findings in torture cases.

2. Practical aspects of autopsy on torture cases

2.1. Guidelines

The medicolegal investigation of death in the setting of torture, death in custody, and extrajudicial execution ought to include an autopsy. Failure to undertake an autopsy, whatever the cause of death proves to be, may well constitute a breach of the victim's right to life, as states have an international obligation to properly investigate potentially unlawful deaths. One of the main challenges in these cases is to undertake a comprehensive postmortem examination using the appropriate techniques and methods. There are several barriers which challenge the forensic pathologist (or other physicians) that may be tasked with the examination of bodies, in these circumstances. The main difficulty is access to the remains. However, even if forensic pathologists are permitted access to a body, the facilities available for postmortem examination range from inadequate to well-equipped facilities. Only rarely will facilities have modern technology, such as postmortem imaging capacity. On this basis, forensic pathologists must be highly adaptable to the situations presented by these cases. It is seldom helpful for a forensic pathologist to take a hard line position on the inadequacy of available facilities (e.g., lack of radiographic facilities) and refuse to examine a body. In general, a postmortem examination of the remains should be undertaken even in exigent circumstances. An external examination of the remains of the body may be the only practical approach that can be undertaken in some cases. Some experts may warn against only undertaking an external examination, if dissection is prohibited. However, a chance to collect information and provide at least a partial data set can be useful. A limited external examination of the body may raise more questions than it answers, but when balancing the benefits that can flow from an external examination of the body, there are considerable reasons to undertake such an approach.

If the postmortem examination of a body can occur without restrictions, several guidelines and protocols are available to provide guidance for conducting the autopsy. The main documents that are available and provide good guidance in the field include the United Nation's revised Minnesota Protocol [11] and the autopsy protocol of the International Committee for the Red Cross [12]. Furthermore, several professional organizations have provided autopsy protocols and guidelines which can be adapted for use in these cases (e.g., Royal College of Pathologists). In addition, clinical guidelines, such as the Istanbul Protocol [13,14], are helpful guides to the approach of the postmortem examination of cases of possible torture. If an authority blocks conducting an autopsy, if is of note to recognize that the Minnesota protocol indicates that the decision not to undertaken an autopsy must be provided in writing and subject to judicial review.

Whenever possible, radiological and laboratory investigations should be undertaken in the investigation of these cases. Histological and toxicological studies, often supplemented by biochemical analysis, can be helpful. Specifically, histological examination is crucial for dating and timing injuries, and toxicological examination is required if exogenous compounds such as drugs and poisons have been administered. Furthermore, biochemical examination of the urine for myoglobin (e.g., rhabdomyolysis) and vitreous biochemical testing for electrolytes (e.g., dehydration), and creatinine and urea (e.g., renal failure) can provide important clues to metabolic derangements. Tissues for histological examination should be fixed in formalin. However, in some contexts, it may be impossible to obtain formalin. A potential substitute for formalin is 70% ethanol. But, if alcohol is not available, tissues can often be kept wet and refrigerated for several days prior to subsequent formalin fixation and histological preparation. Freezing the tissue is not advised, but is the option of last resort. Similarly, samples of body fluids should be refrigerated, or frozen, if there will be a delay in submission of the samples to the laboratory.

2.2. Photography

Producing a photographic record of the postmortem examination is a key role for the forensic pathologist in these cases. The importance of high quality photographs cannot be over emphasized for two main reasons. First, macroscopic photographs provide independent reviewability of the pathologist's findings by other experts. Independent reviewability is an important cornerstone of modern forensic pathology. The availability of photographs, will allow disputes about the presence or absence of wounds and their interpretation, to be more easily resolved. Second, photographs provide powerful transparency of the postmortem findings for non-medical stakeholders. This is important because it embraces an unbiased truth seeking stance by the pathologist. The images are a permanent record. Thus, the truth that is displayed by photographic evidence, while vital for expert interpretation, can also provide a more accessible and open demonstration of what happened to a decedent, which often extends the report and opinion of the forensic pathologist. Such photographic documentation can be critical in the context of fact finding missions for international organizations, truth and reconciliation processes, and Courts.

In the modern era, digital photography has expanded the availability of images. Specifically, digital photography in the autopsy of these cases has increased the availability of photographic documentation of injuries. The main shortcoming that is encountered with such photographs is the lack of a scale (ruler) in the image. In addition, photographs are sometimes obtained without properly cleaning blood away from the skin surface. On this basis, photographs of wounds should be obtained before and after the wound has been cleaned. A scale must be placed adjacent to the injury. The use of trained and official photographers is preferred. However, the widespread availability of mobile phones with digital photographic capability opens up new opportunities to obtain images. Therefore, if a postmortem examination is occurring under exigent circumstances, and only digital photographs using portable or mobile devices are available, these devices ought to be used to obtain images.

2.3. Dissection

A complete traditional medicolegal postmortem examination consists of dissection of the head (cranial cavity), neck, chest,

abdomen and pelvis (pelvic organs). However, additional dissections can be important in cases of torture, death in custody, and maltreatment. Musculocutaneous dissection of the anterior torso, posterior neck, back, and limbs can be essential to determine the extent of injury (Table 1). Furthermore, layered dissection of the neck is often required to determine the specific injuries are present due to neck compression. Layered dissection of the face can reveal deep injuries and facial fractures. Dissection of the neck and face should only be performed following passive drainage of the blood through the great veins of the head and chest. This is achieved by eviscerating the thoracoabdominal organs and removing the brain prior to dissection of the head and neck. Specifically, elevating the neck such that the great vessels of the chest (subclavian veins) and the jugular foramina (at the base of the skull) are in a position that is lower than the anterior neck will promote adequate decompressive drainage of blood from the neck. Unless this procedure is performed, there is a risk of producing artefactual hemorrhages in the neck tissues and in the strap muscles.

In cases of suspected falanga, dissection of the soles of the feet is required. Furthermore, in cases where death occurs in police custody after interrogation with minimal autopsy findings, it is necessary to dissect the feet to determine if injuries of falanga are present.

An often unrecognized pattern of trauma found in fatal cases of torture is injury to the major joints. The reason that these injuries escape detection is that the shoulder and knee joints are usually not dissected at most autopsies. Dissections of the glenohumeral joint, and the muscles surrounding the shoulder and scapula, can provide critical information on the nature of the injuries sustained in the upper arms and shoulder girdle. Furthermore, dissection of the knee, including examination of the patella, knee joint and ligaments can provide important information about injuries sustained in this area.

3. Specific signs of torture at autopsy

3.1. Blunt impact trauma

The most frequently encountered injuries related to torture and maltreatment of detainees and prisoners are due to blunt impact trauma (Table 2). Specifically, the body can be struck with an object or the body can be otherwise injured by impacts or striking the body against objects. One of the most characteristic patterns of injury observed at autopsy are tram track bruises related to impacts with elongated rigid or semi-rigid implements (Fig. 1a). Tissue injury with patterned weapons, such as rods and whips, can also cause superficial lacerations that can become infected with delayed healing (Fig. 1b). Healed patterned injuries are often visible as tram track scar or U-shaped scars (Fig. 1c). The scars are often represented by patterned areas of altered pigmentation (hypopigmentation or hyperpigmentation) and must be differentiated from post-inflammatory changes from dermatological conditions.

Blunt impact trauma may only be represented by non-pattern injuries such as bruises, abrasions and lacerations. However, an

Table 1
Special dissections for autopsies in torture cases.

Dissection	Technique
Musculocutaneous dissection of the anterior torso, posterior neck, back, and limbs	A Y shaped incision of the anterior torso is made, extending from both shoulders to the sternal notch and from the sternal notch to the pubis. The skin is then reflecting by incising the subcutaneous fat. This will reveal the underlying muscles of the chest and the muscles of the anterior abdominal wall. The reflection is extended to the lateral aspects of the chest and abdomen to maximally examine the sides of the body and the axilla. The muscles covering the rib cage are dissected to allow inspection of the ribs. The abdominal cavity is then opened by dissection of linea alba and the subcostal muscles. The posterior neck is dissected with an inverted T shaped incision across the shoulders (with the vertical incision over the back of the neck) and an inverted Y shaped incision down the back, extending to the buttocks. The limbs are further dissected by extending the incisions from the shoulder to the wrists and from the buttock to the ankle. The skin is reflected to form large flaps that run the length of the limbs. The upper back and posterior neck are dissected by reflecting two flaps from the inverted T shaped incision. The lower back and buttocks are similarly examined by reflecting the skin from the inverted Y shaped incision. Subcutaneous tissues and muscles can then be incised and further inspected for injuries.
Layered dissection of neck and face after passive venous drainage of the head	An incision is made extending from the tip of both shoulders along, on the sides of the neck, connecting to the incision across the dome of the head used to remove the brain. The incisions join just beneath the ear. The skin is reflected towards the nose and the skin flap is pulled upward over the face. Once the skin is entirely reflected, the individual strap muscles are incised at their distal insertion and reflected toward the upper neck. The thyroid gland is removed and the lamina of the thyroid cartilage inspected for injuries. The soft tissues of the superior cornu of the thyroid cartilage are then dissected with the larynx in situ to determine if fractures are present involving the superior cornu. Special attention should be made to not mistake triticeous cartilages for fractures. The hyoid bone is exposed and examined for fractures while it is in situ in the neck. Once the larynx and hyoid have been examined for fractures, the neck organs can be eviscerated with the tongue. The tongue is removed by incising the floor of the mouth adjacent to the mandible and the neck organs extending from the tongue to the thoracic inlet can be removed en bloc and then dissected on a dissecting board. The pharynx and esophagus are opened. The larynx on the dissecting board is further examined using a single, horizontal section through the cricoid cartilage to examine for cricoid fracture. The larynx is then opened along the posterior aspect of the larynx and trachea. The mucosal surfaces are examined for hemorrhage or other abnormalities.
Dissection of the shoulder and knee joints	The shoulder joint is dissected by extending the incision from the tip of the shoulder to the elbow over the anterior or lateral surface of the biceps. Once this skin is reflected, the upper arm, shoulder and clavicular region are exposed. The individual muscles can be cut from their attachments and reflected. In addition, the lateral clavicular end can be removed from the shoulder joint and the clavicle mobilized to expose the glenohumeral joint. The muscles are inspected and serial sectioning. The glenohumeral joint is opened by incising the capsule of the joint. A similar approach is used for the knee by making a linear incision on the anterior surface of the knee above the patella. The skin is reflected medially and laterally to expose the patella. The patella can then be freed from its attachment and the joint capsule of the knee can be directly opened for inspection of the synovial surface and the synovial cavity.
Dissection of the feet	Either a T shaped incision is made on the sole of the foot, or a straight incision is made on the sole of the foot. The skin is reflected, exposing the subplantar tissues.

Table 2
Specific signs of torture at autopsy.

Types of torture	Common postmortem findings
Blunt impact trauma	
Patterned injuries	Impact with rods, whips, semi-rigid tubing indicated by tram track bruises (bruises are mostly intra-dermal).
Diffuse musculocutaneous injury	Widespread subcutaneous and intramuscular hemorrhage involving the torso and extremities; compartment syndrome due to edema and hemorrhage along deep myofascial planes; necrosis of injured muscle (especially involving thigh and gluteal muscles).
Falanga	Subcutaneous hemorrhage involving the soles of the feet and often extending onto the dorsum of the feet; hemorrhage beneath plantar fascia; occasionally, massive hematoma of the sole of the foot with swelling and deformity.
Head injury or injuries to internal organs	Subscalp bruises; skull fracture; subdural hemorrhage; rib fractures; and hemoperitoneum from laceration of liver, spleen, or mesentery.
Stress positions	
Reverse hanging (reverse suspension by arms, akrab, stappado, scorpion position)	Ligature marks on wrists/forearms; shoulder joint injuries including dislocation; brachial plexus injury; and necrosis of the major muscles of the shoulder and chest.
Helicopter (chicken kebab, reverse hanging by knees)	Deep venous thrombosis and pulmonary thromboembolism.
Wrist suspension	Ligature marks on wrists; ischemic necrosis of hands, including gangrene; and thrombosis of ulnar and radial arteries.
Electrical and thermal trauma	
Joule burns from the application of electrodes	Joule burns appear as pale, firm, well-demarcated areas of skin coagulation often with a blister; frequently, Joule burns involve symmetrical locations (feet, legs, and chest) and genitals.
Burns from the application of heated objects	Thermal burns (mostly second-degree) range in appearance but are usually variably-sized grey-black blisters; localized burns often involve the digital pads of the toes and fingers; widespread scalding burns can occur; burns can be secondarily infected; cigarette burns are usually circular and about 6 mm in diameter.

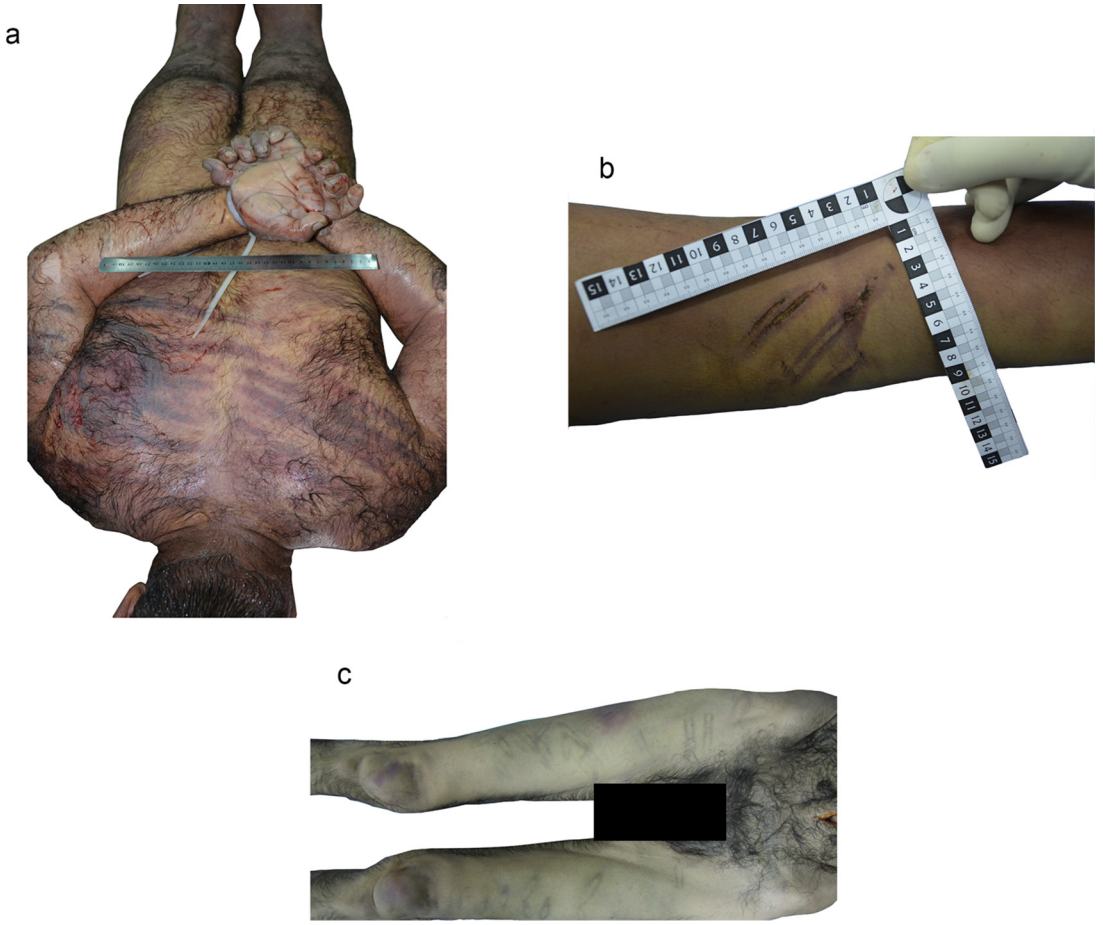

Fig. 1. Patterned injury.
A. Tram track bruises. B. Infected tram track injuries. C. Tram track scars.

important variant that is frequently encountered in cases of fatal torture is diffuse musculocutaneous injury. Widespread and broad impacts on the torso and extremities may reveal no well-marked evidence of external bruising on the skin surface, but there can be extensive bruising beneath the skin. Widespread subcutaneous and intramuscular hemorrhage can involve the torso and the extremities. This pattern of injury underscores the need for careful musculocutaneous dissection at autopsy, particularly on the back of the body (Fig. 2a–d). If this form of injury involves the muscles of the extremities, compartment syndrome may develop due to edema and hemorrhage deep within the central anatomy of the limbs. This may cause secondary ischemic necrosis of muscle and soft tissues. In addition, direct contusion and intramuscular laceration can often be found in the large muscles of the arms, thigh and buttocks, most commonly the gluteus maximus. Dissection of these muscles will show extensive hemorrhage and necrosis within the muscle belly.

Internal blunt impact injuries are frequently encountered in the head, chest and abdomen. Head injuries will range from simple subscalp bruises and lacerations visible on the skin surface to subscalp bruising associated with skull fracture. The pattern of skull fracture can range from simple linear fractures to depressed or comminuted fractures. Significant head injury is often associated with subdural hemorrhage, subarachnoid hemorrhage, single cortical contusion and deeper traumatic brain injury such as traumatic axonal injury. Sometimes, the head injuries can be rapidly fatal but in many cases, death will occur in a delayed circumstance with features of raised intracranial pressure and mass effects from swelling of contused brain tissue or mass effects of space occupying hematomas. Other common internal injuries include laceration of the liver (Fig. 3), spleen or mesentery with subsequent hemoperitoneum. Acute blunt impact trauma to the chest may cause death by hemopneumothorax and lung injury, often in the setting of rib fractures. However, it is not infrequent to simply find chest wall bruising and rib fractures without deeper internal injury.

Fig. 3. Liver laceration.

Repeated blunt impact injury on the feet can result in subcutaneous hemorrhage involving the soles of the feet and hemorrhage beneath the plantar fascia [15]. This characteristic type of torture is falanga (falaka in Arabic) and may be invisible upon external examination of the foot. Occasionally, minor bruising is found on the sole of the foot, but this may be confused with postmortem hypostasis. Dissection of the foot typically reveals more extensive subcutaneous and subplantar hemorrhage, indicative of marked blunt trauma (Fig. 4a, b). In extensive cases of falanga, the bruising may extend to the dorsum of the feet and the

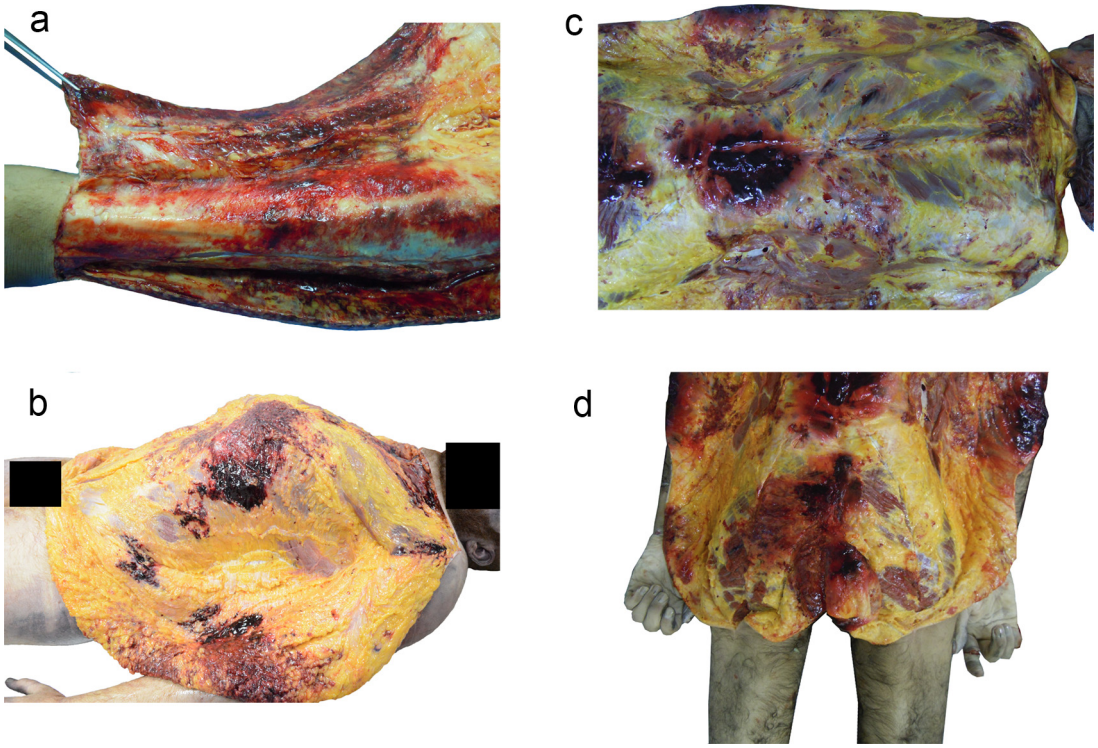

Fig. 2. Subcutaneous bruises.

A. Leg. B. Side of torso. C. Back. D. Buttock.

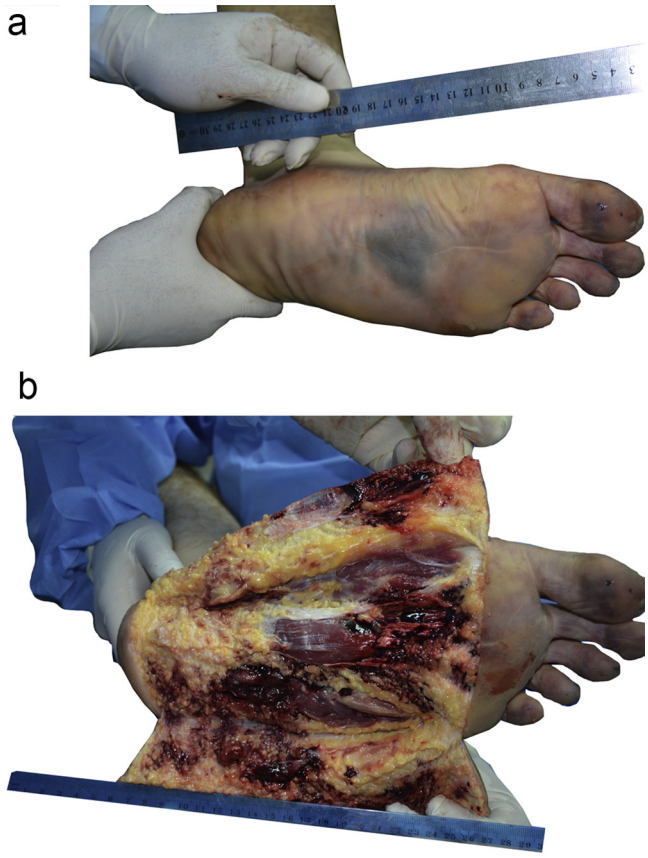

Fig. 4. Falanga.
A. External appearance. B. Internal appearance.

foot may be markedly misshapen and deformed due to massive accumulation of subcutaneous blood clots. This can also result in compartment syndrome.

Torture by targeted and repeated trauma of specific body parts is often encountered (Fig. 5a). These injuries include: crushing of digits, avulsion of nails (Fig. 5b), repeated whipping, and long-term shackling (Fig. 5c), and other serious healing injuries (Fig. 5d). Some long-term detainees may be subjected to a pattern of repeated physical abuse and neglect for months or years.

3.2. Stress positions

The most systematically under-documented form of torture and maltreatment of detainees are the injuries caused by stress positions (Table 2). Stress positions occur when the individual is forced to maintain a static posture across one or more joints, either through suspension or other physical means of fixing the person into the position. Stress positions can lead to discomfort and ongoing morbidity related to peripheral neuropathy from traction injury to peripheral nerves. In addition, stress positions may produce secondary consequences which can lead to death. Most frequently, death from stress positions is a delayed complication of the injuries that occur associated with suspension. The most extreme form of stress position which may cause death is crucifixion [16].

A simple form of stress position is complete suspension by the wrists by hand cuffs or ligatures. At autopsy, ligature marks are found on the wrists and there may be ischemic necrosis of the hands, including the development of frank gangrene. The main finding upon dissection of the wrists is thrombosis of the ulnar and radial arteries which results in the ischemia of the fingers and hand. Careful dissection of the blood vessels of the wrist, beneath the ligature marks is often helpful in determining the duration of suspension. Extensive ischemic necrosis of the hands causes the hands to appear swollen and congested with blisters.

A form of suspension where individuals are suspended upside down from the knees, placed over a dowel or bar, can cause deep venous thrombosis and pulmonary thromboembolism. This form of suspension is sometimes known as “helicopter” or “chicken-kebab” [10]. The pressure exerted on the popliteal vein causes occlusive thrombosis of the popliteal vein and femoral vein. Upon release from the suspension, the thrombi can become dislodged and cause sudden unexpected death from pulmonary thromboembolism. In all cases of pulmonary thromboembolism that occur in police custody, particularly after interrogation, the lower extremities should be dissected for evidence of venous thrombi and to search for injuries on the posterior surface of the knee, and within the knee joint.

A common form of fatal stress position is reverse hanging also known as akrab (in Arabic), strappado, scorpion position, or by the obsolete term Palestinian hanging. This stress position was documented to occur in the Spanish inquisition [17] and World War II. The individual is suspended by the wrists after the hands are tied at the back. The elbows and shoulders extended backwards. The suspension is usually prolonged over a period of hours, but can occur for days. At autopsy, there are ligature marks on the wrists and on the forearms (Fig. 6a). However, the external examination is largely unremarkable. Dissection of the body may reveal dislocation of the glenohumeral joint and coagulation necrosis of the major muscles of the shoulder and chest at the points of insertion in the shoulder joint (Fig. 6b). In addition, there may be hemorrhage into the joint capsule of the shoulder and hemoarthrosis of the glenohumeral joint (Fig. 6c). There may be frank brachial plexus injury with hemorrhage along the nerves. The muscle necrosis is due to over-stretching of the muscle belly causing ischemic necrosis of the myocytes. This muscle necrosis can give rise to myoglobinuric renal failure if extensive involvement of the pectoralis major, deltoid and scapular muscles occurs due to prolonged suspension [9]. In addition, long term survivors of reverse hanging have neurologic deficits related to brachial plexus palsy with sensory and moderate impairment of the upper limbs [18]. If detainees survive reverse hanging and do not obtain rehabilitation or physical therapy, the resulting paralysis can severely reduce the quality of life. Survivors often show extensive edema of the hands due to gravitational dependency and the inability to raise their arms.

3.3. Electrical and thermal trauma

Joule burns from the application of electrical energy can occur during interrogation (Table 2). At autopsy, Joule burns appear as pale, firm and often well demarcated areas of thermal coagulation of the skin, often with an associated blister that has been ruptured. Joule burns are often symmetrical and in peripheral locations such as the feet and legs. However, in several circumstances, electrical injury can be observed in the external genitalia. Sometimes the electrical current is delivered on skin, without a localized electrode but rather using a wet cloth. Thus, it may be difficult to detect electrical burns in some cases.

Thermal burns (mostly second degree burns) can often be found at postmortem examination. These burns variably are well demarcated and either show a blister, or a ruptured blister. The burns are often circular and localized to the digital pads of the toes and the fingers or the dorsum of the hand, although such burns can be found in any body location. Burns from cigarettes are usually circular and about 6 mm in diameter, although there may be a variation in size (Fig. 7a). Burns due to the application of heated

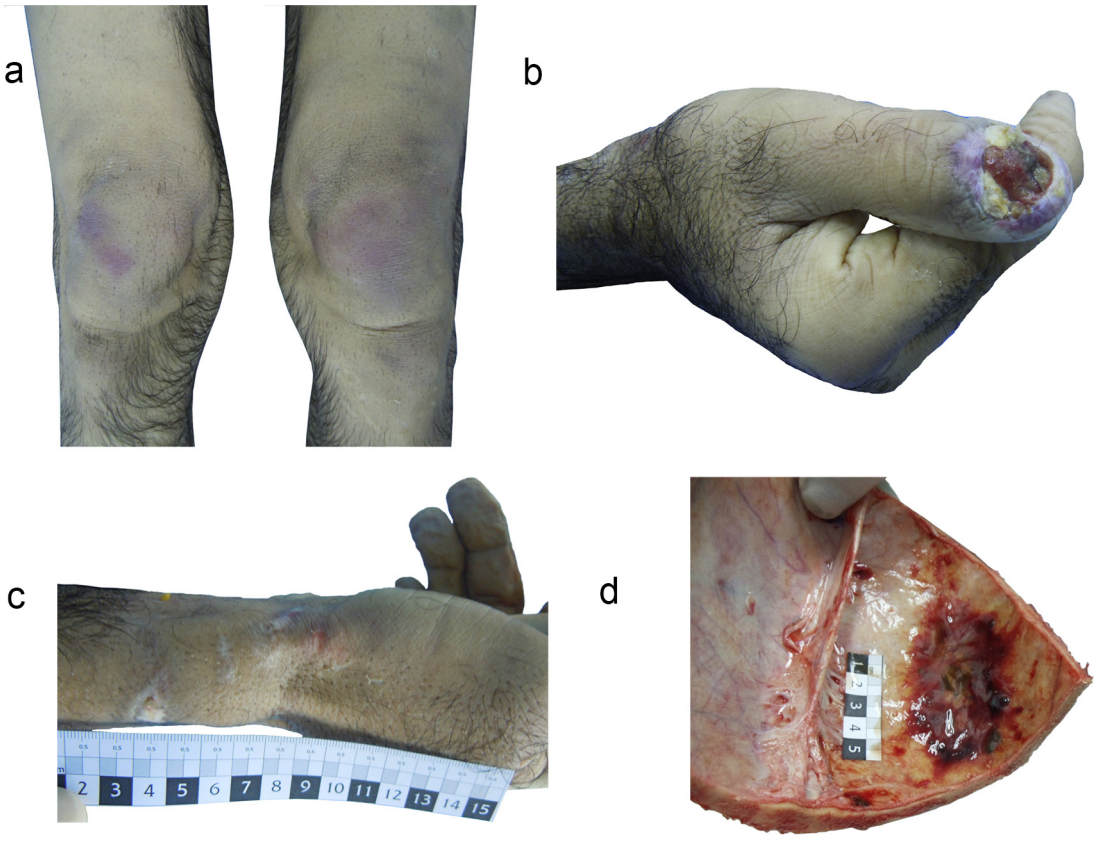

Fig. 5. Repeated torture of long term detainee.
A. Knee bruises. B. Avulsion of thumbnail with healing. C. Chronic wrist restraint injuries. D. Organizing subdural hemorrhage.

objects, torches, or scalds (hot liquid burns) may also undergo secondary infection. Large burns inflicted by large heated objects, such as clothing irons (Fig. 7b), can result in fatal infection (Fig. 7c).

One of the main challenges to the correct interpretation of electrical and thermal burns at the time of postmortem examination is differentiation from postmortem artifact. In the early postmortem period, particularly in arid environments, there may be considerable postmortem drying and mummification of the skin. If these artifacts occur in the fingers and toes, the changes may obscure or complicate the interpretation of punitive burn injuries. Furthermore, perimortem burns can often be diagnostically challenging because the injuries are superficial and the blister may become denuded from the injury. On this basis, the injuries may be misinterpreted as round abrasions with postmortem drying. Histologic examination is often helpful to confirm whether or not a lesion is a burn. Histologic examination will reveal nuclear streaming in the epidermis. In addition, heat coagulation of the dermal collagen will cause the collagen fibres to appear red on the Masson's trichrome stain [19]. In some cases in electrical burns, tissue samples can be obtained for the laboratory investigation of metallization of the skin surface. This analysis can be done in cases where there is considerable dispute of the nature of the injury.

4. Causes and mechanisms of death associated with torture

4.1. Torture-associated deaths

If a death occurs during or after torture, the forensic pathologist will need to decide if the torture caused or contributed to the death, or was simply associated with torture by coincidence (Table 3). In practice, there are four main categories of death associated with torture. First, acute death may occur during torture and can be directly causally related to the torture injuries. Second, sometimes a death occurs after torture and is caused by delayed complications of the torture-related injuries. Typically, the fatal pathophysiology is related to hemorrhagic shock, embolism, sepsis, or renal failure. Third, in some cases, death may ensue from the conditions of the detention, either through neglect, airborne infection (or infections related to poor custodial hygiene), or the lack of health care for an acute disease. Finally, although the detainee may have been subjected to torture, the death may be unrelated to the maltreatment or injuries sustained during torture. Such deaths are often due to suicide.

4.2. Death during torture

In many cases of torture with fatal physical injury, death is due to hemorrhagic shock. The hemorrhagic shock is often related to internal bleeding which results in hemothorax, hemoperitoneum, retroperitoneal hemorrhage, or extensive subcutaneous and intramuscular hemorrhage. In many of these cases, external inspection of the body may reveal only a few injuries or no injuries. However, dissection will reveal clear evidence of internal bleeding that resulted in death. It is essential to quantify the volume of blood that is in body cavities, or estimate the extent of blood loss into soft tissues. In many cases, only a qualitative description of the amount of blood loss can be achieved due to extensive interstitial spread of hemorrhage. Forensic pathologists may initially suspect exsanguination by internal bleeding if the postmortem hypostasis appears to be faint or poorly developed upon external examination of the body. Secondary indicators of hemorrhagic shock are also often helpful at autopsy. In the circumstances of acute blood loss, pallor of the brain, liver, kidneys, and skeletal muscle is often very helpful to ascertain the extent of

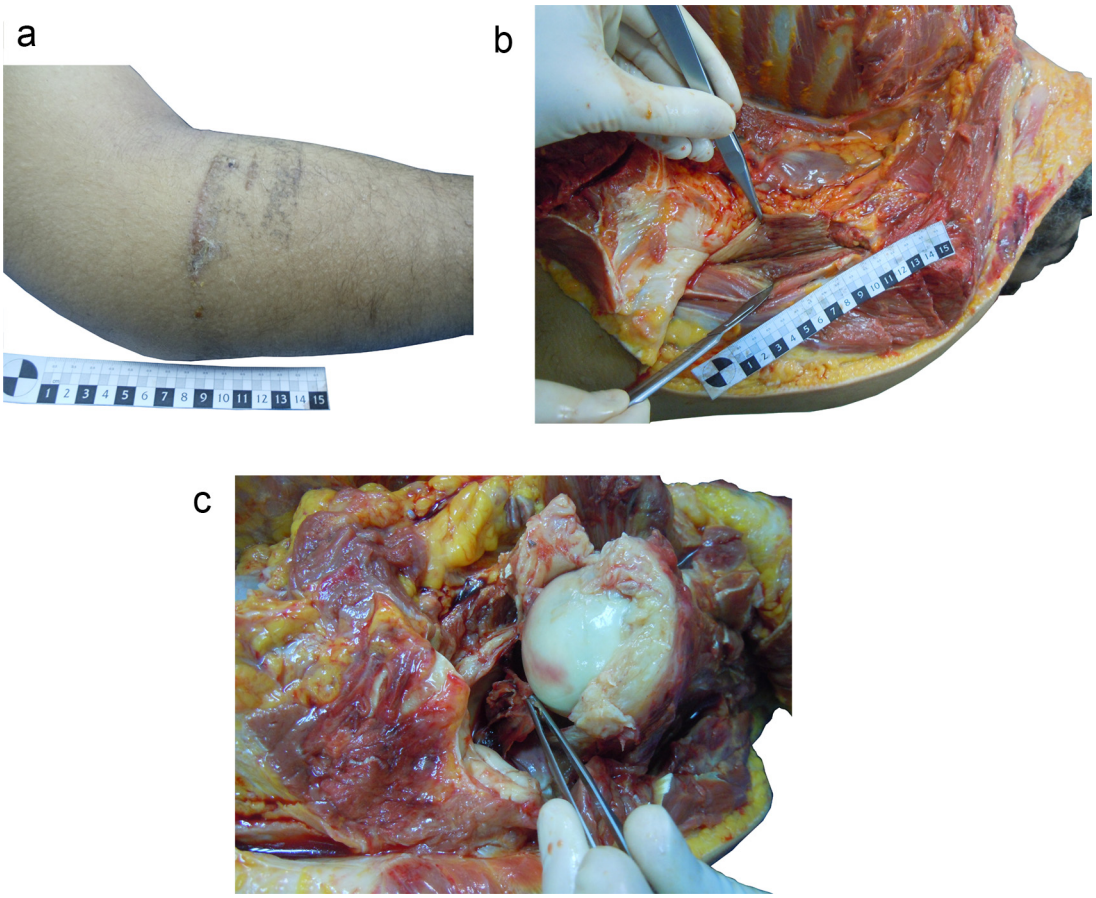

Fig. 6. Reverse hanging.
A. Ligature marks of forearms. B. Necrosis of skeletal muscles of shoulder. C. Organizing hemoarthrosis of shoulder joint.

blood loss. Furthermore, the size of the spleen may indicate extensive blood loss because the spleen is usually shrunken and small (splenic contraction). Other indicators can include extensive subendocardial hemorrhage of the left ventricular outflow tract, which is a consequence of catecholamine-surge in shock.

Torture-associated deaths may also be related to asphyxiation. Asphyxia can occur with obstruction of the airway, usually through physical interference with the nose and mouth, such as with gagging or taping of the nose and mouth. This may provide considerable challenge for the forensic pathologist who performs the autopsy in such cases, if the gag or obstructing object has been removed prior to autopsy. The gag or foreign body in the air passages may have been removed by the torturers, or maybe removed by other people who have come in contact with the body prior to the forensic pathologist's examination. This is often the case with cloth gags, or plastic bags, placed over the head. Indicators of airway obstruction may include injuries of the face, lips and the mucosal surfaces of the mouth. Furthermore, residue of adhesive tape on the skin of the face and lips, in and around the nostrils can be very helpful in determining if tape has been applied to the face. Asphyxiation can also occur by strangulation, often with a ligature. Ligature marks may range in size and shape and width and shape. However, fatal neck compression is nearly invariably associated with conjunctival petechial hemorrhages. A detailed layered dissection of the neck is essential in these cases.

Death may also occur during immersion of the head in water, either in the context of submersion or by controlled flooding the air passages with water (e.g., water-boarding). The findings at autopsy may be minimal in such cases. One consistent pattern of case that is often observed with detainees who died during interrogation is a relatively negative autopsy. Careful examination of these cases would often reveal minor injuries or evidence of falanga. Some of these cases may be deaths related to asphyxiation (airway obstruction or flooding the air passages with water), or low-voltage electrocution. However, it may be difficult to definitively establish the cause of death due to the lack of the specific postmortem findings.

Electrocution may cause death in the context of interrogation and can be determined if Joule burns are present. However, there is no consistent internal pathology associated with electrocution, nor is there histological evidence of electrocution in the major organs.

Sudden unexpected death may occur in the context of interrogation with injuries in the setting of ischemic heart disease. At autopsy, there are sub-lethal injuries with evidence of marked atherosclerotic and/or hypertensive heart disease. Specifically, there may be cardiomegaly and left ventricular hypertrophy (hypertensive heart disease) and coronary atherosclerosis with or without evidence of old myocardial infarcts in the left ventricle. In these cases, the stress invoked by the maltreatment or torture can precipitate death by cardiac arrhythmia. The pre-existing heart disease is a pro-arrhythmic substrate that is a susceptibility factor to develop a stress-related fatal cardiac arrhythmia. These cases are often challenging because the forensic pathologist does not have a structural or biochemical indicator that can prove that a fatal cardiac arrhythmia occurred. The inference that death was caused by the torture or maltreatment is a reasonable inference based upon the presence of injuries that were inflicted in the setting of pre-existing heart disease. Such cases may attract some controversy and be debated. However, if a complete postmortem examination has been conducted and circumstances of the case

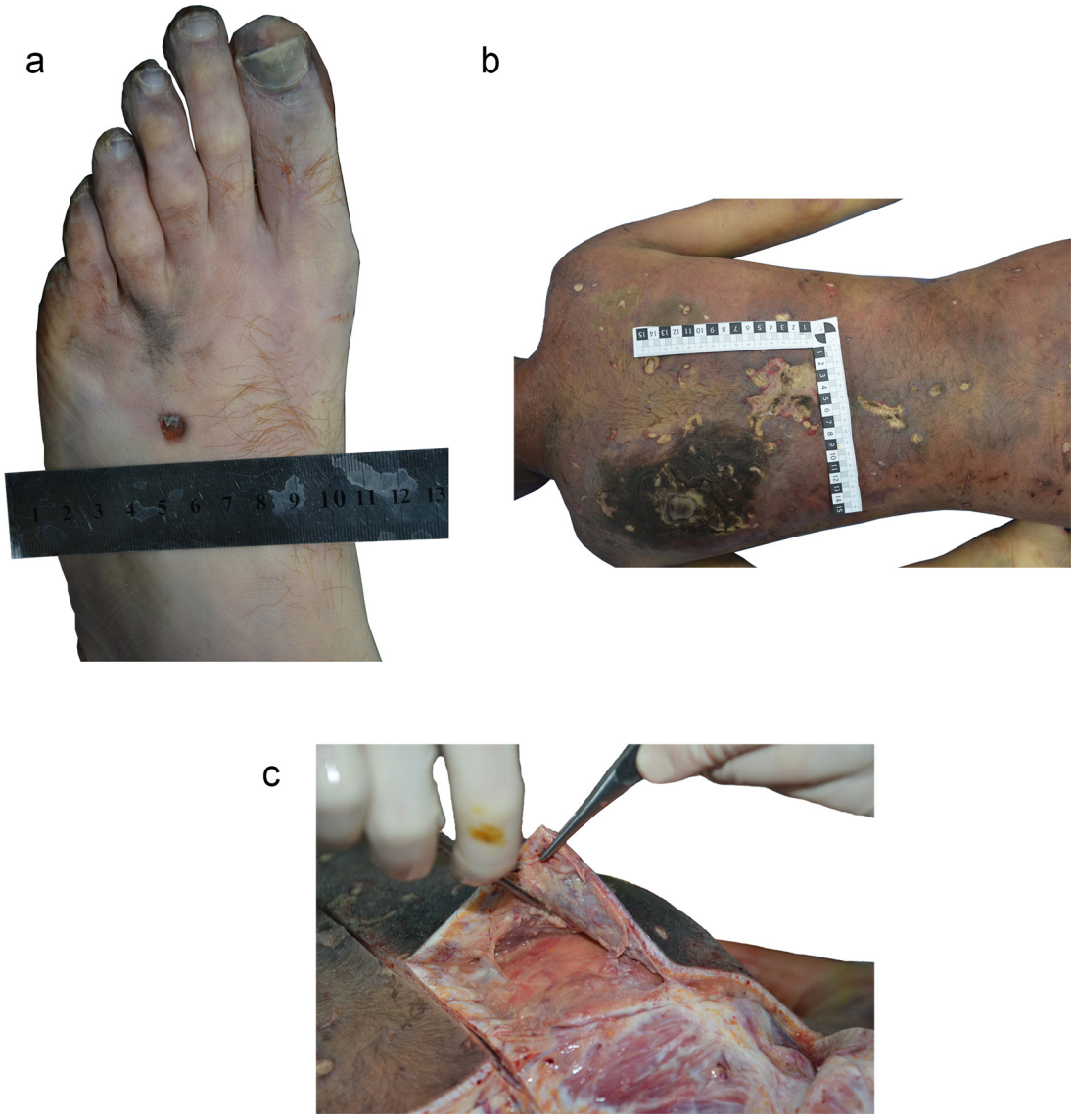

Fig. 7. Thermal burns.
A. Perimortem cigarette burn. B. Infected burn from clothing iron. C. Abscess of paraspinal muscle beneath infected burn.

are known, it is reasonable for the forensic pathologist to conclude that the death is related to stress, in the setting of heart disease.

4.3. Delayed death after torture

Death may ensue from the progressive onset of hemorrhagic shock from slow internal bleeding after injuries sustained by blunt trauma. Specifically, laceration of the liver, spleen or mesentery may result in ongoing internal bleeding that causes death by progressive shock. Furthermore, subcapsular hematomas of the liver or spleen may develop in a relatively silent manner in the hours or days after injury. The subcapsular hematomas can acutely rupture, causing rapid death due to acute internal bleeding. In these cases, histological examination of the lacerated organs or the subcapsular hematoma is essential to establish the timing of the injuries. In many cases, the date of the injuries associated with the interrogation (and presumably the injuries associated with the interrogation) is known and the date of death is known. The interrogation and death may be separated by a few days and therefore the causal connection between the injuries and death is a matter of dispute. If histological examination can demonstrate the presence of an inflammatory reaction and healing, it is often reasonable to connect the death with the injuries sustained. Specifically, the infiltration of injured tissue by neutrophils, macrophages and the presence of hemosiderin laden macrophages, can be objective observations that can lead to reliable inferences regarding timing (Table 4). Another typical example is delayed death following head injury with a lucid interval due to the mass effects of an accumulating subdural or epidural hemorrhage.

Myoglobinuric renal failure due to skeletal muscle necrosis (rhabdomyolysis) can cause delayed death following major trauma sustained during interrogation [20–22]. At autopsy, these detainees are often edematous due to fluid overload from renal failure. The soft tissue injuries will be readily apparent upon musculocutaneous dissection, and often on external examination. The kidneys will be stained brown and there will be myoglobin in the urine. In some of these cases, death will actually occur in the hospital, in the setting of acute renal failure. In the hospital, clinicians may not connect the cause of the renal failure to the injuries present. However, this is usually obvious at autopsy. Histological examination of the kidneys will reveal myoglobin casts in renal tubules. In some cases it may be necessary to

Table 3
Causes and mechanisms of death associated with torture.

Type of torture	Postmortem findings
Death during torture	
Hemorrhagic shock due to injury	Internal bleeding will often result in a large volume of blood accumulating in body cavities or the retroperitoneal space (including the pelvic basin); extensive subcutaneous and intramuscular hemorrhage can also cause shock; secondary indicators of hemorrhagic shock include pallor of the lividity, brain, liver, kidneys and muscle; splenic contraction; subendocardial hemorrhages in the left ventricular outflow tract.
Asphyxiation and drowning	Asphyxiation can occur with gagging, plastic bag enclosure of the head, external obstruction of the nose and mouth during physical restraint, and strangulation (typically ligature strangulation). The autopsy findings may not be fully developed in some cases. In addition, the definitive determination of the cause of death may be difficult if the gag or plastic bag has been removed, or if there are minimal injuries of the nose, mouth, and neck. Fatal drowning during immersion of the head in water during interrogation can be difficult or impossible to establish, unless there is a history of immersion.
Electrocution	Joule burns are present; no consistent observations are present in the internal organs and tissues (cause of death needs to be inferred based on the presence of Joule burns and the absence of an alternate cause of death).
Sudden cardiac death in the setting of ischemic heart disease	Coronary atherosclerosis, typically with old myocardial infarcts; cardiomegaly with left ventricular hypertrophy; injuries are typically non-fatal (falanga) but invoke a stress-reaction that precipitated death by cardiac arrhythmia.
Extra-judicial execution immediately after torture	Executions can be by various methods including: hanging, ligature strangulation and gunshot wounds.
Delayed death after torture (complications of torture related injuries)	
Delayed shock from slow internal bleeding	Internal bleeding from lacerated abdominal organs such as the liver, spleen, and mesentery can result in progressive intra-peritoneal, and retro-pertioneal hemorrhage that may accumulate and cause death over hours to days. In addition, delayed rupture of subcapsular hematoma of the liver or spleen can occur. Death from mass effects related to subdural hemorrhage can follow after a lucid interval. Thus, it is important to correctly ascertain the timing of the fatal injury and death, since deaths may occur hours or days after interrogation but still be related to injuries inflicted at the time of interrogation.
Myoglobinuric renal failure	Skeletal muscle necrosis (rhabdomyolysis) from direct traumatic injury and/or compartment syndrome (leading to ischemic necrosis of muscle) can cause myoglobin deposition in the kidney. This can lead to fatal renal failure. At autopsy, there is anasarca, brown staining of the kidneys, brown urine and myoglobin casts in renal tubules.
Sepsis and embolism	Delayed death after injury may be related to infection (e.g., hypostatic or aspiration pneumonia), wound infection, or immobility-related pulmonary thromboembolism.
Death related to conditions of detention	
Neglect	The inadequate provision of food and water can lead to malnutrition, starvation, and susceptibility to fatal infection. In some cases of water restriction (thirsting) and rehydration, osmotic demyelination can occur resulting in central pontine myelinolysis. Poor hygiene and skin infections are common in neglected detainees.
Tuberculosis	Tuberculosis may cause death in prisons either from de novo infection in the prison, or reactivation. The emergence of drug-resistant tuberculosis is a serious problem in prisons.
Lack of healthcare	Detainees may die to intercurrent medical conditions that cause death after torture injuries have healed, or while detained and not subjected to torture. However, some acute medical emergencies that could be treated may be fatal due to the lack of access to healthcare. This includes adhesion-related small intestinal obstruction and diabetic ketoacidosis. If epileptics are not provided anti-epileptic drugs, death can occur by sudden unexpected death in epilepsy (SUDEP).
Death unrelated to torture	
Suicidal hanging	Hanging is one of the most important causes of death in prison. If a soft broad ligature is used (e.g., bed sheet) there may be no ligature mark present on the neck. Suicidal hangings in jails are often difficult cases that require a careful scene investigation to ensure the correct interpretation. Sometimes a classical V-shaped ligature furrow is present.
Chronic diseases	Death may occur by natural disease in prison and be entirely unrelated to maltreatment, or the maltreatment occurred in the remote past and has not contributed to death that was caused by a pre-existing chronic disease such as ischemic heart disease, diabetes mellitus, or cancer.
Judicial execution remotely after torture	Executions can be by various methods including: hanging, ligature strangulation, and gunshot wounds.

Table 4
Histologic phases of tissue repair.

Time	Phase	Cellular reaction
Recent (perimortem; minutes to hours)	Tissue and vascular damage	Hemorrhage and tissue disruption only
Recent with early healing (hours to days)	Acute inflammation	Neutrophil and macrophage infiltration with progressive erythophagocytosis and the appearance of hemosiderin-laden macrophages at approximately 3 days
Healing (days to weeks)	Tissue repair	Fibroplasia to granulation tissue in tissue and primary (chondral) and secondary (osseous) callus in fractures
Healed (weeks and onwards)	Repaired tissue	Scar in tissue or remodelled/reintegrated secondary callus in bone

undertake immunohistochemical studies to demonstrate the myoglobin in the renal tubules.

In some delayed deaths after injuries produced by torture, death is related to infection or pulmonary thrombembolism. The fatal infection may be either related to infection of the wound (Group A streptococcal cellulitis, or necrotizing fasciitis), hypostatic pneumonia from immobility, or aspiration pneumonia. If the injuries resulted in a bedridden state or immobility, this can predispose to the development of fatal pulmonary thromboembolism. In these cases, carefully connecting the injuries with the pulmonary thromboembolism or sepsis will reveal the true underlying cause of death.

4.4. Death related to conditions of detention

The ill-treatment of detainees and prisoners may also involve neglect. In many cases, after physical injuries have been incurred, the detainee may be subjected to food and water restriction. The inadequate provision of food and water can lead to fatal consequences. Often malnutrition and starvation cause death through secondary infection (bronchopneumonia). In these cases, there is often poor hygiene with pyogenic infections of the skin, overgrowth of nails, lice infestation, and matting of hair. In cases of water deprivation there may be dehydration. In addition, if there is water restriction and dehydration with subsequent rehydration, this may lead to serious neurologic complication. Specifically, the large shift in serum sodium concentration can result in osmotic demyelination and central pontine myelinolysis. This is an often unrecognized complication of malnutrition and water restriction [23], in the setting of captivity and neglect (Fig. 8). The diagnosis of central pontine myelinolysis can only be made if the brain (pons) is carefully examined. Histological examination with myelin stains (Luxol fast blue) is necessary to establish the diagnosis. In addition, detainees may die from infections that occur in the prison environment such as tuberculosis or outbreaks of community acquired pneumonia. In some parts of the world, such as Uzbekistan, drug resistant tuberculosis is a serious problem is prisons [24].

Many detainees die of inter-current medical conditions while in prison due to the lack of medical care. This may be related to the lack of access to medications required for pre-existing illnesses (anti-epileptic drugs) or the development of acute medical/surgical emergencies that are not treated due to the lack of access to health care. For example, detainees may die suddenly and unexpectedly related to small bowel obstruction or diabetic ketoacidosis, unless medical care is provided soon after symptoms develop. Death from medical/surgical conditions that could be treated is an under recognized cause of death of prisoners in unlawful detention across the world.

4.5. Death unrelated to torture

Suicide by hanging is one of the most frequent causes of death in prison. Specifically, detainees who are imprisoned unlawfully, or under appropriate judicial authority, may kill themselves by suspension by the neck. A soft, broad ligature usually made from bed sheets or clothing is used to achieve the suspension. This can lead to serious medicolegal difficulties at the time of autopsy. In particular, soft broad ligatures often leave little evidence of injury on the surface of the neck. In some cases, no injuries can be apparent on the neck. If the forensic pathologist is not provided with the ligature to examine, or does not have reliable information about the scene, it may be impossible to objectively establish that the death is related to suicidal hanging. In many such cases, suicidal hanging is the actual cause of death but the forensic pathologist is confronted with a negative autopsy, often in the context of controversy. Therefore, despite the best efforts and a complete postmortem examination, the cause of death may need to be officially listed as undetermined. However, if the forensic pathologist is provided with unrestricted access to the scene and the relevant information, it may be possible to definitively ascertain that the death is related to hanging. The additional complexity that may develop in these cases is that the body may also show signs of injury related to torture or maltreatment. The combination of the injuries, an otherwise negative autopsy and the suspicion of suicidal hanging may result in an unresolvable controversy about the cause of death.

In addition, some cases of death in police custody or prison are entirely unrelated to torture, maltreatment, or the environment of the custodial facility. Many deaths in lawful or unlawful detention are related to chronic pre-existing diseases such as ischemic heart disease, diabetes mellitus, or cancer. In these cases, a complete medicolegal autopsy is also useful and provides an equally valid public service. If a custodial death can be definitively related to natural disease and injury can be excluded, this is important information for the family and the community at large.

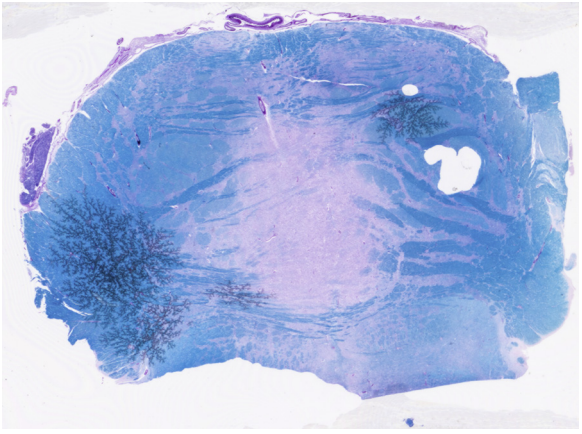

Fig. 8. Central pontine myelinolysis after prolonged captivity (whole mount of basis pontis, Luxol Fast Blue with Hematoxylin and Eosin).

5. Discussion

The systematic examination of people who die during detention or in custody of state authorities is vital for the protection of human rights. Specifically, the awareness of injuries related to torture and how to conduct a satisfactory medicolegal autopsy on a detainee is critical for the international community and families to understand the true cause of death. Applying proper methodology to autopsies to fully characterize torture-related injuries is essential, whenever practical. The wide array of injuries and modes of torture, such as stress positions, underscores the relevance of forensic pathology. The use of special dissections, particularly to search for musculocutaneous injuries and joint injuries, is of paramount consideration. However, examination of bodies from custodial institutions can also be examined under exigent circumstances, even if a detailed dissection of the body cannot be undertaken.

Forensic pathologists working in post-conflict countries and active conflict zones must be aware of the methods for postmortem examination of deaths in custody. It is only through the sharing of postmortem techniques and knowledge with our colleagues around the world that we can increase awareness on how to detect and correctly interpret the injuries related to maltreatment of detainees. Furthermore, the systematic publication of clinical and postmortem case reports that describe the range of injuries and their complications is essential for the progression in this area of medical knowledge. On this basis, forensic pathology capacity development including strengthening autopsy methodology in low and middle income countries, often where human rights abuses occur, is essential. Furthermore, capacity development in medical aspects of prison monitoring and clinical forensic medicine is similarly important. It is only through the antemortem detection of injuries and maltreatment that considerable advancement will be made in ameliorating suffering and disability associated with torture.

The postmortem examination of victims of torture is also helpful to interpret and manage signs of torture in living detainees. One of the common conundrums that challenge clinical forensic

medical examiners is how to interpret scars that occur in suspected cases of torture. In many cases of fatal torture, after prolonged detention, there is a combination of fresh injuries and scars related to the same type of maltreatment. On this basis, knowledge of the postmortem appearances of wounds can be highly instructive in correctly interpreting scars that are identified in living victims. In addition, understanding the range of torture-related injuries can provide important information for prison monitoring in screening various injury types such as stress positions (e.g., reverse hanging). Knowledge of the long term consequences of peripheral nerve injury and the pain syndromes that can result from blunt trauma will contribute to more a more scientific approach to rehabilitation of torture survivors [25–30].

Overall, the application of forensic medicine to interpreting the signs of torture will contribute to the reduction of torture in the world at large. It is only through the increased awareness and careful examination that medical knowledge will grow and develop in this area of humanitarian forensic science. The core element to support this progress will be to ensure that postmortem examinations are performed on all detainees who die in custody, to determine if torture played a role in their death.

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