CASE REPORT

Deadly cerebral ischemia due to carotid stenosis following a facial shot with a pellet gun: An autopsy case report

Décès suite à une ischémie cérébrale par sténose carotidienne en rapport avec un traumatisme facial par un fusil de chasse: Rapport de cas autopsique

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Abstract

Introduction: Facial gunshot wounds have devastating functional and aesthetic consequences for the patient. If associated with penetrating craniocerebral injuries, the prognosis is rather compromised even with appropriate medical and surgical treatment. Chop-off injuries with penetrating wounds constitute a challenging situation for the facial reconstructive surgeon in facial trauma.

Observation: This case involved a 49-year-old man who sustained an accidental facial shot from a pellet gun. Radiological and clinical investigations revealed complex ballistic trauma to the maxillofacial region, with projectiles reaching the base of the skull. One of the projectiles migrated via the carotid canal towards a cerebral artery, leading to obstruction of the artery with cerebral infarction. An autopsy was performed which evaluated that the shooting distance was compatible with a long distance, causing the dispersion of lead grains with the absence of a wad inside the trauma site.

Conclusion: In some cases of facial gunshot wounds, despite a complex and extensive lesion assessment, death may occur due to a neurological complication rather than sustaining hemodynamic shock, depending on the trajectory of the projectiles.

Key words: autopsy, facial trauma, forensic pathology, gunshot

Résumé

Introduction: Les blessures par arme à feu au niveau du visage ont des conséquences fonctionnelles et esthétiques néfastes pour le patient. Si elles sont associées à des lésions crânio-cérébrales pénétrantes, le pronostic reste compromis, même en dépit d'un traitement médical et chirurgical approprié. Les blessures par arme à feu associées à des blessures pénétrantes constituent un défi pour le chirurgien maxillofacial.

Observation: Nous rapportons le cas d'un homme de 49 ans qui a été blessé accidentellement au visage par une arme type fusil de chasse à grains de plombs. Les examens radiologiques et cliniques ont révélé un traumatisme balistique complexe dans la région maxillo-faciale, avec des projectiles atteignant la base du crâne. L'un des projectiles a migré via le canal carotidien vers une artère cérébrale, entraînant l'obstruction cette artère et un infarctus cérébral. Une autopsie a été demandée, ayant conclu que la distance de tir estimée était longue à l'origine de la dispersion des grains de plomb en l'absence de bourre à l'intérieur du site du traumatisme.

Conclusion: Dans certains cas de blessures par arme à feu, malgré une évaluation complexe et approfondie des lésions, le décès peut survenir en raison d'une complication neurologique plutôt que d'un choc hémodynamique, en fonction de la trajectoire des projectiles.

Mots clés: autopsie, arme à feu, traumatisme facial

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Introduction

Firearm-related deaths are uncommonly frequent worldwide with over 250,000 deaths in 2019 alone (1). Nearly 71% of these firearm deaths were related to homicides, around 21% to suicides, and 8% were due to unintentional firearm accidents (1). In Tunisia, the firearm mortality rate stands at 0.2 per 100,000 inhabitants, with 0.16 firearm suicides per 100,000 inhabitants and 0.32 accidental deaths per 100,000 inhabitants (1). With relatively low overall mortality (<10%) (2), facial gunshot wounds have devastating functional and aesthetic consequences for the patient (3). If associated with penetrating craniocerebral injuries and an initial low Glasgow Coma Scale score, the prognosis is rather compromised even with appropriate medical and surgical treatment (66-90% of fatal outcomes according to some studies (4,5). Depending on the weapon caliber and the shot distance, the transmitted kinetic energy of the projectile can cause fragmenting and fracturing skull bones, severe brain damage, and massive tissue destruction, which constitutes a challenging situation for the facial reconstructive surgeon (6). We reported the case of a man who suffered a gunshot wound to the face, resulting in his death a few days later from cerebral ischemia due to carotid stenosis, confirmed at autopsy. We aimed to discuss the difficulties involved in managing this type of wound, as well as the autopsy procedures to be performed in the event of complex ballistic trauma.

Case report

Case presentation

The case involves a 49-year-old man who sustained an accidental facial shot from a pellet gun. His medical examination upon his admission to the Emergency Department found a comatose patient (Glasgow coma score of 6/15: Eye opening=1; Verbal response=1; Motor response=4), a blood pressure of 180/100 mmHg, oxygen saturation of 68%, heart rate of 100 beats per minute, with significant tissue damage over the right hemiface with profuse bleeding. No exit head wound was visualized nor were any other entry wounds on the body. A full-body Computed Tomography (CT) scan was performed, after patient stabilization and monitoring, which showed multiple millimetric metallic foreign bodies in the right temporal bone (including one projectile in the carotid canal and one projectile in the Eustachian tube), a displaced comminuted fracture of the right orbital walls associated with pneumorbitia, a complex displaced comminuted fracture of the right zygomatic bone and right maxillary sinus with extensive hemosinus, a displaced bifocal fracture of the right mandible, and a dislocated fracture of the right temporomandibular joint (Fig. 1). The same metallic foreign bodies were also found in the facial subcutaneous soft tissues and throughout the deep spaces of the face, reaching the level of the clivus (i.e., the bone that lies in a central position of the skull base). On the cerebral level, there were multiple millimetric metallic foreign bodies in the subdural and intraparenchymal regions (right superior temporal gyrus, right inferior frontal gyrus, and right precentral frontal gyrus), with fractures of the greater wing of the right sphenoid bone. No other bullets were found in the neck, chest, or abdomen. The patient was admitted for closed monitoring, with prophylactic antibiotic therapy initiated against infection. The patient was taken to the operating room the following day for facial tissue repair, cleaning, and suturing of the facial wounds, along with accessible projectile removal. The location of the projectiles in the right carotid canal was deemed inaccessible.

Figure 1. Maxillofacial computed tomography (CT) with three-dimensional rendering showing complex ballistic trauma to the right hemiface.

It was also decided to delay reconstruction and management of mandibular fractures until the patient's condition had stabilized. The evolution was marked on the second day by anisocoria of the left eye, upon the discovery of extensive right hemispheric cortico-subcortical hypodensity (Fig. 2) on the brain scan, responsible for a 21mm midline deviation and collapse of the right lateral ventricle. The rest of the brain scan report visualized retained metallic foreign bodies in the right carotid canal and along the course of the right middle cerebral artery. The patient subsequently increased his requirement for vasoactive drugs and died shortly afterward.

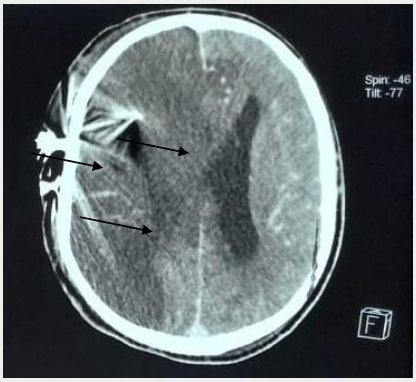

Figure 2. Brain CT scan showing extensive right hemispheric cortico-subcortical hypodensity with midline deviation and collapse of the right lateral ventricle.

Autopsy findings

The autopsy revealed extensive hemorrhagic infiltration of the inner surface of the right temporal scalp, with fractures of the roof of the right orbit extending to the roof of the left orbit, and hemorrhagic infiltration of the right temporal muscle with local encrustation of lead pellets (Fig. 3).

Figure 3. Autopsy finding showing extensive hemorrhagic infiltration of the inner surface of the right temporal scalp, with projectile incrustation (enlarged image).

The brain weighed 1320g with right hemispheric cerebral softening. The rest of the autopsy findings revealed a bifocal fracture of the right mandible, a dislocated fracture of the right temporomandibular joint, with a stenosis of the right carotid artery ahead of the projectiles found in the artery. Significant pulmonary edema (right lung weighing 1079g, left lung weighing 970g), atheromatous coronary arteries (heart weighing 272g), and nonspecific organ congestion were highlighted through thorax and abdomen examination. The autopsy revealed no other concomitant pathological events or traumatic injuries that might have contributed to the cause of death. The conducted toxicological analysis didn't detect drugs or ethanol through sample screening. The retained cause of death was concluded as a ballistic trauma to the face complicated by carotid stenosis caused by a fragment of a lead projectile.

Discussion

Facial gunshot wounds have devastating functional and sometimes life-threatening consequences.

Gunshot wounds are generally classified as penetrating, perforating, or avulsive. Penetrating wounds occur when a low-velocity projectile pierces tissue with no exit wound (7). Perforating wounds, on the other hand, are characterized by the presence of a neat exit wound in addition to the entrance wound (7). These exit wounds are often larger, with jagged or stellate edges that flare outwards (7). Avulsive injuries are essentially penetrating injuries, featuring acute tissue loss and destruction as a result of the projectile's passage in and out of the body (7). Another type of injury described in the literature is the "Chop off" injury (6). This type of injury involves extensive loss of hard and soft tissue as a result of high-velocity, close-range gunfire (6). In our case, the sustained wounds have associated chop-off injuries with penetrating wounds to the face.

Given its vascularity, it has been reported that only 19% of facial gunshot victims present with life-threatening hemorrhage, and 6.2% of associated facial fractures require life-saving emergency surgery (5,6). Fracture reduction is usually delayed until the patient has been stabilized, although reduction of displaced maxillofacial fractures is reported to reduce hemorrhage and partially restore the airway (6). The extent of injury, conditioned by the proximity of the shot to the affected area, also depends on internal lacerations, tissue compression, and temporary cavities created along the projectile's trajectory (7). In our case, the shot was fired from a multi-pellet shotgun, with multiple trajectories, secondary impacts on a bone, and damage to the skull region. The first stage of treatment in those cases requires measures to secure the airways, control bleeding, and identify other injuries through radiological examinations (8). These steps were followed in the patient's care. Projectile extraction is also essential. In our case, projectiles were lodged at the level of the right petrous part of the temporal bone, the Eustachian tube, and the right carotid canal. Bullets lodged in the vascular axes tend to migrate away from their initial location (8). The time and distance covered are highly variable (8).

Carotid wounds following gunshot in the neck and maxillary region have been described in the literature (8,9), with successful surgical repair. This was not the case for the current reported case, as the location of the retained bullet was deemed inaccessible, despite its dangerous and inevitable consequences on the brain. To reach the inside of the skull, the internal carotid artery runs through the carotid canal on the underside of the skull, crosses the rock bone (the petrous part of the temporal bone), and emerges at the tip of the rock into the middle cranial fossa above the foramen lacerum. It then passes through the cavernous sinus to finally join the circle of Willis. The internal carotid artery then divides into the middle cerebral artery and the anterior cerebral artery. The projectiles followed the arteries' dividing path, obstructing the lumen of the middle cerebral artery and causing cerebral infarction.

In case of ballistic trauma, autopsies enable trajectories to be estimated using a protractor, with identification of the angle of the shot around at least 2 planes of space (horizontal and vertical). Estimating the projectile trajectory is only approximate, as ballistic trajectories are rarely straight, with the possibility of internal ricochets against a hard plane. Besides, all the changes in organic density as the process advances can lead to a modification of the projectile's trajectory. In all instances, it is necessary to compare autopsy data with radiological data (10). In our case, the distance of the shot was compatible with a long-distance shot, with multiple entry wounds caused by the dispersion of lead grains given the absence of wad frequently found inside the body, in the extension of the lesion over distances of up to one meter (11). Beyond this distance, the pellets become sufficiently dispersed to demonstrate a central wound with multiple satellite

pellet holes, with no burning or reddening of tissue, no soiling, and no tattooing.

Our case describes a single patient experience that died after being shot in the face. This limited sample size makes it difficult to generalize the findings to a wider population.

We were unable to document the initial wound immediately after the shot was fired, as the patient was quickly taken into care owing to his unstable hemodynamic state. However, within a forensic context, it is essential to study the characteristics of firearm wounds, as these characteristics enable us to identify essential data for the forensic investigation, such as the nature of the weapon, the firing distance and its direction, as well as the distinction between an entry orifice from an exit orifice. In our case, we based our analysis on the description of the facial wound in the subject's medical file (the face wounds were sutured and manipulated by the medical team), by confronting them with the autopsy data in our report conclusion.

Conclusion

The severity of gunshot wounds to the face depends on the caliber of the weapon used and the distance at which the patient was hit. Short-range, high-velocity gunshot wounds, as well as shotgun wounds, can have devastating functional and aesthetic consequences for the patient. In some cases, despite a complex and extensive lesion assessment, death may occur due to a neurological complication rather than sustaining hemodynamic shock depending on the trajectory of the projectiles.

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