

CASE REPORT

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Scleral and Conjunctival Hemorrhages Arising from a Gunshot Wound of the Chest: A Case Report

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ABSTRACT: A young man committed suicide in the back seat of an automobile, witnessed by two law enforcement officers sitting in the front seat who had attempted to dissuade him from killing himself over an eight hour period. Death was caused by a contact gunshot wound of the anterior chest, which entered the midsternum and disrupted the anterior right atrium and ventricle of the heart, without involvement of either left ventricle or atrium. At the autopsy, bilateral fresh, confluent scleral and conjunctival sulcus hemorrhages were discovered, with no other evidence of facial or intracranial trauma. These hemorrhages are postulated to have arisen from a sudden pressure wave ascending through the superior vena cava, in a manner similar to the ocular findings associated with the retrograde venous blood flow that occurs during severe thoracic compression. These hemorrhages should not be mistaken for evidence that a decedent was beaten or otherwise involved in an assault episode.

KEYWORDS: pathology and biology, forensic science, gunshot wounds, wound ballistics, ballistics, ocular hemorrhages

Experimental terminal ballistics studies and the extensive experience derived from over a century of gunshot wound victim scientific and autopsy examination has proven the relationship between kinetic energy dispersal and tissue disruption when a missile strikes a human body. The force of an impacting missile may be transmitted radially as a shock wave that is absorbed by tissues that exhibit varying degrees of elasticity and friability. In certain instances, most notably gunshot wounds that involve the head, a pressure wave may be generated by the kinetic energy imparted to the intracranial contents (both brain and cerebrospinal fluid), such that injuries will be observed in regions that are not directly traumatized by the missile penetration alone.

The most common examples of this phenomenon are supraorbital plate fractures with accompanying periorbital and eyelid soft tissue hemorrhage (so-called "raccoon mask" hemorrhages), either unilateral or bilateral, that can develop in gunshot wound cases (as well as other head injury scenarios) even when the missile track passes nowhere near the anterior cranial fossae. Pontine and medullary hemorrhages have also been related to the concussive effects of cranial gunshot wounds. In the case of a contact-range wound, the intensity of the intracranial pressure wave would be expected to be greater than in a distant-range wound occurring with the identical missile, as the expanding gases vented

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through the weapon muzzle and directed into the cranial cavity would add to the effect generated by the missile alone. The cranial vault is a rigid structure enclosing a fixed space, and internal pressure can be vented only through the foramen magnum, by bony fracturing, or by separation through incompletely fused sutural synostoses.

This report documents unusual confluent scleral and conjunctival hemorrhages that arose from an intravascular (venous) pressure wave that was generated by a contact gunshot wound of the anterior chest, with internal involvement restricted to the right heart chambers.

Case Report

A 23-year-old white male was served with a bench warrant by a sheriff's deputy at his residence. However, he was not searched prior to entering the deputy's car, and after he was in the back seat, he produced a .357 magnum caliber revolver and threatened to shoot himself. The deputy called for assistance, and for the next eight hours, the deputy and an agent from the Georgia Bureau of Investigation sat in the front seat, attempting to dissuade the young man from shooting himself. At the end of this period, the man placed the barrel of the weapon against his chest and pulled the trigger. Emergency rescue personnel were called, but he was pronounced dead at their arrival; no cardiopulmonary resuscitative maneuvers were performed. The body was transported to the State Crime Laboratory for an autopsy examination.

The body exhibited a typical contact-range gunshot wound located on the anterior precordial area (Fig. 1) with marginal abrasion that corresponded to the gunsight and gun barrel. Extensive soot and gunpowder fragment deposition was evident in the margins, and along the superficial wound track. The track penetrated the mid sternum, at the level of the third costal cartilage insertions. The decedent had unbuttoned his shirt prior to shooting himself, so that the weapon muzzle was in direct contact with his skin.

When the eyes were examined, large, confluent scleral and conjunctival sulcus hemorrhages were readily apparent (Fig. 2). These were nearly symmetrical in the lower scleral surfaces of both eyes, but extended more into the medial canthal regions of the right eye (Fig. 3) and lateral scleral area of the left eye (Fig. 4). The hemorrhages were all bright red-purple, and quite recent appearing. No petechial hemorrhages were visible anywhere else within the eye, nor in the oral mucosa or elsewhere on the face. When these hemorrhages were seen by the pathologist, the officers who had maintained the vigil in the car with the decedent were contacted, and queried about whether they had seen these hemorrhages during the time period they were with him. Both denied seeing any hemorrhages of any sort, and also indicated that at no time has the decedent been involved in any struggle or altercation with either them or anyone else. No contusions or other superficial injuries were found anywhere on the face, head, hands, or any other body surfaces. No attempts to remove intraocular fluid had been made by anyone prior to the autopsy examination.

Internally, the missile track passed acutely posteriorly and slightly to the right, entering the pericardial sac and then the heart. The cardiac examination revealed that the missile track injuries were confined to disruptive fragmentation of the right ventricle and right atrium; the missile had entered immediately at the atrioventricular sulcus. The tricuspid valve was lacerated. The missile exited from the posterior right ventricle, and then exited the thoracic cavity in the right paravertebral region. The missile was recovered from the back seat of the vehicle in which the shooting had taken place.

No other internal injuries were identified during the course of the autopsy, and specifically, no scalp, cranial vault, or cerebral trauma was observed. No petechiae were within the laryngeal or pharyngeal mucosa. Toxicologic studies revealed no detectable drugs or ethanol in the blood.



FIG. 1—Thorax of the decedent following cleaning and shaving, revealing a typical contact gunshot wound of the anterior precordium. The weapon used was a .357 magnum caliber revolver.



FIG. 2—Right and left eyes of decedent, illustrating the confluent hemorrhages distributed over the lower scleral and conjunctival sulcus surfaces.

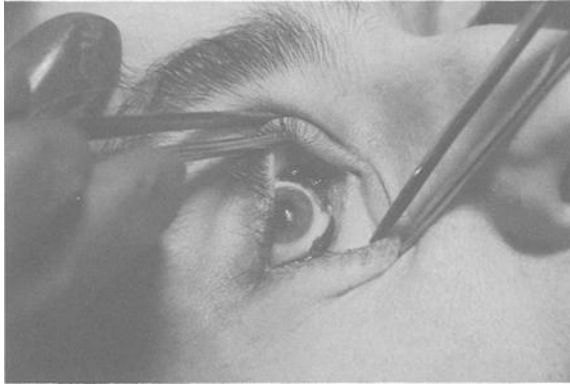


FIG. 3—Right eye; with the upper lid reflected, the hemorrhage is exposed, extending well into the medial globe surface and lid sulcus.



FIG. 4—Left eye, illustrating the lateral extent of the hemorrhage.

Discussion

Confluent scleral and/or conjunctival hemorrhages may result from a variety of causes, nearly all of which include blunt facial or head trauma that directly injures the eyes, or results in soft tissue hemorrhage that diffuses through the periorbital tissues to eventually invest the eye surface. However, when direct craniofacial traumatic sources are excluded,

confluent orbital and internal eyelid surface hemorrhage has been described only in several relatively well-defined scenarios. Scleral hemorrhage is a well-known postmortem artifact that may arise from blood leakage into the sclera from small vascular ruptures produced during attempts to remove vitreous fluid for toxicologic analyses [1]. Petechial hemorrhages are commonly associated with asphyxial deaths, and particularly with strangulation and other mechanically obstructive mechanisms, as well as encountered coincidentally in other situations, including natural deaths from a variety of causes [2-4]. However, no typical petechiae were discerned in this case. Occasionally, the ocular surface hemorrhages in strangulation deaths may assume a more confluent appearance, but there was neither historical nor autopsy evidence in this case to suggest such a possibility.

Perhaps the most frequent scenario in which confluent ocular surface hemorrhages are identified is compression, or traumatic, asphyxia, which has also been designated as cervicofacial static cyanosis [5-9]. Compression asphyxia results when the thorax is compressed externally by a great force, such as an individual trapped beneath a motor vehicle, or pinned beneath a great weight of some nature. This compressive phenomenon has a dual effect. First, respiratory excursion is severely compromised, preventing thoracic cavity expansion and effective ventilation. Second, the intrathoracic pressure is acutely and dramatically increased, and this pressure rise is then transmitted into the right heart chambers, resulting in corresponding pressure rise and retrograde blood flow in the superior vena cava. The intensity of the back flow pressure is transmitted throughout the small vessels of the head and face, causing intense, confluent cutaneous, mucous membrane, and ocular hemorrhages that vary from simple petechiae to gross confluency. The particular profound intensity of the hemorrhages within the sclerae and conjunctivae has fostered the term "ecchymotic mask" to designate the striking appearance of the eyes in compression asphyxia [10]. However, the specific reason or mechanism that explains the particular predilection for intense hemorrhages within the sclerae and conjunctivae in compression asphyxia is not known.

Concussive forces are readily transmitted through liquid media. Underwater blast forces will cause disruptive internal injuries in individuals who are within a certain radius of the explosion, with characteristic pulmonary and internal viscus trauma patterns. In certain instances, firearm missile or shotgun injury that directly impacts the spine has been shown to produce intracranial subarachnoid hemorrhage, discontinuous from the direct spinal trauma caused by the missile or shot pellets themselves [11]. In these instances, the hypothesized mechanism for the intracranial subarachnoid hemorrhage was that the intense force striking the spine produced a pressure or shock wave, that was transmitted superiorly by the cerebrospinal fluid.

In the case presented here, the gunshot wound received by the decedent has several notable features. First, the wound was clearly a contact wound. Contact gunshot wounds will have varying degrees of the explosively discharged, expanding gases blown into the wounds, depending upon the cartridge type and the circumferential skin pressure and continuity exerted by the weapon's muzzle. Thus, much or even all of the discharged gases may enter the wound, accentuating the internal pressure exerted upon the organs and tissues along the wound track. Second, the wound passed immediately through the sternum. This relatively rigid structure would probably have anchored the immediate wound area more than an intercostal space location, or the abdomen, thus allowing the internal pressure to be directed inward, rather than disseminated by direct skin and subcutaneous tissue expansion. Third, the wound passed directly into the heart, and more specifically, caused disruptive perforating injuries confined to the right ventricle and atrium, without penetration of the interventricular septum.

When all of these factors are considered, it is logical to conclude that this particular gunshot wound produced an intense, acutely expanding pressure wave that entered the front of the chest and was directed fully into the right heart. The sternum essentially

“reinforced” the area, preventing significant dispersion through the skin and subcutaneous tissues. As the wound penetrated only into and through the right heart, this shock wave could have been directed into and traveled up the superior vena cava (which does not have the venous valves seen in peripheral veins), and thus into the head. From here, the pressure wave would travel into the jugular system and thence into the ophthalmic veins, reaching the scleral and conjunctival venous vasculature. If the pressure within these small vessels exceeded their intrinsic strengths, multifocal rupture would result, producing the confluent hemorrhages as were observed.

This hypothesis regarding the possible mechanism whereby the hemorrhages were produced in this specific ocular surface location is certainly conjectural, but reasonable, in light of similar hemorrhages that are produced by the pressure wave phenomena inherent in compressive asphyxial mechanisms. It is not possible to explain why no other hemorrhages were evident in other locations on the surface or interior of the head, but the brevity of the shock wave produced by the gunshot wound may be significant in this respect. Rao and Wetli have described ocular petechial (not confluent) hemorrhages in gunshot wound victims who received only chest wounds (comprising 3 of 22 shooting victims in which ocular petechiae were observed), although they do not mention the specific intrathoracic organs which were involved by the missiles, nor the weapon caliber, weapon type, or range of fire for these cases [4]. Perhaps most importantly, the shooting death described in this report was directly witnessed by two individuals (as well as other officers who had gathered outside of the vehicle and in the immediate area), and there exist no other reasonable and documentable explanations to account for the presence of these hemorrhages.

Conclusion

Scleral and conjunctival confluent hemorrhages have been described in several settings, and in compression asphyxia, result from increased ocular venous pressure transmitted from the thoracic cavity and right heart chambers. It is also known that a pressure wave may be transmitted through the spinal fluid in gunshot and shotgun injuries of the spine, producing intracerebral subarachnoid hemorrhage that is not contiguously related to the spinal trauma itself. In the case presented here, an individual committed suicide by shooting himself from contact range in the anterior chest, producing an isolated disruptive injury of the right heart. The autopsy examination disclosed large, confluent scleral and conjunctival hemorrhages within both eyes. The shooting was witnessed, and the decedent underwent no procedures or resuscitative efforts that could be possibly construed to cause his ocular surface hemorrhages. In this respect, the conclusion is that a pressure wave was transmitted into the superior vena cava and thus to the cranial venous vasculature, producing the ocular hemorrhages in a manner similar to the mechanism known in compression asphyxia. This unusual phenomenon should not be misinterpreted as having resulted from a beating, or other direct trauma to the head and face.

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