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A Case of Cardiac Pellet Embolism Unmasked the Current Status of Radiological Modalities in Egyptian Mortuaries

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ABSTRACT

Background: A rare, but well-known consequence of penetrating trauma is the migration of bullets and other foreign bodies inside the blood vessels. Only, few cases of pulmonary or arterial emboli reported in literature. These injuries have a significantly high mortality rate. Therefore, they can pose a diagnostic problem. A shotgun pellet embolism to the heart requires rapid detection and careful radiological testing.

Case study: This case report presents the death of a 19-year-old male following head shotgun injury. Investigating the current case highlights the importance of radiology in firearm injuries.

Conclusion: It is crucial to use every practical and available approach during the autopsy and examination to reach proper diagnosis and hence adequate management. The use of virtual autopsies in Egypt faces several challenges that need to be overcome**.**

Keywords: Embolism, Shotgun, Craniocerebral, Pellets, Virtual autopsy, Radiology, Case report, Cairo University.

INTRODUCTION

Violent crime - including firearms - is a serious social and legal issue. Shotgun wounds can occur accidently or in homicide/suicide incidents [1]. Shotguns are the most common type of weapons frequently used by criminals. Its unique modifications, such as sawn-off barrels, make the weapon easier to use [2].

In recent decades, many homicides have been committed using the so-called pump action shotguns especially in developed countries [2,3]. A shotgun is a weapon that fires by employing an explosive power of a fixed shotgun shell to discharge either one projectile pellet or a number of pellets, often known as ball shots, where rifles and handguns discharge a single bullet. The mechanism of gunshot-related injuries varies according to the type of firearm and projectile used [4].

The distance between the target and firearm influences the severity of the injury. Intravascular missile migration is one of the most devastating consequences that can be life-threatening [5,6]. Migration episodes might occur immediately following the injury or afterwards whereas extravascular migration occurs in some cases [7]. Only few cases of bullet-related embolism have been documented in literature, particularly, wounds related to the lower back [8], chest [9], neck [10], and abdomen [11].

Therefore, radiological assessment is essential for evaluating tissue damage and detecting potential complications, and it should not be delayed either in firearm living victims or autopsy of firearm dead victims. We aimed to present a case of intravascular embolism of a pellet to the right ventricle following a shotgun injury, diagnosed during autopsy.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Cairo University (IRB code: N-2-2023). This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

CASE PRESENTATION

A 19-year-old male worker presented to the emergency department with a shotgun wound of the head during an incident. He was comatose with rapidly deteriorating vital signs. Few minutes later, the patient was arrested with unsuccessful resuscitation efforts. According to the Egyptian law, the deceased victim transferred for a postmortem legal examination at the Zeinhom morgue (the official referral governmental morgue). A standard x-ray was performed before the autopsy showed no significant findings except a faint radiopaque shadow in the cardiac area.

Postmortem external examination of the firearm wound revealed an ovoid 1x 0.5 cm purple fresh inlet wound with inverted edges at the right lower forehead, 0.3 cm just above the right eyebrow without soot deposition (**Figure 1**).

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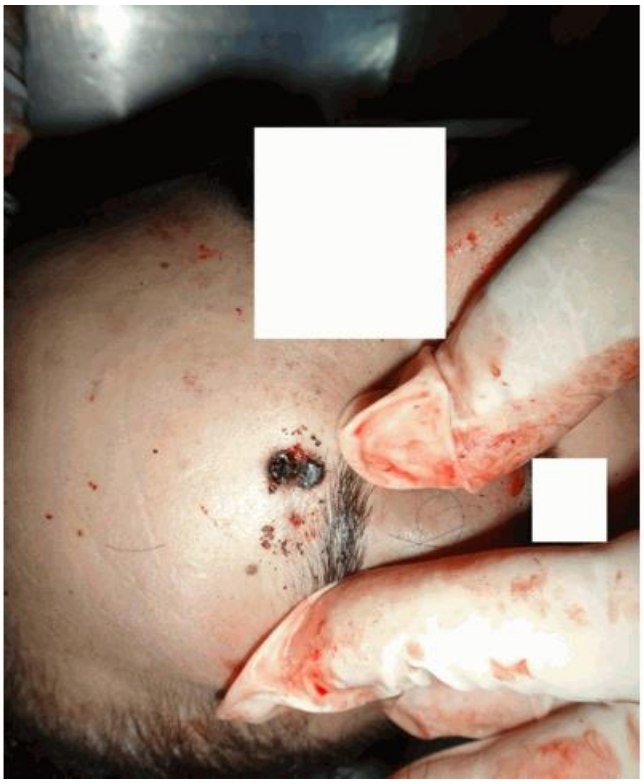

Figure (1) Inlet wound, Zeinhom morgue

During internal examination and upon reflecting the scalp there was scalp hematoma corresponding to the inlet site (**Figure 2**), absent dural hemorrhage (**Figure 3**) in presence of severe brain congestion and intracranial hemorrhage without laceration (**Figure 4**). Upon brain removal, there were no skull fractures. No exit wound was detected.

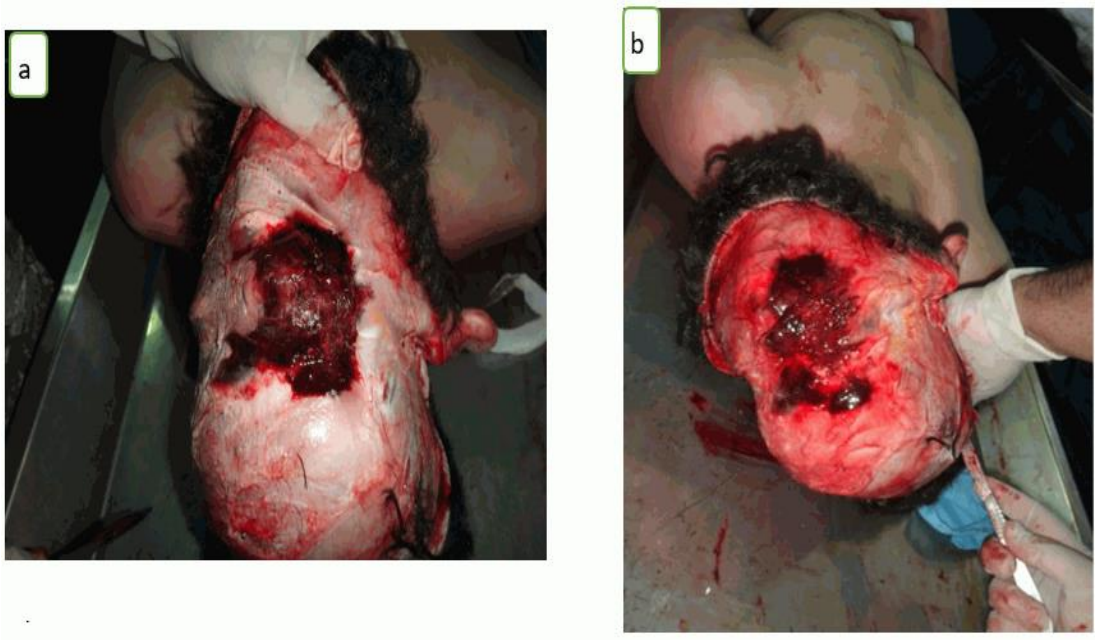

Figure (2 a & b): Scalp hematoma.

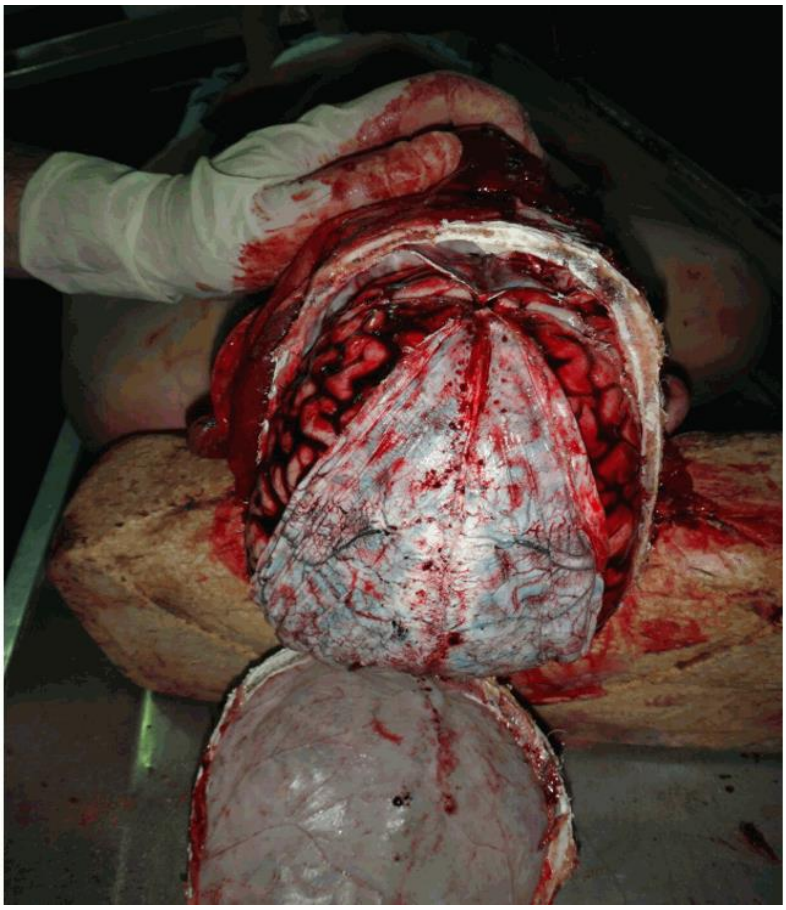

Figure (3): Opening the dura, Zeinhom morgue.

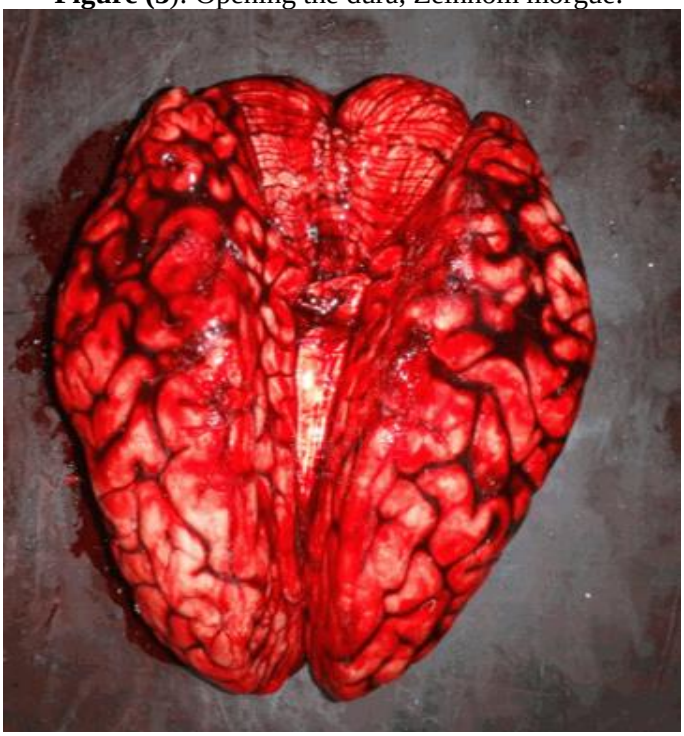

Figure (4): Brain congestion & areas of severe hemorrhage, Zeinhom morgue.

The heart examination showed a small, rounded silver small pellet (5 mm) (Figures 5 and 6) in the right ventricle.

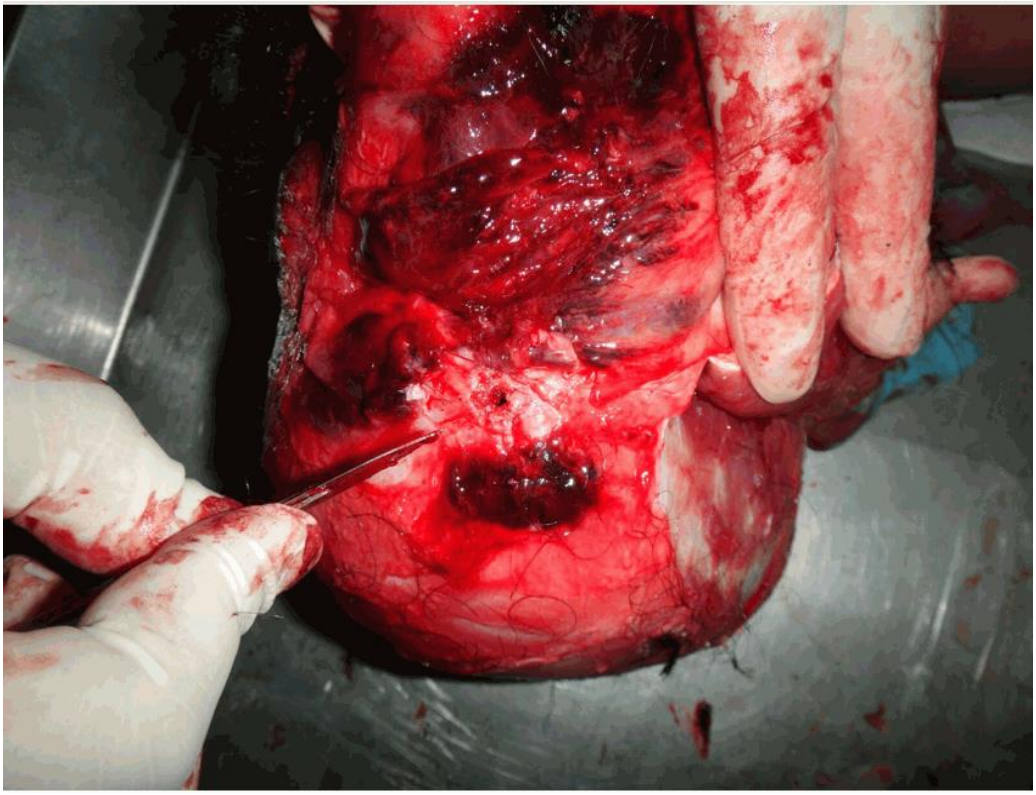

Figure (5): Heart opening, Zeinhom morgue.

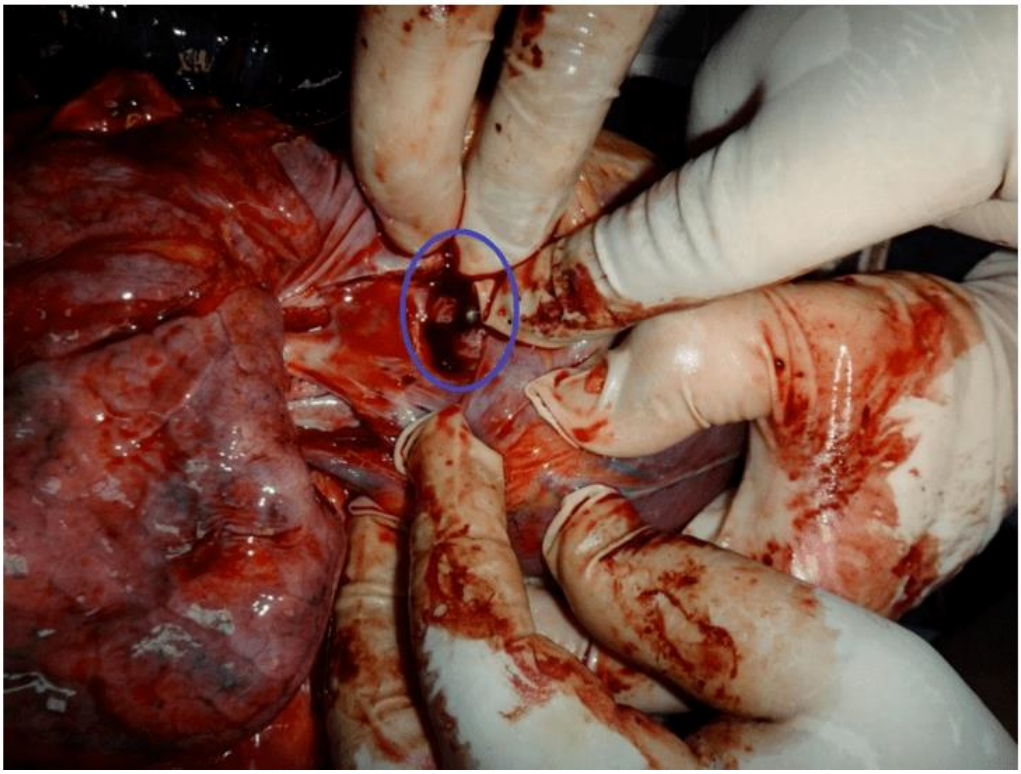

Figure (6): Small metallic pellet inside the heart, Zeinhom morgue.

This pellet (**Figure 7**) belonged to a non-rifled country- made shotgun where its caliber couldn't be detected. The firing distance was far, and no other projectiles were found except one single pellet. The pellet most probably entered through cavernous sinus down to be impacted into the right ventricle.

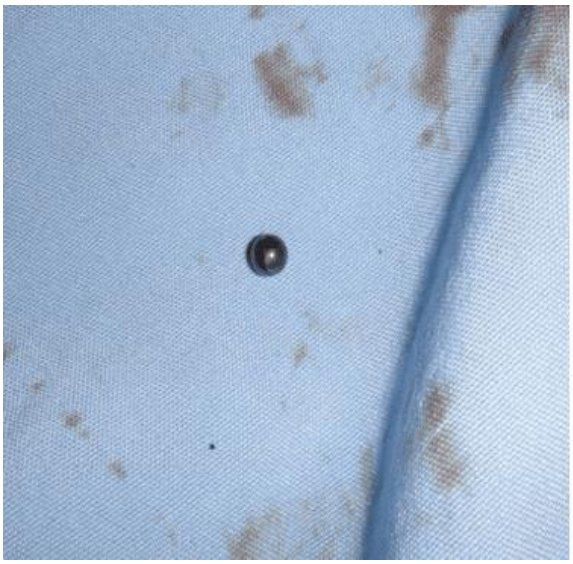

Figure (7): Recovered pellet, Zeinhom morgue.

Lack of accurate radiological modalities including computed tomography (CT) and Magnetic resonance imaging (MRI) at the mortuary resulted in failure of detecting the projectile trajectory and the pellet itself. The rest of autopsy revealed no other injuries or pathology. A post-mortem toxicological analysis revealed no evidence of drugs or poison in the blood or urine. None of the samples contained any alcohol. The cause of death was intracranial haemorrhage with cardiovascular collapse.

DISCUSSION

Thomas Davies was the first to describe a missile embolism in 1834, and it was later identified during the Vietnam War as being caused by small-caliber, slow-moving projectiles penetrating the vasculature and fragmenting to become emboli [12]. In 1964, the first case of a cranial embolus through the venous sinus affecting the heart was reported. The case was initially treated by craniotomy for management of intracranial hemorrhage [9]. In the same context, five cases of pulmonary artery infarction due to bullet embolism have been previously reported [13,14,15].

An old American study was carried out at a specialized neurosurgery hospital. The study included 103 soldiers suffered from various brain injuries during the Vietnam War. Delayed death was reported in eight cases with pulmonary embolism was being the major cause of death in two of them [12].

There are two distinct types of embolization documented in literature [16,17]. The first type is *retrograde embolization*, which occurs in 15% of venous cases, and it is described as projectile movement against the usual flow direction [18,19]. The second type is *paradoxical embolization*, which is defined as foreign body transfer from the venous to the arterial system via a right-to-left shunt. Ventricular septal defect, atrioventricular perforation, or patent foramen oval are among the causes of paradoxical embolization [17,20,21].

A retained bullet or projectile could leave an uneven number of entry and exit wounds [22,23]. Therefore, bullet embolism should be suspected when a bullet deviates from its intended path or when a wandering bullet is visible on radiographs [23]. In autopsy scenarios, the corpse should always be evaluated by x-ray to visualize bullets that may have traveled through the bloodstream and lodged in a different locus. In such circumstances, the use of x-ray could be a time-saver. When it comes to shotgun wounds, x-rays indicate both the spread of the shot and the possibility of an embolized pellet far away from the damaged area [3]. Hence, to identify the projectiles, determine their course, and assess tissue and organ damage, imaging examinations are required [5,6].

Associated vascular injuries may not always be visible. Based on the blood flow direction, the embolism is frequently anterograde. In 80% of cases arterial emboli are symptomatic and might cause ischemia, necessitating an immediate diagnosis [17]. While, the majority of venous emboli move to the pulmonary arteries, where they rarely produce symptoms, thus they are usually accidentally identified [23,24].

CT chest scans are useful for determining the missile trajectory, evaluating vascular structures and lung parenchyma. However, due to the presence of metallic artifacts and cardiac motion, this method is insufficient for assessing pellets located close to the heart [25].

Role of radiology at autopsy of firearm victims

Detection and diagnosis of pellet embolization at autopsy in absence of the exit wound represents a real challenge particularly in a limited-resource setting with lack of adequate postmortem imaging techniques. During autopsy, if there is no exit wound after a firearm injury, the projectile should be located and carefully removed to allow for additional ballistic analysis and to identify the offending sidearm, especially if a criminal way of death is anticipated.

In a recent forensic death investigation, postmortem computed tomography (PMCT) replaced the plain x-ray examination. The ability to do multiplanar reformation enables the creation of 3D images and the visualization of trajectories. Generally, x-rays are advised in all cases with gunshot wound for locating the projectile. This is recommended in both circumstances, either the projectile is known to be inside the body, or it has allegedly exited [26,27]. This idea might shorten the time needed for dissection to get the ball during the autopsy.

In this context, the use of advanced radiological techniques in firearm wounds is mandatory in both living and deceased firearm cases for detecting track of projectile and diagnosing any embolization and tissue damage.

In Egypt and the majority of Arab nations, conventional autopsies are performed under the supervision of the Interior Ministry of Justice or the Health Ministry [28].

To prepare a final official medicolegal report and submit it to the general prosecuting authority in Egypt, the forensic expert typically conducts an entire autopsy as well as all aspects of the death investigation with sampling for serological, histopathological, chemical, microbiological, or genetic examination, including DNA fingerprinting [29]. Recently, some forensic specialists discovered that the standard autopsy, in addition of being destructive technique, is insufficient to obtain all the necessary information. Therefore, they started looking for nondestructive and noninvasive technology, such as virtual autopsy that entails imaging techniques that can provide further information and take place of the traditional autopsy [28].

The investigation of gunshot wound victims may make advantage of the synergistic usage of CT and MRI. Special modality of CT, MDCT, has been widely used and replacing the conventional radiography in modern times [31]. However, because MRI is more sensitive than CT, it may be employed in particular circumstances, such as the identification of subarachnoid hemorrhage [30]. Conventional radiography (x-ray) (which is the main radiological technique present in most of Egyptian mortuaries) is an outdated method of postmortem inquiry that involves direct x-ray radiation. It is utilized in anthropology, assessment of the skeletal system in cases of trauma and detecting foreign bodies [28].

LIMITATIONS AND RECOMMENDATIONS

Virtual autopsy in Egypt is still facing numerous difficulties that need to be overcome. As a result, Egyptian legal organizations should permit virtual autopsy as a supplemental or adjunct method to traditional autopsy in order to examine the corpse in more accurate details and record the findings. Legal implementation of the virtual in addition to the regular autopsy is a need rather than an option for a forensic expert. Hence, the court will accept the results of the virtual autopsy. Due to the expensive cost of the virtual autopsy instruments and the ongoing maintenance they demand, it should also save money.

The Egyptian Forensic Medicine Authority has several branches distributed all over Egyptian governorates. This requires introducing more radiological units inside each morgue [32]. Forensic experts and technicians should be enrolled in training courses for virtual autopsy. These courses should be designed and validated by collaboration between forensic and radiological departments in different Egyptian institutions.

To achieve this point, there should be a policy for cooperation between the Egyptian Forensic Medicine Authority and the Ministry of Health in order to overcome the lack of facilities and budgetary challenges, this is the first step.

CONCLUSIONS

A cardiac shotgun pellet embolism is a rare outcome that necessitates prompt identification through adequate radiological examination. Our case indicates that postmortem forensic radiology is crucial for gunshot wounds. It also confirms that PMCT observation combined with traditional autopsy is the gold standard in ballistic instances. Virtual autopsy application in Egypt still has a long way to go and must overcome numerous difficulties. During autopsy and examination, it is essential to employ every practical and available technique that may help in making the final conclusion.

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