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TECHNICAL NOTE

PATHOLOGY AND BIOLOGY

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Positive ‘‘Water Test’’—An External Indicator of Base of Skull Hinge-Ring Fracture

ABSTRACT: Despite having significant internal injuries, victims of motor vehicle accidents may have surprisingly few external manifestations of trauma. The water test describes a technique whereby water placed in an upwardly facing ear results in drainage from the nose and opposite ear, thus demonstrating transcranial passage of water. This sign can be demonstrated in cases of blunt cranial trauma where there is a “hinge” fracture involving the petrous temporal bones bilaterally associated with a ring fracture extending around the foramen magnum posteriorly. Such a fracture results in separation of the posterior and middle cranial fossae providing a track for water to traverse. The water test provides a quick and noninvasive method for demonstrating the presence of a particular type of skull fracture.

KEYWORDS: forensic science, base of skull, hinge, ring, fracture, vehicle accident, water test

Prosectors have traditionally performed tests during autopsies to identify particular conditions prior to organ dissection. These include penetrating the chest cavity with a blunt probe under a water seal to check for intrapleural air in cases of pneumothorax and incising the heart under water to check for possible air embolism (1). While modern radiographic studies, utilizing computerized tomography scanning, would now be considered the preferred means for detecting these conditions, these are not always available. Under these circumstances, the reliance remains upon basic autopsy procedures. An additional test is described that has application in demonstrating base of skull hinge-ring fractures prior to formal autopsy dissection.

Technique

During routine washing of the externally intact head of a motor vehicle crash victim, it was noted that water in the ear that was uppermost drained away and was seen dripping from the opposite ear; i.e., the water was transiting through the cranial vault from one ear to the other. Autopsy dissection of the skull and brain subsequently revealed a hinge-ring fracture of the base of skull that extended from one petrous temporal bone to the other across the midline and then posteriorly to form a ring fracture around the back of the foramen magnum through the occiput. During routine washing of subsequent motor vehicle crash victims, attention was paid to any transcranial transfer of water as a marker of this type of base of skull fracture. The results of two such cases are reported.

Case 1

A 36-year-old man was involved in a vehicle accident where he was found dead at the scene. On external examination, he had bilateral periorbital hematomas, bruising of the left side of his forehead, and parchmenting of his lower anterior chest. Fresh blood was present in both external ear canals and in his left nostril. During preparation of the body for autopsy, it was noted that water washing over his right ear quickly drained out of his left ear and nostril (Fig. 1). Upon internal examination, lethal injuries were confined to the head where there was a hinge-ring fracture of the skull that extended from one petrous temporal bone to the other across the midline and then posteriorly around the foramen magnum through the occiput (Fig. 2). There was also subarachnoid and intraventricular hemorrhage. Other injuries included rib fractures with anterior mediastinal bruising, mesenteric bruising, and pelvic fractures. Death was because of blunt cranial trauma.

FIG. 1—*Blood-stained water streaming out of the left nostril in case 1.*

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FIG. 2—*Characteristic associated hinge-ring fracture of the base of skull in case 1 that extended from one petrous temporal bone to the other across the midline and then posteriorly to form a ring fracture around the foramen magnum through the occiput.*

FIG. 3—*Water dripping out of the right ear in case 2.*

Case 2

An 83-year-old woman was knocked down by a car while crossing a road and was dead at the scene. On external examination, she had multiple abrasions and bruises of the head, face, chest, abdomen, and limbs. Dried blood was present in both external ear canals. It was noted that water quickly drained from the left ear out of the right ear (Fig. 3). Upon internal examination, multiple lethal injuries were identified including transection of the aorta, laceration of the heart, multiple bilateral rib fractures, and rupture of the diaphragm. There was also a characteristic hinge-ring fracture of her skull that extended from one petrous temporal bone to the other across the midline and then posteriorly around the foramen magnum through the occiput. Death resulted from multiple injuries.

Discussion

Determining the extent of internal injuries from external examinations following blunt trauma is often extremely inaccurate if there are no lacerations or defects in body cavities to expose internal tissues and organs (1,2), although the nature of the injuries may be influenced by the size and age of the victims (3,4). A typical example involves adults who may have died in vehicle crashes, who may have minimal signs of injury externally, and yet who are discovered on dissection to have multifocal significant and lethal injuries to abdominal and chest organs, the brain and skull, vertebral column and rib cage. Techniques that enable an assessment of internal injuries to be made prior to dissection may, therefore, be potentially useful.

In situations where radiological facilities are not available, the water test may be an example of this. It represents a quick and noninvasive indicator that a hinge-ring basal skull fracture is present. The technique is simple, cost effective, and nondisfiguring, and provides information on the presence of a particular type of cranial injury. If an autopsy is not being considered for religious or other reasons, demonstration of this sign may be used to confirm the presence of a specific form of significant blunt craniocerebral trauma with skull fracture without the requirement of complex imaging.

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