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CASE REPORT

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Blunt Force Cranial Trauma in the Cambodian Killing Fields*

ABSTRACT: In this paper we present a unique pattern of blunt force cranial trauma that was observed in 10 of a sample of 85 crania from a Cambodian skeletal collection comprised of Khmer Rouge victims. Initial examination of the trauma, which presents as substantial damage to the occipital with fractures extending to the cranial base, suggested the pattern was classifiable as a basilar or ring fracture. However, further investigation, including trauma analysis and historical research, revealed that this fracture type is distinctive from basilar and ring fractures. Historical data indicate that a particular execution method was the likely source of the trauma. Recognition of this trauma pattern is significant because it exemplifies the distinct fracture configuration resulting from an apparently categorical and methodical execution technique. Identification of this fracture type could potentially assist forensic investigators in the recognition of specific methods of murder or execution.

KEYWORDS: forensic science, forensic anthropology, cranial trauma, blunt force trauma, ring fracture, basilar fracture, execution

Recognizing patterns of skeletal trauma is a crucial step in the forensic analysis of mass murders; however, identifying the specific cause of a given type of skeletal trauma is not always straightforward. This study focuses on a fracture pattern observed in a skeletal collection comprised of Khmer Rouge victims who were buried in mass graves outside of Phnom Penh, Cambodia between 1975 and 1979. The trauma was tentatively classified as ring or basilar fracture types, but reconsideration revealed inconsistencies with both types. Historical data were consulted to find potential clues about the source of the trauma. This research revealed that the likely cause of the trauma was a specific method of execution used by Khmer Rouge soldiers that involved a variety of blunt weapons applied to the back of the head/neck.

In this paper, we present a brief historical summary to establish the context of the skeletal collection and highlight the significance of identifying this distinctive pattern of trauma. We discuss historical data specifically pertaining to the etiology of the trauma, describe the skeletal sample, and explain methods of observation. Finally, the observed trauma pattern is described and differentially diagnosed with other fracture types.

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Historical Context

In April 1975, a radical faction of communists known as the Khmer Rouge gained control of Cambodia. They pursued a revolution that involved evacuating urban areas and attempting to transform the entire population of the country into rural peasant farmers. The Khmer Rouge regime was marked by intense paranoia and extreme intolerance for perceived disloyalties. Although certain members of society such as intellectuals, former government officials, or social elites were specifically targeted for harsh treatment, no member of society was immune from suspicion or accusation. Men, women, and children from all walks of life were tortured, executed, or simply worked and starved to death.

In January 1979, Vietnamese forces invaded Cambodia and put an end to the Khmer Rouge juggernaut. By that time, roughly 1.5 million Cambodians had died from starvation, disease, or execution. Approximately 14,000–16,000 of these victims passed through the central prison in Phnom Penh, known as "S-21" or Tuol Sleng (1,2). The vast majority of these prisoners were executed, and many were buried in a field of mass graves on the outskirts of Phnom Penh, known as Choeung Ek. In the early 1980s, Vietnamese authorities excavated approximately half of the mass graves at Choeung Ek. When the remains were disinterred, they were disarticulated, sorted by element, and stored in a *stupa* (a Buddhist shrine) built on the site. The Cambodian government now administers Tuol Sleng as a museum, and the Choeung Ek site as a memorial. Choeung Ek is informally referred to as "the Killing Fields." Numerous such mass grave sites are scattered throughout Cambodia.

Khmer Rouge Executions

A growing volume of literature details the recollections of witnesses who lived through the Khmer Rouge era, along with documents the Khmer Rouge themselves left behind. Such documentation indicates that firearms were not the preferred weapon for executions, since ammunition was scarce. Witness accounts refer to executions by drowning, shooting, stabbing, throat-cutting, and suffocation (1–3). A number of accounts also refer to execution by beating with various objects such as pick axe handles, poles, bamboo sticks, axes, ox-cart axles, or shovels (1,3). Of particular relevance to this study are reports of people being struck in the *back of the neck* with blunt objects (1,3). Details of methods of torture and execution available in the documents left behind at Tuol Sleng prison recurrently use the word "*komtec*," a Khmer term meaning to "kill" or "destroy" that, literally translated, means "to smash" (3) or "to shatter."

Execution methods can in fact be documented directly from the executioners themselves. Through a series of interviews with a Mr. Him Huy, Chandler (1) published perhaps the only firsthand account to date from an individual who identified himself as a Khmer Rouge executioner at Choeung Ek. Mr. Huy was an important figure in the administration of Tuol Sleng prison and a participant in the executions at Choeung Ek (1). Although Mr. Huy admitted to driving trucks full of prisoners to Choeung Ek and participating in "one or two" executions, interviews with other witnesses suggest he may have been directly involved in hundreds of executions. According to Chandler's interview with Mr. Huy, every few weeks, two to three trucks carrying 20–30 prisoners each would be sent to Choeung Ek from Tuol Sleng prison. There, the prisoners were led to ditches and pits where:

> They were ordered to kneel down at the edge of the hole. Their hands were tied behind them. They were beaten on the neck with an iron ox-cart axle, sometimes with one blow, sometimes with two . . . (1).

A painting currently on display at the Tuol Sleng museum depicts this same scenario: an executioner preparing to strike a blindfolded prisoner kneeling over a large pit (Fig. 1). This image was painted by Mr. Vann Nath, one of only a few prisoners who survived Tuol Sleng. The prison administrators kept Mr. Nath alive in order to paint portraits of Khmer Rouge leaders (4). Much of his artwork details prison torture and execution methods, and many of his paintings are displayed at the Tuol Sleng museum.

The number of prisoners incarcerated at Tuol Sleng prison and the number of executions carried out at Choeung Ek at any given time fluctuated significantly. On the basis of a study of prison documents and witness testimony, Chandler (1) estimates that the prison reached a maximum capacity of *c*. 1500 prisoners in 1977. During this time, many prisoners were likely transported for execution shortly after arriving. Chandler (1) estimates that in December 1978, only about 370 prisoners were being held at Tuol Sleng. On the basis of these estimates, executions likely occurred in waves varying between tens to hundreds of people at a time.

Materials and Methods

A sample of 85 crania housed in the *stupa* at Choeung Ek was examined. Crania were selected by local assistants based primarily on ease of access inside the *stupa*. The sample is biased in terms of positive selection for comparatively complete crania (i.e., isolated cranial fragments were not included in the sample). Each cranium was assigned a number (1–85) based on the order it was examined. Subadult crania were excluded from the sample. A sex estimate was recorded for each individual, which was based solely on observable cranial morphology, as all crania were disassociated from their respective postcranial portions and mandibles. A majority of the 85 crania examined (74 out of 85, or 87%) were estimated to be male. A separate study of morphology and trauma was conducted on a sample of mandibles from the collection (5). Since this study involved a limited sample of available crania from the memorial *stupa*, statistical estimates of the frequency of this particular trauma pattern in the overall skeletal population of Choeung Ek cannot be reasonably calculated.

Taphonomic factors complicate interpretations of the observed trauma. All of the crania display some degree of weathering as a result of a suboptimal curation facility where remains are subject to intense sun exposure, and cyclical extremes of wet and dry weather

FIG. 1—*Painting by Tuol Sleng prison survivor Mr. Vann Nath, depicting execution by blunt force to the back of the head.*

FIG. 2—*Cranium #15.*

FIG. 4—*Cranium #36.*

conditions. Although the primary fracture margins in each case are clearly perimortem, the crania also display more recent postmortem damage or mishandling, e.g., the postmortem loss of teeth in all crania examined. In at least one case, perimortem fracture margins show additional postmortem damage. As previously noted, the remains were disinterred by Vietnamese excavators who were not trained in forensic archaeology, so not all fragments were retained.

Description of the Trauma

Of the 85 crania examined at Choeung Ek, 10 (12%) displayed blunt force trauma to the occipital. Perimortem blunt force trauma was not observed on the rest of the 85 crania, although two (crania 3, 9) displayed probable perimortem sharp force trauma. Nine of the 10 individuals with blunt force injuries were probable males; one was a probable female. Figures 2–6 present photographs of five of the 10 crania, and Table 1 provides a summary description of the trauma on each cranium. The trauma presents as substantial damage to the occipital from the foramen magnum to the external occipital protuberance (roughly between opisthion and opisthocranion). In three cases, the fractures are focused centrally on the squamous portion of the occipital (crania 15, 47, 56); in six cases the fractures are oriented to the left or right (crania 34, 36, 39, 44, 67, 82); in one case the trauma is focused on the basilar portion of

FIG. 3—*Cranium #34.*

FIG. 5—*Cranium #39.*

FIG. 6—*Cranium #67.*

the occipital (cranium 43). In four cases (crania 36, 47, 56, 82) the occipital is fractured posterior to the occipital condyles; in the other six cases the entire occipital base is absent.

The breakage pattern includes fractures that migrate across the spheno-occipito sutures and into the lesser wings of the sphenoid, but in only one case (cranium 67) is the petrous portion of either temporal completely fractured. Radiating fractures are visible on all but one cranium (cranium 43), and two exhibit concentric fractures (crania 15, 47). Multiple blows are apparent on four crania (crania 39, 44, 56, 67). In one case (cranium 39), a radiating fracture penetrates the external occipital protuberance, splitting a well-developed inion hook (see Fig. 5). In addition to occipital trauma, cranium 67 displays blunt force trauma to the right temporal, including a radiating fracture that splits the squamous portion of the temporal in half and extends to the tip of the mastoid process.

Internal beveling is present on some fracture margins in all but two of the crania (crania 15, 44). In four instances (crania 15, 36, 43, 67) some margins display external beveling. Internal beveling is particularly marked at the internal/external occipital crests and protuberances in five cases (crania 34, 39, 47, 56, 82). Two cases (crania 36, 67) display both internal and external beveling in this particular section of the occipital.

The general appearance of the fractures in crania 15, 34, 39, and 47 can be described as rounded on at least one margin. In the other cases the shape of the defect can be described as oval (cranium 36, 82) or jagged (crania 44, 56, 67). The areas of missing bone range in size from maximum dimensions of 9.7×8.5 cm (cranium 67) to 6.0×3.5 cm (cranium 36).

Discussion

Fracture morphology associated with blunt force trauma is dependent on a variety of intrinsic factors such as bone buttressing, thickness, and plasticity, as well as extrinsic factors, such as the direction and intensity of the blow(s) and the shape and size of the implement (6). Beveling of cranial fractures can indicate direction of force in many cases (6,7), although in some cases beveling may be misleading or unclear because the spherical shape and buttressed structure of the cranium can be confounding factors (8). Interpretation of fracture patterns may be obfuscated by taphonomic factors such as bone degradation, ground pressure forces, and weathering, if the postmortem interval is sufficient. Given these limitations, the fracture patterns, complicating factors, and differential diagnoses must be considered in order to assess the root cause(s) of the observed trauma.

TABLE 1—*Summary of cranial trauma.*

Cranium	Dimensions*	Description
15	8.4 A–P 7.1 M–L	Two round-shaped defects with associated concentric fractures are focused inferior to the external occipital protuberance. External beveling is visible on the lateral fracture margins
34	8.2 A–P 6.7 M–L	A round-shaped defect is focused on the right side of the occipital. The primary fracture edges are internally beveled, markedly so at the internal occipital protuberance
36	6.0 A–P 3.5 M–L	An oval-shaped defect is focused between the left mastoid and the external occipital protuberance, bisecting the occipital posterior to the occipital condyles. The fracture margins are beveled both internally and externally at the occipital crest
39	6.5 A–P 8.0 M–L	A round-shaped defect is focused on the right side of the occipital inferior to the external occipital protuberance, and a second fracture with a straight edge is focused on left side of the occipital. The two fractures are separated by a 4.8-cm-long radiating fracture extending superiorly through a well-developed inion hook. The fractured surfaces are internally beveled, particularly at the occipital crest. Lateral fracture surfaces are straight
43	6.2 A–P 7.3 M–L	Two straight fractures extend horizontally between the jugular fossae and the foramen magnum. The fractured surfaces are internally beveled along the left lateral margin. The right lateral margin appears to be externally beveled, but postmortem damage obscures this section
44	5.0 A–P 8.5 M–L	A jagged defect is focused on the right side of the occipital, affecting the posterior portion of the right temporal, superior to the right mastoid. It incorporates a diastatic fracture along the right lambdoidal and squamosal sutures
47	6.5 A–P 6.0 M–L	A round-shaped defect, including concentric fractures, is centered on the occipital between the posterior margin of the foramen magnum and the external occipital protuberance. Internal beveling is marked in the area of the occipital crest
56	6.3 A–P 8.5 M–L	A jagged defect is centered on the occipital between the posterior margin of the foramen magnum and the external occipital protuberance. Internal beveling is marked at the occipital crest
67	9.7 A–P 8.5 M–L	A jagged defect is focused on the left side of the occipital between the external occipital protuberance and the left mastoid process. Fracture surfaces are externally beveled on the left side of the occipital crest, but internally on the right side. A separate fracture is focused on the right temporal immediately posterior to the pterion region
82	4.5 A–P 8.7 M–L	An oval-shaped defect is focused on left side of the occipital. Fracture surfaces are internally beveled, markedly so around the occipital crest

*Maximum anterior–posterior (A–P) and medial–lateral (M–L) dimensions in approximate centimeters; in cases where margins of the foramen magnum are intact, measurements incorporate the foramen magnum.

Of the currently defined types, ring and basilar fractures most closely resemble the observed pattern. Ring fractures are fractures of the cranial base that are typically disassociated with the impact site. They usually occur as a result of either (1) falls from a height where the cranium is forced down against the spine (9) or (2) an oblique force applied to the cranium that tears the occipital away from the spine (6). Ring fractures may be incomplete, partially encircle the foramen magnum posteriorly, extend anteriorly across the petrous portions, or may completely encircle the foramen magnum. When ring fractures occur from force applied in an upward direction to the chin or posterior vault, resulting in a tearing away of the occipital from the spine, an externally directed beveling pattern is typical (6). Basilar fractures, longitudinal, or transverse fractures of the sphenoid, are usually associated with blows to the front or side of the head or indirect spine compression (6,9). These fractures may extend posteriorly into the occipital bone, passing through the foramen magnum, or may travel laterally around it. Basilar skull fractures are associated with high mortality rates due to brain stem contusions and tears (10).

The Choeung Ek fracture pattern is remarkably similar to both ring and basilar fracture types in general appearance and affected areas, but the types can be distinguished from each other on several levels. In a majority of the Choeung Ek crania, the observed beveling patterns are internally directed, but in three cases (crania 36, 43, 67) there is a combination of internal and external beveling, particularly, in two of these three cases, along the posterior occipital fracture margins. This variable beveling pattern is not consistent with the typical ring or basilar fracture pattern. Such beveling was ostensibly caused by forces directly focused on the squamous portion of the occipital, which has a strong and complex buttressed structure.

The purported mechanism of injury in the pattern observed at Choeung Ek is distinct from that of ring and basilar fractures. The Choeung Ek fractures are the result of direct blows to the back of the head/neck, with distinct impact points on the occipital bone. Ring or basilar fractures result from the vertebral column being forced superiorly (or the skull forced inferiorly) or severe hyperextension of the head, such as from a blow to the chin. Essentially, ring or basilar trauma occurs as a result of force applied to a disassociated cranial vault zone that forces the spine into or away from the cranium, while the Choeung Ek fractures are a result of forces applied directly to the occipital, without necessarily displacing the spine. This distinction is critical because the resulting injuries to the underlying brain are different. An injury inflicted by a moving object on a stationary head will create cortical contusions at the site of the primary impact (coup contusion) (11). This is the pattern of injury presumed in the Choeung Ek fractures. On the other hand, when a head in motion strikes a fixed or firm surface, such as occurs with falls, jumps from heights, and motor vehicle accidents (all of which may produce ring or basilar fractures), contusions of the brain occur opposite the site of impact (contre-coup) (11). Although coup and contre-coup contusions may be associated with ring or basilar fractures, contre-coup contusions would not be expected with fractures inflicted in the manner described in historical documents and witness accounts relating to Choeung Ek.

For the reasons stated above, the observed trauma pattern is not entirely consistent with published cranial trauma exemplars. The Choeung Ek pattern stemmed from one or more direct blows to the back of the head/neck and not from an indirect application of force to the cranium that forced the spine into or away from the cranial base. The pattern is summarized as follows:

(1) Blunt object impact sites are found on the squamous portion of the occipital bone.
(2) Internal beveling is present along the resulting posterior fracture margins, particularly at the internal/external occipital crests and protuberances. Variable beveling may be present along occipital fracture margins due to the complex bone structure of these areas.
(3) The cranial base may be missing or severely fractured. Radiating fractures either terminate at the foramen magnum or completely encircle it, allowing it to become detached from the parent bone. These fractures can be observed splitting strong bony structures, such as robust external occipital protuberances and the petrous portion of the temporal bone.

Finally, the defect sizes apparent in the Choeung Ek crania deserve additional attention. The reported measurements are somewhat misleading in terms of interpretations about likely weapon size because the force of the blow typically created radiating fractures that effectively loosened the entire cranial base, which then split completely off the cranium. The overall size of the defect may reflect the intensity of the force and sometimes the size and shape of the weapon used to inflict the damage (12), but not always. In cases of blunt force trauma, the specific weapon implement can sometimes be deduced given appropriate circumstances, but even inferring such details as, for example, projectile calibers in cranial vault wounds can be problematic (13). In this study, the entire occipital base of cranium 56 is loose due to the damage on the squamous section of the bone and associated radiating fractures; given slightly more force, or given slightly more disturbance to the cranium in the excavation and curation stages, the base of this cranium may have broken completely off as it did in other crania. Although it is clear that these individuals were executed using a systematic method of blows to the back of the head, the specific implements used (e.g., axe handles, ox-cart axles, wooden staves) cannot be definitively identified.

Conclusion

The Choeung Ek fracture pattern represents an atypical but clearly effective method of systematic execution. The pattern is consistent with documentary records that indicate different weapons were used for essentially the same execution technique. The executioners maximized the effectiveness of the strikes—blows were not struck randomly, but rather focused intentionally on the specific region of the inferior squamous portion of the occipital that, although strongly supported, is particularly sensitive because of its proximity to the cerebellum, the brainstem, and the spinal cord.

On the basis of the assertion that the Khmer Rouge favored execution methods that preserved bullets, one would expect to find forensic evidence of other non-firearm-related methods of execution in other victims. Many other methods, such as suffocation using plastic bags, would leave no trace on skeletal material, but could perhaps be detected if careful forensic archaeology were carried out on intact mass graves. Documentation of forensic anthropological data pertaining to victims of the Khmer Rouge has been limited to date (14,15); however, numerous intact mass graves still exist in the country, and further research would undoubtedly reveal additional valuable details.

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