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Letter to the Editor

Identification of a bronze weapon based on an embedded fragment in a 3000-year-old skull

Identification of the weapon used is one of the difficult problems that forensic pathologists often face on the occasion of a murder case by stabbing. Bauer and Patzelt recently identified a steel weapon by using digital superimposition on CT scans for a case with intracranial stab injury [1]. Compared to this kind of present-day case, ancient cases are much more difficult. Here we report identification of a bronze weapon based on an embedded fragment in an ancient human skull.

Yin, located at Anyang, China, was a capital of the late Shang Dynasty (3400–3200 BP), one of the oldest civilizations in the world. The Shang Dynasty is famous for its sophisticated bronze tools, jewelry, and letters written on turtle shell. For ancient DNA analysis, we examined human bone samples from the Yin ruins as an extension of our previous studies [2,3]. We found a bronze fragment at the top of a skull in the process of the sampling (Fig. 1A). Estimating age-at-death based on the degree of suture closures (ectocranial, endocranial, and hard-palate) [4–6] and the Suchey–Brooks method [7] indicated that the skull was that of a young adult (20–34 years). The amelogenin gene locus for sex identification [8] could not be detected by polymerase chain reaction (PCR). Based on morphological analysis, however, we could be fairly certain that it was a male's skull. This man was buried in a vermilion-lacquered wooden coffin with articles such as a jade cup. According to archaeological findings, the

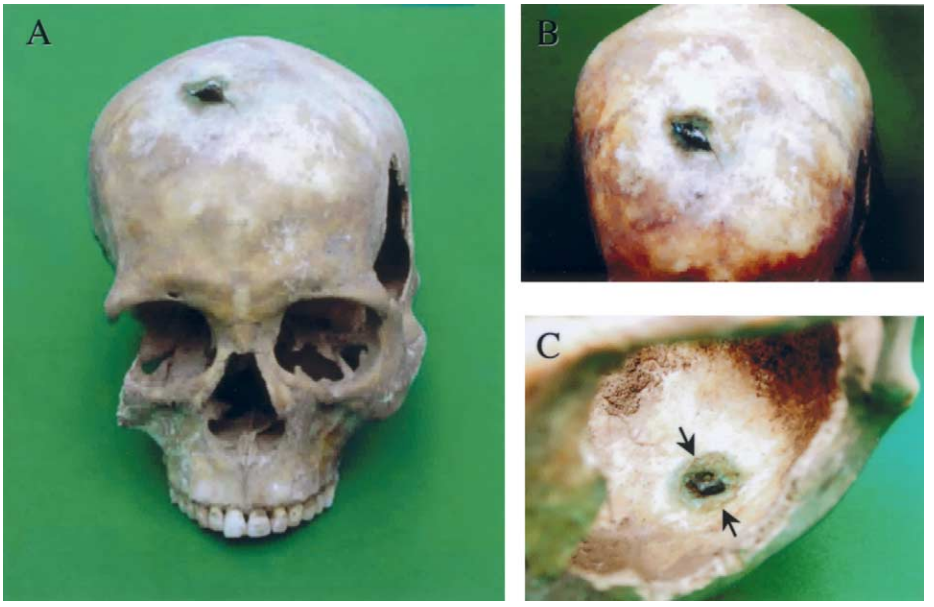

Fig. 1. A fragment of a bronze weapon found in the skull of an ancient male: (A) general view, (B) upper view, and (C) internal view. The area between the two arrows indicates the circle-shaped detachment of the inner table of the skull.

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remains belong to the late Shang (Tang et al., unpublished).

What kind of bronze weapon was this fragment from? This question is difficult to answer because only an apical fragment of the weapon remains and such an object is not used in the present day. In order to identify the ancient weapon, it was necessary to observe the shape of the fragment minutely, to obtain information regarding weapons of that era, and to carry out appropriate image analysis.

The bronze fragment embedded in that particular skull is located on the top of the frontal bone and projects 21 mm above the skull surface. Orientation of the stuck fragment is from the left front towards the right back. Its length and width measure 23 and 5 mm, respectively. The cross-section (wound shape) exhibits a slender and asymmetrical rhombus-like shape (Fig. 1B). The wound is accompanied by surrounding coloration with verdigris and a fissured fracture on an anterior extension line. The metal breaks through the skull with circle-shaped detachment of the inner table (Fig. 1C). As a result, the point of the weapon fragment is crushed flat.

Weapons of the Shang Dynasty were classified into five groups: arrowheads, axes, battle-axes, spears, and dagger-axes (Fig. 2A) [9–11]. The first three weapons do not conform to the projected thickness of the blade and the shape of the shoulder part of the bronze weapon fragment embedded in the skull, so the fragment was either from a spear or a dagger-axe. The spear is generally pointed and has a spindle shape, whereas the edge of a dagger-axe is slightly round, thin, and flat [10]. The circle-shaped detachment of the inner table of the skull indicates that the wound did not result from

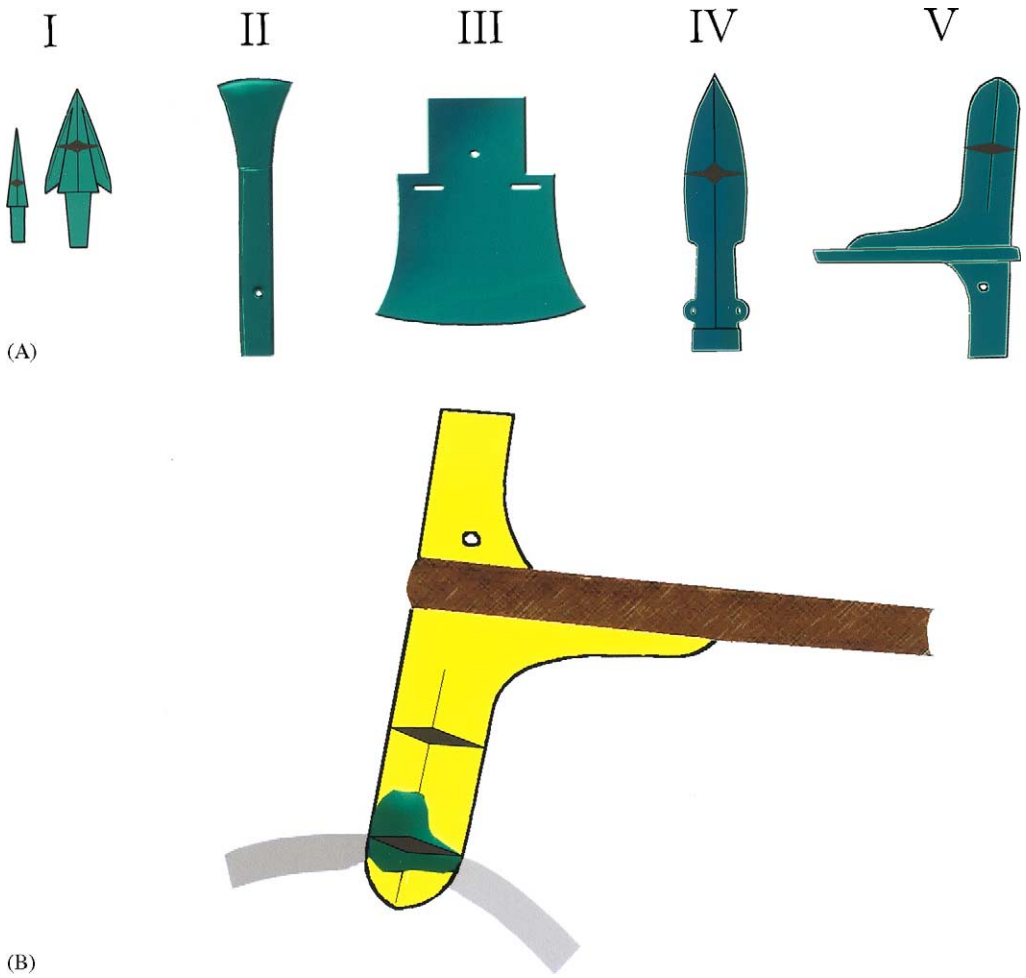

Fig. 2. (A) Schematic view of the bronze weapons used during the Shang Dynasty. I, arrowhead; II, axe; III, battle-axe; IV, spear; V, dagger-axe. Size of these weapons displayed is not proportional. (B) Reconstruction of the dagger-axe from the fragment embedded in the skull.

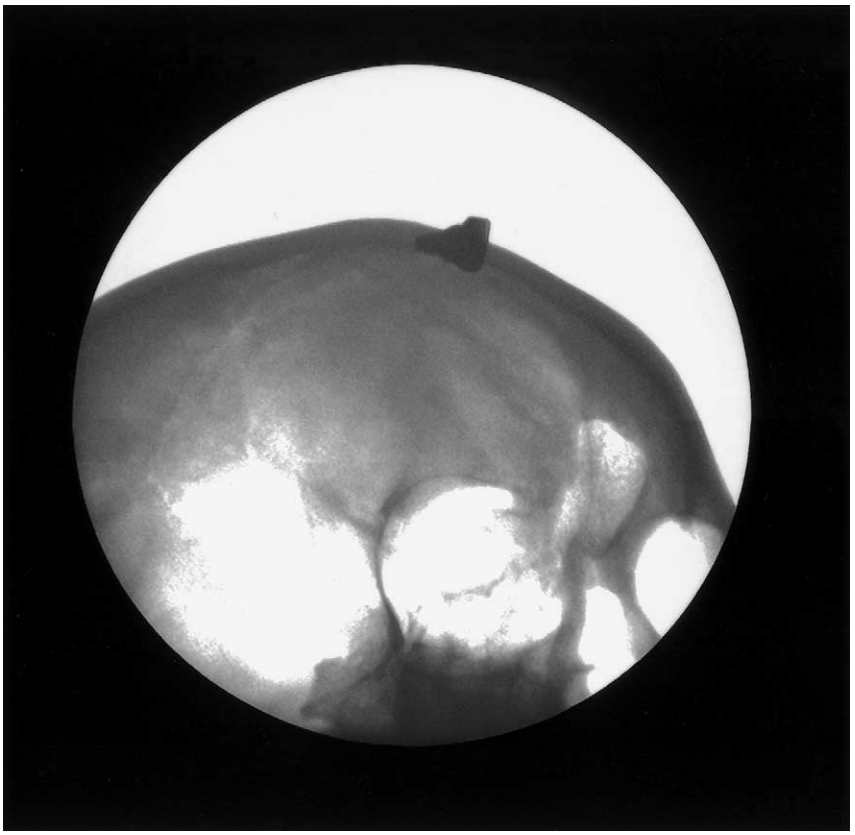

Fig. 3. A radiograph of the skull, right oblique view, reveals the shape of a hidden portion of the bronze fragment.

a sharply pointed weapon. This suggests that a dagger-axe is the likeliest candidate. The structural information on the embedded fragment will be crucial to make a definitive conclusion. Although it is desirable to remove the fragment from the skull in order to thoroughly observe the actual object, this cannot be done without destroying precious archeological remains. We thus took plain X-ray photos, scanograms, and CT photos of the specimen (Fig. 3). These photos reveal that the angle of the embedded part of the bronze fragment was not acute at all. Its breadth is rather wide and looks like a water drop rather than a spindle. The horizontal view shows typical characteristics of a dagger-axe: a thin and flat edge. We also reconstructed a three-dimensional image of the fragment. The data clearly show that the bronze fragment constitutes part of a rather dull-edged weapon. We concluded that the bronze fragment found in the human skull is the tip of a dagger-axe.

The dagger-axe is considered by archaeologists as a war instrument exclusively, and is supposed to have been attached to a wooden shaft [10]. The cross-section of the embedded fragment shows an asymmetric rhombus-like shape, whose right back half (triangle) is slightly taller and acute than the left front half. Given that the shape of the right back part corresponds to the characteristics of the lower blade of a dagger-axe, it is most likely that the weapon was swung downward onto the head of the deceased (Fig. 2B), probably from the right rear. He had four additional incisura on the skull and one on his left humerus, probably also caused by a bronze weapon. These wounds showed no periosteal healing. Findings suggest that he died within 3–4 weeks at most after receiving these wounds. We cannot conclude whether the blow to the skull was lethal, due to the lack of information on damage to organs and vessels. However, because the tip of the embedded weapon did not arrive at a deep part of the intracranial cavity, it can be supposed that the brain damage was not severe. On the other hand, one of the above-mentioned wounds was found in the middle and front part of his left humerus. This fact suggests that main vessels such as the brachial artery were probably damaged. If this inference is accurate, the upper-arm injury, rather than the blow to the skull, appears to have been the lethal wound.

To our knowledge, this is the oldest killing case in which the weapon was identified from a small fragment based on the viewpoint of forensic sciences. We should also add that a bone embedded with a fragment of a bronze weapon is the first case in the archeological history of China.

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