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Forensic Anthropology and the Most Probable Cause of Death in Cases of Violations Against International Humanitarian Law: An Example from Bosnia and Herzegovina

ABSTRACT: This study presents the results of the analysis of at least 298 predominantly male individuals, between 15 and 75 years, who were recovered from an open cast mine in Bosnia–Herzegovina. Particular attention is paid to identifying the mechanisms of injury and determination of the most probable cause of death based on the assessment of lethal or lethal-if-untreated injuries recorded in the skeleton. It was calculated that at least 38.9% (155/398) of individuals sustained gunshot wounds (GSWs) (plus one shrapnel wound) and may have died as consequence of these injuries. Among individuals who died from GSWs, there were 142 males (91.60%), eight females (5.1%) and five cases that were (3.2%) undetermined. One male individual sustained shrapnel injuries. This study presents an example of the multidisciplinary approach to the effective forensic investigation of violation against International Humanitarian Law, as well as an example of how it is possible to obtain meaningful results to assist the needs of the prosecution in these kind of cases despite the large number of cases and technological constraints.

KEYWORDS: forensic science, Bosnia and Herzegovina, genocide, forensic anthropology, forensic pathology, minimal number of individuals, cause of death, International Humanitarian Law

Forensic anthropologists and pathologists are able to provide their expertise to characterize patterns of violations against International Humanitarian Law.

Anthropologists determine the demographic profile, as well as document the pattern of injuries sustained by the population sample. One of the main drawbacks of forensic pathology in the absence or presence of little soft tissues is the limitation in determining whether injuries were produced immediately before or after death. Forensic anthropology has a primary role in recording skeletal injuries of known mechanism and etiology (i.e., gunshot wounds). The context in which the remains were found, together with the observations of the forensic anthropologist, allow the pathologist to interpret the most probable cause of death and avoid overly restrictive interpretations focusing on the mechanism of death. This is necessary to transform forensic pathology and anthropology into a useful tool for the effective investigation of human rights violations.

In investigations into violations of international humanitarian law, such as those conducted in Bosnia and Herzegovina (BiH), anthropologists and pathologists work closely with one another to document the demographic profile of skeletal remains, and reconstruct skeletal trauma to determine the number, type, and direction of injuries. The analysis of trauma by the anthropologist ultimately leads the pathologist to make a determination as to the individual's cause of death, which is vital to the prosecution of war crimes.

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Since the Nuremberg and Tokyo Trials, only the International Tribunal for Rwanda and that for the former Yugoslavia (ICTR and ICTY, respectively) used large-scale forensic evidence for the prosecution of war crimes (1–9).

This article is based on the report submitted to the Office of the Prosecutor of the International Criminal Tribunal for the former Yugoslavia (ICTY) in the case against Radoslav Brdjanin (2) for charges of Genocide, Crimes Against Humanity, Grave Breaches of the Geneva Conventions of 1949 and Violations of the Law and Customs of War during the "ethnic cleansing" of Northwestern Bosnia in 1992. The following study discusses the anthropological protocol used in these types of investigations, taphonomic and demographic results of this investigation, and analysis of skeletal trauma. Moreover, an in-depth review of the mechanisms of injury and determination of the most probable cause of death are provided.

Materials and Methods

In 1993, the remains of hundreds of people were disposed in Jakarina Kosa, an open cast mine near to the town of Prijedor in Northwestern Bosnia, after being removed by a mechanical excavator from a primary burial site. Once extracted from the primary grave, the bodies may have been put in trucks and emptied down the slope to the bottom of the mine pit. Shortly after, one of the walls of the pit was blown up with explosives, causing an avalanche of rubble and rocks that covered the slope and the bodies until the time they were excavated in 2001 by the Bosniak Commission on Missing Persons.

The bodies were partially or fully skeletonized, disarticulated and mostly incomplete. There was a high potential for postmortem damage, either at the time of burial or subsequently during the removal of the bodies from primary into secondary grave.

In late 2001, a minimum of 298 individuals (minimal number of individuals (MNI) = 298, 139 almost complete bodies and 259 isolated body portions) were examined by a team from the ICTY,

in a makeshift mortuary outside the town of Sanski Most in Northwestern Bosnia. Since the mortuary did not have radiograph facilities, all remains that had soft tissues or were mummified were defleshed, which allowed the recovery of a large number of bullets and bullet fragments. The clothes and personal artifacts were separately washed, dried, and photographed in anatomical position. Age-at-death estimates for adults were estimated using the changes in the sternal end of the fourth rib (3) and the pubic symphysis (10–13). The ages at death for subadults (<17 years) were determined using standards for epiphyseal union and dental calcification (14–16). Sex estimation was diagnosed using skeletal features of the pelvis, skull, and long bones, using the standards described by Buikstra and Ubelaker (17). When dealing with body parts or isolated bones, only the morphology of the pelvic girdle was used in the determination of sex. Estimates of antemortem stature were derived from long bone length using the equations developed by Trotter and Glesser (18,19) and Trotter (20). Special attention was given to reconstructing broken bony parts and determining the type of trauma inflicted. Trauma types included blunt force trauma (BFT), sharp force trauma (SFT) and gunshot wounds (GSW). Many of the remains consisted of disarticulated body parts due to extensive damage to the bodies resulting from being buried twice.

Preservation of the remains defined and limited the scope of the work carried out. The relevant conditions were:

(1) Fragmentation of the remains during the first exhumation (i.e., from primary burial site);
(2) Fragmentation of the remains during their depositing into the open cast mine; and
(3) Fragmentation of the remains during the blast and reburial.

These three conditions created a number of problems for the analysis of the remains, and hence limited the scope of interpretation from the remains examined. The first problem is the number of people represented in the grave. Considering the fragmentation and comingling of the remains, it is only possible to determine the MNI based on the number of people represented by the same body parts in the assemblage. The second problem is the classification of injuries, which involves differentiation between trauma that occurred before death (antemortem), at or near the time of death (perimortem), or after death (postmortem) as well as the types of trauma (BFT, SFT, GSW).

The third problem is to assess the cause of death for each individual, given that the majority were disarticulated limbs and body parts.

Classification of injuries involved a number of challenges. Given that the bodies had been allegedly buried for almost 9 years, most soft tissues including organs had decayed. Therefore, the majority of cases were skeletons with little or no tissue. This meant that our observations were already limited to injuries that affected the skeletal system. To complicate matters further, bodies had been extracted from a primary grave and redeposited in a secondary grave. This process generated postmortem damage to bone and bone parts. Therefore, fractures caused by an excavator ripping through bodies and the effects of the explosion on the bones while being buried were factors that must be taken into account. We could conclude that the postmortem damage caused by the exhumation of the primary grave and subsequent deposition was BFT, since the damage was caused by low velocity force applied over large areas of bone.

A number of events related to the disposal of the remains would mimic BFT caused by many familiar weapons. These would include direct impacts over limbs and other parts of the body by the blade of the excavator that extracted the remains from the primary grave as well as rocks that crushed the remains after the blast of the walls of the mine. However, the characteristics of other injuries such as GSW could not be attributed to these processes. Therefore, it was decided that the examination of the remains would only concentrate on recording skeletal injuries thought to have been caused by gunfire. All injuries classified as BFT were assumed to have occurred postmortem except where the BFT could be demonstrated to have occurred prior to a GSW (i.e., a fracture line that occurred prior to those originating from a gunshot wound to the head).

It is assumed that a GSW occurred at the time of death and therefore contributed to it. This approach has been used in successful prosecutions of war criminals in the Balkans (1–4,6–9).

The location of GSWs was paramount in formulating the cause of death. Shots through the head and chest were classified as *lethal*, because of the short survival time of individuals suffering a GSW through the brain, heart, lungs, and major blood vessels surrounding the chest (21,22).

A second category of injuries was defined as *lethal if untreated*. Such injuries include trauma to the abdomen, in which perforation of viscera may have led to blood loss, infection, and eventually to death. This category relied heavily on the evaluation of the pathologist who assessed the gravity of the injury and its consequences if untreated. Two other areas where gunshots were considered lethal if untreated were the proximal one-third of the upper arm and the thigh. In other words, it was recognized that GSWs that caused comminuted fractures of the diaphyses of the humerus and the femur would have compromised the brachial and femoral arteries leading to death following severe blood loss (Figs. 1*a–c*).

GSWs classified as nonlethal if untreated were described but were not used in formulating the cause of death. Injuries that could not be attributed to a specific mechanism of injury, or those that simply relate to BFT were described as "cannot tell." The latter means that the injuries recorded in this study may be only a fraction of those that occurred at or around the time of death (see also de la Grandmaison et al. 2001 (23)).

Death could have been caused by a single injury or a combination of injuries of different kinds. Since the bodies were not always complete or articulated, it was decided to report the frequency of injuries per anatomical segment (i.e., head, trunk, and abdomen, upper and lower limbs) and by combined anatomical areas (i.e., head, trunk, and abdomen, head and lower limbs). Frequencies of injuries were determined using all available complete bodies or segments of bodies showing distinct injuries.

Results

A total of 139 bodies and 259 body parts were examined. The MNI based on the right femur was 298.

The demographic profile of the sample is presented in Fig. 2. This chart shows the frequencies of individuals per decade using mean age estimates ($n = 270$). Those cases not included were too fragmentary for an age interval to be estimated. Sex was determined in cases in which secondary sexual characteristics could be recorded ($n = 298$). Figure 3 presents the sex distribution for the bone sample in terms of the MNI.

At least 38.9% (155/398) of individuals sustained GSWs (plus one shrapnel wound) and died as a consequence of those injuries (Figs. 4–7). Among individuals who died from GSWs, there were 142 males (91.60%), eight females (5.1%), and five cases that

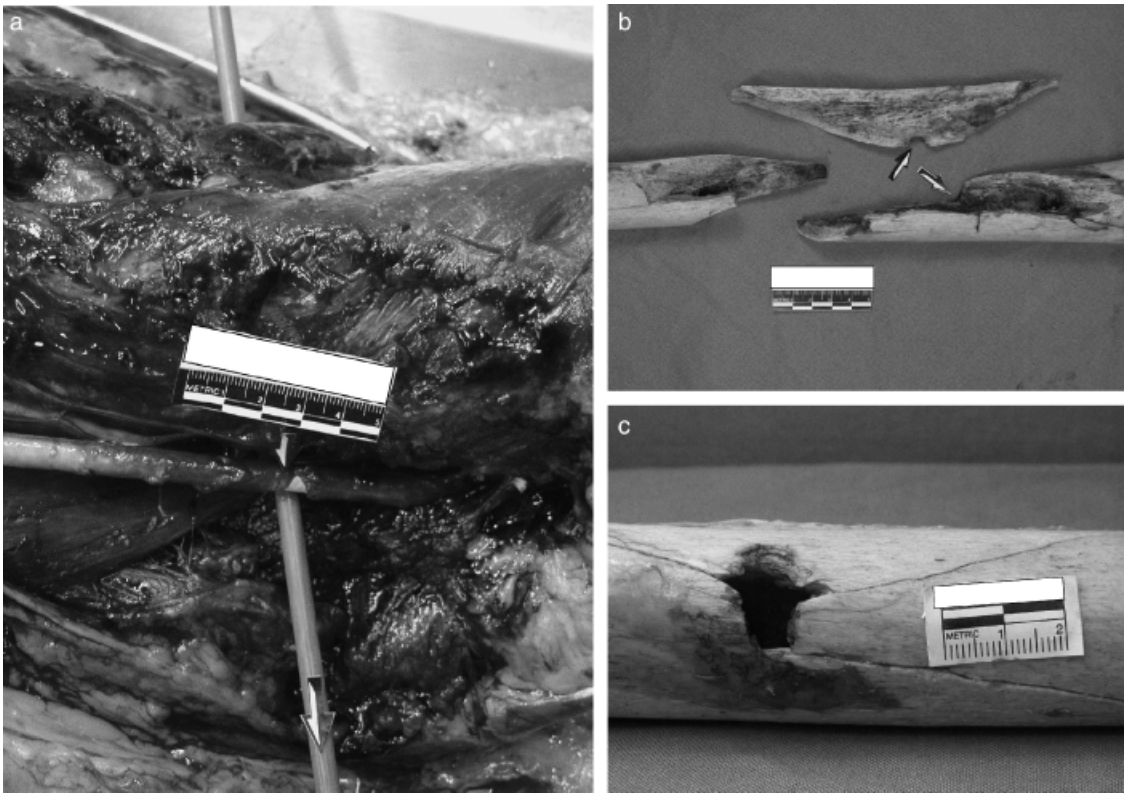

FIG. 1—*(a)–(c) Through and through, indeterminate range gunshot wound through the anterior aspect of the left thigh with high-velocity ammunition (7.62 × 39 mm). The projectile penetrated from the lateral aspect of the left thigh (a) and exited through its medial wall, creating a keyhole on the anterior wall of the proximal one-third of the femoral shaft. (a) Trajectory of the bullet as well as piercing of the femoral artery. (b) Comminute femoral shaft before reconstruction. (c) Femoral shaft after reconstruction (proximal to the right).*

were (3.2%) undetermined. One male individual sustained shrapnel injuries (Fig. 5).

The number of shots per any anatomical region ranged from one to six. The higher frequency of shots in decreasing order was the head, trunk, legs, and arms (Fig. 8). The direction of fire was determined with certainty in the majority of cases involving gunshot injuries to the head. In decreasing order, the gunshot injuries were posterior to anterior (i.e., in the back) (53.1%), anterior to posterior (i.e., from the front) (24.0%), left to right side (17.7%) and right to left side (7.5%). The cause of death of 139 individuals dying of GSWs was immediate while in 16 cases it was classified as lethal if untreated (Fig. 9). Only one individual showed a penetrating sharp force wound that may have occurred during the perimortem interval. The injury was consistent with a penetrating object driven through the ilium and then removed (hence the short fracture of the lateral wall.) Considering the shape of the defect, it is suggested that some sort of thick knife (i.e., bayonet) could have been used from back to front and left to right. This individual died of GSWs (lethal if untreated) to the arms.

All fired ammunition recovered (bullets, cores, jacket fragments) from the bodies or in association with the bodies were of high velocity rifles (i.e., 7.62 × 39 mm).

The most common type of postmortem damage was butterfly fractures of long bones crushing fractures of the ribs and skull with plastic deformation (Figs. 10 and 11). The former were most likely caused by the direct impact of an object against the bone

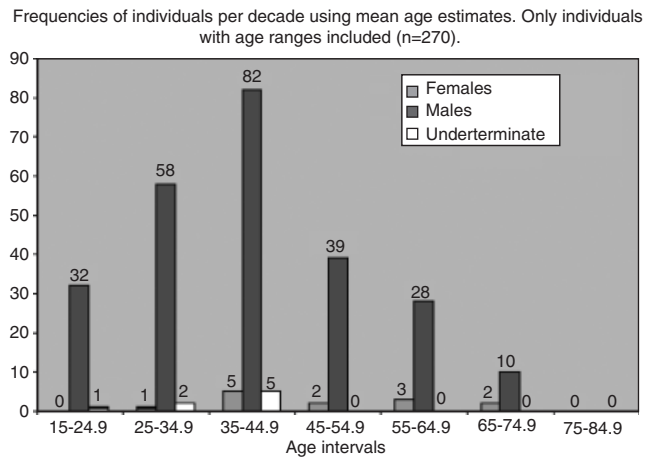

FIG. 2—*Frequencies of individuals per decade using mean age estimates (n = 270).*

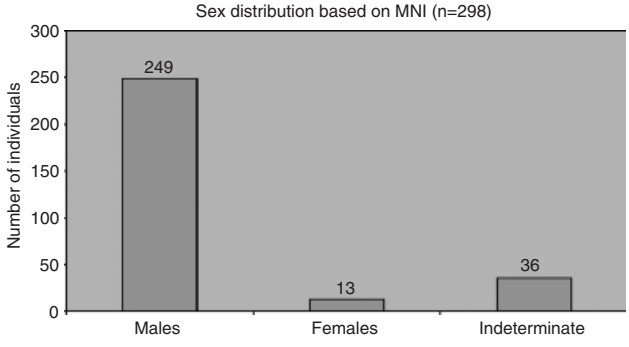

FIG. 3—*Sex distribution based on minimal number of individuals (n = 298).*

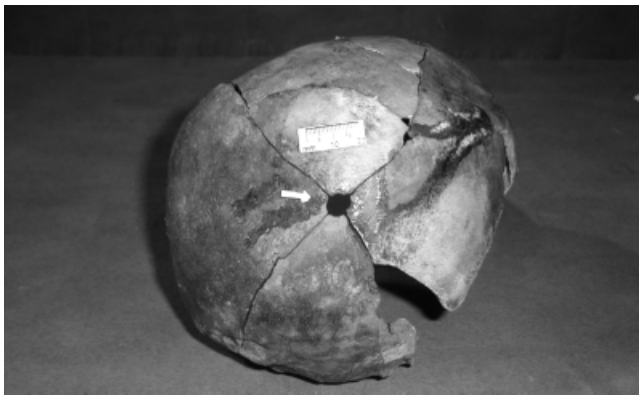

FIG. 4—*Typical gunshot wound through right parietal with fractures radiating away from entrance site.*

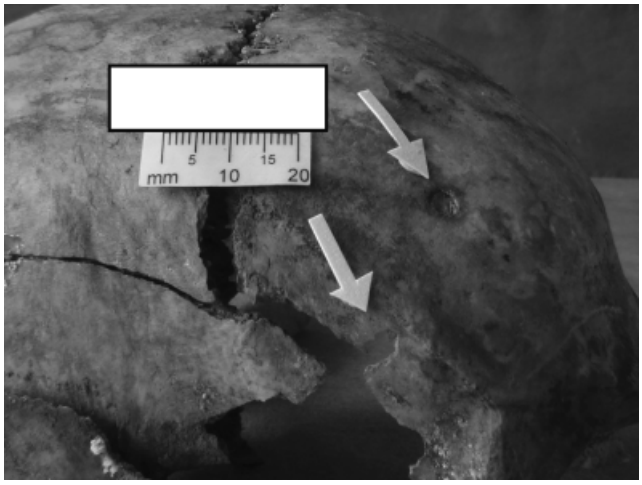

FIG. 5—*Shrapnel wounds on the left side of the frontal bone.*

shaft, possibly by the blade of the excavator that extracted the bodies from the primary grave.

Discussion and Conclusions

Traditional approaches to the interpretation of injuries on skeletonized remains based on the pathophysiological mechanisms of

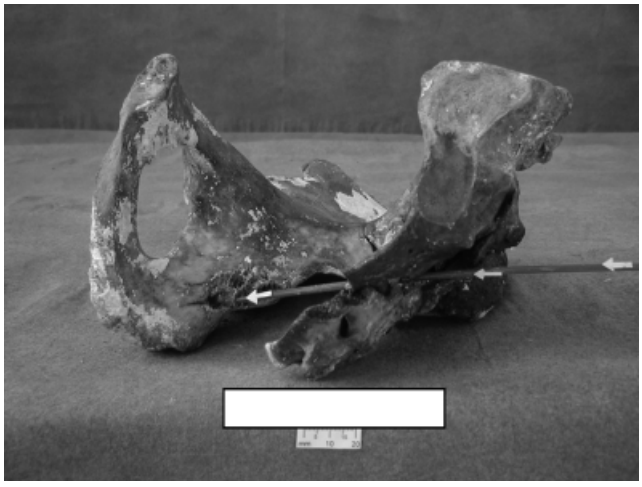

FIG. 6—*Gunshot injury from back to front through sacrum and with bullet embedded in the ischium. Arrows show the direction.*

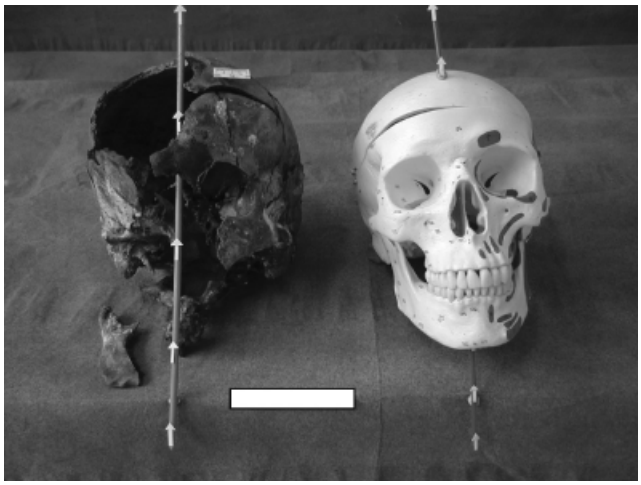

FIG. 7—*Trajectory of bullet passing through reconsructed but incomplete skull. Skull plastic model used for reference. Arrows indicate the direction of shot.*

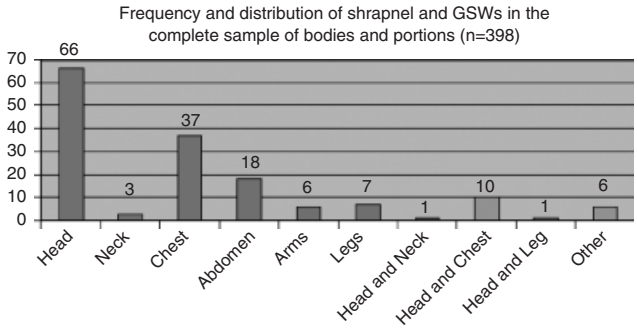

FIG. 8—*Frequency and distribution of shrapnel and gunshot wounds in the complete sample of bodies and body portions (n = 398).*

death rather than on the cause of death, i.e., whether a gunshot wound through the head was inflicted prior to or after the clinical death of the victim, are of limited value. Ascertaining the "most probable cause of death" requires the identification of unmistakable pathological evidence with solid clinical correlates (i.e., survival time). This study provides a multidisciplinary approach to the effective forensic investigation of violations against International Humanitarian Law. The distribution of injuries suggests that

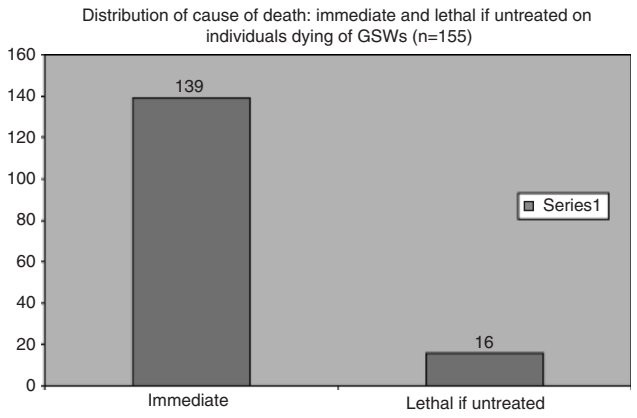

FIG. 9—*Distribution of cause of death: immediate and "lethal if untreated" on individuals dying of gunshot wounds (n = 155).*

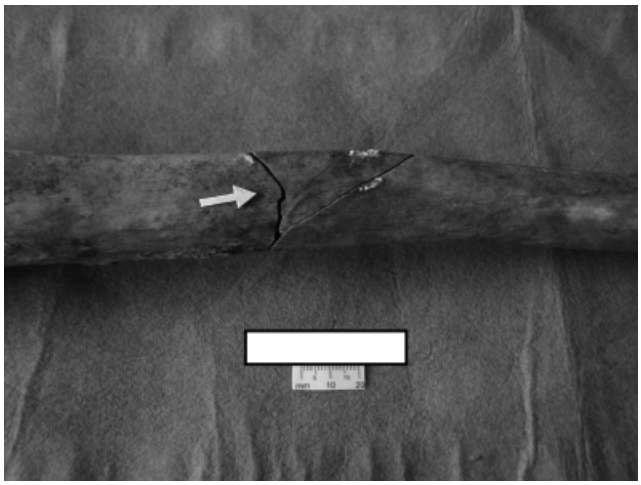

FIG. 10—*"Butterfly fracture" of the shaft of the left tibia.*

the majority of victims in this study sustained GSWs while a significantly smaller number may have sustained injuries from fragmenting munitions (i.e., shrapnel from bombs, shells, and grenades). This difference is important since in combat contexts, most civilians are injured by the latter (24). The anatomical distribution of gunshot injuries is also telling inasmuch as the skeletal injuries are distributed in decreasing order from the head, chest, and extremities. In addition, over 50.0% of gunshot injuries to the head were fired from back to front; all this information suggests an act of volition from the weapon user to kill rather than to wound their victims (24,25). While only 155 individuals were diagnosed to have died of gunshot wounds (139 immediately and 16 if untreated), it is clear that the observations were severely limited by the preservation and completeness of the remains. It is therefore possible that the real number of injuries caused by gunshot was much higher than recorded. The latter, together with the lack of therapy in any of the cases, and the attempts to conceal and destroy the remains, strongly suggests that the ratio of the number of people wounded to the number of people killed would have to be lower than the threshold of 1, strongly suggesting the killing of a defenseless population rather than the confrontation between two armed groups (26).

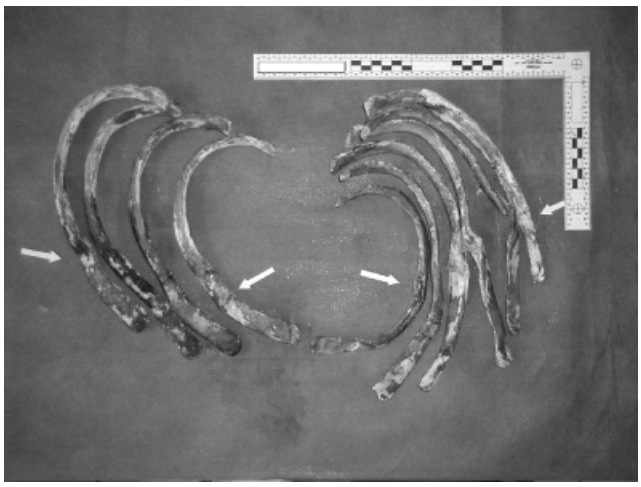

FIG. 11—*Bilateral crushing of the rib cage with extensive plastic deformation.*

This study calls for the participation of experienced personnel, the systematic examination and reconstruction of skeletal trauma, and in-depth analysis to determine the mechanisms of injury and the most probable cause of death. Despite the fact that such an approach records only a fraction of lethal injuries, it provides a better understanding of the manner in which those injuries were inflicted as well as the context in which they may have occurred (armed confrontation vs indiscriminate killing of unarmed civilians). This study also provides an example of how it is possible to obtain meaningful results complying with the needs of the prosecution of crimes against International Humanitarian Law, despite a large number of cases and technological constraints.

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Disclaimer: This paper does not represent in whole or in part the views of the United Nations but does express those of the author.

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