BROKEN BONES

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Anthropological Analysis of Blunt Force Trauma

Edited by

ALISON GALLOWAY, PH.D., D.A.B.F.A.

(With 16 Other Contributors)

Charles C Thomas
PUBLISHER • LTD.

Published and Distributed Throughout the World by

CHARLES C THOMAS • PUBLISHER, LTD.
2600 South First Street
Springfield, Illinois 62704

ISBN 0-398-06992-1

Library of Congress Catalog Card Number: 99-34122

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Printed in the United States of America
TH-R-3

Library of Congress Cataloging-in-Publication Data

Broken bones: anthropological analysis on blunt force trauma / edited by Alison Galloway; with 16 other contributors
p. cm.
Includes bibliographical references and index.
ISBN 0-398-06992-1
1. Forensic anthropology. 2. Blunt trauma. 3. Fractures.
I. Galloway, Alison, 1953-
GN69.8.B76 1999
614'.1--dc21 99-34122
CIP

To
Walter H. Birkby
whose guidance has helped so many of his students,
whose professional standards provided our goals,
and who knew when we should be allowed to work on our own.

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PREFACE

Forensic anthropology builds upon the skills developed within physical anthropology which focus on human osteology. The aim is to allow the bones to "speak," to allow the deceased to tell a story about who they were, how they lived and how they died. Our ability to "listen" depends largely upon our willingness to understand the principles by which the body is formed, how and why humans may vary phenotypically, and how the body responds to the environment in which it lives and dies.

Traditionally, physical anthropologists have engaged in analysis of archaeological skeletal series. The primary information gained includes the age, sex and ancestry that is used to construct life tables and position the collection within the past populations. Analysis of trauma has been used to discuss the difficulty of life, the types of injuries which affected different social classes of people, sex differences in injury and the ability of people to survive and accommodate to injury. While the results of analysis can be contested, differences of opinion are expected and tolerated.

Forensic anthropology faces a different situation. In most cases, we deal not with a skeletal series, which can be sorted with an understanding of populational variation, but with isolated individuals. In some respects, this parallels the situation of the paleoanthropologist with the exception that forensic anthropologists have the ability to generate information from the greater contemporary population. Unfortunately, information on the smaller population from which the specific individual was drawn is often obscured and may be the reason for the request for anthropological analysis.

Forensic practitioners must develop information a step further in some areas but, simultaneously, pull back from the interpretations of trauma possible in archaeological material. Each individual injury must be more extensively examined, recorded and fit within a set of plausible causes. On the other hand, the interpretations cannot extend beyond the forensic anthropologist's area of expertise–the human skeleton. Interpretations can include the application of forces and indications that the defects are or are not consistent with specific causes. They may not include the discussion of the scenario in which these injuries may have been inflicted unless this can specifically be read from the bone. They also should not cross into the arena of the forensic pathologist and address the clinical implications of such injuries.

This delicate balance is not easily mastered. Unlike archaeological analysis, the costs of an overextended or incorrect interpretation in forensic analy-

sis are high. At the extreme, it may cost a defendant his or her life or freedom or may produce subsequent victims if the evidence is found insufficient to convict a guilty party. Fortunately, in most cases the testimony of the anthropologist is not critical to the determination of "ultimate cause" (guilt or innocence). Ignorance of the limitations of forensic analysis can, however, leave the anthropologist open for extremely aggressive cross-examination. Aside from demolishing the ego and reputation of this individual, impeachment of the anthropologist casts a poor light on the subdiscipline and on other, more seasoned practitioners.

Forensic analysis places the individual under extreme scrutiny–everything relies on what can be read from the bones recovered. Each bone must be thoroughly examined and, often, each has a "story" to tell. The victim in many forensic cases lived a life that took its toll on their body. Rarely, then, can the anthropologist find this chance to devote so much time to a well-preserved skeleton with the hope of checking his or her conclusions in the relatively near future.

Forensic cases present a rare opportunity to examine bone in often pristine condition. While preservation is compromised due to differential predation, trauma or recovery, in many cases the bone in forensic cases is extremely well preserved with remarkable surface detail. This is particularly so when the skeletal remains are still housed in soft tissue. This allows interpretation of details often obscured by time, burial and other taphonomic factors.

While forensic anthropologists are working within the medicolegal community and must respect its requirements, we are still anthropologists. In addition to the questions raised with regards to the individual cases, we must retain a broader perspective. Forensic anthropology provides an excellent opportunity to examine the factors and influences that affect the human body.

Human skeletal structure has evolved in such a way as to withstand the normally encountered stresses with a relatively large safety margin. At the same time, the bones must retain the ability to distort during stress. This seeming contradiction enables the body to monitor the stresses it encounters and allows the bone to respond to increases or decreases in dynamic loading. Decreases in loading typically result in gradual loss of bone mass while increased loading is accompanied by activation of bone formation processes.

At the same time, bones fulfill many other functions within the body. Since both the anatomical and physiological requirements of bone change throughout life, the morphology, microstructure and associated organic components may also change. While forensic anthropologists exploit this trend in order to estimate age, these variables also affect how the bones resist forces and ultimately fail.

The morphology of the skeletal elements must be seen as having evolved to cope with a range of motions and loading that has been the norm during our evolutionary past. In most cases, this evolutionary pathway has not included changes in response to violence or accident. Unfortunately, the modern world also imposes an additional set of hazards that may often greatly exceed even the extremes of loading experienced in our evolutionary past as well as the resistance of bones to loading. To our benefit, we have also improved our ability to medically repair this damage, increasing survivability and decreasing morbidity.

Frequently, we, as forensic anthropologists, deal with an individual, or a small group of individuals, lacking the luxury of a populational perspective. How much can we say? What can we substantiate? How can we begin to address the broader questions that can be raised in the individual cases with which we work. An examination of the bone shape, an understanding of bone tissue and strength and analysis of the biomechanics of fracture production combine to allow interpretation of skeletal trauma. With such a foundation, the forensic anthropologist can begin to address broader questions of secular change in bone strength, the influence of normal life events on bone morphology, the range of phenotypic expression, genetic factors in bone strength and the influence of habitual loading.

Much of our thinking in human osteology has been geared toward the determination of patterns. What features are "characteristic" of females or males? What clusters of anatomical traits are indicative of certain ancestries? How can we assess age from the pattern of skeletal and dental changes? While these interests have stimulated much valuable research, it has also led us away from the assessment of the individual. Many of the "sex determination features" are, in fact, simply differences in robusticity. The principles that predict how trauma may affect "females" could, therefore, be as easily applied to gracile males.

While there will always be a need for updating and refining our understanding of the patterns within populations, forensic anthropologists are in the position to reaffirm the focus on the individual. We need to study how the complex of skeletal characteristics that identify each person work together. What features within the life-style, physiology, disease profile or activity patterns will affect the expression of the skeletal traits that would be predicted due to sex or age or ancestry?

This volume is designed to serve as an overview of the principles behind interpretation of skeletal blunt force trauma. It is intended for those of us confronting human skeletal material, whether from archaeological or forensic contexts which requires analysis of traumatic defects. While relying on clinical reports in large part, it is designed for those dealing with dry bone. Survivability of injuries and morbidity is rarely mentioned and treatment

ignored. Rather, the emphasis is first on documentation and second on interpretation.

At a second level, this volume aims to emphasize the importance of the individual in interpretation of skeletal trauma. The inclusion of case studies returns to this focus. Small peculiarities of the circumstances of injury, including the position of the body, the configuration of the impacting object and the speed of impact; the anatomical structure of the individual at that point in his or her life; and the perspective of the anthropologist must all mesh to produce a viable interpretation of the trauma production. In forensic anthropology, as in anthropology in general, when all else is done, we must still deal with the individual.

Alison Galloway

ACKNOWLEDGMENTS

In the creation of any work, there are many people to whom thanks is owed–and this work is no exception. This book began as a suggestion by J. Stanley Rhine and George Gill that a volume of case reports be compiled on trauma analysis by forensic anthropologists. Over the next several years this project was substantially modified, but, to them, I owe thanks for lighting the spark. The members of the Mountain, Desert and Coastal Forensic Anthropologists (MD&C) kept the spark alive.

Completing this work required time away from my other responsibilities at the University of California. The bulk of the writing and all the illustrations were completed while on sabbatical leave for which I am very grateful. Their computer support and other facilities were essential in preparing this manuscript.

There have been many contributors and collaborators who participated in the book. Their endurance in the lengthy production of this work is most commendable. In addition, I have had considerable editorial assistance from J. Josh Snodgrass, who took time away from his other projects to meticulously read this work and from Lauren Rockhold, who also read through the volume and made many suggestions.

On a personal level, I would like to thank Dr. Walter Birkby at whose doorstep responsibility for my training lies. I would also like to thank Dr. M.E. Morbeck most heartily for continual encouragement in my work, even when it was not aligned with her interests. The members of the MD&C and the Physical Anthropology section of the American Academy of the Forensic Sciences whose research and enthusiasm have driven this field must also be acknowledged. This is truly a community of scholars, each of whose work builds upon that of the others.

Finally I need to thank my family for their support. My parents have always stressed academics and service to others. I cannot blame them for my involvement in forensic anthropology, but they have been very supportive of my interests (after I finally told them what I do). My daughter has always been very helpful and greatly amused by her mother's work–unfortunately to the point of demonstrating what it takes to produce a supracondylar fracture of the humerus! I hope her interests will continue and I thank her for her presence which connects me to an exciting new world.

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TRAUMA ANALYSIS

Chapter 1

THE ROLE OF FORENSIC ANTHROPOLOGY IN TRAUMA ANALYSIS

ALISON GALLOWAY, STEVEN A. SYMES, WILLIAM D. HAGLUND AND DIANE L. FRANCE

As forensic anthropologists are increasingly being asked to render an opinion on the circumstances of death and the decay process, analysis of traumatic defects of the skeletal material is also falling within their purview. The forensic anthropologist does not determine the cause of death which is a medical opinion, just as he or she does not determine manner of death (Galloway *et al.* 1990a). The expertise of the anthropologist may contribute to the interpretation of the evidence and determination of the manner of death by the medical examiner or coroner through the documentation of the injuries present on bone, analysis of the interval at which these were formed (antemortem, perimortem or postmortem) and the mechanisms involved in their formation.

In this volume, analysis of trauma concerns injuries inflicted to bone as the result of blunt force forces applied with sufficient velocity to cause some degree of fracturing or breakage. Skeletal trauma can be divided into three primary forms based upon the type of force used: (1) blunt force trauma, (2) sharp force trauma and (3) gunshot and projectile injuries. Blunt force trauma is defined as relatively low-velocity impacts over a relatively large surface area. In homicidal cases, this includes blows delivered with sticks, clubs, pipes, boards, rocks, fists, etc. These objects cause bone breakage due to direct impact and, indirectly, through the bending, pulling and twisting of skeletal elements. In addition, the definition of blunt force trauma can be expanded to include the fracturing resulting from vehicular accidents and falls and compaction of the body such as occurs with manual strangulation. Massive trauma, involving fragmentation of the body, may occur in high-speed, heavy-impact situations such as aircraft accidents, train wrecks and explosions. These result in a less organized pattern of injury but one in which there are unique requirements in the analysis of bones in terms of establishing not only identity but location and position of the victim at the