Forensic Medicine of the Lower Extremity

Human Identification and Trauma Analysis of the Thigh, Leg, and Foot

EDITED BY

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FORENSIC MEDICINE
OF THE LOWER EXTREMIT Y

HUMAN IDENTIFICATION AND TRAUMA ANALYSIS
OF THE THIGH, LEG, AND FOOT

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Humana Press
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Publius Syrus stated back in 42 B.C.,
“You cannot put the same shoe on every foot.” (Maxim 596)

Though written long before the advent of forensic science, Syrus’ maxim summarizes the theme of *Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot*.

Put simply, the lower extremity is a tremendously variable anatomic region. This variation is beneficial to forensic experts. Differences in the leg and foot can be used to establish individual identity. Analysis of damage to the lower limb can be used to reconstruct antemortem, perimortem, and postmortem trauma.

As a forensic anthropologist, I analyze cases involving decomposed, burned, mumified, mutilated, and skeletal remains. Many of the corpses I examine are incomplete. Occasionally, I receive nothing but the legs and feet; a lower torso dragged from a river; a foot recovered in a city park; dismembered drug dealers in plastic bags; victims of bombings and airline disasters; and the dead commingled in common graves.

Though the leg and foot contain much that is useful in forensic analysis, before this publication, investigators faced a twofold problem. Little research that focused on the lower extremity was available in the literature, and the existing research was published in diverse sources, making its location and synthesis a daunting task.

Recognizing this difficulty, Jeremy Rich, Dorothy E. Dean, and Robert H. Powers brought together into one volume articles addressing a broad range of topics specific to the forensic examination of the lower limb. Each chapter deals with a technique or research area in terms of methodology, reliability, and interpretive import.

Included in these chapters are descriptions of the biochemical events of decomposition; discussions of osteology, emphasizing the implications of skeletal anatomy for age, sex, race, and height estimation; and extensive outlines of the role of radiology. They also include thorough explorations of trauma analysis and reconstruction, including details on such specialty areas as slip-and-fall incidents, and impact, traffic, and pediatric injuries, as well as considerations of foot and footprint identification.

As an active practitioner, I greet the publication of this volume with thankful appreciation. *Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot* will simplify my task. The book is, appropriately, a major step forward.

*Kathleen J. Reichs, PhD, DABFA*
Preface

There remains a paucity of text literature regarding forensic implications of the lower extremity. *Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot* encompasses human identification, biomechanics, trauma analysis, and new areas for potential forensic research with regard to the thigh, knee, leg, ankle, and foot. Initially, the reader may question what makes the lower extremity different enough from other anatomic regions that it merits a separate text. Simply put, the lower extremity can provide a plethora of forensically useful information from an identification and biomechanical perspective.

The anatomic regions used for identification may include the dentition, skull, lumbar spine, and pelvis. If the remains are from an isolated body part as may be frequently encountered in violent deaths, mass disasters, and/or cases of human rights abuse including torture, the task of positive identification and trauma analysis may represent a significant and daunting task for forensic experts. Moreover, the aforementioned anatomic regions may be unavailable or too destroyed to be of forensic value.

*Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot* focuses on the use of the lower extremity to facilitate the identification of decomposed, mutilated, incinerated, and/or fragmented human remains. Additionally, trauma analysis is discussed with an emphasis on accident reconstruction and the biomechanics underlying the trauma from both a theoretical and practical perspective. The book is meant not as an all-inclusive discussion of forensic aspects of the lower extremity, but rather as a treatise on topics specific to the potential of this region relative to investigations involving human identification and trauma analysis. Areas for future research are presented, and each chapter is followed by references for further study.

*Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot* is divided into three parts. Part I of the text lays the groundwork for the applied forensic processes detailed in later chapters. The biochemical decomposition processes of human remains are discussed to help develop a greater appreciation of the mechanistic events surrounding a death scene. Perhaps the most challenging task of the forensic team is the positive identification of the remains. A discussion of human development, skeletal variations, and forensic analysis is included. Forensic radiology is explored, with emphasis on the use of radiographs to facilitate
identification and evaluate trauma. This section also discusses the practical aspects and processes of identification from the lower extremity.

Part II focuses on ante- and postmortem processes that can produce identifiable markers in the remains. Soft tissue and skeletal injuries and their implications for accident investigation and reconstruction are reviewed. A discussion of the physics of skeletal trauma is also presented. These chapters translate the theoretical considerations of the preceding chapters into practical information relevant to clinical observation and/or forensic inference.

Part III discusses case studies involving the foot and ankle and presents potential areas of investigation that may offer promise in medicolegal contexts. Specific identification processes and ongoing research are reviewed including the forensic potential of feet and footwear and barefoot impression evidence.

*Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot* serves as a comprehensive review of both the theoretical and practical aspects of the lower limb for the forensic expert. The readership may include physicians, physical anthropologists, engineers, and criminalists, along with other forensic investigators.

We are indebted to all the authors who contributed to this text. It was a privilege to have worked with such a distinguished group. The editors and authors also extend their appreciation to Nicole Furia, Elyse O’Grady, and the staff at Humana Press for assisting in the preparation of this book.

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Color Plates

Color Plates 1–4 appear as an insert following p. 240.

Color Plate 1:
Chapter 7, Figure 1. Epidermolysis bullosa mimics scalded skin from a hot liquid in this infant. The distribution of this disease mimics injury patterns that are usually found in children struggling to get away from the heat source. A bulla (blister) is also seen on the proximal thigh. See discussion on pp. 247–248.

Color Plate 2:
Chapter 7, Figure 2 A,B. Stevens-Johnson syndrome in the distal lower extremity intraoperatively (A) and showing healed lesions (B). These lesions mimic thermal trauma, such as that caused by cigarette burns or wounds induced with a heated implement. See discussion on pp. 248–250.

Color Plate 3:
Chapter 10, Figure 22. The pattern of hip dislocation in a frontal collision depends on the initial sitting position of vehicle occupants. See discussion on pp. 326–327,333.

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Part I

Analysis, Development, and Identification Markers
Chapter 1

The Decomposition of Human Remains

A Biochemical Perspective

Robert H. Powers, PhD

1. INTRODUCTION

The end result of decomposition of humans is more intimately familiar and perhaps of greater interest to forensic pathologists than to any other group whose duties include the evaluation and investigation of postmortem remains on a routine basis. From such remains, the forensic pathologist may be asked to make an evaluation of the cause and manner of death and, perhaps, how long the body had been in situ. These determinations may be challenging, even for the experienced investigator, depending on the condition and location of the remains. The extent, pattern, and nature of decomposition in a specific circumstance may be of great significance and utility in the forensic investigation of a death. Conclusions and inferences drawn from the investigation can be the subject of scrutiny, consideration, and documentation.

Clearly, an understanding of the processes of decomposition can be of benefit for such purposes as estimation of the postmortem interval, recognition of postmortem artifacts, and in an overall evaluation of the death scene. For the forensic pathologist faced with the even more complex issues associated with partial remains, such as the lower extremity, knowledge of the mechanistic processes of decomposition may facilitate an understanding of the specific circumstances of the death in question.

Because the physical appearance and sequence of decomposition events has been extensively detailed and reviewed in the forensic literature, the focus of this chapter is to explore the biochemical reactions and processes that provide the ultimate basis for