Head and Neck Injuries in Sports

Earl F. Hoerner, Editor

ASTM Publication Code Number (PCN):
04 012290-47

ASTM
1916 Race Street
Philadelphia, PA 19103
Printed in the U.S.A.
Library of Congress Cataloging-in-Publication Data

Library of Congress Cataloging-in-Publication Data

ISBN: 0-8031-1886-4
PCN: 04-012290-47
LOC: 94-42668

Copyright ©1994 AMERICAN SOCIETY FOR TESTING AND MATERIALS, Philadelphia, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the AMERICAN SOCIETY FOR TESTING AND MATERIALS for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of $2.50 per copy, plus $0.50 per page is paid directly to CCC, 222 Rosewood Dr., Danvers, MA 01923; Phone: (508) 750-8400; Fax: (508) 750-4744. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is 0-8031-1886-4/94 $2.50 + .50.

Peer Review Policy

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

To make technical information available as quickly as possible, the peer-reviewed papers in this publication were printed "camera-ready" as submitted by the authors.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution to time and effort on behalf of ASTM.

Printed in Philadelphia, PA
December 1994
Foreword

This publication, *Head and Neck Injuries in Sports*, contains papers presented at the symposium of the same name, held in Atlanta, GA on 19–20 May, 1993. The symposium was sponsored by ASTM Committee F-8 on Sports Equipment and Facilities. Earl F. Hoerner, Chairman of Committee F-8, presided as symposium chairman and is the editor of the resulting publication.
Contents

Overview—E. F. HOERNER ix

KEYNOTE PAPER

Cornerstones for Future Directions in Head/Neck Injury Prevention in Sports—K. S. CLARKE 3

EPIDEMIOLOGY

A Summary of Head and Neck Injuries in Collegiate Athletics Using the NCAA Injury Surveillance System—R. W. DICK 13

F. O. MUELLER AND R. C. CANTU 20

Head and Neck Injuries in Equestrian Sports—D. M. BIXBY-HAMMETT 28


The National Electronic Injury Surveillance System (NEISS) Program and Hazard Analysis—R. E. FRYE 47

Causes of Pool Diving Accidents—M. GABRIELSEN AND A. H. MITTELSTAEDT, JR. 57

RISK FACTORS

Risk Factors of Head and Neck Injuries in Equestrian Activities—J. W. T. BYRD 73

A Uniform Minimum Safe Diving Depth for Swimming Facilities—R. R. GILBERT 77
Psychological Characteristics of the Chronically Injured Athlete—
F. M. DUFFY

Cerebral Concussions in Tae Kwon Do Athletes—E. D. ZEMPER AND W. PIETER

BIOMECHANICS, LABORATORY SIMULATION, AND MODELING

Impact Postures and Neck Loading in Head First Collisions: A Review—
P. J. BISHOP

The Response of the Cervical Spine to Axial Loading: Feasibility for Intervention—A. H. BURSTEIN AND J. C. OTIS

The Application of Rodent Models to the Study of Brain Injury Biomechanics—C. E. DIXON


30-Plus Years of Head and Neck Injuries: Primate and Human Models’ Responses to Energy Load and Forces—F. J. UNTERHARNSCHEIDT

Experimental Production of Head-Neck Injuries Under Dynamic Forces—
F. A. PINTAR, N. YOGANANDAN, A. SANCES, JR., AND J. F. CUSICK

The Effect of Head Position on the Analysis of Cervical Motion—
N. R. ORDWAY, W. T. EDWARDS, R. G. DONELSON, AND M. BOSCO

MECHANISM OF INJURY

Ball Standards Relevant to Risk of Head Injury—J. H. HEALD AND D. A. PASS

The Incidence of Spearing by Ball Carriers and their Tacklers During High School Football Season—J. F. HECK

How to Make Professional Boxing Safer—The American Medical Association Controversy—R. C. CANTU

The Historical and Medical Aspects of Boxing—F. J. UNTERHARNSCHEIDT

Head Injured Patients Who Talk Before Deterioration or Death: The TADD Syndrome—A. K. OMMAYA, L. E. THIBAULT, R. J. BOOCK, AND D. F. MEANEY
Measurement of Sensory Functioning and Integration Following Closed Head Injuries—C. INGERSOLL

PROTECTIVE EQUIPMENT APPLICATIONS

Accident Performance of Motorcycle and Bicycle Safety Helmets—
H. H. HURT, JR. AND D. R. THOM

ASTM Standard F-1292 as a Tool for Playground Injury Severity Reduction—
R. C. SHIFFER

Jaw Joint Disorders in Contact-Sports Athletes: Diagnosis and Prevention—
E. D. WILLIAMS

Author Index

Subject Index
Overview

Conferences and symposiums on head and neck injuries in sports are not a recent development. It is noted in the many references to the papers authored in this special technical publication (STP) that they are dated over a 50- to 60-year span. The pioneers that have been evaluating and assessing the risk factors and equipment and facility protection include scientists and investigators such as Burstein, Patrick, Hodgson, Fenner, McElhaney, Schneider, and others. Although independent papers and publications appear on a sporadic basis in the literature, it has been a number of years since a group of scientists of various disciplines got together to review and present their research, clinical experiences, data collection, and the application of their accumulated experiences and knowledge.

In 1969, the American Society for Testing and Materials (ASTM) initiated a group composed of scientists, manufacturers of equipment, academicians, and other interested parties to prepare and write a standard for a helmet to be used in American football for head protection. To establish this standard, an ASTM Subcommittee, F08.53 on Headgear, was formed under the existing Committee F-8 on Sports Equipment and Facilities. As interest and scope broadened in the early 1970s, other subcommittees, including F08.51 on Medical Aspects and Biomechanics, as well as F08.91 on Biostatistics and Epidemiology, were established.

During this same time frame, basic and clinical Sciences, using the development of technology, established reference databases, as well as data collection and information sources for the study of motion, the application of physics, and the laws of natural science with special emphasis on the effects and results of forces and energy (kinetic) on the human body. In addition, scientific groups and associations began to evolve within the applied specialties of biomechanics, bioengineering, mechanical and electrical engineering, including as well, the clinical skills of human factors, ergonomics, and applied Physiology. These scientific groups and associations include the American Society of Biomechanics, the International Society of Biomechanics, the International Society of Sports Biomechanics, the American Academy of Orthopedic Surgery, the American College of Sports Medicine, Stapp Conferences, and others.

In 1992, ASTM Committee F-8, along with representatives from the other professional groups, initiated the planning to organize an international symposium on head and neck injuries in sports that would assemble a group of scientists in various disciplines to participate in this event. In May of 1993, the international symposium was conducted in Atlanta. However, it is extremely important that on a frequent and repetitive cycle, a review and summation of information and data be compiled by all personnel concerned with the topic of this symposium.

An important focus of the Symposium was on the epidemiology of head and neck injuries in sports. The article and presentation of Kenneth S. Clarke entitled, "The Critical Role of Epidemiological Studies in Assessing the Frequency and Causation Factors in Sports-Related Injuries," presented and published in Safety in Ice Hockey, ASTM STP 1050, had previously established the standard and parameters for the professional field of epidemiology. This standard was applied by such authors as Drs. Dick, Bixby-Hammett, Mueller, Clarke, and others in their excellent presentations and critical reviews published in the epidemiology section of this STP, Head and Neck Injuries in Sports.

In addition to epidemiology and the critical review of the data and information in this reservoir of information, the symposium also had these objectives:
1. Review and evaluate the effectiveness of factors related to safety, "Risk Factors."
2. Determine whether these safety factors could be modified/improved to reduce injury rates, while in the process, not adversely modifying or affecting the basic nature of the physical activity or sport in which the injuries occurred.

In the symposium, high priority and consideration was also given to presentations concerning the "Mechanism of Injury," with emphasis on the application of biophysics, mechanical engineering, biomechanics, and bioengineering. The role of the medical clinician, both on-field and within the laboratory, is considered to be an integral aspect in correlating, integrating, and establishing the factors involved in the "Mechanism of Injury." This is true for both the anatomical areas addressed in this symposium, the head and the neck, or both.

The presentations published cover a broad spectrum of sporting activities including ice hockey, football, baseball, swimming and diving, equestrian, soccer, gymnastics, and others. Topics such as playing facilities, playing, and protective equipment were also addressed. Other relevant and associated factors (for example, in the sport of equestrian, the Horse) are also reviewed, analyzed, and assessed by the various authors and symposium presenters. Examined as a whole, it can be seen that these articles serve to reveal the very complex nature of the subject of head and neck injuries in sports.

Although the views expressed within the articles and presentations generated by this symposium are those of the authors of the various papers, and while their readers may or may not agree with the methods used in their analysis or the conclusions drawn, such presentations will undoubtedly foster additional investigation and application, thereby ultimately improving safety in the field of physical activity. It is the resolution of these differing views coupled with new findings that will inevitably emerge in the future, which forms the basis of ASTM consensus standard philosophy and its review process.

Despite the broad spectrum of topics covered in this international symposium, it is important to note that there are areas in the applied sciences that are not included in this volume but that need to be further explored, expanded, and applied. The head and neck deserve attention, and the protection of these areas should continue to be a prime subject for the ongoing evaluation and application of new data and information, including the application of data concerning newer products and materials for head protection. For example, research regarding the unresolved problem of trying to protect for both linear as well as angular acceleration in head protection needs to be continued. Another area that needs further study is the question of whether neck rolls, shoulder pads, or some other method of neck protection can be of value or even considered in the cervical/neck area. The application of technology is a dynamic process that needs to be constantly reassessed and evaluated.

It is the steering committee and the leadership of ASTM Committee F-8 on Sports Equipment and Facilities' recommendation that this volume will serve as a significant catalyst and stimulate the scientific aspects of data and information on this important subject from interdisciplinary groups. This will continue to promote safety and decrease risk factors through better equipment, facilities, and knowledge of the mechanism of injury. The ongoing evaluation of the constant changes that occur with the playing and participating in a physical activity, whether it be leisure, recreational, wellness/fitness, or a competitive athletic contest, is a major factor in the success of protection in head and neck injuries in sports.

Earl F. Hoerner, M.D.
Chairman, Subcommittee F08.51 on Medical Aspects and Biomechanics, ASTM