# Injury in Sport

The Physiology, Prevention and Treatment of Injuries associated with Sport

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# FOREWORD

IT IS an anomaly that this country, rightly regarded by the rest of the world as the pioneer of sport, should be behind in attention to the injuries and other afflictions inevitably encountered by athletes, in contrast to the practice throughout the Continent and the United States where every club or organisation has its 'sports doctor'. In many instances his is a whole time appointment appropriately subsidised, and there are examples of such elaborateness of administration as a Professor of Physical Culture at the head of a team of assistants, physiotherapists, trainers, coaches and everything devoted to athletic well being.

Not that this country lacks the personnel. There are a number of medical men with the athletic interest and experience well known for their services, of course in an honorary capacity but necessarily handicapped by the lack of financial aid and—it must be admitted—the lack of encouragement on a national scale and of what may be regarded as official recognition.

Among our authorities, Bill Tucker is outstanding. He adds to athletic prowess and distinction (he captained Cambridge at rugger and was an English International) an unparalleled enthusiasm and inexhaustible enterprise in the investigation and treatment of athletic injuries. J. R. Armstrong, the author of two famous orthopaedic monographs, *Lumbar Disc Lesions* and *Bone Grafting*, and he have edited this remarkable symposium, remarkable in that they have enlisted the co-operation of physicians and surgeons interested and experienced in every branch of sport from Association Football to Winter Sports who have dealt individually with the injuries encountered. They have gone further; they have secured the services of some of the greatest performers who have contributed their views as practical exponents. Among these may be recognised: Miss Pat Smythe, Dan Maskell, Jim Peters, Denis Compton, to name only a few of world repute.

The subject is introduced, as is proper and logical, with details of the anatomy, physiology and psychology of the normal. Mr Tucker himself deals with posture and the mechanics of movement, subjects in which he has always exhibited special interest; after which the separate categories of sport are left in the hands of doctor and athlete as individual pairs.

A final section describes the diagnosis and treatment of every form of injury. Mr Tucker has been responsible for soft tissue lesions throughout the body, Mr Armstrong for fractures and spinal injuries. In all an ambitious, highly successful undertaking which it is no exaggeration to say is of national importance comprising something which no other country could have pro-

duced and appropriate to the princes of sport who may well feel proud in maintaining a claim to lead the world.

ADOLPHE ABRAHAMS

# PREFACE

UNLESS there is a nuclear catastrophe, it seems certain that during the next fifty years one of the major problems facing mankind will be the employment of leisure. Increasing mechanisation and industrial efficiency must ultimately leave everyone with time on their hands.

In these circumstances various things might happen. It might be that the vast majority of people would demand to be entertained and this demand would be catered for by a small group of professionals which would, of course, include professional athletes of all kinds. The undesirability of such a state of affairs is obvious and, happily, there are already clear indications that most people would wish to employ their spare time by participating actively in some sport or other pastime. Huge problems will arise if the majority of people wish to participate rather than watch, for example, the difficulties and expense of building a stadium to house 100,000 spectators are nothing compared with the problems of providing facilities for 100,000 people to take active part in various games and sports. Nevertheless, with the coming of ample leisure these problems must be faced and overcome.

One of the points which is certain to demand attention is the risk of physical injury associated with all sorts of recreations. There is, of course, no sport which is entirely without risk and, indeed, it has been claimed that an element of danger might be an attraction. This is highly doubtful, especially from the participants point of view, and certainly no professional athlete will willingly incur avoidable risk. It is also doubtful whether the element of danger is desirable from the spectator's point of view—humanity has progressed a little since the days of the gladiators and bear baiting.

In the future, therefore, it is going to be the concern of an increasing number of people to render all forms of sports safer. This book is an examination of the injuries which may occur in sports of all kinds. It is true that the large part of it is occupied with the nature and management of these injuries but this must lead to an understanding of how injuries occur and how they may be prevented. If it succeeds in rendering sport a little safer and in decreasing the amount of permanent or temporary disability following inevitable accidents it will have served its purpose.

No book in one volume can contain everything that can be said on this subject. There are bound to be certain omissions due to lack of space and many injuries are not discussed in detail. In such instances the reader can

amplify his knowledge from standard textbooks and many such references are given.

We are grateful to our many friends and acquaintances who have allowed us to use material from their work, both as quotations and in the form of figures and diagrams. We also tender our thanks to the following publishers for permitting us to reproduce diagrams and illustrations from medical works published by them: Ernest Benn Ltd (*Hand Atlas of Human Anatomy*, 1900): Blackwell Scientific Publications Ltd (D. Sinclair: *An Introduction to Functional Anatomy*): Dr P. A. Merton and J. & A. Churchill Ltd ('Speculations on the servo-control of movement' in CIBA Foundation Symposium on *The Spinal Chord*; 1953): Her Majesty's Stationery Office (Medical Research Council Memorandum No. 20—*The Physique of Young Adult Males*): E. & S. Livingstone Ltd (G. A. G. Mitchell and E. L. Patterson; *Basic Anatomy*, 1954): Longmans, Green & Co. Ltd (E. G. Walsh; *Physiology of the Nervous System*, 1957): Oxford University Press (Samson Wright; *Applied Physiology*, 1955): to Dr Katharine Wells of Mary Washington College of the University of Virginia for permission to use material from her *Kinesiology*, published by W. B. Saunders Company, Philadelphia, USA., and to Sir Wilfred le Gros Clark for permission to reproduce two figures from the fourth edition of his book, *The Tissues of the Body*, published by The Clarendon Press, Oxford.

We wish to acknowledge the help that we have had from many people in the preparation of this book. Group Captain Dhenim, J. Mahoney, F.R.C.S., Dr A. B. Corrigan, Dr R. P. Goulden and Dr W. Hargreave-Wilson have been of the greatest assistance. We would like to thank our artists, Miss Fairfax-Whiteside and Mr R. N. Lane. Our contributors and our publishers have been unfailingly patient with the many delays caused by other demands on our time. Finally, without the work of our secretaries, Miss A. M. Carding and Miss P. E. Timson this book would probably never have been completed.

J. R. ARMSTRONG
W. E. TUCKER

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# PART I

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# 1

# BODY STRUCTURE IN RELATION TO LIMB MOVEMENTS

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## INTRODUCTION

IN ATTEMPTING to understand the way in which skilled movements are made, it is first of all essential to know something of the various structures involved; for the design and composition of the moving parts determine to a very large extent the type of movement which it is possible to make. The strength, range and accuracy of movements of different body members in any given direction are dependent on a number of factors which are discussed in the following sections. The variation in strength, range and accuracy of movements of the same body members in different people is also briefly considered.

Structural features do, of course, vary from person to person and this is simply an example of biological variation. In the same way that people vary in height and weight (i.e. general body size), so their component parts may vary or the internal organisation of the parts relative to one another. Fig. 1 shows the frequency of occurrence of each measurement of one particular dimension of body size in a sample of the normal British population. It should be noted that there is a continuous variation in size from very small to very large. There are a few people at the extremes but most are included within definable limits. In a normal distribution, 68 per cent of the observations lie within a distance equal to the standard deviation* on each side of the mean, while plus or minus twice the standard deviation includes 95 per cent and plus or minus three times the standard deviation includes 99·7 per cent of the observations. Human anatomy is the study of those structural characteristics which are common to man, taking into account normal variation.

The structures mainly concerned in making movements are bones, muscles and nerves, which together form the Locomotor System. All movements are

* The standard deviation is a statistical measure of scatter and may be expressed as 'the square root of the mean of the squares of the deviations of the observations from their arithmetic mean': (see Chambers, 1946, p. 17).

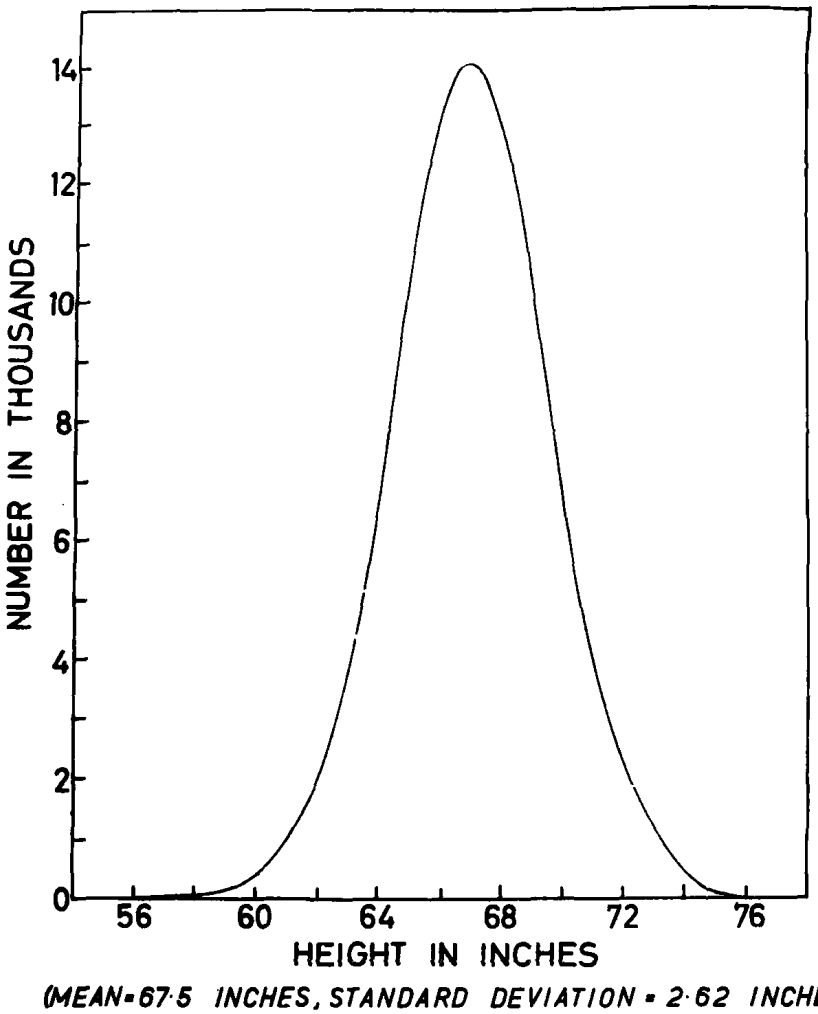


FIG. 1. Height distribution of a sample of 91,163 males aged twenty years (data taken from W. J. Martin; 'The physique of young adult males'; *Medical Research Council Memorandum No.* 20; London, H.M.S.O. 1949).

initiated by nerve impulses which cause contraction of the muscles acting about the joints. Consequently the structural limitations of these components considered separately and their organisation in any particular situation will primarily determine the limitations of the ensuing joint movement. The precise nature of these limitations is made clear in the following sections.

*Bones*

Bones form the skeletal framework of the body. They provide for the other living tissues a system of support which resists gravity and enables an upright posture to be maintained. In other words, bones give the human body rigidity which not only allows it to resist external forces, but also to exert forces against objects in the environment.

Some of the lower animals, such as worms, have no bony skeleton at all; their mode of progression is slow and they are very much at the mercy of their environment. Others, such as insects, and crustaceans like the crab or lobster,

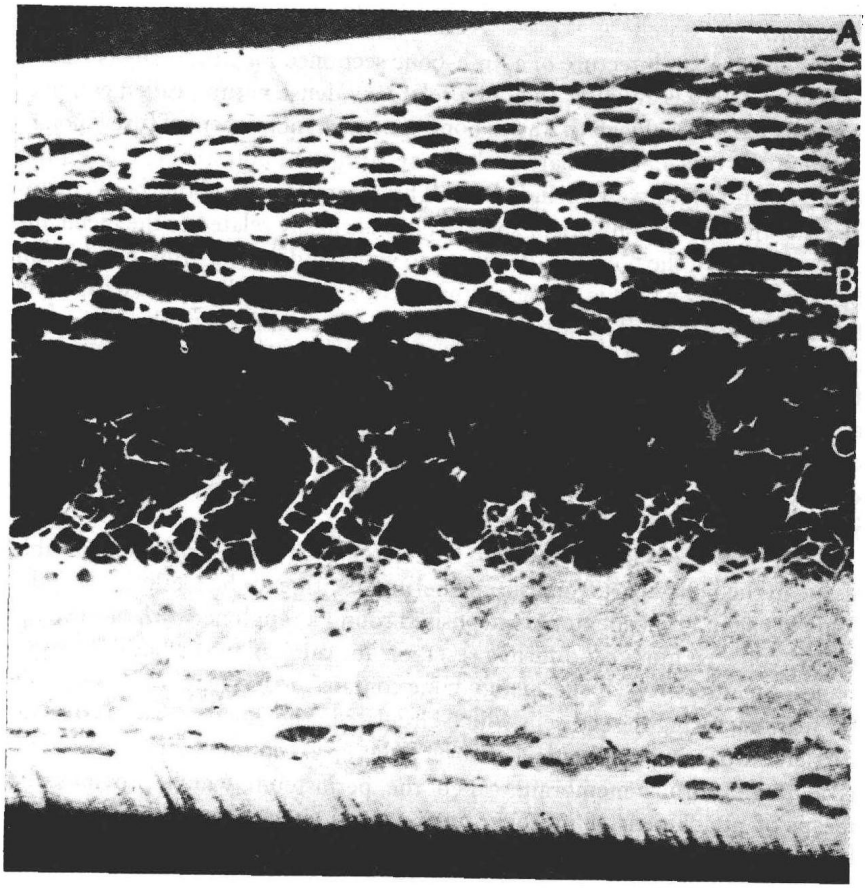


FIG. 2. Longitudinal section of bone showing A, outer compact bone enclosing B and C, spongy or cancellous substance with delicate interlacing bony plates (lamellae).

have an exoskeleton; that is, their supporting framework is on the outside and their muscles and other tissues are completely enclosed. While this arrangement makes for much improved methods of locomotion, it is very clumsy, and severely restricts the range of movements possible at any one joint. Furthermore, the size of the muscular tissue of the limbs is limited by the internal dimensions of the skeleton. In vertebrates, however, the muscles are attached to the outside of the bony framework of the limbs, an arrangement which, in man, with his upright posture, allows considerable freedom of movement of the hands and arms. Other bones such as the skull and ribs which do enclose certain organs of the body primarily serve a protective function.

The internal architecture of a limb-bone sectioned longitudinally is shown in Fig. 2. There is an outer shell of a relatively dense nature, called compact bone, which gradually gives way to bone of a much more open texture (spongy bone) at the centre. The shaft of the bone is thus a hollow tube, combining strength and rigidity with lightness. The arrangement of the bony plates forming the open meshwork of spongy bone is closely related to the mechanical forces which the bone is called upon to withstand during growth. This can be seen in Fig. 3 which is a longitudinal section through the upper part of the femur or thigh bone. The lattice-work of bony plates reflects the lines of stress and strain to which the bone has been subjected; and their arrangement has frequently been likened to the pattern of iron girders in a crane or bridge. As a result of injury or deformity, the internal architecture of a bone may be considerably modified. Much information now exists on the breaking strength of bones. The interested reader is referred to a recent monograph on the subject by F. Gaynor Evans (1957).

Bone is mainly composed of inorganic salts which make it the most durable tissue in the body apart from the enamel and dentine of the teeth. These salts (chiefly calcium phosphate) are deposited round a tough network of inelastic tissue (collagen fibres) and form a reservoir for calcium in the body. In some bones, the interstices of the spongy bone contain the red marrow responsible for manufacturing the red cells which circulate in the blood and act as oxygen carriers. Covering the bone shaft everywhere, except at the joint surfaces, is a tough fibrous membrane called the periosteum which provides the means of attachment of muscles, tendons and ligaments to the underlying bone.

*Joints*

The junction of one bone with another is called a joint. There are three main types of permanent joint and these may be classified as:—

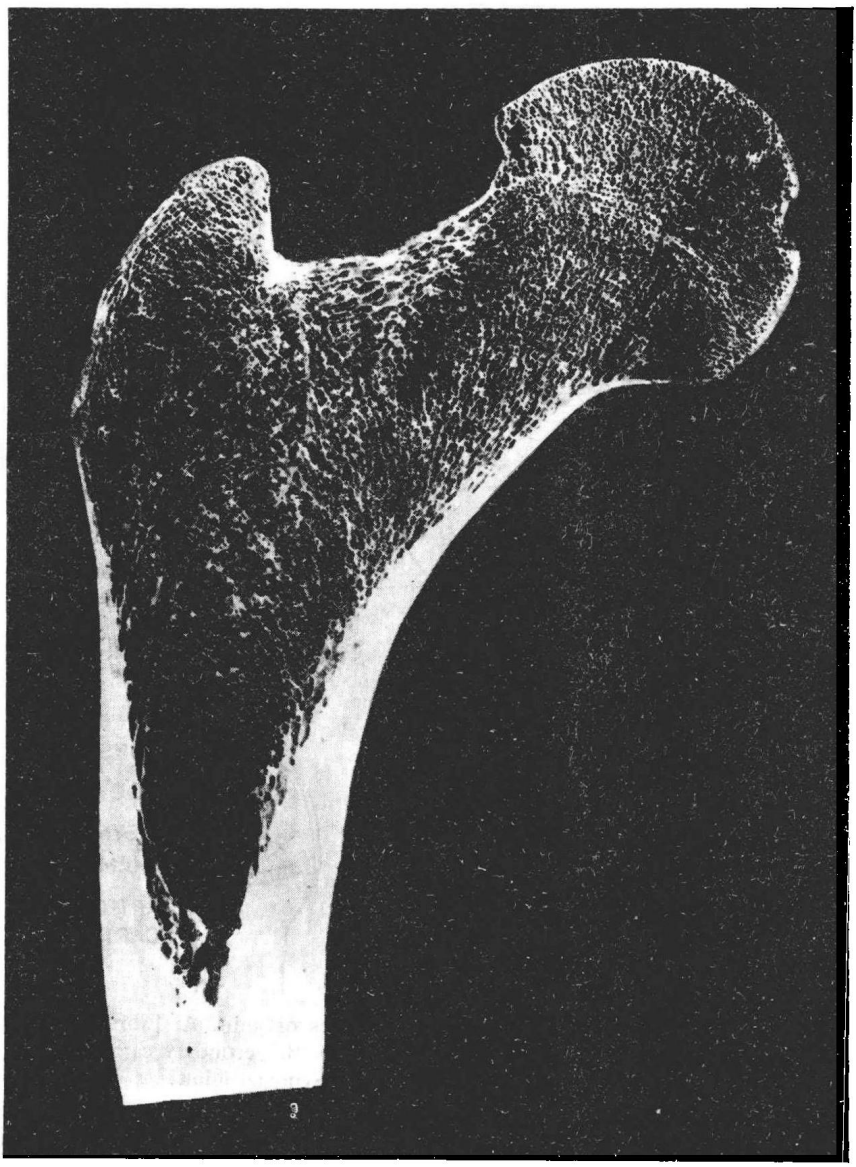

FIG. 3. Longitudinal section of head of femur showing internal arrangement of the lamellae.