THE IOC MANUAL OF SPORTS INJURIES

AN ILLUSTRATED GUIDE TO THE MANAGEMENT OF INJURIES IN PHYSICAL ACTIVITY

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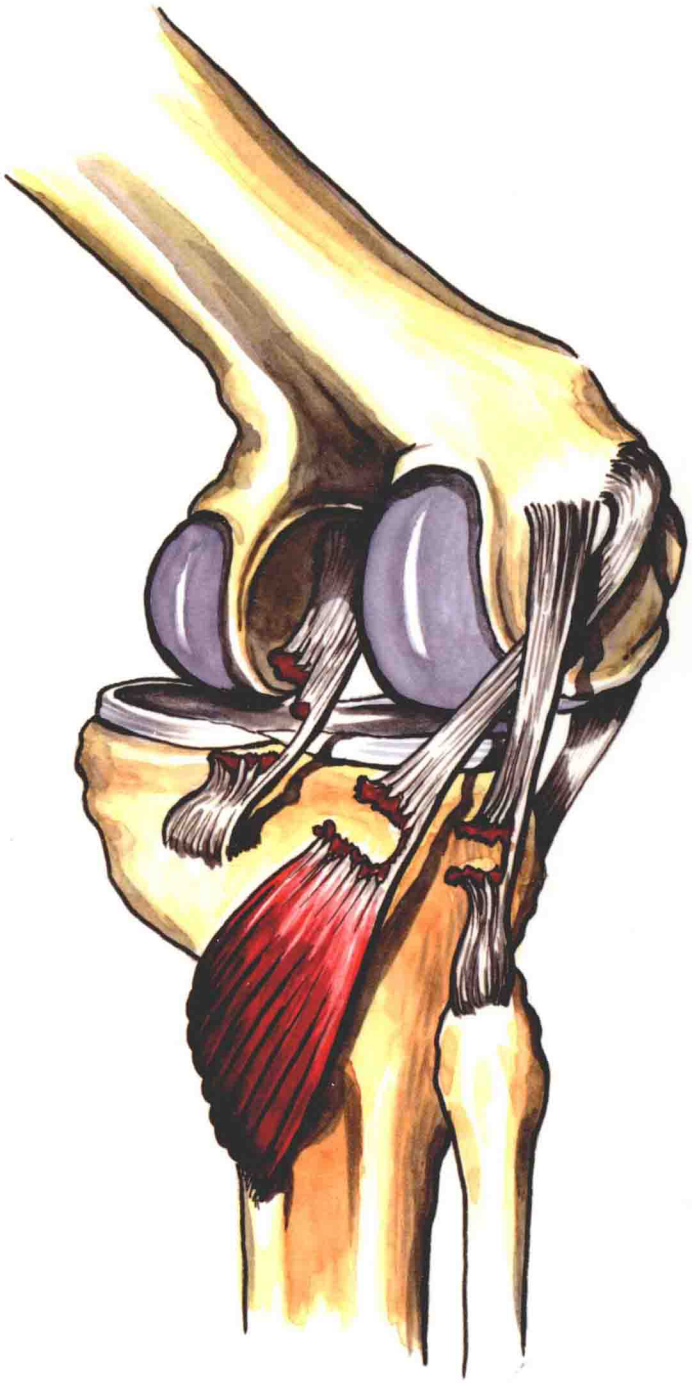

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An Illustrated Guide to the Management of Injuries in Physical Activity

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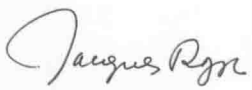
Foreword

The extensive involvement of athletes both in training sessions and competitive events exposes them to numerous possibilities for injury. The potential for injuries that could place limitations on training and could hamper competitive performance constitutes a major concern for each and every athlete. It is, therefore, vitally important that those involved with the health and welfare of athletes are highly knowledgeable with respect to the diverse injuries that can be sustained by the athletes when they are involved in the various sports on the Olympic programme.

This Manual presents comprehensive information related to the assessment and treatment of injuries in chapters organised according to body regions. Each chapter contains sections arranged according to the "presenting symptoms" for both acute and overuse injuries, and includes information regarding rehabilitation and procedures for returning to training and competition.

Dr Roald Bahr has assembled a highly knowledgeable and experienced group of associate editors and contributing authors to produce this comprehensive coverage of a highly important topic. We welcome this splendid contribution to the international literature on sports medicine.



Dr Jacques Rogge
IOC President

Preface

One of the most important medical advances is the understanding that regular physical activity substantially reduces the risk of premature mortality as well as coronary heart disease, hypertension, colon cancer, diabetes, and obesity. In fact, recent studies have shown inactivity and low cardiorespiratory fitness are more important mortality and morbidity predictors than the better known risk factors such as obesity, smoking, elevated cholesterol levels, or elevated blood pressure.

Regular physical activity is the critical factor for optimal health from cradle to grave; it is necessary for normal development during childhood and adolescence and essential for the maintenance of functional ability and independence in later years.

And there is more good news. As people are becoming aware that their daily energy demands are decreasing due to reduced opportunity and increased mechanization at home, at work and during leisure time, they are taking to physical activity and sports in increasing numbers. However, sports participation also entails a risk for injuries. So if we are to succeed in encouraging our patients to become more physically active, it demands us to take this side effect seriously.

This book is meant as a tool to aid not just specialist sports physicians and physical therapists, but also primary care physicians, ER physicians, general physical therapists, athletic trainers, nurse practitioners, physician's assistants, and all those involved in assessing and treating the active individual with injuries sustained in sports and physical activity.

One important point is that the contents of this book are not meant for the elite athlete alone. Modern sports medicine has developed assessment and treatment algorithms–particularly through its focus on early, active rehabilitation–which will benefit all patients, whether the injury was sustained in professional sports, on the school playground, or by just being outdoors enjoying an active lifestyle.

The IOC Manual of Sports Injuries is based on the highly acclaimed *Idrettsskader* (Gazette Bok/Fagbokforlaget: Oslo, Norway), which was written by a group of Norwegian specialists in 2000 and has been published in several languages (Norwegian, English, Spanish, Swedish, Greek, and simplified and traditional Chinese). The English-language version was heralded as "Book of the year!" by the British Journal of Sports Medicine in 2006.

Since 2000, there have been a number of significant developments in our understanding of sports injuries–what they are, how they should be assessed, and how they should be treated. To ensure that *The IOC Manual of Sports Injuries* accurately reflects these advances, we have recruited an international cast of world-leading experts as co-editors and authors.

We have deliberately used a problem-oriented approach to guide the practitioner through a standardized and structured approach to the assessment and management

of injuries in physical activity. We cover the various body regions, hoping to distinguish the common from the less common, to link history taking and physical examination to the diagnosis, and to provide detailed guidance on management of the most common injuries and disorders. An added value lies in the exceptional artwork by our medical illustrator, Tommy Bolic; the many illustrations can be used as a tool to improve communication with patients about what their injury represents.

I would like to thank everyone involved for their many contributions to this book–none mentioned, none forgotten. It is our hope that *The IOC Manual of Sports Injuries* will become a valuable clinical guide for practitioners and a helpful teaching tool for students and patients world-wide in years to come.

Roald Bahr
Editor

2012

Contents

1 Types and Causes of Injuries

Roald Bahr[1], Håkan Alfredson[2], Markku Järvinen[3], Tero Järvinen[3], Karim Khan[4], Michael Kjær[5], Gordon Matheson[6], and Sverre Mæhlum[7]

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Exercise and physical activity are the most important determinants of health in developing and transitioning countries, and sedentary living is the fourth independent risk factor for morbidity and mortality from noncommunicable disease. Regular physical activity reduces the risk of early death in general, and of cardiovascular disease, high blood pressure, type 2 diabetes, and even some types of cancer. Indeed, physical *in*activity can present as great a risk to health as smoking, being overweight, high cholesterol, or high blood pressure. Furthermore, intense exercise is not necessarily more effective than other forms of exercise for prevention and treatment of chronic disease. Significant health benefits can be achieved through moderate physical activity; as a matter of fact, standing as opposed to sitting will also incur health benefits. This holds true even at an advanced age. The least fit people are the ones who can derive the greatest health benefit from regular physical activity.

Unfortunately, exercise and physical activity also have some unfortunate side effects. Injuries are a particular risk. Nevertheless, the net health effect is positive–the benefits of physical activity far exceed the problems caused by injuries.

Acute Injuries and Overuse Injuries

A sports injury may be defined as damage to the tissues of the body that occurs as a result of sport or exercise. In this book, the term applies to any damage that results from any form of physical activity. Physical activity can be defined as moving or using the body, and it includes numerous forms of activity such as working, fitness exercise, outdoor activity, playing, training, getting in shape, working out, and physical education.

Sport injuries can be divided into acute injuries and overuse injuries, depending on the injury mechanism and onset of symptoms. In most cases, it is easy to classify an injury as acute or overuse, but in some cases it may be difficult. Acute injuries occur suddenly and have a clearly defined cause or onset. Overuse injuries occur gradually. However, an important concept with overuse injuries is that they exist along a spectrum where the inciting events are below the threshold for clinical symptomatology, but if not rectified, they eventually produce sufficient tissue damage to result in clinical symptoms. This is important for physicians, therapists, and patients

The IOC Manual of Sports Injuries, First Edition. Edited by Roald Bahr.

to understand, because it is not uncommon to "react" to "new" clinical symptoms the same way one reacts to acute injuries. Such a response may ignore the underlying clinical symptomatology and thus may interfere with effective treatment. For example, an athlete with a stress fracture (a fatigue fracture) in the foot will often state that the symptoms originated during a specific run, perhaps even from a specific step. The injury may accordingly be misclassified as an acute injury. However, the actual cause of the stress fracture is that the specific run was a precipitating event on top of the underlying spectrum of tissue damage on the skeleton from overuse over time. Therefore, these types of injuries should be classified as overuse injuries.

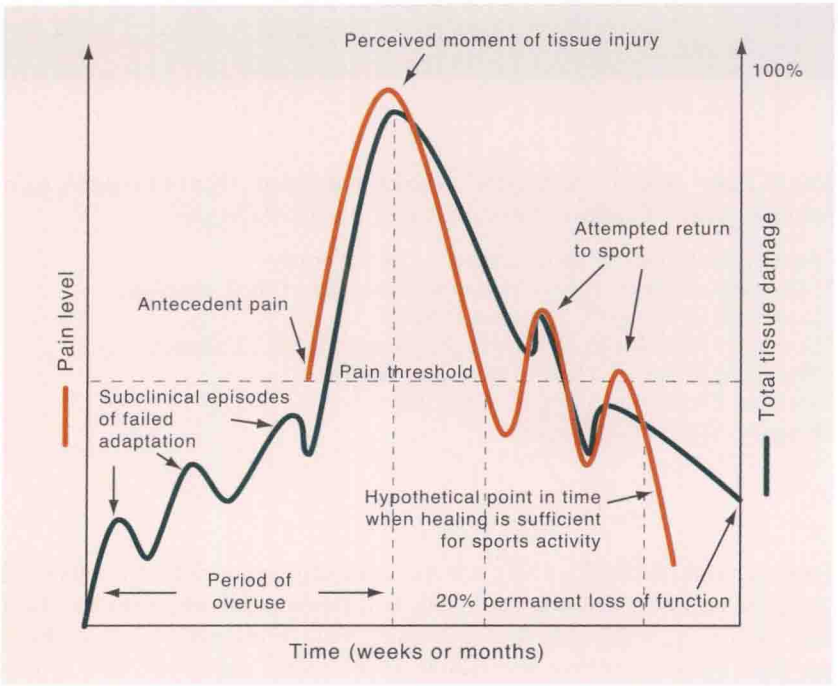

Figure 1.1 Hypothetical overview of pain and tissue injury in a typical overuse injury. (Reproduced with permission from the Norwegian Sports Medicine Association.)

As shown in Figure 1.1, the pathological process is often under way for a period of time before the athlete notices the symptoms. Repetitive low-grade forces that lead to microtrauma in the tissues cause overuse injuries. In most cases, the tissue will repair without demonstrable clinical symptoms. However, if this process continues, the ability of the tissue to repair can be exceeded, resulting in a clinical overuse injury with symptoms. It is vitally important that athletes as well as therapists and physicians understand this concept so that correct treatment can be initiated.

The difference between acute injuries and overuse injuries can also be described in biomechanical terms. Dynamic or static muscle action creates internal resistance in the loaded structures (stress) that counteracts deformation (strain) of the tissue. All tissue has a characteristic ability to tolerate deformation and stress, and injuries occur when the tolerance level is exceeded. An acute injury occurs when loading is sufficient to cause irreversible deformation of the tissue, whereas an overuse injury occurs as a result of repeated overloading either in the loading itself or through inadequate recovery time between loadings. Each incidence, alone, is not enough to cause irreversible deformation, but the repeated actions can result in an injury over time.

Acute injuries are most common in sports in which the speed is high and the risk of falling is great (e.g., downhill skiing) and in team sports where there is much contact between players (e.g., ice hockey and soccer). Overuse injuries make up the large portion of injuries in aerobic sports that require long training sessions with a monotonous routine (e.g., long-distance running, bicycling, or cross-country skiing). But a large number of overuse injuries also occur in technical sports, in which the same movement is repeated numerous times (e.g., tennis, javelin throwing, weightlifting, and high jumping).

Why Do Injuries Occur?

The basic principle for training is that the body reacts to a specific physical training load with specific predictable adaptation. Loading that exceeds what an athlete is

used to will cause the tissue that is being trained to attempt to adapt to the new loading. For example, training provides a stimulus that causes the muscles to increase the production of contractile proteins, the muscle fibers become larger (and more numerous), and the muscle fibers specifically adapt to whether the training requires primarily endurance or maximum strength. This principle applies to all types of tissue. The skeleton, tendons, ligaments, and cartilage adapt accordingly. The tissue becomes stronger and tolerates more (Figure 1.2).

Figure 1.2 Adaption to training. Immobilization significantly weakens the biological properties of the tissue, whereas exercise improves function. (Reproduced with permission from the Norwegian Sports Medicine Association.)

However, if the training load exceeds the tissue's ability to adapt, injuries will occur. The risk of overuse injuries increases when training load increases. This could result from an increase in the duration of individual training sessions or an increase in training intensity or the frequency of training sessions. Often the duration, intensity, and frequency of training increase at the same time, such as at a training camp or at the beginning of the season. Therefore, it is common to say that overuse injuries are due to "too much, too often, too quickly, and with too little rest," which means that training load increases more quickly than the tissue is able to adapt.

Various Types of Injuries

Sport injuries can be divided into *soft-tissue injuries* (cartilage injuries, muscle injuries, tendon injuries, and ligament injuries) and *skeletal injuries* (fractures). The various types of tissue have distinctly different biomechanical properties and their ability to adapt to training also varies. This chapter examines the characteristics of the various types of tissue and the ways in which the skeleton, cartilage, muscles, tendons, and ligaments can be injured.

Ligaments

Structure and Function

Ligaments consist of collagen tissue that connects one bone to another. Their primary function is passive stabilization of the joints. In addition, the ligaments serve an important proprioceptive function.

Ligaments consist primarily of cells, collagen fibers, and proteoglycans. Fibroblasts are the most important cell type, and their main function is to produce collagen (primarily type I but several other types as well). The amount of proteoglycan is much lower than the amount found in cartilage. While the collagen fibers in tendons are organized in a parallel manner (in the longitudinal direction of the muscles), the orientation of the fibers in ligaments can be parallel, oblique, or even spiral (e.g., the anterior cruciate ligament). The organization of fiber direction is specific to the

function of each ligament. In addition, ligaments contain slightly more elastic fibers than tendons.

Ligaments may insert directly or indirectly into the bone: directly with a transition zone consisting of fibrocartilage first and mineralized fibrocartilage last (including specialized collagen fibers that go down into the bone vertically), or indirectly by growing into the surrounding periosteum.

Ligaments may be intra-articular (localized within a joint inside the joint capsule), capsular (where the ligament projects as a thickening of the joint capsule), or extra-capsular (localized outside the joint capsule). The cruciate ligaments are intra-articular ligaments. The anterior talofibular ligament is a capsular ligament, where it may be difficult to distinguish between the ligament and the rest of the capsule, whereas the calcaneofibular ligament is an extracapsular ligament. The type of ligament is important for the healing potential after a total rupture. Following total rupture of an intra-articular ligament, such as the anterior cruciate ligament, healing will not take place, whereas the capsular ligaments have excellent healing potential. Blood supply to ligaments also differs. Capsular ligaments have a good blood supply, just as the surrounding joint capsule does, whereas the blood supply to intra-articular ligaments enters proximally or distally, typically resulting in a midzone of marginal vascularization. The blood supply is important for the healing potential after an injury.

Ligaments contain a number of different nerve endings that supply the nervous system with information about body position, movement, and pain. This information is key in controlling the muscles that surround a joint such as the knee. Even if the main function of ligaments is passive stabilization of the joint, much evidence indicates that the proprioceptive function of ligaments is more important than previously thought. Ligament injuries may reduce the ability to register the position and movements of the joint, even when the injury does not result in significant mechanical instability. This may increase the risk of recurrent injuries.

Figure 1.3 shows how ligaments react to stretching. At first, the wavy pattern of the microscopic collagen fibers straightens out and minimal force is required to cause a significant change in length. As force increases further, the collagen fibers will be stretched, and the relationship between load and deformation is linear. This means that the ligament serves as an ideal spring in the elastic zone, as long as the change in length does not exceed about 4%. If a force causes a change in length in excess of this, the collagen fibers will rupture–first single fibers and then all of the fibers will fail (a total rupture). The strength and stiffness of a ligament depends on the longitudinal and cross-sectional area. The greater the cross-sectional area, the stronger and stiffer the ligament. A longer ligament is less stiff, but the maximum tensile strength

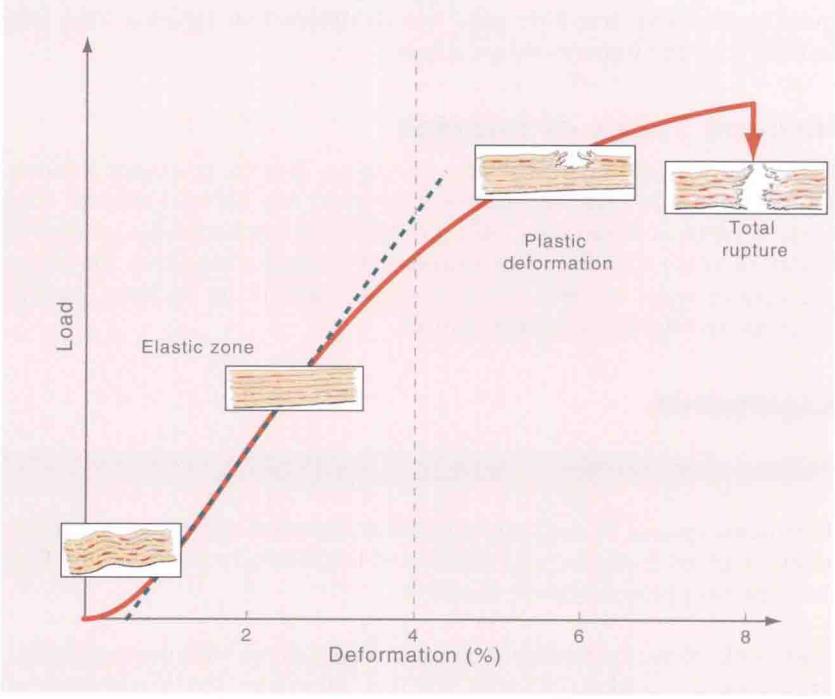

Figure 1.3 Acute stress–deformation curve for ligaments. (© Medical Illustrator Tommy Bolic, Sweden.)