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Preface

Millions of people of all ages participate in sports or are physically active in other ways. Around the world every day sports give a feeling of togetherness and social interaction as well as of well-being.

Physical activity is also very important for one's overall health. Regular physical activity, exercise, training and sports can increase cardiovascular, metabolic and muscular functional capacity and help efforts to reduce risk factors for diseases: they thus play a favorable role in both primary and secondary prevention, as well as in therapy and rehabilitation. Physical activity is beneficial for all the tissues in the body and can help reduce the risks of injury, especially for overuse injuries. According to the US Surgeon General's Report on Physical Activity and Health, regular physical activity performed on most days of the week reduces the risk of developing or dying of something that causes illness and death. Physical activity improves health in the following ways: it reduces the risks of dying from heart disease, or of developing diabetes, high blood pressure, or colon cancer; it also helps those who already have high blood pressure to reduce it, helps control weight, helps build and maintain healthy bones, muscles and joints, helps older adults become stronger and better able to move without falling, and promotes psychological well-being.

Being physically active is thus beneficial and essential for good health, which is of great value for the active individual as well as for society. Some contend that sports injuries and problems are very costly for society, so it should be pointed out that the cost to society of injuries in sports is very small compared to the health and social benefits generated by sports and physical activity.

There are, however, potential risks for injuries and other medical problems. With increased information about the value of physical activities and about how injuries can best be treated and prevented, the costs to society will decrease. There is therefore a great need for sports medicine expertise and information. Hopefully, this book will fill an important role in spreading information about how most correctly to manage and prevent injuries in sports and physical activity.
Introduction

Sports medicine encompasses the following elements: preparation and training; prevention of injuries and illnesses; diagnosis and treatment of injuries and illnesses; and rehabilitation and return to physical activity and participation in sports. This book deals mainly with the part of sports medicine focused on injuries, their prevention, diagnosis, treatment and rehabilitation (i.e. orthopedic sports medicine). Preparation and training includes instruction in training methods, technique, dietary requirements, the abusive effects of drugs, alcohol and doping as a whole, as well as psychological preparations for competition. This part is only briefly discussed in this book.

The prevention of injuries in sports depends on being well prepared, but also on appropriate clothing and protection, good equipment, sensible rules, adequate facilities, regular health controls, and so on.

Diagnosis and treatment of injuries are the main bulk of orthopedic sports medicine. A correct diagnosis is a requirement for successful treatment. Serious acute injuries are generally treated adequately in the emergency departments. The subacute and chronic injuries present more of a problem to the coach, the trainer, or the physician. Injuries such as those from overuse of the tendons and bones, as well as articular cartilage injuries, are often difficult to diagnose and treat, and they are not always well understood.

Rehabilitation and return to sport often require teamwork involving the physician, the physical therapist, the trainer, and the athlete. Injuries heal at varying paces depending on what type of tissue is involved, but also on the severity and location. If the rehabilitation is to be successful, it is essential that the person in charge of treatment have a thorough knowledge of the healing process in the different tissues and also be familiar with the demands of the sports concerned.

Finally, sports medicine is a discipline involving many different medical specialties. The sports medicine doctor can be an orthopedic surgeon, a rehabilitation specialist, a family physician, a rheumatologist, or one of many other specialists. In a few countries there are special education programs to become a sports medicine specialist. Every country has its own slightly different system, but it is to be hoped that in the long term there will be some kind of consensus in this area. Whatever the training, a good sports medicine doctor will be one familiar with the principles of sports medicine as outlined above, as well as with the demands of the different sports.
Glossary

Note: Illustrations of anatomic terms are listed in italic in the Index.

**abduct:**
to move a part of the body away from the midline of the body.

**adduct:**
to move a part of the body toward the midline of the body.

**avulsion fracture:**
tearing off of an attachment to a bone.

**bursa:**
a small sac of fibrous tissue, lined with a synovial membrane and filled with synovia.

**cartilage:**
dense connective tissue composed of a matrix produced by specialized cells (chondroblasts).

**chondral:**
describing cartilage.

**concentric work:**
muscle contraction during shortening of the muscle.

**crepitation:**
creaking or crackling sound.

**cutting:**
a sudden sharp turn (e.g. as performed by the knee in running sports).

**debridement:**
excision of devitalized material.

**distal:**
situated away from the origin or point of attachment or the median line in the body.

**dorsiflexion:**
backward flexion of the foot or hand or their digits, i.e. bending towards the upper surface.

**eccentric work:**
muscle contraction during lengthening of the muscle.

**epiphysis:**
the end of a long bone, initially separated by cartilage from the shaft of the bone.

**evert:**
turn outwards.

**exostosis:**
bony outgrowth.

**hallux:**
the big toe.

**hypertrophy:**
increase in the size of tissue or an organ brought about by the enlargement of its cells rather than by an increase in their numbers.

**hypotrophy:**
decrease in the size of tissue or an organ brought about by the shrinking of its cells rather than by a decrease in their numbers.
invert:
turn inwards.

isokinetic training:
a form of muscle training performed at a constant speed and against a variable resistance.

isometric training:
a form of muscle training performed at a constant position (without a change in the length of the muscle) and variable load.

isotonic training:
a form of muscle training performed at variable load.

-itis:
inflammation of an organ, tissue, etc.

kinetic chain:
multi-segmental motion involving one or more joints: (closed) when the distal segment is stable and the proximal is free; (open) when the proximal segment is stable and the distal segment is free.

lateral:
relating to or situated at the side of an organ or organism.

ligament:
a tough band of white fibrous connective tissue that links two bones together.

luxation:
complete dislocation of a joint: opposing articular surfaces are no longer in contact.

medial:
relating to or situated in the central region of an organ, tissue or the body.

multiplane exercises:
limbs are exercised in a variety of different planes of motion (frontal, sagittal).

osteochondral:
describing bone and cartilage.

osteophytes:
bony deposits.

periosteum:
a layer of dense connective tissue that covers the surface of a bone, except at the articular surfaces.

plantar:
relating to the sole of the foot.

pronation:
the act of turning the hand or foot so that the palm or sole faces downwards.

proprioception:
the ability to apprehend positional changes of parts of the body or degrees of muscular activity without the aid of sight.

proximal:
situated close to the origin or point of attachment or close to the median line in the body.

rotator cuff:
the area of emergence of the tendons of subscapularis, supraspinatus, infraspinatus and teres minor muscles.
**subluxation:**
partial dislocation of a joint: opposing articular surfaces are no longer correctly aligned.

**supination:**
the act of turning the hand or foot inward so that the palm or sole faces as far upwards as possible.

**synovia:**
thick colorless lubricating fluid that surrounds a joint or bursa and fills a tendon sheath, secreted by the synovial membrane.

**trabecular:**
porous (cancellous) bone.

**valgus:**
describing any deformity that displaces a joint towards the midline.

**varus:**
describing any deformity that displaces a joint away from the midline.
1
General principles

Sports injuries are caused by trauma of different degree. For simplification we divide injuries into traumatic injuries, caused by large forces (macrotrauma), and overuse syndromes, caused by repetitive microtrauma.
Traumatic injuries

Acute traumatic injuries are common in athletics and attract the most publicity and research. This is because the cause of the injury can be pinpointed, making it easier to define the injury and search for an appropriate treatment. The frequency of traumatic injuries varies greatly between sports. Contact sports, such as soccer, ice hockey, team handball, wrestling, American football, and rugby, tend to have higher rates of traumatic injuries.

The cause and severity of a traumatic injury are usually obvious. The athlete will usually experience rapid onset of pain, and swelling will begin to develop but typically requires several hours to reach its maximum. For this reason, the best time to examine a traumatic injury is immediately after it has occurred, before the swelling makes the athlete unable to tolerate the pain associated with exploration of the injured area.

Initial control of swelling can contribute greatly to a quicker return to sport. Treatment principles are described in Chapter 5. Once these early interventions have been completed, an assessment is made as to whether further advice is needed from a doctor and appropriate action is taken.
Overuse syndromes

Overuse syndromes are difficult to diagnose and treat. These injuries are becoming increasingly common as both participation in sport in general and the intensity and duration of training increase. Although overuse injuries (stress fractures) were first documented as early as 1855, little research has been done since, and today's knowledge is based mainly on practical, clinical experience. Overuse injuries are generally caused by repetitive overloading, resulting in microscopic injuries to the musculoskeletal system. Tissues can withstand great loads but there is a critical limit to this capacity, which varies greatly between individuals and according to the frequency of load (Figure 1.1). Tissues may be made more susceptible to injury by *intrinsic* factors such as malalignment of the leg, muscle imbalance, and other anatomical problems, and *extrinsic* factors such as training errors, faulty technique, incorrect equipment and surfaces and poor conditions.

The actual frequency of injury due to overuse is unknown, but it is estimated that 25–50% of athletes visiting sports medicine clinics have sustained an overuse injury. The age of occurrence of overuse injuries also varies: they are most common in top-level athletes aged 20–29 years, but are also seen in noncompetitive athletes aged 30–49 years. In adults, overuse injuries are more prevalent after 2 years of regular daily training. Some sports carry a greater risk: 80% of overuse injuries are reported to occur in endurance sports such as long-distance running, or in individual sports requiring skilled technique and repetitive movements, such as tennis, gymnastics, and weightlifting; of these injuries, 80% occurred in the lower extremities of the body, most frequently at the knee (28%) and at the ankle, foot, and heel (21%). For most overuse injuries, the underlying problem is an inflammatory response. Overuse injuries in tendons are often secondary to degeneration (p. 43).

**Inflammation**

Inflammation is the body's response to tissue injury caused by pressure, friction,
repeated load or overload, and external trauma. Trauma is associated with bleeding, which causes swelling and increased pressure. Both extrinsic and intrinsic factors (see above) contribute to the inflammatory reaction in tendon sheaths, tendon and muscle attachments, bursae, and the periosteum. Overuse injuries can result from various combinations of frequency and loading, such as:
– normal load at high frequency/many repetitions;
– heavy load at normal frequency;
– heavy load at high frequency.
Inflammation also occurs in response to bacterial infections. It both confines and combats such infections as well as stimulating healing. Whatever the nature of the underlying cause, the inflammatory response leads to impaired and painful mobility of the affected part and thus enforces rest. If it affects gliding surfaces, such as those of tendons and their sheaths, crepitus or 'creaking' may develop. If inflammation goes unchecked, scar tissue will develop, and early intensive treatment is therefore recommended.

The most important step in the management of inflammation is the removal or reversal of its cause. Next in importance is the reduction of swelling so as to relieve pain, improve mobility, and encourage healing. Symptoms typical of inflammation include the following:
– swelling caused by accumulation of fluid;
– redness caused by increased blood flow;
– local rise of temperature, caused by increased blood flow around the injured area;
– tenderness on touching the affected area;
– impaired function of the affected part due to swelling and tenderness.
Inflammation often begins insidiously, and initially pain and stiffness may decrease or even disappear after warm-up. Usually, however, the pain returns and intensifies during continued activity and unless a rest break is taken, there is a great danger of entering the 'pain cycle' where continued activity leads to further injury, inflammation and pain. Unless the cycle is interrupted, chronic pain results and can be extremely difficult to treat.

**Pain**

The sensation of pain originates in free nerve endings which end blindly between the tissue cells. These pain receptors are present in most tissues, but are especially numerous in the skin. Pain is a mechanism to alert us to injury so that we can react appropriately.
Different types of pain that may be experienced include acute pain caused by a fracture, aching pain caused by chronic inflammation, continuous pain such as heartburn, pounding pain such as vascular compromise, referred pain caused by nerve entrapment, and burning pain. The type of pain can be a pointer to the correct diagnosis. The most common types encountered in sports injuries are acute pain, and the chronic, dull ache experienced following activity or during the night due to chronic inflammatory problems. Pain can often be effectively treated with medication, but it will not go away until its cause has been removed.
Pain should be interpreted as a warning sign of tissue injury and should lead to modification of activity or
resting the injured tissue.
2

Injuries in musculoskeletal tissues
Injuries to bone

Skeletal injuries are common in sport, especially in contact sports such as football (Figure 2.1), and in individual sports such as skiing, gymnastics, and riding.

Figure 2.1 One of the players here has suffered a fracture of the lower leg (arrow) (by courtesy of All Sport: photographer, Shaun Botterill).

Functional anatomy

The bones of the skeleton primarily serve three purposes. The first is to provide a rigid weightbearing structure, enabling the body to stand: this is the primary function of the pelvis, spine and lower extremities. The second is to provide rigid attachment sites for the muscles, tendons and ligaments, to allow efficient movement. The third is to protect vulnerable soft tissues.

Bones are living material and can remodel themselves in response to changes in the local environment (Wolff’s law). Activity causes the bones to become strong; inactivity weakens them (see p. 481). Pounding activities such as running cause thickening and strengthening of the weightbearing bones. Bones are also able to react to other stressors, such as fractures: the cells within the bone are able to remove the dead bone of the fracture and replace it with new, healthy bone. Some stress on the bone promotes the healing process, but too much will damage the healing structures, so a 'happy medium' must be attained. Disruption of the healing process can result in a non union.

Bones are better at resisting compression rather than tension and/or torsion. That is why most fractures occur when a bone is twisted or bent. The bending motion puts tensile stress (pulling apart) on the opposite side of the bone, where the fracture begins. The repetitive tensile stresses on the bone can result in stress fractures.

Fractures
A fracture is a potentially serious injury, damaging not only bone but also the soft tissues in the surrounding area—tendons, ligaments, muscles, nerves, blood vessels, and skin. Fractures may be the result of direct trauma, e.g. an impact to the leg, or indirect trauma, e.g. when the foot is trapped, causing the athlete to fall awkwardly and break the leg.

**Types of injury**

Skeletal fractures may be transverse, oblique, spiral, or comminuted (Figure 2.2). When the fractured ends of the bone pierce the skin the injury is an open or compound fracture (Figure 2.3); when the skin remains undamaged, it is a closed or simple fracture. With compound fractures there is a great risk of infection to the bone, and special treatment is required. If the fracture involves an adjacent articular joint surface it is called an articular surface fracture. An avulsion fracture means that a bone attached to a muscle or ligament has been torn away.

The different types of fracture displacement are angulation, rotation, and shortening. The aim of any treatment should be to return the fractured ends as precisely as possible into their correct position, that is, to reduce displacement and return the bone to its normal alignment by manipulation. For fractures in children and adolescents, see p. 444.

![Different types of fractures (from left) transverse fracture, oblique fracture, spiral fracture and comminuted fracture.](image1)

![The fractured tibia is here seen piercing the skin (by courtesy of All Sport: photographer, Mike Powell).](image2)