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Muscle Injuries in Sports

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Abstract

Sport injuries are the damage of tissues or pathological damages of the human body under the influence of external or internal forces during recreational or professional pursuit of sports activities. Injuries are an integral part of every sport activity, and something more common in martial and extreme sports. Of particular significance is the procedure of athletes immediately after the injury. Although injuries to sport, by their nature, are usually easy, they may become a problem in terms of competing ability, due to the fact that the injury can be cured faster by the natural processes. Recuperation of an athlete after an injury has to be complete, because there is a risk of re-injuring, which in many cases is much more difficult.

Key words: *Muscle; Injury; Health; Prevention; Law*

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Introduction

Muscle injury has been related to resistance exercise and prolonged endurance exercise paradigms both leading to significant local mechanical constraints followed by focal disorders such as sarcolemmal damage and leakage of intracellular proteins, oedema, myofibrillar disorganization and microtrauma-triggered inflammation [1]. These unfavorable events lead to variable soreness, swelling, loss in muscle strength and function with reduced range of motion. To date strategies finalized to minimize exercise-induced muscle injury are scarce and often not adequately supported by research studies.

Based on the notion that dietary supplementations may exert a variety of beneficial effects on the skeletal muscle, in the last 20 years there has been a great deal of interest in nutritional strategies aiming to attenuate signs and symptoms of exercise induced muscle injuries. Anyhow a large number of variables influences the muscular outcome of nutritional supplements, strongly depending on nutrient type, genotype, age, and regulation of nutrient sensing pathways.

The feet of athletes of all ages can be categorized as belonging to one of three specific types: rectus, planus, or cavus [2]. Some athletes who are affected with congenital deformities and who suffer from chronic pain, discomfort, or reoccurring injuries can be treated. A basic knowledge of these foot types is necessary for athletes, certified athletic trainers, and sports medicine professionals. With this knowledge, sensible and informed decisions can be made in selecting appropriate footwear and orthoses in their sport.

Injuries to the elbow, forearm, and wrist account for approximately 25% of all sport-related injuries [3]. Specific elbow injury patterns can be so common to a specific sport that associated names have been applied to them such as tennis elbow, golfer's elbow, or little leaguer's elbow.

The initial management of an acute sporting injury is vital as optimal treatment will shorten the recovery time, protect the athlete from further injury, and enable the athlete to return to training and competition as soon as possible [4]. Delayed or inappropriate treatment has the opposite effect and may adversely affect an athlete's career.

Good initial management requires on-site recognition of the injury and prompt initiation of treatment. It requires a team approach with experienced medical and physiotherapy staff working with coaches, referees, and administrators. Sports injuries may be as a result of trauma or overuse and can involve any of the tissues of the body. The most commonly involved are muscles, ligaments, and tendons, (soft tissue injury) or the bony skeleton. Some serious joint injuries may involve a combination of bone and soft tissue.

Muscle Fibers

Cycles of repetitive eccentric and concentric contractions represent a fundamental source of mechanical stress for active skeletal muscle and vulnerability of skeletal muscle fibers appears to be particularly evident in unaccustomed individuals [1]. In fact conditioning of the muscle through prior similar activity may minimize damage appearance (so called "repeated bout effect"). Overall the process appears as a fundamental step for the arising of exerciseinduced plastic response as it is followed by muscle remodeling and adaptation. However muscle damage may delay muscle recovery from exercise and performance thus reducing the athletes compliance to exercise programmes.

The direct consequence of mechanical stress on active skeletal muscle fibers is the appearance of soreness (delayed onset muscle soreness, DOMS), stiffness and reduced force production. This is particularly the case as a consequence of strenuous physical work involving heavy resistance exercise including eccentric (i.e. lengthening) actions. In these conditions force loss appears immediately post-exercise whereas soreness becomes evident within 24-48 hours after and, as the force impairment, may last several days depending of the extent of damage. At the microscopic and submicroscopic level fibers damage, which preferentially involves fast twitch fibers, is already evident within minutes from the mechanical insult displays throughout individual fibers (i.e. focal injury), and includes plasma membrane disruption accompanied by the loss of muscle proteins in the serum (i.e. creatine kinase (CK), myoglobin, lactate dehydrogenase (LDH), aldolase, troponin), myofibrillar disorders as streaming and broadening of the Z-lines, loss of sarcomeres register, the appearance of regions of overextended sarcomeres, regional disorganization of the myofilaments, subsarcolemmal lipofuscin granules accumulation, alterations of the proteoglycan components, increased interstitial space, and capillary damage. Interestingly dramatic changes in the organization of the membrane systems involved in excitation-contraction coupling have been also found following eccentric contractions. The most commonly identified alterations include disorders of the T tubule, changes in the direction and spatial orientation of the triads, and the appearance of caveolar clusters, pentads and heptads (close apposition of two or three T tubule elements with three or four elements with three or four elements of terminal cisternae of sarcoplasmic reticulum).

Although it is widely accepted that high intensity eccentric exercise is the fundamental exercise paradigm resulting in muscle damage and subsequent adaptation, structural and functional damage may also arise following long lasting endurance exercise paradigms as demonstrated by the appearance of ultrastructural alterations, as fibers necrosis, sarcolemmal disruption, Z discs streaming, contracture knots, and inflammatory infiltration in endurance athletes even before a race [1]. Anyhow even though the extent and location of damage may greatly vary according to the exercise paradigm and the previous conditioning of the muscoloskeletal system, the extent of damage observed with low intensity and long duration endurance exercise is often less pronounced than with higher intensities. This is the main reason of why most of works finalized to the identification of the physiological mechanisms that regulate the response to exercise-induced stress in skeletal muscle and the possible countermeasures, including the approach based on nutrient supplementation, have been focused on strength training exercise.

Healthcare

Although sports physicians may occupy other medical and healthcare functions beyond their sports medicine practice, the proposals below refer specifically to their interaction with any athlete patient [5]. Where there is overlap between their role as consulting physician (i.e. general practitioner) and sports physician, it is the duty of the physician clearly to distinguish this and to communicate it both to patients and other interested parties. In all the scenarios that sports medicine presents the sports physician, it is recommended that sports physicians are focused on the care they give to their athlete patients. Best practice may be difficult to determine in a young medical specialization, where the nature of individual care and the demands upon athlete patients may appear ambiguous.

It is not always clear how to interpret the best interests of the patient. Nevertheless, if sports physicians are to give their athlete patients the highest level of care they are able to, it is of the greatest importance that they develop trusting relationships. Athlete patients who do not trust their sports physicians to act always in their best interest are unlikely to share with them such information as may help diagnosis, cure and prevention of athletic injuries and other deleterious conditions. In order to provide their athlete patients with the highest level of care, it will be necessary, therefore, for a clear separation of roles where possible between the sports physician, the athlete patient and the relevant third parties such as team coaches or managers; club owners, press officers; and those involved in team or squad selection. While this is not always possible, and while the sports physician may be burdened with a number of potentially conflicting roles, they should always seek to clarify and minimize such risks before the engagement of their services, consulting with colleagues and up-to-date sources of professional guidance.

Muscle injuries are debilitating injuries, especially for athletes who risk setbacks in their career [6]. A subcutaneous muscle tear can be caused by direct trauma, such as a contusion from a blunt object or strains, or by indirect trauma such as ischemia or a neurological dysfunction. In any case these injuries are difficult to treat and unfortunately there are no clear and defined guidelines to help the physician. From a biological point of view muscles have been shown to be particularly active and capable of excellent tissue regeneration. The gap between the muscle fibers is filled thanks to the myocyte cell reactivity, the presence of replicative phase cells and the production of connective tissue scar. The healing process of muscle injury consists of three phases: the degeneration-inflammation phase, the reparative phase and the remodeling-fibrosis phase.

The first phase (first few days post-injury) is characterized by inflammatory stimulation caused by the cellular debris and the pro-inflammatory molecules that are released as a result of necrosis of the injured tissue; also the severed blood vessels release blood within the tissue forming hematoma, which in turn stimulates the inflammatory response. This cascade of events results in the release of cytokines, interleukins, adhesion molecules (e.g., P-selectin, Lselectin, E-selectin), Tumor Necrosis Factor alpha and growth factors (e.g. insulin-like growth factor 1 IGF-1, hepatocyte growth factor HGF, EGF, epidermal growth factor, transforming growth factor alpha and TGF beta, platelet-derived growth factor PDGF) that promote inflammation, cell migration and stimulate progress to the next stage.

The reparation phase (from day 7-10 to week three-four post-injury) begins with the cleaning of the tissue formed in the acute phase by macrophages that engulf the injured tissue and allow the regeneration of tissue within the lesion: it stimulates the proliferation of striated muscle tissue, the neo-angiogenesis within the neo-tissue and stimulates the production of connective scar tissue. The cells that are more active from the point of view of replication (myogenic precursor cells, or satellite cells) are located between the basal lamina and the plasma membranes of each individual myofiber; once they are released by the lesion of the basal lamina and activated by growth factors, they differentiate into myoblast and replicate forming multinucleated myotubes and possibly myofibers.

The final phase, the remodeling-fibrosis, involves the maturation of the neo-muscle tissue and the reorganization of the scar tissue, and is strongly driven by mechanical stress and the stress of the surrounding tissue that drive the neo-tissue to organize in the most functional way possible for contraction. The connective tissue produced is partly demolished, gradually leaving more space for the connections between the myofibers.

Histological evidence demonstrates that muscle injury repair involves scar formation at the site of injury [7]. It is considered that the formed scar does not have the same properties as the pre-existing muscle with respect to load attenuation making the injured muscle and surrounding muscle area more prone to further injury (re-injury). By commencing activities early in the post-injury period it is thought that the scar formation at the site of injury will be improved in terms of attaining properties that are more like the pre-existing muscle. This would then result in an increased tolerance of the muscle to load when more strenuous activity is recommenced with a subsequent reduced risk for re-injury.

Injury Prevention

The majority of injury prevention training studies have generally examined the effects of individual components on injury incidence [8]. However, this is not representative of a soccer specific environment where the time constraints dealt necessitates the development of a mixed conditioning approach that allows for the simultaneous development of several fitness qualities. From a practical perspective, injury prevention programs are implemented with the expectation that they will elicit improvements in performance (through increasing players' availability and reducing lay-off durations when injury occur) and reduce the incidence of injury, however, this is not always representative of research findings. Recently, it has been suggested that a multicomponent injury prevention intervention may increase motivation through an integrated approach within a team sport environment.

This particular investigation recently reported that significantly less muscle injuries were observed during integration of a 4-part injury prevention program concomitant with a bigger squad size (large effect, $p<0.001$) when compared to a control season. It was reported during this investigation that high levels of contusion injuries were apparent within this study, which led the author to suggest that the multicomponent prevention technique is beneficial when integrated in order to reduce muscle injuries but may not be able to prevent other types of injuries (contact injuries). Prevention exercise is commonly included before, during or/and after the training sessions and matches.

Football is the highly recognized, No.1 sports game in the world that no other sports games can approach in terms of its influence and popularity [9]. With great charm, it has developed a lot of followers among young people. However, with the increased competitiveness, speed, and ferocity, more and more football players are exposed to sports accidents, which not only affect their trainings and life but also to some extent their health and growth. In order to ensure football players' better development and reduce the possibility of sport injuries, it is necessary for us to carry out in-depth surveys and work out preventive measures against such injuries. Football injuries refer to all physical injuries to football players when they playing football. Foreign surveys find that football is a sports game that has the highest incidence of injury. Such injuries include bruises, fractures, dislocations, and even visceral ruptures.

Law

Compensation for injuries in sport is a complex matter [10]. Sometimes the injured person cannot get compensation, because the injury is part of the risk involved in the sport and is not caused by anyone. In some circumstances, compensation may be provided by the common law of tort, which involves one person suing another for damage suffered. The damage must result from the action of the person who is sued or the failure of that person to act. The main areas of tort apply to sporting situations are negligence and assault. In other situations, compensation is provided by laws that have been enacted for that specific purpose. Workers' compensation laws, for example, may apply to professional sportspeople.

Tort law is an important area of sports law [11]. There has been an increase in the number of cases filed based on intentional or unintentional tort theories over the past several decades. There are many reasons for this increase, including the astronomical rise in medical costs that injured athletes or other plaintiffs are unable to meet, along with a prevailing notion that one who injures deliberately or negligently should pay for such actions when he or she creates serious harm.

Civil law provides injured individuals with a cause of action by which they may be compensated or "made whole" through the recovery of damages. This cause of action comes under the general heading of torts. A tort is a private (or civil) wrong or injury, suffered by an individual as the result of another person's conduct. Tort law deals with the allocation of losses via monetary compensation of the individual for injuries sustained as a result of another's conduct.

Civil law and criminal law share the common end of inducing people to act for the benefit of society by preventing behavior that negatively affects society and by encouraging behavior that has a positive effect. Civil law and criminal law differ, however, in their means of achieving this common end. Criminal law seeks to protect the public from harm through the punishment of conduct likely to cause harm. Civil law, on the other hand, aims to compensate an injured party for the harm suffered as a result of another person's conduct.

Conclusion

Injuries and chronic damages of the movement system (cartilages, muscles, tendons or bones) are very common occurrences. Muscle fibers and tendons that bind muscles to the bones are caused by excessive pressure on the muscles and may occur during normal daily activities; during sports and in the sudden rise of heavy load. Any muscle in the body can be damaged or injured. Correct clinical examination is usually sufficient to diagnose, and an athlete is advised to do an ultrasound examination of the injured muscle as the sonogram (ultrasound finding) provides a precise insight into the extent and intensity of the injury.

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