Fabrizio Margheritini
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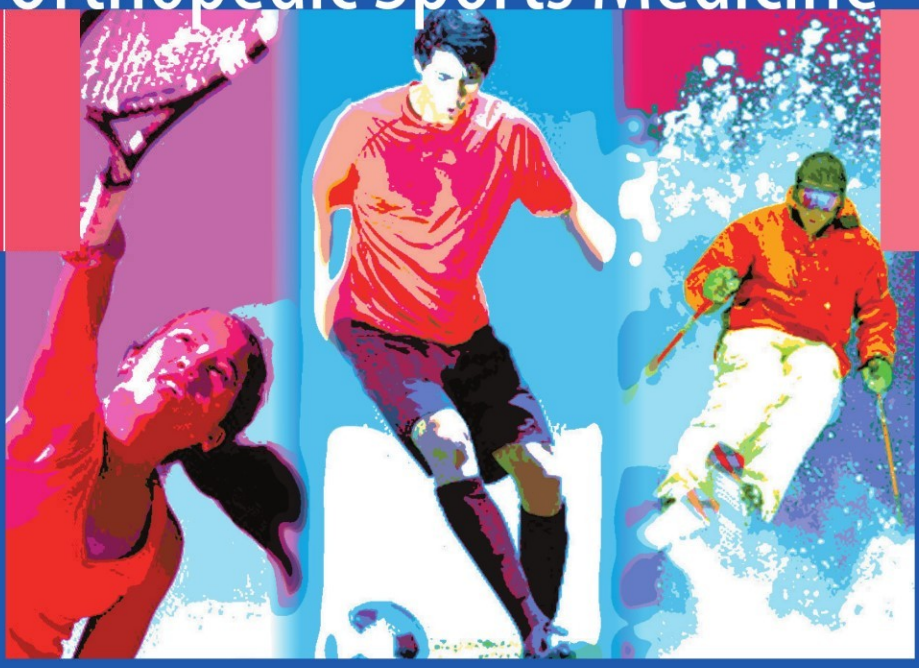
Editors

Orthopedic Sports Medicine



Principles and Practice

Springer

Orthopedic Sports Medicine

Fabrizio Margheritini · Roberto Rossi (Eds.)

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Foreword

Sports have become an important part of our civilization and of our social life. With the multitude of sports activities available to people of all ages, the number of injuries has increased dramatically, paralleled by modifications in their treatment. For example, in the field of knee surgery, when we started our careers some 30 years ago, treatment of a ligament injury usually consisted of rest and immobilization but the end of the sports activity was a frequent outcome.

Nowadays, the athlete can choose between a wide variety of therapeutic approaches, which in many cases will allow a resumption of the sport, e.g., anatomic arthroscopic ligament reconstruction, a specific rehabilitation program, or biological stimulation via the delivery of growth factors.

There is probably no other field in Orthopedics like Sports Medicine, in which the treatment options have so tremendously improved. This has been due not only to new medical technologies but also to better knowledge of the underlying science.

Today, Sports Medicine is not limited to surgery, but rather is an ever-changing and evolving field that encompasses many subspecialties. As such, it requires knowledge of the basic principles of Cardiology, Nutrition, and – especially given the widespread problem of doping among athletes – Sports Pharmacology.

In addition, the Sports Medicine specialist serving as team physician must be able to recognize and manage on-field emergencies and all the medical issues they encompass.

This book is a state-of-the-art guide for those starting in the field of Orthopedic Sports Medicine, as well as for experienced specialists. The reader will become acquainted with many aspects of basic science that have improved the treatment of sports injuries and which have established a foundation for the operative management of orthopedic pathologies.

Orthopedics is a fascinating area of medicine that will continue to grow. The Editors and contributors should be proud of their accomplishment in having provided an outstanding

compilation and reference for postgraduate researchers as well as practicing clinicians in the fields of Orthopedics and Sports Medicine.

Rome and Turin, September 2010

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Preface

Sports Medicine is a rapidly evolving interdisciplinary field that has benefited from recent scientific and clinical advances in many medical specialties, including Nutrition, Physiology, Biomechanics, and, of course, Orthopedics. The idea to create a text focused on the fields of Orthopedics and Sports Medicine with a specific orthopedics viewpoint that would present this wide range of information originated two years ago, while we were attending a conference on Sports Medicine.

To realize this book, we invited orthopedic surgeons, medical fellows and residents, and researchers from Italy, Europe, and the USA to share their personal experiences regarding the main principles and practice of Orthopedic Sports Medicine. The text includes sections on the pathophysiology of musculoskeletal structures, injury prevention, and the related medical issues. The second part focuses on the upper and lower extremities and the spine.

The goal of this book is to provide a novel global overview of sports-related pathologies and the many treatment options offered by the specialty of Sports Medicine. We are therefore pleased and honored to have assembled leading experts in the field and are indebted to them for their excellent contributions. We hope this book will allow established Sports Medicine specialists to further hone their skills, and novices in the field to improve their knowledge.

We would like to thank each of the contributors and to join them in expressing appreciation and gratitude to the publisher for the opportunity to develop and realize this ambitious project.

Rome and Turin, September 2010

Fabrizio Margheritini
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About the Editors

Fabrizio Margheritini (*left*). Roberto Rossi (*right*)

Fabrizio Margheritini was born in Rome, where he graduated from the University "La Sapienza" (1992). Honorary Observer in Orthopedics at Princess Elizabeth Orthopedic Hospital, Exeter, UK (1996); Clinical Research Fellow at the Cambridge Lea Hospital, Cambridge, UK (1997-1998); visiting physician at the Sports Medicine Department of the Cleveland Clinic Foundation, Cleveland, OH (1999); visiting physician at the Sports Medicine Department at the University of Pittsburgh, PA (2000), and post-doctoral research fellow in the the university's Department of Orthopedics (2001). In 1998 he completed his residency program cum laude in orthopedics and traumatology. Selected in 2005 for the the ESSKA-AOSSM traveling fellowship in North America. He is currently Assistant Professor at the University of Rome "Foro Italico" and a member of scientific committees of different national and international professional societies. He has also served as Editorial Board Member of the Arthroscopy Journal and as a reviewer in several international journals. His main interest is in hip and knee surgery.

Roberto Rossi was born in Genova in 1972 and attended school in Torino. He graduated from the University of Torino and finished his residency in Orthopedics and Traumatology in 2003. He has completed two fellowships in the USA (2002) and in the UK (2005). During his career, he received several national and international awards in joint replacement, arthroscopy and sports medicine. In June 2010, he became Associate Professor of the University of Torino. He has authored over 60 articles in peer-reviewed journals, 14 book chapters in internationally published books, and over 100 Abstracts. His research interests are in the fields of sports injuries, arthroscopy surgery, and knee joint replacement.

Acknowledgments

Editing this book would have been impossible without the help of many people before and during its compilation. Many thanks to all those involved and many apologies to those whom I forget to mention. Specifically, I would like to thank my mentors, both in Italy (Prof. Pier Paolo Mariani) and abroad (Prof. Chris Harner and Prof. Freddie Fu), who have encouraged and supported me throughout my professional career.

Special thanks go to Dr. Richard Villar, who first introduced me to hip arthroscopy and thus allowed me to discover an exciting world, and to Prof. Savio Woo, who opened my narrow clinical mind to a wider biomechanical approach. Lastly, of course, I am grateful for the patience and tolerance of my family (Sabina, Filippo Maria, Tommaso Maria, and Costanza) who have long become accustomed to the locked study door and to the chaos on my desk, both meaning "Danger! Daddy is working".

F.M.

This book is dedicated to my family: first and foremost to my mother and my father, who inspired me to enter Orthopedics and Sports Medicine, and then to my wife, Micaela, and two daughters, Francesca and Cecilia, for their constant support in all my endeavors.

R.R.

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Section I
Special Issues

Present and Future of Sports Medicine

1

K.D. Illingworth, S.M. Vyas, V. Musahl and F.H. Fu

Abstract Sports-related injuries are expected to increase with time and health-care professionals of all disciplines are becoming aware of common injuries and their treatment. Sports medicine is expanding in recognition of the fact that: (1) athletes participate in sport-specific training year round and often in multiple sports, (2) there has been a steady increase in "weekend warriors", (3) the patient population is better educated and has higher performance expectations and a greater awareness of physical fitness, and (4) recreational activities for the general population have increased tremendously. This chapter provides a brief overview of the current state of management of common sport-related injuries, including injuries in the shoulder, elbow, hip, knee, foot and ankle, head and spine, and concussion. It also describes some of the current controversies existing in these areas. The topics of cartilage, soft tissue injury, stem cells in orthopedics, proprioception in sports, biologics and imaging are also addressed in terms of current issues and what the future holds for their application in orthopedic sports medicine.

1.1 Introduction

In the USA, the first American Academy of Orthopedic Surgeons sub-committee on sports medicine was formed in 1967 with the first American Orthopedic Society for Sports Medicine (AOSSM) meeting held in New Orleans in 1975. Currently, there are over 2600 members in the AOSSM and 81 accredited fellowship programs. Sports-related injuries are expected to increase with time and health care professionals of all disciplines are becoming aware of common injuries and their treatment. Both the breadth and depth of sports medicine is expanding in response to the fact that: 1) athletes participate in sport-specific training year round and often in multiple sports, 2) there has been a steady increase in "weekend warriors", 3) the patient population is better educated, has higher performance

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expectations, and an increased awareness of physical fitness, and 4) recreational activities for the general population have increased.

Orthopedic sports physicians specialize in the operative and non-operative management of the active individual. Their patient population ranges from those in the general population who choose to live an active lifestyle to the care of dedicated professional athletes. Training in arthroscopic surgery is required to treat intra-articular derangements of the shoulder, elbow, wrist, hip, knee, and ankle. The orthopedic sports specialist is further qualified to manage acute on-field injuries and make decisions for the injured athlete that are in his or her best interest in the face of pressures from the team, fans, family, and even from the injured individuals themselves. The academic sports specialist is also involved in contributing to the vast field of sports research, whether it is on the cellular, biomechanical, or clinical level. Orthopedic sports specialists also help promote awareness of new methodologies and philosophies in sports-related care, two areas that are in constant flux and improvement, at the hundreds of centers of excellence worldwide. Sports medicine is one of the few orthopedic sub-specialties in which the surgeon is not simply treating the patients' pain, but rather, has the added challenge of optimizing athletic function. This chapter provides a brief overview of the scope of sports medicine, including a description of current treatments and controversies as well as its future directions.

1.2 Rotator Cuff

Pathology of the rotator cuff is one of the most common reasons for visits to the orthopedic sports specialist. In the last decade, treatment of rotator cuff injuries has significantly improved, with adjustments made to surgical indications, surgical techniques, surgical philosophy, and rehabilitation protocols. Whereas in the past, the results of arthroscopic rotator cuff surgery were questioned regarding the advantages over open or mini-open methods of repair, the recent literature has shown arthroscopic rotator cuff to be equal, if not superior to open techniques [1-4]. Current controversies in rotator cuff surgery include single- vs. double-row fixation, the utility of acromioplasty, the difficulties in treating massive cuff tears, and the incorporation of the dozens of constantly evolving surgical devices and biological agents that have continued to flood the industry. Several recent reviews of the literature have failed to show a clinical difference between double-row and single-row techniques of rotator cuff repair [5, 6]. A systematic review by Wall et al. showed that in three level-one studies and two level-two studies there was no clinical difference at one year in the single-row vs. double-row technique for rotator cuff repair [7]. However, Wall et al. also systematically reviewed the literature on the biomechanical strength of single- vs. double-row rotator cuff repair and concluded that the biomechanical properties of the double-row technique are superior to those of the single-row technique [8].

1.3 Shoulder Instability

The treatment of shoulder instability is one of the primary reasons for younger athletes to see the orthopedic sports specialist. Studies have characterized the risk for future recurrence and have found that those in their teens and twenties have a significantly higher risk of repeat episodes of instability than those in their thirties and forties [9-11]. Controversy remains regarding whether or not to immobilize the shoulder of a patient presenting with a dislocation for the first time, the position of the immobilization, and the considerations for early surgical repair of the capsulolabral structures. Patients with atraumatic multidirectional instability have generally been treated with shoulder rehabilitation, and in some cases surgical indications may be revised. Finally, those patients with recurrent instability are being more closely evaluated for the etiology of their pathology. Depending on whether the etiology is due to capsulolabral laxity, bony glenoid deficiency, humeral head morphology, etc., treatments can vary. Arthroscopic soft-tissue restoration has been the front-line treatment for recurrent instability. However, it is backed by open stabilizing procedures such as the open Bankart repair, Latarjet procedure, remplissage, and humeral head morphology restoration with allograft.

1.4 Superior Labrum/Biceps Anchor/Acromioclavicular Joint

The diagnosis and treatment of superior labral and biceps anchor pathologies is a common challenge for the orthopedic sports physician. Conservative vs. operative treatment have had mixed results depending on the level of activity, type of superior labral tear, and concurrent pathology. Also, the debate over biceps tendon tenotomy vs. tenodesis remains an active issue for the orthopedic surgeon [12, 13]. The sports medicine literature is evolving in the development of an algorithm for the treatment of superior labral and biceps disease. Disorders of the acromioclavicular joint can be acute or chronic. Acute type I and type II acromioclavicular separations have traditionally been managed non-operatively, but controversy exists over early vs. delayed surgical reconstruction of the type III acromioclavicular disruption [14, 15]. Chronic end-stage acromioclavicular arthrosis, traditionally managed with an open distal clavicle resection, is increasingly being treated arthroscopically, with excellent results [15, 16]. Chondrosis of the shoulder continues to be a challenge for the sports specialist. Arthroscopic debridement of the arthritic shoulder is a short-lasting option with early promising results for added microfracture techniques [17]. Diffuse chondrosis refractory to alternative management has been treated with humeral hemi-arthroplasty or glenohumeral arthroplasty.

1.5 Elbow

The throwing athlete is particularly susceptible to ulnar collateral ligament injury and its associated sequelae [18, 19]. While the gripping athlete (e.g., tennis and golf) is predisposed to tendinopathies about the elbow [20], common elbow pathologies include lateral and medial epicondylitis, triceps rupture/tendinitis, olecranon bursitis, distal biceps rupture, ulnar collateral ligament injuries, valgus extension overload, osteochondritis dissecans (OCD), elbow arthritis, ulnar neuropathy, fractures, and dislocations.

Arthroscopic treatment of intra-articular elbow pathology has advanced over the past decade, with indications expanding beyond simple diagnosis and loose-body removal. The arthroscope is being used to treat impingement, arthritis, contractures, OCD stabilization, and certain intra-articular fractures [21]. Techniques and procedures continue to evolve as surgeons gain more insight and skill in the indications for arthroscopic treatments of the elbow.

1.6 Hand and Wrist

Hand injuries during athletic participation are common and the sports orthopedic specialist is often the front-line physician seeing these athletes. While many hand injuries are ultimately cared for by a hand surgeon, the sports orthopedist must be facile in the diagnosis and management of acute hand injuries. Common acute injuries include dislocations, fractures, and ligamentous injuries. Wrist arthroscopy has also benefited from advances in surgical technique and equipment advances. Current usage of wrist arthroscopy includes evaluation of chronic wrist pain, treatment of triangular fibrocartilage complex and ligament tears, resection of synovitis and joint-based ganglia, visualization for reduction and fixation of intra-articular fractures and acute carpal dislocations, treatment of ulnar styloid impaction syndrome, loose-body removal, and debridement and partial or complete ostectomy for arthritis [22].

1.7 Hip

The approach and treatment of intra-articular hip pathology in the active individual has seen a dramatic change over the last five years. Disease of the labrum and femoroacetabular impingement (FAI) are diagnoses that are being made with more evidence and confidence. FAI has been shown to present in two varieties: cam-type impingement refers to the abnormal morphology of the femoral head/neck junction while pincer-type impingement refers to morphological abnormalities on the acetabular side, with many

patients being affected by a combination of both. Ultimately, both have been shown to cause labral and chondral disease [23-26]. Concordantly, arthroscopic treatment of these conditions has also seen a dramatic rise, with demonstrated success for osteo-chondroplasty as well as labral debridement and repair [27-29]. With time, long-term data will become available regarding the efficacy of arthroscopic hip surgery in treating immediate symptoms and in the prevention of long-term degeneration. Other conditions currently being treated with hip arthroscopy include septic arthritis, intra-articular loose bodies, pigmented villonodular synovitis, synovial chondromatosis, and ruptured ligamentum teres. Expansion of the indications of hip arthroscopy is on the forefront of sports medicine.

1.8 Anterior Cruciate Ligament

The anterior cruciate ligament (ACL) continues to be the most extensively researched and reconstructed of the ligaments. In 2008, there were approximately 105,000 ACL reconstructions in the USA [30]. Despite the extent of ACL research, many controversies remain, involving autograft vs. allograft [31-34], optimum allograft sterilization and processing [33, 35], location of tibial and femoral tunnel placement [36-39], single vs. double bundle technique [36, 40-44], transtibial vs. medial portal femoral tunnel drilling [45-47], fixation methods, and post-operative protocols.

Indications for ACL reconstruction are debated. Most surgeons agree that athletic patients with a previously normal knee, with new-onset subjective instability with activity, benefit from ACL reconstruction. Thus far, the results of ACL reconstruction have largely been good to excellent, with a majority of patients able to return to pre-injury activity level [48]. However, the challenge of improving on a generally successful operation has been proposed. Currently, "anatomic" ACL reconstruction is receiving much attention as it is felt that reconstruction of the native anatomy of the athlete with respect to graft size, tunnel location, tunnel shape, and collagen orientation results in optimal return to pre-injury function.

The most common natural history of an ACL-deficient knee is chondral degeneration [49, 50]. The restoration of knee kinematics is hypothesized to be the most important factor in long-term outcomes and the prevention of early arthritis associated with current ACL reconstructions. As the anatomic technique and double-bundle concept continue to be investigated, long-term follow-up and biomechanical data will be crucial to make the necessary conclusions regading optimal reconstruction techniques.

The use of an allograft vs. autograft in ACL reconstruction has long been debated. Autografts have the disadvantage of resulting in higher surgical morbidity. Allografts incorporation and healing take longer than is the case for autografts but have the advantage of no donor site morbidity and allowing the surgeon to choose a graft size that is not constrained, unlike in autografts. Recent reviews have shown no difference in clinical outcome between autograft and allograft in ACL reconstruction [32, 33, 51].

1.9 Posterior Cruciate Ligament

The posterior cruciate ligament (PCL) has received significant recent attention. Grade I and most grade II PCL injuries are treated non-operatively. Grade III PCL and combined PCL/PLC and PCL/MCL injuries continue to challenge the orthopedist with regard to management decision-making. The natural history of a grade III PCL injury has been shown to result in medial and patellofemoral compartment chondrosis and degeneration [52, 53]. Surgical intervention is influenced by age and activity level of the patient, subjective instability, and other concurrent ligamentous injuries. There is variation amongst surgeons with regard to the "inlay" technique vs. the transtibial approach to reconstruction [54, 55]. Furthermore, the utility of osteotomy to decrease the biomechanical demand on the PCL is an unanswered question outside the laboratory. Identification of simultaneous ligament injuries and their appropriate management has been shown to influence the outcome of PCL reconstruction [53]. The goal of PCL reconstruction should be the restoration of early stability and of knee kinematics to a near native state in order to prevent long-term complications, such as osteoarthritis. Clinical outcome studies involving PCL reconstruction are necessary to help address these unresolved issues.

1.10 Posterolateral Corner

The anatomy of the posterolateral corner (PLC) has been well characterized and shown to contribute static and dynamic stability to the knee. The critical structures of the PLC are the lateral collateral ligament (varus stability), the popliteus tendon (rotational stability), and the popliteofibular ligament (rotational stability). The PLC is commonly injured concomitant with other ligamentous injuries, with the torn ACL being its most common partner [56]. The deficient PLC has been shown to be a primary cause of failed cruciate reconstruction surgery as it allows excessive stress on the reconstructed grafts [53, 56, 57]. Algorithms have been developed to include treatment of the PLC to avoid these disastrous consequences. Currently, it is believed that in acute high-grade injuries of the PLC in which a specific major PLC structure is obviously deficient, primary repair is effective within 2–3 weeks of the injury [58]. However, beyond this time frame, primary repair is difficult and reconstruction of the posterolateral stabilizing structures must be undertaken. Finally, with chronic PLC injuries, ligament reconstruction may not be enough and concurrent realignment osteotomy may be necessary to prevent further chondrosis of the knee joint.

1.11 Medial Collateral Ligament

The medial collateral ligament (MCL) is the most commonly injured of the knee ligaments; however, it has been shown to have good healing potential [59, 60]. Grade I and II injuries of the MCL most commonly improve with appropriate bracing and activity modification [61]. Grade III injuries are often given a non-operative trial, during which many also improve. A majority of MCL injuries occur in the mid-substance and femoral insertion site with a minority at the tibial insertion site. Tibial-sided grade III MCL injuries are the subset of MCL injuries associated with worse clinical outcome, and surgical repair is therefore more often advocated. Reconstruction of the MCL is less common, as repair is usually effective.

1.12 Meniscus

The meniscus serves to provide joint stability, shock absorption, load distribution, and proprioception. Preservation of the meniscus has recently been in the spotlight as the primary goal for meniscal surgery. With menisectomy as one of the most commonly performed surgical procedures, physicians must be educated on the significance of meniscal preservation when there is potential for healing. Research into the use of biologics (e.g. fibrin clot, PRP, platelet-rich plasma) in meniscal repair has attempted to expand the indications of meniscal repair over subtotal meniscectomy [62-66]. Further, meniscal root tears are now increasingly being recognized as devastating injuries resulting in the alteration of knee contact forces [67, 68]. Surgical techniques are being developed to repair the meniscal root in an attempt to restore its function. For end-stage meniscal disease, meniscal transplantation is an option [69], but the indications are still a source of controversy. Superior surgical techniques, the use of biologics for meniscal healing, long-term data on root repair, indications for transplantation, and physician education on the critical role of the meniscus are at the frontier of meniscal surgery.

1.13 Patellofemoral Disorders

Disease involving the patellofemoral joint is often the most difficult problem for the sports surgeon to address. Patellofemoral pathology can stem from instability, chondrosis, and tendonosis. In recent years, patellar instability has been shown to involve loss of the medial patellar stabilizing structures. In particular, the medial patellofemoral ligament (MPFL) has been identified as a primary stabilizing structure for the patellofemoral joint and has been an effective target for repair or reconstruction in the patient with chronic

instability [70]. However, treatment algorithms have recently been developed that consider the etiology of the instability and focus on treatment to address a possible anatomic cause (such as patella alta, trochlear dysplasia, and atypical tubercle anatomy). In such cases, other procedures that address this anatomic variation may be added to MPFL repair or reconstruction.

1.14 Foot and Ankle

Foot and ankle injuries are common to the athletic population. The nature of these injuries varies depending on the sport. Chronic overuse injuries are seen in endurance athletes such as long-distance runners while acute bone, ligament, tendon, or cartilage injuries are more seen in contact athletes. Ankle sprains are the most common ankle injury in athletes and are most often treated conservatively. First-line treatment of chronic conditions such as Achilles, peroneal, or posterior tibialis tendonitis as well as stress fractures of the feet continue to be managed non-operatively. Tibiotalar impingement as well as chondral or osteochondral lesions of the ankle joint are more readily being treated with ankle arthroscopy, with good evidence-based medicine [71]. The role of microfracture in acute ankle cartilaginous lesions and the benefits of autologous cartilage transplantation and open osteochondral transplantation are questions that are currently being investigated [72-74].

1.15 Head and Spine

Although the head and spine are often left outside the surgical scope of a sports medicine practice, these injuries are the most crucial when evaluating acute on-the-field injuries. It is estimated that nearly 70% of all sport-related deaths can be attributed to head injuries. Recent sport-related rule changes and advances in equipment have been implemented as part of the greater emphasis being placed on protecting the head, neck, and spine for contact athletes. In the National Football League, spearing and leading with the head are examples of illegal forms of tackling that have helped decrease the incidence of head and neck injuries, not only in professional athletes but at all levels of football. There is continued emphasis on protecting athletes from these catastrophic injuries through education, equipment technology, and medical advances. In addition, identifying patients who are at risk of spine and spinal cord injuries is imperative and questions regarding the relationship between spinal stenosis and spinal injury continue to be debated.

1.16 Concussion

Over the past several years, significant knowledge has been gained in the area of concussion and the approach to return to play for athletes. The diagnosis and treatment of concussion has evolved from a rudimentary diagnosis and classification to a more sophisticated process that better protects athletes from devastating outcomes. The center for disease control estimates that there are more than 300,000 sport-related concussions each year [75]. The advent of Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) has revolutionized the approach to concussion management, taking into consideration the somatic, cognitive, and neurobehavioral sequelae of concussion [76-78]. It has been shown that early return to play while still symptomatic from concussion-like symptoms predisposes the athlete to an increased risk of subsequent concussion and further neurological damage [76]. The future of concussion management includes better identifying athletes at risk of a second neural injury and protecting them from further longer-lasting consequences. In addition, the utility of neurologic therapy (e.g. psychological therapy, vestibular therapy) warrants further exploration.

1.17 Cartilage

Much energy has been focused on the injury and repair of the articular cartilage; however, restoration of lost cartilage is not yet possible. Current research focuses on the use of smart polymers, stem cells, and gene therapy to deliver growth factors known to induce chondrogenesis. Biodegradable hydrogels are also being developed for use as an artificial matrix for tissue engineering and drug delivery. Tan et al. developed an injectable biodegradable hydrogel from chitosan and hyaluronic acid and demonstrated its in vitro potential by implanting bovine chondrocytes and showing their survival and proliferation [79]. Cartilage imaging has expanded to include optical coherence tomography (OCT) and multi-parametric quantitative magnetic resonance imaging (MRI), both of which attempt to detect early reversible articular cartilage damage [80-82]. The continued goals of basic science, radiographic, and clinical research in the field of cartilage are to help identify the etiology of cartilage loss, improve early visualization of cartilage damage, and devise effective means to restore lost cartilage to prevent and treat osteoarthritis. Current methods of treating articular cartilage injuries include chondroplasty, microfracture, autologous chondrocyte implantation, osteochondral grafting, osteotomy to redirect weight-bearing forces, and arthroplasty.