Return to play following spinal cord injury

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ABSTRACT

Approximately 9% of spinal cord injuries (SCI) occur during sports. Decisions concerning return to play (RTP) have to be made for all the injured athletes at all levels of competition.

This study aims to review the existing literature concerning RTP on athletes with SCI regardless of the level of competition and to assess guidelines and protocols concerning RTP after SCI. Through the online PUBMED, CINAHL, EMBASE and AMED databases and following the PRISMA guidelines, studies regarding RTP after SCI were identified.

In total twelve studies were included. Four studies assessed RTP of athletes after a SCI, whereas, the remaining eight studies dealt with RTP protocols and guidelines.

RTP after a SCI must be individualized based on the mechanism of injury, the anatomical site of injury, the imaging studies, and the athlete's recovery response. Future studies providing evidence on thoracic and lumbar injuries are needed in order to achieve stronger recommendations and protocols for a safer RTP.

Key Words: spinal cord injuries, sport injuries, return to play

Introduction

Spinal cord injury (SCI) is a serious medical condition, which often results in severe morbidity and permanent disability. It occurs when the axons of the nerves running through the spinal cord are disrupted, leading to a loss of motor and sensory function below the level of injury [1]. Approximately, 250,000 to 500,000 patients can suffer a SCI every year. Most of these cases are due to preventable causes such as violence and motor vehicle accidents. In the United States, there are approximately 17,000 new cases of SCI every year, and around 282,000 people are estimated to be living with a SCI. The leading cause of SCI is motor vehicle accidents, accounting for 38% of new SCI cases every year. Thirty percent of SCI cases are due to falls, 13% to violence, 9% to sports injuries, and 5% are due to medical and surgical complications. The age group with the highest risk for SCI is 16 to 30 years of age. Males represent the majority of patients with sports injury related SCI. [2]

Regardless of the cause of injury, decisions on the return-to-play (RTP) have to be made for the injured athletes. Since SCIs are among the most devastating injuries in all of sports and the stakes can be so high for the athlete, returning to play after a SCI is one of the most difficult decisions in sports medicine.

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VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

Standardized protocols have been, or are currently being, developed for RTP after anterior cruciate ligament (ACL) reconstruction, concussions, and many other musculoskeletal injuries treated both operatively and conservatively. However, there is no such consensus for RTP after an injury to the spine and the spinal cord. The reasons for the lack of guidelines are multifactorial due to the more complex anatomy and wide spectrum of injuries to the spine, as well as the decreased incidence of these injuries over the past 40 years. The myriad spinal conditions, injuries, and surgical options highlight the need to evaluate RTP guidelines after a SCI according to each specific injury and its respective treatment modality. Most would agree that the athlete returning to sport following a SCI must be asymptomatic, have full strength, and have full active range of motion (ROM); however, each case is unique.

The aim of this study is to review the existing literature concerning return to play of athletes after SCI regardless of their level of competition and to assess guidelines and protocols concerning returning to following after a SCI. This review adheres to the guidelines set out by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). A literature search was conducted in the following databases; PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Allied and Complementary Medicine (AMED) and Embase, using the terms "spinal Cord injury" AND 'return to play'.

Study inclusion criteria: The literature research main focus was on recent publications concerning the impact of SCI in RTP. As far as the primary goal of the study was concerned, only case studies were included. The target population was male and female athletes who suffered a SCI during sport participation. Only articles written in English that had their whole text accessible were included. In addition, only articles that were recently published (1990-2020) and presented clinical results of RTP after SCI were included. Concerning the second aim of the study, reviews with guidelines and criteria for RTP after SCI were included. Only recently published articles (1990-2020), written exclusively in English and having their whole text accessible were included.

Study exclusion criteria: Articles that that did not meet the above-mentioned criteria were excluded from the study: articles not written in English, with no access to the whole text and not recently published were excluded. Case reports were excluded too (Table 1).

Discussion

The electronic database search resulted in a total of sixty two articles. One study was excluded as a duplicate. Seven studies were excluded due to lack to full-text access. Thirty four full-text studies were excluded due to lack of relevance. Additionally, eight more studies were excluded: three were not performed to humans, two were case-reports and three were systematic reviews. The final studies that met the study criteria were twelve. Four of those studies assessed RTP after SCI and eight of those assessed guidelines and recommendations for RTP.

The four studies that assessed RTP after SCI included one hundred and thirty three SCI patients (Appendix 1). All patients were athletes and sustained their injury during sports. Most of them were males. Football was the leading sport. All injuries occured between 1974 and 2022. The age range was between thirteen and thirty three years. Most of the injuries were cervical and cervical cord neuropraxia. Some patients had undergone operative treatment and others conservative. All patients were assessed for RTP and some of them were followed up after RTP.

A recent study by Poudel and Sherman included 14 cases of football-related SCI. Eight out of 14 patients had suffered a vertebral fracture-dislocation, whereas two had concomitant traumatic brain injury. Neurologically, 54% had tetraplegia, 39% paraplegia, and 7% suffered from hemiplegia and sensory deficit. Two patients regained the ability to walk with orthosis and four (28.5%) regained full mobility and RTP. The overall mortality was 14%.[4] In 2012, Brigham and Capo reviewed the case history, physical examination, and MR images of 4 professional athletes who suffered from cervical cord contusions. None of them had an acute disc herniation, fracture, instability or focal cord compression. All underwent anterior fusion at the level of their contusion and were later oncontacted by phone to assess symptoms at a minimum follow-up of

VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

2 years after the injury. All athletes returned to active competition (100% RTP). During follow-up, 2 athletes developed new contusions. One athlete suffered a new contusion adjacent to the fusion approximately 5 years later and the second athlete suffered a contusion away from the fusion site approximately 2 years later. None of the athletes developed permanent neurological damage.[9] In 1997, Torg et al. reviewed 110 cases of cervical cord neurapraxia. Overall, 60% of them returned to sports participation at their previous level of competition. Of the patients returning to contact sports, 35 (56%) experienced a recurrent episode.[15] Maroon et al. studied five elite football players who had experienced episodes of neurapraxia. All patients experienced bilateral paresthesias. Three patients experienced paresthesias in all four extremities and two in the upper extremities, lasting from a few minutes to more than 24 hours. Transient motor deficits occurred in two patients with no permanent sequelae. In all cases, neuroimaging confirmed the presence of herniated discs and focal cord compression but no parenchymal changes. All patients underwent anterior cervical microdiscectomy and fusion, and cervical plates were placed in four patients. After aggressive rehabilitation and confirmation of fusion ranging from 9 weeks to 8 months postoperatively, all players were allowed to return to active play (100% RTP). Two of them developed recurrent career-ending disc herniation, one above and the other below the fusion level. One player required repeated spinal cord decompression.[16]

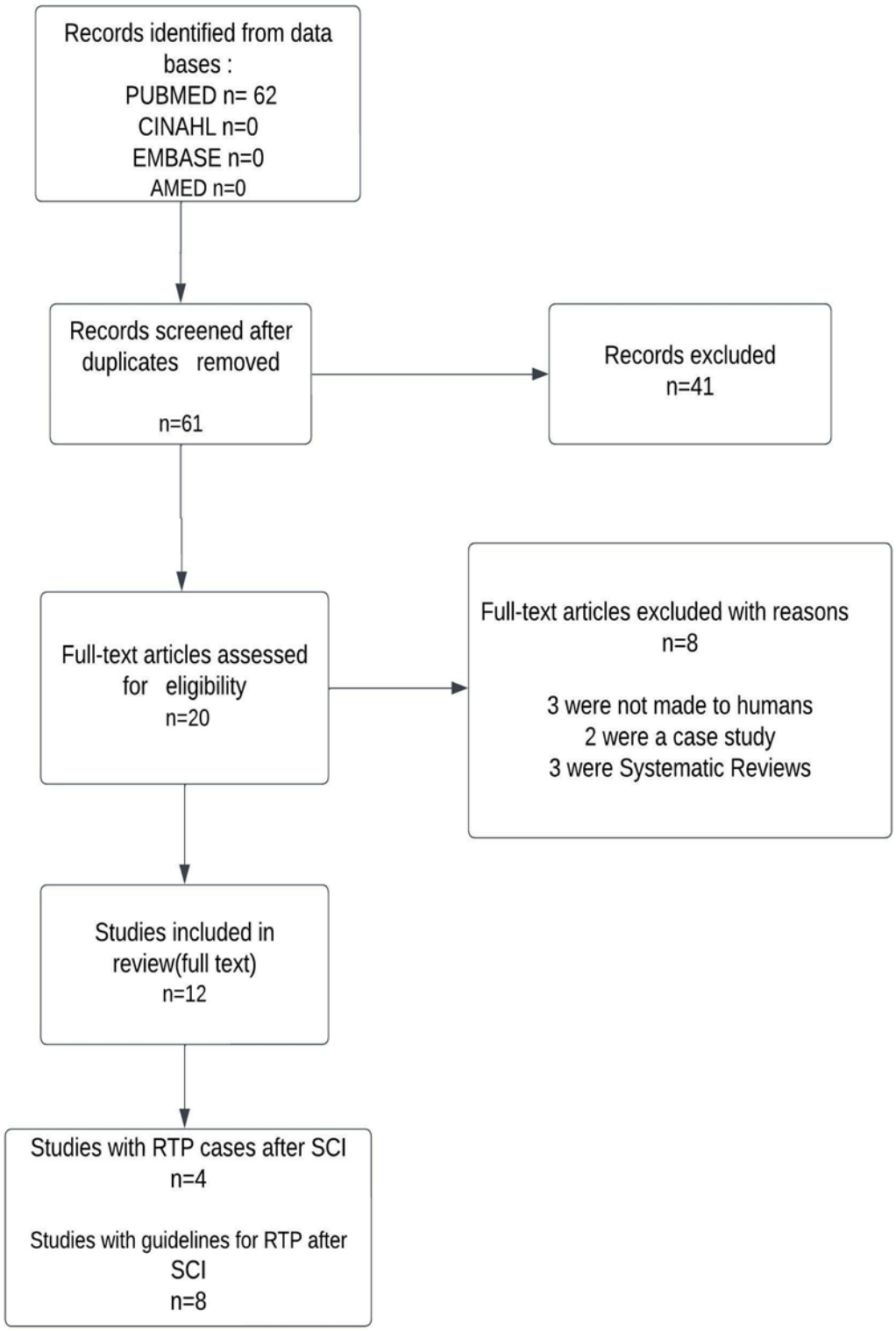
Concerning the second aim of the study, to reassess the guidelines for RTP, eight studies were included and evaluated. Only six articles presented guidelines for RTP following cervical SCI. One study assessed recognition and management of SCI in sports while another study presented RTP recommendations following cervical, thoracic and lumbar SCI. [6]''A study conducted by Robert C. Cantu et al. concluded that RTP following cervical spine injury is complex, often controversial, and patient specific. There are no universally accepted RTP criteria. The decision to RTPt after a cervical spine injury must be individualized based on the mechanism of injury, anatomical site, imaging studies, and athletes' recovery response. [5] A study conducted by Philip Huang et al concerning RTP recommendations following cervical, thoracic and lumbar SCI concluded that there are no standardized consensus guidelines for RTP after spine injuries. However, there was a good general agreement on 4 fundamental criteria that must be met for a player to return to sport; (i) the athletes should be pain free, (ii) have full range of motion, (iii) regain full strength, and (iv) show no evidence of neurologic injury. [6] In their survey, John C. France et al., suggested a consensus among surgeons for allowing patients with relatively normal imaging and resolution of symptoms to return to high-contact activities; however, patients with cervical stenosis or clinical symptoms continue to be a challenge for future management [7]. Robert Brian Bettencourt and Michael M. Linder concluded that research best supports that, in the absence of cervical spine instability or cervical spine stenosis (CSS), temporary cervical cord neuropraxia (CCN) and transient quadriparesis (TQ) are not associated with a significantly increased risk for permanent or catastrophic SCI. However, investigators' opinions vary widely on return-to-play criteria after TQ or CCN in the setting of CSS [8].

Another study conducted by Alexander R Vaccaro et al., concluded that the issue of RTP for an athlete after a cervical spine injury is controversial. It was also emphasized that there are no firm criteria for return to play, although most authors agree on many specific issues. Tremendous extrinsic pressures may be exerted on the physician from noninvolved and involved parties in regards to returning an athlete to competitive activities. The decision to permit the RTP to a particular sport should be based on the mechanism of injury, objective anatomical injury (as demonstrated by clinical examination and radiographic evaluation) and athlete's recovery response [10]. In their study, Jeffrey A. Rihn et al. stated that despite significant efforts to develop guidelines for RTP for cervical spine injury, the issue remains controversial. Currently, no set of guidelines for RTP exists for cervical lesions. This issue is often complicated by extrinsic pressures placed on the physician from coaches, players, families and other involved parties. Injured players desiring to return to play must be evaluated thoroughly to minimize the risk of recurrent injury. Evaluation includes a detailed history and physical examination

VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

TABLE 1

Flow diagram of studies though the review



VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

and a complete neurological examination. The patient must be able to demonstrate a full, painless cervical range of motion and have no evidence of neurological deficit prior to returning to play [11]. In his study, Charles H. Tator stated that the issue of return to play presents a specific management challenge in athletes. In general, the treating team should use the same return-to-play guidelines for professional and amateur athletes, although professionals often treat themselves differently from the general population. Practitioners should be prepared for resistance from some relatives, coaches, trainers, league officials, and players' agents and should be prepared for a higher percentage of noncompliance from professional athletes. Many factors need to be considered when advising athletes about return to play after spinal injuries. Although there have been good attempts to develop return-to-play guidelines for spinal injuries, there is still a great deal of uncertainty. The decision about return to play depends primarily on the nature of the injury and the nature of the activity in which the athlete is engaged. [12] A study contacted by Robert C. Cantu concluded that return-to-play decisions after traumatic spine or spinal cord injury are not always clear and often require individualization. The study attempted to provide a framework for these decisions. Type 1 athletic injuries are those with permanent neurologic injury and preclude further participation of the player in contact sports. Type 2 injuries consist of transient neurologic disturbances with normal radiographic studies. If the complete workup reveals no injury, these players may return to competition once they are symptom free. Type 3 injuries are heterogeneous, including all players with radiographic abnormalities. Those athletes with significant bone or ligamentous spinal instability, spinal cord contusion, or significant spinal stenosis are advised not to return to contact sports. Other radiographic abnormalities, such as spear tackler's spine, posterior ligamentous injury, congenital fusion, herniated disks, or degenerative spondylitic disease, require consideration on an individual basis. [14]

From the twelve studies that were included in this review only four assessed patients' RTP following SCI, while the other eight assessed existing guidelines for RTP after a SCI. Based on the number of such events, there is limited evidence regarding RTP following SCI. Future prospective multicenter studies are needed to better address our purpose and key questions. Eight studies addressed cervical SCI. Only the study by Huang et al provided guidelines for RTP after thoracic and lumbar SCI. This is due to the fact that the number of cervical SCIs in sports is significantly higher than thoracic and lumbar SCIs. Out of the one hundred and thirty three cases included in this review only four cases were non cervical. Due to the low number of thoracic and lumbar SCIs in sports, more studies need to be published.

One of the aims of our study was to assess guidelines for RTP after a SCI. In a recent study, the authors concluded that there are no universally accepted RTP criteria and that RTP after a cervical spine injury is complex, controversial and patient specific. The decision to RTP after a cervical spine injury must be individualized based on the mechanism of injury, the anatomical site, the imaging studies and the athlete's recovery response. In general, athletes can return to contact sports after cervical spine injury when they are asymptomatic, demonstrate full ROM, have regained pre-injury neck strength, and their imaging shows no evidence of spinal stenosis, disc disease or instability. [5,6,10,11,14] Another recent study concluded that advances in on/off field evaluation and management, rehabilitation strategies and return-to-play guidelines have improved the care of athletes that sustain cervical injuries. Continued surveillance of cervical injuries in football and other contact sports will hopefully lead to further improvements in preventative strategies. [11]

Most of the cases included in this review (one hundred and fifteen) where episodes of Cervical Cord Neuropraxia (CCN). In their study, Torg et al concluded that CCN is a transient neurological phenomenon and that individuals with uncomplicated CCN may be permitted to return to their previous activity without an increased risk of permanent neurological injury. They also concluded that congenital or degenerative narrowing of the cervical canal is a strong risk factor, increasing the overall recurrence rate after RTP to 56% and that the risk of recurrence is strongly and inversely correlated to the canal's sagittal for future CCN episodes (p;0.001). These data enable the physician to counsel individuals regarding a predicted

VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

risk of recurrence based on canal measurements. [15]. In another recent study, the authors concluded that the athlete with previous transient CCN must accept that his injury was not necessarily benign and that returning to play to contact or collision sports carries an apparently small, but nonetheless present, risk of permanent SCI [16]. Torg et al reported that cervical stenosis was predictive of another episode of CCN (53%) but not predictive of a catastrophic injury [3]. Dailey et al concluded that return to full participation in high-energy contact sports could be based on radiographic findings: patients with transient neuropraxia without stenosis could return to sports (strong recommendation), whereas stenotic patients could not return to sports (weak recommendation). Furthermore, a strong recommendation was made to permit players to return to full participation after decompression with a single-level anterior cervical fusion. [17]

Limitations:

This review presented the following limitations: (a) the small sample size of 12 articles that met the eligibility criteria, which could be overcome by searching additional databases; (b) studies were only published in English language, which should be taken into consideration when interpreting the conclusion of the study.

Conclusion:

There is limited evidence on the current practice standards RTP following SCI. More studies need to be made in order to have stronger recommendations and protocols for a safer RTP after SCI especially in thoracic and lumbar SCI where the evidence is extremely low. Most of the studies included in this review agree that RTP after a cervical spine injury is complicated, often controversial, and patient specific. The decision to return an athlete to a sport after a cervical spine injury must be individualized based on the mechanism of injury, anatomical site, imaging studies, and the athlete's recovery response. There are some strong recommendations about safe RTP after CCN without spinal stenosis but further studies need to be made too.

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APPENDIX 1

Data extraction list

Study	Year	Population	Intervation	Results
Football (soccer)-related spinal cord injury—reported cases from 1976 to 2020(Manoj K. Poudel, Andrew L. Sherman)	2020	Fourteen cases of football-related SCI	Eight of 14 individuals had vertebral fracture/dislocation, whereas two individuals had concomitant traumatic brain injury. Neurologically, 54% had tetraplegia, 39% had paraplegia, and 8% each suffered from hemiplegia and sensory deficit. Two cases could regain ability to walk with orthosis and four had full mobility with "Return to Play" (RTP). Themortalitywas 14%.	More than 50% of the individuals with football-related SCI were able to walk or RTP after rehabilitation. Further studies are required to establish universal RTP criteria and formulate preventive measures.

VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

Cervical Spinal Cord Contusion in Professional Athletes(Craig D. Brigham et al)	2013	4 professional athletes 27 year of age .	All athletes had documented cervical cord contusions. None of the athletes had an acute disc herniation, fracture, instability, or focal cord compression. All athletes were contacted by telephone to assess symptoms at a minimum follow-up of 2 years after injury.	Return-to-play guidelines should emphasize the athletes' history of symptoms in context with their MR image because there is poor correlation between the finding of a contusion and the clinical presentation. Recurrence of symptoms is common and the long term consequences of repeated episodes remain unknown
Cervical cord neurapraxia: classification, pathomechanics, morbidity, and management guidelines (Joseph S. Torg et al)	1997	One hundred ten cases of the transient neurological phenomenon, cervical cord neurapraxia (CCN), are presented. One hundred nine males and one female were included in the study; the average age of the participants was 21 years	All episodes occurred during sports participation; 87% occurred while the patient was playing football. Follow-up review lasting an average of 3.3 years was available for 105 patients (95%)	1)CCN is a transient neurological phenomenon and individuals with uncomplicated CCN may be permitted to return to their previous activity without an increased risk of permanent neurological injury; 2) congenital or degenerative narrowing of the sagittal diameter of the cervical canal is a causative factor; 3) the overall recurrence rate after return to play is 56%; and 4) the risk of recurrence is strongly and inversely correlated with sagittal canal diameter and it is useful in the prediction of future episodes of CCN (p , 0.001). These data will enable the physician to counsel individuals regarding a predicted risk of recurrence based on canal measurements.
Cervical neurapraxia in elite athletes: evaluation and surgical treatment (Joseph C. Maroon et al)	2007	Five elite football players were evaluated after experiencing episodes of neurapraxia	All patients underwent anterior cervical microdiscectomy and fusion, and cervical plates were placed in four. After aggressive rehabilitation and confirmation of fusion ranging from 9 weeks to 8 months postoperatively, the players were allowed to return to active play. Two of the players developed recurrent career-ending disc herniations, one above and the other below the fusion level. Oneplayerr equiredrepeatedspinalcorddecompression	Neurologically intact athletes with focal cord compression due to a single-level herniated disc may safely return to football after undergoing decompressive surgery and confirmation of fusion. It appears, however, that there may be an increased chance of repeated herniation above or below a fused level.

VOLUME 74 | ISSUE 2 | APRIL - JUNE 2023

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