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Sports-Related Cervical Spine Injury: A Series of Two Cases with Literature Review

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Abstract

Sports-related cervical injuries pose a significant concern in the realm of sports medicine, affecting athletes across various disciplines and levels of competition. Cervical injuries in sports primarily result from a combination of high-impact forces, sudden acceleration–deceleration movements, and improper techniques. Common cervical injuries include sprains, strains, fractures, and more severe conditions such as cervical spine dislocations. The mechanisms underlying sports-related cervical injuries involve complex interactions between biomechanical forces, player dynamics, and environmental factors. Understanding the biomechanics of these injuries is crucial for developing effective preventive strategies. This study highlights the mechanism of injury, primary intervention including transport of athletes, and medical and surgical management with the help of two such cases managed in a single institute in this year, 2023. By addressing the multifaceted aspects of these injuries, the sports community can strive toward creating a safer environment for athletes and minimizing the impact of cervical injuries on their overall well-being and athletic performance.

Keywords
- sports
- cervical
- mechanism
- subluxation
- fixation

Introduction

Injury to the cervical spine in athletes is a rare but catastrophic event. As per the National Spinal Cord Injury Statistical Center, sports injuries are the fourth most common cause of spinal cord injury (SCI), behind motor vehicle accidents, falls from height, and violence.[1] It is more common among young adult males. It is mainly associated with contact sports like football, rugby, ice hockey, and skiing; however, it is also seen in track and field events like the high jump and long jump, as well as in events like diving and swimming.

In this series, we are discussing two cases of sports-related cervical injury with particular emphasis on the mechanism of injury, protection against such injury, and current recommendations for managing and treating these potentially catastrophic injuries to the spine.

Case 1

Case 1 is a 16-year-old adolescent boy who is a sports athlete specializing in high and long jump. During training, while trying to perform a back flip, he landed on his head and sustained a neck hyperflexion. Following the event, he developed right upper and bilateral lower limb weakness with sensory deficit and bladder–bowel involvement. As per the neurological evaluation, he had an American Spinal Injury Association (ASIA) grade A with a level of motor weakness below the shoulder level with a single breath count (SBC) of 24 without the presence of any Horner's syndrome. He was evaluated with computed tomography (CT) and magnetic resonance imaging (MRI) of the cervical spine, which showed grade IV cervical subluxation at the C5–C6 level with bilateral locked facets. MRI of the cervical

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spine with whole spine screening confirmed the finding of CT with traumatic disks noted at the C5–C6 level with indentation on the cord associated with cord signal changes seen from C4 to C7.

After essential investigations, he was taken up for surgery, where Gardner–Wells cervical traction was applied after endotracheal intubation (►**Fig. 1**). Reduction was attempted under general anaesthesia which resulted in unlocking of the facets, and intraoperative fluoroscopy confirmed the unlocking of bilateral locked facets at C5–C6. Subsequently, a traction weight of 8 kg was applied, per his body weight, to keep the spine unlocked. He underwent an anterior cervical approach with C5–C6 diskectomy with the cutting of the posterior longitudinal ligament, interbody fusion using a polyetheretherketone (PEEK) cage and fixation using self-tapping cortical screws (►**Fig. 2**). Postsurgery, however, there was no improvement in power, and his ASIA grade at 3 months of follow-up was still grade A..

Case 2

A 20-year-old gentleman in a local swimming event dived headfirst into a pool with a depth of 5 feet, where his head collided with the bottom of the pool, and his neck suffered hyperflexion. Following the impact, he developed complete weakness in the bilateral upper and lower limbs with bladder–bowel involvement. At the time of presentation, he was ASIA grade A with motor weakness at the level of the shoulder, sensory level below the level of clavicle, and SBC of 20 without any features of Horner's syndrome. He was evaluated with CT and MRI of the cervical spine, which revealed a C4–C5 grade III subluxation with a bilateral locked facet (►**Fig. 3**). Under general anesthesia, following the application of Gardner–Wells cervical traction, the initial reduction attempt was unrewarding. He underwent a posterior cervical approach where drilling of the locked facets and fixation using bilateral C3, C4, and C5 lateral mass screws and rods were performed; given the disk prolapse, the anterior cervical approach C4–C5 diskectomy with fusion using PEEK cage and fixation using cortical cervical screws was performed (►**Fig. 4**). Postsurgery, however, there was no improvement in sensorimotor functions, and he remained grade A on the ASIA scale at 30 months of follow-up.

The patient characteristics are presented in ►**Table 1**.

Discussion

The Allen and Ferguson classification system has categorized the principle loading forces with resultant spinal injuries as follows:

- Hyperflexion injury occurs after sustained hyperflexion of the cervical spine following a loading event. It can cause

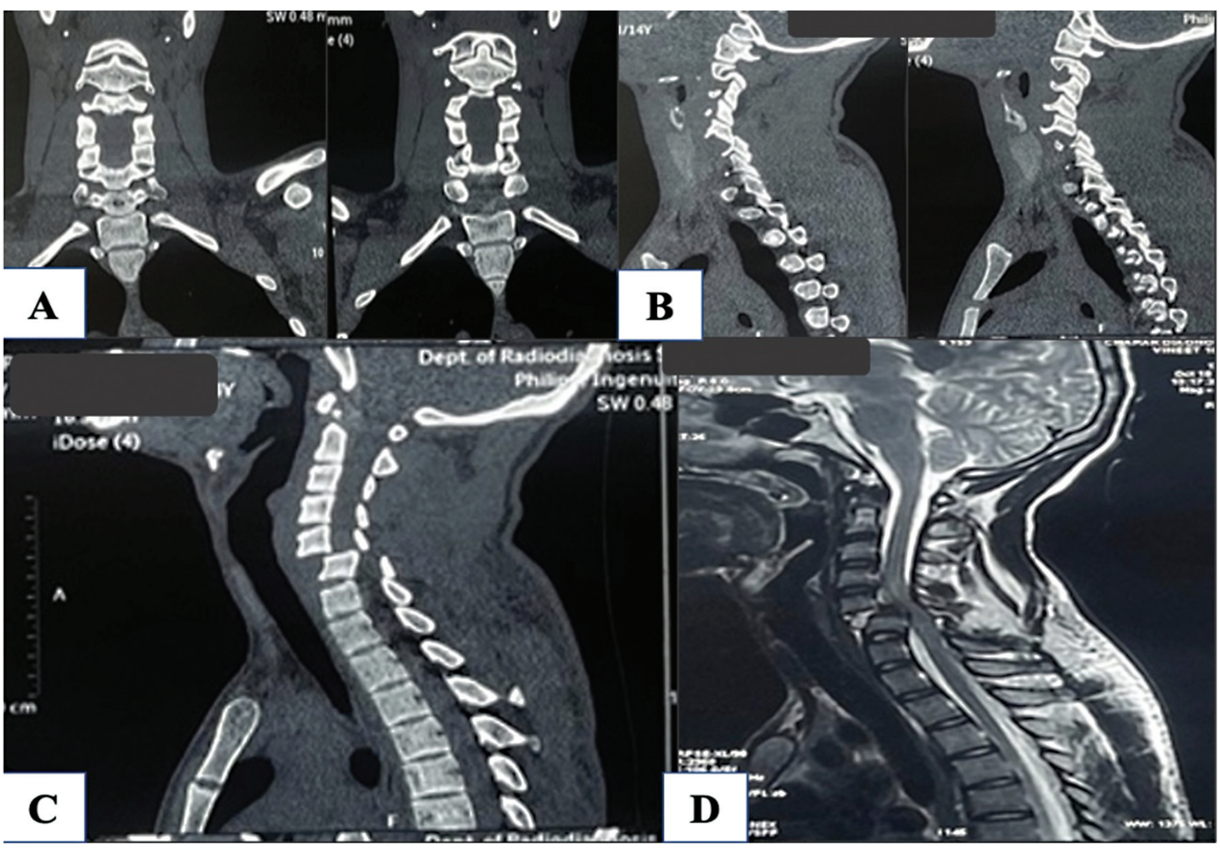

Fig. 1 (**A,B**) The coronal and sagittal cuts of the cervical spine computed tomography (CT) scan showing bilateral locked facets at the C5–C6 level. (**C**) The sagittal cut of cervical spine CT depicts grade III subluxation at the C5–C6 level. (**D**) The sagittal cut of magnetic resonance imaging (MRI) of the cervical spine shows C5–C6 subluxation with cord compression and signal changes at the index level.

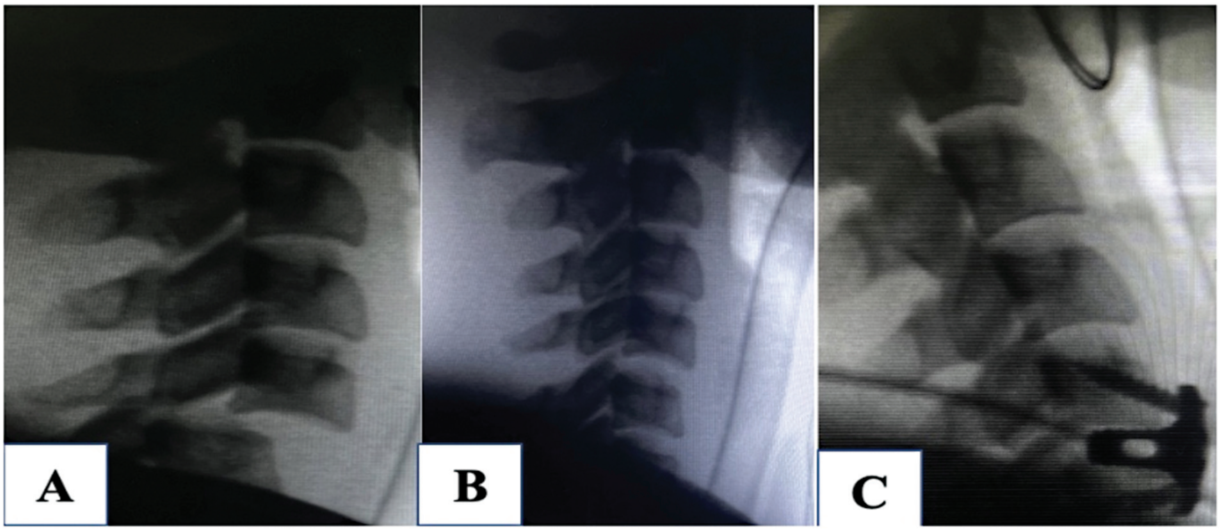

Fig. 2 (**A**) The intraoperative fluoroscopy of cervical spine of the same patient in Fig. 1 after induction of anesthesia before application of cervical traction. (**B**) The fluoroscopic image after the application of Gardner–Wells cervical traction depicts complete reduction. (**C**) The cervical spine intraoperative fluoroscopy image (lateral view) suggests anterior cervical diskectomy and fusion after evaluating the intact osteoligamentous complex at the C5–C6 level.

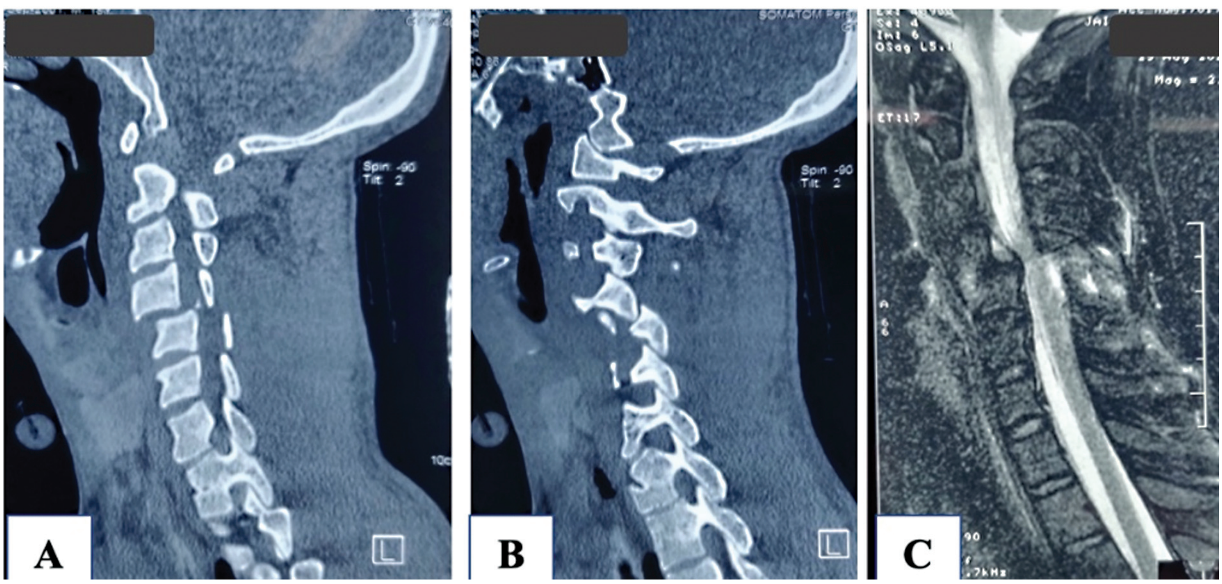

Fig. 3 (**A,B**) The sagittal images of computed tomography (CT) of the cervical spine show C4–C5 grade II subluxation and locked facet at the same level. (**C**) The sagittal cut of magnetic resonance imaging (MRI) of the cervical spine of the same patient suggests C4–C5 subluxation with significant cord compression at the same level.

unilateral or bilateral locked facets with associated injury to the interspinous ligaments, and teardrop fracture.

- Hyperextension injury occurs following sustained neck hyperextension following the event leading to injury. It can lead to fracture of the facets, lamina, and posterior subluxation following disruption of the anterior longitudinal ligament.
- Axial loading occurs when heavy weight falls over the head, causing axial loading on the cervical spine, leading to burst fracture and damage to all ligaments.[2]

The primary mechanisms causing bilateral facet locking include hyperflexion injury, axial loading, and anterior shear.[3]

In the first case, the patient, while doing a backflip, landed on his head, causing axial loading, following which his neck suffered sustained hyperflexion. Similarly, in our second case, the patient dived into the pool headfirst and his head hit the bottom of the pool, which caused axial loading, following which he suffered hyperflexion. Thus, in both cases, the mechanism of injury was axial loading with hyperflexion.

In 1996, Maroon and Bailes proposed a broad classification system for evaluating and managing athletes with cervical spine injury (CSI).[4]

- **Type I spinal injury:** This includes a spectrum of cord injuries ranging from immediate and complete paralysis

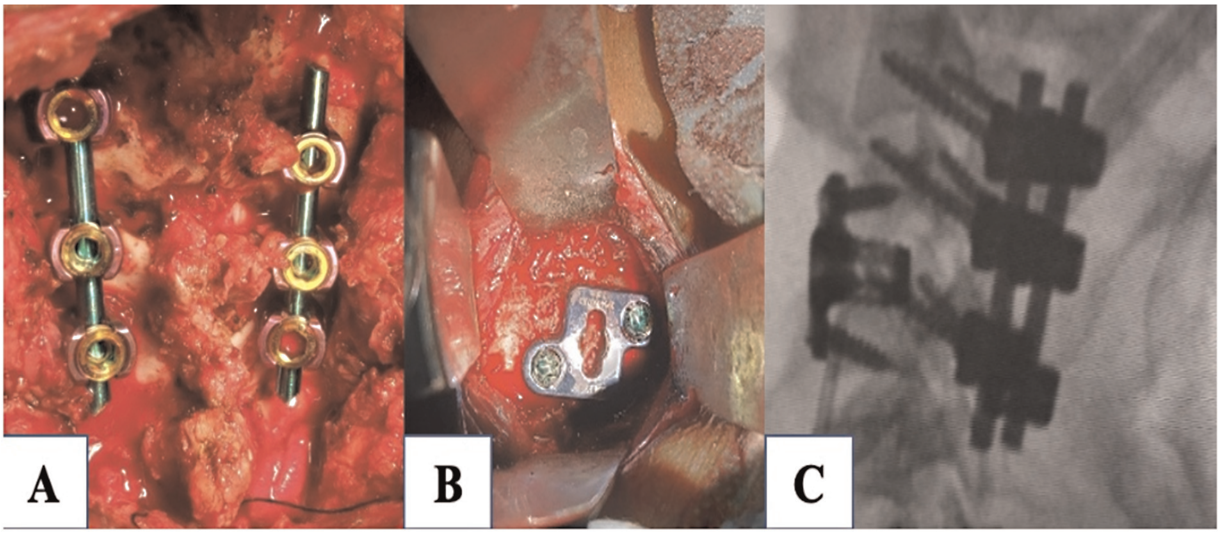

Fig. 4 (A) Intraoperative image showing posterior cervical fixation in the form of lateral mass instrumentation from C3 to C5. (B) Intraoperative image of the anterior approach showing anterior cervical diskectomy and fusion using a stand-alone cage and plate system. (C) Postoperative lateral X-ray of the cervical spine displays a circumferential stabilization of the involved cervical segments.

below the level of injury to various patterns of incomplete SCI.[4,5] Various radiographic abnormalities consistent with the neurological deficit are seen in this type of injury.[5]

- **Type II spinal injury:** These include injuries that are transient and radiographically occult.[5] Deficits can be either motor, sensory, or combined, lasting from seconds to hours. Obersteiner, in 1879, called it "spinal cord concussion," and it is a relatively common occurrence among collision sport athletes.[4,6–9] The pathophysiology of neuropraxic SCI is poorly understood; however, it is believed to be the result of compression of the spinal cord transiently between the posteroinferior vertebral body and the lamina of the level below when the cervical spine is hyperextended.[7,8,10] During stenosis, infolding of the ligamentum flavum during cervical extension causes further injury.[11] Most cases are resolved within 24 hours.[12]
- **Type III spinal injury:** This consists of cases with radiographic abnormalities without any neurological deficits.[4] Unstable fracture, stable spinal fracture, ligamentous injury, and acute intervertebral disk herniation are included in this category.[5] The significance of this type of injury is that it poses the risk of long-term neurological dysfunction and possible disability as it relates to spinal stability.

The ASIA Impairment Scale is a classification system used to assess and categorize the severity of SCIs, including those affecting the cervical spine. The ASIA Impairment Scale is divided into five grades (A–E), each representing a different level of neurological function. Here is an overview of the ASIA grades:

- **ASIA grade A (complete injury)** indicates a complete loss of sensory and motor function below the level of injury. Both motor and sensory functions are absent in the sacral segments (S4–S5).
- **ASIA grade B (incomplete injury):** Sensory function is preserved, but motor function is absent below the neurological level.
- **ASIA grade C (incomplete injury):** Motor function is preserved below the neurological level, and more than half of the key muscles below this level have a muscle grade less than 3.
- **ASIA grade D (incomplete injury):** Motor function is preserved below the neurological level, and at least half of the key muscles below this level have a muscle grade of $\geq$3.
- **ASIA grade E (normal):** Both sensory and motor functions are normal, and the individual has regained full function.

These ASIA grades help health care professionals and researchers communicate consistently about the extent of SCIs and their impact on a person's functional abilities.

Both cases in our report fall under type I SCI with complete SCI (ASIA grade A) with a defined radiological diagnosis. Incomplete type I SCI can have different SCI syndromes, usually based on vascular dysfunction.

- **Central cord syndrome:** This occurs due to hemorrhagic and ischemic injury to the corticospinal tracts, causing disproportionate loss of motor function affecting the upper extremity more than the lower extremity. The injury pattern is often seen in older patients with vertebral osteophytes and those with hyperextension injuries.
- **Anterior spinal cord syndrome:** It involves the anterior two-thirds of the spinal cord in the region of an anterior spinal artery, causing complete loss of all motor function below the level of injury, in addition to loss of sensation conveyed by the spinothalamic tracts (pain and temperature).

Table 1 Patient characteristic of the two cases

Sl. no.	Age (y)/sex	Event	Mechanism of injury	Presentation	Type of injury	Spinal injury syndrome	Surgery	Outcome
1	16/male	Backflip	Hyperflexion injury	Complete motor and sensory weakness below the C6 level, bladder and bowel incontinence	Type 1	Complete spinal cord injury	Traction followed by anterior fixation	Nonimprovement
2	20/male	Diving into pool	Hyperflexion injury	Complete motor and sensory loss below the C5 level. Bladder and bowel incontinence	Type 1	Complete spinal cord injury	Posterior followed by anterior instrumentation	Nonimprovement

- **Brown–Sequard syndrome:** Classically described as a hemi-section of the spinal cord with loss of ipsilateral motor function and contralateral spinothalamic (pain and temperature) modalities. This syndrome does not occur in an isolated form but as a combination with other types of incomplete injury.
- **Posterior spinal cord syndrome:** This is a rarely seen condition in which dorsal column function is lost with corticospinal and spinothalamic function preservation. It occurs due to selective ischemia in the distribution of the posterior spinal artery.
- **Burning hands syndrome:** This is characterized by burning dysesthesias and paresthesia in bilateral hands and is generally seen as a variant of central cord syndrome with selective injury to the central fibers of the spinothalamic tract. It occurs commonly in athletes who participate in contact sports.[12]

Following a CSI to the athlete, it is imperative that the head be immobilized. The best combination for head immobilization is a rigid cervical collar and supportive blocks on either side of the head with adhesive tapes across the forehead.[13] None of these recommendations were followed in either case in our study, and the patient's head was immobilized after reaching our center. This may have further aggravated the instability and injury. After transport to a definitive care hospital, the patient should be evaluated and methylprednisolone should be administered if it had not been previously administered. If the radiological diagnosis is suggestive of instability and SCI, the patient should be put on traction followed by surgical treatment. Both our patients were put on cervical traction followed by surgical fusion. In one of the patients, subluxation was reduced with traction, and he underwent only anterior fixation. In contrast, subluxation was not reduced with traction in other patients, and he underwent posterior and anterior fusion and fixation. Patients with minor fractures that are stable radiographically, as documented by flexion–extension films, and who do not have SCI are allowed to return to their normal activities of daily living. Athletes who are shown to have radiological evidence of instability in the form of a kyphotic angle greater than 11 degrees, translation of greater than 3.5 mm in an adult and greater than 4.5 mm in a child, evidence of a distraction injury, or presence of subaxial spine fractures with malalignment have an absolute contraindication for return to play.[5,14,15]

Conclusion

Sports-related CSIs occur primarily in young adults and, although infrequent, can have devastating neurological consequences. Understanding the mechanism and biomechanics of cervical injury can help physicians and surgeons in early management. Proper transport of athletes with cervical immobilization is imperative for the reduction of further aggravation of cervical injury. Early imaging using CT and MRI is helpful in the management of cases. Wherever indicated, dynamic imaging is used to identify any instability. Prompt management, including surgical intervention, wherever indicated, is advised. Our take-home message is “prevention is better than cure” with athletes being aware of these injuries and their mechanisms and ways to prevent them.

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Conflict of Interest
None declared.

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