

## Case Report

# Spinal cord injury in a 14-year-old male secondary to cervical hyperflexion with exercise

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**Study design:** Case report.

**Objectives:** To present an interesting case of a 14-year-old male with acute paresis of upper extremities and progressive difficulty with lower extremities. The patient is a competitive wrestler and was performing his daily abdominal workout ‘sit-ups’ with hands interlocked behind his head. During the end and immediately following his abdominal workout, he felt progressive weakness in his upper extremities. He was rushed to the hospital within an hour and seen in the emergency room and admitted to the neurology service for a presumed thromboembolic event.

**Setting:** New York, USA.

**Results:** The patient was negative for any hematologic disease or coagulopathy. Magnetic resonance imaging was negative for any mass effect on the spinal cord and neurological examination revealed bilateral upper extremity paraparesis 3/5 and lower extremity spasticity and proprioceptive dysfunction. The patient was treated with corticosteroids and rigid collar, follow-up examination at 3 months revealed resolution of symptoms.

**Discussion/Conclusion:** The pathophysiology of central cord syndrome is thought to be primarily secondary to a hyperextension injury, which causes buckling of the ligamentum flavum and increasing spinal cord diameter which leads to cord compression. This syndrome is more commonly seen in the spondylotic elderly. This case involves a teenager with normal canal diameter; however, combining aggressive exercise with extreme cervical hyperflexion, one can plausibly account for an acute ischemic event or repetitive microinjury to the spinal cord.

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## Introduction

Cervical spine injuries in teenagers is generally due to high-impact injuries with hyperextension or hyperflexion.<sup>1,2</sup> The cervical spine is predisposed for injuries at the C4–C6 levels due to the major levels of motion occurring at these levels.<sup>3</sup> The primary fulcrum for flexion and extension in the cervical spine occurs in the C4–C6 levels.<sup>3</sup> Injuries related to abdominal exercises have been reported secondary to the inevitable Valsalva maneuver that occurs with contraction of the abdominal muscles.<sup>4</sup> There are no reports of cervical spine ligamentous or spinal cord injuries (SCI) occurring during ‘sit-ups’. The pathophysiology and biomechanics of spinal cord and cervical spine injury occurring with

‘sit-ups’ and the appropriate form in performing sit-ups to prevent injury will be reviewed.

## Case report

A 14-year-old healthy male was presented with acute onset paresis of the upper extremities and gait difficulty. The patient admitted to performing abdominal exercises, ‘sit-ups’, as part of his daily workout for wrestling. During the end of his last few sit-ups, he felt tingling in his arms and shoulders, which progressed to 3/5 weakness within 10 min. He was brought to the emergency room within 1 h of symptom onset and admitted to some gait difficulty upon entering the emergency room. The neurology service was consulted and began intensive work-up for presumed vascular insult secondary to a hypercoagulable state. Plain

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radiographs and computed tomography scan were performed in the emergency room, which were normal (Figure 1). A magnetic resonance image of the cervical spine was performed within 24 h and revealed a normal spinal cord and no evidence of abnormalities (Figure 2). Neurosurgery was consulted on day 3 hospital admission and we immediately performed physician-supervised flexion/extension films of the cervical spine, which were also normal (Figure 3). Examination on day 3 was significant for 2/5 weakness in biceps and deltoids bilaterally with 3+/5 strength in remaining upper extremity muscle groups. Lower extremities were spastic (Ashworth 4) with difficulty in gait secondary to proprioceptive difficulties in the lower extremities with right worse than left and his ASIA score was 78. The patient was placed on Decadron (dexamethasone) 4 mg every 6 h with rapid taper over five days. The patient made significant improvement over the next 24 h with 3+/5 strength in biceps and deltoids and 4/5 in remaining upper extremities and gait improved. The patient was discharged on a rapid taper of Decadron, placed in a rigid collar, instructed not to participate in any physical activity for 3 months and return for repeat magnetic resonance imaging (MRI) in 3 months. A repeat MRI revealed no changes as compared to the initial MRI and the patient had returned to normal functional status.

### Discussion

Cervical spinal cord neuropraxia typically occurs in the elderly patient or athlete with predisposing spondylosis/stenosis.<sup>2,6-10</sup> Pediatric patients suffering SCI may have a congenital cervical spondylosis or craniovertebral anomaly.<sup>2,9,11</sup> Studies on cervical spinal cord neuropraxia in pediatric athletes have demonstrated that congenital stenosis is not common.<sup>1-3,11</sup> The biomechanics of cervical SCI in pediatrics has been postulated to be secondary to hypermobility.<sup>1,2,11</sup> We agree with this theory, our patient had a normal spinal canal diameter and did not demonstrate any instability on flexion-extension films. Interestingly, there is a case of flexion myelopathy in a 22-year-old patient with a 7-year history of 'flexion tics' of the neck, with about 40 tics per minute. Thorough radiographic examination revealed no spondylosis or degeneration but on dynamic MRI during flexion the patient had flattening of the spinal cord with dorsal compression, thought to be due to stretching of the spinal cord with subsequent compression by the dorsal dura.<sup>12</sup> MRI studies on juvenile flexion myelopathy revealed three possible mechanisms: (1) over-stretch of the spinal cord with hyperflexion, (2) dorsal compression by the dura, (3) arterial ischemia secondary to venous congestion during flexion.<sup>13</sup>

A brief discussion on the mechanism of injury is warranted based on the popularity of 'sit-ups' in the general population. Our patient was performing standard 'sit-ups', as performed by our own military services and numerous instructional exercise videos.<sup>14</sup> The



Figure 1 Lateral computed tomography scan of the cervical spine demonstrating normal canal diameter



Figure 2 Sagittal T1-weighted MRI demonstrating normal signal characteristics in the spinal cord without edema or hematomyelia



**Figure 3** Flexion and extension lateral radiographs demonstrating normal motion without subluxation or fracture

patient was lying supine with his fingers interlocked behind his occiput and feet flat on the ground. He attempted to touch his elbows to his knees, causing abdominal contraction but also inducing hyperflexion of the cervical spine. He performed two sets of 50 repetitions for 'sit-ups', experiencing neurological symptoms during his last set. Our patient had been performing these abdominal exercises for years without neurological sequelae. The patient admitted that he was fatiguing in his last set of 'sit-ups', which likely led to less abdominal contractions and a tendency to increase the use of the interlocked-hands behind the occiput to assist in the exercise, thus causing a hyperflexion of the cervical spine and likely inducing either repetitive microinjury to the spinal cord or ischemia. There are several reports of injuries occurring with 'sit-ups' including cervical spine fractures, cerebrovascular accident and a cervical spine epidural hematoma.<sup>5,15</sup> The numerous reports of SCI without radiographic abnormality (SCIWORA) in the pediatric population demonstrates the mobility within the spinal column in the young patient.<sup>1,3,16</sup> Of interest in this case would have been the utilization of dynamic MRI to reveal any occult instability, hypermobile segments or dorsal areas of compression.<sup>17</sup>

Owing to the popularity of abdominal exercises, in particular 'sit-ups', we would like to recommend an alteration to standard 'sit-ups' that involves crossing the arms over the chest rather than behind the head to prevent such injuries in the future. This report exemplifies the occult mobility of the premature cervical spine

which in most cases is a beneficial effect preventing the common fractures and injuries that occur in the adult population. However, in this instance the hypermobility was detrimental, allowing for repetitive microinjury to the cervical spinal cord. We hope that this report assists physicians that manage athletes and patients involved with exercise in emphasizing the importance of proper form and technique, as one can see even with the most common exercises, when done incorrectly, catastrophic injury can occur.

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