

# Central Cord Syndrome After Fall From Inversion Table

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## ABSTRACT

**Introduction:** Central cord syndrome, the most common incomplete traumatic spinal cord injury, often results in functional impairment with variable recovery.

**Case Presentation:** Central cord syndrome developed in a 64-year-old man during routine home use of an inversion table.

**Discussion:** The incidence of central cord syndrome, which occurs most frequently after a fall, is increasing among older persons. Age-related changes in the cervical spine may predispose the spinal cord to compression and injury during a fall. Evidence for lumbar traction as treatment of low back pain is limited.

**Conclusions:** This unusual case of spinal cord injury during inversion table use highlights the relationship between anatomical changes in the cervical spine and the mechanism of injury typical in central cord syndrome. The resulting increased risk of central cord syndrome for older adults should be discussed with patients in the context of activities that could lead to falls or cervical spine extension.

## INTRODUCTION

Billions of dollars are spent annually by individuals and insurance plans on treatment of low back pain.<sup>1</sup> Although noninvasive and accessible options such as home inversion tables are commonly used, falls and serious injuries can occur during inversion table use. In general, falls are a leading cause of death and morbidity among older persons.<sup>2</sup> Specifically, spinal cord injury (SCI) due to a fall is more likely in older persons, in part because of degenerative changes that commonly alter spinal anatomy.<sup>2</sup> Central cord syndrome (CCS), the most common incomplete traumatic SCI,

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can cause considerable functional impairment.<sup>2,3</sup> Weakness affecting the legs more than the arms and bladder dysfunction are typical in CCS.<sup>4</sup> Among older persons, CCS most frequently occurs because of a fall.<sup>3</sup> As patients seek relief from pain thought to result from degenerative spinal processes, they may be more predisposed to falls and SCIs because of these same degenerative processes.

We present a case of CCS resulting from an injury during use of a common home lumbar traction device. In general, evidence supporting the efficacy of lumbar traction is limited.<sup>5</sup> We discuss how the conversation about lumbar traction changes as patients age and related anatomical changes occur; we review how CCS can affect an individual; and we highlight the importance of CCS in the population as a whole. Our case emphasizes the importance of considering the added risk from age-related changes, especially with the use of therapy for low back pain that has limited evidence.

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## CASE PRESENTATION

A 64-year-old retired male construction worker with a history of chronic low back pain arrived at the emergency department by ambulance after an injury at home. His wife, who had not seen him for 2 or 3 hours, found him after he had partially fallen from his home inversion table. He was conscious when she found him, but he could not remember the event. He described neck pain and weakness in his arms and legs. He could not stand and was bleeding from a wound on the back of his head. Emergency medical services was activated. In the emergency department, the Glasgow Coma Scale score was 14 because of lack of spontaneous eye opening. Grip strength was graded 1/5 bilaterally. Elbow

**Figure 1.** Computed Tomography of the Neck



Sagittal view shows right-sided perched facets at C5-6 (arrow).

**Figure 2.** Magnetic Resonance Imaging of the Neck



T2-weighted image shows spinal cord edema (arrow).

flexion and extension were graded 4/5 bilaterally. Ankle dorsiflexion, knee extension, and hip flexion were graded 4/5 on the left. The right lower extremity was strong. Sensory examination was not done initially, but results were normal during his hospital course. Computed tomography of the cervical spine showed perched facets at C5-6 on the right with marked anterolisthesis and severe central canal stenosis from C4 through C7 (Figures 1 and 2). Magnetic resonance imaging showed cord edema at C5-6. The neurosurgery service was consulted, and decompression and fusion were performed.

In the days immediately after surgery, the patient's markedly impaired hand function was a primary concern. An indwelling catheter remained in place because of urinary retention, and he had episodes of bowel incontinence. Orthostasis was treated with an abdominal binder, elastic bandage wraps, and midodrine. He ambulated 50 meters with a front-wheeled walker and contact guard assistance. He was discharged to an acute inpatient rehabilitation unit, where over the next 11 days the indwelling urinary catheter was removed and volitional voiding returned. Upper extremity function improved. At his discharge, finger flexion and abduction strength had increased to 4/5 bilaterally, and he could ambulate unlimited distances independently without a cane or walker. Use of midodrine was tapered and discontinued. He returned home to his wife and daughter and continued therapy as an outpatient.

At his 1-month follow-up in the rehabilitation clinic, the patient had normal bowel and bladder function. On examination, he had 4/5 finger abduction bilaterally and 4/5 finger flexion on the left only. He could perform a body-weight squat, heel walk, and toe walk. He described improving neuropathic pain in his upper extremities and no longer required pain medication. Overall, he was encouraged by his functional gains and had already returned to many of his previous household activities.

## DISCUSSION

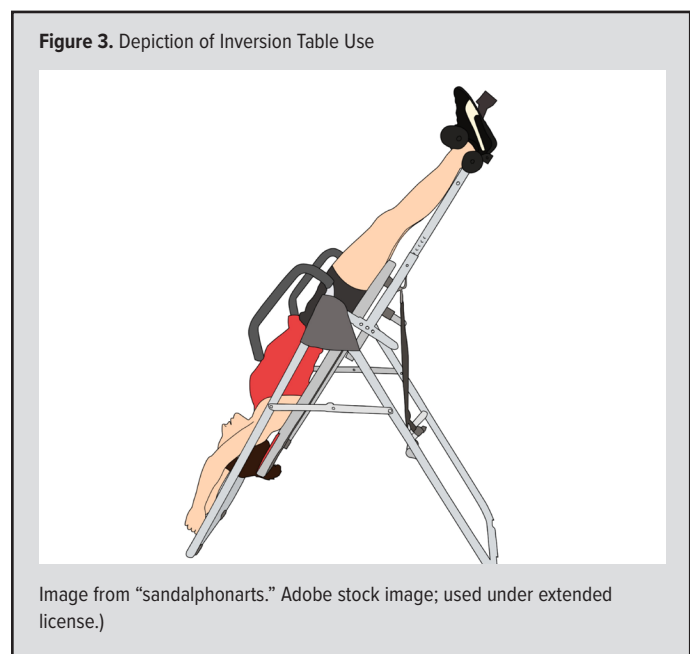
Low back pain is common, and the risks and benefits of the numerous treatments available for low back pain require ongoing discussion. The lifetime prevalence of low back pain is 75% to 84% in industrialized countries.<sup>1</sup> Patients and health plan providers spend billions of dollars annually on low back pain treatments with variable efficacy.<sup>4</sup> The independent use of devices to treat low back pain is commonly reported in our clinic and thought by many patients to be safe and effective. Lumbar traction has been used as a relatively inexpensive and noninvasive treatment option. Benefit theoretically results from decreased pressure on intervertebral discs and sensitized neural tissue.<sup>6</sup> Although patients often report therapeutic benefit, only limited evidence supports the effectiveness of lumbar traction for treatment of low back pain.<sup>5,6</sup> In a randomized controlled trial of 120 patients with low back pain, no benefit was observed between

those who received mechanical lumbar traction in addition to physical therapy and those who received physical therapy alone.<sup>7</sup> Specific patient subsets may be more likely to benefit from lumbar traction as an adjunctive treatment. A recent meta-analysis of the efficacy of mechanical traction for treatment of lumbar radiculopathy symptoms suggested possible short-term effectiveness of supine mechanical traction when used in combination with supervised physical therapy.<sup>5</sup> Adverse effects are infrequently described, although Thackeray et al<sup>7</sup> described aggravation of low back or leg pain in 44% of 61 patients who used lumbar traction. We could not find published articles that addressed the safety of lumbar traction devices specifically with older persons.

Lumbar traction can be applied in various ways. There is little if any standardization among health care professionals and individuals who use it. The type of device, method for securing oneself to the device, and duration of traction vary. Use of a home inversion table is perhaps the most common method of therapeutic lumbar traction for treatment of low back pain, and home inversion tables are readily available in retail stores and online. Inversion table therapy is often performed independently by securing one's feet to an adjustable platform and lying supine before using the device to gradually rotate into an inverted position and thereby exert traction on the lumbar spine. Typically, the body is positioned supine approximately 60 degrees below horizontal with the feet pointed upward and the head downward (Figure 3). The head is typically 3 to 6 inches above the ground. It has been theorized that when a person is in this position, some intervertebral separation occurs, relieving painful pressure on structures within the lumbar spine.<sup>6</sup> Relieving compressive forces on an intervertebral disc or spinal nerve is thought to lessen nociceptor activity, with the result that users of an inversion table may feel relief of low back pain.<sup>5</sup>

Medical literature specifically addressing the effectiveness of inversion table treatment is limited. In our review, we did not find discussions on the safe use of inversion tables. Injuries related to inversion table use have been reported but only sparingly. Jung et al<sup>8</sup> described 3 cases of cervical SCI during use of an inversion table in South Korea, where inversion tables are widely used and often are available in public spaces. In each of the 3 cases, the person's feet slipped from the inversion table harness and their head struck the ground. Of the 3 patients, 1 had a complete SCI and 2 had incomplete SCI; all 3 patients required decompression surgery and placement in long-term rehabilitation facilities.

The worldwide prevalence of traumatic SCI is bimodal, with 1 peak between the ages of 15 and 29 years and a second peak at ages older than 50 years.<sup>3</sup> The US often has the highest annual incidence of SCI among reporting countries and has an estimated 17 000 new cases annually.<sup>7,9,10</sup> CCS, which accounts for about 10% of SCIs in adults, also has a bimodal distribution.<sup>3,9</sup> In younger patients, CCS usually results from high-energy events (eg, motor vehicle accidents, assaults, and athletic injuries),



but among patients older than 60 years, falls are the most common cause of CCS.<sup>3</sup> As the mean age of the US population has increased, the number of SCIs and the mean age of injured persons have increased.<sup>9,10</sup> Degenerative changes and spinal stenosis, which become more common with older age, generally predispose older persons to spinal cord compression.<sup>4</sup> In cervical stenosis, less space is available to accommodate the spinal cord in the central canal, so the spinal cord is more vulnerable to compression, especially on hyperextension.<sup>4</sup> These changes in both spinal morphology and mechanics most likely account for the age-related variation in injury patterns and the increasing incidence of CCS in the US.<sup>2,4,6,9</sup> Most SCIs now occur in older patients.<sup>9</sup> As the US population ages, CCS could account for more than half the SCIs by the end of the century.<sup>9</sup> Safe and appropriate use of treatments, such as home inversion tables, is increasingly important for CCS prevention.

The clinical description of CCS has remained relatively consistent since it originally was delineated in the 1950s.<sup>4</sup> Arm weakness with comparative preservation of leg strength is pathognomonic.<sup>4</sup> Bladder dysfunction and urinary retention are common.<sup>4</sup> Sensory impairment below the level of injury is variable.<sup>4</sup> A simplified definition of CCS has been proposed that allows for the variability often observed in clinical presentations and includes patients who have any posttraumatic sensory or motor deficits localized to the cervical spinal cord.<sup>9</sup> Prognosis varies, but patients generally have marked improvement—particularly if they are young and the motor deficits are moderate.<sup>4</sup> For most patients, the American Spinal Injury Association motor score doubles after 1 year.<sup>4</sup> In a systematic review of 12 articles evaluating prognosis in traumatic CCS secondary to extension of a stenotic cervical spine, patients had excellent recovery of hand function with preserved lower extremity function at presenta-

tion.<sup>11</sup> This is similar to our patient's presentation, although we have found limited information specifically on inversion table injuries and their mechanism. Age and degree of SCI are important prognostic factors, and older patients who have a stenotic spinal canal stenosis have poorer outcomes.<sup>4</sup> Decompressive surgery may be required, particularly for fracture and dislocation.<sup>9</sup> Neuropathic pain and functional impairments may persist, negatively affecting independence—especially among patients older than 50 years.<sup>4</sup>

Historically, the presumed pathogenesis of CCS has been based on spinal cord anatomy and the somatotopic organization of the corticospinal tracts.<sup>9</sup> Mechanical compression is thought to injure the central spinal cord, preferentially disrupting the medial corticospinal tracts that control upper extremity function while sparing the more lateral corticospinal tracts that control the lower extremities.<sup>9</sup> Postmortem studies have identified selective damage to white matter in the area of the corticospinal tracts. However, the exact influence of corticospinal tracts on motor function and the specific location of neuronal injury in CCS are topics of debate.<sup>12</sup> Wallerian degeneration has occurred in patients with acute traumatic CCS without a decrease in the number of motor neurons supplying the hand musculature.<sup>12</sup> Rostral injury to the corticospinal tracts as they decussate in the brainstem also has been postulated.<sup>9</sup> Many conclusions about the details of corticospinal tract anatomy come from observations in nonhuman primates; only a few human postmortem studies are available. Some investigators believe that the evolution of human corticospinal tracts has resulted in an innately greater role in upper extremity function.<sup>9</sup> The considerable variability in CCS pathophysiology reflects many factors, including injury severity.<sup>9</sup> However, clinical diagnosis of CCS is dependent on the neurologic examination.<sup>9</sup>

Our patient is part of the growing segment of the population with higher risk for CCS. Portions of the case presented here are classic for CCS in presentation and in course. The patient was a retired manual laborer who most likely had preexisting cervical spondylosis and then had an injury resulting in arm weakness greater than leg weakness; impaired bowel and bladder function recovered within days. Perched facets on imaging suggest flexion and distraction of the cervical spine rather than hyperextension as the mechanism of injury classically thought to occur in most cases of CCS.<sup>13</sup> At follow-up 1 month after his injury, the patient had only slight hand weakness and mild neuropathic pain, despite severe injury. This is consistent with other reported cases of CCS in which surgical intervention targeting a specific pathologic site was done shortly after presentation.<sup>11</sup>

Our patient's inciting traumatic event occurred during independent use of a home inversion table for the treatment of chronic low back pain. This mechanism of injury may be underreported given the prevalence of both low back pain and this treatment modality. The evidence for the efficacy of lumbar traction for

relief of low back pain is minimal compared to the evidence for the efficacy of established treatments, such as therapeutic exercise. Information on how to safely use an inversion table is also limited. It may be helpful to ensure the safety of ankle-holding or harness mechanisms. Compared with independent use of an inversion table, the use of lumbar traction in a therapy office or with a spotter may decrease the risk of injury. Health care professionals must carefully consider a patient's specific risk factors when they consider options for treatment of low back pain.

## CONCLUSIONS

The balance between risk and benefit is important to consider with treatment of any condition, including low back pain. Commonly available home medical devices should be included in the discussion. Challenges specific to inversion table use include limited safety guidance and the usual practice of independent use. Our case shows the potential for SCI—especially for patients at higher risk—as an important consideration in discussions of inversion table treatment. Although the prognosis is usually favorable, CCS can lead to serious long-term functional impairments. An understanding of how age-related anatomical changes contribute to common mechanisms of injury in CCS allows for more informed discussions of the risks and benefits of certain treatments, including lumbar traction. For some patients, these discussions may lead to the determination that the risk of severe injury outweighs the perceived benefit of inversion table use—particularly given the paucity of evidence for lumbar traction as an effective treatment of low back pain and the availability of proven techniques, such as therapeutic exercise.

Trauma prevention is primary in averting SCIs at a societal level. Limiting the occurrence of traumatic events can help mitigate morbidity and maximize quality of life in the growing older population. Accordingly, we advocate careful consideration before use of home medical devices such as inversion tables.

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