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Review Article

Surgical management of posttraumatic thoracolumbar kyphosis

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Abstract

BACKGROUND CONTEXT: Spine trauma is relatively common, and each year approximately 10,000 to 17,000 people in the United States will sustain a spinal cord injury and approximately 150,000 to 160,000 will fracture their spinal column. Posttraumatic spinal deformity is a common potential complication of spinal injury and poses one of the greatest challenges in spinal surgery.
PURPOSE: To provide a comprehensive and current review of posttraumatic deformity focusing on the epidemiology, clinical and radiographical presentation, treatment options, and prognosis.
STUDY DESIGN/SETTING: A thorough review of the English literature on the management of posttraumatic deformity was performed. Pertinent articles were identified by using PubMed and a review of publications by the American Academy of Orthopaedic Surgeons.
METHODS: Each article was reviewed, and findings were analyzed to formulate a concise review of current treatment methods for posttraumatic deformity.
RESULTS: Successful treatment of posttraumatic deformity is dependent on careful patient selection and appropriate surgical intervention, which should be considered in the presence of significant or increasing deformity, increasing back and/or leg pain, ''breakdown'' at levels above or below the deformity, pseudarthrosis or malunion, and increasing neurological deficit. The goals of surgery should be to decompress the neural elements if neurological claudication or a neurological deficit is present, to recreate normal sagittal contours and balance, and to optimize the chances for successful fusion; these goals can be achieved through an all-anterior, all-posterior, or a combined anterior/posterior approach assuming that close attention is paid to using the appropriate bone-grafting techniques, selecting technically sound segmental instrumentation, and providing appropriate biomechanical environment for maintenance of correction and successful fusion.
CONCLUSIONS: Posttraumatic spinal deformity is a common complication of spinal injury, and it is therefore essential for patients with vertebral column injuries to have a careful initial evaluation, close follow-up, and early intervention when needed. Once posttraumatic deformity is present, successful outcome is achievable assuming a thorough, systematic, and technically well-executed surgical intervention is performed.

Keywords: Spinal deformity; Spine trauma; Posttraumatic deformity; Posttraumatic kyphosis; Sagittal imbalance

Introduction

Spine column injuries, whether associated with a neurological injury or not, can be devastating, especially when a spinal cord injury is present, and result in profound changes in quality of life. Consequences of such injuries can be seen both in the short and long term, especially if complications develop and lead to further deterioration in function and quality of life. Posttraumatic spinal deformity is one such potential complication and poses one of the greatest challenges in spinal surgery.

Epidemiology

Each year, approximately 10,000 to 17,000 people in the United States will sustain a spinal cord injury and

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approximately 150,000 to 160,000 will fracture their spinal column [1–3]. Lumbar spine injuries account for approximately 15% of these injuries [4–6]. As would be expected, most spinal column injuries are related to trauma [4,5]. The prevalence of these injuries is bimodal with an increased prevalence in people between 15 and 24 years of age and in people 50 years and older with an overall mean age of 33 years [1,3]. With advances in safety standards, improvements in emergency medical services, appropriate immobilization, and improved trauma care, the incidence of spinal cord and column injury and related mortality has been decreasing over the years [1,7]. Because more patients survive their injuries, a greater number are now faced with the long-term consequences of their spinal column fractures; posttraumatic spinal deformity is thus becoming more common, and, therefore, correct management of this problem is becoming ever more important.

Patient presentation

Posttraumatic spinal deformity most often presents after major trauma resulting in spinal column fracture(s); however, it can also present after minor trauma in patients in whom ''bone quality'' is diminished such as those with osteoporosis, ankylosing spondylitis, osteogenesis imperfecta tarda, and other endocrine or genetic disorders. Patients may present having undergone no treatment at all, after a trial of casting or bracing, or after surgical intervention. Regardless of the etiology of the posttraumatic deformity or the methods through which the initial injury was managed, the most common late complaints include one or more of the following: deformity in the sagittal and/or coronal plane, increasing pain, or an increasing neurologic deficit.

Posttraumatic spinal deformity

Posttraumatic spinal deformity is a common potential complication of spinal trauma, and its proper management depends on the thorough understanding of the normal sagittal and coronal alignment of the spine [7].

The thoracic, thoracolumbar, and lumbar segments of the spine each contribute to the overall sagittal alignment of the spine. The contribution of each segment is best assessed by measuring the amount of kyphosis or lordosis produced by the segment; by convention, kyphosis is a positive angle measurement and lordosis is a negative angle measurement. Although thoracic sagittal alignment is measured by convention from the upper end plate of T2 to the lower end plate of T12 because the upper thoracic spine is often difficult to visualize, thoracic kyphosis can also be measured from the upper end plate of T4 to the lower end plate of T12. Typically, thoracic kyphosis ranges from $+20^\circ$ to $+50^\circ$ of kyphosis with a mean of $+35^\circ$ in normal adults [8–10]. Middle and lower thoracic sagittal alignment are measured from the upper end plate of T5 to the lower end plate of T12 and normally range from $+10^\circ$ to $+40^\circ$ of kyphosis. The thoracolumbar junction (T12–L1) is the area of transition from kyphosis to lordosis and is usually straight [9]. The sagittal alignment in this transition zone is usually measured from the upper end plate of T10 to the lower end plate of L2 and should be in neutral to slightly lordotic alignment. Lumbar sagittal alignment is measured from the upper end plate of T12 to the end plate of S1; it normally ranges from -40° to -80° of lordosis with a mean of approximately -60° in normal individuals [8–10]. When the contour of the entire spine in the sagittal plane is examined more closely, kyphosis in the thoracic spine usually starts at T1–T2 (averaging $+1^\circ$ at that segment) and increases at each segment until the apex of the kyphosis is reached at T6–T7 where it measures approximately $+5^\circ$. The kyphosis at each level below the apex then gradually decreases until the thoracolumbar junction is reached and the spine becomes straight. Lumbar lordosis usually begins at L1–L2 (averaging -4°) and gradually increases at each level down to the sacrum with an apex at L3–L4 [9].

In addition to understanding the normal thoracic, thoracolumbar, and lumbar sagittal alignment, it is important to understand how these individual segments contribute to global sagittal alignment. In patients with normal sagittal alignment, the head should be positioned over the pelvis; in other words, a plumbline dropped from the center of the C7 vertebral body should pass over the posterior-superior corner of S1. If the C7 plumbline is anterior to the posterior-superior corner of S1, the patient is said to have a positive sagittal balance (ie, he/she is pitched forward), and if the C7 plumbline is posterior to the posterior-superior corner of S1, the patient is said to have a negative sagittal balance. In patients with normal coronal alignment, the head should also be positioned over the pelvis so that a plumbline dropped from the middle of the C7 vertebral body should pass over the center of the sacrum (ie, the C7 plumbline and the center sacral vertical line should be one and the same), even in patients older than 40 years of age [10]. Any of these parameters can be disrupted by a traumatic injury to the spine, but, typically, an injury to the spinal column results in increased thoracic, thoracolumbar, and/or lumbar kyphotic alignment and potentially a positive global sagittal balance (Figs. 1–3). Although without compensatory changes, an increase in thoracic, thoracolumbar, and/or lumbar kyphotic alignment would automatically lead to a more positive global sagittal balance, many patients with posttraumatic deformity have normal balance secondary to compensatory changes in alignment by levels above and/or below the deformity. Focal changes in sagittal alignment are most accurately assessed by measuring the angle between the superior and inferior end plates of the vertebral bodies cephalad and caudal to the injured level [11]. Measuring posttraumatic kyphosis of an individual fractured vertebra