

# Spinal Degeneration-Instability is the Cause and Stabilization is the Treatment

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**Abstract**

Spinal instability forms the basis of spinal degeneration. Muscle weakness related to their disuse, abuse or injury initiates and later propels the process of degeneration. All the known and so-called 'pathological' processes like osteophyte formation, disc space reduction, buckling of intervertebral ligaments are secondary processes and are possibly natural protective in nature and are reversible after spinal stability is restored. It is not compression or deformation of neural structures but it is segmental spinal instability that causes symptoms in spinal degeneration. Identification of unstable spinal segments and their stabilization and aiming for arthrodesis forms the basis of surgical treatment. Decompression of neural structures by resection of bones and soft tissues can have negative connotation in the treatment.

**Keywords:** Spinal degeneration; Osteophytes; Intervertebral disc; Spinal stabilization.

**Introduction**

Disc space reduction, disc degeneration and disc herniation has been implicated for decades as the initial event that propels the process of spinal degeneration. The general observation is that such degeneration is a result of 'old-age' related abnormalities or reduction in the 'water content' of the intervertebral discs. Disc space reduction, bulging of disc into the spinal canal, osteophyte formation, 'pseudofusion', buckling of intervertebral ligaments that includes posterior longitudinal ligaments and ligamentum flavum bulging are prominent components of the 'pathological complex' in spinal degeneration that result in spinal canal and neural foraminal size reduction and com-

pression of the neural structures. Such compression and neural deformation is relatively easily observed on MRI and CT scan. Surgical strategy for spinal degeneration has been focused on relieving the neural structures of the compression and on increasing the spinal canalicular and neural foraminal dimensions to make space for the nerves to travel a stretch free and compression-less course. Resection of indenting osteophytes or making space to facilitate accommodation of the bony or soft tissue intrusions forms the primary focus of surgical treatment. To achieve this purpose discectomy, corpectomy, laminectomy, laminoplasty and several such 'decompressive' maneuvers have been widely used. The indications of fixation following decompression vary but has not

been universally recommended or accepted. Most accepted indication for considering fixation is the possibility of delayed instability following single or multiple level bone manipulation or resection.

Our studies identified that weakness of muscles facilitating human standing position related to their disuse, abuse or injury forms the nodal point of genesis of degenerative spinal disease.<sup>1-7</sup> Muscle weakness and the related facet incompetence leads to 'vertical' spinal instability and telescoping of the spinal segments.<sup>1-7</sup> All the known and so called pathological features discussed in spinal degeneration are secondary to vertical spinal instability, have a naturally 'protective' role and have the potential to regress after spinal stability is restored.

### *Influence of radiological diagnosis*

The understanding of spinal degeneration developed on the basis of radiological information. For several decades' plain radiographs was the primary diagnostic modality. Reduction of the disc space was the main diagnostic feature of spinal degeneration. Identification of osteophytes, reduction in spinal canal dimension and altered spinal curvatures were the features that directed towards diagnosis and further treatment. As reduction in the disc space was the main radiological observation, the understanding of pathogenesis of spinal degeneration was focused on this issue. Reduction in the water content of the disc and consequent disc space reduction were considered to be primary issues that formed the basis of spinal degeneration and directed the surgical treatment strategy.

Introduction of the computer based investigations like computed tomography and magnetic resonance imaging altered the understanding of spinal degeneration. Neural compression and deformation by osteophytes, abnormal bone formation and pseudo-fusion, disc bulges and herniation and ligamentum flavum bulges and consequent reduction in the spinal canalicular and neural foraminal dimensions were vividly identified. Dural and neural 'compression' as a cause of symptoms and 'decompression' by resection of the offending factor is currently a standard of surgical treatment. The indications and need for simultaneous or delayed spinal fixation has continued to be debated.

### *Relevance of clinical information*

Before the advent of computer based imaging that clearly depicted the structural effects of spinal degeneration, diagnosis on the basis of clinical information and on the nature of presenting symptoms influenced the surgical strategy. Nature of pain and

extent of motor and sensory deficits directed the indication and type of surgery.

Essentially neural compression as depicted on imaging is correlated with the clinical information to design the treatment strategy.

### *Factor of spinal instability*

Our several recent articles discuss the relevance of 'muscle-weakness' related spinal instability as the nodal point of pathogenesis of spinal degeneration. 1-12 Weakness of the muscles that facilitate standing human posture related to their disuse, abuse or injury leads to 'vertical' spinal instability and telescoping of the spinal segments.

### *Anatomical subtleties*

Primarily the 'extensor' groups of muscles located on the posterior aspect of human torso facilitate standing human posture. A large majority of muscles that 'move' the spine are located on the posterior aspect of the bony spinal column. The muscles are pulleys and the fulcrum is at the facet articulation. Only thin and flat bands of muscles are located around the intervertebral discs. This fact suggests that a large majority of muscles do not act on or around the disc but focus their activities on the facet articulation.

The entire focus of spinal degeneration has traditionally been on intervertebral disc. Our earlier articles simulate disc to opera conductor who regulates the orchestra without holding any instrument in his/her hand. Disc is the 'brain' of spinal movements.<sup>13-15</sup>

### *Manifestations and Indicators of Spinal Instability*

The initial manifestation of vertical spinal instability is listhesis of inferior facet of the rostral vertebra over the superior facet of caudal vertebra.<sup>6</sup> Due to the subtleness of listhesis, lateral location of the facet articulation that is away from the neural structures, such facet listhesis may not be identified even on modern computer based imaging. Buckling of the intervertebral ligaments that include posterior longitudinal ligament and ligamentum flavum, reduction in disc space, bulging of disc in spinal canal, osteophyte formation, reduction in the spinal canal and neural foraminal dimensions are subsequent processes.

### *Facet distraction-arthrodesis*

In the year 2010, we introduced facet distraction arthrodesis as treatment for single and multiple segment cervical and lumbar radiculopathy/myelopathy.<sup>1-3</sup> We identified immediate post-operative relief

from all major symptoms. Unbuckling of intervertebral ligaments, increase in the intervertebral disc space and restoration of spinal canal and neural foraminal dimensions were observed in the immediate postoperative period. Identification of the levels of unstable spinal segments formed a major diagnostic issue. Instability of spinal segments is usually of more than a single spinal level and there may not be any direct radiological evidence of instability. Presence of osteophytes/reduction in the disc space, bulging of the discs into the spinal canal, bulging of the ligamentum flavum are indicators of spinal instability. Clinical indicators include the nature and level of radiculopathy and myelopathy. Direct visual assessment of unstable spinal segments both above and below the levels suspected on clinical and radiological guides and their stabilization forms the basis of treatment. Our recent studies have identified spontaneous reduction of osteophytes after stabilization of the spine.<sup>16</sup>

#### ***Atlantoaxial Instability and Subaxial Spinal Degeneration***

Atlantoaxial joint is the most mobile joint of the spine and is most likely to develop instability and spinal degeneration. We have recently introduced the concept of 'central' or 'axial' atlantoaxial instability.<sup>16,17</sup> It was observed that atlantoaxial instability can be present and there can be related symptoms even in the absence of any abnormal alteration in atlantodental interval, any evidence of abnormal spinal movements on dynamic imaging or any direct evidence of neural or dural compression. Identifying atlantoaxial instability and appropriately stabilizing the joint forms an important part of surgical treatment. On the other hand, ignoring atlantoaxial joint in the stabilization construct can be an important cause of surgical failure. Atlantoaxial instability is present in a large number of patients having multisegmental spinal degeneration and particularly in those patients who present with symptoms related to severe myelopathy.<sup>9,10</sup>

#### ***Ossification of Posterior Longitudinal Ligament (OPLL) and Cervical Myelopathy***

Our studies have identified that like osteophyte formation, OPLL is a manifestation of unstable spinal segment. Instability of the spinal segments initiates the process of abnormal ossification. Atlantoaxial instability is frequently associated with subaxial spinal instability in cases with OPLL. The pathogenesis of

both spinal degeneration and of OPLL is related to subtle and long-standing spinal instability.<sup>11,12</sup>

#### **Conclusions**

Essentially, our studies identify the validity of spinal stabilization and futility of any form of spinal decompression. Muscle weakness related instability of the spinal segments is the cause of spinal degeneration and correct identification of unstable spinal segments and their strong stabilization forms the basis of surgical treatment.

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