

Degenerative Spinal Disease: Evaluating the Role of Instability

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Short Communication

The subject of degeneration of spine has been under evaluation for over a century. A number of contributions from all over the world have laid a foundation for understanding of the pathogenesis and rationalising the treatment strategy. The biomechanical role of each spinal component is still under intense study. Advancement of the imaging technology has had a significant influence in the contemporary thought on the subject. Apart from understanding of philosophy of spinal degeneration, technological advances in investigations, surgical instrumentation and nature of implants have had an impact on the development.

The intervertebral discs were seen and analysed without being actually visualised on plain radiological images. The prominent space occupied by the disc as seen (or not seen) on plain radiology diverted the focus of evaluation towards the disc. Disc and its size alteration was identified relatively clearly making the entire understanding of the subject 'disc-centric'. Reduction of the disc water content and decrease in the height of the intervertebral space has been the basis of understanding of pathogenesis of the disc related spinal degeneration.

A number of features characterise spondylotic disease. Disc space reduction, osteophyte formation, ligamentum flavum hypertrophy and eventual reduction of spinal and root canal dimensions that result in symptoms of radiculopathy or myelopathy. In cervical spondylosis, facet arthropathy is included in the gamut of degenerative changes and is considered to be a secondary phenomenon to primary disc space reduction. In essence the definition of degenerative spondylosis is the secondary processes that result from primary disc degeneration, reduction of its water content and disc space reduction.

Advances in the MRI and CT scan technology now provide a clear image of the consequence of spinal degeneration. Compression of the neural structures by osteophytes and thickened ligaments are clearly visualised. Effect on the spinal cord is demonstrated by signal alterations. The stark evidence of spinal compression and the compressing elements and the reduction in spinal canal dimensions have now changed the focus of evaluation from the disc to the consequence of degeneration. As cord compression has been considered to be the primary sequelae of spinal degeneration, decompression of the spinal cord by anterior decompressive measures like corpectomy and discectomy and posterior decompressive measures like laminectomy and

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laminoplasty have been the prime focus of surgical treatment. The aim of decompression is to provide space for the spinal cord so that the intruders could be accommodated and tolerated. Osteophytes and hypertrophy of the ligamentum flavum and other intervertebral ligaments are considered to be the prime factors that result in cord compression and its related ill effects. The more modern treatment focuses on the osteophytes and thickened ligaments and the surgical procedure aims to resect these pathological entities.

The concept that disc degeneration or disc space reduction is not the primary issue in spondylotic spinal disease has a potential to influence the treatment strategies. The issue of instability has never been incorporated as the primary and nodal point of pathogenesis of spondylotic process. The need of treatment by stabilization arises as the surgical treatment by anterior or posterior decompression is considered to have a secondary destabilizing effect of the spine. Considering this possibility, decompression-fixation have been the preferred twin operations. Specialised distractor-spacer-fixator placed in the intervertebral space after wide removal of the disc partakes in the process of decompression and provides a background for arthrodesis. Posterior interlaminar and interspinous process spacers have also been popular options.

More recently, some authors prefer to introduce artificial disc with the aim of retaining the movements of the intervertebral joint after wide and appropriate decompression. The possible issues with movement preserving option over fusion-fixation option are currently a highly debated issue.

In the year 2010, Goel introduced an alternative concept regarding the pathogenesis of degenerative spondylotic disease [1-5]. This concept hypothesised that spinal instability is the primary pathogenetic issue in the initiation, progression and development of degenerative spinal disease. Instability is related to the weakness of the muscles of the nape of the neck and back [6,7]. The weakness can be related to injury, misuse or disuse of the muscles and lack of their proper care by appropriate and full use. The weakness of the muscles is also related to standing human position that lays long-term stress. The weakness of the paraspinal muscles and its related instability is manifested by its effects on facet overriding or listhesis. Even modern images do not show clearly the alignment and abnormalities of the facet joint. Due to oblique profile of the facets in the cervical and dorsal spine and a more vertical orientation in the lumbar spine the dislocation is not horizontal but vertical or oblique when observed from a profile view. The facets have a central role in the stability of the spine and is the fulcrum of all spinal movements [7,8]. The concentration of all major muscles of spine on its posterior perspective emphasizes this point. On the other hand, the intervertebral disc is the controller and director of the movements without active physical contribution. The disc, like the odontoid process, is the brain of all spinal movements, the brawn being the muscles that focus and concentrate its energies on the facets.

Goel speculated that the primary or the initiation point of spinal degeneration is the facet joint. This is the point of initiation and progression of pain and of the 'spondylotic' disease process. Facetal instability is of vertical nature and results in facet overriding or listhesis. The facet instability is manifested by reduction in the intervertebral spaces and buckling of the ligaments. This concept is in marked variation of the earlier hypothesis that suggested disc space reduction is the primary issue and rest of the consequences being secondary. From reduction of the anterior intervertebral space the concept now places focus on the overriding of the posterolaterally placed facets. Despite the fact that the issue is reduction of either anterior or posterior intervertebral spaces, the emphasis on instability has the potential of changing the focus of treatment from decompression to stabilization. The symptom of claudication pain related to lumbar canal stenosis also appears to be secondary to weak back muscles that give way after a period of walking. It seems that the muscles not only play a role in the movements of the spine but also participate in distraction of the intervertebral segments.

Facet distraction and arthrodesis as treatment of single or multiple level cervical radiculopathy and myelopathy and lumbar spine degeneration added a new dimension to the treatment and to the understanding of the process of spinal degeneration. Introduction of intra-articular interfacetal spacers reversed or had the potential of reversal of the entire spectrum of degenerative processes in the spine [1-4]. Distraction of the facets resulted in an immediate increase of dimensions of spinal canal and neural foramen and also increased the intervertebral distances that included an increase in the intervertebral height. Distraction resulted in stretch to the buckled ligamentum flavum and circumferential intervertebral ligaments that included the posterior longitudinal ligament. There is a potential of regression of osteophytes and restoration of disc fluid following facet distraction [9]. The fact that there is a reversal or potential of reversal of all known pathogenetic factors described in degenerative spinal disease

following a single act of facet distraction points towards the point of initiation of the process of degeneration.

The technique of facet distraction involves opening of the joint, denuding of the articular cartilage, introduction of bone chips within the articular cavity and impaction of Goel facet spacer. The adjoining posterior surfaces of the laminae of the spine are widely decorticated and bone graft harvested from the spinous processes or from the iliac crest is placed in the region and forms an additional ground for bone fusion and arthrodesis.

As we mature further in the understanding of spinal degeneration, we realise that spinal stabilization alone without distraction can be a rational form of treatment [10-14]. This understanding is based on realization that more than neural deformation or compression, it is repeated microtrauma or injury to the spinal cord related to instability that is the cause of symptoms of radiculopathy and myelopathy. Long term deformation or compression of the neural structures is well tolerated. This fact can be observed in cases with benign spinal tumors and syringomyelia that develop over long periods and the reduction in cord girth is surprisingly well tolerated by the patient. We resorted to transfacetal screw insertion in the affected spinal segments and identified this as a more effective, safe and rather simple surgical procedure [15]. Wide exposure can lead to identification of the weak or unstable facet joints. Real-time identification of unstable joints by direct inspection and their stabilization can lead to effective treatment of spinal instability.

The issue of atlantoaxial joint instability has generally not been considered along with instability at other spinal levels. Cervical spondylosis is usually considered to involve only the lower cervical vertebral levels and less commonly upper cervical levels. Atlantoaxial joint degeneration is seldom associated with cervical spondylosis. Atlantoaxial joint is the most mobile joint of the body. Special architecture of flat and round joint surfaces, rather than ball-socket or hinge-type articulation helps the joint to conduct its wide and circumferential movements and are least restrictive. Whilst this special structure of the joint assists in performance of movements, it also makes it more susceptible to instability. It seems that the instability of the atlantoaxial joint can be a primary or secondary association with degeneration or instability at the subaxial spinal levels [16-18]. Instability of the atlantoaxial joint can be identified by direct observation by manual handling of the bones during surgery or can be evaluated by radiological demonstration of facet malalignment in neutral spinal position. We have realised that ignoring atlantoaxial instability whilst treating subaxial instability can be a major cause of failure of treatment or a poor surgical outcome.

From decompression, the treatment is thus focussing on stabilization of the affected spinal segments [19,20]. The spinal bones are used for arthrodesis of segments and their removal is identified to be not necessary or counter-productive. It does seem that a ground has been laid for relegating surgery of spinal canal and foraminal decompression by laminectomy and corpectomy-discoidectomy into realm of history [21]. The era of only stabilization as treatment has arrived. Surgical processes that enhance the fixation and arthrodesis should be appropriately adopted in the treatment. It is important to identify the levels that need stabilization and atlantoaxial joint should not be ignored when treatment is planned and executed.

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