Beyond radiological imaging: Direct observation and manual physical evaluation of spinal instability

If the facts don't fit the theory, change the facts

- Albert Einstein

The science of spine surgery revolves around the identification of spinal instability and its subsequent treatment. However, both clinical and radiological guides for the identification of spinal instability are rather presumptive and arbitrary. It seems that the issue of spinal instability is underdiagnosed and undertreated as radiological imaging is not conclusively contributory and definite clinical diagnostic criteria are not laid down and uniformly agreed. Our clinical experience in the field suggests that spinal instability forms the nodal point of pathogenesis of number of spinal pathologies that include spinal degeneration and ossified posterior longitudinal ligament.[1-4] Understanding of the fact that instability is the causal or primary issue in a number of spine-related problems can lead to rational treatment.

Radiological evaluation of the spine was based on plain radiography for several decades. The large bulk of the vertebral bodies and the discs and their relatively clear identification on plain radiography have directed the focus of diagnosis of instability on the profile of vertebral bodies. Spinal instability is generally diagnosed radiologically on the basis of malalignment of the vertebral bodies.

Anterolisthesis, retrolisthesis, and spondyloptosis of vertebral bodies are the known radiological features that suggest spinal instability. Gross alterations of other spinal components are other evidences of instability. Introduction and developments in the computer-based imaging have allowed evaluation of spinal cord alterations and visualizing evidences of neural compression. However, identification of features that can suggest spinal segmental instability continues to be beyond the scope of modern imaging. Moreover, there are only limited criteria that suggest the presence of spinal instability.

All the available investigations focus on the larger and more visible vertebral bodies and the degenerated discs as the cause of spinal problems. The current available plethora of investigations just scratches the surface but fail to reveal what lies beneath.

The eyes will not appreciate what the mind does not know.

We recently speculated that the facets are the center of all spinal movements.[5-9] While the facets and the large related muscle mass in the posterior paraspinal region are the brawn of movements, the anteriorly located odontoid process and the intervertebral discs are the brain of movements.[10,11] Both discs and the odontoid process are like opera conductors that coordinate the entire orchestra without being directly involved in any movements by themselves. The standing human posture makes the extensor muscles of the spine a dominant force. While the extensor muscles are large and bulky and perform the active movements, the thin and weak flexor muscles have a more passive role in spinal movements. The large posteriorly located spinal muscles are attached to the spinous processes, laminae, and the transverse processes and act by pulling like strings and conduct movements that are centered on the facets. The understanding of the fact that spinal facets are the point of fulcrum of movements and also the center of instability can change the understanding of the subject and institution of appropriate treatment protocol.

Standing human position lays lifelong stresses on the extensor muscles of the spine. Weakness of the interspinous and paraspinous muscles related to their disuse, abuse, or misuse leads to vertical spinal instability that is manifested by listhesis of superior facet over the inferior facet. We first introduced the concept that it is not the disc degeneration

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or disc space reduction, but it is "vertical" spinal instability that is manifested by overriding of the facets that is the nodal point of pathogenesis of degenerative spinal disease.[2] We speculated that multisegmental vertical instability focused on the facets can also be the primary point of pathogenesis of Hirayama disease and spinal pathologic lesions such as ossified posterior longitudinal ligament.[3,12] On the basis of this understanding, we introduced the concept of facetal distraction and fixation or only facetal fixation as the primary mode of treatment of "degeneration" and other related spinal diseases.[4-9]

We recently discussed an alternative classification of atlantoaxial facetal instability that was based on alignment of the atlantoaxial facets.[13] Atlantoaxial facets are like rectangular blocks and have a brick-over-brick configuration. The alignment of the facets can be relatively easily identified on lateral profile imaging. We identified three types of atlantoaxial dislocation. In Type 1, the facet of atlas is dislocated anterior to the facet of axis. In this type of dislocation, the atlantodental interval increases and the odontoid process compresses over the dural tube and neural structures. In Type 2 atlantoaxial facetal dislocation, the facet of atlas is dislocated posterior to the facet of axis. In such form of dislocation, the atlantodental interval may or may not abnormally alter. In Type 3 atlantoaxial facetal dislocation, there is no facetal malalignment or abnormality of atlantodental interval. Instability in such cases is diagnosed on the basis of associated clinical and radiological parameters and is confirmed by direct and manual manipulations of the bones during surgery. The understanding of the fact that there can be atlantoaxial instability without any alteration in the atlantodental interval or neural compression and even when there is no facetal malalignment (central or axial atlantoaxial instability) has the potential to revolutionize the treatment of craniovertebral junction and even of the cervical spine. The treatment of Chiari malformation, syringomyelia, basilar invagination, cervical spondylosis, ossified posterior longitudinal ligament, and several such issues can be radically and rationally altered on the basis of evaluation of their relationship with instability of atlantoaxial joint.[14-21] The fact that atlantoaxial dislocation can be diagnosed on the basis of clinical parameters and direct observations during manual manipulations of the bones of the atlantoaxial region has expanded the scope of treatment of craniovertebral junction instability.

Atlantoaxial facets are rectangular and block like in lateral profile imaging and their malalignment can be relatively easily identified. On the other hand, subaxial facets are obliquely oriented in the cervical and dorsal spine and vertically oriented in the lumbar spine, and instability at the facets of the subaxial spine is difficult if not impossible to diagnose even on modern dynamic and high-resolution imaging.[22,23] Oblique orientation, lateral placement, and location away from neural structures make identification of instability at the facet joints and its related effects difficult. Indirect radiological evidences that can suggest the presence of vertical facetal instability include bulging of the intervertebral ligaments, namely, ligamentum flavum and posterior longitudinal ligaments and related osteophyte formation, reduction in the intervertebral disc space, and reduction in the spinal canal and neural canal dimensions, all classical features associated with description of "degenerative spinal disease."

Touch is the most basic sense and the most reliable. We begin to exercise this sense long before we are born and long before we learn to use sight, hearing or taste.

We identified that the most reliable and effective method of identification of facetal instability is by direct observation and manual manipulation of the bones of the region during surgery. Thin or absent articular capsule, presence of osteophytes in the periarticular bones, and demonstrable instability during handling of bones can determine the presence of instability. Experience in facetal handling can assist the surgeon in such a diagnosis. Instability can be present in multiple spinal segments even in the absence of any disc, bone, or ligamentous alterations. Real-time observations and diagnosis of instability can certainly enhance the scope of diagnosis of instability. Central atlantoaxial instability can be associated with multilevel spinal instability.[24] On the basis of clinical evaluation and on extent of neurological involvement, assisted by impressions from radiological imaging, one can make a reasonable impression on the number of spinal levels involved in instability and confirm them during surgery. Manual manipulations and identification of atlantoaxial and subaxial instability have the potential of revolutionizing the treatment of a number of craniovertebral junction and spinal ailments.

In the scientific method there is a clear distinction between facts, which can be observed and/or measured, and theories, which are scientists' explanations and interpretations of the facts.

In the words of Thomas Huxley, the greatest tragedy of science is the slaying of a beautiful hypothesis by an ugly fact. The ugly fact in question is the identification of facetal instability. Recognition of this has the potential of reversing management of degenerative spinal disease, with focus on the facet joints rather than the disc and vertebral bodies.

Understanding of the fact that there can be multilevel spinal instability even when there is no radiological demonstration opens up newer vistas in the treatment of spinal diseases. Direct visual assessment and manual manipulations on the basis of high degree of clinical, radiological, and operative experience can be a real-time evaluation of spinal instability. Identification of instability can lead to institution of correct treatment, selection of unstable spinal segments for treatment, and avoidance of events such as adjacent segment degeneration following spinal surgery.

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