Cervical Alignment

Virginie Lafage, MD

Significance of Spinal Alignment
- The spine allows the body to maintain upright posture and horizontal gaze
- Dubousset’s “conus” – ranges from the “cone of economy” (minimal exertion), to the “cone of maximum work” (upper limit of energy expenditure)

Radiographic Parameters

Cranio cervical
- In 1885, the Frankfurt horizontal line was the first cranio cervical radiographic parameter to be described
- The chin-brow vertical angle (CBVA) is an important parameter for understanding a patient's ability to maintain horizontal gaze

Cervical
- Cervical Lordosis (CL) Measurement Methods
  - Cobb angle – easiest to use, most reliable
  - Harrison posterior tangent – best estimate of CL
  - Jackson physiological stress lines

Cervicothoracic Junction
- Thoracic Inlet Angle (TIA) = T1 Slope (T1S) + Neck Tilt (NT)
  - analogous to Pelvic Incidence (PI) = Sacral Slope (SS) + Pelvic Tilt (PT)

Thoracic and Lumbar
- There exists known regional parameter chain of correlations, such that: PI ∝ Lumbar Lordosis (LL) ∝ Thoracic Kyphosis (TK) ∝ CL

Normal Cervical Alignment
- In asymptomatic normal volunteers mean CL is ~ 40°
- The C1-C2 articulation is responsible for the largest percentage of CL (75-80%)

Cervical Myelopathy in the Setting of Cervical Deformities

Pathophysiology
- The pathophysiology of CSM can be summarized as symptomatic compression of the spinal column by spondylotic changes
  - The insult to the column can occur by:
    - Direct compression from an offending structure
    - Indirect compression via vascular supply damage that then leads to cord dysfunction
- Spondylosis is defined as degenerative changes affecting the vertebrae, intervertebral disks, facets, and associated ligaments

Kyphosis
- Cervical kyphosis (CK) causes myelopathy secondary to compression of the anterior cord against the vertebral bodies

Sagittal Malalignment
- Sagittal malalignment is defined as anterior deviation of the C7 plumb line >5cm from the posterior superior corner of S1
- In 2012, Le Huec et al reported that more than a third of their asymptomatic normative cohort, presented with a kyphotic cervical spine, but without any complaints
  - Neither kyphosis nor spondylosis, necessitates myelopathy; as the relationship between imagining findings and pathology is complex
Villavicencio et al conducted a double blinded randomized controlled trial elucidating that improved cervical Cobb doesn’t correlate with clinical outcomes, but maintaining/improving segmental sagittal alignment does have significant implications for greater improvement in HRQOL scores.

One of the most important parameters that drives disability and captures kyphosis is the SVA:
- C2-C7 SVA is correlated to mJOA scores ($r = -0.282$)

**Dynamic Alignment**

- Brain et al demonstrated with myelogram studies, that a C5-6 disc protrusion causes cord compression in extension, and but not in flexion.
- Adams et al, in 1971, demonstrated the association between canal diameter and motion within the canal:
  - Unstable segments have narrow canals.
- Dynamic elements can magnify static components of canal deformation, through ligamentous and osseous pathology.
- During cervical motion, the spinal cord is injured by osteophytic bars and discal protrusion.
- With flexion, the spinal cord is draped over the vertebral bodies and can be compressed against osteophytic spurs and protruding disks.
- During extension, the ligamentum flavum (or laminae) bulges inward, pinching the cord posteriorly against the posterior margin of the vertebral body, ultimately causing a posterior stenosis.
- One of the pathways in which these dynamic factors lead to myelopathy is through reducing cord space and microvascular compromise.
  - The accumulation of static and dynamic degenerative changes, reduces canal diameter and the overall the sagittal mobility of the spine.
- Biomechanical and motion-related factors may transiently compress the spinal cord, nerve roots, and their vascular supply.
- The cervicothoracic junction (CTJ) has been implicated in driving myelopathy on a dynamic basis.
- Bony destruction due to neoplasm or trauma, or surgical decompression at this location, can result in major concern for spinal instability.

**Focal Alignment**

- A more posterior center of rotation (COR), anterior to posterior along a cervical vertebral body, correlates with worse SF-36 scores.
- Studies of focal alignment have shed light on the possible link between the pathophysiology of cord lengthening and tension, and myelopathy severity.
- The number of vertebral levels involved in CSM has been correlated with severity.
- Sagittal slip (spondylolisthesis) increases the degree of narrowing in the cervical canal.
- Minimizing kyphosis and improving sagittal alignment are well recognized objectives of surgical planning.
- Special attention must be paid to areas in the cervical spine that are prone to instability such as the cervicothoracic junction, in order to adequately treat CSM and avoid unwanted side effects of surgical intervention.

**Surgical Planning**

- The initial step in surgical planning is obtaining preoperative 3-ft standing radiographs to provide adequate visualization, from the external auditory canal (center of mass of the head) to the femoral heads.
- Next, the radiographic parameters discussed above should be appropriately.
measured
  o There are several software planning tools that aid the surgeon in incorporating these radiographic parameters into surgical planning

- After measuring the appropriate radiographic parameters, the surgeon must determine what the goals are, in terms of restoring these parameters to normal levels
  o Protopsaltis et al stated that cervical alignment parameters are critical during surgical planning for cervical deformity correction
    - CBVA, T1 slope, C2 SVA, and regional CL should be considered in planning strategies
- Despite these successful results, the precise relationship between correcting alignment and myelopathy severity is not fully understood