Assessment and Treatment of Cervical Deformity

Justin K. Scheer, BS[a], Christopher P. Ames, MD[b],
Vedat Deviren, MD[c,*]

KEYWORDS

• Cervical deformity • Cervical spine osteotomy • Cervical alignment • Pedicle subtraction osteotomy

KEY POINTS

- The significant mass of the head is supported by the cervical spine, and significant deviation from normal alignment increases cantilever loads and muscular activity. In addition, the flexible, mobile cervical segment is connected to the relatively fixed thoracic spine.
- The T1 inclination will determine the amount of subaxial lordosis required to maintain the center of gravity of the head in a balanced position and will vary depending on global spinal alignment as measured by the sagittal vertical axis (SVA) and by inherent upper thoracic kyphosis.
- The radiographic parameters that effect health-related quality of life scores are not well defined in comparison with global/pelvic parameters in thoracolumbar deformity. Chin-brow vertical angle, cervical SVA (C2 SVA), and regional cervical lordosis should all be considered in preoperative planning strategies involving standing 3-ft radiographs in which the external auditory canal (approximation of head center of mass) to femoral heads are visible.
- At the craniocervical junction, an anterior approach with initial anterior linear osteotomy, posterior release and reduction of facet-joint subluxation, and segmental stabilization may be used. A SmithPetersen osteotomy, a pedicle subtraction osteotomy, or a circumferential osteotomy may be used at the mid cervical to cervicothoracic junction to achieve the desired correction.
- Intraoperative imaging guidance systems and intraoperative neuromonitoring can help prevent complications related to the osteotomy. Furthermore, all-posterior approaches may reduce, but do not eliminate, swallowing dysfunction.
- 360 and 540 techniques are best for restoring mid subaxial lordosis while C7 pedicle subtraction osteotomy is best for correction of cervical sagittal imbalance.

INTRODUCTION

The cervical spine is complex, supports the mass of the head, and also allows the widest range of motion relative to the rest of the spine.[1–5] Because of this complexity, the cervical region is susceptible to a variety of disorders and complications, which may lead to malalignment causing significant deformity that may warrant surgical consideration. Abnormalities of the cervical spine can be very debilitating and can induce adverse effects on the overall functioning and health-related quality of life (HRQoL) of the patient.

Indications for surgery to correct cervical malalignment are not well defined and there is no set

Disclosures: None.

[a] University of California, San Diego School of Medicine, 9500 Gilman Drive, La Jolla, CA 92093, USA; [b] Department of Neurosurgery, University of California, San Francisco, Medical Center, 400 Parnassus Avenue, A850, San Francisco, CA 94143, USA; [c] Department of Orthopaedic Surgery, University of California, San Francisco, Medical Center, 400 Parnassus Avenue, San Francisco, CA 94143, USA
* Corresponding author.
E-mail address: devirenv@orthosurg.ucsf.edu

Neurosurg Clin N Am 24 (2013) 249–274
http://dx.doi.org/10.1016/j.nec.2012.12.010

standard to address the amount of correction to be achieved. Furthermore, classifications of cervical deformity have yet to be fully established, and treatment options defined and clarified. Therefore, this article focuses on normal cervical parameters, deformity evaluation and examination, and treatment options for the proper management of cervical deformity.

NORMAL CERVICAL ALIGNMENT

The cervical spine is primarily responsible for the location of the head over the body as well as the level of horizontal gaze. The center of mass of the head in the sagittal plane directly overlies the occipital condyle approximately 1 cm above and anterior to the external auditory canal (**Fig. 1**),[6] and any deviations from the normal alignment of the mass of the head result in an increase in cantilever loads, which subsequently induces an increase in muscular energy expenditure. The weight of the head is borne through the condyle to the lateral masses of C1 and then to the C1-C2 joint. This load is then divided via the C2 articular pillars into the anterior column and C2-C3 disc, and posterior column and C2-C3 facet.[7] The load distribution of the cervical spine is primarily in the posterior columns, with 36% in the anterior column and 64% in the 2 posterior columns,[7] in contrast to the lumbar spine where the anterior loads (67%–82%) have been reported as higher than the posterior loads (18%–33%).[8,9] The natural curvature of the cervical spine maintains a lordotic shape[10] as a result of the wedge-shaped cervical vertebrae and the need to compensate for the kyphotic curvature of the thoracic spine.[10] This thoracic kyphosis permits expanded lung volumes in the normal range and has been shown to increase with age. The caudal end of the lordotic cervical spine joins the rigid kyphotic thoracic inlet at the cervicothoracic junction (CTJ). Deviations from this curvature, such as a loss of lordosis or the development of cervical kyphosis, are associated with pain and disability.[1,10–13]

Because the cervical spine is the most mobile part of the spinal column, a wide range of normal alignment has been described (**Table 1**).[1,12,14,15]

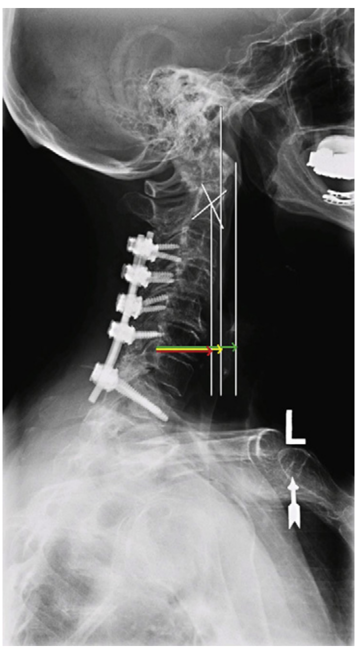

Fig. 1. Technique used to measure cervical sagittal vertical axis (SVA). The green arrow represents C1-C7 SVA (distance between plumb line dropped from anterior tubercle of C1 and posterior superior corner of C7), the red arrow represents C2-C7 SVA (distance between plumb line dropped from centroid of C2 and posterior superior corner of C7), and the yellow arrow represents center of gravity–C7 SVA (distance between plumb line dropped from anterior margin of external auditory canal and posterior superior corner of C7).

Table 1
Normal cervical spinal values in asymptomatic adults from the literature

Segmental Cervical Angles[1]

Level	Angle (°)
C0-C1	2.1 ± 5.0
C1-C2	−32.2 ± 7.0
C2-C3	−1.9 ± 5.2
C3-C4	−1.5 ± 5.0
C4-C5	−0.6 ± 4.4
C5-C6	−1.1 ± 5.1
C6-C7	−4.5 ± 4.3
C2-C7	−9.6
Total (C1-C7)	−41.8

Cervical Sagittal Vertical Axis[1]

Odontoid marker at C7	15.6 ± 11.2 mm
Odontoid marker at sacrum	13.2 ± 29.5 mm

C2-C7 Lordosis[14]

Age Group (y)	Men (°)	Women (°)
20–25	16 ± 16	15 ± 10
30–35	21 ± 14	16 ± 16
40–45	27 ± 14	23 ± 17
50–55	22 ± 15	25 ± 11
60–65	22 ± 13	25 ± 16

Values are presented as the mean ± standard deviation, and the negative sign indicates lordosis in the segmental values.