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Commentary

Surgical Management of Cervical Disc Arthroplasty

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The vast majority of radiculopathy and myelopathy in the cervical spine occurs as a result of spondylosis and degenerative disc disease. For years, anterior cervical discectomy and fusion (ACDF) has been the gold standard treatment for symptomatic cervical disease. The ACDF procedure is a reliable method for achieving wide neural decompression, spinal stabilization, and excellent clinical outcomes.[1] Unfortunately, the elimination of motion through fusion may lead to increased stress across adjacent disc spaces, thereby contributing to adjacent segment pathology.[2,3]

Theoretically, continued motion at the disc space may decrease the stress at adjacent levels, as compared with a fusion, and consequently reduce iatrogenic adjacent segment degeneration. Over the past decade, cervical disc arthroplasty (CDA) has become increasingly regarded as an acceptable surgical treatment for cervical radiculopathy and retrodiscal myelopathy. CDA was developed to preserve subaxial cervical spine biomechanics and natural segmental motion without fusion. The hope was to avoid the complications of nonunion and accelerated adjacent segment pathology associated with ACDF.

Cervical kinematics encompasses both the quantity and quality of cervical range of motion (ROM). Normal ROM of the cervical spine in flexion/extension, lateral bending, and axial rotation is 68° to 76° (range 24°-114°), 45° (range 22°-81°), and 139° to 145° (range 80°-200°), respectively.[4] Cervical spine motion decreases linearly with age in all 3 planes, with extension showing the largest loss. CDA implants attempt to maintain segmental cervical motion with the various prostheses capable of 15° to 20° of flexion-extension, 7° to 10° of lateral bending, and 20° to 360° of rotation.

The center of rotation (COR) about each disc space of the subaxial cervical spine is defined by several parameters. Traditionally, the COR axis is referenced at the midline of the superior end plate of the subjacent vertebral body in the sagittal plane.[5] Braakman et al[6] described the axis of C2 to be in the posterocaudal body of C3 but as one progresses further down the subaxial spine the axis travels cranially and anteriorly. With this in mind, the axis of C6 is found centrally in the upper end-plate of C7. Motion about the cervical spine is coupled. Flexion is closely associated with anterior translation, and axial rotation occurs concurrently with lateral bending.[4] With respect to both lateral bending and rotation, the center of rotation is located in the anterior portion of the body of the moving vertebra and in the sagittal plane.[1] Ishii et al[7] utilized cervical spine magnetic resonance images in 10 healthy volunteers to demonstrate motion coupling between axial rotation with lateral bending and flexion-extension in the subaxial spine.[7] When the superior cervical vertebra rotates to the left, the left inferior articular process translates anteriorly and cranially on the superior process of the lower vertebra while the contralateral inferior articular process translates posteriorly and caudally resulting in lateral bending to the side of rotation. The identical process occurs with contralateral cervical rotation. Anderst et al[8] described the instant center of rotation (ICR), which accounts for the change in location of the center of rotation about each cervical segment as dynamic motion occurs about the cervical spine.

Progressing caudally, the ICR location moves superiorly during flexion and extension, and the anterior-posterior change in ICR location decreases at each successive motion segment. Various CDA implants attempt to mimic this coupling and reapproximate the native motion of the cervical spine.[9,10]

On introduction to the market, the indications for CDA were stringent: single-level, myelopathic, or radiculopathic cervical disease between C3 and C7 in a symptomatic patient after failing 6 weeks of conservative management . Osteoporosis, significant kyphosis, instability, greater than 50% loss of disc height, facet arthropathy, ossification of the posterior longitudinal ligament, inflammatory arthropathy, and multilevel disease were exclusion criteria in the initial prospective randomized controlled trial investigational device exemption (IDE) studies. Within this specific patient population, there is quite a large body of literature supporting the use of CDA over discectomy and fusion. A recent Cochrane review found that, although small in magnitude, results are consistently and statistically in favor of arthroplasty in single level disease, with regard to arm pain, neck pain, neck-related function, and global health status.[11] At 7-year follow-up of the prospective randomized US Food and Drug Administration (FDA) IDE Study of ProDisc-C total disc replacement, there were more than 400% more revision procedures in the ACDF group compared with the CDA group (P = .0099).[12] Furthermore, ProDisc-C disc replacement resulted in mean savings of $12 789 and quality-adjusted life year (QALY) gains of 0.16 compared with ACDF over this same 7-year period.[13]

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