Cervicothoracic junction

The cervicothoracic junction (CTJ) represents a unique region in the spine because of its biomechanical properties.

The thoracic inlet (TI) forms the cervicothoracic junction, which is a fixed bony circle composed of the structures of the first ribs on both sides, T1 vertebral body, and the upper part of the sternum; while the TI consists of 3 important sagittal parameters: thoracic inlet angle (TIA), T1 slope, and neck tilt [1].

It is the transitional region between the cervical and thoracic sections of the spinal axis. Because it is a transitional zone between the mobile lordotic cervical and rigid kyphotic thoracic spines, the CTJ is a region of potential instability. This potential for instability may be exaggerated by surgical intervention.

It is predisposed to various traumatic injuries, tumor. It is also a difficult region to access anteriorly because of the vital structures ventral to the CTJ. The development of new surgical techniques and new instrumentation has allowed better access and fixation to the CTJ [2].

The complex anatomy of the cervicothoracic junction region makes a reliable assessment of plain radiographs in lateral projection difficult or even impossible, which may result in failure to detect fracture or other pathology in this region of the spine.

Surgery

Direct ventral access to the cervicothoracic spine (C7-T4) poses a technical challenge in spine surgery, given the vital neurovascular structures residing anterior to the cervicothoracic junction (CTJ). The transsternal approach is a feasible surgical option that allows for direct anterior exposure of the lower cervical and upper thoracic vertebrae.

Posterior plate or rod and screw fixation is a good method of treatment for cervicothoracic instability in spine tumors. Facet screw fixation in the cervical spine with Roy-Camille drilling technique and transpedicular screw fixation in the thoracic spine provides an efficacious means by which to stabilize the cervicothoracic junction. This stabilization technique was effective even in cases of high postoperative instability, such as with partial or total vertebrectomy. This screw-type stabilization is clinically effective and well documented. The evolution through 3 different systems reflects our attempts to improve accuracy in light of variable facet and pedicle interspaces. Importantly, posterior instrumentation will not interfere with subsequent laminectomy or more extreme surgical procedures [3].

Case series

2016

Between January 2009 and September 2013, posterior cervicothoracic spine fusion cases were identified from a large spine registry (Kaiser Permanente). Demographics, diagnoses, operative times, lengths of stay, and reoperations were extracted from the registry. Reoperations for symptomatic nonunions were adjudicated via chart review. Logistic regression was used to estimate odds ratios and 95% confidence intervals. Kaplan-Meier curves for the non-bone morphogenetic protein (BMP) and BMP groups were generated and compared using the log-rank test.

In this cohort there were 450 patients (32.7% with BMP) with a median follow-up of 1.4 years (interquartile range [IQR] 0.5-2.7 years). Kaplan-Meier curves showed no significant difference in reoperation rates for nonunions using the log-rank test ($p = 0.088$). In a subset of patients with more than 1 year of follow-up, 260 patients were identified (43.1% with BMP) with a median follow-up duration of 2.4 years (IQR 1.6-3.3 years). There was no statistically significant difference in the symptomatic operative nonunion rates for posterior cervicothoracic fusions with and without BMP (0.0% vs 2.7%, respectively; $p = 0.137$) for more than 1 year of follow-up.

This study presents the largest series of patients using BMP in posterior cervicothoracic spine fusions. Reoperation rates for symptomatic nonunions with more than 1 year of follow-up were 0% with BMP and 2.7% without BMP. No statistically significant difference in the reoperation rates for symptomatic nonunions with or without BMP was found. [4].

2006

A retrospective review of all patients who underwent surgery involving the CTJ in the Department of Neurosurgery at the Cleveland Clinic Foundation during a 5-year period was performed. The CTJ was strictly defined as encompassing the C-7 vertebra and C7-T1 disc interspace. Patients were examined after surgery to determine if treatment had failed. Failure was defined as construct failure, deformity (progression or de novo), or instability. Variables possibly associated with treatment failure were analyzed. Statistical comparisons were performed using the Fisher exact test. Between January 1998 and November 2003, 593 CTJ operations were performed. Treatment failed in 14 patients. Of all variables studied, failure was statistically associated with laminectomy and multilevel ventral corpectomies with fusion across the CTJ. Other factors statistically associated with treatment failure included histories of cervical surgery, tobacco use, and surgery for the correction of deformity.

The CTJ is a vulnerable region, and this vulnerability is exacerbated by surgery. Results of the present study indicate that laminectomy across the CTJ should be supplemented with instrumentation (and fusion). Multilevel ventral corpectomies across the CTJ should also be supplemented with dorsal instrumentation. Supplemental instrumentation should be considered for patients who have undergone prior cervical surgery, have a history of tobacco use, or are undergoing surgery for deformity correction [5].

2005

During the period from November 2001 to June 2004, 34 patients with disorders of the C7-T3 region were treated surgically at the Department of Spinal Surgery, Motol Teaching Hospital, which accounted for 2.1% of the 1537 patients treated for spinal diseases in this period. Instability of the cervicothoracic junction was caused by tumors in 15 and by injury in 14 patients. Other diagnoses

included deformity associated with rheumatoid arthritis (RA) in two patients, spondylodiscitis in one, and hemivertebral deformity at C7 and T1, each in one patient. The group included 16 women and 18 men between 8 and 75 years, with the mean of 52.3 years (after excluding the two children with hemivertebral deformity aged 8 and 9 years, respectively). The trauma subgroup had a significantly lower mean age (43.6 years) than the tumor subgroup (59.9 years).

We placed the patients in three groups according to the etiology of cervicothoracic junction disorder, namely, 1. tumors and spondylodiscitis; 2. injuries; 3. others. Group 1 included 16 patients, 15 with tumors and one with spondylodiscitis. Two patients were treated by dorsal stabilization, one by ventral stabilization and the rest underwent combined surgery. Of 14 patients in group 2, three were treated from the posterior approach, six from the anterior approach and five by the combined approach. All group 3 patients underwent surgery from the posterior approach, with two patients being treated without instrumentation. RESULTS:

Of the 34 patients, only 33 were included; one was lost to follow-up soon after the operation. In group 1, no excellent, five very good, five satisfactory and two unsatisfactory outcomes were recorded. No intraoperative complications such as injury to the major vessels or nerve structures occurred; in one patient, profuse bleeding from arteries supplying a metastatic tumor had to be arrested. Late complications included loosening of the dorsal instrumentation in two patients, who required repeat operations. In group 2, there were six excellent, four good, two satisfactory and one poor outcomes. Late complications in one patient included loosening of the ventral instrumentation, followed by repeat surgery. Group 3 showed two excellent and two satisfactory outcomes; the latter were in the RA patients. Late complications involved one loosening of the dorsal instrumentation requiring repeat surgery. No injury to the major vessels or nerve structures was recorded in either group 2 or group 3. No deep infection was recorded in any of the three groups.

The results of our evaluation are in agreement with those of other authors and, similarly to them, we had to deal with the difficult issues of diagnosis. Currently, we prefer, in addition to conventional X-ray examination, CT scans including sagittal and frontal reconstruction, recently completed with magnetic resonance imaging, in all patients with cervicothoracic junction disorders. This policy allows us to avoid delays in making correct diagnosis and to provide conditions for effective treatment. In stabilization from the posterior approach we use rod-screw fixation that, in the majority of cases, is not combined with thoracic fixation. Previously, we have inserted screws in the articular processes at the C7 level, but now we prefer transpedicular fixation. Complicated anterior surgical procedures, such as complete or partial sternotomy, are always performed with the assistance of a thoracic surgeon. A noticeably high number of patients with neurological deficit was seen also in our group. Postoperative care is always provided in cooperation with the spinal unit of our hospital. Intensive inter-disciplinary cooperation has an important role in that our patients have a minimum of complications in comparison with the literature data.

Injuries and diseases of the spine at the cervicothoracic junction present a complex issue with a high potential for mistakes and complications. The principle of success lies in a high-quality X-ray examination, CT scans with sagittal and frontal reconstruction, and magnetic resonance imaging of the region affected. The complex anatomy of that region requires demanding surgical procedures, which can be performed only by a highly qualified and specialized team with appropriate facilities [6)].

Case reports

Le et al., report a case of an elderly gentleman with upper thoracic (T1-2) vertebral osteomyelitis and epidural abscess who underwent a transsternal full median sternotomy for ventral decompression and

fusion of C7-T2. They also detail our operative procedure and review relevant literature on different transsternal approaches to the CTJ [7].

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