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SAGITTAL PLANE CORRECTION IN FIXED CERVICAL DEFORMITY

Sagittal Plane Correction in Fixed Cervical Deformity

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Abstract

Background Data: Fixed cervical deformities are devastating pathological entities that interfere with normal daily activities and may progress to leave patients bedbound.

Purpose: To present early experience and outcome of managing fixed cervical deformities, and to explore the safety and efficacy of the methods used.

Study Design: A retrospective clinical case series that tracks subjects with fixed cervical deformities as regard presentation, treatment and outcome.

Patients and Methods: Patient sample included those presented with kyphotic segmental deformities causing regional angular and translational deformities with presenting clinical picture related to the deformity. The patients were corrected by either anterior-only or combined approached, with assessment of outcome using radiological sagittal plane profile, neurological improvement (Nurick classification) and overall work capacity (Odom's criteria).

Results: Eleven patients (78.6%) underwent anterior-only, while 3 patients underwent combined approaches in posterior-anterior-posterior fashion. Perioperative complications were minor and managed conservatively. The mean correction in segmental kyphosis was 27.3±6.7 degrees, that of regional kyphosis was 29±12 degrees, while mean correction in cervical SVA was 22±12 mm. Lordotic curves were achieved in 68.5% of patients

(the overall mean of postoperative C2-C7 angle=9±6.4°). The mean improvement in Nurick grades was 1.5 and the good (Odom grade 2) to excellent (Odom grade 3) outcome was reported by 10 (71%) of our patients.

Conclusion: Sagittal plane-based correction of cervical fixed kyphosis is a safe and effective strategy that spinal surgeons should bear in mind in addition to the usual neural decompression target. Angular and translational should be both used in assessment as they may be no closely correlated. (2016ESJ114)

Keywords: sagittal balance, cervical deformity, cervical kyphosis

Introduction

Cervical deformities are one of the most frustrating and handicapping deformities that are not only a cause of debilitating pain, but can also result in limiting daily activities, dysphagia and foreword gaze difficulty. Moreover, decision-making and surgical management of such pathology often represents a challenge to the spine surgeon.[6,16] When these deformities are fixed, this may pose an additional challenge and risk to the surgical correction which sometimes requires osteotomies, corpectomies and combined approaches. However, surgical success in managing these fixed lesions may be a life changing event that save motor power, alleviate pain and improve function.

Several causes of cervical kyphotic deformity were identified in the literature. Ventral etiologies may include multilevel degenerative disc disease, neoplastic or infective infiltration destructing the vertebral bodies and failure of previous cervical fusions.[1,3,5,6,16] Dorsal causes involve mainly interruption and failure of the posterior tension band allowing for progressive flexion deformity as seen in postlaminectomy kyphosis.[2-4,6,16] Surgical goals are mainly neural release, restoration of sagittal balance and spinal fusion. Various surgical strategies are reported in the literature including; anterior-only, posterior-only and combined approaches.

The aim of this study was to present our experience with fixed cervical kyphotic deformities, explore leading causes, management strategies and outcome including sagittal plane correction.

Patients and Methods

This is a retrospective analysis of prospectively collected data of patients presented to our department with the diagnosis of fixed cervical deformity. During the period of 4 years (January 2012 to January 2016), 14 patients underwent surgical treatment of fixed segmental cervical kyphosis due to various causes. Fixed kyphotic deformity of cervical spine was either ankylosed (fused) or non-ankylosed. Fixed kyphosis was defined as less 50% correction of the Cobb angle of the segmental deformity on flexion-extension lateral radiographic study. Ankylosed (fused) deformities were those showing anterior and/or posterior bony fusion on thin CT-films. Non-ankylosed deformities were those with failed correction on dynamic study, yet no bony fusion could be detected. Inclusion criteria included patients presented with a segmental kyphotic deformity of cervical spine from any cause, not corrected at least by 50% on standing extension films, and associated with symptoms presumed to be accounted for by their deformity with violation of at least one radiographic measurement of the regional sagittal balance; namely C2-C7 Cobb angle and C2-C7 SVA.

Patients were assessed by detailed history-taking, thorough clinical examination and radiological evaluation. The patients were then evaluated using Nurick classification[13] to obtain a baseline for comparison with postoperative status. Initial imaging studies included standing anteroposterior and lateral radiographs with dynamic flexion extension views. CT scan for assessment of various bony structures and presence of fusion, as well as, MRI for assessment of neurological compromise were further ordered.

On radiographic studies, the evaluation included both the segmental and the total cervical deformity. Segmental deformity was assessed using the Cobb angle method between the upper and lower endplates of the vertebral bodies included and fixed in the deformity. Total cervical deformity was assessed as regard angular and translational abnormality by using both Cobb method[9] and sagittal vertical axis (SVA),[18] respectively. The Cobb angle of the cervical curve was measured between the lines drawn parallel to the lower endplates of the second and the seventh vertebrae. Intersection of these lines in front of the spine meant a kyphotic deformity and was presented as a negative angle, while intersection behind the spine meant a lordotic curve and was presented as a positive angle. The SVA was defined as the horizontal distance between the posterior superior corner of the seventh cervical vertebra and C2 plumb line dropped from its center. These measurements were carried on both in pre- and postoperative intervals.

After full assessment of patients, the patient was assigned to one of two categories of kyphotic deformity; ankylosed (fused) and non-ankylosed (non-fused) fixed deformities. Non-ankylosing fixed deformities were managed in this study solely by anterior approach through discectomies, removal of anterior and posterior bony osteophytes, and resection of uncovertebral joints helped by insertion of lordotic interbody cages with securing of the correction by anterior plate-screw fixation. This maneuver was thought to be quite enough in augmenting anterior column height and contouring of the normally gliding posterior facet joints. Ankylosed fixed deformities were managed by an osteotomy targeting the ankylosing segment followed by correction and fusion. This was accomplished through anterior or combined (posterior-anterior-posterior) approaches. Combined approaches were reserved to patients with junctional segment kyphosis and those with sever degree of kyphosis with ankylosing anterior and posterior elements that required combined anterior and posterior osteotomies. Combined approaches were carried on using the posterior-anterior-posterior fashion.

Anterior approach to the cervical spine was performed using Smith-Robinson approach from the right side. Depending on the deformity anatomy, discectomies or corpectomies were performed as needed. The extent of discectomy or corpectomy should be posterior enough to include the posterior longitudinal ligament and lateral enough to disrupt the uncovertebral joints. This was done using bone drilling with a 3-mm burr tip with continuous gentle strikes and irrigation until the uncinate process was thinned out to a delicate shell that was then removed using a microcurette. The cortical surfaces of the opposing vertebral plates at the end of discectomy or corpectomy were preserved to lessen the risk of subsequent cage subsidence. Intraoperative correction of kyphosis was helped using Caspar distractor with its pins inserted perpendicular to the anterior plane of the uppermost and lowermost

vertebrae involved in the kyphotic segment. This makes the pins in a divergent position with their proximal tips closer to each other. Following anterior release by doing the planned discectomy and or corpectomy, distraction of the Casper pins helped by manipulation of head and neck can result in achievement of the desired lordosis. Insertion of lordotic interbody cages or corpectomy cages packed with local autograft or synthetic bone graft helped in maintaining the corrected alignment which was then secured using anterior plate-screw fixation system. Intraoperative correction could be appreciated during anterior approach in patients with no posterior ankylosing segment using C-arm fluoroscopic imaging. (Figures 1 and 2)

In planned combined approaches, patients were first operated in prone position to approach the posterior cervical spine through a midline incision. Smith-Petersen osteotomies were performed using a high speed drill; starting will limited resection of the inferior facet to give an enough window for superior facet resection. The osteotomies were performed 2 to 3 levels above and below the apex of deformity. Segmental instrumentation in the cervical subaxial segment consisted of lateral mass screws, while in the thoracic lower extension pedicle screws were generally used. After complete osteotomy and instrumentation, the wound was closed without placement of the rods and the session was finished. A second stage surgery was conducted 5 to 7 days later, in which the cervical spine was approached anteriorly for further bony release and neurological decompression as described before. In this stage, after completing the required anterior correction and fixation, the patient was turned prone for final placement of the rods to the previously inserted posterior screws and finalizing the process of fixation and fusion. All wounds were closed in anatomical layers over drains.

In the postoperative period, the patients were admitted to the surgical ICU for monitoring 2 days after surgery, with the decision of airway management being discussed with anesthetic team and intensivists. Once the airway was clear and stable, the patient was transferred to the regular ward. Drains were removed when the output was less than 50 cc per 12-hour shift for 2 successive shifts. All patients were kept in hard Philadelphia neck collar for at least 12 weeks, until solid fusion was ensured by appropriate imaging. All patients were assessed using standing lateral radiographs and the regional Cobb angle (Figure 3) and cervical SVA (Figure 4) were re-measured and compared to preoperative values. These measurements were reassessed periodically every 3 months, and the preoperative and final postoperative measures were used to calculate the final correction values. Thin film CT scans were done to all operated patients to evaluate the degree of sagittal plane correction, accuracy of instrument placement and integrity of reconstruction, while MRI was reserved for patients with significant preoperative neural compression to assess the achievement of neural release. (Figure 5) At final assessment visit, Nurick classification was used for comparing to the preoperative status, in addition to Odom criteria[14]

The following variables were collected for analysis; age, sex, presenting symptoms and signs, history of previous related surgeries or injuries, pre- and final postoperative focal deformity and regional curve Cobb angles in neutral standing position, pre- and final postoperative cervical SVA, pre- and final postoperative Nurick classification and Odom criteria (Nurick for neurological status pre-

and postoperatively and postoperative Odom criteria for the overall clinical improvement), type of bone release, surgical approach (anterior versus combined), length of surgery (total length in staged operations), blood loss, perioperative complications and finally, pre-and postoperative swallowing and foresight abilities as one of the following categories; no difficulty, minor, or major difficulty. Statistical analysis was done using the Statistical Package for the Social Sciences (SPSS Statistics) for Microsoft Windows (Version 17.0, 2008; SPSS Inc., Chicago, IL, USA), with P value of 0.05 as significant.

Results

During the pre-mentioned time interval we operated on 14 patients of fixed cervical kyphotic deformity due to various causes. Age ranged between 25 and 48 years with a mean age of 36.9±7.2 years. The majority of our patients were males (10 patients, 71.4%). The most constant presenting symptom was pain (100% of patients) of axial type in all patients and 9 patients having radicular pain in association. Five patients (35.7%) had associated swallowing difficulties of minor type, with one more case (7.1%) which had a significant bothering dysphagia. Minor foresight difficulties were reported by 2 (14.3%), while major difficulty by one (7.1%) of our patients. Radiculopathy was detected in 9 patients (64.3%) and myelopathy in 5 patients (35.7%) with one patient presented with a combined radiculomyelopathy. Among our patients, 2 patients (14.3%) underwent cervical laminectomy in early age for cord lesions with gradual progression of post-laminectomy kyphosis, while 4 patients (28.6%) had cervical injuries with posttraumatic kyphosis. These traumatic patients presented late after trauma, except for one patient which presented in early posttraumatic period with C5 fracture dislocation resulting in a severe fixed kyphotic deformity that failed to reduce with cervical traction. Other patients in the study were multilevel disc degeneration patients.

Preoperative radiologic evaluation revealed preoperative segmental deformity angles ranging from -42 to -19 degrees with mean of -29±8.3 degrees. The C2-C7 Cobb angle ranged from -41 to 18 degrees with mean angle of -20±13.3 degrees. The C2-C7 SVA ranged from 21 to 59 mm with a mean of 33±11.4 mm. Preoperative Nurick classification varied between grades 1 and 5 with a mean of 2.7±1.3. The cervical regional Cobb angle was found to be substantially correlated to the preoperative Nurick classification at a marginal statistical significance (Spearman's rho=0.527, P=0.053). However, the cervical SVA showed a strong positive correlation, with statistical significance to the Nurick grades (Spearman's rho=0.0735, P=0.003). The cervical regional angle and the cervical SVA on the other hand failed to correlate to each other (Spearman's rho=0.142, P=0.628).

Eleven patients (78.6%) underwent anterior-only correction surgeries, while the remaining 3 patients underwent combined approach in posterior-anterior-posterior fashion. Smith-Petersen osteotomies were performed in four patients, combined with anterior release in 3 of them (2 corpectomies, 1 double-level ACDF). Cervical corpectomy was performed as the only bone release in 1 patient, while combined with posterior osteotomy in another 2 patients. Multiple ACDF with plate-screw fixation was the procedure of choice in 9 patients (64.3%). The length of the procedures varied from 180-611 minutes, with a mean of 330±151 minutes. The length of procedures was longer in combined patients (Mean 552±52 minutes) compared to those operated by anterior-only approach (Mean 270±102 minutes) with a statistically significant

difference (Mann-Whitney test, P=0.024). The amount of blood loss ranged between 200 and 1500 cc with a mean loss of 658±423 cc. Comparing the amount of blood loss among the 2 approach-fashion groups again revealed more blood loss among combined approach patients (Mean of 1367±115 cc) compared to anterior-only patients (Mean of 465±194 CC), which was also a significant difference (Mann-Whitney test, P=0.010).

Perioperative complications were minor and needed conservative management and follow up. None of patients developed a complication that required redo surgery or additional surgical procedures. Three patients developed superficial wound infection (managed by culture and sensitivity test with specific antibiotic administration), one patient had an intraoperative inadvertent posterior durotomy (with no postoperative leak) and two patients developed immediate postoperative transient C5 radiculopathy (managed with steroids and physiotherapy). Hospital stay after last procedure done varied between 9 and 19 days. Preoperative swallowing difficulties disappeared in 4 of the 6 patients with persistent minimal swallowing difficulty reported by two (one of them with preoperative significant difficulty). All patients reported improvement of foresight gaze.

Patients were discharged with follow up schedule after discharge at the following time points; 2 weeks, 3 months, 6 months and 1 year from discharge. Clinical and radiological data of the last visit were used for outcome assessment. Two patients were lost after the 6-months visit and one patient was lost after 3-months, so, the data of their last visit were used as the final postoperative data. The follow up period ranged from 3 to 36 months with a mean of 15±9.6 months. The postoperative segmental deformity angle ranged from -11 to 7 degrees with a mean angle of -1.9±6.1 degrees. The postoperative C2-C7 Cobb angle ranged from -3 to 18 degrees with a mean angle of 9±6.4 degrees. The cervical SVA varied between 2 and 24 mm with a mean of 11±7.2 mm. All these values were significantly better when compared with preoperative values (Student paired t-test, P<0.001).

The mean correction in segmental kyphosis was 27.3±6.7 degrees, while that of regional correction (C2-C7 Cobb angle) was 29±12 degrees. The mean correction in cervical SVA was 22±12 mm. Eleven of our patients (68.5%) had a lordotic curve (C2-C7 Cobb < 4^{o}) after surgery, while the remaining 31.5% displayed neutral curves (between +4 and -4 degrees). The postoperative neurological outcome presented by Nurick grades, ranged from grade 0 to grade 4 with a mean of 1.2, and the overall clinical outcome presented by Odom's criteria ranged from fair (4 patients) to excellent (5 patients). This achieves good (Odom grade 2) to excellent (Odom grade 3) outcome in 10 (71%) of patients in our study. The only preoperative bedbound patient who presented with fresh trauma (Nurick 5) was seen in last follow up (18 months) walking assisted (Nurick 4). The postoperative cervical curve (Cobb) angle and cervical C2-C7 SVA were found to be positively correlated to the postoperative Nurick classification (Spearman's rho=0.667 and 0.540, P=0.009 and 0.046, respectively). However, the cervical curve SVA was more strongly correlated to the Odom's grade when compared to the cervical curve angle (Spearman' rho=-0.947 and -0.531, P<0.001 and P=0.051, respectively).

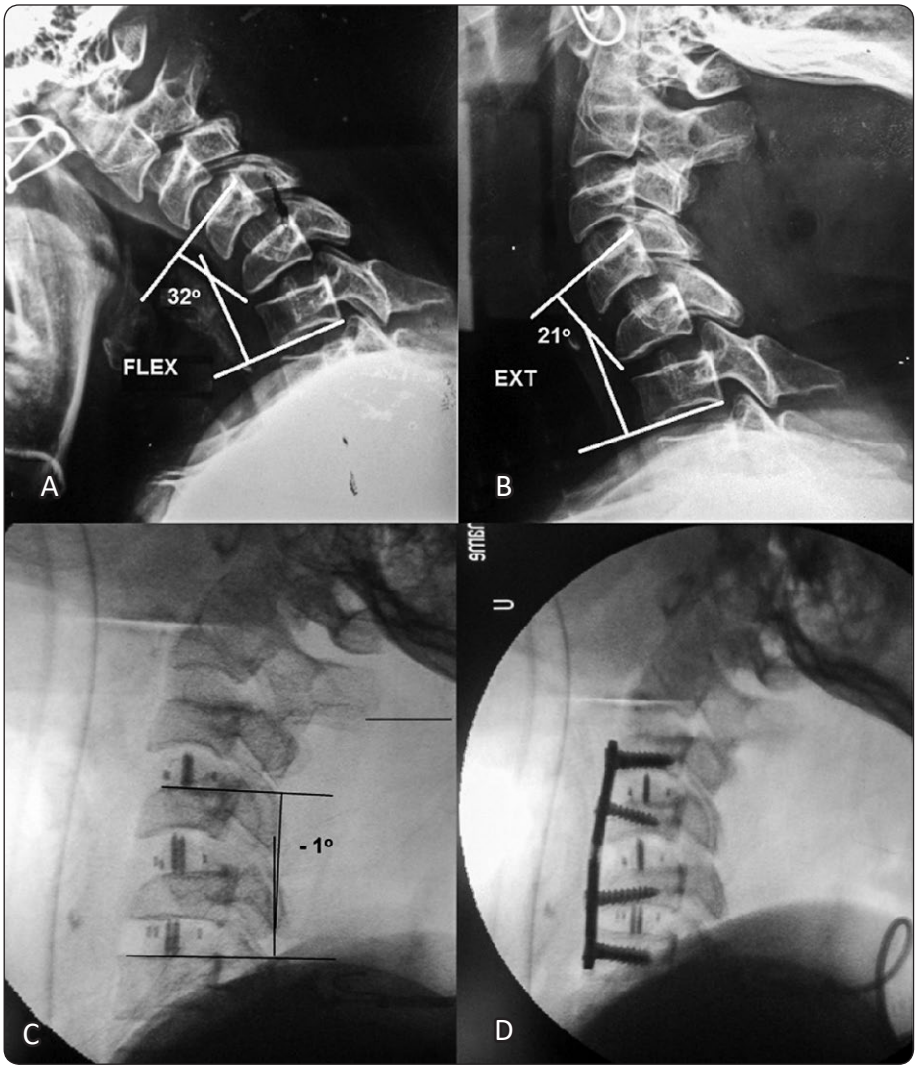

Figure 1. A patient with postlaminectomy fixed non-ankylosig kyphotic deformity. The angle of segmental kyphosis (A) achieved less than 50% correction in extension film (B). Intraoperative anterior discectomy and osteotomy done by resection of the uncovertebral joints bilaterally in three levels helped by distraction and use of lordotic cages achieved intraoperative correction of 33° (C), followed by anterior plate-screw fixation to secure the achieved correction (D).

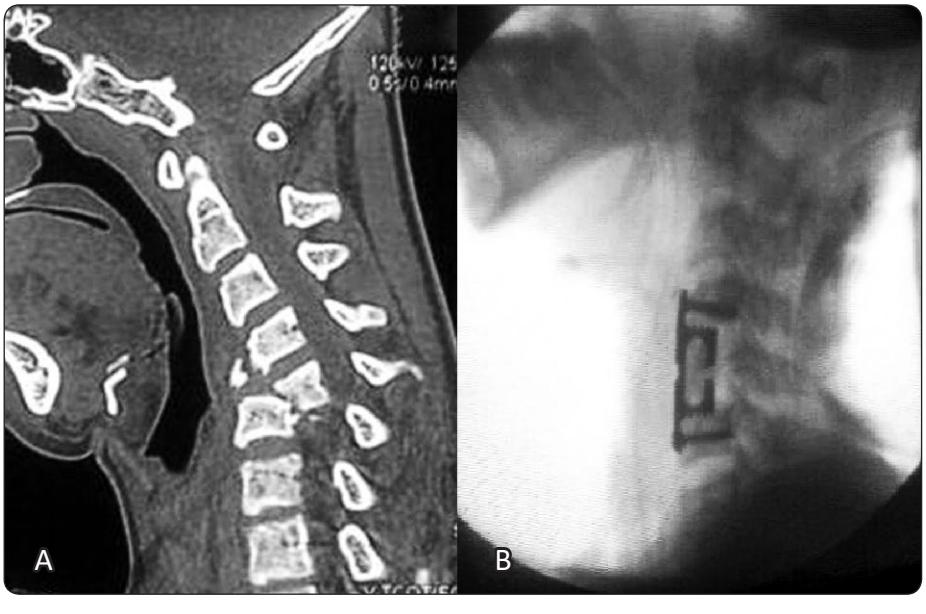

Figure 2. The only patient of fresh trauma with C5/6 fracture dislocation and backward displacement of C5 and failure of cervical traction to correct kyphosis (A). Intraoperative correction using C5 corpectomy and cage plate system achieved correction of segmental as well as, regional curves (B)

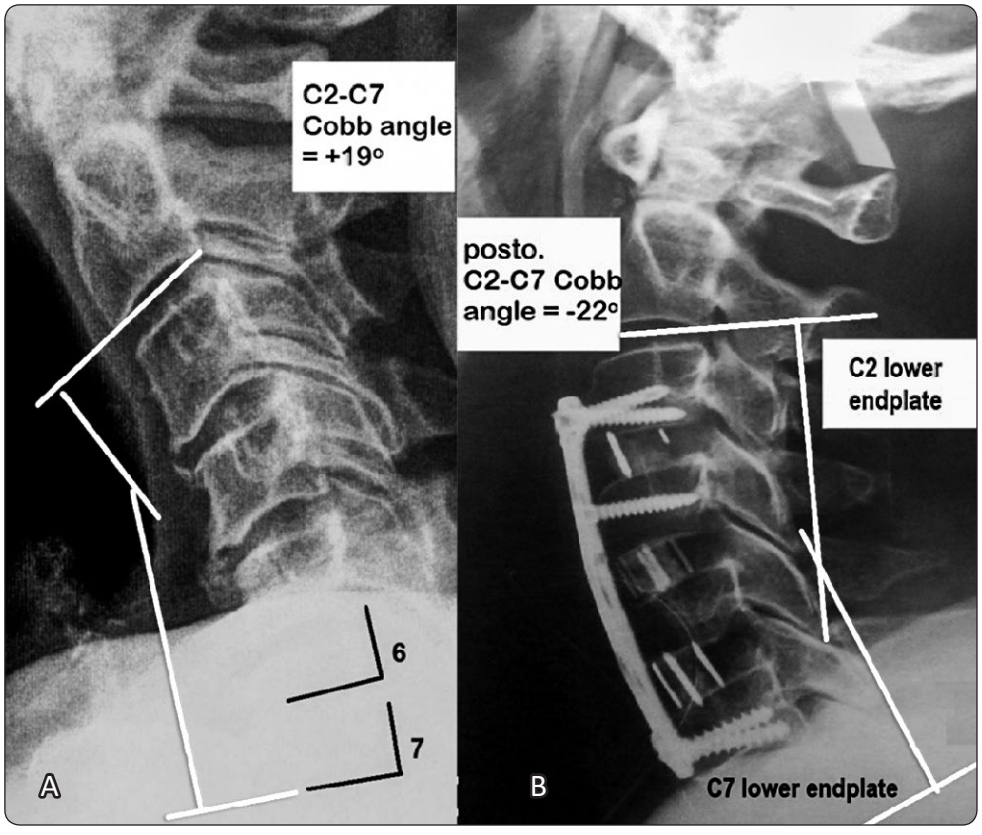

Figure 3. Multilevel disc degenerative kyphosis of cervical spine (A) corrected through multilevel anterior osteotomies and ACDFs with plate-screw fixation resulting in 41° correction in the sagittal profile (B).

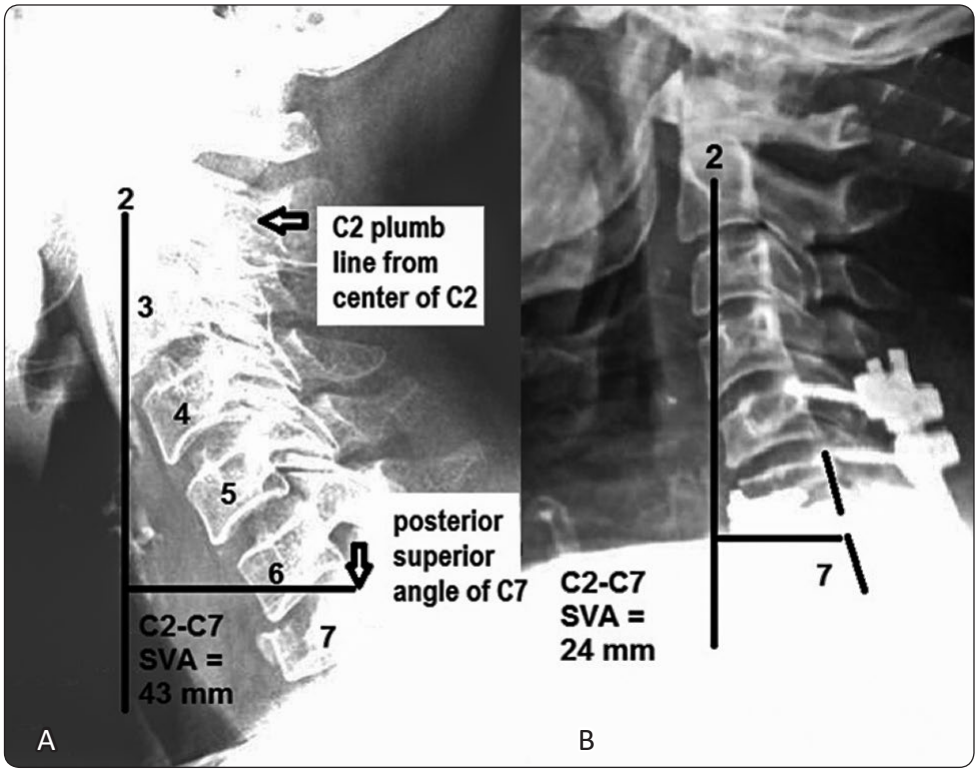

Figure 4. (A) A patient of C7 compression fracture with progressive cervicothoracic kyphosis. (B) After combined anterior osteotomies (with C6/7, C7/T1 ACDFs and C6/T1 plate-screws) and posterior C5 to C7 SPO osteotomies (with C5/6 lateral mass screws to T1/T2 pedicle screw construct), correction in the cervical SVA improved by 19 mm.

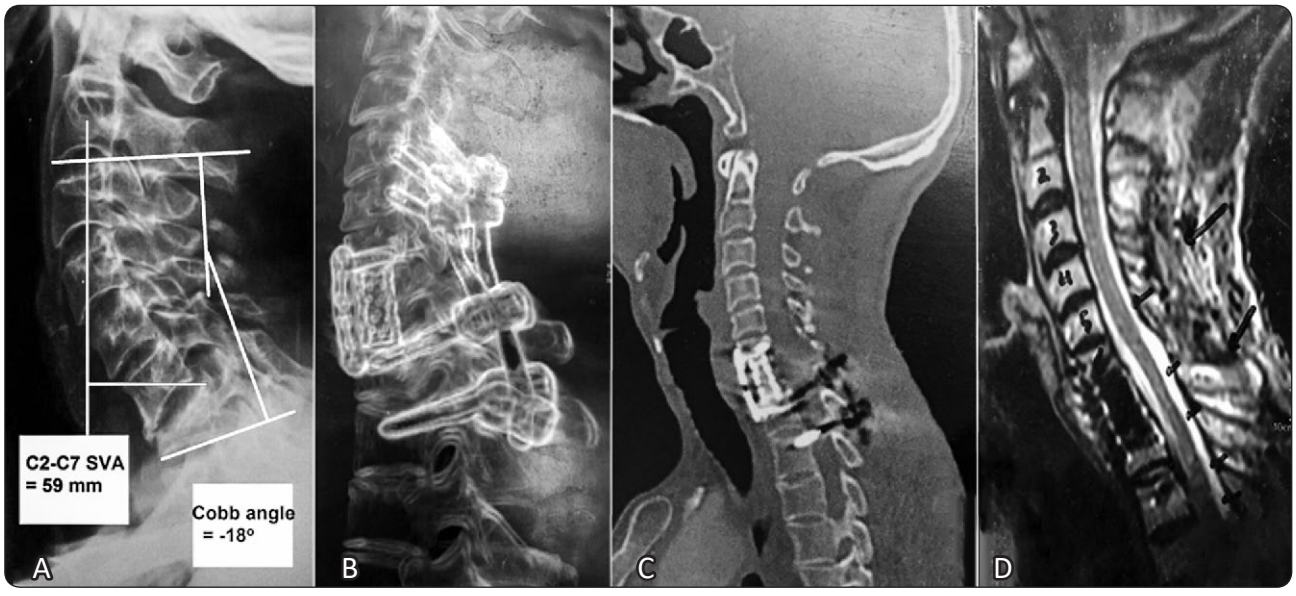

Figure 5. A patient of neglected C7 compression fracture with progressive cervicothoracic kyphosis; (A) anterior shift deformity of the healthy flexible spine at C7 resulted in increase in the C2-C7 SVA (59 mm), while the C2-C7 Cobb angle remained within normal (-18°) range due to compensatory hyperlordosis. (B) 3D CT reconstructed images revealed proper placement of the construct. (C) CT sagittal reformat images revealed complete clearance of the spinal canal and proper corpectomy cage position. (D) MRI sagittal view demonstrates complete cord decompression with free passage of CSF in front and behind the cord.

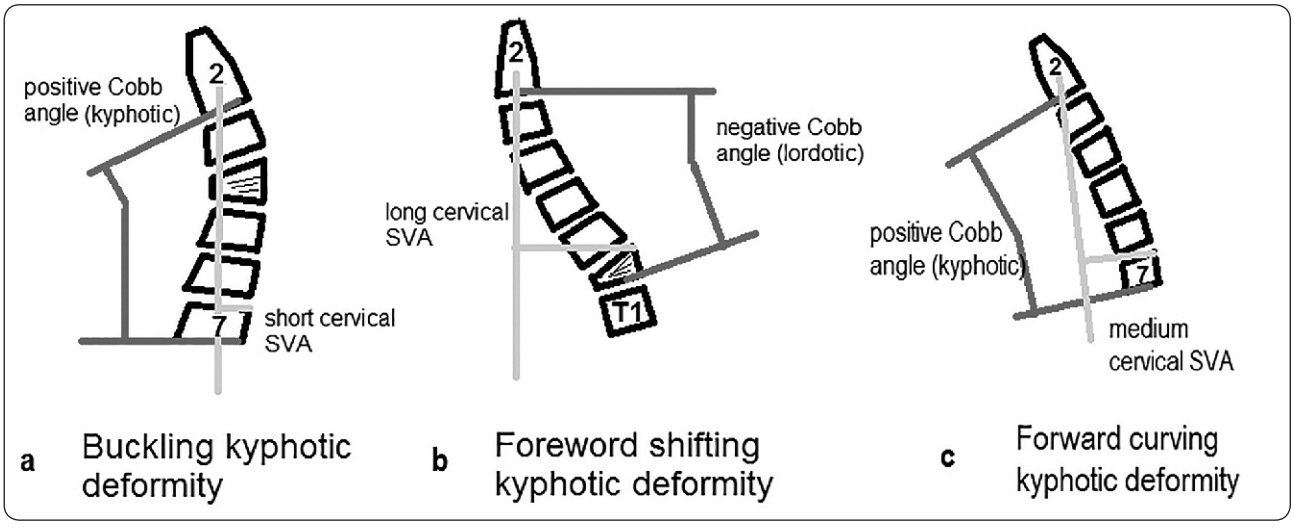

Figure 6. Artistic drawing (by the authors) demonstrating the possible kyphotic curve morphologies that makes angular and translational measurements not correlated in our study. (A) Kyphosis with buckling of the cervical curve increasing the angular measure while keeping C2 not significantly translated on C7. (B) Significant kyphosis at lower cervical spine causes forward shit of C2 plumb line with hyperlordosis of above healthy segments causing minimal change in angular measurements. (C) Smooth kyphotic deformity due to multilevel disc degeneration causing an increase of both angular and translational values.

Discussion

In this study, we present our early single institute experience of managing 14 patients with fixed cervical deformities and evaluating the results based on clinical and radiographic sagittal plane measurements. To alleviate the effect of an associated other regional imbalance that may influence preoperative and postoperative picture as well as, overall patient satisfaction, we generally excluded any patient with positive global sagittal balance as measured by standing films C7-sacrum SVA. In the single patient with fresh trauma presented bedbound, this standing film could not be done, yet in view of the patient's young spine and excluded fractures and deformities on routine posttraumatic CT scanning, this patient was included in the study population.

Better correlation of C2-C7 SVA than cervical Cobb angle to the preoperative Nurick's classification was an interesting finding indicating its important role in patient's assessment and decision making. Higher values of cervical SVA was found to negatively impact the health-related quality of life (HRQOL) in those who underwent posterior cervical fusion, especially at values ≥ 40 mm.[8,18] Absence of significant correlation between preoperative cervical Cobb angles and cervical SVA is considered another interesting finding proving that these two parameters are not necessarily closely related. This means that patients with identical Cobb angles may have different C2-C7 SVA, and vice versa. This may depend of several factors like; the location of segmental deformity, number of levels involved, the flexibility of the remaining cervical spine and its ability to compensate by hyper-lordosis and the cervicothoracic alignment. At the extremes of this variability one may encounter a kyphotic cervical angle with normal SVA, or normal lordotic angle with longer than normal cervical SVA, (Figure 5(A) and Figure 6). This indicates that, it is more appropriate to evaluate the cervical kyphotic deformities using both measures.

The vast majority of our patients were managed by anterior-only approach. The proper discectomy, resection of uncovertebral joints or corpectomy helped by the easier manipulation of the head in the supine position, the use of Casper distracting pins as well as, lordotic cages, all made anterior approach successful in managing most patients. However, the combined approach was mandatory in patients with a posterior ankylosing element especially near the cervicothoracic junctional area to achieve better correction and more stable fusion. The combined approaches were done through a posterior Smith-Petersen osteotomy followed by anterior osteotomy in the form of corpectomy or discectomy with uncovertebral joint resection. Although other highly effective posterior osteotomy techniques like opening wedge osteotomy,[11,12,19] and pedicle subtraction osteotomy (PSO)[20] are reported in the literature, these osteotomies are more risky procedures, carrying hazards to the anterior soft tissues, vertebral arteries and cervical nerve roots. Moreover, studies comparing mean angular and translational corrections achieved by isolated posterior cervical PSO to those achieved by combined anterior osteotomy with posterior SPO were statistically identical.[10]

The mean correction of sagittal profile in our patients was 29 degrees which compares favorably with others.[1,17] However, our mean correction lies far lower than that achieved by O'Shaughnessy and his colleagues,[15] who reported 48 degrees of correction. The main reason may be because, they included significantly bigger preoperative angles of kyphosis (38 versus 20 degrees in our study),

and used combined approaches in all patients performing multiple anterior and posterior osteotomies with C2/C3 to upper thoracic fixation systems. Their final cervical curves were lordotic in 75% of patients and neutral in 25%. We achieved lordotic curves in 68.5% and lordotic curves in the remaining 31.5%, which is not far less than their reported figures. In addition to the radiological sagittal profile improvement, there was a substantial improvement in the neurological status of patients as revealed by change in the mean Nurick classification grade from 2.7 preoperatively, to 1.2 in the last follow up visit. The overall success was achieved in 71% of our patients who reported a good to excellent outcome on final Odom's criteria. The paucity of perioperative complications, together with satisfactory improvement of the preoperative complications make sagittal plane correction in fixed kyphotic cervical deformities a safe and effective strategy.

Conclusion

We conclude that sagittal profile minded surgical planning and correction of cervical kyphotic deformities, proved to be a safe and effective approach that should be considered beside the focal neurological decompression target, to improve the overall patient satisfaction and neurological outcome. Evaluation of the cervical sagittal profile should include assessment of both angular and translational deformities as they may be not closely related to each other.

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الملخص العربي

التصحيح الجراحي للمستوى السهمي في علاج التشوهات الحدابية الثابتة للفقرات العنقية

البيانات الخلفية: تعتبر التشوهات الحدابية الثابتة بالفقرات العنقية من الإصابات التي تسبب عجزا شديدا للمرضى قد يؤدي بهم إلى عدم القدرة على ممارسة الأنشطة اليومية وأحيانا فقد القدرة على الحركة تماما.

الغرض: عرض خبرتنا المبكرة في التعامل مع تلك الإصابات عن طريق تقييم تراصف الفقرات العنقية في المستوى السهمي قبل وبعد الجراحة وعرض النتائج التقويمية لتلك التشوهات.

تصميم الدراسة: سلسلة من الحالات السريرية بأثر رجعي.

المرضي والطرق: شمل البحث المرضى المصابون بحداب قطعي ثابت بالفقرات العنقية أدى إلى حداب ناحي بمنطقة العمود الفقري العنقي وتسبب في أعراض عصبية وغير عصبية كصعوبة البلع واختلال الرؤية الأفقية وذلك خلال الفترة بين يناير ٢٠١٢ إلى يناير ٢٠١٦. تم تقييم التراصف السهمي عن طريق قياس زاوية "كوب" القِطَعية والناحِيّة بالإضافة إلى قياس المحور العمودي السهمي للمنطقة العنقية. قيمت الحالة الإكلينيكية عن طريق مقياس "نيوريك" قبل وبعد الجراحة بالإضافة إلى معايير "أودوم" لقياس التحسن النهائي بعد الجراحة.

النتائج: تم التصحيح الجراحي بواسطة الجراحات الأمامية فقط في ١١ حالة مع استخدام جراحات أمامية - خلفية في ثلاث حالات. نتج عن الجراحات مضاعفات محدودة تم التعامل معها تحفظيا. تم تحقيق تصحيح بزاوية التحدب بمتوسط ٢٧,٣ ± ٦,٧ درجة للحداب القطعي و ٢٩ ± ١٢ درجة للحداب الناحي للمنطقة العنقية. كما تحقق تقويم للمحور العمودي السهمي بمتوسط ٢٢ ± ١٢ مم. تم تحقيق منحنيات عنقية مقعرة في ٦٨,٥٪ من الحالات (متوسط زاوية "كوب" للمنطقة العنقية = ٩ ± ٦,٤) ومتوسط تحسن بمقياس "نيوريك" يقدر بـ ١,٥ درجة. كانت النتائج جيدة إلى ممتازة حسب مقياس "أودوم" في ٧١٪ من الحالات.

الاستنتاج: خلصت الدراسة إلى أهمية علاج حالات تحدب العنق التشوهي الثابت بأسلوب يعتمد على التقييم الجانبي لزوايا التحدب والإزاحة الأمامية. وأثبتت النتائج نسب نجاح ودرجات أمان جيدة للإصلاح الجراحي لتلك الحالات.