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MANAGEMENT OF SUBAXIAL CERVICAL SPINE FRACTURES WITH ANTERIOR CERVICAL CORPECTOMY AND ANTERIOR PLATING-SINGLE CENTER EXPERIENCE

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ABSTRACT

Objective: Anterior cervical corpectomy and fusion (ACCF) is a surgical treatment option for cervical trauma. It is usually preferred to better decompress the spinal cord and preserve cervical alignment. Meanwhile, there are some contradictions regarding the indications of this procedure. The aim of this study was to present our series on the use of ACCF in subaxial cervical traumas.

Materials and Methods: The data of 20 patients who underwent ACCF for subaxial cervical trauma between 2016 and 2021 were retrospectively reviewed. The demographic, clinical, and radiological characteristics of the patients were collected and presented in detail. American Spinal Injury Association (ASIA) scores and Cobb's angles were statistically compared for the pre- and postoperative periods.

Results: The mean age was 48.7 (23-78) years. The female/male ratio was 1/5. The most common type of trauma was motor vehicle accident (55%), followed by falls and diving traumas. The most frequently affected level was C6. All cases underwent single-level ACCF, and anterior plating was performed after the placement of an expandable titanium cage. Cobb's angles and ASIA scores were significantly improved in all patients.

Conclusion: ACCF is a good option for subaxial cervical fractures to obtain better clinical and radiological outcomes. It has less complication risk and provides excellent cervical alignment. Further clinical studies with larger series are needed to demonstrate the efficacy of this procedure.

Keywords: Corpectomy, cervical fracture, Cobb angle, outcome

INTRODUCTION

Cervical spine injury occurs in 2.4% of patients with blunt trauma[1]. It is generally seen in young males and the most common reasons are fall accidents (FA) and motor vehicle accidents (MVA)[2,3]. The most commonly affected area in the subaxial cervical spine is the C6 and C7[1-3]. Fractures after high-energy trauma often cause spinal instability and nerve compression[1]. In cases with major spinal damage, pathology is present in an additional segment of the spine in 20% of the cases, and this damage doesn't necessarily have to be in the adjacent segment[4,5].

Surgical treatment methods and frequency for spinal injury are increasing in both younger and older patients[1,6,7]. It is especially preferred in the treatment of the elderly with fractures secondary to osteoporosis or malignancy[1,2,7-9]. The main goal of surgery is the restoration of vertebral body height, ensuring the continuity of the normal spinal axis, and stabilization[2,9,10]. Another goal is the fusion of stabilized segments[3]. In surgical treatment, anterior, posterior, and combined approaches can be preferred[9]. The method to be preferred first is still a matter of debate. The generally accepted approach is the decompression of the segment causing compression on the spinal canal[4,6].

The anterior approaches are less traumatic and allow access to the target area without damaging the paraspinal muscles[11]. One of the most widely accepted anterior approaches is anterior cervical corpectomy and fusion (ACCF)[1,12]. Our aim is to evaluate the postoperative outcomes and complications of cases where we perform ACCF and anterior plating in subaxial cervical spine fractures. We reviewed the clinical and radiologic results of anterior cervical corpectomy in trauma patients, as well as the safety of the procedure.

MATERIALS AND METHODS

Study Design

The study was initiated after obtaining the University of Health Sciences, Gülhane Training and Research Hospital Ethical Committee approval (decision no: 2021-238, date: 20.05.2021). In this study, patients who underwent ACCF at our institution between 2016 and 2021 were retrospectively evaluated. Cases between the ages of 18 and 80 who underwent surgery due to

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trauma were included in the study. Patients who underwent an anterior cervical procedure at a different center, those outside the age range of 18-80 years, and patients who underwent ACCF for non-traumatic reasons were excluded.

Data Collection

Records of patients were collected from electronic databases. Patient data including age, gender, type of trauma, time elapsed until surgery, preoperative and postoperative American Spinal Injury Association (ASIA) scores, length of hospitalization, and perioperative complications were recorded. Preoperative radiological images, postoperative early-phase and final follow-up radiological images [computed tomography (CT), X-ray, magnetic resonance imaging], and intraoperative neuromonitoring data were examined.

Radiological Assessment

The images were grouped into preoperative, early postoperative, and final follow-up categories. The C2-T1 Cobb angle was measured for all cases preoperatively and postoperatively and evaluated by two independent surgeons. Additionally, postoperative fusion assessment was conducted in the cases. Furthermore, the height of the corpectomized segment was compared between early-phase and final follow-up controls. The height of adjacent vertebrae, implant position, and spinal canal diameter were measured. The spinal canal diameter was determined by measuring the distance between the posterior border of the vertebral corpus and the mid-anterior point of the corresponding lamina on mid-sagittal cervical tomography images.

Statistical Analysis

IBM SPSS Statistics software version 28.0.1.0 (IBM, SPSS, Chicago, Illinois, USA) was used for the statistical analysis of this study data. The collected data are expressed as mean ± standard deviation. The Shapiro-Wilk test was used to evaluate whether parameters were normally distributed. Paired sample t-test were used to compare normally distributed parameters in the same group, while the Wilcoxon rank sum test was used for comparing data without normal distribution.

Surgical Technique

Under general anesthesia, with intraoperative neuromonitoring, the patient was placed in a supine position with slight head retraction and 10 degrees of contralateral rotation. Using an oblique skin incision, the classic Smith-Robinson approach was employed for anterior cervical intervention. Sharp dissections were performed to reach the prevertebral fascia. Subsequently, vertebral body identification was achieved through blunt dissections. The level for corpectomy was confirmed using lateral X-ray. Upper and lower intervertebral disc spaces were visualized. Kaspar retractors were placed on the upper and lower vertebral bodies and a distraction was performed. The subsequent stages of the procedure were carried out under a microscope. Bilateral longus colli muscles were laterally retracted. Bilateral upper and lower uncovertebral joints (UVJ) were identified (Figure 1). Special attention was given to identifying UVJ to avoid iatrogenic vertebral artery (VA) injury. After discectomy of the upper and lower intervertebral disc spaces, the endplates of the adjacent vertebrae were decorticated (decortication is important in terms of functional fusion, but this procedure is performed so gently, not to damage the cortical bone). Corpectomy was performed with a high speed diamond drill and rounger. After placement of the expandable titanium cage, its position was checked with lateral and anterior-posterior (A-P) X-rays. The bones obtained from the corpectomy are then placed on the sides of the cage to contribute to the fusion. Anteriorly, the cervical plate was fixed to the upper and lower vertebral corpus with screws (Figure 2). Then, 1 gram of vancomycin powder was placed on the operation field, drainage was placed and the operation was completed.

Baseline motor evoked potential (MEP) is performed before starting skin incision. Continuous electromyelography and somatosensorial evoked potential montoring was performed throughout the operation. MEP is performed at intervals and the surgeon is informed by comparing with baseline. The cuff of the endotracheal intubation tube is lowered during surgical manipulations to prevent compression of the recurrent laryngeal nerve between the trachea and soft tissue.

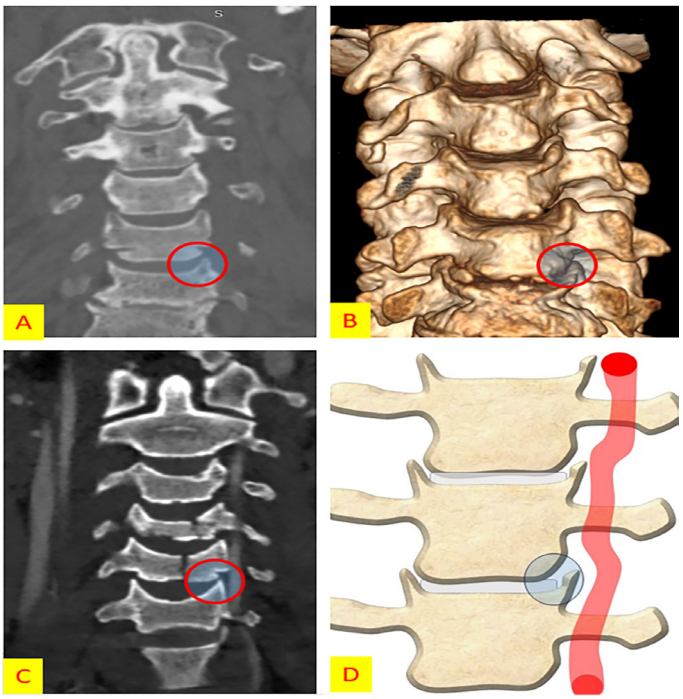

Figure 1. The coronal section of cervical CT reveals left UVJ at C5-C6 level with anterior aspect **(A)** and reconstructed posterior aspect **(B)**. Left C5-C6 UVJ of another patients at coronal plan of CT angiogram **(C)** and illustration shows the relationship between the joint and vertebral artery **(D)**
CT: Computed tomography, UVJ: Uncovertebral joints

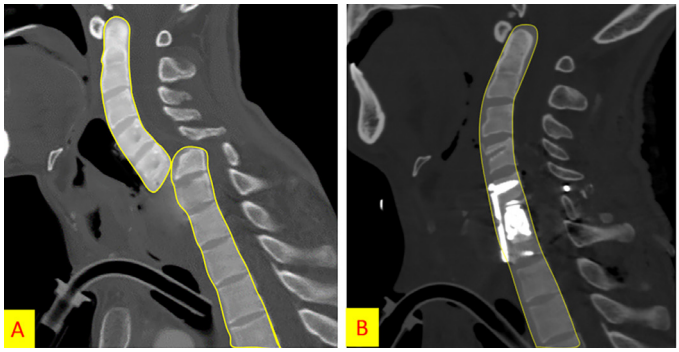

Figure 2. The preoperative **(A)** and postoperative **(B)** sagittal CT scan images show preoperative fracture and dislocation at C5-C6 level and postoperative instrumentation
CT: Computed tomography

RESULTS

Data from 20 cases that met the inclusion criteria for participation were evaluated. The average age of the patients was 48.7 (23-78) and the female/male ratio was determined as 1/5. The most common type of trauma was first MVA (n=11) with 55%, followed by FA (n=7) with 35%, and diving trauma (n=2) with 10%. The most frequently affected vertebra is C6. All cases underwent single level corpectomy. In all cases, anterior plating was performed after placement of an expandable titanium cage. Additionally, posterior instrumentation was added to the treatment of the 3 patients. In 1 case, we added posterior fusion because of facet locking or fracture. In 2 cases, decompression was performed due to posterior spinal canal compression. in these cases, ACCF was supported with posterior fusion to prevent the development of iatrogenic kyphotic deformity in the future. The average ACCF duration is 136 minutes but total operation time including PF is 153.8 minutes (80-290). The average length of hospitalization is 6.4 (3-30) days. Last follow-up 100% fusion rate was observed. One patient underwent urgent reoperation at the 8th postoperative hour due to a hematoma causing airway compression in the surgical site. Wound dehiscence was detected in 2 patient. One patient with frequent left C5 root irritation on neuromonitoring was found to have root injury on postoperative examination. Baseline neuromonitoring records worsened in 1 patient. Current data showed a 15% decline compared to the baseline data. No postoperative neurologic deficit was detected. The demographic, epidemiologic and clinical characteristics of the patients were summarized (Table 1). Preoperative VA occlusion was detected in 1 patient. The preoperative C2-T1 Cobb angle was 6.6 (± SD) degrees, which was measured as 13.8 (± SD) degrees in the postoperative final assessment. Comparison of preoperative and postoperative Cobb in patients showed a statistically significant difference, with the postoperative group having a significantly higher Cobb value (p<0.001) (Table 2). Five patients had preoperative kyphotic angulation 0.4-37 degrees (mean: 11.2). The mean preoperative length of between the adjacent vertebral bodies was 1.8 (± SD) cm, and postoperatively it was measured as 2.2 (± SD) cm. We found the statistically significant differences (p<0.001). The preoperative diameter of the cervical canal was 0.99 (± SD) cm, and postoperatively it was measured as 1.52 (± SD) cm. Differences of cervical canal diameter is significant higher in preoperative group (p<0.001). Transient dysphagia was observed in 4 patient during the early postoperative period, which improved within 7-10 days. In the early postoperative period, hoarseness was detected in 6 patient. Two patients were diagnosed with recurrent laryngeal nerve injury. Prednisolone treatment was initiated for these cases. Complete recovery was observed in 5 patient, partial hoarseness persisted in 1 patient, and at the 3-month follow-up, complete recovery was noted. At the first hospitalization, 10 patients were ASIA E, 4 patients were ASIA C, 5 patients were ASIA D and 1 patient was ASIA A. At the last postoperative control, 12 patients were evaluated as ASIA E, 3 patients as ASIA C, 4 patients as ASIA D, 1 patient as ASIA A. Neurological improvement was observed in 4 patient when compared to the preoperative physical examination. The patients were followed for a minimum of 6 months, maximum of 18 months, with an average follow-up of 10.2 months. All cases used a soft cervical collar for 4-6 weeks postoperatively.

DISCUSSION

In this study, we evaluated the clinical and radiological outcomes of ACCF and plating in subaxial cervical spine traumas. We explored ways to further enhance ACCF procedures based on the results obtained from our own cases.

Surgical treatment is the generally accepted rule in patients with unstable spine fractures and neurologic deficits secondary to the fracture[1]. Surgery should be performed with an approach that has low risks and high effective results. The preferred surgical approach and timing are important in terms of functional outcomes[10]. The type of surgical method should be decided by considering the patient's health status, type of trauma, preoperative radiologic imaging data, expectations and possibilities. In this study, we applied ACCF and plating approach to prevent neural compression and provide spinal stability in selected cases.

ACCF is a commonly preferred method for the surgical treatment of spinal instability caused by traumatic, infectious, neoplastic, and other factors[11-13]. In the case of traumatic fractures, it is necessary to use bone grafts to enable the union of adjacent segments[1]. After corpectomy, spinal reconstruction can be performed using autograft and allograft materials[14]. In cases where autografts are used, fusion occurs more naturally and quickly[14,15]. However, the literature has reported issues related to the donor site and the target region[8,14,16]. Alternative reconstruction methods such as titanium mesh cage, expandable cage and peek cage have been developed as alternatives to problems such as donor site issue, graft resorption and kyphotic angulation[15,17-19]. We do not prefer this method in reconstruction in our clinical practice due to

problems with autografts. We used expandable titanium cage in all of our cases (Figure 3). Bones collected during corpectomy were placed into and to the sides of the cage to facilitate fusion. It was supported with anterior plating. In the literature, high fusion rates have been found in single level anterior cervical corpectomy procedures performed in this way[4,15]. For example, Dorai achieved fusion in 97.5%, Majd achieved 97% fusion and Das achieved a 100% fusion rate[15,18,20]. We found a fusion rate of 100% in the minimum 6-month follow-up of our case series of 20 patients. Despite the high fusion rates of ACCF, we added posterior fusion in 3 cases due to the damage of posterior elements. The issue of supporting anterior corpectomy with posterior fusion has been evaluated on a case-by-case basis and has not been clarified[16,21,22]. Many authors believe that additional posterior stabilization should be performed after corpectomy in the spine, especially in the thoracolumbar region[23]. Studies emphasize that anterior fusion alone is more likely to fail after multilevel corpectomy[1,23].

Considering the biomechanics of the spine, ACCF is a procedure with direct access to the target and without damaging the

Table 1. The epidemiologic, demographic and clinical characteristics of the patients

Patient	Age (year)	Sex	Etiology	Corpectomy level	Time until the operation (hour)	Duration of ACCF (minute)	Hospitalization period (day)
1	54	M	FA	C5	10	145	6
2	30	M	MVA	C5	7	145	4
3	37	M	FA	C7	5	170	4
4	78	F	MVA	C7	8	103	5
5	51	M	FA	C6	4	140	3
6	69	F	FA	C7	10	80	15
7	46	M	MVA	C6	6	105	4
8	67	M	MVA	C6	5	145	4
9	56	M	MVA	C6	7	135	30
10	65	M	FA	C6	4	200	4
11	25	M	DA	C6	16	115	4
12	26	M	MVA	C5	192	160	7
13	23	M	DA	C4	24	180	5
14	69	M	MVA	C6	48	180	6
15	78	M	MVA	C5	9	157	6
16	75	M	FA	C5	6	150	4
17	45	M	FA	C3	10	120	4
18	29	F	MVA	C7	7	90	4
19	36	M	MVA	C7	36	110	4
20	39	F	MVA	C7	20	100	5
ASIA scores	**Preoperative (n)**				**Postoperative (n)**		
	ASIA A: 1				ASIA A: 1		
	ASIA B: 0				ASIA B: 0		
	ASIA C: 4				ASIA C: 3		
	ASIA D: 5				ASIA D: 4		
	ASIA E: 10				ASIA E: 12		

MVA: Motor vehicle accident, FA: Fall accident, DA: Diving accident, ASIA: American Spinal Injury Association, ACCF: Anterior cervical corpectomy and fusion

Table 2. Preoperative and postoperative measurements

	Preoperative (mean ± SD)	Postoperative (mean ± SD)	P value
Sagittal Cobb	6.6000±7.52952	13.8350±6.80103	<0.001*
LBAV	1.8275±0.39975	2.2280±0.36913	<0.001⁺
CCW	0.9995±0.36227	1.5225±0.20486	<0.001⁺

*Wilcoxon rank sum test, ⁺Paired samples t-test, SD: Standard deviation, LBAV: Length between adjacent vertebrae, CCW: Cervical canal width

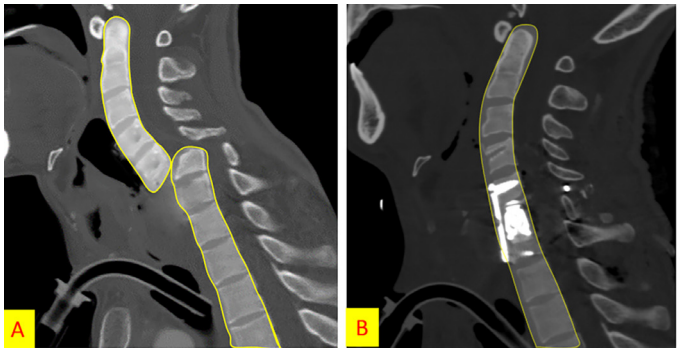

Figure 3. Expandable titanium cage and anterior cervical plate with screws

connective tissue elements involved in spinal stability. This technique minimally disrupts normal cervical muscles and is associated with a low risk of injuring surrounding structures[11]. In this way, segmental instability is also prevented. Kyphosis did not develop in our patients in whom we performed only anterior cervical corpectomy. Although anterior interventions are superior in preserving spinal biomechanics compared to posterior approaches, and the likelihood of neural damage is low, various complications have been reported in the literature[4,11,24]. These complications include wound site infections, dural injury, dysphagia, cerebrospinal fluid fistula, and nerve root damage. In addition to these, major complications such as VA rupture, esophageal injury, and damage to the recurrent laryngeal nerve have also been reported[19,22,25,26].

The incidence of VA injury, which is one of the destructive complications of anterior corpectomy, has been reported at around 3% in studies[26]. Eleraky et al.[11], in their study involving 185 ACCF cases, mentioned 4 cases of iatrogenic VA injury. They emphasized that 2 of the cases had VA anomalies, one case had a tumor adhering to the VA artery, and the fourth case had a loss of midline orientation. They indicated that direct repair was performed in two cases, ligation in the other two, and that all patients started postoperative aspirin. They also noted that none of the cases experienced postoperative neurological problems[11]. The identification of the UVJ plays an important role in avoiding VA injury[11,26,27]. In our own cases, we measured the height, width, and depth of the vertebral body using preoperative tomography. CT Angiography was performed to assess the VA in all cases. During corpectomy, we continuously monitored our measurement data along with anatomical landmarks to prevent neural and vascular injuries. In a case consulted 10 hours after trauma, left VA occlusion was identified on preoperative CT angiography. Posterior fossa infarction was present on preoperative CT. The patient had facet locking and accompanying dislocation. The patient was operated under aspirin treatment and later referred to a palliative care center.

Wound site problems were observed in 2 out of 20 cases, and they healed with local debridement in our study. Transient recurrent laryngeal nerve injury occurred in 2 patient. Medical treatment was applied, and at the postoperative 3-month follow-up, complete recovery was observed. Transient dysphagia was seen in 4 cases. In approximately 7-10 days, all cases completely recovered. The root damage was detected in one patient. There were no dural injury and postoperative cerebrospinal fluid fistula. No collections were observed at the wound site. Due to early postoperative complications, 1 patient required reoperation. A patient with tracheal compression and dyspnea due to prevertebral hematoma was urgently re-operated at the 8th hour for hematoma evacuation. The patient's follow-ups did not indicate any neurological problems. While the literature reports cases that lead to instrument insufficiency in the late period, we did not observe similar situations during the follow-up of our cases.

We adjusted the cage height to not exceed 5-10 mm beyond the height of the corresponding vertebral body to prevent neural damage due to cage distraction. In cases with burst fractures, this measurement might not be effective, so we perform distraction based on lateral X-rays and cervical alignment, guided by neuromonitoring data. Control CT was performed in all cases at 24 hours postoperatively.

One of the goal of surgery is preserving normal spinal axis, including cervical lordosis, related segment height. We detected postoperatively patients mean Cobb angle were improved. Cage distraction improved the Cobb angle and increased the distance between adjacent vertebrae by 0.4 cm. At the same time, a 0.5 cm enlargement of the spinal canal diameter was achieved. We found improvement in 40% of cases with neurological deficit. Our results demonstrate that ACCF is good choice for subaxial cervical fractures and providing high fusion rates and biomechanical stability

Study Limitations

The limitations of our study include a small sample size and a restricted follow-up period. Additionally, since the cases encompass a selected patient group, the results may differ from those of larger general groups undergoing ACCF.

CONCLUSION

After cervical trauma, the preferred surgical approach is still a topic of ongoing debate. Anterior approaches are gaining popularity due to their minimally invasive nature. Also ACCF may be preferred for the reconstruction of cervical lordosis. We found significant changes in postoperative radiological evaluations. To avoid perioperative complications in the anterior approach, thorough preoperative radiological assessment is crucial. Intraoperative assistance techniques should also be utilized. We believe that ACCF and plating is a safe and suitable approach for subaxial spinal trauma in appropriate cases.

Ethics

Ethics Committee Approval: The study was initiated after obtaining the University of Health Sciences, Gülhane Training and Research Hospital Ethical Committee approval (decision no: 2021-238, date: 20.05.2021).

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.C.E., G.K., Concept: M.C.E., G.K., Design: M.C.E., G.K., Data Collection or Processing: M.C.E., G.K., Analysis or Interpretation: M.C.E., G.K., Literature Search: M.C.E., G.K., Writing: M.C.E., G.K.

Conflict of Interest: The authors have no conflicts of interest to declare.

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