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Two Level Cervical Corpectomy with Iliac Crest Fusion and Rigid Plate Fixation: A Retrospective Study with a Three-Year Follow-Up

İliak Krest Füzyonu ve Rijit Plak Fiksasyonu ile Beraber İki Seviye Servikal Korpektomi: Üç Yıllık Takip ile Retrospektif Bir Çalışma

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ABSTRACT

AIM: There is no clear knowlegde in the literature about two-level vertebral corpectomy using the iliac bone crest for fusion and rigid plate fixation. We present our experience with two-vertebral level cervical corpectomy and reconstruction.

MATERIAL and METHODS: Each patient was graded according to the Nuricks Grade (1972) and the modified Japanese Orthopaedic Association (mJOA) Scale (1991), and the recovery rates were calculated. All patients had two-level vertabral corpectomy. Anterior iliac crest bone graft with titanium plate fixation was applied to all patients.

RESULTS: Postoperatively the mJOA score raised up to 15.5. Mean recovery rate was 69%. Average 25.2 degrees correction of kyphosis was achieved in 21 patients. Among the postoperative complications, three cases (12%) had temporary C5 nerve palsy that was resolved in three weeks, two cases had (8 %) graft malposition and infection, and three cases (%12) had temporary donor site pain.

CONCLUSION: Excellent fusion rates can be achieved following two-level corpectomy with iliac bone graft repacement. This techique is easy, cost effective and safe. If the bone graft is harvested from the iliac crest by standart approach and between anatomical landmarks, most patients do not experience persistent pain at the donor site.

KEYWORDS: Two level corpectomy, Cervical, Iliac crest, Fusion, Plate fixation

ÖZ

AMAÇ: Literatürde iliak krest füzyonu ve rijit plak fiksasyonu ile beraber yapılan iki seviye vertebral korpektomi ile ilgili net bir literatür bilgisi yer almamaktadır. İki seviye vertebral servikal korpektomi ve rekonstrüksiyon deneyimimizi paylaşıyoruz.

YÖNTEM ve GEREÇLER: Herbir hasta Nurick Skalasına(1972) ve modifiye Japon Ortopedi Derneği (mJOA) Skalasına (1991) göre evrelenmiştir ve iyileşme oranları hesaplanmıştır. Tüm hastalar iki seviye vertebral korpektomi geçirmiştir.Anterior iliak krest grefti ve titanyum plak fiksasyonu tüm hastalara uygulanmıştır.

BULGULAR: Preoperatif Nurick skoru 4.13 iken postoperatif Nurick skoru 1.12 e geriledi. Preoperatif mJOA skoru 9.67 idi. Postoperatif mJOA 15.5 e yükseldi. Ortalama iyileşme oranı %69 idi. Ortalama 25.2 derece kifozda düzelme 21 hastada sağlandı. Postoperatif komplikasyonlar arasında , üç vakada(%12) meydana gelen geçici C5 sinir parezisi 3 haftada düzelirken iki vaka(%8) greft malpozisyonu ve enfeksiyon yaşadı, üç vakada (%12) geçici dönor alan ağrısı oldu.

SONUÇ: İliak greft yerleştirilmesi ve 2 seviye korpektomi sonrası mükemmel füzyon oranlarına ulaşılabilinir. Bu teknik kolay, ucuz ve güvenlidir. Kemik grefti standart yaklaşımla ve anatomik landmarklar arasından iliak krestten alınırsa birçok hasta dönor sahada inatçı ağrıyla karşılaşmayacaktır.

ANAHTAR SÖZCÜKLER: İki mesafe korpektomi, Servikal, İliak kanat, Füzyon, Plak fiksasyon

INTRODUCTION

Cervical spondylotic myelopathy (CSM) is the most common cause of cervical spinal cord compression in the elderly (23,33,37). Optimal surgical approach for multilevel CSM remains controversial.

Cervical laminectomy and/or laminoplasty is considered as the treatment of choice for patients who suffer with circumferential cervical spinal cord compression (19,33). Spinal cord and/or nerve root injury are among the complications of posterior cervical spine surgery that result in pain or neurological deterioration and may require re-operation (20,29). Anterior

approaches for cervical spine are considered for the patients who suffer predominantly with ventral spinal cord compression due to a herniated disc and/or osteophytic vertebral body endplates (10,30,33).

Although both autograft and allograft are the first choice for bony fusion, PEEK and titanium expandable cervical corpectomy cages can be considered occasionally (12,18). The neurological improvement rate of patients with CSM treated with corpectomy and bony fusion has been reported to be between 39–83% (10,30).

Following anterior cervical discectomy, anterior iliac crest is preferred in anterior cervical fusion (13,22). However we have not encountered a prospective clinical study for three level disc and two-body corpectomy with iliac crest fusion. This study is an effort to evaluate the functional outcome of two-body corpectomy in patients with CSM.

MATERIAL and METHODS

This is a single center retrospective clinical study that includes the medical records and radiological findings of 25 consecutive patients who underwent two level cervical corpectomy and iliac bone graft fusion between January 2004 and December 2008. Each patient was graded according to the Nuricks Grade (26) (Table I) and the modified Japanese Orthopaedic Association (mJOA) Scale (4) (Table II), and the recovery rate was calculated. All patients had two level anterior cervical corpectomy. Anterior iliac crest bone graft and titanium plate were used for fusion and stabilization in all patients. All patients underwent plain cervical X-rays, computerized tomography scans and magnetic resonance imaging studies pre-operatively and early post-operative plain cervical X-rays and late post-operative computerized tomography scans were obtained (Figure 1, 2).

During follow-up visits lateral neutral, flexion and extension plain cervical x-rays were obtained to assess bony fusion of the graft. The radiographs were reviewed by an independent radiologist to assess the fusion. Magnetic resonance imaging (MRI) of the C-spine was obtained in all cases. The most common levels of involvement were C4-C5 and C5-C6 (15 patients, 60 %) followed by C5-C6 and C6-C7 levels (10 patients, 40%). Patients were operated on by the main author. Two-level vertebral corpectomy was carried out with a high-speed drill. The defect was reconstructed with an autogenous iliac tricortical bone graft and the graft was fixed with titanium plates and screws. The iliac crest bone graft was harvested from the right side in each patient. The tricortical grafts had mild lordotic curve and were placed into the corpectomy defect under distraction. The mean length of the grafts was 5 cm (4.2-5.2). Post-operative motion exercises for neck were started at the post-operative fifth day. All patients wore cervical collars intermittently until the bony fusion of the graft was radiographically confirmed. The mean follow-up was 3.1 years (range 18 months to 5 years).

Student's t test was used for statistical analysis of the difference in the mean values of pre- and post-operative JOA scores and Nurick scale. The same statistical analysis was used in the comparison of pre- and post-operative alignment of the cervical spine. Statistical significance was set up at $P<0.05$

RESULTS

The mean age of patients suffering from CSM was 60.4 years (range 58–82 years). Men were three times more affected than women (M:F ratio 3:1).

The mean duration of disease was 14.5 months (range, 9–58 months). The duration of disease was mostly less than seven months (n = 18, 72%). The majority of the patients had an insidious onset of disease (n = 15, 60%). The patients were diagnosed with cervical MRI.

Preoperative and postoperative neurological evaluation of each patient is presented in Table III. 17 patients (68%) had neck pain, 3 patients had headache (12%), and 2 patients (8%) had giddiness. Postoperatively on final follow-up three patients (12%) had neck pain, and no patient had giddiness.

Preoperatively 21 out of 25 patients (84%) had pain radiating along upper limb, 19 patients (76%) had paresthesias along upper limb, 24 patients (96%) had weakness along upper limb, and 12 patients (48%) had problems with fine motor functions of either of the hands.

Postoperatively on final follow-up 3 out of 25 patients (12%) had radiating pain along upper limb, 2 patients (8%) had paresthesias along upper limb, 6 patients (24%) had weakness along upper limb, and 12 patients (48%) had problems with fine motor functions of either of the hands.

Preoperatively 23 out of 25 patients (92%) had a positive Hoffman reflex. Postoperatively 13 (52%) had a positive Hoffman reflex.

Preoperatively 12 out of 25 patients (48%) had paresthesias along lower limb, 20 patients (80%) had weakness of lower limbs, 20 patients (80%) had numbness of lower limbs, 6 patients (24%) had fasciculations of lower limb, and 20 patients (80%) had gait abnormalities (neurological claudication).

Postoperatively on final follow-up, 7 out of 25 patients (28%) had paresthesias along lower limb, 7 patients (28%) had

Table I: Grading of Cervical Spondylotic Myelopathy (Nurick, 1972)

Modified Nurick Classification (24)	
Grade 0	No root or cord symptoms
Grade I	Root signs or symptoms. No evidence of cord involvement.
Grade II	Signs of cord involvement. Normal gait.
Grade III	Mild gait abnormality. Able to be employed.
Grade IV	Gait abnormality prevents employment.
Grade V	Able to ambulate only with assistance.
Grade VI	Chair bound or bedridden.

Table II: Author's modification of Modified Japanese Orthopaedic Association Grading for CSM (1991)

Modified Japanese Orthopaedic Association Grading for CSM (1991)		
I.	**Motor dysfunction score of the upper extremity**	**Grade**
	Inability to move hands	0
	Inability to eat with spoon but able to move hands	1
	Inability to button shirt but able to eat with spoon	2
	Able to button shirt with great difficulty	3
	Able to button shirt with slight difficulty	4
	No dysfunction	5
II.	**Motor function score of the lower extremity**	
	Complete loss of motor and sensory function	0
	Sensory preservation without ability to move legs	1
	Able to move legs but unable to walk	2
	Able to walk on flat floor but with walking aid	3
	Able to walk up and/or down with handrail	4
	Moderate to significant lack of stability but able to walk up and/or downstairs without hand rail	5
	Mild lack of stability but walks with smooth reciprocation unaided	6
	No dysfunction	7
III.	**Sensory dysfunction score of the upper extremity**	
	Complete loss of hand sensation	0
	Severe sensory loss of pain	1
	Mild sensory loss	2
	No sensory loss	3
	Sphincter dysfunction score	
	Inability to micturate voluntarily	0
	Marked difficulty in micturation	1
	Mild to moderate difficulty in micturation	2
	Normal micturation	3

Total score = 18

Table III: Preoperative and Postoperatively Neurological Evaluations of Patients

	PREOPERATIVELY	POSTOPERATIVELY
Neck pain	17 (78%)	3 (12%)
Giddiness	2 (8%)	-
Headache	3 (12%)	-
Upper extremities		
Radicular pain	21 (84%)	3 (12%)
Paresthesia	19 (76%)	2 (8%)
Weakness	24 (96)	6 (24%)
Hoffman sign	23 (92%)	13 (52%)
Lower extremities		
Fasciculation	6 (24%)	5 (20%)
Paresthesia	12 (48%)	7 (28%)
Weakness	20 (80%)	7 (28%)
Neurological claduation	20 (80%)	4 (16%)
Numbness	20 (80%)	16 (64%)
Babinski sign	21(84%)	4 (16%)
Nurick's grade	4.13	1.12
mJOA score	9.67	15.5

weakness of lower limbs, 16 patients (64%) had numbness of lower limbs, 5 patients (20%) fasciculations of lower limb, and 4 patients (16%) had gait abnormalities. 8 out of 25 patients (32%) had lumbar spinal stenosis.

The number of patients with a positive Babinski's reflex also decreased postoperatively. Preoperatively 21 out of 25 patients (84%) had a positive Babinski's reflex. Postoperatively four (16%) had a positive Babinski's reflex.

Totally, 25 patients were followed and analyzed for radiographic fusion. Fusion had occurred at the end of 12 weeks in all cases but one. Delayed fusion was observed in only one patient, but there was no clinical symptom. The radiographic fusion was occurred at the 7 months. Mean total fusion time was 10 weeks.

The mean preoperative sagittal angle was 25.2 degrees of kyphosis (range: 13 to 38 degrees). The mean correction

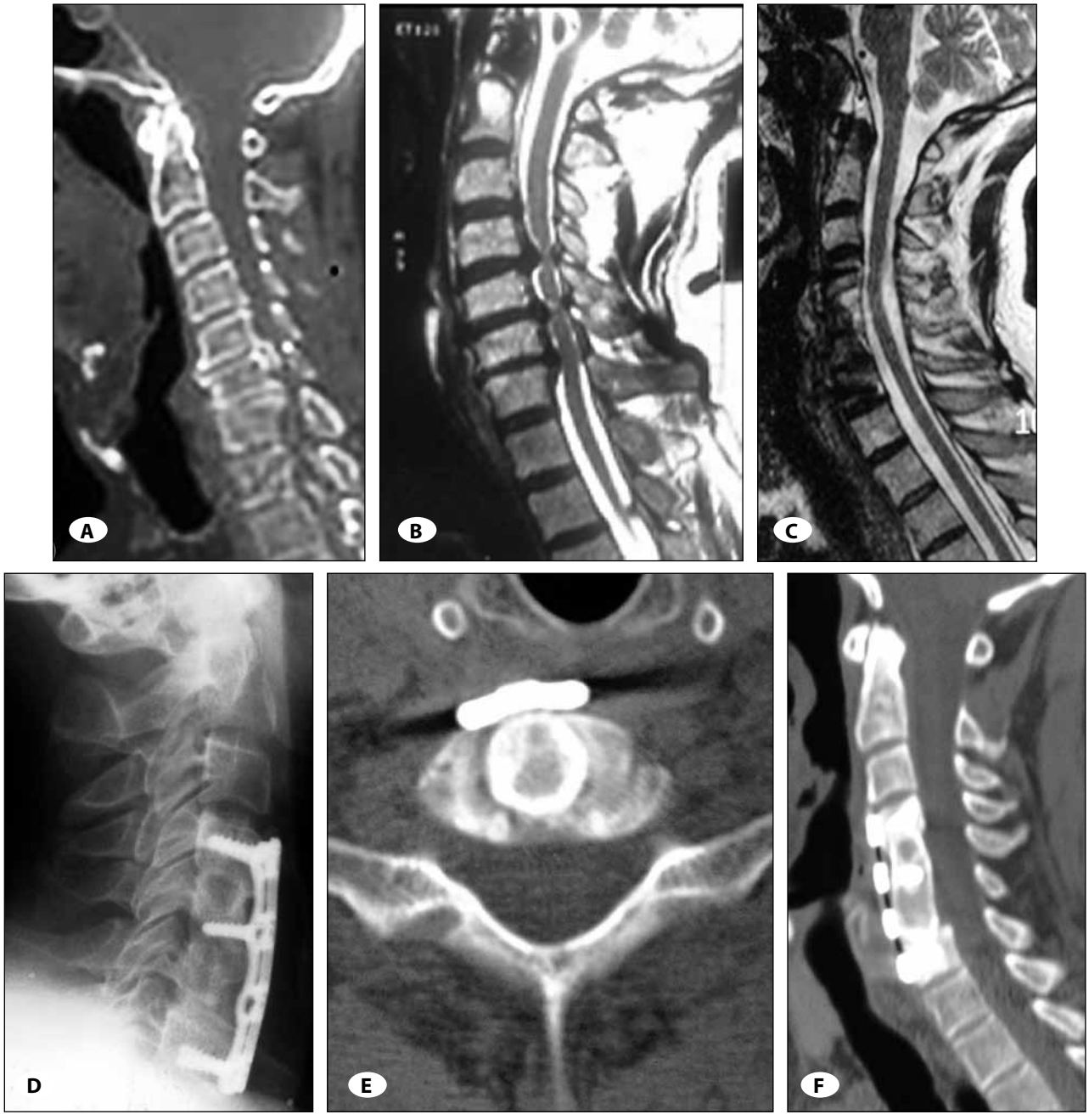

Figure 1: A) CT scan of the cervical spine (lateral view) showing cervical spondylosis and spondylotic ossification. **B)** T2W MRI (saggital section) showing cervical spondylotic myelopathy pre-operative. **C)** T2W MRI (sagittal section) showing post-operative period (2.3 years). **D)** Post operative X-ray cervical spine showing C5-C6 corpectomy, anterior iliac crest fusion and anterior cervical plate (2.3.years after the operation). **E-F)** Postoperative CT is showed to fusion and decompressed spinal canal.

Figure 2: X-ray cervical spine (lateral view) shows graft malposition.

of sagittal angle was 22 degrees (range: 5 to 36 degrees), resulting in a postoperative mean sagittal angle of 4-degree lordosis in 21 patients. 4 of 25 patients had same lordosis. There was no loss of correction across the instrumented segments in any patient.

The complications included C5 nerve palsy in three cases (12%), graft malposition in two cases (8 %), donor site pain in three cases (12%), donor site infection in two cases (8%) (superficial). None of the patients was reoperated for these complications, and all resolved. Dysphagia observed in 20 patients resolved spontaneously in two weeks.

The grafts were attached to the plaques with 3x8 mm screws in order to enhance graft stability and prevent graft extrusion.

The recovery rate after surgery was evaluated using the formula of Hirabayashi et al(19): Recovery Rate (RR,%) = Postoperative Score x Preoperative Score/18 - Preoperative Score) x 100.

RR (%)=15.5-9.67/18-9.67X100=69, RR:69%

Preoperative mean Nurick's grade of the patients was 4.13. Postoperatively the mean Nurick's grade decreased to 1.12. Moreover, preoperative mean mJOA score of the patients was 9.67. Postoperative mJOA score increased to 15.5 (Table III). The increase in mJOA scores after surgery was statistically significant ($p < 0.005$).

DISCUSSION

With this study we have shown that two-level CSM could be treated by two level corpectomy and iliac bone graft fusion. This is a more cost-effective surgical approach than other anterior cervical spinal surgery procedures for treatment of CSM. In this study donor site pain was an acceptable temporary discomfort rather than a postoperative morbidity.

CSM is the most common cause of non-traumatic spastic paraparesis and quadriparesis. Patients commonly become symptomatic when the cord is compressed by 30% or more (1,10,11,37). Decompressive surgery of the cervical spine has been the treatment of choice for CSM in patients with major neurological deficits. Excellent to good outcomes have been reported in many series in which anterior and posterior approaches were used (4,7,11,14-16,24,25,32). A careful review of the literature revealed a few studies in which fusion rates ranged between 34% and 97.4% after anterior decompression and fusion with either autograft (3) or allograft (12,21,27). However, in previous clinical studies (36) multilevel corpectomy along with bone graft fusion and plate fixation was associated with 9% failure rate. As the levels decompressed in multilevel corpectomy increase, so does the risk of possible post-operative complications. Under these circumtances, if more than two levels of corpectomy are involved, an additional posterior approach or halo immobilization is recommended, or posterior expansive laminoplasty instead of anterior decompression is considered (14).

Corpectomy has emerged as an excellent surgical modality for CSM treatment. In our study, the Nurick's Score decreased from 4.33. to 1.12. In other studies, Chagas et al (8) and Rajashekar and Kumar (28) reported mean Nurick Score improvements following corpectomy (8). This procedure also increases the mJOA score and the quality of life and activities of daily living. In our study, the increase was from a preoperative score of 9.67 to 15.50. In a similar study of Chibbaro et al, an improvement of mJOA score from 12.2 to 15 was observed (9).

The choice of allograft or autograft use in anterior cervical fusion operations has been widely discussed. Autograft use results in increased arthrodesis rates and graft collapse is rarely seen (5,22). However, autograft harvest has an acceptable morbidity rate. Allografts avoid the morbidity associated with autograft harvest but result in decreased arthrodesis rates and increased graft collapse rates. The decreased arthrodesis rate associated with allografts becomes more significant in multilevel surgery and in patients who smoke (12). Although we have not questioned the patients for smoking in our series, we accomplished the fusion in all cases at the end of the 3rd postoperative month.

Higher rates of fusion have been reported with autograft than allograft. For patients requiring multilevel reconstruction surgery, fusion rates of approximately 100% have been achieved using autogenous strut grafts from the iliac crest and fibula, with a lower rate of incorporation for fibula allograft (5,22,27). Since the fibula is biomechanically and functionally more important than iliac crest bone, iliac crest bone graft has been the first choice in this study.

Since the iliac crest bone graft harvesting has been associated with some morbidity and complications, new graft harvesting methods has been described (2,6,13,17,18,34). The incidence of donor site pain varied between 10 and 43% (2,17,18). The majority of patients suffered only mild to moderate acute pain. At long-term follow-up, all patients became pain free. Postoperative donor site parasthesia was also a significant problem, and graft harvesting should be done by the senior surgeon. Since the major problem in these patients is donor site pain, local anesthetic infiltration (0.5% Marcain, 10 cc) to the donor site is recommended for all patients to reduce acute post-operative donor site pain. We had three cases that had donor site pain, and 2 out of 25 patients had donor site infection.

Donor site pain was 17.4% at 15 weeks in the Pollock et al. series (13). In our series this was 12% at 24 weeks.

Recovery rates in our study were 69 % ± 43%. In a study by Sorar et al, 85% of patients experienced 50% or more recovery rate (35). Similarly Vyas et al have reported recovery rates of 66.9% following corpectomy (26).

Fusion is usually accomplished in 6-12 months after anterior intervertebral bone grafting along with the formation of cervical lordotic curvature. Satisfactory bony fusion developed in all of our patients. Since the ventral site of the harvested iliac crest bone graft is usually concave mild to moderate lordotic curvature was accomplished in all our patients. The titanium plate curvature is more important than bone graft (6). An average of 25.2 degrees of kyphosis correction was achieved in 21of 25 patients.

In this study three patients experienced unilateral deltoid weakness post-operatively due to C5 nerve root palsy. All patients recovered completely at the postoperative third week In different studies most patients experiencing C5 nerve root palsy recovered completely in a few weeks (3,31).

Unless three or more level corpectomy is required, anterior column support after corpectomy can be restored by anterior iliac crest strut grafts (6). With iliac crest strut graft, it is hard to maintain the lordotic position of the cervical spine because it has no lordotic curve.

CONCLUSION

Two level CSM can be treated effectively with gratifying results with anterior iliac crest bone graft fusion technique. The procedure has relatively better results and is very cost effective when compared to other surgical modalities fort he treatment of CSM. Donor site pain may be an acceptable discomfort rather than a complication.

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