The Value of Corpectomy and Fusion With or Without Plating in the Surgical Treatment of Lower Cervical Spine Fractures

Alt Servikal Omurga Kırıklarının Cerrahi Tedavisinde Korpektomi ve Plaklı ya da Füzyonun Değeri

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Abstract: *Objective:* The aim of this study is to evaluate retrospectively the results of 37 patients who underwent anterior cervical corpectomy due to cervical spine fractures and fracture-dislocations.

Methods: Skeletal traction with skull tongs was applied in 24 patients who had fracture-dislocations prior to surgery. Anterior interbody fusion was performed in 13 patients using iliac autograft (Group I), and additional plating in 24 patients (Group II) for stabilisation of cervical spine after corpectomy. The patients were scored neurologically according to the functional grading scale of Benzel and Larson in order to assess the existence of correlation between timing of surgery and functional recovery during the follow-up.

Results: The success of reduction was 75 %. Four patients (10.81 %) died postoperatively. Of 29 out of remaining 33 patients with complete and incomplete deficit, 23 (79.31 %) showed at least one grade of functional recovery. There was no significant correlation between timing surgery and functional recovery ($p>0.05$). Among patients of group I, a total of 5 patients developed complications; three (23.07%) underwent revision surgery for early anterior graft dislodgement, while 2 (15.38%) developed an anterior kyfotic deformity. No such complication was observed in the patients of group II, which did differ significantly when compared to group I ($p<0.05$).

Conclusions: It seems that anterior cervical corpectomy, when combined with plate and bone fusion, is appropriate for decompressive surgery in selected patients in the

Özet: *Amaç:* Bu çalışmanın amacı, servikal omurgada kırık ve kırık-dislokasyon nedeni ile anterior servikal korpektomi yapılan 37 hastanın sonuçlarını retrospektif değerlendirmektir.

Yöntem: Servikal omurunda kırık-dislokasyonu olan 24 hasta, cerrahiden önce kafatası kancaları ile iskelet traksiyonuna alındı. Korpektomiden sonra servikal stabilizasyonu sağlamak amacı ile, 13 hastada (Grup I) iliak kemik otogrefti kullanılarak anterior füzyon yapılırken, 24 hastada (Grup II) bunlara ek olarak plaklama yapıldı. Hastaların takip döneminde cerrahi zamanı ile nörolojik iyileşme arasında bir korelasyon olup olmadığı Benzel ve Larson derecelemesi skalası kullanılarak değerlendirildi.

Bulgular: Kırık-dislokasyonu olan hastalarda redüksiyon başarı oranı % 75 idi. Dört hasta (%10.81) post-operatif dönemde kaybedildi. Geri kalan 33 hastanın 29'u tam veya kismi nörolojik defisite sahipti ve buların 23'ü (% 79.31) en az bir derece fonksiyonel iyileşme gösterdi. Cerrahinin zamanı ile fonksiyonel nörolojik iyileşme arasında anlamlı bir korelasyon saptanamadı ($p>0.05$). Grup I'deki hastaların 5'inde komplikasyon gelişti. Bunların 3'ünde (%23.07) postoperatif greft kayması nedeni ile revizyon yapılırken, 2'sinde (%15.38) anterior açılanma deformitesi saptandı. Benzer bulgular grup II'deki hastalarda gözlenmedi. Bu, grup I' deki hastalarla karşılaştırıldığında istatiksel olarak anlamlı idi ($p<0.05$).

Sonuç: Kemik füzyon ve plaklama ile anterior servikal korpektomi, servikal omur kırığı ve kırık

treatment of cervical spine fractures and fracture-dislocations.

Key Words: Anterior fusion, Cervical spine trauma, Corpectomy, Fracture-dislocation, Instrumentation.

dislokasyonlarında dekompresyon sağlamak amacı ile uygun bir yaklaşım olarak görülmektedir.

Anahtar Kelimeler: Anterior füzyon, Servikal omur travması, Korpektomi, Kırık-dislokasyon, Enstrümantasyon,

INTRODUCTION

The goal of treatment of cervical spinal injuries is decompression of neural elements, realignment and stabilisation of cervical spine. The closed reduction of segmental fracture-dislocation with skull tongs is applied for early decompression of spinal cord and as a method of conservative treatment (9,11,22). The most widely accepted and applied surgical approach for the treatment of cervical fractures, since its introduction by Cloward (10), and Bailey and Badgley (2) has been anterior fusion by use of bone graft. Alternatively, preference has been given to anterior cervical corpectomy for achieving extensive decompression of the neural elements and avoidance of possible complications to neural and vascular structures in cases with spondylotic myelopathy, ossification of the posterior longitudinal ligaments, postlaminectomy kyphosis and lower cervical fractures (7,16,19,21).

Bone graft extrusion and angulation are the most common complications after anterior fusion (10,20,28), so metal plate fixation to supplement the fusion has often been applied for achieving more effective stabilisation and early mobilisation of patients with cervical unstable fracture-dislocations (7,14,15,18,28).

Our aim was to evaluate retrospectively the results of 13 patients undergoing anterior spinal fusion with autogenous iliac bone graft and those of 24 patients undergoing additional plate application after corpectomy, following rapid skeletal traction in the majority of cases.

MATERIALS AND METHODS

During the period 1989-1999, corpectomy was performed on 37 patients with lower cervical spine fracture, fracture /dislocation in the Neurosurgical Department of Osmangazi University. Thirty-six patients had a single level corpectomy except one with two levels (Fig. 1). Twenty-three patients were male and 14 female. Aetiology for the cervical trauma of 37 patients was as follows; traffic accidents for 25 patients, falls for 9, diving in a shallow pool for one, the collapse of a building due to earthquake for one and a fight for one. In the evaluation of cervical pathologies, a cervical plane radiogram was taken from all patients, as well as computed tomography from 22 and magnetic resonance imaging from 18 patients. There were fracture-dislocations in 24 patients, burst fracture in 8, unstable tear-drop fractures with pedicle in 2 and compression fractures with instability in remainders. The average age was 40 ± 12 years. Our protocol was urgent application of skeletal traction on admission, when dislocation of cervical spine was identified. Twenty-three patients underwent skeletal traction by means of skull tongs, beginning with a weight 5 kg up to 9 kg (approximately 1.5 kg ˜ for each vertebrae above dislocation) within the first day, checking the reduction of dislocation by serial lateral cervical plain radiogram. If correction of cervical alignment was not achieved, the weight was increased to a maximum of 13 kg over a few days. In the event the reduction was still unsatisfactory, a decision was made for anterior decompression. A standard anterior approach to the cervical column was applied

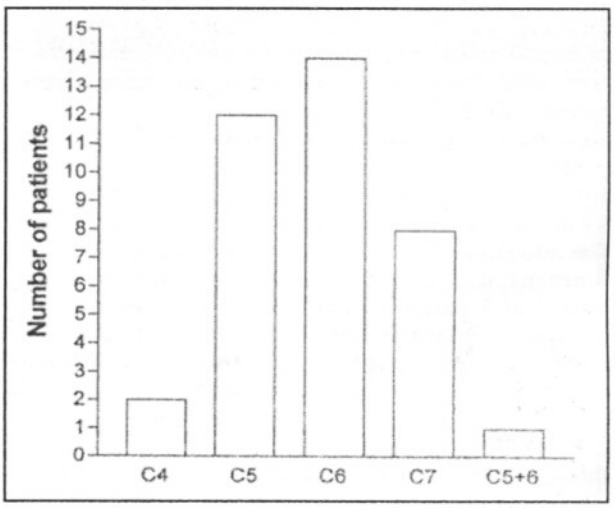

Figure 1: The levels of corpectomy in all patients.

to remove affected vertebrae and discs, including their upper and lower surfaces (10). Corpectomy was carried out with rounger and high-speed drills under an image intensifier. A tricortical bone graft of the required dimension taken from one iliac crest was inserted into the space created by vertebral body removal and discs under traction of neck. A fibular graft was used as a fusion material in a patient who underwent two level corpectomy. In addition to 13 patients (Group I) undergoing fusion procedure, a metal plate was inserted into the anterior aspect of the body of the adjacent vertebrae including the graft in 24 patients (Group II). In seven of the latter, corticospongy screws were used for plating (Anterior cervical osteosynthesis system, Biomat, Fig. 2), and recently medullary-locked screws (Aline anterior cervical plate system, Surgical Dynamics. Fig. 3) in the remainder. Following the operation, traction was reduced to between 0.5-1 kg for over 1 week in the patients of group I. The patients in group II were routinely mobilised with plastic cervical collar within 3 days, and those in group I, six weeks after operation.

Average follow-up was 38 months (3-120 months) in group I and 24 months (5-42 months) in group II. Cervical plain radiograms were reviewed for evaluation of fusion and/or instrumentation. On admission and during the follow-up period, the patients were scored neurologically according to the functional grading scale of Benzel and Larson (4) (Table I).

Table I: Neurological grading system of cervical injuries with regard to myelopathic function.

Grade	Description
Grade I	Complete-Functional Neural Transection
Grade II	Motor Complete; no voluntary motor function below the level of injury with preservation of some sensation

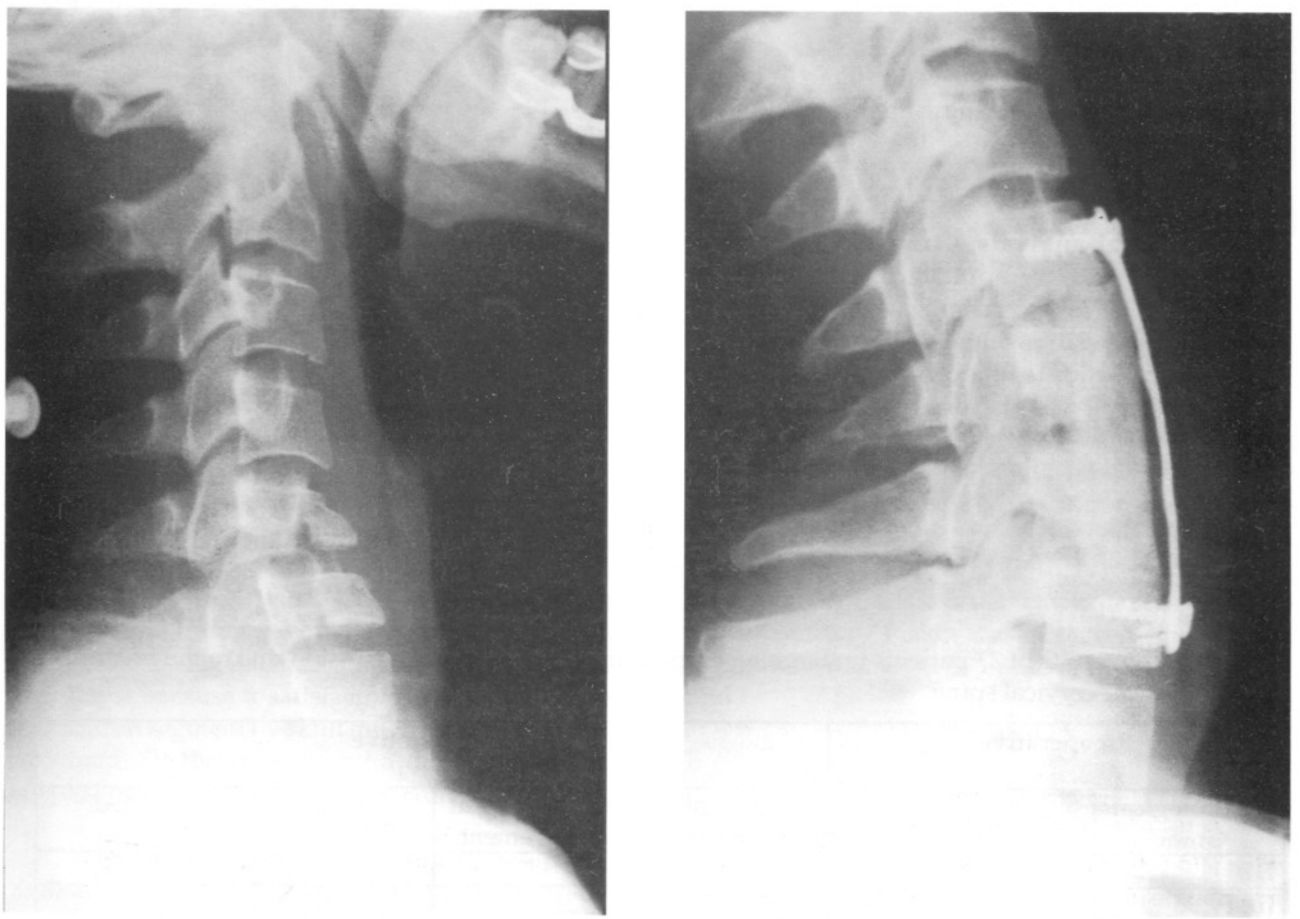

Figure 2: Tear-drop fractures of C6 and C7 as well as C6-7 fractures-dislocation in a patient undergoing corpectomy at those levels. a) The preoperative lateral view, and b) 16 months after anterior bone fusion and stabilisation with the corticospongy screws.

Grade III	Motor Complete-Nonfunctional; minimal non-functional voluntary motor function below the level of injury
Grade IV	Motor Incomplete-Functional- Unable to walk; some functional motor control below the level of injury that is significantly useful for patient's assistance in transfer, but that is not sufficient for independent walking
Grade V	Motor incomplete-Functional- Limited walking; motor function allows walking with assistance or unassisted, but significant problems secondary to lack of endurance or fear of falling limit patient mobility
Grade VI	Motor Incomplete- Functional; ambulatory without assistance and without significant limitations other than one or both of the following: Difficulties with micturition or slightly discoordinated gait
Grade VII	Normal; neurologically intact with the exception of minimal deficits that cause no functional difficulties

Statistical analysis: Correlation and linear regression tests were applied, using a software programme (24), for ascertaining whether there were correlation or relationships between neurological recoveries in relation to time of operation. Chi-square fisher's exact test was also used for the comparison of complications between the groups of I and II (GraphPad Software, Inc). Statistical significance was defined by a p value <0.05.

Figure 3: Lateral cervical radiograph of the patient showing bone fusion at 6 months after plating with medullary-locked screws.

RESULTS

A successful reduction of dislocation was achieved in 18 out of 24 (75 %) patients; in the remainder, reduction failed in 6 patients. On

Table II. The results of 37 patients undergoing corpectomy and anterior bone fusion due to the fractures of lower cervical spine.

Preoperative		Postoperative		
Neurological Grade	Number of patients	Number of patients showing at least one grade improvement	Unchanged	Died
I, II	10	4	2	4
III, IV, V	18	14	4	-
VI	5	5	-	-
VII	4	-	-	-
Total	37	23	6	4

admission, the neurological functional grades of the patients was summarised in Table II. Ten patients had complete motor myelopathy (grade I and II). Of these 4 died postoperatively due to respiratory and cardiac arrest and 2 was unchanged. Four patients showed a neurological improvement in this group. Of 18 patients with incomplete myelopathy (Grades; III, IV and V), 14 showed neurological improvement. Five patients who were of grade VI showed functional improvement during follow-up. As a result, of the 29 patients with neurological deficit, improvement occurred in 23 (79,31 %) patients.

There was no correlation between the interval

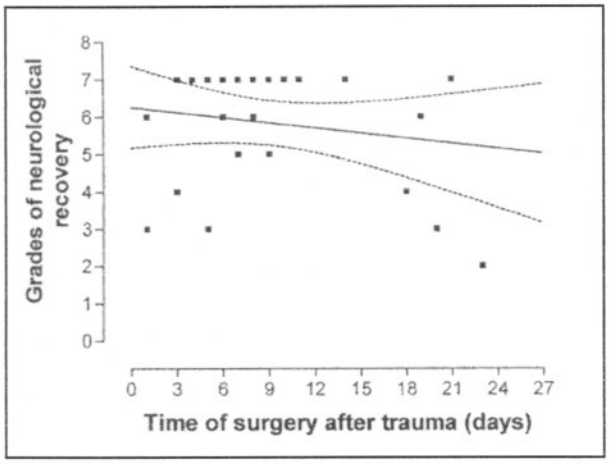

Figure 4: Graph of regression analysis showing no significant relationship between the interval from trauma to operation and the grades of functional recovery in 29 patients available for follow-up (r^2:0.03317, two-tailed P: 0.3443).

from injury to operation and functional recovery in the 29 patients whom we were able to follow up, except those patients were at grade VII on admission (Pearson r: -0.1821, P: 0.3443, Fig. 4). The mean interval from trauma to operation was 8.62 days in these patients. Six patients were operated on earlier (1-3 days) because a satisfactory alignment of the dislocation segment by skull tong was not able to be obtained. Of the patients who did not undergo skeletal traction, 8 had a burst fracture.

Complications and Fusion: Follow-up was available in 33 patients. In all series, 2 patient developed temporary dysphagia and 2 transient recurrent laryngeal nerve palsy (5.7 %). In the group I, 5 patients developed complications; three (23.07

Figure 5: Lateral radiograph of cervical spine demonstrating angular kyphotic deformity in a patient undergoing anterior bony fusion alone, after ten years operation.

%) underwent revision surgery because of graft displacement in early period, while 2 (15.38%) developed kyfotic deformity during the follow-up (Fig. 5). No such complication was observed in the group II, which did differ significantly from group I ($p<0.05$). In the remain patients of group I, a satisfactory fusion was observed (Fig. 6). The fusion rate was 93.93 % in the patients of group II and I.

DISCUSSION

Since the application by Crutchfield (11) in 1936, reduction of cervical dislocation with skull tongs is preferred not only to secure the more mobile spine but also to achieve rapid decompression of the spinal cord prior to operation or prolonged conservative treatment (17,22) Although there is no agreement regarding traction weight, for which 160 lb is

Figure 6: Lateral cervical radiograph showing solid fusion without plating 4 years after operation.

recommended as a maximum in terms of safety (25), we applied the skull tongs with weights starting at 5 kg and increasing to 9 kg for the first day of the patient's admission, up to a maximal weight of 13 kg within a few days where realignment was unsatisfactory. In the study of Bohlman (5), the extent of the damage to the spinal cord was not found to correlate well with the clinical patterns of loss of neuronal function observed at the autopsy of patients dying due to cervical injury. However, contusion of the spinal cord and mechanical compression seem to be major factors for the loss of neurologic function in patents with incomplete cord lesion, on the basis of the examination of pathological specimens and results of operations. A similar conclusion comes from Lee et al (22), that rapid reduction of unilateral and bilateral facet dislocations offers the best chance of neurological recovery in patients with neurologic deficits. This outcome probably results from the fact that reduction may decompress the blood supply of the spinal cord and minimizes ischaemic and hypoxic damage (27). The success of reduction is 75 % for patients undergoing skeletal traction by means of skull tongs. If realignment of segmental dislocation is not obtained satisfactorily by this method, as observed in 6 patients, the operative procedure should be performed without delay. Of 13 patients where skull traction was not applied, 8 had a purely compression fractures. It has been already noted that skull traction is not effective in reducing posterior dislocation of the vertebral body in the majority of compressive injuries (8,12).

There is still controversy as to the appropriate timing of surgical decompression and stabilisation for cervical spine fractures or instability. Our results accord with those of previous studies in which the timing, namely early or delayed, was not found to be a prognostic factor in the surgical treatment of cervical spinal injuries (23,29,30). We believe that the most appropriate time for surgery and stabilisation is the second week in cases where effective reduction is achieved, because cord oedema reaches a maximum within a few days and remains at this level through 7 days in the spinal cord trauma model of animals (13,31). The realignment of cervical spine by reduction and anti-oedematous treatment prior to operation may permit more reliable graft placement and instrumentation, avoiding possible complica+tions to neural structures.

In the present study, anterior graft displacement occurred in three patients of group I (23.07%), of which one underwent plate stabilisation at revision surgery. Angular deformity occurred in two patients of this group (15.38 %) after anterior antibody fusion without plating, as has been reported (3,20,26). Once reported (8,12,14,15), anterior plate fixation combined with bone fusion after corpectomy seems to be the best method for stabilisation of cervical fractures or instability since we observed no such complications in the patients of group II. The loosening of cortical type screws was seen in some patients with disc disease who underwent anterior bone fusion with allo fibular graft by Cloward procedure (unpublished data), after which cortical locking type screws started to be used in all plate applications. No such complication was encountered in the patients who underwent plate stabilisation with the same screws system combined with bone fusion with iliac crest graft after corpectomy. No difference regarding fusion rates or complications was found to be associated with allo- and autograft in corpectomies (15). A fibular graft has been

recommended, however, for multilevel corpectomies (14) since the iliac autograft is seen to fracture in some cases of multilevel fusion (1). We opted to use autogenous iliac crest bone as a graft material because the highest fusion rate is reported in association with this type of graft material (15).

In our series, 79.31 % of patients with complete or incomplete deficit showed neurological improvement. This rate is reported in the series of Bohlman and Anderson to be 66.6 % in patients with cervical trauma after corpectomy (6). In the study of Eleraky et al (15), neurological functional recovery was seen in 86.5% of patients with a variety of cervical diseases, including trauma, after single or multilevel corpectomy. In conclusion, cervical corpectomy in selected patients with cervical fractures and fracture-dislocations is a satisfactory procedure when combined with plate fixation and anterior bone fusion with autogenous grafting.

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A prospective multicenter study of cervical spine injury in children.

Viccellio P, Simon H, Pressman BD, Shah MN, Mower WR, Hoffman JR; NEXUS Group.

The lower cervical spine is the most common site of cervical spine injury (CSI) in children, and fractures are the most common type of injury. CSI is rare among patients aged 8 years or younger. The NEXUS (the National Emergency X-Radiography Utilization Study - The presence or absence of the following criteria was noted: midline cervical tenderness, altered level of alertness, evidence of intoxication, neurologic abnormality, and presence of painful distracting injury) decision instrument performed well in children, and its use could reduce pediatric cervical spine imaging by nearly 20%. However, the small number of infants and toddlers in the study suggests caution in applying the NEXUS criteria to this particular age group.