Anterior cervical approach for decompression and fusion in middle and lower traumatic cervical fractures

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Abstract:

Objectives: The aim of this report is to establish the efficacy of anterior cervical decompression fusion (ACDF) in patients with traumatic lesions of the middle and lower segments of the cervical spine. The goals of surgical treatment are: maintenance of neurological function, prevention of additional functional loss and restoration of spinal stability with bony fusion

Materials and methods: Between 2007 and 2014, a total of 35 patients (27 male and 8 female) with trauma to the middle and lower cervical spine were treated in our clinic. The operative levels were C3-C4 in 3 patients, C4-C5 in 7 patients, C5-C6 in 15 patients, C6-C7 in 9 patients and C7-D1 in 1 patient. The preoperative degree of neurological deficit was evaluated with Frankel scale. According to the Frankel scale, 4 (11.4%) patients were grade A; 6 (17.1%) were grade B, 5 (14.3%) were grade C, 8 (23%) were grade D and 12 (34.2%) patients were grade E. The average preoperative VAS was 8.

The majority (30 of 35 patients) were investigated with MRI scan. All patients underwent ACDF using a Peek cervical cage and titanium plate fixation, and in 11 cases the operation was performed after application of cervical traction. The follow-up period ranged from 12 to 24 months with clinical and radiological evaluation.

Results: After the ACDF, 4 (11.4%) patients with complete lesion cord remained unchanged; 4 (11.4%) were grade B, 3 (8.6%) were grade C, 10 (28.6%) were grade D and 14 (40%) patients were grade E. Of patients with E grades, 5/14(36%) had isolated radiculopathies; 3/5(60%) patients recovered totally and the neurologically intact patients remained unchanged. The mean postoperative VAS at the latest follow-up was 8. The follow-up showed good clinical and radiological outcome and body fusion. For 32 patients, the follow-up was at 24 months. In this group, fusion occurred in 31/32 patients (97%) (Fig 2-4). No wound complications or infection were present.

Conclusion: Our study shows that ACDF with fusion and titanium plate fixation can be considered a safe and effective technique to restore the stability of traumatic lesion of middle and lower cervical spine.

Keywords: ACDF, Peek Cage, Cervical spine lesions
Introduction

The anterior approach to cervical decompression was first described by Cloward(2) and Robinson and Smith(9) in the 1950s. Both described an anterior approach via a longitudinal incision along the anterior border of the sternocleidomastoid muscle to allow for soft tissue dissection and annular incision. Following discectomy and removal of any compressive structures, fusion was then achieved using an autogenous graft.

The most important developments in anterior cervical surgery are related to the introduction of anterior cervical instrumentation with technologies that have evolved steadily over the last 40-50 years. In 1960, Bailey and Badgley expanded the usage of ACDF to treat neoplasm and instability(3). The anterior cervical plates were developed by Declos and Tapies in 1970, and they were the first to be used in an unstable cervical lesion induced by a trauma(21). The plates and screws system was subsequently improved by the studies of Caspar who developed a system of trapezoidal anterior stabilization that improved the fusion after the trauma(6).

The apposition of a plate, in theory, determines an immediate stabilization, prevents the extrusion of the graft and reduces the necessity of an additional cervical external stabilization to the surgical procedure. Furthermore, an anterior stabilization with plates helps to reconstitute the sagittal alignment of the cervical spine and prevents the collapse of the graft and its expulsion. The purpose of this study is to analyze the results in terms of neurological outcome, fusion rates, symptomatic adjacent-segment disease, complications following ACDF with cage in Peek, and use of titanium plate fixation with bicortical screws in treatment of traumatic lesions of the middle and lower cervical spine.

Materials and methods

Between 2007 and 2014, a total of 35 patients (27 male and 8 female) with a mean age of 48 (aged between 18 and 78 years) with trauma to the middle and lower cervical spine were treated in our clinic. The cause of the trauma was due to a road accident in 20 patients, a fall from a height in 10 patients and a dive in water in 5 patients. The operative levels were C3-C4 in 3 patients, C4-C5 in 7 patients (Fig. 1), C5-C6 in 15 patients, C6-C7 in 9 patients (Fig. 3) and C7-D1 in 1 patient.

The AO classification showed type A injury in 24 patients, type B in 7 patients and type C in 4 patients.

<table>
<thead>
<tr>
<th>Type-A injuries</th>
<th>Failure under axial compression of the anterior elements with intact posterior constraining elements</th>
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<tr>
<td>Type-B injuries</td>
<td>Failure of the posterior constraining elements</td>
</tr>
<tr>
<td>Type-C injuries</td>
<td>Failure of anterior and posterior elements leading to displacement</td>
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</tbody>
</table>
The preoperative and postoperative degree of neurological deficit was evaluated with the VAS and Frankel scales. All patients had severe pain at the site of lesion and the preoperative VAS was 8. According to the Frankel scale, 4 patients were grade A, 6 were grade B, 5 were grade C, 8 were grade D and 12 patients were grade E (Table 1).

Table 1: The Frankel scale for spinal cord Injury that classifies the extent of the neurological/functional deficit into five grades

<table>
<thead>
<tr>
<th>Frankel scale</th>
<th>Preoperative neurological status</th>
<th>Postoperative neurological status</th>
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<tbody>
<tr>
<td>A Complete</td>
<td>No motor or sensory function below level of lesion</td>
<td>4(11.4%)</td>
</tr>
<tr>
<td>B Sensory only</td>
<td>No motor function, but some sensation preserved below level lesion</td>
<td>6(17.1%)</td>
</tr>
<tr>
<td>C Motor useless</td>
<td>Some motor function without practical application</td>
<td>5(14.3%)</td>
</tr>
<tr>
<td>D Motor useful</td>
<td>Useful motor function below level of lesion</td>
<td>8(23%)</td>
</tr>
<tr>
<td>E Recovery</td>
<td>Normal motor and sensory function, may have reflex abnormalities</td>
<td>12(34.2%)</td>
</tr>
</tbody>
</table>

The majority (30 of 35 patients) underwent an MRI scan. All patients underwent ACDF using a Peek cervical cage and titanium plate fixation. In 11 cases, the operation was performed after application of cervical traction. The follow-up period ranged from 12 to 24 months with clinical and radiological evaluation.

Results

After the ACDF, 4 (11.4%) patients with complete lesion cord remained unchanged; 4 (11.4%) were grade B, 3 (8.6%) were grade C, 10 (28.6%) were grade D and 14 (40%) patients were grade E. Of patients with E grades, 5/14 (36%) had isolated radiculopathies, 3/5 (60%) recovered totally, and the neurologically intact patients remained unchanged. The mean postoperative VAS at the latest follow-up was 2. The length of post-operative hospital stay was three days for patients in D/E grade of the Frankel scale and two or three weeks for other patients. All patients received a Philadelphia collar for thirty days. Radiographic outcomes with respect to segmental stability were excellent.
For 32 patients, the follow-up was at 24 months. In this group, fusion occurred in 31/32 patients (97%) (Fig 2-4). Three patients were not included due to a too short follow-up period. There were no wound complications. One patient had a transitory dysphagia. At the latest follow-up we found no cases of screw breakage.

Discussion

Cervical spine injury is the most frequent problem in young adults with a male predominance. The goals of surgical treatment are: maintenance of neurological function, prevention of additional functional loss and restoration of spinal stability with bony fusion. Road accidents are the most frequent cause of spinal cord lesions(20), and in our study road accidents were the cause of trauma in 20 patients.

The rationale for the use of screw-plate system is that patients who receive these implants may require shorter hospitalizations and may return to normal socio-economic activities earlier than those undergoing cervical fusion procedures without plating.

The appropriate selection of position and length of the screws is important. In our procedures we used bi-cortical screws, although several issues stressed the concept of damage to the spinal cord with the use of bi-cortical screws(7-19). No spinal cord injury was present in our study.

We had a good restoration of spinal alignment and adequate stabilization during the follow-up period. The risk related to screw-plate stabilization of cervical spine includes all of those associated with an anterior cervical discectomy: injury to branches of the vagus nerve, dysphagia, radicular or myelopathic injury, cerebrospinal leakage, anterior or posterior migration of cage, screws and plate fracture, post-operative hematoma, tracheoesophageal lesions, vascular injuries and infection. Oesophageal injuries are rare, but have dreaded complications. Injury to the recurrent laryngeal nerve is considered the most common neurological complication after anterior cervical spine surgery, and the incidence varies between 0.2 and 11%(5-15). In anterior cervical discectomy and fusion (ACDF), Flynn reported an incidence of 0.05% of postoperative spinal cord injury(11).

The placement of a bone graft is a potential trauma to the spinal cord. The depth of the bone graft should be less than that of the vertebral body. Autologous bone graft has been used in cervical anterior procedures for more than 50 years.

A frequently reported complication of autologous grafting from the iliac crest is post-operative pain at the donor site reported in about 22%. Other complications include wound infection, hematoma, pelvic fracture and nerve palsy at the donor site region. A valid alternative to avoid this morbidity is represented by use of allografts, but their use is too expensive. For all these reasons in recent years there has been an increase in the use of cages of different materials.

The incidence of nerve root palsy has been estimated to be 0.17%(11). Ventral decompressive procedures have reported rates of radiculopathy from 2 to 15% caused from symptomatic adjacent–segment disease(22). Hilibrand et al.
followed, in a consecutive series for twenty years, 374 patients who had a total of 409 anterior cervical arthrodesis for the treatment of cervical spondylosis and report a constant incidence of a symptomatic adjacent–segment disease of 2.9% per year (16). Ishihara, in a series of 112 patients followed for more than 2 years, report an incidence of symptomatic adjacent–segment disease from 7% to 15%(17). In the present study, 5 of 10 patients (14.3%) followed for 24 months had a permanent radiculopathy caused by a traumatic lesion of the root nerve.

Vascular injuries can occur during ventral approaches to the cervical spine. The carotid artery may be torn during exposure and may be occluded due to excessive retraction; vertebral artery injury can occur if the dissection is taken too far laterally (14-25). The reported incidence of this ranges from 0.3 to 0.5% of cases(12-14-25).

Coe and Vaccaro in their review of literature, reported that the prevalence of screw and plate loosening was between 0 and 15.4%, the prevalence of screw fracture was between 0 and 13.3%, the prevalence of plate fracture was between 0 and 6.7%, the prevalence of plate and graft displacement was between 0 and 21.4%, and the prevalence of implant malposition was between 0 and 12.5%(10). Fortunately, infection after cervical spine fusion is uncommon, with a prevalence ranging from 0 to 4.5%(28).

Many clinical studies have reported high fusion rates with anterior cervical plates (4-26-27). In several trials the fusion rate is reported from 90-100% for single level implant and from 70-95% for multilevel procedures(13-24). Cheng et al. reported a fusion rate of 100% in a series of 17 patients(8). Ripa et al. and Aebi et al. reported a fusion rate near to 100% in their series(1-23). In contrast, Johnson, in a group of 87 patients, describe a fusion rate near 93% and incomplete fusion in 27% patients(18). The fusion in our study was of 97% (31 of 32 patients); in three patients the follow-up period was too short for establish an adequate fusion rate. In our study we had no complications, in contrast to other studies in which is reported a rates of complications from 2-3% to 17%. Only one patient experienced a transitory dysphonia.

The results of our study, in line with the literature, shows that the ACDF with the use of cervical cage and titanium plates, is safer and without complications with respect the use of autologous bone graft, and has the same favourable clinical outcome and fusion rates.

**Conclusion**

The effective surgical treatment of instability and operative strategies are directed at decompressing neural structures, fixating unstable segments and preserving as much normal cervical mobility as possible. A good understanding of the biomechanics of the implant and the cervical spine is essential to selecting the appropriate plating system for anterior cervical spine surgery. Our study shows that ACDF with fusion and titanium plate fixation can be considered a safe and effective technique to restore the stability of traumatic lesions of the middle and lower cervical spine.
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References

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Figures:

Preoperative X-ray and MRI showing traumatic C4-C5 subluxation (fig: 1)

Post-operative X-Ray of a traumatic C4-C5 subluxation (fig: 2)
Traumatic instability C6-C7. Preoperative CT Scan (fig. 3)

Post-operative X-Ray of a traumatic instability C6-C7 (fig. 4)