Neurological outcome following early versus delayed lower cervical spine surgery

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ABSTRACT

**Purpose.** To determine whether the timing of surgery affects neurological outcome in patients with lower cervical spine trauma.  

**Methods.** 29 patients with a fracture and 38 with a fracture-dislocation of C3 to C7 cervical vertebrae were treated operatively during the inclusive period January 1987 to December 2000. Surgery was performed as soon as the patient’s medical condition allowed, within 72 hours in 31 and more than 72 hours after the injury in 36.  

**Results.** Only patients with incomplete spinal cord injury had neurological improvement after surgery. There was no statistically significant difference in final neurological outcomes in patients having early as opposed to delayed surgery.  

**Conclusion.** Surgical intervention for cervical injuries is safe, as no postoperative neurological deterioration was recorded. Timing of surgery does not affect neurological outcome.  

**Key words:** cervical vertebrae; neurologic manifestations; quadriplegia; spinal cord injuries; surgical procedures, operative

INTRODUCTION

One third of all spinal injuries involve cervical vertebrae, and the impact of injury to the cervical spinal cord is profound and requires systemic treatment. When spinal cord injury is complete, the patient has no voluntary motor or conscious sensory function below the injury level. About 40% of such injuries are complete, another 40% are incomplete, and the remaining 20% spare the cord and involve only root lesions. Some authorities recommend early surgery, as the neurological condition may worsen due to haematoma formation, oedema progression, and/or spinal instability. Others argue that delaying
surgery decreases physiologic complications and prevents iatrogenic cord injuries. Whether early or delayed spinal stabilisation decreases morbidity remains controversial. We aimed to determine whether the timing of surgery affected neurological outcomes in patients with unstable lower cervical spine injuries affecting C3 to C7 vertebrae.

MATERIALS AND METHODS

Records of 49 men and 18 women aged 16 to 72 (mean, 36) years who sustained an acute unstable injury of the lower cervical spine (C3–C7) between January 1987 and December 2000 inclusive were retrospectively reviewed. Indications for surgery were: spinal instability, deformity, and neurological compromise due to compression of neural elements. Injuries were classified as burst fractures or facet fracture-dislocations. Surgery was performed as soon as the patient’s medical condition allowed; 31 underwent surgery within 72 hours of injury (early group) and 36 others underwent surgery later (delayed group). Anteroposterior, lateral, and oblique plain radiography, computed tomography (CT), and magnetic resonance imaging were undertaken pre- and post-operatively. Neurological status was measured according to the Frankel classification as grades A to E and correspondingly recorded as one to 5. Pre- and post-operative neurological status of the patients with incomplete spinal cord injury (Frankel grades B to D) in the early and delayed surgery groups was compared.

Cranial traction was applied pre- and intra-operatively; steroids were administrated preoperatively in some patients. Open reduction, decompression, and spinal stabilisation were performed via a posterior, anterior, or combined approach based on the location of injury. An anterior (left-side Robinson) approach was performed in anterior and middle column injuries with bony and neurological compromise. The posterior approach was used for fracture-dislocations and burst fractures without significant bony compromise. A combined approach was used for a patient with severe anterior vertebral translation and disk extrusion, or as a complementary procedure for posterior stabilisation (because of insufficient screw grip). It was also used for neglected fracture-dislocations, to remove anteriorly formed scar and any disk that prohibited reduction of the injured level.

Most patients were anatomically reduced using Roy-Camille plates. Screws were inserted into the lateral vertebral masses according to Roy-Camille and Magerl techniques. Autogenous bone grafting was performed in all patients. The number of fused segments ranged from one to 3. Postoperatively, a Philadelphia cervical collar was applied for 6 weeks, followed by a soft collar for another 6 weeks. Fusion was defined as the presence of a homogenous mass on lateral CT scans, and segmental movement of <2° on flexion-extension lateral radiographs.

Statistical analysis was performed using the independent sample Student’s t test and Chi squared test. A p value of <0.05 was considered significant.

RESULTS

The mean follow-up period was 4 (range, 1–9) years. The causes of injury were road traffic accident (n=49, 73%), fall from a height (n=12, 18%), diving (n=5, 7.5%), and sports injuries (n=1, 1.5%). Associated injuries involved the head and abdomen, as well as femoral, clavicular, and rib fractures. 29 patients had a burst fracture between C3 and C7 vertebrae (C3=1, C4=1, C5=12, C6=7, and C7=8). 38 patients sustained a fracture-dislocation between C3 and T1 vertebrae (C3–C4=3, C4–C5=8, C5–C6=7, C6–C7=19, and C7–T1=1). Posterior translation ranged from 20 to 80%, whereas anterior translation ranged from 15 to 95%. The ratio between unilateral and bilateral fracture-dislocations was 3.5:1. Most dislocations were unilateral; anterior translation of the involved vertebra was more than 25% below the C5–C6 level; above this level the anterior translation was less than 20% (p<0.005, Chi squared test). No statistically significant difference was found in the distribution of ages and genders between the early and delayed surgery groups (p=0.232, independent samples Student’s t test and p=0.428, Chi squared test, respectively).

Preoperatively 58 (87%) of the patients had a neurological deficit (20 grade A, 10 grade B, 11 grade C, and 17 grade D). Nine patients without neurological deficit were graded as E (Table). The mean Frankel grade was 2.8 in the early group and 3.6 in the delayed group. The difference was not statistically significant (p=0.306, independent samples Student’s t test). Postoperatively, only patients with incomplete spinal cord injury (grades B to D) had neurological improvement. The respective mean neurological improvement for patients undergoing posterior, anterior, and combined approaches amounted to 1.1, 1.2, and 1.6 Frankel grades. These differences were not statistically significant (p=0.511, p=0.146, and p=0.135; independent samples Student’s t test, respectively).

In 2 patients with grade B injury preoperatively,
posterior stabilisation was incomplete because of insufficient screw grip, therefore a complementary anterior stabilisation was performed. A 60-year-old patient had re-dislocation 25 days after surgery due to retrogression of a screw. The patient was re-operated on via an anterior procedure. Another had screw loosening of the posterior instrumentation system 44 days after surgery; a complementary anterior stabilisation at the C6–C7 level with a homogenous iliac graft was therefore performed. In 2 patients with grade C injury preoperatively, cervical translation (up to 3 mm above the injured area) occurred 5 to 6 months after surgery, but without neurological aggravation. In 4 patients treated by an anterior approach, disk degeneration was present one level cephalad to fusion. None of these complications affected the postoperative neurological status of the patients; the spinal arthrodesis was solid in all of them. The mean neurological improvement amounted to 4.2 Frankel grades for the early group, and 4.8 grades for the delayed group. The difference was not statistically significant (p=0.440, independent samples Student’s t test; Table). Two patients with grade A injury died due to cardiopulmonary insufficiency within 2 to 4 months of surgery.

**DISCUSSION**

The timing of surgery had no effect on neurological recovery in patients with cervical spinal cord injury.\(^{10-12}\) However, experimental studies showed that early surgery might be associated with improved results.\(^ {13,14}\) Some authors considered early surgery (<72 hours from injury) the best treatment for cervical spinal cord injury.\(^ {13,15}\) Others reported improved neurological outcome after delayed surgery.\(^ {16-18}\) Surgical treatment (compared to conservative treatment) may be associated with higher complication rates,\(^ {9}\) particularly within 5 to 7 days of injury.\(^ {7,8,19}\) Neurological deterioration was more likely in patients with unstable spinal injuries and less likely to be related to the timing of surgery. Early surgery gave improved results in patients with cervical spinal cord injury.\(^ {4}\)

Although surgical treatment may not be necessary because of spontaneous fusion,\(^ {20}\) anatomical reduction appears to be necessary to minimise the risk of dynamic cervical translation and to decrease pain and stiffness or both.\(^ {21}\) Therefore, internal fixation is often required for immediate mechanical stabilisation,\(^ {22}\) to decrease post-traumatic complications resulting from immobilisation,\(^ {7}\) and to improve the physiological environment and thus maximise neurological improvement.\(^ {6}\) Cranial traction was applied preoperatively in all patients, as immediate reduction (<6 hours after injury) is more important for improving neurological outcome than surgical techniques.\(^ {10,23,24}\) Surgery promotes spinal stabilisation, facilitates patient mobility and prevents spinal deformity.

Implant loosening seen in 4 patients was attributed either to osteoporosis or poor instrumentation technique. The anterior translation seen in 2 patients occurred one level above that of the initial injury and was attributed to reduction failure or misdiagnosis of the injured level. Adjacent disk degeneration seen in 4 patients treated via an anterior approach was attributed to increased loads on the disk. Surgical approaches (anterior vs. posterior vs. combined) did not correlate with postoperative neurological status. The percentage of improvement was 50% for the early group and 33% for the delayed group, but this difference was not statistically significant. Only patients with incomplete spinal cord injury had neurological improvement postoperatively.
Early surgery might benefit patients with incomplete injury. Pathologic changes in neural tissue accelerate within 8 hours of injury, and the use of steroids is neuroprotective if administered within that period. Therefore, surgery appears beneficial if performed within 8 hours. Early surgery (<72 hours after injury) may not in fact be early enough for optimal neurological recovery.

Surgical intervention for cervical injuries is safe, as no postoperative neurological deterioration was recorded between the early and delayed surgery groups. Neurological recovery may be expected in patients with incomplete spinal cord injury. There was no statistically significant difference between the neurological outcomes associated with early versus delayed surgery. Prospective randomised studies are needed to better document the results according to the timing of surgery.

REFERENCES