

Complications of Posttraumatic Dorsal Cervical Spine Fusion

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Abstract

Background:

This study evaluates the occurrence of complications of dorsal cervical spine fusion after cervical spine injuries.

Methods:

Dorsal cervical spine fusion due to fractures of the cervical spine was performed in 40 patients. During the first 6 postoperative weeks the occurrence of complications was observed.

Results:

In most cases the dorsal fusion was performed in the upper cervical spine. Severe systemic diseases were common in the cohort. No intraoperative complications, implant malpositioning or postoperative neurologic deficits were observed. In 3 cases a revision operation was performed due to surgical site infection. General complications were common (19 cases = 47.5 %) with pneumonia (20%) and cardiac complications (12.5%) as the most frequent complications. In 2 cases (5%) the complications led to death due to sepsis and cardiogenic shock.

Conclusions:

Following the findings of our study there is a low surgical revision and complication rate after dorsal cervical spine fusion, while the rate of general complications appears to be much higher. Taking these complications into account cervical fusion operations should carefully be taken into consideration as a therapy option in cervical spine fractures.

Trial registration:

All procedures performed in the present study were in accordance with the ethical standards approved by the Ethical Committee of University Hospital Bonn, Bonn, Germany (reference number: 406/17)

Background

Cervical spine injuries are common in elderly patients, while fractures of the upper cervical spine are most common. Either major trauma in young adults or minor trauma with osteoporotic bone quality in elderly patients is associated with these fractures. Therefore, there is a double peak distribution of incidences. As population demographics change, a progressive increase of the prevalence of cervical spine injuries is expected. Especially the atlantoaxial joint has complex biomechanical properties with its unique anatomy and high level of mobility. A conservative treatment of cervical spine fractures is possible in several cases. Usually, a surgical treatment of cervical injuries is indicated in dislocated fractures with or without associated neurologic deficits. There are several techniques for dorsal stabilization of the cervical spine,

including posterior wiring and screw fixation techniques. The fixation techniques have progressed rapidly in recent years. There is controversy in the literature regarding the appropriate surgical management of cervical spine injuries [1–5]. While wiring techniques (e.g. Brooks-Jenkins and Gallie method) are technically simple, their fusion rates are reduced due to biomechanical limitations [6]. A highly biomechanically robust construct is the advantage of the screw technique of Jeanneret and Magerl but it has an increased the risk of injury to the vertebral artery [7]. There are other screw constructs like the Goel-Harms C1 lateral mass–C2 pedicle screw construct, the Wright C1 lateral mass–C2 translaminar screw construct, and the C1 lateral mass–C2 pars screw construct, each with individual advantages and disadvantages [8–10]. In general, dorsal screw instrumentation techniques require high technical skills but have better biomechanical results. They show advantages in stabilizing especially the atlantoaxial complex [11].

Dorsal cervical instrumentation as a surgical option can be superior to halo-vest immobilization regarding nonunion rates and mortality[12] and provides excellent immediate and long-term stability. Still it can have several disadvantages, such as neck pain or the risk for screw malpositioning[13] Safety and accuracy of screw placement can be achieved by using intraoperative fluoroscopy and CT-based computer navigation systems. The management of cervical spine injuries may be complicated by several factors, including pre-existing medical conditions such as cardiopulmonary compromise, diminished ability to tolerate immobilization and reduced bony quality. The group of treated patients is usually very small and hardly comparable. This study aimed to evaluate the general and surgical complication rate of dorsal cervical spine fusion after cervical spine injuries without neurological deficits.

Methods

40 consecutive adult patients (52.5% male, 47.5% female) underwent posterior cervical screw instrumentation. Patients with preoperative neurological deficits were excluded due to a modified morbidity and mortality rate in comparison to patients without neurological deficits. Before surgery, all patients underwent evaluation cervical spine computed tomography (CT) scans with sagittal and coronal reconstructions and magnetic resonance imaging when indicated. Fractures were classified as unstable according to an initial displacement of over 4 mm and initial angulation of over 11° on the CT scans as well as anteroposterior displacement of over 2 mm on lateral flexion-extension sagittal radiographs, when indicated. The indication for operation was given in all fractures that fulfilled the above criteria for instability. Dependent on the type of fracture (according to classification systems of Gehweiler, Anderson and D'Alonzo, Eysel and Roosen and AO Spine), the method of instrumentation was chosen. Twenty-three patients (57.5%) were treated with the Goel-Harms technique of stabilizing the upper cervical spine (see Fig. 1). The method of Jeanneret and Magerl was used in 4 patients (10%). The Wright C1 lateral mass–C2 translaminar screw construct was performed in one case. In 12 patients (30%), there was chosen a modified technique including lateral mass screws and pedicle screws in the subaxial spine. All screws were inserted under an image intensifier in lateral projection supported with CT based navigation. The midline approach was performed in all patients. In general, no cervical orthosis was used in the postoperative period, unless bone quality was determined to be particularly poor intraoperatively. Surgical

and general complications during the first six postoperative weeks were observed retrospectively. Patients were followed up with the use of plain radiographs and cervical spine CT scans. Imaging was assessed for proper bony alignment and integrity of the instrumentation.

The following complications were categorized: blood loss, misplacement of instruments, nerve or dural injury and postoperative complications, such as surgery related vs. non-surgery related. Fisher's exact test, chi-square test and Mann-Whitney-U test were used for statistical analysis using the IBM SPSS 25.0 version (Chicago, IL, USA), and $P < 0.05$ was considered statistically significant. All procedures were in accordance with the ethical standards of the institutional ethical committee and with the Helsinki Declaration.

Results

The average age at surgery was 71.6 years (IQR 59–88). Fractures of the upper cervical spine were the most frequent injuries: 90% affected the axis, 22.5% affected the atlas, and 32.5% were combined fractures. In Particular the most frequently fractures were dens axis fractures type Anderson II (50%) and Anderson III (25%). Therefore most patients were undergoing surgery of the upper cervical spine. Mostly, surgery was performed in segments of C1/2 (50%), C1-3 (27.5%) and C0-3 (5%). Therefore the dorsal cervical spine instrumentation was performed in 1 segment (50%) mostly (see Fig. 1), followed by instrumentation in two segments (30%) and three segments (10%) (see graph 1). The mean duration of surgery was 229 minutes (IQR 167–277).

Overall there were 201 screws inserted. A total of 52 screws were inserted in the atlas, and 70 screws were inserted in the axis. Thirty screws were inserted in the C3 vertebra, followed by 12 screws in the C4 vertebra, ten screws in C5, 12 screws in C6 and six screws in C7. In 3 patients, there were used occipital screws, nine screws in total (see graph 2).

Overall there were 114 screws inserted in the lateral mass of a cervical vertebra, 68 screws were pedicle screws, eight screws were inserted transarticular in C1/2, and two screws were inserted intralaminar in the C2 vertebra.

Most patients had severe systemic diseases (52.5% ASA-3, 7.5% ASA-4). On average, the patients had five comorbidities (IQR 3–8). Furthermore, 55% of the patients had accompanying injuries, which needed surgery in 25% of the cases. Most patients had no previous surgery of the cervical spine (82.5%), while 17.5% had treatment of the cervical spine by an anterior approach in the past. 77.5% of the patients were monitored in the intermediate care unit (IMC) for postoperative surveillance. The mean stay on IMC was four days (IQR 1–6), while the mean stay in hospital was 18 days (IQR 9–27).

Preoperative, there was no neurologic deficit in all patients (ASIA E). No intraoperative complications or postoperative neurologic deficits were detected. The immediate postoperative radiographic examinations showed proper alignment and correct implant position in all cases. Also, the radiographic examinations

six weeks after surgery showed identical results and no cases of implant loosening or indications for revision surgery.

In three cases (7.5%), a revision of the wound had to be performed due to complications of wound healing. In 19 cases (47.5%) at least one general complication was registered (see Table 1): respiratory dysfunction due to pneumonia (20%), postoperative delirium (12.5%), cardiac complication (12.5%), urinary tract infection (7.5%) and complications associated to accompanying injuries (5%). In two cases (5%), the complications led to death due to pneumonia sepsis and cardiogenic shock.

Table 1
Summary of complications

Complication	No. of patients
Wound infection	3 (7.5%)
Pneumonia	8 (20%)
Delirium	5 (12.5%)
Cardiac dysfunction	5 (12.5%)
Urinary tract infection	3 (7.5%)
Accompanying injury complication	2 (5%)
Death	2 (5%)

Most patients (87.5%) acquired self-determined mobility until discharge from the hospital. Nearly half of the patients were discharged home (47.5%). Twelve patients (30%) were discharged to a geriatric department, while 7.5% were discharged to rehabilitation.

In a univariate analysis, a significant correlation was shown between the occurrence of complications and duration of stay in hospital ($p < 0.001$), ASA-Score ($p = 0.03$), number of comorbidities ($p = 0.022$) and duration of stay at intensive care unit ($p = 0.004$).

There was no significant difference of patients with or without complications regarding age, gender, operated levels and surgery time.

Discussion

Spinal injury can be a significant source of morbidity and mortality in all age groups. C2 vertebra fractures are the most frequent fractures of the cervical spine in persons aged 65 years and older [14], which is supported by the injury distribution in our study. The incidence of combined fractures of the cervical spine seems to be high and is also confirmed by the findings in our study (32.5% combined fractures).[15]

The rate of surgical site infections and operative revisions (7.5%) in our cohort shows a lower postoperative infection rate than in a study of Kaminski et al. where posterior fusion was associated with postoperative infections in 33% [16]. Dorsal instrumentation of the cervical spine can be quite challenging due to complex anatomic variants. The rate of screw malpositioning is variable in the literature. The reported incidence is 2–15% [17, 18]. According to other studies, the techniques of dorsal instrumentation of the cervical spine seem to be safe, especially when using navigation [18–20]. On the contrary, our findings show no intraoperative complications or screw malpositioning,

In contrast to a low rate of surgical complications in our cohort, there was a high rate of general complications (47.5%) after posttraumatic dorsal cervical spine fusion. Kaminski et al. had a similar proportion of complications not associated with the procedure (44.4%) [16]. Another study by Molinari et al. shows similar rates of respiratory complications due to pneumonia compared to this study (17% vs 20%) [21].

Considered in summary, patients with cervical spine injuries seem to be associated with high complication risk. Studies comparing complication rates of surgical and nonsurgical treatment of cervical spine fractures show similar complication rates of both groups. [22, 23] A prospective AOSpine trial showed a trend towards more complications in the nonsurgical group (36% versus 30%). On the other hand, surgically treated patients had a higher percentage of dysphagia compared to nonsurgically treated patients (11% versus 5%) [24]. This complication mostly occurs in ventral cervical spine surgery. Due to another study by Malik et al., 18.6% of patients with cervical spine injuries developed complications. In-hospital mortality was 11.2%, while 19% died post-discharge during follow-up, yielding overall mortality of 30% [25]. In contrast, our findings show low 6-week mortality (5%).

Conclusion

Regarding our results, dorsal cervical fusion is a safe procedure and should be considered as an effective therapy option in traumatic cervical injuries. Nevertheless, the patients belong to a high-risk group with and without surgery, in which in particular the general complications must be recognized and addressed early, especially in geriatric population. Early mobilization is highly recommended for elderly patients, as prolonged periods of immobilization have a high incidence of complications, mainly respiratory. Therefore hospitals that offer maximum care should be considered as the first option for the treatment of high-risk patients. Close cooperation with geriatric departments should be aimed for the best medical care.

Abbreviations

CT computed tomography

IQR interquartile range

ASA American Society of Anesthesiologists physical status classification system

IMC intermediate care unit

ASIA American Spinal Injury Association-Classification, ASIA-Impairment Scale

Declarations

Ethics approval and consent to participate

All procedures performed in the present study were in accordance with the ethical standards approved by the Ethical Committee of University Hospital Bonn, Bonn, Germany (reference number: 406/17). Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

There are no contributions for all authors.

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Not applicable.

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Figures



Figure 1

Postoperative radiographic examination of dorsal cervical C1/2 fusion with Goel-Harms technique

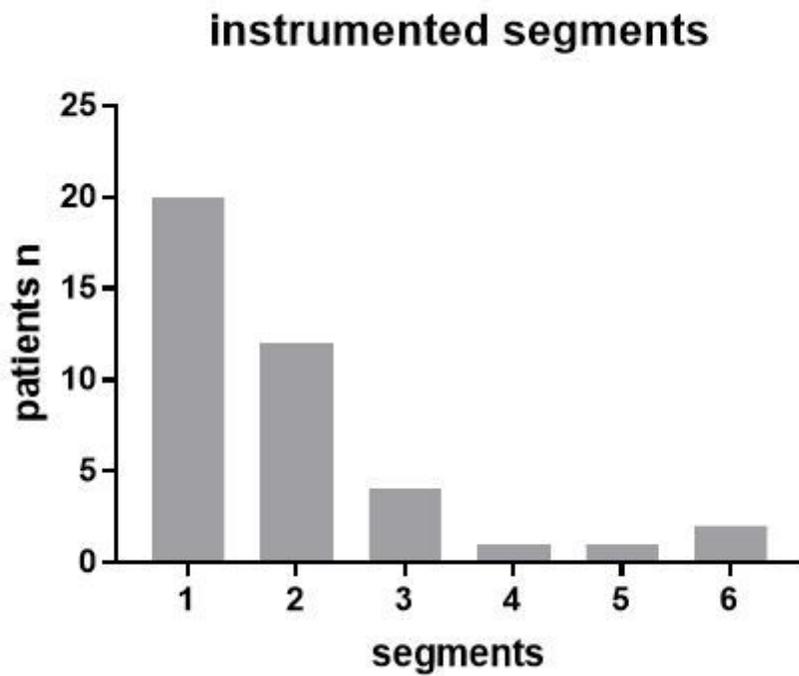


Figure 2

Number of instrumented segments of the cervical spine

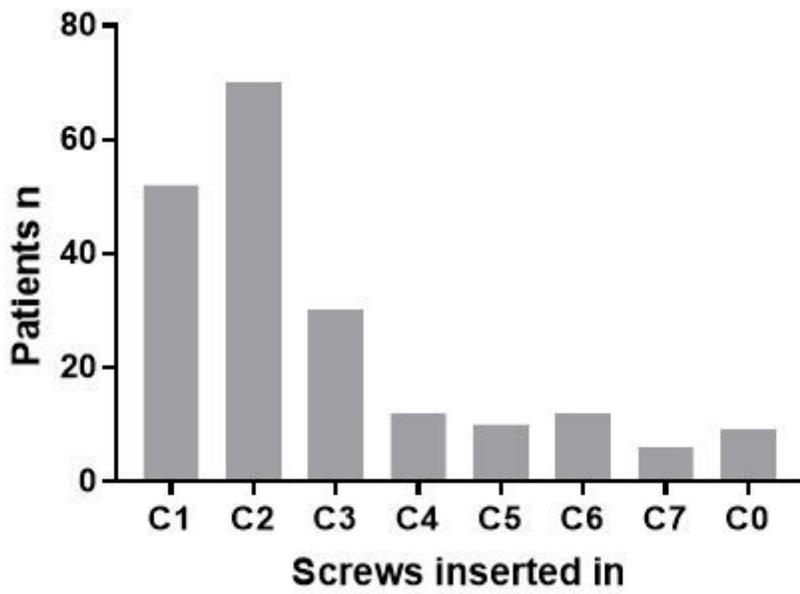


Figure 3

Number of screws inserted in cervical vertebrae