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# The impact of fusion on adjacent levels in cervical spine injuries: Is it really important?

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ABSTRACT

*Objective:* Although the literature on degenerative disease of the cervical spine contains numerous articles studying the changes on levels adjacent to a fusion, there exist very few such studies concerning cervical spine stabilization for trauma.
*Methods:* Over a 16-year period (1989–2005), one hundred and twelve patients underwent stabilization of the lower cervical spine (C3–T1) for subaxial cervical spine injuries, either with an anterior or posterior procedure, or both. Eighty-one patients with adequate follow-up were included in the study and 3 groups were identified: Group A, consisting of 8 patients who underwent anterior stabilization and developed Adjacent Level Ossification Development (ALOD), Group B, comprising 53 patients who were anteriorly plated but who did not develop ALOD and Group C, comprising 20 patients who received posterior stabilization.
*Results:* Eight out of 61 patients (13.1%) who were anteriorly operated developed ALOD in 11 adjacent levels (Group A). Severe (grade 3) ossification was noted in 6/8 patients at the cranial adjacent level, and in 2/8 patients at the caudal one. Three out of 8 patients presented with early ALOD at 3, 4 and 18 months respectively. Despite the radiographic abnormalities showing ossification, all the patients had an uncomplicated course without symptoms. All the radiographs of Group B and Group C patients demonstrated grade 0 ossification for both the cranial and caudal adjacent levels.
*Conclusion:* Adjacent-level ossification in cervical spine injuries may appear very early in the postoperative period and it can have a different course than in the degenerative disc disease population, at least in some patients. The first cephalad level adjacent to a fusion appears to be at greater risk. However, even when ALOD is evident radiographically, it very rarely produces any symptoms.


## 1. Introduction

Degenerative changes of the cervical spine are well described in the literature, although the clinical relevance of such radiographic findings is not always apparent. In asymptomatic people, it is reported that by age 60–65 years, 95% of men and 70% of women have at least one degenerative change on their radiographs [1]. On the other hand, in the population of patients who undergo cervical fusion for spondylosis associated problems, concern has been raised whether fusion imposes the development of these changes on adjacent levels. This is still a matter of debate, but the same concern also exists for patients who undergo cervical spine fusion due to traumatic instability.

However, such adjacent-level changes are rather underreported in the literature concerning cervical spine stabilization for trauma. To date, very few studies have reported on their incidence in cervical spine injuries [2–7]. The aim of the current study was to examine the effect of fusion on adjacent levels, in patients who sustained an unstable cervical spine injury and were stabilized surgically with fusion in our institution.

## 2. Materials and methods

### 2.1. Patient population

Over a 16-year period (1989–2005), one hundred and twelve patients underwent stabilization of the lower cervical spine (C3–T1), either with an anterior or posterior procedure, or both. Demographic information, mechanism of injury, preoperative and postoperative imaging studies, and operative records were

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evaluated. The American Spinal Cord Injury Association (ASIA) scale was utilized to evaluate the neurologic status of the patients.

### 2.2. Evaluation of adjacent-level changes

The severity of Adjacent Level Ossification Development (ALOD) was graded using the system of Park et al. [8] as follows: grade 0 (none), grade 1 (mild), grade 2 (moderate), and grade 3 (severe). This corresponds to the "nose-like" and "bridging" osteophytes reported in the study of Mähring [6], which can be considered as mild-moderate and severe ossification, respectively.

Postoperative radiographs were also examined for implant position, especially the plate-to-disc distance, which was measured from the tip of the plate to the cephalad and caudal adjacent disc space on the postoperative lateral radiograph of the cervical spine [8]. At follow-up, dynamic views with flexion–extension radiographs were taken in all patients. Patients whose radiographs had evidence of pre-existing degenerative changes were excluded from the study, as well as patients whose radiographs were insufficient for the assessment of the level adjacent to fusion, or their follow-up was inadequate. Follow-up time was stratified for each group as follows: Group A: 7.75 years, Group B: 5.1 years (mean 6.4 years for these two groups), while Group C patients had 9.4 years of follow-up on average.

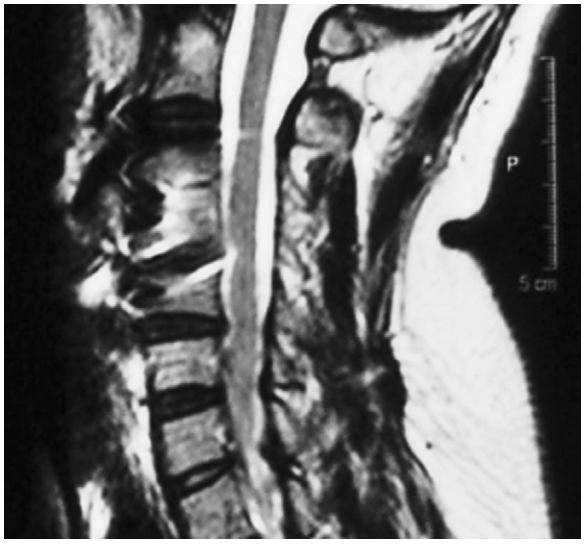



**Fig. 1.** T2-weighted mid-saggital MR image of the cervical spine in a patient with single level ALOD. Both cranial (C2–C3) and caudal (C5–C6) adjacent level discs appear hypointense with loss of distinction between nucleus and annulus and they were assigned Grade 4 in Miyazaki's scale.

### 2.3. Data collection and assessment

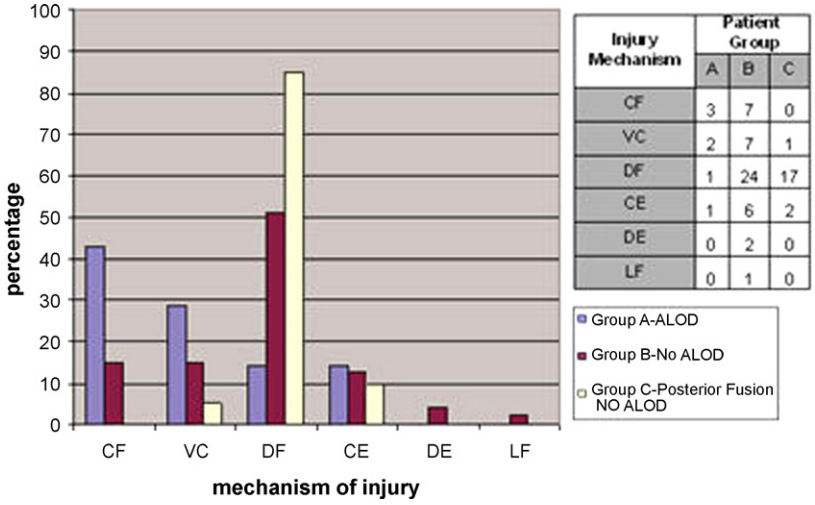
Thirty-one patients were either excluded due to pre-existing disease (17/31), due to inadequate follow-up (11/31), or due to insufficient quality of the radiographs (3/31), i.e. only the cranial but not the caudal adjacent segment was visible. Of the patients with pre-existing disease, only 1 had undergone posterior stabilization. Three individuals were stabilized both anteriorly and posteriorly, but their follow-up was inadequate to include them in the study. There were 3 revisions in the anteriorly operated group of patients. This applies to significant screw backout causing dysphagia, no purchase of the screws being completely in the adjacent disc and screw breakage, respectively.

Eighty-one patients with adequate follow-up were included and 3 groups were identified: Group A, consisting of 8 patients who underwent anterior stabilization and developed ALOD, Group B, comprising 53 patients who were anteriorly plated but who did not develop ALOD and Group C, comprising 20 patients who received posterior stabilization.

Magnetic resonance (MR) imaging was then performed in all patients of Group A and in a subset of Group B patients matched for age and level of surgery, in order to study the intervertebral disc status adjacent to the fusion.

T2-weighted mid-sagittal MR images were used in order to investigate the relation between disc degeneration and ALOD. In T2-weighted images the mean signal intensity of adjacent discs represents their water content, and thus degenerated discs appear darker. The evaluation scheme introduced by Miyazaki et al. [9] was employed for characterizing degeneration severity of adjacent disc levels (see Fig. 1). This is a five grades scheme with Grade 1 corresponding to normal discs and Grade 5 corresponding to severely degenerated discs.

A subset of Group A patients who developed ALOD in only one adjacent level was used, in order to investigate the relation between ALOD and disc degeneration. For this purpose, disc status of the ALOD level was compared to the normal adjacent level in the same patient. In addition, the degeneration grades of these ALOD levels were compared to those of the corresponding normal levels of a




| Injury Mechanism | Patient Group | | |
|---|---|---|---|
| | A | B | C |
| CF | 3 | 7 | 0 |
| VC | 2 | 7 | 1 |
| DF | 1 | 24 | 17 |
| CE | 1 | 6 | 2 |
| DE | 0 | 2 | 0 |
| LF | 0 | 1 | 0 |

**Fig. 2.** Distribution of the various mechanisms of injury in the three groups of patients CF: compression–flexion; VC: vertical compression, CE: compression–extension, DE: distraction–extension, DF: distraction–flexion, LF: lateral flexion.