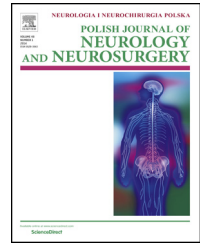


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Original research article

Assessment of cervical range of motion in patients after axis fracture

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ABSTRACT

Background: Surgical treatment of odontoid fractures with posterior C1/C2 fusion always Q2 leads to severe limitations in mobility of the cervical spine and head.

Purpose: To assess the mobility of the cervical spine in patients treated with various surgical methods after an axis body fracture.

Material and methods: A group of 61 subjects receiving surgical treatment in a group of 214 subjects treated for odontoid fractures at one ward of neurosurgery at a regional hospital. Studies also included odontoid peg and Hangman fractures. The range of motion of the head was compared to standards by the International Standard Orthopedic Measurements (ISOM) and to head mobility in a control group of 80 healthy subjects without any pathologies or complaints associated with the cervical spine. Ranges of motion were measured with the CROM goniometre with regard to flexion, extension, right and left lateral flexion and right and left rotation. The functional status was evaluated with Neck Disability Index (NDI) standard questionnaires indicated for patients with cervical spine pain.

Results: Except for flexion and extension, patients after odontoid fractures had a statistically significantly smaller range of motion of the cervical spine in all planes compared to the control group and ISOM standards.

Conclusions: Odontoid fractures lead to limitations in mobility of the cervical spine even after treatment with methods that in theory should preserve the C1/C2 mobility.

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1. Introduction

Depending on a surgical method treatment of odontoid fractures includes permanent exclusion of at least one segment of the upper cervical spine from the range of motion.

As C1/C2 and C0/C1 segments are responsible for nearly half of total axial rotation, flexion and extension of the head, consequences of fusion in the upper section of the cervical spine include severe limitations in mobility of the head [1]. These are least pronounced if the fusion selectively involves C2/C3 segment, and they are greater in the case of atlantoaxial

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or occipitocervical area [2]. The more distally craniocervical fusion reaches the greater reduction of the cervical spine mobility can be observed [3–6]. Based on our clinical observations, limitations in mobility of the head are present in patients operated on with selective odontoid peg fusion. It is surprising to observe because in theory this method preserves the mobility of the upper section of the cervical spine and of subaxial spine segments. Because of such observations a decision was made to review the mobility of the cervical spine more precisely in all patients receiving surgical treatment due to odontoid fractures. Another assumption to start studies is a low number of reports regarding spine mobility after odontoid fractures in literature [7–11].

2. Purpose

Objectives of the studies were as follows:

- (i) evaluation of the range of motion of the cervical spine in patients receiving surgical treatment because of odontoid fractures and a comparison of these ranges to ISOM physiological standards and results from the control group including healthy subjects
- (ii) evaluation of the range of motion of the cervical spine depending on a surgical technique used

3. Material and methods

3.1. Participants

The study group was recruited from a group of 214 subjects treated for odontoid fractures at a ward of neurosurgery at a large regional hospital in the period 2004–2012. This series of cases included 152 odontoid peg fractures, 45 Hangman fractures and 17 odontoid body fractures (Table 1). Surgical treatment was applied in the majority of these fractures, and the remaining cases received conservative treatment (Tables 2–4). The incidence of synostosis depended on the type of treatment and applied surgical technique as well as the patient's age (Tables 5–7).

61 patients from the whole group of 214 subjects were enrolled into the study regarding head mobility. They had to meet the following inclusion criteria:

1. isolated odontoid fracture without accompanying fractures in the upper and subaxial segment of the cervical spine.
2. observed bony union of the odontoid fracture documented by a computed tomography scan.
3. minimum 2 years of follow-up.

Table 1 – Odontoid fractures between 2002 and 2012.

Fracture type	Number of cases
Odontoid peg	152
Hangman	45
C2 vertebral body	17
Total	214

Table 2 – Treatment of odontoid peg fractures.

Treatment modality	Number of cases
Surgical	118
Conservative	28
Spontaneous fusion without treatment (neglected cases)	3
Early in-hospital death	3
Total	152

Table 3 – Treatment of Hangman fractures.

Treatment modality	No. of cases
Total	45
Surgical (C2/C3 anterior fusion)	38
Conservative	7

Table 4 – Treatment of C2 body fractures.

Treatment modality	No of cases
Total	17
Surgical (C2/C3 anterior fusion)	5
Conservative	12

A bony union was evaluated with bone windows of computed tomography in three reconstructions (transverse, sagittal and frontal). A bony union was confirmed when there were bony bridges in at least one of three reconstructed planes.

All study participants had been informed about the objective of the study and had given their consent for participation before the study started. The study plan was approved by the Bioethics. The study group included 19 women and 42 men. The mean age of patients was 49.2 ± 18.3 years (18–80 years). 50.8% of patients with odontoid peg fractures were operated on with the use of a direct odontoid screw, 49.2% with posterior selective atlantoaxial fusion (Table 8).

The control group included 80 subjects (46 women and 34 men) without a clinically diagnosed disease of the cervical spine and without any complaints of this section. This group was matched to the study group with regard to the age. The mean age was 48.6 ± 17.5 years (range 19–79 years).

3.2. Measurements

The examination of the range of motion of the cervical spine was performed with the CROM (Cervical Range of Motion) goniometre using the SFTR protocol (measurements in the sagittal, frontal and transverse planes, and in axial rotation). Ranges of motion in the study group were compared to the ranges in the control group and to the ranges of motion of the cervical spine according to ISOM (International Standard Orthopedic Measurements). Standards were prepared by ISOM using a group of 1000 healthy subjects [7]. All measurements were performed in a sitting position, with the back supported and the head in the Frankfurt plane [11,12].

The functional status was evaluated with Neck Disability Index (NDI) standard questionnaires indicated for patients

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