



## Early Morbidity and Mortality in 50 Very Elderly Patients After Posterior Atlantoaxial Fusion for Traumatic Odontoid Fractures

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■ **BACKGROUND:** Traumatic odontoid fractures (tOFs) in the very elderly are associated with high morbidity and mortality. The best treatment strategy (conservative vs. surgery) is still unclear.

■ **METHODS:** Between April 2008 and April 2014, fifty (17 male, 33 female) patients (mean age  $87.2 \pm 4.4$  years; range: 80–99) were included in this retrospective cohort study. All patients underwent posterior fusion surgery for tOF. Early outcome, morbidity and mortality, length of hospital and intensive care unit (ICU) stay, comorbidities, and perioperative complications were assessed.

■ **RESULTS:** The mean age-adjusted Charlson Comorbidity Index (CCI) was  $5.8 \pm 3.9$  (range: 0–13), and the mean American Society of Anesthesiologists score was  $3 \pm 0.5$  (range: 2–4). Surgery was delayed in 48% of patients. Thirty percent of patients had preoperative complications (72.4% severe), of which a leading cause was dysphagia with subsequent pneumonia, and 18% required preoperative assessment or improvement of health status. Surgery-related complications were experienced in 14% with no neurovascular lesion. Postoperative medical complications occurred in 52% of patients (67.3% severe). Major complications were mostly respiratory/pulmonary (66.7%), of which postoperative pneumonia (36.4%) was leading. Twenty-four percent of patients were ICU monitored. Mean length of ICU stay was  $9 \pm 6.6$  days (1–20). Mean length of hospital stay was  $15 \pm 8.6$  days (4–56). There was no in-hospital mortality, and 30-day mortality was 6%.

■ **CONCLUSIONS:** Posterior fusion for tOF in patients 80 years or older seems to be a feasible treatment option in these high-risk patients. Despite a high incidence of severe comorbidities and perioperative complications, outcome was satisfactory.

■ **LEVEL OF EVIDENCE:** Our research was a retrospective cohort study, Level III.

### INTRODUCTION

Traumatic odontoid fractures (tOFs) are the most common fractures of the cervical spine in the elderly population. No matter which treatment modality is applied, these injuries are associated with high morbidity and mortality.<sup>1–21</sup>

Old age seems to play a pivotal role with regard to clinical outcome, complications, and death.

Despite a rapidly growing geriatric population and an increasing incidence of tOF, the best treatment option is still undecided. Do these patients benefit most from conservative management or surgery?

Halo vest immobilization is being used with declining frequency with reported mortality rates of up to 42%.<sup>8–10</sup>

Including short- and long-term results, mortality rates between 2% and 38% for surgical treatment,<sup>7,9,10,14–16,18,22–24</sup> and between 6% and 85% for conservative treatment show a trend toward favorable results in surgically treated patients.<sup>7,9,10,14,18–21,23,24</sup>

Moreover, the best results in terms of osseous union, fracture stability, clinical outcome, and mortality seem to be achieved by

### Key words

- Comorbidities
- Early morbidity and mortality
- Posterior atlantoaxial fusion
- Traumatic odontoid fracture
- Very elderly

### Abbreviations and Acronyms

- AOSF:** Anterior Odontoid Screw Fixation  
**ASA:** American Society of Anesthesiologists  
**CCI:** Charlson Comorbidity Index  
**ICU:** Intensive care unit  
**NSTEMI:** Non ST-Segment Elevation Myocardial Infarction  
**RBC:** Red blood cell

**tOF:** Traumatic odontoid fracture

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surgery.<sup>3,11,12,15,19,23,24</sup> An increase of surgical management can be observed during the past 2 decades.<sup>14,25</sup>

Surgery, however, has been associated with longer lengths of hospital and intensive care unit (ICU) stays and increased numbers of ventilator days compared with conservative therapy.<sup>9,14,18</sup>

A systematic review on the optimal treatment in the elderly gives a weak recommendation for surgical treatment (versus conservative) and a strong recommendation for posterior arthrodesis (versus anterior).<sup>12</sup> In addition, certain conditions such as osteoporosis, affection of the atlantoaxial joint, fracture dislocation, and certain fracture types are contraindications for anterior odontoid screw fixation (AOSF). Furthermore, a significantly higher risk of postoperative dysphagia and pneumonia are further arguments against anterior odontoid screw fixation in patients older than 75 years of age.<sup>26</sup>

On account of the aforementioned reasons that favor surgery over conservative management and posterior surgery over AOSF, all geriatric patients admitted for tOF to our department have been treated exclusively by posterior fixation surgery since 2008. Previously, geriatric patients were also treated by AOSF in our hospital. However, high rates of screw loosening and/or nonunion after AOSF made us change our surgical treatment paradigm to posterior fixation only in 2008.

Reports on posterior fusion surgery for odontoid fractures in geriatric patients are rare and mostly comprise small patient cohorts or heterogeneous treatment methods or surgical techniques.<sup>3,14,16,18,19,23,27</sup> Morbidity and mortality in the elderly after treatment of tOF are dealt with in a number of articles, but larger studies focusing on comorbidities and complications in geriatric patients >80 years of age are scarce.

The aim of this study was to present a single-center experience of posterior fusion surgery for tOF in the, to our knowledge, largest series of patients 80 years or older and to analyze morbidity and mortality with special focus on comorbidities and preoperative and postoperative medical complications.

## MATERIALS AND METHODS

In 2008 there was a change in treatment paradigm for tOF in our department. Before 2008, geriatric patients with tOF were treated with either AOSF or posterior screw fixation on the basis of the fracture type and/or the surgeon's predilection. Since we experienced a high rate of nonfusions, pseudarthrosis, and screw loosening after AOSF, we decided to treat all geriatric patients with posterior fixation surgery only from 2008 onwards.

### Patients

All geriatric patients  $\geq 80$  years admitted to our hospital between April 2008 and April 2014 for tOF were included in this retrospective cohort study from a prospective database. All 50 patients (17 male/33 female) with a mean age of  $87.2 \pm 4.4$  years (range: 80–99 years) were treated surgically by posterior C1-2 or C1-2-3 fusion for either type II (38) or atypical type III (with associated unilateral or bilateral hangman's fracture) (12) odontoid fractures. Eight patients (16%) had associated C1 fractures. Radiologic fracture evaluation was performed with computed tomography scans in all patients and additional magnetic resonance imaging in 27 patients. In the majority of cases (86%; 43) odontoid

fractures were sustained through low-velocity falls in a domestic environment. Three patients suffered falls from stairs or ladders, 2 patients fell from a bicycle, and 2 patients were injured in motor/person vehicle accidents. Seventy-eight percent (39) of patients were admitted with acute odontoid fractures, and 22% (11) had subacute/chronic fractures (mean age  $3.4$  months  $\pm 5$ ; range 0.8–18) after failed conservative treatment (10) or failed prior surgery with anterior odontoid screw fixation (1). Fifty-two percent (26) of patients suffered from accompanying injuries (Table 1).

Early outcome, morbidity and mortality, length of hospital and ICU stay with regard to comorbidities and perioperative surgical, and medical complications were assessed. Comorbidities were classified with use of the American Society of Anesthesiologists (ASA) score, and with use of the Charlson Comorbidity Index (CCI).<sup>28,29</sup>

The study was approved by the local ethics committee.

### Surgical Technique

Surgery was performed in Goel-Harms technique with a polyaxial screw rod system.<sup>30-32</sup> Patients were placed in a prone position on the operating table with the head fixed in neutral position in a Mayfield clamp. In cases of displaced odontoid fractures, closed reduction was performed before surgery after the patient was turned to a prone position on the operating table with the aid of the Mayfield clamp under lateral fluoroscopy. No traction was applied intraoperatively. After a posterior midline approach, a posterior C1-2 fixation was performed with lateral mass screws placed in C1 and isthmus screws in C2 under lateral fluoroscopy (Figures 1 and 2). In patients with atypical type III fractures with associated unilateral or bilateral hangman's fractures, posterior fixation was

**Table 1.** Accompanying Injuries

Total Number of Patients (52%; n = 26)	
Major*	Patients (69.2%; n = 18)
Fractures	
Accompanying C1-fractures	44% (8/18)
Other vertebral body fractures	33% (6/18)
Extremity/other fractures	28% (5/18)
Midfacial/skull (base) fractures	22% (4/18)
Traumatic brain injury	
Brain contusion	11% (2/18)
Traumatic subarachnoid hemorrhage	11% (2/18)
Acute subdural hematoma	11% (2/18)
Minor to moderate*	Patients (30.8%; n = 8)
Midfacial fractures (nasal bone; lateral orbital rim)	75% (6/8)
Brain concussion	50% (4/8)
Scalp lacerations/hematomas	63% (5/8)
*Some patients had multiple injuries.	

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