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Original article

# Conservative versus surgical treatment for type II odontoid fractures in the elderly: Grading the evidence through a meta-analysis

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ABSTRACT

*Background:* Odontoid fractures are common C-spine fractures in the elderly. However, the optimal treatment of odontoid fractures in the elderly is, still subject to controversy.
*Hypothesis:* Surgical treatment has several advantages on conservative treatment, such as reduced mortality and lower incidence of non-union. This meta-analysis was performed to identify the efficacy of conservative treatment compared with surgical treatment and provides recommendations for using these procedures to treat type II odontoid fractures in the elderly.
*Materials and methods:* A systematic search of all studies published was conducted using the PubMed, EMBASE, OVID, ScienceDirect and Cochrane CENTRAL databases. The randomized controlled trials (RCTs) and non-randomized controlled trials (non-RCTs) that compared conservative treatment with surgical treatment and provided data on clinical effects were identified. The included trials were screened out strictly based on the criterion of inclusion and exclusion. The quality of included trials was evaluated. RevMan 5.1 was used for data analysis.
*Results:* Twelve studies involving 730 patients met the inclusion criteria. There were 441 patients with conservative treatment and 289 with surgical treatment. The results of meta-analysis indicated that no difference with regard to the mortality was noted ($P > 0.05$) between the two procedures. However, there was statistically significant difference with respect to the non-union numbers ($P < 0.05$) between the two procedures.
*Discussion:* Conservative treatment and surgical treatment are both effective procedures for treating type II odontoid fractures in the elderly. Compared with surgical treatment, there is no significant difference in mortality; With respect to non-union numbers, conservative treatment numbers are higher than surgical treatment. Due to the poor quality of the evidence currently available, high quality RCTs are required.
**Level of evidence** Level II: low-powered prospective randomized trial meta-analysis.


## 1. Introduction

Odontoid fractures count to nearly 20% of all cervical fractures. Among these, 65–74% are type II fractures according to Anderson and D'Alonzo. They are the most common cervical fractures in the elderly [1,2]. Currently, the treatment of type II odontoid fractures remains a challenging problem, particularly in geriatric population [3].

The treatment of odontoid fractures mainly involves conservative treatment and surgical treatment. Both conservative treatment and surgical treatment have advantages and disadvantages for treating odontoid fractures. The patients typically suffer from an increased risk of operation complications when treated surgically as well as from an increased risk of second surgery and prolonged treatment duration when treated conservatively [4]. Although there are a limited number of studies have been published, the optimal treatment of odontoid fractures in the elderly is, however, still subject to controversy [5,6].

The purpose of this meta-analysis is to evaluate the evidence from RCT and non-RCT studies that compared the efficacy of conservative treatment and surgical treatment for treating odontoid fractures patients and to provide recommendations for using the procedures to treat odontoid fractures.

## 2. Materials and methods

### 2.1. Search strategy

A systematic search of all studies published was conducted using the PubMed, EMBASE, OVID, ScienceDirect and Cochrane CENTRAL

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databases from their inception to January 2015. Other Internet databases were also performed to identify trials according to the Cochrane Collaboration guidelines. The following search terms were used to maximize the search specificity: odontoid fracture, dens fracture, surgery and conservative treatment. The reference lists of all the full-text papers were examined to identify any initially omitted studies. We made no restrictions on the publication language.

### 2.2. Inclusion criteria

The following inclusion criteria were applied:

- study design: interventional studies (RCTs or non-RCTs);
- population: elderly patients (> 60 or older) with type II odontoid fractures;
- intervention: conservative treatment (collar, cast or halo-vest);
- comparator: surgical treatment (anterior or posterior operation);
- case series: study of > 10 cases;
- outcomes: reported at least one of the mortality and non-union numbers.

### 2.3. Exclusion criteria

The following exclusion criteria were applied:

- no separate analysis of type II odontoid fractures;
- elderly group not analysed separately or not identifiable in the paper;
- case series < 10 cases;
- review articles or experimental studies.

### 2.4. Study selection

Two reviewers (ZY and ZZY) independently screened the titles and abstracts for the eligibility criteria. Subsequently, the full-text of the studies that potentially met the inclusion criteria were read and the literature was reviewed to determine the final inclusion. We resolved disagreements by reaching a consensus through discussion.

### 2.5. Data extraction

Two of the authors (ZY and ZZY) independently extracted the relevant data from each full-text report using a standard data extraction form. The data extracted from studies included the title, authors, year of publication, study design, sample size, population, age, gender, type of interventions, surgical procedures, duration of follow-up and outcomes parameters. The corresponding authors of the included studies were contacted to obtain any required information that was missing. The extracted data were verified by XLM.

### 2.6. Methodological quality assessment

We evaluated the RCTs using the "Cochrane collaboration's tool" for assessing the risk of bias. Non-RCT [i.e., retrospective comparative study (RCS) and prospective comparative study (PCS)] methodological quality was assessed using the Methodological Index for Non-Randomized Studies (MINORS) form[7], which was a valid instrument designed to assess the quality of comparative or non-comparative non-RCT studies.

### 2.7. Data analysis and statistical methods

The meta-analysis was undertaken using RevMan 5.1 for Windows (The Cochrane Collaboration, Oxford, United Kingdom). We assessed statistical heterogeneity for each study with the use of a standard $\text{Chi}^2$ test (for heterogeneity, a level of $P < 0.1$ was considered significant) and the $I^2$ statistic. An $I^2$ statistic value of 50% was considered to indicate substantial heterogeneity. In comparing trials showing heterogeneity, pooled data were meta-analyzed using a random-effects model. Otherwise, a fixed-effects model was used for the analysis. Odds ratio (OR) and 95% confidence intervals (CIs) were calculated for dichotomous outcomes and mean differences (MDs) and 95% CIs for continuous outcomes. Publication bias was estimated by funnel plot, and asymmetry in the funnel was present if publication bias existed.

### 2.8. Evidence synthesis

The evidence grade was determined using the guidelines of the GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) working group. The GRADE system uses a sequential assessment of the evidence quality followed by an assessment of the risk–benefit balance and a subsequent judgment on the strength of the recommendations. The evidence grades are divided into the following categories:

- high, which indicates that further research is unlikely to alter confidence in the effect estimate;
- moderate, which indicates that further research is likely to significantly alter confidence in the effect estimate and may change the estimate;
- low, which indicates that further research is likely to significantly alter confidence in the effect estimate and to change the estimate;
- very low, which indicates that any effect estimate is uncertain.

Study limitations, results inconsistency, indirectness, imprecision and publication bias may lower the grade of the quality of evidence. The reasons for increasing the quality of evidence include a large effect, presentation of a dose–response gradient and plausible confounders that would decrease an apparent treatment effect. As recommended by the GRADE working group, the lowest evidence quality for any of the outcomes was used to rate the overall evidence quality. The evidence quality was graded using the GRADEpro Version 3.6 software. The strengths of the recommendations were based on the quality of the evidence.

## 3. Results

### 3.1. Search results

A total of 1258 titles and abstracts were preliminarily reviewed, of which 12 studies eventually satisfied the eligibility criteria [8–19] (Fig. 1). These studies included 11 RCS [8–18] and 1 PCS [19]. In total, 730 patients and were included in the 12 studies. There were 441 patients with conservative treatment and 289 with surgical treatment. The basic information of included studies was presented in Table 1.

### 3.2. Quality assessment

Among the 12 included studies, only 1 PCS had a low risk of bias, and the remaining 11 RCS studies had a high risk of bias resulting from study design limitations. The MINORS quality scores of the non-RCTs are presented in Table 1. The mean score was 13.0 (range, 11–18), which corresponded to a 54% score. This result indicated that there was considerable variability in the evidence base.