

Identification of risk factors for odontoid fracture nonunion: Predictive modelling in a retrospective multi-center approach.

Iris Leister ^{1,2,3,4}, Matthias Vogel ^{1,2}, Jan Vastmans ¹, Patrick Langthaler ^{4,5,6}, Georg Mattiassich ⁷, Thomas Haider ⁸, Alexandra Christ ⁸, Martin Etschmaier ⁹, Alexander Eijkenboom ¹, Julia Burghuber ¹⁰, Harald Kindermann ¹¹, Doris Maier ^{1,2}, Florian Högel ^{1,2}

¹ Spinal Cord Injury Center, BG Trauma Center Murnau, Murnau, Germany

² ParaMove, SCI Research Unit, BG Trauma Center Murnau, Murnau, Germany, Paracelsus Medical University, Salzburg, Austria

³ Institute of Molecular Regenerative Medicine, Paracelsus Medical University, Salzburg, Austria

⁴ Spinal Cord Injury and Tissue Regeneration Center Salzburg (SCI-TReCS), Paracelsus Medical University, Salzburg, Austria

⁵ Department of Neurology, Christian Doppler University Hospital, Paracelsus Medical University and Centre for Cognitive Neuroscience, Austria

⁶ Department of Mathematics, Paris Lodron University, Salzburg, Austria.

⁷ Department of Orthopedics and Trauma Surgery, Klinik Diakonissen Schladming, Schladming, Austria

⁸ Department of Orthopedics and Trauma Surgery, Medical University of Vienna, Vienna, Austria

⁹ Department of Trauma Surgery, AUVA Trauma Center Graz, Graz, Austria

¹⁰ Department of Trauma Surgery, AUVA Trauma Center Linz, Linz, Austria

¹¹ Department of Marketing and Electronic Business, University of Applied Sciences Upper Austria, Steyr, Austria

Abstract

Background:

Type II and III odontoid fractures represent the most common cervical spine fracture in elderly and are associated with a relatively high rate of pseudarthrosis. Odontoid fracture nonunion can lead to severe sequelae, such as persistent neck pain, and myelopathy. Also, the management of odontoid fractures is controversial, and

treatment modalities range from conservative treatment to extensive surgical stabilization and fusion.

Research question:

The underlying aim of this study is to assess if the choice of treatment affects osseous union and to identify potential risk factors for odontoid fracture nonunion.

Design:

This study is a retrospective analysis of data from a total of 419 individuals who sustained odontoid fracture and were treated in either of four hospitals in Austria and Germany.

Methods:

We included the following potential contributing factors for fracture nonunion in 5-fold cross-validated extreme gradient boosted (XGBoost) and binary logistic regression models: age, gender, fracture displacement, injury mechanism, fracture classification (Anderson II vs III), presence of comorbidities, and treatment method (conservative, anterior or posterior screw fixation, cervico-occipital fusion). Performances of the different models were compared using the area under the receiver operating characteristic curve (AUROC).

Results:

In our cohort 189 (45%) had radiologically confirmed dens nonunion six months post-injury. Rates of nonunion were significantly different between the treatment groups ($p < 0.001$) with the highest rate in the conservatively treated group. The factors age, fracture classification, conservative treatment, anterior screw fixation with one screw, and cervico-occipital fusion showed the highest model contributions in the XGBoost.

Conclusion:

Higher age, Anderson type II, conservative treatment, and surgical anterior screw fixation with one screw are the main risk factors for odontoid nonunion.