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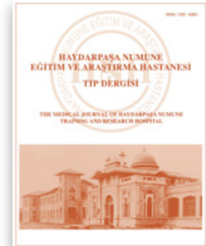

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Original Article

Surgical Management of Type II Odontoid Fractures

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Abstract

Introduction: Type II fractures are the most common odontoid fractures. This study is a retrospective evaluation of surgically treated type II odontoid fracture cases.

Methods: The parameters studied were age, gender, and characteristics of the fracture, such as degree of odontoid displacement, displacement of the odontoid relative to the body of the C2, anatomy of the fracture line, and the distance between fragments. The cases of 19 patients with a type II odontoid fracture were analyzed.

Results: Anterior odontoid screw fixation (n=6, 31.6%), posterior cervical atlantoaxial instrumented fusion (n=7, 36.8%), and occipitocervical fusion (n=6, 31.6%) were performed. The fracture line was posterior oblique in 11 (58%), anterior oblique in 4 (21%), and horizontal in 4 (21%) patients. Anterior and posterior displacement of the odontoid was detected in 12 (63.2) and 7 (36.8%) patients, respectively.

Discussion and Conclusion: Surgical treatment of type II odontoid fracture is still controversial. The appropriate approach should be determined based on the clinical and radiological characteristics of the patient. It was observed that the fracture fragment was displaced posteriorly in all patients. The distance between the fracture fragment and the C2 was smaller in those treated with an anterior approach.

Keywords: Anterior odontoid fixation; type 2 odontoid fractures; type 2 odontoid fractures surgical approach.

Nearly 20% of all cervical fractures are C2 vertebral fractures. More than half of C2 fractures affect the odontoid process [1,2]. The incidence of odontoid fracture increases with age. In patients older than 70 years of age, cervical fractures affecting the odontoid process are most common, while in people older than 80 years of age, spinal fractures are most often seen [3,4]. Odontoid fracture is more frequently seen in young men; however, with aging, the gender difference is eliminated.

In 1979, Althoff [5] performed the most comprehensive study examining the mechanism of odontoid fracture in an experimental study using cadaver specimens. It was determined that impact that combined horizontal shear and vertical compression directed to the sagittal plane produced an odontoid fracture. Hyperflexion is the most frequently seen mechanism of cervical injury, and typically results in anterior displacement of C1 on C2. Hyperextension trauma rarely leads to odontoid fractures; posterior displacement is more frequently seen [6].

Odontoid fractures are frequently associated with head and face trauma and subaxial injuries, and neurological deficits are present in 2% to 27% of the cases [7,8]. Between 25% and 40% of the patients with cervical fractures that were the result of high-energy traumas are lost at the scene [9].

The 3-tier classification system of odontoid fractures developed by Anderson, and D'Alonzo [10] in 1974 is the most

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commonly used. A type I fracture is an avulsion fracture of the apex of the odontoid, a type II fracture occurs at the junction between the base of the odontoid and body of the C2 (the most frequently seen type, comprising 65-74% of all cases), and a type III fracture line extends through the body of C2. Hadley introduced the definition of subtype IIA fracture in 1988 for a comminuted fracture of the base of the odontoid. The type IIA fracture has the greatest risk of nonunion and requires surgical treatment. For better discrimination between type II and type III fractures, Grauer et al. [11] suggested a modified classification system based on fracture line obliquity, displacement, and comminution. A nondisplaced transverse fracture line is present in type IIA, and these patients may be followed up conservatively. It has been reported that 49% of type II fractures can be classified in this subtype. Type IIB is a displaced fracture with the fracture line extending from anterosuperior to posteroinferior. This type represents 34% of type II fractures, and requires surgical treatment. Type IIC is generally a comminuted fracture, with the fracture line extending from anteroinferior to posterosuperior. This subtype accounts for 16% of type II fractures.

Odontoid fractures are most frequently associated with neck pain, weakened muscle strength, and changes in the senses and reflexes. The best visualization is achieved with computed tomography (CT) reconstruction. Direct plain radiograms and magnetic resonance imaging (MRI) can also aid in arriving at diagnosis, performing the differential diagnosis, and demonstrating transverse ligament and spinal cord injuries. The parameters used for typing odontoid fractures and surgical planning are degree of odontoid displacement, displacement of the odontoid relative to the C2 body, anatomy of the fracture line (transverse, anterior oblique, or posterior oblique), distance between fragments, presence of comminution, contact area between the odontoid and the C2 body displacement of an odontoid fracture fragment on the C2 vertebra, the direction of any displacement of an odontoid fragment (anterior, posterior, or no displacement), anatomy of the fracture line, the presence and grade of the distance between an odontoid fragment and the C2, and the presence of atlantoaxial instability, grade, and fracture fragments [12].

There are a number of alternatives available in the treatment of type II odontoid fractures, including external immobilization using a halo orthosis or cervical collar, and surgical treatment, through an anterior or posterior approach. At present, there is no consensus on the optimal treatment. Herein, surgical treatment of patients with type II odontoid fractures is discussed.

Materials and Methods

The cases of 19 patients with a type II odontoid fracture who were operated on in the clinic between 2011 and 2016 were examined retrospectively. The patients were analyzed according to demographic characteristics and features of the fractures. Data regarding age, gender, and comorbidities of the patients were evaluated, as well as preoperative X-ray, CT, and MRI images. The degree of odontoid displacement, displacement of the fracture fragment in relation to the body of the C2, anatomy of the fracture line, and the distance between fracture fragments were examined (Fig. 1).

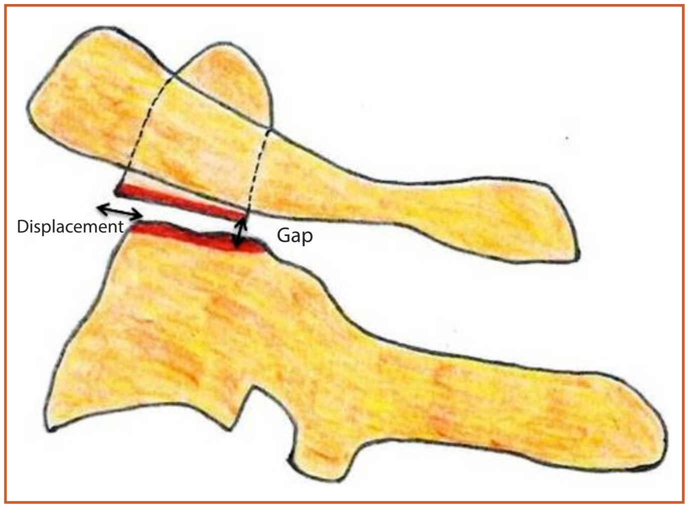

Figure 1. The degree of odontoid displacement and the displacment of the fracture fragment in relation to the body of the C2.

Table 1. The correlation between the characteristics of the fracture and the surgical technique applied

	Cases (n)	Orientation of the fracture fragment Anterior, Posterior	Distance between the fracture fragment and C2 body (mm)	Distance between the fracture fragments (mm)
Odontoid screw	6	0, 6	2.83±0.17	2.25±0.15
C1-C2 screw	7	6, 1	3.07±1.72	2.46±0.94
Occipitocervical screw	6	6, 0	3.38±1.38	3.55±1.09

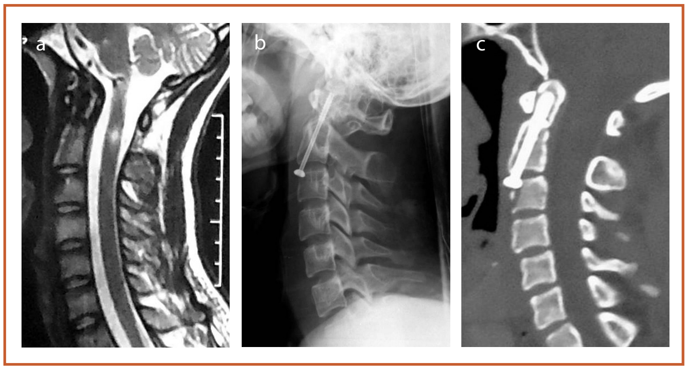

Figure 2. (a) Sagittal magnetic resonance image of type IIA odontoid fracture. **(b)** Postoperative radiogram of odontoid screw. **(c)** Postoperative computed tomography image.

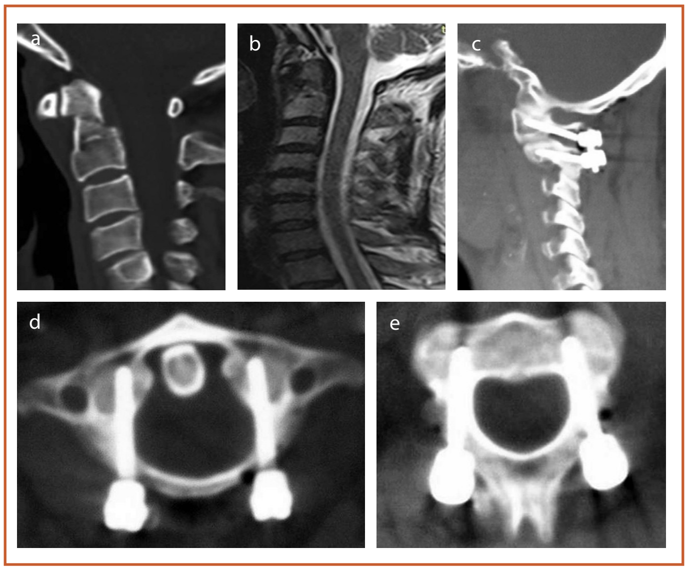

Figure 3. (a) Sagittal computed tomography image of type IIB fracture. **(b)** Sagittal magnetic resonance image. **(c)** Postoperative sagittal computed tomography image of a case treated with C1 mass-C2 pars screw fixation. **(d)** Axial image of C1 mass screw. **(e)** Axial image of the C2 pars screw.

All of the patients in this study presented with acute trauma. In 3 cases, the type II odontoid fracture was accompanied by a C1 vertebral fracture. A type IIA fracture was seen in 1 patient.

Descriptive statistics (mean, SD, median, minimum, maximum) were used to describe continuous variables. For the comparison of categorical variables, s chi-square test (Fisher's exact test where appropriate) was used. A p value of 0.05 was accepted as the level of statistical significance.

The median age of the patients was 54.2 years (min-max: 19-91 years). There were 7 female patients and 12 male patients in the study group. Comorbid diseases (hypertension, diabetes mellitus, coronary artery disease) were detected in 10 (52.6%) study participants. In all, there were 11 (58%) posterior oblique fractures, 4 (21%) were anterior oblique, and another 4 (21%) were horizontal fractures. The odontoid fracture was anteriorly displaced in 12 (63.2%) cases and posteriorly in 7 (36.8%). Odontoid screw fixation was applied in 6 (31.6%) cases, and the other patients were managed with a posterior cervical approach. C1-C2 fusion (n=7, 36.8%) and occipitocervical fusion (n=6, 31.6%) were performed (Table 1; Figs. 2-4). In all cases of odontoid screw fixation, the fragment was displaced posteriorly and the distance between the fracture fragment and the C2 was smaller relative to the cases treated with a posterior approach (Table 1). A statistically significant difference was not found between the fracture type and the surgical approach performed (Fisher's exact test, p=0.330).

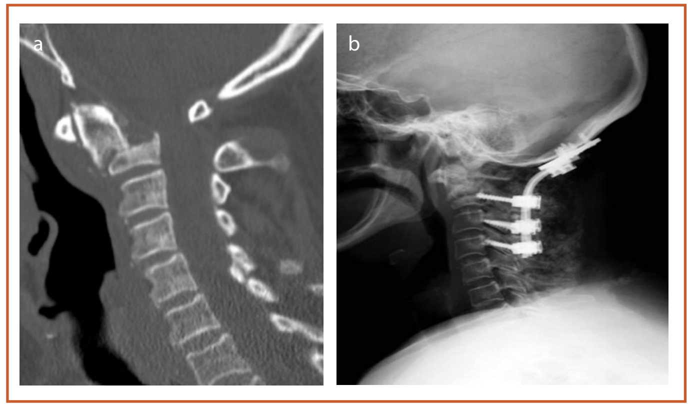

Figure 4. (a) Sagittal image of case with type IIC odontoid fracture. **(b)** Postoperative sagittal radiogram of a patient who underwent occipitocervical fusion surgery.

Discussion

Type II odontoid fractures are the most frequently seen, and the most controversial type of fracture. Surgical treatment is not always applicable in the presence of potential surgical risks, poor bone quality, or if the anatomy of the fracture is not suited to surgery [13]. In these conditions, immobilization with a halo orthosis or cervical collar is recommended. In elderly patients, use of a halo has been associated with pneumonia and cardiac arrest. Therefore, a cervical collar is recommended to provide immobilization [14,15,16]. However, the fracture healing rate was lower in a group of type II odontoid fracture patients older than 65 years of age after 12 weeks of use of a cervical collar when compared with posterior fusion surgery. Surgery should be the first alternative for appropriate candidates [17,18].

There is a greater risk of nonunion and instability with conservative treatment. It has been demonstrated in some series that anterior odontoid screw or posterior cervical fixation achieved fusion in more than 80% of the cases [19,20]. In another report, a fracture union rate of 100% was reported using posterior C1-C2 fusion [21].

In type IIA odontoid fractures, there is a greater risk of nonunion with posterior displacement of fragments of more than 4 to 6 mm, angulation of >10º, fracture gap >2 mm, and a patient who is older than 65 years, and surgical treatment should be considered [22]. However, in patients older than 80 years, surgery may not be feasible due to the high risk of morbidity and mortality. In this age group, a cervical collar may be more appropriate than a halo orthosis, as it is associated with fewer complications [22].

Many factors determine the choice of treatment of odontoid fractures. There is no current consensus on a preference between anterior or posterior surgical approach [14,23]. The most appropriate approach should be selected based on the individual characteristics of the patient and the fracture.

Anterior odontoid screw fixation ensures direct osteosynthesis and mobility of C1-C2 joint is preserved [8,24,25]. Odontoid screw fixation has a high union rate (80-100%). It is indicated in cases with transverse or posterior oblique fractures and contraindicated in cases of comminuted odontoid fracture, anterior oblique fracture, transverse ligament rupture, osteoporosis, advanced cervicothoracic kyphosis, and non-recent fracture (>6 months). All of our patients presented with acute trauma and posterior fracture fragment displacement. The gap between the fracture fragment and the C2 vertebra was smaller in those managed with anterior approach. Odontoid fixation may be achieved using 1 or 2 screws. In all of our cases, we preferred to use a single odontoid screw. In a study performed by Jenkins et al., [26] a significant difference in fusion rate was not seen when comparing the use of 1 screw and 2 screws. Dailey et al. [27] demonstrated greater success with 2 screws in patients older than 70 years. However, a greater rate of complications, such as dysphagia and aspiration pneumonia, was detected in these patients.

Management of odontoid fractures can be achieved through a posterior approach using atlantoaxial wiring or screw fixation. Surgery with screw fixation provides greater stabilization. The most frequently used techniques are the C1-C2 transarticular screw fixation method described by Magerl and Seeman, and C1 mass and C2 pars screw fixation using lamina or pedicle screws as described by Goel and Laheri [30]. Seven cases (36.8%) in this study were treated with C1 mass-C2 pars screw fixation, and 6 cases (31.6%) with occipitocervical fusion. All of the patients treated with a posterior approach had additional pathologies. Long-term follow-up of all patients who underwent fixation with posterior screw fixation revealed a nearly 100% fusion rate. The posterior approach is indicated in the presence of an anterior oblique fracture, irreducible fracture, transverse ligament injury, osteoporosis, or severe cervicothoracic deformity. In addition, posterior approaches should be preferred when anterior odontoid screw fixation does not achieve fusion and in cases with a high risk of postoperative complications (dysphagia, aspiration pneumonia, etc.) [9,28,29]. The disadvantages of a posterior approach include restriction of lateral bending and axial rotation of the neck (nearly 50%), risk of injuring the vertebral artery and the root of the C2, and risk of failed realignment of the fracture line in 2% to 4% of cases [30].

In the management of odontoid fractures, the preference for an anterior or a posterior approach is still debated. Atlantoaxial mobility is preserved in odontoid screw fixation through an anterior approach. It is indicated in cases with transverse or posterior oblique fracture lines. However, in the presence of a comminuted odontoid fracture, anterior oblique fracture, transverse ligament rupture, osteoporosis, cervicothoracic kyphosis, or delayed fracture (>6 months), anterior odontoid screw fixation is contraindicated. In these cases, a posterior approach is recommended. This is most often accomplished with a screw fixation technique. Also, in cases where follow-up indicates that anterior odontoid screw fixation did not achieve fusion and in cases where postoperative complications can be anticipated, a posterior approach should be preferred.

Ethics Committee Approval: The approval of the local Ethics Committee was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.T.E.; Design: E.A.; Data Collection or Processing: B.E.; Analysis or Interpretation: O.F.S.; Literature Search: S.T.E., H.S.; Writing: E.A.

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