

# Current Management of Odontoid Fractures

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**Abstract:** Odontoid fracture frequently occurs following cervical trauma. As C1-2 vertebral level allows the maximum motion in the cervical spine, these fractures may often be unstable, causing catastrophic spinal cord trauma and respiratory compromise. In this article, the current management of odontoid fractures is reviewed.

**Keywords:** cervical spine injury, odontoid fracture, odontoid process

## INTRODUCTION AND CLASSIFICATION

Of all the cases of cervical trauma, about one out of five involves the axis<sup>1</sup>. The commonest type of the axis injury is an odontoid fracture at the junction of the dens and the body (type II odontoid fracture)<sup>2</sup>.

The C1-2 complex allows far more motion than any other single level in the cervical spine. This motion is predominantly rotational, since translational motion at C1-C2 is limited by the strong transverse ligament. This restriction is lost after fracture of the odontoid and may be associated with antero- or retrolisthesis of the C1-C2 complex in relation to the C2 body. This may result in spinal cord compression producing severe neurological deficits<sup>3</sup>.

Anderson and D'Alonzo<sup>2</sup> classified dens fracture into three types:

**Type I-** involves the tip of the odontoid process. This is the least common type of odontoid fracture.

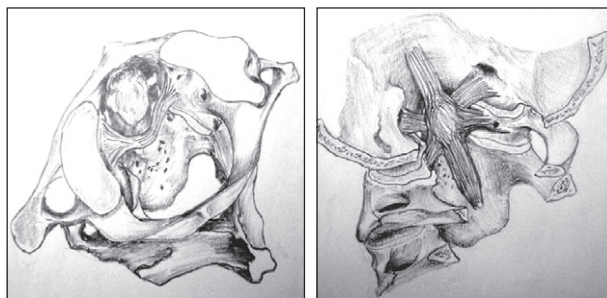
**Type II-** is the commonest type of dens fracture. The fracture line involves the junction of the body of dens with the body of axis. Sometimes type II fracture is associated with a comminuted fragment at the base of dens called the type II A variety of fracture. This fracture is markedly unstable<sup>4</sup>.

**Type III-** The fracture line involves the body of C2 in addition to passing through dens.

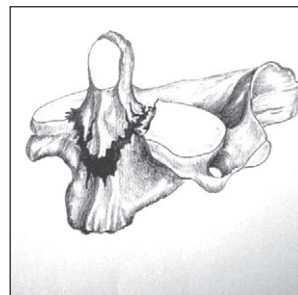
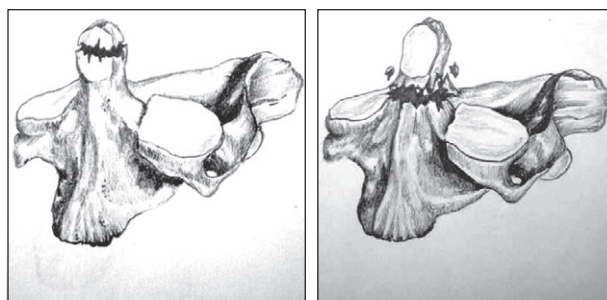
The commonest cause of dens fracture is hyperflexion at the neck. This may lead to an anterior displacement of C1 on C2 (atlanto-axial subluxation). Extension only occasionally produces odontoid fracture and this is usually

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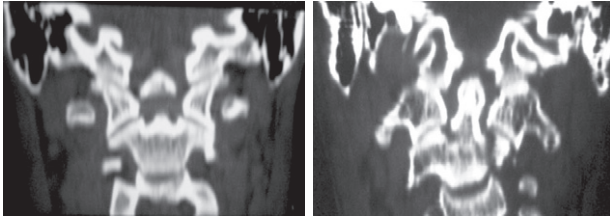
associated with posterior displacement of the C1 arch-fragment relative to the body of axis<sup>5</sup>.



**FIGURE 1:** Diagrams showing a) the transverse ligament supporting the dens to the C1 arch; and, b) the cruciate ligament supporting the occipito-atlanto-axial complex



**FIGURE 2:** Diagrams showing a) the type I; b) type II; and, c) type III odontoid fractures



**FIGURE 3.** Coronal CT scan showing a) type II; and, b) type III odontoid fractures

## CLINICAL FEATURES

Patients with acute dens fractures usually present with upper cervical pain and restriction of neck movements. They may have a tendency to support their head with their hands while moving from an upright to a supine position. In case of cord compression by the displaced fracture segments, cervical myelopathy may occur. In a study, 82% patients of type II fractures presented with intact neurological status; 8% had minimal sensory disturbances over the scalp or limb; and 10% had significant neurological deficits. Type I and type III odontoid fractures are rarely associated with neurological deficits<sup>6</sup>. About 25-40% of dens fractures are fatal at the time of accident.

## MANAGEMENT

### Type I odontoid fractures

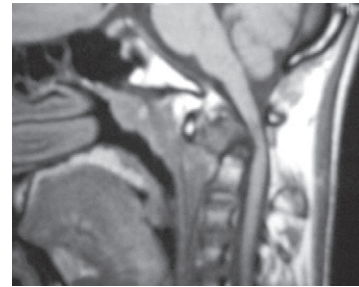
Most neurosurgeons agree that these fractures are generally stable and can be managed with external immobilization using a hard cervical collar. There is very low incidence of non-union, and surgery is seldom indicated for these fractures<sup>2,7</sup>.

### Type II odontoid fractures

#### Conservative treatment

In the management of type II odontoid fractures, long-enduring controversies exist: Should conservative management with halo immobilization be adopted; or, should surgical reduction and fusion be undertaken? In case of the latter, should the approach be anterior or posterior? Studies utilizing external immobilization have reported a wide-ranging result<sup>8-15</sup> varying from ineffectualness<sup>14</sup> to 93 percent<sup>15</sup> success. Various factors affecting the rate of union of fractured odontoid include elderly age, degree of dens displacement, presence of concomitant C1-2 fracture, pre-existing pathological condition and age of the fracture<sup>16</sup>. Apuzzo et al<sup>8</sup> reported that dens displacement exceeding 4mm and an age above 40 years are associated with 88% chance of non-union of fracture odontoid treated with external immobilization alone. Dunn et al<sup>12</sup> reported that age greater than 65 years along with retrolisthesis correlated with about 70-78% chance of non-union of

fracture odontoid treated with external immobilization alone. Hadley<sup>4</sup> described that type II A dens fractures have a very high tendency of non-union. The current role of external immobilization in case of type II dens fractures is where patients are unfit for general anesthesia or they have sustained severe concurrent injury that precludes primary surgical intervention for the fractured odontoid. Apfelbaum et al<sup>17</sup> have found a lower rate of bony fusion in patients with anterior oblique fractures when compared to patients in whom posterior oblique or horizontal fractures were demonstrated.



**FIGURE 4.** Sagittal MR scan showing an atlantoaxial dislocation due to type II odontoid fracture

### Surgical treatment

#### Anterior approach

Anterior odontoid screw fixation was first reported by Nakanishi<sup>18</sup> and Bohler<sup>19</sup>. This procedure provides immediate spinal stability, preserves the normal rotation between C1-2, allows the best anatomical and functional outcome for type II odontoid fracture, and is associated with rapid patient mobilization, minimal postoperative pain and a short hospital stay. Acute odontoid fractures treated by anterior screw fixation have a fusion rate of approximately 90 percent<sup>20</sup>.

**Table 1: Surgical approaches for odontoid fracture**

<b>Anterior approach</b>
<b>Anterior odontoid screw fixation</b>
Single screw
Multiple screw
<b>Posterior approach</b>
<b>C1-2 sublaminar wire fixation and bone grafting</b>
Gallie's method
Brook's method
Sonntag's method
<b>Posterior C1-2 transarticular screw fixation</b>
Magerl's procedure
Magerl's procedure supplemented with
C1-2 sublaminar wire fixation
Jain's method of creating artificial arch on the
occipital bone with sublaminar wiring
<b>Ransford's contoured rod fixation</b>

In the anterior screw fixation procedure, one or more screws may be used. Earlier studies emphasized on the concept of multiple screw usage for type II odontoid fractures mentioning that multiple screws augment the structural strength of the fusion and prevent the rotation of odontoid on the body of C2<sup>21,22</sup>. Recent studies found no significant difference in the fusion rate in the patients treated with single or two odontoid screws<sup>23</sup>.

Various types of screws are available, including cortical or cancellous bone screws, self-tapping or non self-tapping screws, lag screws or cannulated screws, and, fully or partially threaded screws. Partially threaded lag screws are commonly used for fixating the odontoid. Lag compression helps to unite the fracture line by producing a compressive force. This helps in coupling the fractured fragments in addition to providing rigid fixation. Non self-tapping screws provide stronger screw purchase in the bone than self tapping screws<sup>16</sup>.

The anterior odontoid screw fixation has certain limitations. Surgery requires adequate high cervical exposure and soft tissue retraction, which create anatomical limitations, as does the inability to add graft material to enhance fusion stability. Patients with short neck and barrel-shaped chest may not be suitable surgical candidates for the anterior approach because their anatomy interferes with an appropriate screw trajectory. A prerequisite for anterior screw fixation is an intact transverse ligament and a horizontal fracture line, which may not always be the case. In cases of chronic odontoid fracture, anterior screw fixation is associated with a high chance of non-union. The anterior screw fixation for odontoid fracture should be only performed when the fractured odontoid and the remaining C2 body are adequately aligned prior to screw insertion<sup>16</sup>.

### Posterior approach

Posterior approach for stabilization of odontoid fracture is indicated in the cases of odontoid fracture that are not amenable to anterior screw fixation. Commonly used procedures involve wedging a bone graft between posterior arch of C1 and the C2 lamina with sublaminar wiring. The well-described different methods for this C1-2 posterior fusion procedure are the Gallie<sup>24</sup>, Brooks<sup>25</sup>, Sonntag<sup>26</sup> techniques. These procedures have a satisfactory fusion rate of about 74 percent<sup>20</sup>. The demerit of this procedure is that it causes elimination of the normal C1-2 rotatory motion (which accounts for more than 50% of all cervical spine rotatory movements) and reduced cervical spine flexion-extension by 10 percent<sup>21</sup>.

Another excellent alternative technique for odontoid fracture is the posterior C1-2 transarticular screw fixation

(Magerl's procedure) using unilateral or bilateral screws<sup>27,28</sup>. This provides an excellent spinal rotational stability. This is an indirect method of stabilizing the fracture (in which the normal anatomical configuration is disrupted). Preoperative CT evaluation is mandatory to avoid vertebral artery injury in this procedure. This technique can be supplemented with metal plate for occipito-cervical stabilization. Alternatively, Jain's technique of occipitocervical fusion<sup>29</sup>, Goel's plate and screw lateral mass fixation<sup>30</sup>, or a Ransford's contoured rod technique<sup>31</sup> may be utilized.

## Type III odontoid fracture

### Conservative treatment

For type III odontoid fractures, external immobilization is a successful treatment option. Various studies have reported about 85% fusion rate for type III dens fractures treated by external immobilization<sup>27</sup>. Age was not clearly a predictor of successful fusion. The degree of fracture displacement had a negative correlation in few studies. About 97% fusion rate has been demonstrated in cases of type III dens fracture treated with posterior cervical fixation methods and almost 100% fusion rate has been shown by anterior screw fixation<sup>20</sup>.

## CONCLUSIONS

For type I and type III dens fractures, external immobilization provides a satisfactory fusion rate of almost 100% and 84% respectively. However, anterior screw fixation for type III dens fractures improves the fusion rate to nearly 100%. For type II odontoid fractures, the role of external immobilization is limited to only select cases who are not fit for a surgical procedure as it provides a fusion rate of approximately 65%. Anterior screw or posterior cervical stabilization procedures provide a 74 to 90% fusion rate. The former is preferred in acute Type II fractures due to its ability to preserve C1-C2 axial rotation but cannot be applied in cases of transverse ligament disruption, significantly displaced fractured segment or with comminuted fractures.

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