Nonoperative Treatment of Displaced Type II Odontoid Peg Fractures With a Philadelphia Collar

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abstract

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Although a consensus exists on the nonoperative management of types I and III odontoid peg fractures, treatment of type II fractures remains controversial. An increasing trend exists toward primary fixation of type II peg fractures due to a high rate of nonunion, especially if the displacement is >4 mm. This article reports the results of nonoperative treatment of patients with displaced odontoid peg fractures (>4 mm) using a Philadelphia collar.

A retrospective review of clinical and radiological records was performed for nonoperatively treated patients who sustained displaced type II peg fractures between January 2003 and April 2008. The study group comprised 9 patients (2 men and 7 women), and all patients were treated with Philadelphia collars. Patients were followed up for an average of 24.8 months (range, 8-28 months) for clinical and radiological outcomes. Functional outcomes were measured according to the Smiley-Webster scale. Fractures united uneventfully in 6 patients, but nonunion developed in 3 patients. Average time to union was 12.3±2.94 weeks (95% confidence interval, 9.97-14.68 weeks; range, 10-16 weeks). No patient had clinical or radiological signs of instability or delayed onset myelopathy at follow-up. Three patients had excellent, 4 had good, and 2 had fair results as per the Smiley-Webster functional scoring system.

Displaced type II peg fractures can be managed nonoperatively in patients who refuse surgery or those with multiple comorbidities. Adequate patient counseling and compliance with close clinicoradiological follow-up is paramount to avoid adverse clinical events and achieve an optimal functional outcome.

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Figure: Coronal computed tomography scan showing a type II odontoid peg fracture.
Odontoid fractures typically result from a flexion injury (ie, anterior movement of the head on the neck) and infrequently result from an extension injury (ie, posterior head movement). Odontoid fractures make up 20% of all cervical fractures, with the majority being type II (65%-74%) as per the Anderson and D’Alonzo classification. Up to 40% of the injuries are immediately fatal, and survivors are at risk of fracture nonunion and progressive neurological damage. Odontoid peg fractures can occur in all age groups, with a mean age of 47 years at occurrence, and they have a bimodal age distribution. High-energy trauma in young patients and low-energy falls in elderly patients are common mechanisms of injury leading to odontoid peg fractures.

Although a consensus exists on the nonoperative management of types I and III odontoid peg fractures, treatment of type II fractures remains controversial. An increasing trend exists toward primary operative fixation of type II fractures due to claims of a higher union rate. In our institution, operative stabilization with internal fixation is the treatment of choice for displaced (>4 mm) type II peg fractures. This article reports the results of 9 patients with displaced odontoid peg fractures treated nonoperatively because they were unsuitable for surgery due to existing comorbidities or they had refused operative intervention.

**Materials and Methods**

A retrospective study was conducted between January 2003 and April 2008, and patients treated nonoperatively for displaced type II peg fractures were identified. Inclusion criteria were patients treated nonoperatively, displacement >4 mm, and the absence of concomitant neurological deficit. Collected data included variables such as age, sex, mechanism of injury, fracture type, presence of neurological deficits, associated injuries, pre-existing systemic disease that may affect bone healing, and clinical and radiographic outcome after nonoperative treatment. Exclusion criteria were patients with minimally displaced type II odontoid fractures (fracture gap of <2 mm, initial displacement <4 mm), type III odontoid fractures, penetrating mechanism of injury, congenital cervical spine anomalies, or the presence of concomitant neurological deficit.

The study group comprised 9 patients (2 men and 7 women). Mean patient age was 55.11 ± 27.41 years (95% confidence interval [CI], 37.2-73.01 years; range, 18-93 years). Average follow-up was 24.8 months (range, 8-28 months). Seven (77.77%) patients sustained their fractures due to a mechanical fall. Car accident (11.11%) and orthostatic hypotension leading to collapse (11.11%) were the mechanisms of injury in 1 patient each. All patients had anteroposterior (AP), lateral, and open-mouth radiographs as per hospital protocol. Computed tomography (CT) scans of the cervical spine were performed when deemed necessary (Figures 1 and 2). The fractures were classified according to Anderson and D’Alonzo classification. All patients were treated by 1 senior spinal surgeon (J.L.).

Seven patients were offered operative treatment but were treated nonoperatively for various reasons (Table 1). Two patients were treated nonoperatively because they were not suitable for surgery due to associated medical comorbidities. Seven patients were treated definitively with a Philadelphia collar. Two patients were treated initially with halo vest immobilization but were later converted to Philadelphia collars because 1 patient did not tolerate the halo vest and the other patient’s pins became loose. The decision to treat these 2 patients with a halo vest was made due to their noncompliance with the Philadelphia collar in the immediate postinjury period. All patients were advised to use the collar continuously, 24 hours a day, for the entire treatment duration until fracture union. Compliance with removable collars is always an issue and cannot be guaranteed after discharge. We educated our patients and their families about the rationale for treatment and the importance of wearing the Philadelphia collar regularly to avoid complications. This was necessary to maximize patient compliance with the Philadelphia collar.

Patients were followed up clinicoradiologically at the outpatient clinic until the fractures had united. Subsequent follow-ups occurred at 6 monthly intervals for clinicoradiological assessment to observe for delayed onset myelopathy.
Radiographic assessment consisted of a 3-view cervical spine series (AP, lateral, and open mouth) at each follow-up visit. Degree of fracture displacement was calculated using PACS (Picture Archiving and Communication System). The stability and status of the fracture healing were determined radiographically. Criteria for osseous union were evidence of trabeculation across the fracture and absence of peg movement on lateral flexion-extension radiographs. Fine-cut CT scans with 2-mm slices were used to confirm union when concerns arose regarding fracture union on plain radiographs. Clinical examination included range of motion, local pain, activities of daily living, and full neurological assessment. Clinical results were scored on the Smiley-Webster scale as excellent, good, fair, or poor according to patient feedback (Table 2).

**RESULTS**
Fractures united uneventfully in 6 (66.66%) patients. In 3 (33.33%) patients, fractures failed to achieve bony union, but they were stable on clinicoradiological examination. A Philadelphia collar was used for fracture immobilization for 10 weeks in 3 patients, 12 weeks in 1 patient, and 16 weeks in 2 patients. Average displacement was 4.28±0.44 mm (95% confidence interval, 4.00-4.57 mm; range, 4-5.1 mm). Associated injury was observed in 4 (44.44%) patients (Table 1). Average time to radiological union was 12.3±2.94 weeks (95% CI, 9.97-14.68 weeks; range, 10-16 weeks). Plain radiographs were

<table>
<thead>
<tr>
<th>Patient No./ Sex/Age, y</th>
<th>Mode of Injury</th>
<th>Associated Injuries</th>
<th>Fracture Displacement, mm</th>
<th>Treatment</th>
<th>Time to Union, w</th>
<th>Functional Outcome*</th>
<th>Reason for Nonoperative Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/86</td>
<td>Fall from stairs</td>
<td>Nose bleed, facial bruising</td>
<td>4.1</td>
<td>Philadelphia collar</td>
<td>Nonunion</td>
<td>Good</td>
<td>Unfit for surgery</td>
</tr>
<tr>
<td>2/M/47</td>
<td>Fall from ladder</td>
<td>Scalp laceration</td>
<td>4.0</td>
<td>Philadelphia collar</td>
<td>Nonunion</td>
<td>Good</td>
<td>Refused surgery</td>
</tr>
<tr>
<td>3/F/63</td>
<td>Fall, alcohol abuse</td>
<td>None</td>
<td>5.1</td>
<td>Halo vest converted to Philadelphia collar at 10 d due to poor tolerance</td>
<td>16</td>
<td>Good</td>
<td>Refused surgery</td>
</tr>
<tr>
<td>4/F/25</td>
<td>Fall from fourth floor, self-harm</td>
<td>Humeral fracture</td>
<td>4.0</td>
<td>Philadelphia collar</td>
<td>10</td>
<td>Good</td>
<td>Unable to consent due to paranoid schizophrenia; family refused surgery</td>
</tr>
<tr>
<td>5/F/83</td>
<td>Fall from bed</td>
<td>None</td>
<td>5.0</td>
<td>Halo vest converted to Philadelphia collar at 18 d due to pin loosening</td>
<td>12</td>
<td>Excellent</td>
<td>Refused surgery</td>
</tr>
<tr>
<td>6/F/93</td>
<td>Collapse</td>
<td>Black eye</td>
<td>4.0</td>
<td>Philadelphia collar</td>
<td>10</td>
<td>Excellent</td>
<td>Severe dementia</td>
</tr>
<tr>
<td>7/F/42</td>
<td>Fall from stairs, alcohol abuse</td>
<td>None</td>
<td>4.0</td>
<td>Philadelphia collar</td>
<td>16</td>
<td>Fair</td>
<td>Refused surgery</td>
</tr>
<tr>
<td>8/F/39</td>
<td>Car accident</td>
<td>None</td>
<td>4.2</td>
<td>Philadelphia collar</td>
<td>Nonunion</td>
<td>Fair</td>
<td>Refused surgery</td>
</tr>
<tr>
<td>9/M/18</td>
<td>Fall, alcohol abuse</td>
<td>None</td>
<td>4.2</td>
<td>Philadelphia collar</td>
<td>10</td>
<td>Excellent</td>
<td>Refused surgery</td>
</tr>
</tbody>
</table>

*Smiley-Webster scale.*

<table>
<thead>
<tr>
<th>Score</th>
<th>Pain</th>
<th>Mobility</th>
<th>Return to Activity</th>
<th>Neurologic</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>No pain</td>
<td>Normal</td>
<td>No limitation</td>
<td>Intact</td>
<td>3</td>
</tr>
<tr>
<td>Good</td>
<td>Occasional</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Intact</td>
<td>4</td>
</tr>
<tr>
<td>Fair</td>
<td>Moderate</td>
<td>Severely affected</td>
<td>Severely affected</td>
<td>Slight</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>Significant</td>
<td>Severely affected</td>
<td>Disability</td>
<td>Catastrophic</td>
<td>0</td>
</tr>
</tbody>
</table>
used to diagnose union in 6 patients, but CT scans were required to confirm the radiological union in 3 patients (Figures 3, 4). Three (33.33%) patients had excellent, 4 (44.44%) had good, and 2 (22.22%) had fair results per the Smiley-Webster functional scoring system. No patient had signs of clinicoradiological instability at final follow-up, nor did they exhibit clinical signs of delayed-onset myelopathy.

**DISCUSSION**

Odontoid fractures, especially type II peg fractures, pose a treatment dilemma due to lack of consensus on the ideal treatment of these injuries. The fractures are more common in elderly patients, and recently the incidence of this fracture in patients older than 70 years has risen. Apart from the fracture anatomy, medical comorbidities, age, and patient wishes also play a crucial role in deciding the appropriate management. Various comorbidities compounded with poor bone quality in elderly patients makes them less suitable candidates for operative intervention.

The lack of consensus regarding the most appropriate treatment for type II injuries and the increasing incidence of these fractures in elderly patients often puts the clinician in a perplexing situation.

Four treatment options have been described in the literature: traction followed by immobilization with a cervical collar, rigid immobilization with a halo device/Minerva jacket (plaster of Paris), anterior screw fixation of the odontoid, and posterior C1/2 fusion. Type II odontoid fractures are typically associated with high rates of nonunion due to their intrasynovial location, decreased vascularity at the watershed line of the odontoid base, and presence of more cortical bone. Many studies have reported the risk factors for nonunion of odontoid fractures, including displacement >6 mm, 10° of angulation, fracture comminution, posterior fracture displacement, fracture malalignment during follow-up, delayed treatment (>3 weeks), and patients older than 65 years. The treatment options mentioned above aim to achieve fracture union to prevent late-onset progressive myelopathy secondary to odontoid nonunion.

Debate continues regarding the ideal management of these injuries because supporting evidence exists in the literature in favor of operative and nonoperative treatment. A recent Cochrane database review comparing operative vs conservative management demonstrated no conclusive evidence favoring either treatment. Some randomized control trials currently being conducted may resolve the controversy when the results are published.

Advocates of primary operative intervention have shown higher union rates. Fusion rates following operative intervention have been reported to be between 80% to 92%. Improved fracture healing rates with early operative management of these patients could theoretically decrease the uncommon but devastating complication of late-onset progressive myelopathy. Operative treatment also avoids several halo-related complications, such as pin-site infections, brain abscesses, skin breakdown, facet joint stiffness, and loss of spinal alignment. Decision making regarding the appropriate treatment in young, healthy patients with these fractures is relatively straightforward; however, the same is not true for noncompliant, elderly patients with multiple comorbidities.

Surgery for these injuries can result in complications, such as postoperative hematoma, dysphagia, hoarseness, damage to the vertebral artery, and neural injuries. Direct odontoid fixation is associated with a high complication rate. A 24% incidence of major complications was reported by Aebi et al. Malreduction in extension occurred in 19% of patients and pseudarthosis occurred in 12% of patients in their study. Andersson et al reported an increased complication rate in elderly patients due to associated comminution at the fracture site and stiffness of the cervical spine preventing ideal positioning of the screws.

Despite a recent increasing trend toward primary operative fixation for type II odontoid fractures, nonoperative treatment is an acceptable method of treatment, especially in the elderly population. Studies have shown comparable union rates between halo vest immobilization and surgical stabilization. Vieweg and Schultheiss and Julien et al reported fusion rates of 85% and 70%, respectively, for type II odontoid fractures treated with halo vest immobilization.

Rigid halo vest immobilization has been shown to achieve a higher union rate compared with nonrigid immobilization with a Philadelphia collar. The halo...
vest offers an advantage overall available cervical orthotics in terms of limitation of movement in the upper cervical spine. The halo vest offers 3.4° of freedom in the flexion and extension arc at the C1-C2 level compared with 8.5° with the Philadelphia collar and 13.6° with no immobilization. The halo vest has higher compliance, but tolerance has been poor in elderly patients.

Halo vest immobilization has a high complication rate, including pin loosening, pin-site infection, and dislodgement. Catastrophic complications, such as brain abscess and subdural abscess, have also been reported. Lind et al reported a 60% rate of symptomatic pin-site loosening, a 22% rate of pin-site infection, a 4% incidence of pressure sores from the vest, and 1 pin penetration. In a study of 245 patients, Glaser et al reported a case of cerebrospinal fluid leak, 14 cases of pin-site infection, 4 cases of skin breakdown, and 5 cases of noncompliance leading to premature removal of the device. Botte et al compiled data from the series of Lind et al and Glaser et al and reported an 18% rate of severe pin-related complications. In the current study, patients treated initially with a halo vest were converted to a Philadelphia collar because pin loosening and poor tolerance prevented continuation of further treatment with the halo vest.

Polin et al reported no statistical difference in union rate between rigid and nonrigid immobilization in the treatment of type II and III odontoid fractures. Hence, nonrigid immobilization with a Philadelphia collar is an appropriate treatment option, especially in patients with multiple comorbidities, poor tolerance of the halo vest, and an unwillingness to undergo surgery. Compliance is an issue, but elderly patients tolerate the Philadelphia collar better than the halo vest. In the current study, bony union occurred in 6 patients, and 3 patients had a stable nonunion. None of these 3 patients required further operative treatment because the fractures were stable and developed no signs of late-onset myelopathy at final follow-up. Nonoperative treatment with a Philadelphia collar is a reasonable option, but adequate patient and family education to ensure treatment compliance and lifestyle modification (avoiding hyperflexion or hyperextension) is of paramount importance.

REFERENCES

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