

# Evaluation of Conservative Treatment of Acute Fracture of the Odontoid Process of Axis with a Halo-Vest\*

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## ABSTRACT

We fitted a halo-vest on patients with a fracture of the odontoid process of the axis and evaluated the effects of conservative treatment on cervical muscular atrophy and the number and type of patient complaints after bone union. Four patients had Anderson Type II fractures and 6 patients had Type III fractures. Bone union was observed in all patients within 3 months after injury. After halo-vest fitting, cervical muscular atrophy increased with time, however, it gradually improved after removal of the halo-vest. Patients fixed with a halo-vest for more than 10 weeks complained of cervical discomfort and limited range of motion. No patients with fixation for less than 10 weeks had problems in bone union or had cervical complaints. Thus, less than a 10-week fixation period was considered to be appropriate.

**Keywords:** Fracture; Odontoid Process of the Axis; Halo-Vest; Conservative Treatment

## 1. Introduction

Surgery is recommended for patients with a fresh fracture of the odontoid process of the axis because it allows for early discharge and successful rehabilitation. However, the only option is the conservative therapy if a patient has poor systemic conditions or does not desire surgical therapy.

We examined the appropriate fixation period based on the percentage of bone union and complaints after removal of the halo-vest. We also evaluated the degree of atrophy of the posterior cervical muscle that underwent conservative therapy using a halo-vest.

## 2. Materials and Method

The subjects included 10 patients (6 males and 4 females) aged from 17 to 82 years (mean: 47 yrs) with a fresh fracture of the odontoid process of the axis who underwent conservative therapy using a halo-vest in our hospital between June 2004 and January 2013.

The causes of injury were falling down the stairs (5

patients), traffic accident (3 patients), rugby accident (1 patient), and suicide attempt (1 patient).

The follow-up period was from 7 months to 4 years and 1 month (mean: 1 year and 5 months).

Patients were classified into Anderson Type II [1] (4 patients) and Type III (6 patients). Eight of them had no impaired consciousness or neurological deficits at the initial visit, however, the remaining two were intubated and we could not confirm if they had any impairment (**Table 1**).

The area of muscular atrophy was determined by dividing the CT cross-sections of the sternocleidomastoid and posterior cervical muscles at C5/6 level into segments a, b, c, and d using the Rapideye<sup>TM</sup> (Toshiba Medical Systems Corporation, Japan). The degree of muscular atrophy was measured over time, and we set the degree at the time of injury as 100% (**Figure 1**).

## 3. Results

The fixation period of halo-vest ranged from 6 to 11 weeks (mean: 8 weeks). Bone union was confirmed in all patients within 3 months after injury, however, 2 patients with fixation for more than 10 weeks still had cervical

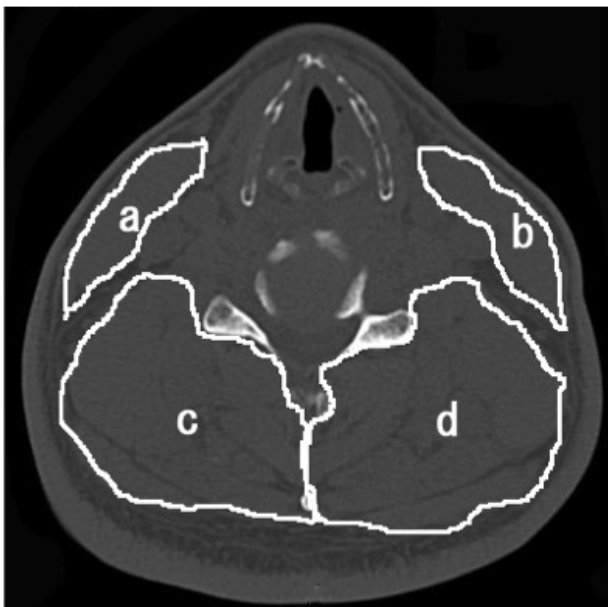
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**Table 1. Patient characteristics [2].**

Case	Age	Fracture type	Neurological deficits	Complication	Fixation period(w)	Cervical complaints	ROM limitation
1	82	Anderson II	•	Head injury	10	+	-
2	20	• II	unknown	Brain injury	7	-	-
3	49	• II	unknown	Levine Type I	8.5	-	-
4	55	• II	•	•	8	-	-
5	72	• III	•	Head injury	7	-	-
6	75	• III	•	Brain injury	8	-	-
7	26	• III	•	•	11	+	-
8	49	• III	•	•	7	-	-
9	17	• III	•	Levine Type I	8	-	-
10	25	• III	•	•	6	-	-



**Figure 1. Method for measuring muscular atrophy. Method for measuring muscular atrophy: the area of the sternocleidomastoid and posterior cervical muscle at C5/6 level is measured by CT.**

complaints at the final examination (**Table 1**).

The degree of muscular atrophy was 95.2% - 99.2% (mean: 98.0%) 12 months after injury (**Table 2**).

In 8 patients with less than a 10-week fixation period, the mean degree of muscular atrophy 12 months after injury was 98.7%, and there were no cervical complaints. In contrast, in 2 patients with a fixation period of 10-weeks the mean degree of muscular atrophy was 95.8% and the complaints included cervical pain, stiff neck, and cervical discomfort (**Table 3**).

Muscular atrophy progressed in all subjects after halo-vest fitting, however, it improved immediately after removal of the halo-vest.

**Table 2. Changes in degree of muscular atrophy.**

Case	at the time of injury	1	2	3	6	12(M)
1	100	90.1	83	79.3	94	96.4
2	100	91.1	83.2	80.3	96.2	98.9
3	100	89.9	81.5	86.5	97.2	99.2
4	100	89.2	82	86.7	97	99
5	100	88.1	79.2	87.6	93.4	98.2
6	100	89.2	83	86	97	99
7	100	90.6	83.6	78.7	94.3	95.2
8	100	89.5	82.9	87.1	95.5	99
9	100	92.1	83.7	79.1	96.8	97.8
10	100	89.7	81.9	85.3	95.1	
mean	100	89.9	82.4	83.6	95.6	98.0%

**Table 3. Relationship between duration of the fixation period and muscular atrophy.**

Duration of fixation period	Degree of muscular atrophy	
	1 month after injury	12 month after injury
6 ≤ and < 10weeks (n = 8)	89.9%	~ 98.7%
≥ 10 weeks (n = 2)	90.3%	~ 95.8%
Total (n = 10)	89.9%	~ 98.0%

#### 4. Case Report

Case 5: a 72 year-old female who was injured from a fall down the stairs. She was transported by ambulance due to a chief complaint of cervical pain but did not have marked neurological deficits. The radiograph findings at the first medical examination showed an Anderson Type III fracture of the odontoid process of the axis. The patient was fixed with halo-vest for 7 weeks and bone un-

ion was confirmed at 12 weeks by radiograph. The degree of muscular atrophy 12 months after injury was

98.2%. She had no cervical pain and had full range of motion at the final examination (**Figure 2**).



(a)



(b)



(c)



(d)

**Figure 2.** A 72-year-old female who was injured from a fall down the stairs. The radiograph findings at the first medical examination showed an Anderson Type III fracture of the odontoid process of the axis. Bone union was confirmed at 12 months after injury. She had no cervical pain and had full range of motion at the final examination. a Lateral cervical radiograph at the first visit; b CT findings at the time of the first visit; c Lateral cervical radiograph at 12 months after injury; d CT findings at 12 months after injury.

## 5. Discussion

Surgical therapy is recommended for patients with a fresh fracture of the odontoid process of the axis because it allows for early discharge and successful rehabilitation. However, surgery cannot always be conducted. If a patient has poor systemic conditions or does not desire surgical therapy, and if there are problems with access to the appropriate equipment, the only option is conservative therapy. Therefore, the percentage of bone union in conservative therapy was evaluated in patients treated in our hospital. The mean percentage of bone union of halo-vest-fixed odontoid process fractures was 72.6% in Anderson Type II patients [1,3-7]. Greene *et al.* [3] showed that the percentage of bone union in 340 Anderson Type II patients treated with conservative therapy was 79%. They also found that the percentage of bone union of patients with a  $\geq 6$  mm fracture dislocation at the time of injury was significantly different, consequently, injury to the soft tissues was affected. It was confirmed that the percentage of bone union in Type III patients was better than that of Type II patients [1,3,4,5,7] and the mean percentage of bone union was 97.5% [1,3,4,5,7] (Table 4). Therefore, an Anderson Type II patient with  $\geq 6$  mm fracture dislocation was considered to be a candidate for surgery in our hospital based on the results of Greene *et al.* [3]. Patients in this study were Anderson Type II with  $< 6$  mm and III fracture dislocations who could not undergo surgery due to multiple trauma or did not desire surgery. Bone union was observed in all of our patients at 3 months after injury.

Muscular atrophy in the sternocleidomastoid and posterior cervical muscles was evaluated based on the duration of the fixation period. Callus formation in radiograph and CT findings was detectable, however, it was difficult to evaluate when the halo-vest was removed. The longer the fixation is, the better the bone union advances. However, muscular atrophy occurs, possibly resulting in cervical pain, stiff neck, cervical discomfort, or limited range of motion in the cervical spine. Therefore, muscular atrophy was measured over time. Ono *et al.* [8] examined cervical muscular atrophy after halo-vest fitting and showed that atrophy was observed in approximately 15% of the sternocleidomastoid muscles and in 22% of the posterior cervical muscles, and cervical discomfort and limited range of motion were found when atrophy was observed in more than 20% of the posterior cervical muscles. Atrophy in the sternocleidomastoid and posterior cervical muscles in this study was less than that in Ono's study because no patients were fixed with a halo-vest for as long as 3 months. However, complaints, including stiff neck and cervical discomfort in patients with fixation for 10 weeks or more, were more frequent than those in patients with cervical muscular atrophy for less than 10 weeks.

Table 4. Bone union rates.

Fracture type		Bone union rates	No. of cases
Odontoid process fracture	Anderson Type II	72.6%	386/531 cases
	Type III	97.5	241/247

Based on these results, no patient with fixation for less than 10 weeks had problems with bone union. Thus, fixation with a halo-vest for less than 10 weeks is appropriate for a fresh fracture of the odontoid process of the axis since cervical muscular atrophy and complaints associated with muscular atrophy are caused by long-term fixation.

## 6. Conclusion

Halo-vest is useful for treatment of a fresh fracture of the odontoid process in patients who cannot have surgery, and the appropriate fixation period should be less than 10 weeks.

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