



Residual Deformity After Anterior Cervical Discectomy and Fusion for Unstable Hangman's Fractures

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BACKGROUND: Anterior cervical discectomy and fusion (ACDF) is a commonly used surgery for unstable hangman's fractures. This study investigated the rate of residual deformity after ACDF for these fractures and the effect of residual deformity on clinical and radiologic outcomes.

METHODS: A retrospective analysis of 28 patients with unstable hangman's fractures treated with ACDF was undertaken. The angulation and anterior translation between C2-C3 were measured on lateral radiographs at the time of admission, after skull traction, in the initial post-operative period, and at final follow-up. Residual deformity after surgery was defined as significant angulation ($\geq 6^\circ$) and/or translation (≥ 3 mm). Patients were divided into 2 groups: with and without residual deformity. Follow-up evaluation included clinical and radiologic outcomes.

RESULTS: Mean follow-up time was 22 months. The group with residual deformity included 7 patients with an angulation of $\geq 11^\circ$ and/or translation of ≥ 4 mm after skull traction. The remaining 21 patients without residual deformity had an angulation of $< 11^\circ$ and translation of < 4 mm after skull traction. Neck pain and neurologic deficits improved significantly in all patients after surgery. No significant changes of alignment of middle and lower cervical vertebrae were observed.

CONCLUSIONS: Residual deformity after ACDF for unstable hangman's fractures is not rare, and it seems to have no significant effect on clinical outcome during short-term

follow-up. A severe deformity between C2-C3 after skull traction may be a predictor of residual deformity.

INTRODUCTION

Traumatic spondylolisthesis of the axis, or so-called hangman's fracture, is characterized by a bilateral fracture through the neural arch of C2 from its corpus vertebra, with the fracture lines passing through the interarticular portion, lamina, articular facets, pedicles, or parts of the axis vertebra.¹⁻³ Levine and Edwards⁴ modified Effendi's system and published the most widely accepted categorization in the literature for hangman's fractures.⁵⁻⁷ Although it is still controversial, Levine-Edwards type II, IIa, and III lesions are usually thought to be unstable and should be treated with rigid immobilization.^{8,9} By considering the limitation of conservative treatment for these unstable injuries, which usually comprises initial skeletal traction followed by external immobilization in a halo orthosis for 8–12 weeks and may result in significant residual deformity at C2-C3 level, early surgical intervention has been increasingly used and reported in many countries.⁸⁻¹¹

Anterior cervical discectomy and fusion (ACDF) with internal fixation at C2-C3 is preferred and reported with satisfactory results for unstable hangman's fractures by many authors.^{3,5,8,9,11} However, residual deformity, such as anterior translation and/or kyphosis of C2-C3, can exist after ACDF for these fractures.^{3,12} To our knowledge, no study has focused on this issue up to this time. To investigate the rate of residual deformity after ACDF, to clarify its effect on clinical and radiographic outcomes of patients, and to make it possible to predict residual deformity,

Key words

- Anterior approach
- Deformity
- Discectomy
- Fusion
- Hangman fractures
- Unstable

Abbreviations and Acronyms

ACDF: Anterior cervical discectomy and fusion

ASIA: American Spinal Injury Association

CT: Computed tomography

VAS: Visual analog scale

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Table 1. Clinical Summary of 28 Patients with Unstable Hangman's Fractures

Case	Age (years)/Sex	Cause of Injury	Levine-Edward Classification	ASIA	Associated Injuries
1	51/M	Fall	II	D	Fractures of posterior arch of C1
2	52/M	Fall	II	D	Thoracic vertebral fracture (T8)
3	63/M	MVA	II	E	Severe head injury
4	71/M	MVA	II	E	Severe head injury
5	54/M	Fall	II	E	C3 body compression fracture
6	27/M	MVA	IIa	E	None
7	52/M	Other	II	E	Left clavicle fracture
8	47/M	Fall	II	E	None
9	51/M	Fall	II	E	Multiple rib fractures
10	24/M	MVA	II	E	None
11	30/M	MVA	II	E	None
12	71/M	Other	II	C*	C3-4 traumatic disc herniation Thoracic vertebral fracture (T10)
13	68/M	Fall	II	E	Fracture of anterior arch of C1
14	25/M	Fall	II	E	Mild head injury
15	38/F	MVA	II	E	None
16	27/M	Fall	II	E	None
17	27/M	MVA	II	E	Pelvic fractures Left femoral fracture
18	32/M	Fall	II	E	Mild head injury
19	40/F	Fall	IIa	E	None
20	29/F	MVA	II	E	Mild head injury
21	46/M	Fall	II	E	None
22	56/M	Fall	II	E	C3 body compression fracture
23	41/M	Fall	II	E	None
24	48/M	Fall	II	D	Thoracic vertebral fractures (T5, T6)
25	42/M	Fall	III	E	Pelvic fractures
26	41/F	MVA	II	E	Mild head injury
27	43/F	MVA	II	E	Fracture of anterior arch of C1
28	28/F	MVA	IIa	D	None

ASIA, American Spinal Injury Association scale; M, male; MVA, motor vehicle accident; female.
*ASIA C caused by C3-4 traumatic disc herniation.

we reviewed 28 patients who underwent ACDF at C2-C3 by a single surgeon.

MATERIALS AND METHODS

Patients

This retrospective study reviewed 30 consecutive patients with unstable hangman's fractures who were treated with ACDF at C2-C3 by a single senior surgeon (L.H.) in our institution

between January 2008 and May 2015. Two patients (6.7%) were lost to follow-up, and a retrospective analysis of the remaining 28 cases (93.3%) was undertaken (Table 1). The diagnosis was confirmed with the combination of x-rays, three-dimensional computed tomography (CT) scans of bony structures, and magnetic resonance imaging of the cervical spine. The patients included 22 men and 6 women. The average age at operation was 43.7 years (range, 24–71 years). The causes of injuries were falls (15 cases), motor vehicle accidents (11 cases), and others

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