

# To Study Factors Influencing Neurological Outcome, Fusion Rate and Complications in Hangmans Fractures: Non - Randomized Ambispective Study.

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## Abstract

**Background:** Traumatic spondylolisthesis of the axis, also known as Hangman's Fracture can be caused by a variety of mechanisms including combinations of extension, flexion, distraction and axial loading of the cervical spine. The fracture line passes through the neural arch of the axis.

**Methods:** Around 27 patients admitted for elective/emergency surgery at the Neurosurgical Centre of a Tertiary Care Hospital having Hangman's Fracture were included in the study after applying inclusion and exclusion criteria. A preoperative X-Ray of the cervical spine with anteroposterior and lateral view, NCCT with 3D Recon CVJ, MRI CVJ & Cervical spine, to assess bony injuries, ligamentous injuries, cord contusions/myelomalacia were done. Post-surgery after 3 months X-Ray, CVJ and NCCT 3D Recon CVJ were done to look for screw placement accuracy, mal-alignment and fusion. Improvement in neurological status and complications postoperatively, after 3 months were recorded and analyzed using relevant statistical data.

**Results:** A total of 27 Hangman's Fracture were studied of which 21 patients (77.7%) were less than 40 years of age, 20(74%) patients were male. 24(88.8%) patients had no neurological deficit pre-operatively, while the remaining 3 patients who had neurological deficit pre-operatively 2(66.6%) improved after surgery. Radiologically, fusion occurred in 19(72.7%) of patients. This was statistically significant ( $p < 0.001$ ).

**Conclusion:** In Hangman Fractures with neurological deficit 66.6% had improved neurological outcome post-operatively, while radiologically bony fusion was seen in 72.7%. Good bony fusion was observed after 3 months of surgery and patients improved neurologically after surgery.

**Keywords:** Hangman, Myelopathy, Fusion, Cervical Spine

## Introduction

Traumatic spondylolisthesis of the axis, also known as Hangman's Fracture can be caused by a variety of mechanisms including combinations of extension, flexion, distraction and axial loading of the cervical spine. The fracture line passes through the neural arch of the axis. These fractures are classified as modified Effendi [8]; Type I fracture occur through the pars interarticularis bilaterally with less than 3 mm translation and no angulation. Type II fractures are bipedicular fracture greater than 3 mm of

displacement and angulation of C2 on C3. Two variants of type II fractures have been described. The type II A fracture shows significant angulation but has minimal (rarely exceeding 2 to 3 mm) translation and includes significant disruption of the disc and posterior longitudinal ligament. Type III Hangman's Fracture are unstable injuries with severe displacement and angulation, associated with unilateral or bilateral facet dislocation of C2 on C3. Disruption of the posterior longitudinal ligament and C2-C3 disc occurs in these injuries. These injuries are commonly associated with neurologic injuries. Isolated type I fracture can be treated in rigid collar for 8-12 weeks. Type II A is treated with immediate application of a halo vest. Traction is avoided in patients with Type II A injuries because even minimal traction can cause severe distraction. All Type III injuries should be treated with surgical reduction and posterior C2-C3 fusion. Nonunion of Type II injuries

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are uncommon.

### Aims and Objectives

To study factors influencing neurological outcome, fusion rates and complications in traumatic Hangman fractures non-randomized ambispective study.

### Material and Methods

Present study was conducted in Department of Neurosurgery at Tertiary Centre. All admitted cases with Hangman's fractures were included in the present study. Patients were studied prospectively from Jan 2015 to Dec 2017 and retrospectively from Jan 2004 to 31 Dec 2014. Patients who had sub axial spine injuries and congenital CVJ anomaly were excluded from study. The purpose of study was explained and written and informed consent was obtained from all patients who participated in the study. Sample sizes of 27 participants were evaluated with preoperative imaging X-ray, CT, MRI and postoperative imaging at 03 months with X-ray and CT scan to see for fusion and complications. Neurological outcome was assessed using ASIA and SF36 scoring.

Data was analyzed by using statistical software Stata 12.1. Quantitative variables were expressed as Mean +/- SD.

Qualitative variables were expressed as frequency and percentage. Quantitative variables followed normal distribution was compared by independent test McNemor test was used to assess change in ASIA score. Chi square/ Fischer exact test was used to check the statistical significance for categorical variable; p<0.05 was considered as statistically significant.

### Results

Out of 27 patients of Hangman fracture, 77.7% were less than 40 years of age and predominantly were males (74%). Majority of these patients were neurologically intact (88.8%). Out of the remaining 3 patients, who had neurological deficit 66.6% of patients improved after surgery. Out of 27 patients only 11 patients could come for radiological follow-up and in them good Bony fusion was observed in 72.7% after 3 months. Complications were minimal and only 3.7% had CSF leak after surgery. Majority of patients (70.37%) underwent C1 lateral mass and C2 Pars screw fixation. Out of the 27 patients studied, only 10 patients could be followed up and out of which, neck pain was reported in 60% of patients while neck movement restriction was noted in 90% of the patients.

**Table 1: Demographics of C1-C2 Injuries**

Type of Fracture	Age	Sex	MOI	Preop. Neurological Status
Hangman Fracture [n=27]	<40yr-21 [77.7%]	Male-20 [74.0%]	High velocity trauma-13 [48.1%]	Normal [ASIA E]-24 [88.8%]
	40-60yr-3 [11.1%]	Female-7 [25.9%]	Low velocity trauma-13 [48.1%]	Deficit [ASIA A,B,C,D]-3 [11.1%]
	>60yr-3 [11.1%]			
			Others-1 [3.7%]	

Hangman fracture occurred in 77.7% patients below 40 yrs with 74.07% male affected and 88.8% patients were neurologically intact preoperatively.

**Table 2: Neurological and Radiological Outcome**

Type of Fracture	Neurological Outcome	Radiological Outcome
Hangman Fracture [n=27]	n=27 24- no neurological deficit 3 – neurological deficit Improved- 2 [66.6%] Same-1 [33.3%]	n=27 Lost to follow-up- 16 Follow- up - 11 Fusion-8 [72.7%] No Fusion-3 [27.2%]

ASIA score was used to define neurological outcome in the present series. Improvement/deterioration was defined as change in ASIA score by factor of one grade as compared to preoperative neurology. In hangman fracture 66.6% patients improved after surgery.

**Table 3: Complications**

	Hangman Fracture
CSF Leak	1[3.7%] (n=27)
Wound Infection	Nil
Meningitis	Nil
Screw Mal Position	Nil
Redo Surgery	Nil
Death	Nil

**C1-C2 Transarticular Screw Fixation**

Fracture Type	No.
C1 Lateral Mass C2 Pars Screw Fixation - Fracture Type	No
Hangman Fracture (n-27)	19 [70.37%]
Occipito Cervical Fixation Fracture Type	No
Hangman Fracture (n-27)	7 [25.9%]
C1-C2 Wiring - Fracture Type	No

**Hangman Fracture - SF36 Score n-10**

Score - 4	6 [60%]
3	3 [30%]
1	1 [10%]

**Neck Pain In Hangman Fracture n-10**

Neck Pain In Hangman Fracture	n-10
Neck Pain - Yes	6[60%]
Neck Pain - No	4[40%]

**Neck Movement Restriction n- 0**

Neck Movement Restriction	n- 0
Neck Movement Restriction-YES	9[90%]
Neck Movement Restriction -NO	1[10%]

Demographics, mechanism of injury and fracture characteristics.

**Review of Literature**

Hangman fractures have been used to describe traumatic spondylolisthesis of axis vertebra since it was initially noted in 1965 by Schneider et al [7]. They studied healing rate in Hangman fractures and found that in Type I fractures treated conservatively successful healing was achieved in all while in Type II and Type III fractures healing was below 50% with conservative management.

Francis et al [2] studied series of 123 patients of Hangman

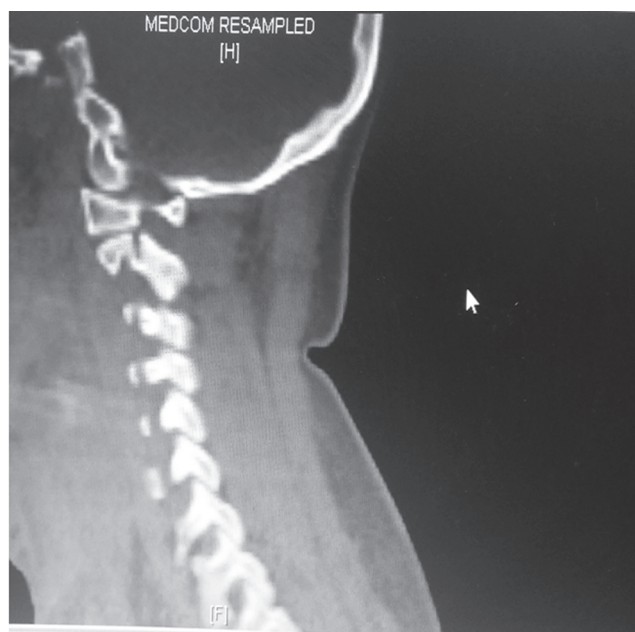


Fig.: Hangman Fracture



Fig.: Occipitocervical Fixation

fractures and found that in only 7 patients required operative intervention and majority were treated by posterior approach.

Brashear R et al [1] studied 29 patients of Hangman fractures which were followed for 6 years and found that none of these patients had any neurological deficit at follow-up. Majority of patients, 23 were managed with traction and immobilization while surgical management in form of posterior fusion was required in 6 patients.

Hadley MN et al [3] in their series of 625 patients of cervical spine injuries found that 25 (23%) patients had Hangman fractures and most of these injuries were managed

conservatively.

Levine AM et al [4] studied 52 patients with Hangman fractures and found that 15 were Type I, 29 were Type II and 8 were Type III. Associated neurological deficit found in only 4 patients and in 8 patients of Type III fractures required surgical intervention.

Moon M S et al [5] in their retrospective study of 42 patients in which 34 were male and 8 were females. 22 fractures were unstable and required operative interventions. No patients had any neurological deficits. Fractures united in all after 13 weeks of conservative management and 8 weeks after pedicle screw fixation.

Mueller E J et al [6] studied 39 patients and found that majority were males (22) and (17) were females. In 75% cases, RTA was the cause and majority were Type II fractures 29 (74.4%). Neurological deficit occurred in 4(0.3%) patients of Type II fractures.

Tans ES et al [8] in their retrospective study from 1975 to 1980 of 31 patients of Hangman fractures found that majority were males (27) and their ages ranged from 16 to 82 years with mean (33.7 years). 21 (63.6%) cases were due to RTA. Type I fractures were found in 21 cases while 11 were Type II and 1 was Type III.

In our study, we found that out of total of 239 patients of high cervical spine injuries, Hangman fracture occurred in 27 (11.29%) patients. Majority of Hangman fracture occurred in males 21 (74%) and high velocity trauma in form of Road Traffic Accident (RTA) was found in 50% cases. In 21 (77.7%) patients affected person were less than 40 years age which was comparable to literature. Neurological outcome was available for 11 patients, it was found that 10 (90.9%) patients had improvement in neurological outcome, while radiologically fusion was seen in 8 (72.7%) patients. Majority of patients of Type III hangman fracture underwent posterior fixation with C1 Lateral mass and C2 PARS in 19 (70.3%) patients which were comparable to literature.

Main limitation of study was short duration of follow up available and limited number of subjects came for follow up.

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<b>Guarantor:</b>	Dr. T. J. Rappai will act as guarantor of this article on behalf of all co-authors.

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