

# Neurological Outcomes Following Suicidal Hanging: A Prospective Study of 101 Patients

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## Abstract

**Context:** Survivors of suicidal hanging can have variable neurological outcomes – from complete recovery to irreversible brain damage. Literature on the neurological outcomes in these patients is confined to retrospective studies and case series. Hence, this prospective study was carried out. **Aims:** The aim is to study the neurological outcomes in suicidal hanging. **Settings and Design:** This was a prospective observational study carried out from July 2014 to July 2016. **Subjects and Methods:** Consecutive patients admitted to the emergency and medicine wards were included in the study. Details of the clinical and radiological findings, course in hospital and at 1 month postdischarge were analyzed. **Statistical Analysis Used:** Statistical analysis was performed using IBM SPSS advanced statistics 20.0 (SPSS Inc., Chicago, USA). Univariate analysis was performed using Chi-square test for significance and Odd's ratio was calculated. **Results:** Of the 101 patients, 6 died and 4 had residual neuro deficits. Cervical spine injury was seen in 3 patients. Interestingly, 39 patients could not remember the act of hanging (retrograde amnesia). Hypotension, pulmonary edema, Glasgow coma scale (GCS) score <8 at admission, need for mechanical ventilation, and cerebral edema on plain computed tomography were more in those with amnesia as compared to those with normal memory and these findings were statistically significant. **Conclusions:** Majority of patients recovered without any sequelae. Routine imaging of cervical spine may not be warranted in all patients, even in those with poor GCS. Retrograde amnesia might be more common than previously believed and further studies are needed to analyze this peculiar feature.

**Keywords:** Hanging, neurological outcomes, retrograde amnesia

## INTRODUCTION

Suicidal hanging is the most common method of committing suicide in India according to recent data published by national crime records bureau, Ministry of home affairs, Government of India.

There are two types of hanging: judicial and nonjudicial. In judicial hanging, the body is dropped from a distance greater than the body's height and instantaneous death occurs due to spinal cord transection.<sup>[1]</sup> In nonjudicial hanging, morbidity is due to compression of the neck structures. It can be further divided into fatal or nonfatal. When the patient is brought to hospital alive, the term near hanging is used.<sup>[2]</sup>

Neurological injury occurs due to compression of the neck. The jugular veins are the first structures to get compressed (force of 2 kg) followed by the carotid arteries (5 kg), causing cerebral edema and hypoxic brain damage, respectively. Compression of the airways needs greater force (15 kg) which can lead

to severe hypoxia and death.<sup>[3]</sup> Injury to the cervical spine is distinctly rare in suicidal hanging as compared to judicial hanging.

Neurological outcomes in hanging, varies from death, permanent hypoxic brain damage to complete recovery.<sup>[4]</sup> Uncommon features include dissection of carotid and vertebral arteries,<sup>[5]</sup> posterior reversible encephalopathy syndrome (PRES),<sup>[6]</sup> hyperthermia,<sup>[7]</sup> amnesia of the event<sup>[8]</sup> and Korsakoff's psychosis.<sup>[9]</sup>

The literature on the neurological outcomes in hanging is limited to case series or retrospective studies. Hence, we

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undertook this study with special emphasis on retrograde amnesia and the need for routine cervical spine imaging.

## SUBJECTS AND METHODS

This was a prospective, observational study carried out over 2 years (July 2014–July 2016). The hospital scientific committee and ethical committee approvals were obtained.

All patients of suicidal hanging admitted in the medical and emergency wards were enrolled into the study. Patients <13 years were excluded from the study.

Data on clinical and laboratory parameters were collected for all patients. Patients were assessed at discharge and then again after 1 month during follow up on outpatient basis.

The following parameters were studied. Age and gender, duration of hanging, type (complete or partial), reason for hanging, type of material used. Clinical parameters included Glasgow coma scale (GCS) score, focal neurological deficits, blood pressure, pulse rate, respiratory rate, oxygen saturation on room air, body temperature and the presence of pulmonary edema. Computed tomography (CT) brain and cervical spine were done in all patients as a part of routine evaluation by the treating physicians.

### Statistical analysis

Data from all patients were tabulated on excel spreadsheet and statistical analysis was performed using IBM SPSS advanced statistics 20.0 (SPSS Inc., Chicago, USA) and univariate analysis was performed using Chi-square test for significance and Odd's ratio was calculated.

## RESULTS

During the 2 years period, 101 consecutive patients were studied. 71.2% were men and 57% were in the age group of 19–39 years. The duration of hanging was <2 min in 43.5% and between 2 and 5 min in 26.7%. In 27.7% of patients, the duration could not be ascertained. Partial hanging was present in 68% and complete hanging in 32%.

The most common reason for attempting suicide was under the influence of alcohol (31%) followed by domestic quarrel (18%), chronic illness (9%), and failure in exams (7%). In 31% of patients, no reason could be identified. Most common materials used for suicidal hanging were saree (71%) and rope (28%).

Pulmonary edema was present in 42.6% and hypoxia (oxygen saturation by pulse oximetry <92% on ambient room air) was present in 31.7%. Fifty-three patients (52.4%) required mechanical ventilation for poor sensorium and pulmonary edema. Most of these patients ( $n = 28$ ) were extubated within 2 days.

### Neurological manifestations

GCS score at admission was <8 in more than half of the patients (55.4%), 22 patients (21.7%) had GCS score between

9 and 12, and score of 15 was present in 17 (16.8%). However, at discharge most of these patients had normal GCS score of 15 (86.1%). Three patients had quadriplegia of whom 1 showed partial recovery and 1 patient had hemiplegia.

CT brain showed features of cerebral edema in 34 patients (33.7%) and PRES in 1 patient. Of the 19 patients who underwent magnetic resonance imaging (MRI) brain for poor sensorium, 5 had features of hypoxic ischemic encephalopathy (HIE). One patient recovered partially from HIE.

Of the 101 patients, only three had radiological evidence of spine injury - C1–C2 (two patients) and C4–C5 dislocation (1 patient). These findings were not associated with clinical features of myelopathy.

Poor neurological outcomes were seen in 10 patients (6 died, 2 had persistent vegetative state, 1 had hemiparesis and 1 recovered partially from HIE). All the 10 patients had complete hanging, pulmonary edema, GCS score <8 at admission, and cerebral edema on CT.

### Retrograde amnesia

Many patients could not remember the act of hanging. Of the 93 patients who had normal GCS at discharge, 39 (41.9%) patients had this novel finding. They attributed the reason for hospitalization to other medical illnesses such as fever, cough and sore throat, and a few of them could not remember the reason for hospitalization. Only after being told by their relatives, did these patients realize that they had hanged themselves. Except for this retrograde amnesia about the event of hanging, the rest of the memory was normal and they could register new ones. MRI done in 7 patients with retrograde amnesia was normal.

Clinical and radiological features like hypotension, pulmonary edema, GCS score <8 at admission, need for mechanical ventilation and cerebral edema [Table 1 and Supplementary Tables 1-6] were more in those with amnesia as compared to those with normal memory and these findings were statistically significant.

## DISCUSSION

Cervical cord injury is extremely rare in suicidal hanging as compared to judicial hanging. In our study, only two had C1–C2 dislocation. Salim *et al.*<sup>[10]</sup> have reported cervical spine

**Table 1: Risk factors for retrograde amnesia in cases of suicidal hanging ( $n=39$ )**

Risk factors ( $n$ )	$P$	OR	95% CI
Hypoxia	0.4	1.57	0.63-3.9
Hypotension	0.001	4.18	1.64-10.6
Pulmonary edema	0.001	6.25	2.5-15.62
GCS score <8	<0.001	10.86	3.97,29.6
Mechanical ventilation	<0.001	6.88	2.72-17.39
Cerebral edema in CT	0.02	2.81	1.19-6.62

OR = Odds ratio, CI = Confidence interval, CT = Computed tomography, GCS = Glasgow coma scale

fractures in 5% of 63 patients while Penney *et al.*<sup>[11]</sup> did not find any case of cervical injury in their study of 42 patients. Subramanian *et al.*<sup>[12]</sup> could identify only 2 cervical injuries in 83 patients with normal GCS.

These reports are similar to the finding in our study, suggesting that emergency cervical spine imaging need not be performed routinely in all patients unless there are signs or symptoms of cervical spinal cord injury.

GCS score at admission was <8 in 56 patients out of 101. Almost all of them required endotracheal intubation for airway protection in view of poor sensorium. Of the 56 patients with poor GCS (defined as GCS <8) in our study, 42 recovered completely and 10 patients had poor neurological outcome. Poor GCS score has been shown to be associated with adverse neurological outcomes.<sup>[13,14]</sup> Apart from poor GCS, factors such as complete hanging, pulmonary edema, and cerebral edema were also associated with poor neurological outcome.

Retrograde amnesia following hanging was initially reported by Wagner. Later only individual case reports were published on this unique finding.<sup>[8,9]</sup> In this study, 39 (41.9%) patients retrograde amnesia. The amnesia was restricted only to the event of committing suicide by hanging. The reason for amnesia has been suggested to be due to compression of the carotids causing ischemic hippocampal damage. MRI brain, done in 15 patients with retrograde amnesia, was normal. We would like to propose that the amnesia might be due to cerebral edema as a result of venous obstruction rather than arterial compression since almost all the patients had cerebral edema but none had arterial infarcts.

Most of these patients assumed that they had been admitted for another medical cause like fever and cold (false memories). The fact that they did not remember hanging themselves, made it challenging to offer them psychiatric counseling.

## CONCLUSIONS

This study shows that routine cervical spine imaging might not be warranted in all cases of suicidal hanging. CT spine can

be considered for elderly patients who might have associated cervical spondylosis and those with long drop heights. Retrograde amnesia might be more common than believed in suicidal hanging. Further studies on retrograde amnesia are needed to understand the reasons for this complication.

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## Conflicts of interest

There are no conflicts of interest.

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**Supplementary Table 1: Effect of hypoxia on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
Hypoxia			
Yes	13	13	26
No	26	41	67
Total	39	54	93

$P=0.4$ , OR=1.577, CI=0.633-3.927. OR = Odds ratio, CI = Confidence interval

**Supplementary Table 2: Effect of hypotension on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
Hypotension			
Yes	19	10	29
No	20	44	64
Total	39	54	93

$P=0.001$ , OR=4.18, CI=1.649-10.6. OR = Odds ratio, CI = Confidence interval

**Supplementary Table 3: Effect of pulmonary edema on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
Pulmonary oedema			
Yes	25	12	37
No	14	42	56
Total	39	54	93

$P<0.001$ , OR=6.25, CI=2.5-15.62. OR = Odds ratio, CI = Confidence interval

**Supplementary Table 4: Effect of poor Glasgow Coma Scale score (<8) at admission on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
GCS <8			
Yes	32	16	48
No	7	38	45
Total	39	54	93

$P<0.001$ , OR=10.86, CI=3.974-29.66. GCS = Glasgow coma scale, OR = Odds ratio, CI = Confidence interval

**Supplementary Table 5: Effect of cerebral edema in computed tomography brain on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
Cerebral oedema			
Yes	22	17	39
No	17	37	54
Total	39	54	93

$P=0.02$ , OR=2.817, CI=1.198-6.62. OR = Odds ratio, CI = Confidence interval

**Supplementary Table 6: Effect of mechanical ventilation on retrograde amnesia (n=39)**

	Amnesia		Total
	Yes	No	
Mechanical ventilation			
Yes	29	16	45
No	10	38	48
Total	39	54	93

$P<0.001$ , OR=6.888, CI=2.728-17.39. OR = Odds ratio, CI = Confidence interval