Prognostic Factors in Hanging Injuries

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The objectives of this study were to review variable factors influencing outcomes in hanging and to identify prognostic factors related to outcomes. Forty-seven patients presented to our department. Eleven patients survived and 36 died. A significant difference in mean hanging time was observed between survivor (11.8 \pm 8.37 minutes) and nonsurvivor \( (50.81 \pm 61.9) \). In survivors, heartbeat was recognized in 63.6% at the scene and in 90.9% on arrival. Conversely, cardiopulmonary arrest (CPA) was recognized in all nonsurvivors and heartbeat was recognized on arrival in only 5.6%. Thirty-nine (83%) had a Glasgow Coma Score (GCS) of 3 on arrival. Three (7.7%) of these 39 patients survived. In survivors, eight patients had a GCS greater than 3. A significant difference in outcome existed between patients with a GCS of 3 and those with a GCS greater than 3. Hanging time, presence of CPA at the scene and on arrival, and GCS on arrival represented prognostic factors of outcome in hanging. (Am J Emerg Med 2004;22:207-210. © 2004 Elsevier Inc. All rights reserved.)

Hanging is a method of suicide with a devastating impact and, unfortunately it is common in Japan, rivaling methods such as falling and poisoning. Patients who have attempted to hang themselves are usually transferred to the ED. Hanging is typically fatal, but sometimes patients recover and leave the hospital without neurologic deficits. The goal of the present study was to review variable factors influencing outcomes in hanging and to identify prognostic factors related to outcomes.

SUBJECTS AND METHODS

All patients with a final diagnosis of attempted suicide by hanging who presented to our department during the 7-year period from January 1995 to January 2002 were included in this study. Charts were reviewed for the following information: age, sex, hanging time, presence of cardiopulmonary arrest (CPA), presence of bystander-initiated cardiopulmonary resuscitation (CPR), time elapsed from the scene to the hospital, previous psychiatric history, blood gas parameters on arrival at the hospital, Glasgow Coma Score (GCS) on arrival at the hospital, computed tomography (CT) findings of the head, ligature marks and abnormalities of the cervical spine, and patient outcome.

Data Analysis

Statistical analysis was performed between two groups (survivors and nonsurvivors). All data were subjected to a test or Mann-whitney rank sum test. \( P < .05 \) was considered statistically significant.

RESULTS

Overview

Forty-seven patients presented to our department during the 7-year period (Table 1). All charts included radiologic investigations and were available for review. All instances of the hanging represented suicide attempts. Patients comprised 22 males (46.8%) and 275 females (53.2%). Ages ranged from 12 to 89 years, with a mean age of 52.7 years. Eleven patients (23.4%) were under 40 years old and six (12.8%) over 80 years. Fifteen patients (31.9%) displayed a history of a psychiatric illness. Eleven patients survived and 36 died. Six patients left the hospital without neurologic deficits. One patient left the hospital with slight cognitive impairment. Four patients were discharged in a persistent vegetative state. Four of the survivors experienced amnesia.

Hanging Time

Hanging time was typically difficult to determine and was estimated from family reports of when the patient was last seen (Table 2). Hanging time ranged from 3 seconds to 360 minutes in all patients. Survivors hanged from 5 seconds to 27 minutes, with a mean of 11.8 \pm 8.4 minutes. Nonsurvivors hanged from 10 to 360 minutes, with a mean of 50.8 \pm 61.9 minutes. A significant difference in mean hanging time was observed between survivors and nonsurvivors. All patients survived when hanging time was less than 5 minutes, and all patients were dead when hanging time exceeded 30 minutes.

Time Elapsed From the Scene to the Hospital

No difference was observed between survivors (mean: 42.5 \pm 26.7 minutes) and nonsurvivors (mean: 42.8 \pm 24.5 minutes).

Presence of Cardiopulmonary Arrest at the Scene and on Arrival

CPA at the scene was recognized in 43 (91.5%) of the 47 patients (Table 3). Heart beat was recognized in seven (63.6%) of the 11 survivors at scene. CPA was recognized in all nonsurvivors. Resuscitation by bystanders or paramedics was attempted on the way to our department in all patients. In survivors, three of the four patients with CPA at the scene were resuscitated by bystanders. However, CPR was performed by bystanders in only 10 (27.8%) of the 36
nonsurvivors. On arrival in our department, heartbeat was recognized in 10 (90.9%) of the 11 survivors. Heartbeat began in the ambulance in three patients and 33 minutes after being at the hospital in one patient. Conversely, heartbeat was recognized in only two (5.5%) of the 36 nonsurvivors. On arrival in our department, heartbeat was recognized in 10 (90.9%) of the 11 survivors. Heartbeat began in the ambulance in three patients and 33 minutes after being at the hospital in one patient. Conversely, heartbeat was recognized in only two (5.5%) of the 36 nonsurvivors.

Blood Gas Analysis

The pH in survivors ranged from 7.181 to 7.556, with a mean of 7.302 ± 0.16. In nonsurvivors, pH ranged from 6.620 to 7.325, with a mean of 6.881 ± 0.29. Base excess in survivors ranged from −16.9 to 5.1, with a mean of −7.9 ± 7.8. In nonsurvivors, base excess ranged from −29.2 to −3.1, with a mean of −18.9 ± 9.0. A significant difference in pH and base excess existed between survivors and nonsurvivors.

Glasgow Coma Score on Arrival at the Hospital

Of the 41 patients, 39 (83%) had a GCS of 3 on arrival. Three (7.7%) of these 39 patients survived, but the outcome was a persistent vegetative state. In survivors, GCS was 12 in one patient, 7 in one patient, 5 in three patients, 4 in three patients, and 3 in three patients. Six patients left the hospital with no neurologic deficit, one displayed mild cognitive defect, and four were discharged in a persistent vegetative state. A significant difference in outcome existed between patients with a GCS of 3 and those with a GCS greater than 3 (Fig 1).

TABLE 1. Demographic Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Survivor</th>
<th>Nonsurvivor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (no.)</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Female (no.)</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Age (yrs: mean ± SD)</td>
<td>36.7 ± 16.0</td>
<td>57.2 ± 17.8</td>
</tr>
<tr>
<td>Hanging time (minutes: mean ± SD)</td>
<td>11.8 ± 8.37</td>
<td>50.8 ± 61.9</td>
</tr>
<tr>
<td>Time to hospital (minutes: mean ± SD)</td>
<td>42.5 ± 26.7</td>
<td>42.8 ± 24.5</td>
</tr>
<tr>
<td>CPA at scene (%)</td>
<td>26.4</td>
<td>100</td>
</tr>
<tr>
<td>CPA on arrival (%)</td>
<td>90.9</td>
<td>5.5</td>
</tr>
<tr>
<td>pH (mean ± SD)</td>
<td>7.302 ± 0.16</td>
<td>6.881 ± 0.29</td>
</tr>
<tr>
<td>Base excess (mean ± SD)</td>
<td>−7.88 ± 7.83</td>
<td>−18.91 ± 9.02</td>
</tr>
<tr>
<td>GCS 3 (no.)</td>
<td>3</td>
<td>96</td>
</tr>
<tr>
<td>GCS ≤4 (no.)</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

SD = standard deviation; CPA = cardiopulmonary arrest; GCS = Glasgow Coma Score.

TABLE 2. Hanging and Outcome

<table>
<thead>
<tr>
<th>Hanging Time (mins)</th>
<th>Survivors (no.)</th>
<th>Nonsurvivors (no.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>&gt;1 to ≤5</td>
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<td>2</td>
<td>4</td>
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<tr>
<td>&gt;5 to ≤10</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>&gt;10 to ≤15</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>&gt;15 to ≤30</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>&gt;30</td>
<td>0</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

Complications

Four (36.4%) of the 11 survivors presented with status epileptics. Only one (2.8%) of the 36 nonsurvivors presented with status epileptics. Pulmonary edema was identified in one nonsurviving patient.

Head Computed Tomography

All survivors underwent head CT on admission and the following day. Six patients displayed normal findings on CT and they were discharged without neurologic deficit. Four patients with CT findings of whole-brain ischemia and cerebral edema underwent tracheostomy and controlled ventilation. Outcome for these patients were all a persistent vegetative state. Variable CT findings were obtained in patients with a persistent vegetative state. In one patient, bilateral low density was revealed in the basal ganglia, suggesting the involvement of the carotid artery system. In another patient, bilateral low density in the thalamus and pons suggested the involvement of the verteobasilar system.

In almost all nonsurvivors, area of low density was observed in the cerebral hemisphere and the corticomedullary junction was indistinct, suggesting brain edema. Whole-brain ischemia was revealed.

Neck and Cervical Spine

The following evaluation was performed: how ligature marks were put on the neck and the presence of a cervical spine abnormality. In four (36.4%) survivors, ligature marks were identified circumferentially around the neck. In one patient, the ligature mark was identified on the anterior surface of the neck. In two patients, redness was identified, suggesting only slight stress on the neck. In four patients, ligature marks were identified around only part of the neck, or just below the mandible, suggesting incomplete closure around the neck. In all nonsurvivors, ligature marks were recognized circumferentially around the neck.

No cervical spine abnormalities were identified in survivors. Abnormalities of the cervical spine were observed on x-ray in four nonsurvivors: fracture of the C2 in three patients and fracture of C3 and C4 in one patient.

TABLE 3. Heartbeat and Outcome

<table>
<thead>
<tr>
<th></th>
<th>Survivors (no.)</th>
<th>Nonsurvivors (no.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heartbeat at scene</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Heartbeat on arrival</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Heartbeat on admission</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>No heartbeat</td>
<td>0</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

DISCUSSION

Hanging is a common method of suicide in Japan, as are falls and poisoning. Judicial hanging involves a drop of from a high place, leading to disruption of the upper cervical cord or brain stem and resulting in instant death. Pathologic investigation displays injury to the pharynx and sometimes to the carotid or vertebral artery. Suicidal hang-
ing differs from judicial hanging in a number of pathologic aspects. Cervical injury is rarely associated, and death usually results from interruption of cerebral blood flow, leading to cerebral ischemia. In suicidal hanging, several factors influence cerebral ischemia: autonomic hyperactivity through the carotid sinus body, leading to cardiac arrest; airway compromise by upward displacement of the tongue and epiglottis, jugular vein occlusion by mild neck closure, carotid artery occlusion by moderate neck closure, and vertebral artery occlusion by spinal injury. These combined factors can more easily lead to acute cerebral hypoxia than any other single condition producing cerebral hypoperfusion such as cerebral infarction. A number of general reviews of hanging in the United States and Europe have been published, but only one report has discussed prognostic factors relating to outcome.

Overview

A total of 42.6% of victims were male and 57.4% were female. In the United States and Europe, males are reportedly predominant in hanging. In Japan, hanging has historically been popular as a method of suicide, but it is less favored in females in other countries.

Hanging Time

One report has examined the relationship between duration of hanging and outcome. The relationship was not established when hanging time was less than 5 minutes, but outcome was poor when hanging time exceeded 5 minutes. Five minutes, therefore, appears to represent a critical time in hanging.

In our study, a marked difference in hanging time between survivors and nonsurvivors was recognized. All three patients were resuscitated and survived when hanging time was less than 5 minutes. Conversely, no patients survived hanging greater than 30 minutes. Hanging time greater than 30 minutes represents a predictor of outcome. It is interesting that eight (50%) of 16 patients survived hanging more than 5 minutes but less than 30 minutes. Permanent brain damage typically occurs after approximately 5 minutes of complete cerebral anoxia. Usually the most common mechanism of ischemia in hanging is obstruction of the carotid artery or jugular vein, which is frequently incomplete. Patients with suspension between 5 minutes and 30 minutes could be successfully resuscitated.

Cardiopulmonary Arrest and Cardiopulmonary Resuscitation

CPA was frequently identified at the scene of hanging (91.5%). An interesting finding was made regarding the relationship between CPA and outcome. In survivors, heart beat was recognized in 63.6% at the scene and in 90.9% on arrival. Conversely, CPA was recognized in all nonsurvivors and heartbeat was recognized on arrival in only 5.6%. In the report by Perry, all patients with spontaneous circulation at the scene survived. We found a significant relationship between CPA at the scene and on arrival and outcome. The presence of heartbeat at the scene or on arrival is a strong prognostic factor of outcome. Immediate initiation of CPR is very important. In survivors, 75% underwent resuscitation at the scene, whereas only 27.8% of nonsurvivors received CPR at the scene. Increased survival rate could have been achieved in nonsurvivors if CPR had been performed promptly. Prehospital care, including bystander CPR, should be encouraged.

Glasgow Coma Score

Few studies have reported the relationship between GCS and outcome. A GCS of 3 almost inevitably leads to poor
outcome, but in rare cases, patients with a GCS of 3 survive without neurologic deficits. A GCS of 3 combined with CPA at the scene is associated with 100% mortality.\(^7\) In our study, 83% of patients had a GCS of 3 on arrival. This suggests that patients with more severe condition than previously reported were treated in our department. Four patients with a GCS of 3 and CPA at the scene survived, and all patients with a GCS of greater than 4 survived. We believe that a GCS of greater than 4 at the scene represents a favorable prognostic factor of outcome. In addition, a GCS of 3 is poor prognostic factor, but it is not absolute.

**Head Computed Tomography**

CT findings obtained in nonsurvivors were indistinct corticomedullary junction of bilateral cerebral hemispheres, brain edema, and hypodensity of the hemispheres. In survivors, characteristic CT findings were recognized. Bilateral low density in the basal ganglia suggests incomplete involvement of the carotid artery system, resembling some anoxic conditions such as carbon monoxide, cyanide, and methanol intoxication or hypoglycemia.\(^{13}\) Bilateral hypodensity in the thalamus and pons suggests involvement of the vertebrobasilar system.\(^6\) Based on these findings, hanging creates a multifactorial hypoxic insult to the brain and might be one of the most difficult pathologies of cerebral hypoxia to treat.

**Cervical Findings**

Circumferential ligature mark was recognized in 36.4% of survivors and 100% of nonsurvivors. Circumferential ligature suggests complete closure, leading to severe brain anoxia. Partial ligature marks or absence can represent a prognostic sign of good outcome.

Cervical abnormality was identified in 8.5% of 47 patients. In survivors, no cervical spine injury was identified. This supports the concept that judicial hanging causes Hangman’s fracture.\(^1\) Suicidal hanging has not recently been reported to be frequently associated with cervical spine fracture\(^{14-17}\): in Clark’s report, Hangman’s fracture and one fracture of the C3 vertebra was identified on only two of 368 victims.\(^{18}\) In Adams’ report, cervical injury occurred in four (0.6%) of 689 victims.\(^{16}\) Routine cervical x-ray investigation for hanging is thus of questionable value.

**CONCLUSION**

In this study, hanging time, presence of CPA at the scene and on arrival and GCS on arrival represented prognostic factors of outcome in hanging. Prehospital management, including bystander CPR, is extremely important to improve survival rate in victims of hanging.

**REFERENCES**