Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijss/2017/374

Original Article

# Study of Postmortem Findings of Neck Structures in Cases of Asphyxial Deaths

**Suresh Chand[1], Rishi Solanki[2], Anil Aggrawal[3], P C Dikshit[4], Rajesh Ranjan[5]**

[1]Assistant Professor, Department of Forensic Medicine, G S Medical College, Pilkhuwa, Hapur, Uttar Pradesh, India, [2]Senior Resident, Aruna Asaf Ali Government Hospital, Rajpur Road Civil Lines, New Delhi, India, [3]Director and Professor, Department of Forensic Medicine, MAMC, New Delhi, India, [4]Professor and Head, Department of Forensic Medicine, Hamdard Institute of Medical Sciences and Research, New Delhi, India, [5]Department of Community Health Administration, Resident, NIHFW, New Delhi, India

## Abstract

**Introduction:** Asphyxial deaths are common in forensic practice. The term "asphyxia" commonly means "lack of oxygen" and literally means "defective aeration of blood" due to any cause.

**Materials and Methods:** The study was conducted in Department of Forensic Medicine, Maulana Azad Medical College, New Delhi. It is a descriptive cross-sectional study. The present study was conducted between September 2010 and March 2012. Cases of asphyxial deaths coming for medicolegal postmortem were examination.

**Results:** Out of these 73 cases of asphyxial deaths, 58 cases of asphyxial deaths due to constriction of the neck were considered and studied to see various changes in the neck structures in deaths due to asphyxia. This study includes 89.65% of cases of hanging, 8.62% of cases of manual strangulation, and 1.72% of cases of ligature strangulation of either sex between 0 and 79 years of age group.

**Conclusion:** The incidence of asphyxial deaths due to constriction of the neck is more in males as compared to females and in most of these cases; the mode of death is hanging. The maximum numbers of cases are seen in young adults (20-29 years). In most of the cases, the soft cloth was used as ligature material. The knot of the ligature material was mostly either on right side or left side in comparison to front and back of the neck. The typical position of the knot is found in a few cases. In a maximum number of cases, the hanging is complete.

**Key words:** Postmortem Findings, Medico legal, Asphyxial Deaths

## INTRODUCTION

Asphyxial deaths are common in forensic practice. The term "asphyxia" commonly means "lack of oxygen" and literally means 'defective aeration of blood' due to any cause. However, the term has been translated from the original Greek, implying "pulselessness/absence of pulsation". Adelson defined "asphyxia" as the physiological and chemical state in a living organism in which acute lack of oxygen available for cell metabolism is associated with inability to eliminate excess of $CO_2$.

Access this article online

www.ijss-sn.com

Month of Submission : 05-2017
Month of Peer Review : 06-2017
Month of Acceptance : 07-2017
Month of Publishing : 07-2017

Generally the term "anoxia" implies "absence of oxygen". However, Bacroft[3] using this term divided the condition into three groups: (1) Anoxic anoxia - meaning prevention of oxygen from reaching the lungs, (2) anemic anoxia - meaning inability of blood to carry sufficient oxygen to the tissues due to low hemoglobin content, and (3) stagnant anoxia - meaning lack of oxygenated blood transport to the tissues due to impaired circulation. Later on, Peters and Van Slyke in 1931 added a fourth group to it called histotoxic anoxia - wherein, though freely available in the blood stream, oxygen cannot be utilized by the tissues.

Although many natural disease processes may involve inadequate uptake and/or delivery of oxygen (e.g. chronic obstructive pulmonary disease), the term "asphyxia" is generally reserved for conditions related to abnormal atmosphere and mechanical and chemical effects directly leading to the aforementioned abnormalities. Determination of the specific type(s) of asphyxia operative

**Corresponding Author:** Rajesh Ranjan,Department of Community Health Administration, National Institute of Health and Family Welfare, New Delhi, India

in a particular case, the cause of death, and the manner of death is dependent on information elicited during the medicolegal death investigation - namely, history (circumstances), scene investigation, and postmortem examination (including appropriate ancillary radiographic and laboratory studies).

Despite the differences of opinion regarding the term "asphyxia" in medical literature, it is widely used for medicolegal purposes and is categorized as mechanical and non-mechanical asphyxia.[1-15]

In mechanical asphyxia,[1] the flow of air into the body is interfered through some physical impediments such as (1) pressure on exterior of the neck, e.g., hanging and strangulation, (2) obstruction of airways from exterior, e.g., suffocation and smothering, (3) obstruction of airways from interior, e.g. gagging, choking, (4) pressure on the chest, e.g., traumatic asphyxia, and (5) submersion death, e.g., drowning.

In non-mechanical asphyxia,[1] physiological impediments cause the exclusion of oxygen by its depletion and replacement by another gas or by chemical interference with its uptake and utilization by the body itself or where there is insufficient oxygen in the atmosphere itself, e.g. CO poisoning and CN poisoning.

At present, the term asphyxia has been used to denote death or sub-lethal injury from mechanically induced cerebral hypoxia accompanied by signs of impeded venous return. Similar degree of hypoxemia of any organ/tissue can be produced by interference with its blood supply or by obstructing its drainage. Pressure on the neck can affect the brain in either way or both ways at the same time, resulting in infarction (ischemic or hyperemic).[16-30]

Asphyxial deaths may be caused by any of the above methods individually as well as in combination with each other. A case study from Romania indicates that a victim was killed by three different mechanisms of asphyxia: Smothering with the hand, manual strangulation (MS) with the other hand, and traumatic asphyxia by thoracic compression with the knees. Certain unusual forms of asphyxial deaths such as autoerotic, positional, and neck holds have also been reported.[2]

## MATERIALS AND METHODS

The study was conducted in the Department of Forensic Medicine, Maulana Azad Medical College, New Delhi.

- Study design: Descriptive cross-sectional study.
- Study period: The present study was conducted between September 2010 and March 2012.
- Study population: Cases of asphyxial deaths coming for medicolegal postmortem examination.
- Sample size: 58 cases.

### Inclusion Criteria

1. Asphyxial deaths (hanging and strangulation) coming for medicolegal postmortem examination.

### Exclusion Criteria

1. Decomposed bodies.
2. Asphyxial cases due to drowning, suffocation.

### Methods

A careful general examination was conducted with special reference to the neck and all characteristics were noted. Ligature when present around the neck was released by preventing the noose. The skull and chest were opened and contents were taken out to drain out the blood from the neck so that the neck structures could be examined in a relatively bloodless field thus avoiding artifactual hemorrhages. We put the Y-shaped incision which permitted a thorough examination of the anterior examination of the anterior neck organs.

The skin and superficial tissue of the neck were reflected to expose the underlying structures by grasping and retracting the cut border of the skin using the fingers or non-toothed forceps and making gentle horizontal slices along the dermosubcutaneous tissue plane. Then, the neck was dissected layer wise.

Following layers were examined in a stepwise fashion:

1. Platysma.
2. Sternocleidomastoid.
3. (a) Omohyoid (b) digastric.
4. Sternohyoid.
5. (a) Sternothyroid and (b) thyrohyoid.

Following structures and associated pathological findings were noted:

1. External injuries - in the form of abrasions, contusions, etc.
2. Internal injuries - Contusions and hemorrhages in the substance of each muscle layer and in front and behind it.
3. Contusion, congestion, and hemorrhages in various neck structures such as lymph nodes, submandibular gland, thyroid, and parathyroids.
4. Damage to the carotid arteries, jugular veins (internal and external), vagus, and phrenic nerves.
5. Fractures of the hyoid, thyroid cartilage, cricoid cartilage, and corniculate and cuneiform cartilages.
6. Damage to vertebral artery.

## RESULTS

The study was conducted in the Department of Forensic Medicine, Maulana Azad Medical College. A total of 1889 medicolegal autopsies were conducted during the period (September 2010 to March 2012) of study, of which 73 (3.86%) cases of asphyxial deaths were recorded. Out of these 73 cases of asphyxial deaths, 58 cases of asphyxial deaths due to constriction of the neck were considered and studied to see various changes in neck structures in deaths due to asphyxia. This study includes 89.65% of cases of hanging, 8.62% of cases of MS and 1.72% of cases of ligature strangulation (LS) of either sex between 0 and 79 years of age group.

Table 1 shows that out of total 73 cases of asphyxia, maximum numbers of cases were of hanging (71.23%), followed by drowning (20.54%). Only 6.84% of cases of MS and 1.36% of cases of LS contribute to deaths due to asphyxia.

Table 2 shows that out of total 58 cases of asphyxial deaths due to constriction of the neck, 89.65% of cases were of hanging, 8.62% of cases of MS and 1.72% of cases of LS.

Table 3 shows that maximum numbers of cases (51.72%) were seen in the age group of 20-29 years followed by 30-39 years of age group (15.51%) in both the sexes. The minimum numbers of cases were seen in extremes of age, i.e., below 10 years and above 60 years. Male predominance was seen in most of the age groups except age group below 10 years. Male-to-female ratio is 2:1. During the study, one case was seen kinner in 20-29 years of age.

Table 4 shows that maximum number of cases were in March (10 cases, 17.24%) followed by February (9 cases, 15.51%) and followed by September (8 cases, 13.79%).

**Table 1: Distribution of cases of asphyxia**

| Type of asphyxia | Number of cases (%) |
|---|---|
| Hanging | 52 (71.23) |
| Drowning | 15 (20.54) |
| MS | 5 (6.84) |
| LS | 1 (1.36) |
| Total | 73 (100) |

MS: Manual strangulation, LS: Ligature strangulation

**Table 2: Distribution of cases of asphyxial deaths due to constriction of the neck**

| Type of asphyxia | Number of cases (%) |
|---|---|
| Hanging | 52 (89.65) |
| MS | 5 (8.62) |
| LS | 1 (1.72) |
| Total | 58 (100) |

MS: Manual strangulation, LS: Ligature strangulation

Table 5 shows that the cloth was used in a maximum number of cases (28) followed by rope (19) and in 4 cases the nature of ligature material was not known.

Table 6 shows that in 43.39% of cases the knot was located on the right side of the neck and in 41.50% of cases on the left side of the neck. Typical site of knot was seen only in 6 cases (11.32%).

Table 7 shows that the percentage of atypical hanging is more as compared to typical.

Table 8 shows that the ligature mark in hanging is present at the level of thyroid cartilage in 25 (48.07%) cases, above the level of the thyroid cartilage in 26 (50%) cases, and in 1 (1.92%) case, the ligature mark was present below the level of the thyroid cartilage.

**Table 3: Distribution of cases according to age groups and gender**

| Age group (years) | Male | Female | Kinner | Total | Percentage |
|---|---|---|---|---|---|
| 0-10 | 0 | 1 | 0 | 1 | 1.72 |
| 10-19 | 3 | 3 | 0 | 6 | 10.34 |
| 20-29 | 20 | 9 | 1 | 30 | 51.72 |
| 30-39 | 7 | 3 | 0 | 9 | 15.51 |
| 40-49 | 3 | 1 | 0 | 4 | 6.89 |
| 50-59 | 3 | 1 | 0 | 4 | 6.89 |
| 60-69 | 1 | 0 | 0 | 1 | 1.72 |
| 70-79 | 1 | 1 | 0 | 2 | 3.44 |
| Total | 38 | 19 | 1 | 58 | |
| Percentage | 65.51 | 32.75 | 1.72 | | 100 |

**Table 4: Distribution of cases according to months**

| Months | *n* (%) |
|---|---|
| January | 5 (8.62) |
| February | 9 (15.51) |
| March | 10 (17.24) |
| April | 3 (5.17) |
| May | 1 (1.72) |
| June | 5 (8.62) |
| July | 2 (3.44) |
| August | 5 (8.62) |
| September | 8 (13.79) |
| October | 4 (6.89) |
| November | 4 (6.89) |
| December | 2 (3.44) |
| Total | 58 (100) |

**Table 5: Distribution of cases according to ligature material used**

| Ligature material used | Number of cases (%) |
|---|---|
| Cloth | 28 (48.27) |
| Rope | 19 (32.75) |
| Wire | 4 (6.89) |
| Rubber fan belt | 2 (3.44) |
| Not known | 5 (8.62) |
| Total | 58 (100) |

Table 9 shows that a number of complete hanging cases are more (98.07%) as compared to incomplete ones (1.92%).

Table 10 shows that ligature mark was present in all the cases of hanging.

Table 11 shows that the saliva stain is present in 25 (48.07%) cases of hanging only.

Table 12 shows that saliva mark/stain present in 25 hanging cases was distributed on both sides of the mouth. It was seen at left angle of the mouth in more than 50% of cases.

**Table 6: Distribution of cases according to the position of knot**

| Position of knot in hanging and LS cases | Number of cases *n*=52+1 (%) |
|---|---|
| Below chin | 2 (3.77) |
| Right side of neck | 23 (43.39) |
| Occiput | 6 (11.32) |
| Left side of neck | 22 (41.50) |
| Total | 53 (100) |

LS: Ligature strangulation

**Table 7: Distribution of cases according to position of knot in hanging cases**

| Type of hanging | Number of cases (%) |
|---|---|
| Typical | 6 (11.53) |
| Atypical | 46 (88.46) |
| Total | 52 (100) |

**Table 8: Distribution of position of ligature mark in relation to thyroid cartilage**

| Position of ligature mark | Number of hanging cases *n*=52 (%) | Number of LS cases *n*=1 (%) |
|---|---|---|
| Above | 26 (50) | 0 |
| At | 25 (48.07) | 0 |
| Below | 1 (1.92) | 1 (100) |

MS: Manual strangulation, LS: Ligature strangulation

**Table 9: Distribution of hanging cases on the basis of degree of suspension**

| Type of hanging | Number of cases (%) |
|---|---|
| Complete | 51 (98.07) |
| Incomplete/Partial | 1 (1.92) |
| Total | 52 (100) |

**Table 10: Distribution of hanging cases according to ligature mark**

| Ligature mark | Number of cases (%) |
|---|---|
| Present | 52 (100) |
| Absent | 0 (0) |

Table 13 shows that in <50% of cases, facial congestion was present.

Table 14 shows that petechial hemorrhages were found in 32 (61.53%) cases of hanging and in 2 (33.33%) cases of strangulation.

Table 15 shows that muscle hemorrhage was seen in all cases of MS while it was seen only in 3 (5.76%) cases of total cases of hanging.

Table 16 shows that the incidence of fracture of the hyoid bone and thyroid cartilage was more common as compared to other findings. Intimal tears were found in 3 (5.17%)

**Table 11: Distribution of hanging cases according to saliva stain**

| Saliva stain | Number of cases (%) |
|---|---|
| Present | 25 (48.07) |
| Absent | 27 (51.92) |
| Total | 52 (100) |

**Table 12: Distribution of hanging cases according to the location of saliva stain**

| Site | Number of cases (%) |
|---|---|
| Right angle of mouth | 12 (48) |
| Left angle of mouth | 13 (52) |
| Total | 25 (100) |

**Table 13: Distribution of facial congestion**

| Facial congestion | Number of cases (%) |
|---|---|
| Present | 28 (48.27) |
| Absent | 30 (51.72) |
| Total | 58 (100) |

**Table 14 : Distribution of petechial hemorrhages**

| Presence of petechial hemorrhages | Complete hanging | Partial hanging | Strangulation (MS+LS) |
|---|---|---|---|
| Present | 32 (61.53%) | 0 | 2 (33.33%) |
| Absent | 20 (38.46%) | 0 | 4 (66.66%) |
| Total | 52 | 0 | 6 |

MS: Manual strangulation, LS: Ligature strangulation

**Table 15: Frequency of muscle hemorrhages in the neck**

| Type of asphyxia | Number of cases | Hemorrhage in muscles | Percentage |
|---|---|---|---|
| Hanging | 52 | 3 | 5.76 |
| MS | 5 | 5 | 100 |
| LS | 1 | 0 | 0 |
| Total | 58 | 8 | 13.79 |

MS: Manual strangulation, LS: Ligature strangulation

cases. Fracture of the cricoid cartilage not seen in even a single case. The laryngohyoid complex was fractured in 9 (15.51%) cases out of 58 cases of asphyxia.

Table 17 shows that hyoid bone fracture was found in 5 cases: 1 Hanging, 3 MS, and 1 LS. Hyoid fractures in males were present in the age group 20-29 (1 case of hanging), 50-59 (1 case of MS), and 70-79 (1 case of MS). Hyoid fractures in females were present in the age group 50-59 (1 case of MS) and 70-79 (1 case of LS). Thyroid cartilage fracture was found in 4 cases: 2 Hanging, 1 MS, and 1 LS. Thyroid cartilage fractures in males were present in the age group 30-39 (1 case of hanging) and 50-59 (1 case of MS). Thyroid cartilage fractures in females were present in the age group 30-39 (1 case of hanging) and 70-79 (1 case of MS). Both hyoid and thyroid cartilage fractures simultaneously were found in 2 cases: 1 MS and 1 LS.

Table 18 shows that hyoid bone fracture occurs in all the cases of strangulation. In MS cases, 3(60%) out of 5 cases showed presence of hyoid bone fracture, and all cases of LS showed this finding. It was present in only one case (1.92%) of hanging.

Table 19 shows that fractures of both greater cornua of the right and left sides were seen in 2 (50%) cases of MS. The fracture left greater cornu was seen in 2 (50%) cases, one in MS, and one in LS. The fracture right greater cornu was seen in 1 case of hanging.

Table 20 shows that fracture of thyroid cartilage was found in 6.89% of all cases. It was evident in 20% of cases of MS and 3.84% of cases of hanging. Fracture of the thyroid cartilage was present in single case of LS.

Table 21 shows that thyroid cartilage fracture was seen in maximum cases at the upper end (laryngeal prominence) of thyroid cartilage in midline followed by the lower end of thyroid cartilage in midline.

**Table 16: Distribution of changes in internal structures of the neck**

| Changes in neck structures | Number of cases (*n*=58) | Percentage |
|---|---|---|
| Fracture of hyoid bone | 5 | 8.62 |
| Fracture of thyroid cartilage | 4 | 6.89 |
| Fracture of cricoid cartilage | 0 | 0 |
| Intimal tears | 3 | 5.17 |
| Total | 12 | 20.69 |

**Table 17: Distribution of fracture of the hyoid bone and thyroid cartilage according to age group and gender**

| Age group (years) | Hyoid | | Thyroid | | Hyoid+thyroid | |
|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female |
| <10 | - | - | - | - | - | - |
| 10-19 | - | - | - | - | - | - |
| 20-29 | 1 (H) | - | - | - | - | - |
| 30-39 | - | - | 1 (H) | 2 (H) | - | - |
| 40-49 | - | - | - | - | - | - |
| 50-59 | 1 (MS) | 1 (MS) | 1 (MS) | - | 1 (MS) | - |
| 60-69 | - | - | - | - | - | - |
| 70-79 | 1 (MS) | 1 (LS) | - | 1 LS | - | 1 (LS) |

MS: Manual strangulation, LS: Ligature strangulation

**Table 18: Occurrence of fracture of the hyoid bone**

| Cases | Number of cases | Fracture of hyoid | Percentage |
|---|---|---|---|
| Hanging | 52 | 1 | 1.92 |
| MS | 5 | 3 | 60 |
| LS | 1 | 1 | 100 |
| Total number of cases | 58 | 5 | 8.62 |

MS: Manual strangulation, LS: Ligature strangulation

**Table 19: Site of occurrence of hyoid bone fracture**

| Neck structure injury | Hanging | MS | LS |
|---|---|---|---|
| Hyoid bone (*n*=5) | 1 | 3 | 1 |
| Greater cornu (right) | 1 | - | - |
| Greater cornu (left) | - | 1 | 1 |
| Both greater cornua (right+left) | - | 2 | - |
| Lesser cornu (right) | - | - | - |
| Lesser cornu (left) | - | - | - |
| Both lesser cornua (right+left) | - | - | - |
| Body | - | - | - |

MS: Manual strangulation, LS: Ligature strangulation

**Table 20: Occurrence of thyroid cartilage fracture**

| Cases | Number of cases | Fracture thyroid cartilage | Percentage |
|---|---|---|---|
| Hanging | 52 | 2 | 3.84 |
| MS | 5 | 1 | 20 |
| LS | 1 | 1 | 100 |
| Total number of cases | 58 | 4 | 6.89 |

MS: Manual strangulation, LS: Ligature strangulation

**Table 21: Site of occurrence of the thyroid cartilage**

| Neck structure injury | Hanging | MS | LS |
|---|---|---|---|
| Thyroid cartilage (*n*=4) | 2 | 1 | 1 |
| Superior cornu (right) | - | - | - |
| Superior cornu (left) | - | - | - |
| Both superior cornua (right+left) | - | - | - |
| Inferior cornu (right) | - | - | - |
| Inferior cornu (left) | - | - | - |
| Both Inferior cornua (right+left) | - | - | - |
| Upper end (laryngeal prominence) of thyroid cartilage in midline | 1 | 1 | 1 |
| Lower end of thyroid cartilage in midline | 1 | - | - |

MS: Manual strangulation, LS: Ligature strangulation

Table 22 shows the presence of intimal tears in 5.172% of total cases, out of which it was seen in 20% of cases of MS and in 3.84% of cases of hanging.

Table 23 shows that intimal tears were seen in 2 cases of hanging. In one case of hanging, it was located in Rt. CCA and in another case in both ICA. In one case of MS, tears were present in both internal carotid arteries.

No injuries were noted in the cervical lymph nodes, submandibular gland, and thyroid and parathyroid glands.

No specific findings were noted in the jugular veins (internal and external), vagus, and phrenic nerves.

## DISCUSSION

Asphyxial deaths due to constriction of neck are common in all parts of the world. In our study, asphyxial deaths contributed to 3.86% deaths between September 2010 and March 2012. Asphyxial deaths due to hanging were most common and seen in 52 cases (71.23%) followed by drowning in 15 cases (20.54%), MS in 5 (6.84%) cases, and LS in 1 (1.36%) cases. The incidence of hanging was the highest (71.23%) among the other types of asphyxia. According to Sharma *et al.,*[18] 5% of cases contribute to asphyxial deaths, hanging was the most common mode observed in 66 (69%) cases, followed by drowning in 10 (11%). In the retrospective study of Amandeep,[16] out of the total number of autopsies conducted during the period of 4 years, i.e., 2000-2003, 111 (5.26%) cases were due to asphyxia, out of which drowning was found to be most common, i.e., 66 cases (59.4%), followed by hanging 27 (24.3%), traumatic asphyxia 7 (6.3%) cases, strangulation 6 (5.4%) cases, and throttling 5 (4.5%) cases. The incidence of drowning was highest among the asphyxial deaths, so this study does not coincide with our study and it may be due to the geographical variations and the presence of easily accessible water bodies in that area.

**Table 22: Distribution of intimal tears**

| Cases | Number of cases | Intimal tears | Percentage |
|---|---|---|---|
| Hanging | 52 | 2 | 3.84 |
| MS | 5 | 1 | 20 |
| LS | 1 | 0 | 0 |
| Total number of cases | 58 | 3 | 5.172 |

MS: Manual strangulation, LS: Ligature strangulation

**Table 23: Location of intimal tears**

| Neck structure injury | Hanging | MS | LS |
|---|---|---|---|
| Intimal tears (*n*=3) | 2 | 1 | 0 |
| CCA (right) | 1 | - | - |
| CCA (left) | | - | - |
| Both CCA | - | - | - |
| ICA (right) | - | - | - |
| ICA (left) | - | - | - |
| Both ICA | 1 | 1 | - |

MS: Manual strangulation, LS: Ligature strangulation, ICA: Internal carotid artery, CCA: Common carotid artery

All the cases of hanging in this study were suicidal, and all the cases of strangulation were homicidal in nature. This finding coincides with findings of the most other authors as hanging is almost always suicidal unless proved otherwise and strangulation is mostly homicidal. Hanging is a leading method of suicide in Germany and Japan, and it is the second leading suicidal method after intoxications in India and United States.[26] The age ranges of the victims in this study were between newborn infant to 70 years. Maximum numbers of cases (51%) were seen in the age group of 20-29 years followed by 30-39 years (15.51%) in both the sexes. This is similar to study reported by Amandeep where maximum number of cases were seen in the age group 21-25 years (29.62%) and 16-20 years (29.62%) followed by 26-30 years (18.51%).[16]

In this study, there was male predominance in all the cases of asphyxia (65.51%) as compared to females (32.75%). The ratio is being 2:1. This is similar to studies reported by various authors. Male predominance in cases of hanging can be explained by the fact that it is not a commonly opted method of suicide by females as compared to poison intake and burning. This figure contrasts with high incidence of hanging in woman (40%) reported in Denmark by Simonsen.[6]

A maximum number of cases in our study were seen in March (10 cases, 17.24%) followed by February (9 cases, 15.51%) and followed by September (8 cases, 13.79%). The incidence of asphyxial deaths due to constriction of the neck in our study was highest in March. Uzun *et al.*[15] reported similar findings of maximum asphyxial deaths in the winter season (December-February) like our study.

### General Gross Findings

In this study, facial congestion and saliva stain were present in <50% of cases and petechial hemorrhages in 58.62% of cases of which 61.53% of cases were of hanging, and 33.33% of cases were of strangulation. In a study on hanging cases by Suárez-Peñaranda *et al.*,[19] facial congestion was found in 42.9% and petechial hemorrhages of the face and conjunctiva in 23.4%.

These findings are not consistent with the study of Sharma *et al.*[18] where petechiae were found only in hanging cases (42%) of which 75% were of incomplete hanging and 25% were of atypical complete hanging.

### Type of Suspension

In this study, complete hanging was found in 98.07% of cases whereas partial hanging only in 1.92% of cases. These incidences were found lower for complete hanging by Suárez-Peñaranda *et al.*,[19] i.e., 62.4% but slightly higher by Sharma *et al.*,[18] i.e., 68%. Similarly, higher incidences of complete hanging were found in a study conducted by Naik and Patil.[13] in 217 cases out of 232 cases of hanging. In the study of Luke *et al.*,[29] the complete hanging was seen in 20 (32.78%) cases of hanging.

### Placement of the Ligature Knot

In this study, typical hanging was seen in 6 (11.53%) cases. Atypical hanging was seen in 46 (88.45%) cases where the knot was present at the left side of the neck in 41.50% of cases, at the right side of the neck in 43.39% of cases, and at the chin in 3.77% of cases. These findings are similar to the study reported by Naik and Patil[13] where they found typical hanging in 7.39% and atypical hanging in 92.6% of cases. Our study differs from the study of Suárez-Peñaranda *et al.*[19] where typical hanging was seen in 32.1% and the rest of the knot locations were 35.3% on the left side of the neck, 28.5% on the right, and 4.1% on the back of the neck. These results are not consistent with our results. Atypical hanging was found in more number of cases (88.46%) as compare to typical (11.53%) which is consistent to Sharma *et al.,*[18] found 88% of cases of atypical hanging. In 1985, Luke *et al.*[29] conducted a study on 61 cases of hanging. The ligature material used in most cases was rope or clothesline. The site of ligature knot was at the left side of the neck in 20 cases, at the right side and back of the neck in 17 cases, and at the front of the neck in 3 cases. No fracture of cricoid cartilage was found.

### Ligature Mark

In our study, ligature mark was present in all the cases of hanging and LS. The ligature mark in hanging was present above the level of thyroid cartilage in 50% of cases, at the level of thyroid cartilage in 48.07% of cases. In one case of LS (1.92%), the ligature mark was present below the level of the thyroid cartilage. These findings are consistent with Sharma *et al.*[18] who reported the presence of ligature above the level of the thyroid in 58% of cases, 27.3% of cases at the level of the thyroid cartilage, and in 15.2% of cases below the level of thyroid cartilage. Naik and Patil[13] documented that out of 257 cases of hanging, the level of constriction was found above the laryngeal prominence in 159 (61.86%) cases. In cases of strangulation, the level of constriction was found on and above the laryngeal prominence and below laryngeal prominence in 3 cases each out of the 7 cases.

In this study, the soft material in the form of cloth was used as a ligature material in a maximum number of cases 28 (48.27%), followed by rope 19 (32.75%), wire 4 (6.89%), and rubber fan belt in 2 (3.44%) cases. In the study of Sharma *et al.*,[18] sari was the most common ligature material used by the males, 14 (30%), whereas females preferred chunni 9 (45%) followed by the sari 7 (35%), so soft material in the form of cloth was used in 45.45% of cases. Hence, our study coincides with the study of Sharma *et al.*[18] Naik and Patil[13] found that soft ligature such as scarf, napkin, sari, and bed sheet was used in 127 cases of hanging, and hard ligature such as jute rope, plastic or nylon rope, and electric wire were used in 105 cases of hanging whereas hard ligature were used in the most cases of strangulation. However, in study conducted by Uzun *et al.*,[15] the most victims selected rope (652 cases) for the ligature with the rest using sheet, belt, cable, and necktie. In one case in our study, fan belt was used as a ligature material. Deceased committed suicide by in a small factory. Hence, by analyzing the ligature material, it was possible to explain to some extent the profession and work place of the deceased.

### Internal Neck Findings

#### *Muscle hemorrhages*

In this study, we found muscle hemorrhage only in 13.79% of total cases, including all the cases of MS and 5.76% of cases of hanging. These incidences are lower than that reported in literature, 55.8% by Suárez-Peñaranda *et al.*,[19] 42% by Sharma *et al.*,[18] and 100% by Uzun *et al.*[15]

#### *Fractures of the hyoid bone and/or laryngeal cartilages*

In this study, the changes in internal structures of the neck present in 20.69% of cases. Out of these, the incidence of fracture of hyoid bone was common and seen in 8.62% followed by fracture of thyroid cartilage (6.89%) and intimal tears found in 5.17% of cases. Fracture of cricoid cartilage not seen in even a single case. Laryngohyoid complex was fractured in 15.51% of cases. Similar order of occurrence has been reported by Uzun *et al.*[15] and Sharma *et al.*[18] in their studies. Uzun *et al.*[15] found fractures in the neck organs in 59.93% of cases including hyoid fracture in 23.26%, a thyroid fracture in 21.42%, and both hyoid and thyroid fractures in 13.93% of the cases. Sharma *et al.*[18] documented hyoid bone fracture in 21% of cases, thyroid cartilage fractured in 17% of cases, and laryngohyoid complex fracture in 33%. Suárez-Peñaranda *et al.*[19] also reported more number of cases of hyoid bone fracture (48.4%) as compared to thyroid cartilage fractures (47.1%). They also found no fractures of the cricoid cartilage. Khokhlov *et al.*[8] found cricoid fractures in 13 (9.5%) cases of hanging.

#### *Age- and sex-wise distribution*

Hyoid bone fracture was more common in males (3 cases) as compared to females (2 cases) while thyroid cartilage

fracture was more common in females. The occurrence of fracture of both bones simultaneously was equal in both sexes. The male: female ratio reported by Sharma *et al.*[18] was 2.5:1 while Suárez-Peñaranda *et al.*[19] found no significant differences in hyoid bone fracture between men and women.

Several authors have shown that the rate of fractures increases with age.[7,11,28] It was more common in the age group of 50-59 years followed by 60-69 years. According to Morild,[7] the proportion of fractures seemed to increase with age and possibly also with increasing suspension time.

In our study also, we found that the damage to laryngeal apparatus increases with the advancement of age and zero occurrences seen in age <20 years. Among both the sexes, the occurrence of hyoid bone fracture was common in the age group of 50-59 years and 70-79 years followed by 20-29 years. However, fracture of the thyroid cartilage was more common in 30-39 years followed by 50-59 years and 70-79 years of age group. In the study of Paparo and Siegel,[5] thyroid cartilage fracture was found more common in females as compared to males combined fracture of both bones seen in the age group of 50-59 years and 70-79 years. Sharma *et al.*[18] also reported maximum cases of laryngohyoid complex fracture in the age group 41-60 years (72%), followed by the 21-40 years age group (16%). Uzun *et al.*[15] also reported a maximum number of cases (25.69%) in 20-29 age group.

Hyoid bone fracture was found in all the cases of LS, in 60% of cases of MS, and in 1.92% of cases of hanging. Fracture of the left greater horn was more common (69% cases) followed by combined fractures of both greater cornua (66.66% cases) and followed by the right greater cornu (1.92%). Sharma *et al.*[18] in their study found that fracture left lesser horn was more common, 9 (14%) followed by the fractures of left greater and right lesser horns, and 8 (12%) each in cases of hanging whereas left greater horn was found fractured more commonly in LS, 2 (67%) and right greater horn in cases of throttling, 2 (67%). Khokhlov[8] studied a total of 137 cases of hanging and using various methods of examinations, e.g., visualization, palpation, and radiography; they got different results. Using stereomicroscopy as the method of choice for examination, they found hyoid bone fracture in 58 (42.3%) cases, mostly of greater cornua. Suárez-Peñaranda *et al.*[19] found fractures slightly more on the right side (17.7%) followed by the left (16.2%) and on both the sides in 14.5% of cases. Fracture of the right greater cornu of the hyoid appeared in 16.7% of all cases, of the left in 17.1%, and both greater cornu were damaged in 13.2%. Naik and Patil[13] found not a single victim having fracture of the hyoid bone in hanging cases whereas in 42.87% of cases of LS and 80% of cases of throttling hyoid bone fracture was present. In the study carried out by Luke *et al.*,[29] hyoid bone was fractured in 14 (22.95%) cases of hanging.

Fracture of thyroid cartilage was found in 6.89% of all cases, including 20% of cases of MS, 3.84% of cases of hanging, and 100% of cases of LS. It was seen in maximum cases at the upper end (Laryngeal prominence) of thyroid cartilage in midline followed by the lower end of the thyroid cartilage. Sharma *et al.*[18] reported fracture of thyroid cartilage in 17% of all cases. In his study, the incidences of fracture of the body of thyroid (17%) were more as compared to the fractures of superior horn (6%). Fracture of the body of thyroid cartilage found in 9% of cases of hanging and 75% of cases of throttling. Nikolic *et al.*[11] reported that superior horn thyroid cartilage fractures were more frequent injuries of the solid neck structures (27.40% left and 25.70% right) and statistically more significant than those of the horn hyoid bone. Suárez-Peñaranda *et al.*[19] reported 47.1% of cases of thyroid cartilage fractures. Khokhlov *et al.*[8] studied steriomicroscopically and found thyroid cartilage fracture in 75 (54.7%) cases, mostly of superior cornua. Luke *et al.*[29] conducted a study in which he found thyroid fractures in 8 (13.11) cases of hanging.

### *Vascular lesions*

In this study, the presence of intimal tears was more in 6.89% of total cases, out of which it was seen in 20% of cases of MS and in 5.76% of cases of hanging. These tears are commonly seen in ICA bilaterally followed by right CCA. Our findings are consistent to Sharma *et al.*,[18] showing 10.3% incidence of injuries to the blood vessels of which 25% found in throttling and 9.1% in hanging. In 9.1% of cases, Suárez-Peñaranda *et al.*[19] found injuries of the intima of the carotid artery. In the study of Nikolic *et al.,*[11] the neck blood vessel injuries (transverse intimal tears and perivascular hematoma) in hanging were rare, i.e., 7.40% on the left side of the neck and 10.90% on the right. There is a higher tendency of blood vessel ipsilateral injuries related to the location of the ligature knot. This finding corresponds to the theory that the injuries of blood vessels in hanging are caused by a traction not a direct pressure on a blood vessel.[30] Bilateral blood vessel injuries (5 cases) found only in the posterior type of hanging also support the same finding.

We could not find the references to correlate the changes in lymph nodes, submandibular gland, thyroid and parathyroid glands, jugular veins (internal and external), vagus, and phrenic nerves.

## CONCLUSION

The conclusion drawn from this study is that in Delhi, the incidence of asphyxial deaths due to constriction of the neck is more in males as compared to females, and in most of these cases, the mode of death is hanging. A maximum numbers of cases are seen in young adults (20-29 years). A maximum numbers of cases are seen in March. In most of the cases, the soft cloth was used as ligature material. The knot of the ligature material was mostly either on the right side or left side in comparison to front and back of the neck. The typical position of the knot is found in a few cases. In a maximum number of cases, the hanging is complete. The ligature mark was present in all the cases of hanging and LS, and in most cases, it was at the level of thyroid cartilage followed by above the level of the thyroid cartilage.

Muscle hemorrhage was present in all cases of MS and in a few cases of hanging. The changes in the internal structures of the neck were present in a few cases only. Hyoid bone fractures were more common in comparison to thyroid cartilage fractures and more commonly seen in males whereas thyroid cartilage fracture was more common in females. The occurrence of fracture of both the bones simultaneously is equal in both the sexes. Combined fracture of both the bones increases with the increase of age and decreases in the lower age groups. Hyoid bone fracture was seen mainly in MS and was very rare in hanging. Fracture of the thyroid cartilage was seen at the upper end in midline.

Intimal tears were seen commonly in the cases of MS and were very rare in cases of hanging.

## REFERENCES


1. Vij K. Textbook of Forensic Medicine and Toxicology. 5th ed. New Delhi: Reed Elsevier India Pvt. Ltd.; 2011. p. 71-2.
2. Adelson L. The Pathology of Homicide. Springfiield: Charles C Thomas; 1974. p. 555-7.
3. Barcroft J. Physiological effects of insufficient oxygen supply. Nature 1920;106:125-9.
4. Prinsloo I, Gordon I. Postmortem dissection artifacts of the neck; Their differentiation from ante mortem bruises. S Afr Med J 1951;25:358-61.
5. Paparo GP, Siegel H. Neck markings and fractures in suicidal hangings. Forensic Sci Int 1984;24:27-35.
6. Simonsen J. Patho-anatomic findings in neck structures in asphyxiation due to hanging: A survey of 80 cases. Forensic Sci Int 1988;38:83-91.
7. Morild I. Fractures of neck structures in suicidal hanging. Med Sci Law 1996;36:80-4.
8. Khokhlov VD. Injuries to the hyoid bone and laryngeal cartilages: Effectiveness of different methods of medico-legal investigation. Forensic Sci Int 1997;88:173-83.
9. Mallach HJ, Pollak S. Simulated suicide by hanging after homicidal strangulation. Arch Kriminol 1998;202:17-28.
10. Green H, James RA, Gilbert GD, Byard RW. Fractures of hyoid bone and laryngeal cartilages in suicidal hanging. J Clin Forensic Med 2000;7:123-6.
11. Nikolic S, Micic J, Atanasijevic T, Djokic V, Djonic D. Analysis of neck injuries in hanging. Am J Forensic Med Pathol 2003;24:179-82.
12. Sharma BR. Ligature mark on neck: How informative? J Indian Acad Forensic Med 2005;27:10-5.
13. Naik SK, Patil DY. Fracture of hyoid bone in cases of asphyxial deaths resulting from constricting force round the neck. J Indian Acad Forensic Med 2005;27:149-53.
14. Verma SK, Lal S. Strangulation deaths during 1993-2002 in East Delhi (India). Legal Med 2006;8:1-4.
15. Uzun I, Buyuk Y, Gurpinar K. Suicidal hanging: Fatalities in Istanbul retrospective analysis of 761 autopsy cases. J Forensic Legal Med 2007;14:406-7.
16. Singh A, Gorea RK, Dalal JS, Thind AS, WaliaD. A study of demographic variables of violent asphyxial deaths. JPAFMAT 2003;3:22-5.
17. Fedakar R, Akan O, Eren B. Autoerotic asphyxia by hanging. J Pak Med Assoc 2008;58:462-4.
18. Sharma BR, Harish D, Sharma A, Sharma S, Singh H. Injuries to neck structures in deaths due to constriction of neck, with a special reference to hanging. J Forensic Leg Med 2008;15:298-305.
19. Suárez-Peñaranda JM, Alvarez T, Miguéns X, Rodríguez-Calvo MS, de Abajo BL, Cortesão M, *et al*. Characterization of lesions in hanging deaths. J Forensic Sci 2008;53:720-3.
20. Demirci S, Dogan KH, Erkol Z, Gunaydin G. Ligature strangulation deaths in the province of Konya (Turkey). J Forensic Leg Med 2009;16:248-52.
21. Sauvageau A, Boghossian E. Classification of asphyxia: The need for standardization. J Forensic Sci 2010;55:1259-67.
22. Charoonnate N, Narongchai P, Vongvaivet S. Fractures of the hyoid bone and thyroid cartilage in suicidal hanging. J Med Assoc Thai 2010;93:1211-6.
23. Clément R, Guay JP, Sauvageau A. Fracture of the neck structures in suicidal hangings: A retrospective study on contributing variables. Forensic Sci Int 2011;207:122-6.
24. Püschel K, Holtz W, Hildebrand E, Naeve W, Brinkmann B. Hanging: Suicide or homicide? Arch Kriminol 1984;174:141-53.
25. Graham MA, Hanzlick R. Asphyxia in *Forensic Pathology in Criminal Cases*. 2nd ed. Carlsbad, Calif: Lexis Law Publishing; 1997.
26. Ojima T, Nakamura Y, Detels R. Comparative study about methods of suicide between Japan and the United States. J Epidemiol 2004;14:187-92.
27. Davison A, Marshall TK. Hanging in Northern Ireland - A survey. Med Sci Law 1986;26:23-8.
28. Feigin G. Frequency of neck organ fractures in hanging. Am J Forensic Med Pathol 1999;20:128-30.
29. Luke JL, Reay DT, Eisele JW, Bonnell HJ. Correlation of circumstances with pathological findings in asphyxial deaths by hanging: A prospective study of 61 cases from Seattle, WA. J Forensic Sci 1985;30:1140-7.
30. Vanezis G. Frequency of Neck Injury. London: Butterworths; 1989.


**How to cite this article:** Chand S, Solanki R, Aggrawal A, Dikshit PC, Ranjan R. Study of Postmortem Findings of Neck Structures in Cases of Asphyxial Deaths. Int J Sci Stud 2017;5(4):248-256.

**Source of Support:** Nil, **Conflict of Interest:** None declared.