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## Original Research Article

## Microscopic analysis of compression injury over neck: One-year prospective study

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## ABSTRACT

The present study was conducted in Department of Forensic Medicine and Toxicology of a Government Medical College and Hospital in year 2017. Total 2781 postmortem examinations were conducted in 2017. Out of that total 2781 cases, 176 compression of neck cases came for postmortem and amongst these 105 cases were studied in detail as per inclusion criteria. Out of 105 cases of compression around neck, which were studied, there were 93 cases of hanging, 10 cases of ligature strangulation, 01 case of manual strangulation and 01 case of accidental strangulation studied. On gross in total 11 cases of strangulation hemorrhage in subcutaneous tissue, strap muscle and sternocleidomastoid muscle observed and in only 20 cases of hanging there was hemorrhage observed in subcutaneous tissue and no hemorrhage observed in strap and sternocleidomastoid muscle in hanging cases. In this present study on histopathology vascular congestion and extravasation of red blood cells observed in 28 cases of compression of neck. These findings indicate the importance of histopathology of underlying neck structure in neck compression cases in documenting antemortem nature of hanging and strangulation in doubtful cases.

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## 1. Introduction

Asphyxia is inability to breath; resulting from obstruction to airflow due to mechanical interference with the process of respiration. In asphyxia, there is prevention of exchange of air between the atmosphere and the lung alveoli and there is lack of oxygen supply to the tissues.<sup>1</sup> Violent asphyxial deaths are one of the most important causes for unnatural deaths. Usual causes of violent asphyxial deaths are hanging, strangulation, throttling, choking and drowning.

In cases of neck compression, ligature is applied to neck and usually within two hours of death it usually produces prominent ligature mark. Postmortem suspension of body may be used by criminals to mislead the investigating agency and to hide the crime. In some cases, hanging may be homicidal and in all such doubtful cases, examination of scene of crime becomes important as a circumstantial

evidence.<sup>2</sup>

The various features of hanging and strangulation deaths can be deduced from the history, police investigation and gross postmortem examination findings. In unusual asphyxial deaths a great challenge rests before the forensic experts to establish the cause and manner of death. Here lies the importance of clubbing the histopathological examination findings with the routine gross autopsy findings.<sup>3</sup>

The histopathological examination of ligature mark and the underlying tissue may help in determining deeper damage to tissues and also to know the antemortem or postmortem nature of injuries.<sup>4</sup> With this in mind the present study was conducted to evaluate the histopathological findings in the neck structures like Sternocleidomastoid muscle, Strap muscle, common carotid artery, Esophagus and skin; and to correlate these changes with the gross findings.

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## 2. Materials and Methods

This observational study was conducted at Department of Forensic Medicine, Government Medical College and Hospital in year 2017. Total 2781 cases were brought for medicolegal postmortem examination and amongst them 105 (3.77 %) cases were studied as per inclusion criteria of all brought dead cases of unnatural deaths due to compression of neck. The study was carried out on medicolegal cases brought for postmortem examination by police with inquest and proper requisition; hence no consent was necessary to obtain from relatives or any other authority in this particular study. As per the prevailing mandatory standard procedures of the Institute, the prior permission cum no objection certificate to carry out the study was obtained from Institutional Ethical Committee. Exclusion criteria were bodies brought with 1) decomposition 2) hospitalization 3) having trauma over neck, extreme overstretching, or whiplash-injuries in vehicular accident, neck surgery and pathological lesion. External and internal examination of neck structure was carried out to note injury over neck, extravasation of blood in soft tissue, muscle, common carotid artery and fracture of throat skeleton. The examination was carried-out with in situ and with en block examination. Tissue specimens were fixed in 10% formalin. For processing and staining of tissue standard procedure as given in Theory and Practice of Histological Techniques by Bancroft and Gamble<sup>5</sup> were followed. Slides were then stained with Hematoxylin and Eosin stains and read under microscope.

## 3. Results

### 3.1. Age and sex

Total 2781 cases were studied in 2017 and among them 105 cases were due to compression over neck. Out of them 66 were males and 39 were females. The age and sex related data given in Table 1. The mean age of male and female was 59.09 and 25.94 respectively.

### 3.2. Manner of neck compression

Table 2 shows manner of neck compression. There were 11 cases of homicidal strangulation and amongst them 10 were of ligature strangulation and 01 case was of throttling. One case was of accidental strangulation. Out of total 93 cases of suicide, all cases were of hanging.

### 3.3. Type of ligature material and type of knot

The most common ligature material used for compression of neck was nylon rope in 48.57 % cases followed by soft material like Shela, Odhani and Sari 13.33%, 09.52%, 06.66% respectively. Coconut rope used as a ligature material in 03.80% cases. Table 3 shows distribution of type of knot. It was observed that 48 (45.72 %) cases

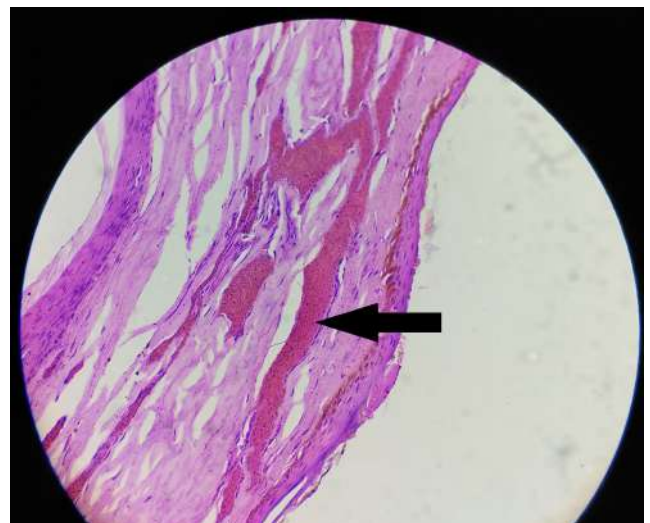
showed fixed noose and amongst them 11 cases were having complete ligature mark around the neck and 37 cases showed incomplete mark. Similarly, there was a running type of noose in total 37 (35.23%) cases, out of which 27 were showing complete ligature mark around the neck and 10 shown incomplete ligature mark around the neck. In 27 (25.71%) cases exact knot type cannot be ascertained. In 15 (14.28%) cases ligature material was not known. In 11 cases (10.47%) knot was opened by the relatives or police officers.

### 3.4. Level and nature of ligature mark

Table 4 shows level and nature of ligature mark. The ligature mark was present above the level of thyroid cartilage in 81 cases (77.14%). The ligature mark was obliquely placed in 97 cases (92.38%). In 79 cases (75.24%) the ligature mark was deep and grooved.

### 3.5. Histopathological findings in the skin of ligature mark

Table 5 shows histopathological findings of the ligature mark skin. In 69 (65.71%) cases, the ligature mark skin showed normal epidermal and dermal tissues with unremarkable and non-specific changes. In 28 (26.66%) cases, the skin of ligature mark showed vascular congestion with extravasations of red blood cells (Figures 1 and 2). In 3 (02.85 %) cases, there was vascular congestion with extravasations of red blood cells and leucocyte infiltration. In 05 (04.76%) cases, autolytic changes were observed.



**Fig. 1:** Skin showing extravasation of blood and vascular congestion (Black arrow) (H & E, 10 X)

### 3.6. Histopathological findings in the neck muscle

Table 6 shows histopathological findings in neck muscles. In 28 (26.66%) cases, hemorrhage in Sternocleidomastoid



**Fig. 2:** Skin showing congestion and extravasation of red blood cells (Black arrow) (H &E, 40 X)

muscle was evident (Figures 3 and 4) and in 21 cases (20.00%) hemorrhage in strap muscles was evident. Contraction bands in Sternocleidomastoid muscle was demonstrated in 79 cases (75.23%) and in strap muscles in 77 cases (73.33%). Contraction band necrosis was present in Sternocleidomastoid muscle in 03 cases (02.85%) (Figure 5) and Strap muscles in 01 case (0.95%). Opaque fibers in Sternocleidomastoid muscle in 79 cases (75.23%) and Strap muscles in 77 cases (73.33%). Infiltrations of leucocytes was evident in 3 cases (02.85%) in Sternocleidomastoid muscle and Strap muscles each. In 5 cases (04.76%) autolysis was evident in Sternocleidomastoid muscle and Strap muscles respectively.

### 3.7. Histopathological findings in carotid artery

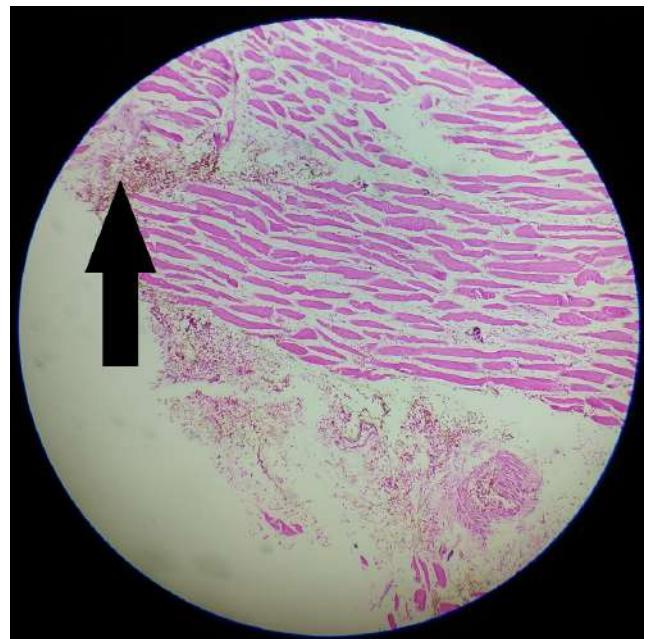
Table 7 shows histopathological changes in the carotid artery. In 87 (82.86%) cases normal arterial structure of carotid was evident. In 05 cases (04.76%), intimal tear was evident; in 1 case (0.95%) (Table 6), intimal tear with blood infiltration was noted and in 3 cases (2.87%) rupture of adventitial layer was evident. In 5 cases (04.76%) autolysis of carotid artery was noted.

### 3.8. Histopathological findings in the esophagus

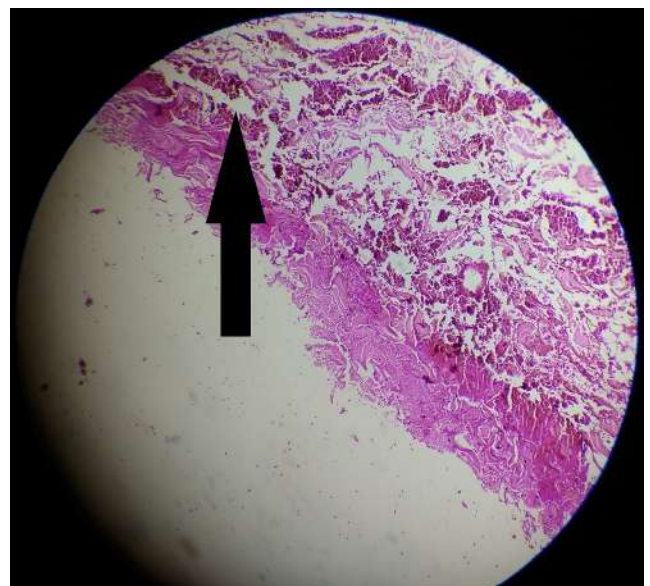
In all cases, histological examination of oesophagus was unremarkable.

## 4. Discussion

In the present study, amongst 105 cases studied, there were 66 male and 39 females. These findings are consistent with the findings of male predominance as observed in the studies Batra et al. (2003),<sup>6</sup> Sharma et al. (2005),<sup>7</sup> Ambade et al.(2008),<sup>8</sup> Uzun et al (2007)<sup>9</sup> and Sharma et al. (2008).<sup>10</sup>



**Fig. 3:** Sternocleidomastoid muscle showing hemorrhages (Black arrow) (H & E, 40 X)



**Fig. 4:** Sternocleidomastoid muscle showing hemorrhages (Black arrow) (H & E, 40 X)

**Table 1:** Age and sex-wise distribution of cases

Sex	Number of cases %	Age in years		Standard Deviation
		Mean	Range	
Male	66 (62.85%)	59.09	3.5 to 80	17.20
Female	39 (37.14%)	25.94	13 to 50	08.97
Total	105	31.11	3.5 to 80	15.17

**Table 2:** Cases according to cause and manner of compression

Cause of death in compression to neck	Homicide (n=11)		Suicide (n=93)		Accident (n=1)	
	Male	Female	Male	Female	Male	Female
Hanging (n=93)	00	00	61	32	00	00
Ligature Strangulation (n=11)	04	06	00	00	01	00
Manual Strangulation (n=01)	00	01	00	00	00	00
Total (105)	04	07	61	32	01	00

**Table 3:** Relation of type of ligature mark with type of ligature knot

Type of ligature knot	Type of ligature mark		Total
	Complete Mark around neck	Incomplete mark around neck	
Fixed	11 (10.48 %)	37 (35.24 %)	48 (45.72 %)
Running	27 (25.71 %)	10 (09.52 %)	37 (35.23 %)
Not known	7 (06.67 %)	13 (12.38 %)	20 (19.05 %)
Total	45 (42.86 %)	60 (57.14 %)	105 (100 %)

**Table 4:** Level and nature of ligature mark in cases

Particulars of Ligature mark	No. of cases	Percentage (%)	
Level of mark over neck	Above the level of thyroid	81	77.14
	At the level of thyroid	18	17.14
	Below the level of thyroid	6	05.72
Direction	Obliquely placed	97	92.38
	Horizontally placed	08	07.62
Depth	Grooved	79	75.24
	Shallow	26	24.76

**Table 5:** Histopathological findings in the skin of ligature mark

Histopathological changes	No. of cases	Percentage
Normal epidermal and dermal tissues with unremarkable changes – Nonspecific changes	69	65.71
Vascular congestion with extravasations of red blood cells	28	26.66
Vascular congestion with extravasations of red blood cells and leucocyte infiltration	03	02.85
Autolysis changes	05	04.76

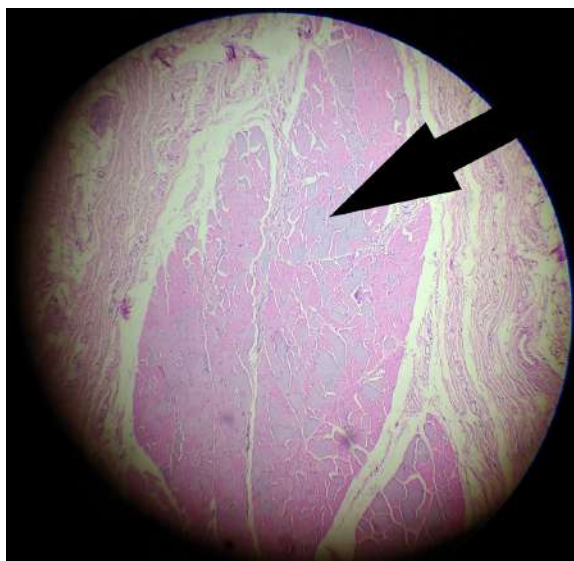
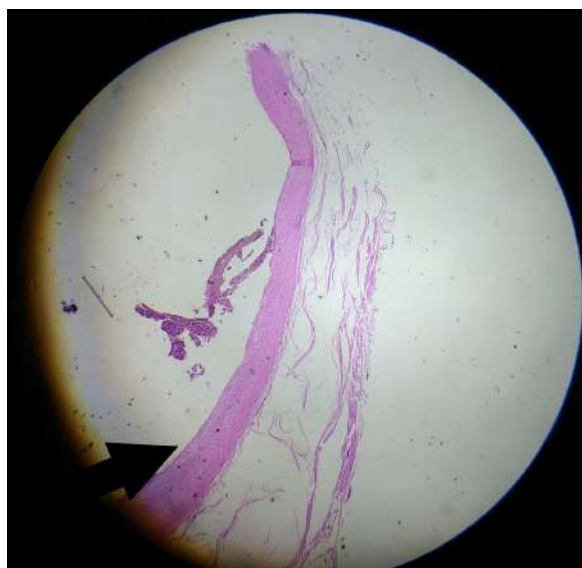
**Table 6:** Histopathological findings in the neck muscle

Histo-pathological change	In Sternocleidomastoid muscle	In Strap muscles
Hemorrhage	28 (26.66)	21 (20.00)
Contraction bands	79 (75.23)	77 (73.33)
Contraction band necrosis	03 (02.85)	01 (00.95)
Opaque fibers	79 (75.23)	77 (73.33)
Infiltration of leucocytes	03 (02.85)	03 (02.85)
Autolysis	05 (04.76)	05 (04.76)



**Table 7:** Histopathological findings in carotid artery

Findings in carotid artery	No. of cases	Percentage
Normal artery	87	82.86
Intimal tear	05	04.76
Intimal tear, Adventitial rupture	02	01.90
Intimal tear, Adventitial rupture and blood infiltration	02	01.90
Intimal tear with blood infiltration	01	00.95
Adventitial rupture	03	02.87
Autolysis	05	04.76

**Fig. 5:** Sternocleidomastoid muscle showing necrosis (Black arrow) (H & E, 40 X)**Fig. 6:** Carotid artery showing intimal tear with rupture (Black arrow) (H & E, 40 X)

However, Naik et al. (2005)<sup>11</sup> reported higher number of females in hanging as well as strangulation cases.

In present study most commonly observed ligature material was a nylon rope (48.57%). These findings coincide with the findings of Dixit et al. (2001)<sup>12</sup> and Cooke et al. (1995).<sup>13</sup>

Incomplete ligature mark (57.14%) was more common than Complete ligature mark (42.86%). In 48 cases (45.72%), fixed noose was evident and amongst them 37 cases (35.24%) had incomplete mark around the neck and 11 cases (10.48%) had complete mark around the neck. In 37 cases (35.23%) of running noose was evident and amongst them 10 cases (09.52%) had incomplete mark around the neck and 27 cases (25.71%) had complete mark around the neck. These findings coincide with Sharma et al. (2005)<sup>7</sup> who reported lower incidence of completely encircling ligature mark (16.48%). Text books authors like Reddy<sup>14</sup> states that the ligature mark completely encircling the neck is usually common with running type of noose because the noose moves towards the neck due to weight of body and thus completely constricting the neck; giving complete ligature mark.

In hanging cases, ligature mark was found above the level of thyroid cartilage 81 (77.14%) cases. The ligature mark was obliquely placed in 97 cases (92.38%) and deeply situated in 79 cases (75.24%). Similar findings were reported by Sharma et al. (2005),<sup>7</sup> Elfawal et al. (1994),<sup>15</sup> Dixit et al. (2001).<sup>12</sup>

In 28 (26.66%) cases, the sections from the skin of ligature mark show vascular congestion with extravasations of red blood cells in sub-epidermal tissues. In 3 (02.85 %) cases, the sections from the skin of ligature mark show vascular congestion, extravasation of red blood cells with focal sparse neutrophilic infiltration which coincides with study of Samantha et al.<sup>16</sup>

Sternocleidomastoid muscle and strap muscles showed hemorrhage in 28 cases (26.66%) and 21 cases (20%) respectively. Contraction bands in Sternocleidomastoid muscle and strap muscles was observed in 79 cases (00%) and 77 cases (00%) respectively. Contraction band necrosis was present in Sternocleidomastoid muscle in 03 cases and Strap muscles in 01 case. Opaque fibers in Sternocleidomastoid muscle in 79 cases and Strap muscles in 77 cases. Tabata (1998)<sup>17</sup> examined histologically and

immunohistochemically the cervical muscles of 15 cases of compression of the neck and the other traumatized skeletal muscles from 54 autopsy cases. He observed opaque fibers in the muscles beneath the compression marks of the neck, whereas in areas where no force had been applied, such fibers did not exist. Furthermore, opaque changes appeared around cavities, which formed within severely compressed injured muscle tissue. It was suggested that there was a close relationship between opaque fibers changes in muscle and force.

Infiltration of leucocytes in sternocleidomastoid muscle and strap muscles was seen in 03 cases each. Gordon<sup>18</sup> in his textbook states that a portion of skin and deeper tissue in relation to the ligature mark should be preserved histologically for evidence of tissue reaction. Although margination and a limited emigration of leucocytes may occur in tissues in response to injury after somatic death in general cases but this investigation would be of value in case of hangings, only if the period of time that elapsed before death was sufficiently long enough for tissue reaction to develop.

Histopathological examination of carotid artery showed normal arterial structure in 87 (82.86%) cases, intimal tear in 05 (04.76%) cases, intimal tear with blood infiltration in 01 (00.95%) cases and rupture of adventitial layer artery in 03 (02.87%) cases. These findings are consistent with study of Samantha et al.,<sup>16</sup> Hejna P,<sup>19</sup> Vinaykumar<sup>20</sup> and Ghodake D.<sup>21</sup>

Histopathological study of esophagus showed normal histology in all cases. Study conducted by Nicolich et al.<sup>22</sup> showed “banding” of esophagus on gross and histopathological examination which was a pale area at the level of constriction. They could not conclude it whether it was a postmortem artefact or bruising due to rupture of vessels at the level of forceful constriction. Knight<sup>23</sup> mentioned banding of esophagus in nontraumatic cases as a routine finding and therefore such finding should be considered as non-specific finding.

## 5. Conclusion

The most common manner of neck compression was suicidal. Hanging was the most common death due to compression of neck studied. Hanging is almost always suicidal; unless and until contrary is proved. One case of throttling was observed in the present study. No case of accidental hanging was reported in present study. Eleven case of ligature strangulation was found in present study and one case of accidental strangulation was noted. Hanging was one of the preferred methods of suicide by males (58.09) than females (30.47). Male cases outnumbered in female cases in hanging but in strangulation female cases outnumbered male cases.

In ligature compression of neck, the commonly used ligature material was nylon rope. The ligature mark

completely encircling the neck was common in running type of noose.

The most common internal neck finding in neck compression deaths was sternocleidomastoid hemorrhage. In 11 cases of strangulation deaths, hemorrhages were observed on gross examination and in 28 cases hemorrhages observed on histopathology. Carotid artery injury was present in few cases of hanging. The histopathological examination of skin of ligature mark shows tissue reaction in those survived cases in which sufficient time period is present for tissue reaction to occur.

The present study concludes that a detail examination of the gross and histopathological findings of the neck structures, in doubtful cases is useful in establishing the cause and manner of death. Histological changes in neck muscles are a useful and effective mean to ascertain presence of compressive forces on neck and its antemortem nature.

## 6. Source of Funding

None.

## 7. Conflict of Interest


The authors declare that there is no conflict of interest.

## References

1. Nandy A. Principles of forensic medicine including toxicology revised. 3rd ed. Kolkata: New Central Book Agency Pvt. Ltd; 2010.
2. Casper JL. Handbook of the Practice of Forensic Medicine. 3rd ed. Balfour GW, editor. London: New Sydenham Society; 1982.
3. Yadav S, Gupta BM. Histopathological changes in skin and subcutaneous tissues at ligature site in cases of hanging and strangulation. *J Indian Acad Forensic Med.* 2009;31(3):200–4.
4. 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(4):1105J. doi:10.1520/jfs11055j.
5. Bancroft. Textbook of theory & Practice of histological techniques. 8th ed. Elsevier Publication; 2008.
6. Batra AK, Dongre AP. A Preliminary Analysis of Medico-legal Autopsies Performed over Five years in a rural Health District of Maharashtra state of India. *J Forensic Med Toxicol.* 2003;20(1):41–6.
7. Sharma BR, Harish D, Singh VP, Sigh J. Ligature Mark on the neck: how Informative? *J Indian Acad Forensic Med.* 2005;27(1):10–5.
8. Ambade VN, Godbole HV, Kukde HG. Suicidal and homicidal deaths: A comparative and circumstantial approach. *J Forensic Legal Med.* 2007;14(5):253–60. doi:10.1016/j.jcfm.2006.08.001.
9. Uzun I, Buyuk Y, Gurpinar K. Suicidal hanging: fatalities in Istanbul retrospective analysis of 761 autopsy cases. *J Forensic Leg Med.* 2007;14(7):406–415.
10. 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 Legal Med.* 2008;15(5):298–305. doi:10.1016/j.jcfm.2007.12.002.
11. Naik S, Patil DY. Fracture of hyoid bone in cases of asphyxial deaths resulting from constructing force around the neck. *J Indian Acad Forensic Med.* 2005;(3):149–53.
12. Dixit PG, Mohite PM, Ambade VN. Study of histo-pathological changes in thyroid, salivary gland and lymph nodes in hanging. *J*

- Forensic Med Toxicol.* 2001;18(2):1–4.
13. Cooke CT, Cadden GA, Margolius KA. Death by hanging in Western Australia. *Pathology.* 1995;27(3):268–72. doi:10.1080/00313029500169093.
  14. Reddy KSN. The essentials of forensic medicine and toxicology. 34th ed. Hyderabad: Om Sai Graphics; 2017.
  15. Elfawal MA, Awad OA. Deaths from Hanging in the Eastern Province of Saudi Arabia. *Med Sci Law.* 1994;34(4):307–12. doi:10.1177/002580249403400406.
  16. Samanta AK, Nayak SR. Newer trends in hanging death. *J Indian Acad Forensic Med.* 2012;34:37–9.
  17. Tabata N. Morphological changes in traumatized skeletal muscle: the appearance of 'opaque fibers' of cervical muscles as evidence of compression of the neck. *Forensic Sci Int.* 1998;96(2-3):197–214. doi:10.1016/s0379-0738(98)00125-x.
  18. Nikolić S, Milovanović P, Živković V. “Banding” esophagus: circumferential bruising due to ligature neck constriction or circumferential hypostasis due to rapid death? *Forensic Sci Med Pathol.* 2015;11:143–4. doi:10.1007/s12024-014-9594-z.
  19. Hejna P. Amussat's Sign in Hanging-A Prospective Autopsy Study. *J Forensic Sci.* 2011;56(1):132–5. doi:10.1111/j.1556-4029.2010.01548.x.
  20. Kumar V. Histopathological Study of Carotid Trauma In Strangulation Deaths. *J Indian Acad Forensic Med.* 2013;35(2):102–5.
  21. Ghodake D, Mohite S, Desai H. Histopathological Study of Carotid Arteries in Deaths due to Hanging. *Medico-Legal Update.* 2014;14(1):82. doi:10.5958/j.0974-1283.14.1.020.
  22. Nikolić S, Milovanović P, Živković V. “Banding” esophagus: circumferential bruising due to ligature neck constriction or circumferential hypostasis due to rapid death? *Forensic Sci Med Pathol.* 2015;11:143–4. doi:10.1007/s12024-014-9594-z.
  23. Saukko P, Knight B. Arnold Publishers. 2016.

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