



# Histopathological Examination Findings in Ligature Mark in Post-Mortem Cases of Asphyxial Deaths: A Prospective Study

Dr. Kunal Khanna <sup>1</sup>, Dr. Jitender Kumar Jakhar <sup>\*2</sup>, Dr. Tarun Dagar <sup>3</sup>, Titiksha <sup>4</sup>, Dr. Meenu Gill <sup>5</sup>,  
Dr. Vijay Pal <sup>6</sup>, Dr. Gajender Yadav <sup>7</sup>

<sup>1</sup>Associate Professor, Department of Forensic Medicine & Toxicology, Kalpana Chawla Govt. Medical College Karnal, Haryana, India.

<sup>2</sup>Professor, Department of Forensic Medicine & Toxicology, Pt. B. D. Sharma PGIMS, Rohtak, Haryana, India.

<sup>3</sup>Assistant Professor, Department of Forensic Medicine & Toxicology, Kalpana Chawla Govt. Medical College Karnal, Haryana, India.

<sup>4</sup>Undergraduate, Sidhartha Medical College, Vijayawada, Andhra Pradesh, India.

<sup>5</sup>Professor, Department of Pathology, Pt. B. D. Sharma PGIMS, Rohtak, Haryana, India.

<sup>6</sup>Professor & Head, Department of Forensic Medicine & Toxicology, Kalpana Chawla Govt. Medical College Karnal, Haryana, India.

<sup>7</sup>Medical Officer, Forensic Medicine & Toxicology, District Hospital, Rewari, Haryana, India.

\*Corresponding author: Dr. Jitender Kumar Jakhar; [jjakhar2008@gmail.com](mailto:jjakhar2008@gmail.com)

Received 11 March 2024;

Accepted 13 April 2024;

Published 17 April 2024

## Abstract

**Background:** Hanging and ligature strangulation are violent forms of asphyxia deaths. Forensic histopathology of these cases, a microscopic analysis of various changes at cellular or tissue level helps to find out the cause of death including solving a crime mystery. **Aim & objectives:** To differentiate between the cases of hanging and ligature strangulation by histo-pathological examination of skin and subcutaneous tissues of ligature mark. To differentiate between ante-mortem and post-mortem hanging by studying the histo-morphological features of ligature mark. **Material & methods:** Skin and subcutaneous tissues of ligature mark in 64 post-mortem cases brought for autopsy with alleged history of hanging and ligature strangulation are studied in a tertiary care centre of Haryana. 60 cases were of hanging while 04 were of ligature strangulation. **Results:** Out of 60 cases of hanging, compression was present in 59 (98%) cases, breaking in 58 (96%) cases, wrinkling in 55 (92%) cases, and all three were present in 53 (88%) cases. All three features were also present in 04 (100%) cases of strangulation. And out of 60 cases of hanging, congestion was present in 51 (85%) cases, infiltration in 38 (63%) cases, haemorrhage in 34 (57%) cases and all three were present in 25 (41%) cases. All three features were also present in 04 (100%) cases of strangulation. **Conclusion:** The present study emphasizes the implementation of histopathological examination of skin in all the cases of asphyxial death where compression of neck took place, as a routine procedure. It concludes that a detailed evaluation of the gross and histopathological findings of the neck structures, if undertaken as a routine would be more conclusive in establishing the cause and manner of death to aid the administration of justice.

**Keywords:** *Ligature, Asphyxia, Thyroid Cartilage, Congestion.*

## Introduction

Skin is the external body surface consisting of epidermis, dermis and hypodermis. The histology of various layers of skin reveals that epidermis is proliferating stratified squamous epithelium, dermis consists of fibrous and fibro-adipose tissue and hypodermis consists of adipose tissue (Young B et al., 2014). Gordon et al., 1982 suggested that a portion of skin and deeper tissue in relation to the

ligature mark should be examined microscopically for evidence of tissue reaction. Careful and detailed microscopic examination may reveal the presence of effusion of red cells but no evidence of tissue reaction, which takes some hours to develop.

The histopathological changes in skin beneath the ligature mark are breaking (discontinuity of epidermal and dermal layers), wrinkling (increase in waviness of epidermal and dermal layers) and compression (decreased thickness with increase basophilia). The

subcutaneous tissue shows congestion (increased blood volume in tissue), haemorrhages and cellular infiltration of neutrophils (Sharma et al., 2018). In asphyxia death due to hanging, subcutaneous tissue under ligature mark is usually dry, white and glistening, more marked, if the body has been suspended for a long time. The presence of tissue reaction in such an event would however indicate antemortem hanging. The absence of tissue reaction does not exclude antemortem hanging (Modi JP, 2018). Meticulous dissection and sharp distinction between hanging and strangulation is warranted during autopsy. Histopathology of various neck tissues can help to sort out this.

The present study was planned to determine the most common histopathological finding of skin and subcutaneous tissue beneath the ligature mark differentiating the pattern of ligature mark in cases of asphyxial deaths due to compression of neck by ligature in hanging and ligature strangulation along with the analysis of these histopathological findings.

**Material and methods**

The present prospective observational study was carried out during medico-legal autopsies on the cases of deaths in 64 post-mortem

cases brought for autopsy with alleged history of hanging and ligature strangulation in a tertiary care centre of Haryana. 60 cases were of hanging while 04 were of ligature strangulation. Samples of skin and subcutaneous tissues beneath the ligature mark were taken from autopsy cases. A portion of skin and subcutaneous tissue from the most prominent area of ligature mark was excised. The excised specimen was preserved in 10 % formalin after autopsy and sent for histo-pathological examination in Deptt. of Pathology, PGIMS, Rohtak. In histo-pathological examination, numbers of sections were taken from different sites according to the size of specimen. Then these representative sections were subjected for processing and automatic tissue processor. After processing the section was embedded in paraffin, cut with microtome at 5 mm thickness and was stained with haematoxylin and Eosin (H&E) stain and slides were examined.

**Observations and results**

The skin and subcutaneous tissue of ligature mark were subjected to histopathological examination and observations were recorded as per Performa. The data were compiled and tabulate as follows:

**Table: 1. Age wise distribution of cases.**

Sr. No.	Age (years)	Number of cases of Hanging (n=60)	Percentage	Number of cases of Strangulation (n=04)	Percentage
1	11-20	10	17%	01	25%
2	21-30	24	40%	01	25%
3	31-40	17	28%	0	0
4	41-50	06	10%	02	50%
5	51-60	02	03%	0	0
6	>60	01	02%	0	0
	Total	60	100%	04	100%

Table 1 shows that out of 60 cases of hanging, 24 (40%) cases were from the age group of 21 to 30 years, followed by 17 (28%) cases of the age group 31 to 40 years, 10 (17%) cases were from the age group of 11 to 20 years and 1(2%) victim belonged to >60 years age group. Out of 04 cases of ligature strangulation, 02 cases were from age group of 41 to 50 years, 1 (25%) case was from the age group of 11 to 20 years while 1 (50%) case was from the age group of 21 to 30 years.

**Table: 2. Sex wise distribution of cases.**

Sr. No.	Sex	Number of cases of Hanging (n=60)	Percentage	Number of cases of Strangulation (n=04)	Percentage
1	Male	47	78%	03	75%
2	Female	13	22%	01	25%
	Total	60	100%	04	100%

Table 2 depicts that out of 60 cases of hanging, males were 47 (78%) and females were 13 (22%). Out of 04 cases of ligature strangulation, 03 (75%) were male and the other 1 (25%) was female.

**Table: 3. Distribution of cases of Hanging and Strangulation as per the histopathology of skin of ligature mark (i.e. compression, wrinkling and breaking).**

Sr. No.	Histopathology of skin of ligature mark	Number of cases of Hanging (n=60)	Percentage	Number of cases of Strangulation (n=04)	Percentage
1	Compression	59	98%	04	100%
2	Wrinkling	55	92%	04	100%
3	Breaking	58	96%	04	100%
4	All three	53	88%	04	100%

Table 3 depicts that out of 60 cases of hanging, compression was present in 59 (98%) cases, breaking was present in 58 (96%) cases, wrinkling was present in 55 (92%) cases, and all three were present in 53 (88%) cases. All three features were also present in 04 (100%) cases of strangulation.

**Table: 4. Distribution of cases of Hanging and Strangulation as per the histopathology of subcutaneous tissues of ligature mark (i.e. congestion, infiltration, haemorrhage).**

Sr. No.	Histopathology of subcutaneous tissues of ligature mark	Number of cases of Hanging (n=60)	Percentage	Number of cases of Strangulation (n=04)	Percentage
1	Congestion	51	85%	04	100%
2	Infiltration	38	63%	04	100%
3	Haemorrhage	34	57%	04	100%
4	All three	25	41%	04	100%

Table 4 depicts that out of 60 cases of hanging, congestion was present in 51 (85%) cases, infiltration was present in 38 (63%) cases, haemorrhage was present in 34 (57%) cases and all three were present in 25 (41%) cases. All three features were also present in 04 (100%) cases of strangulation.

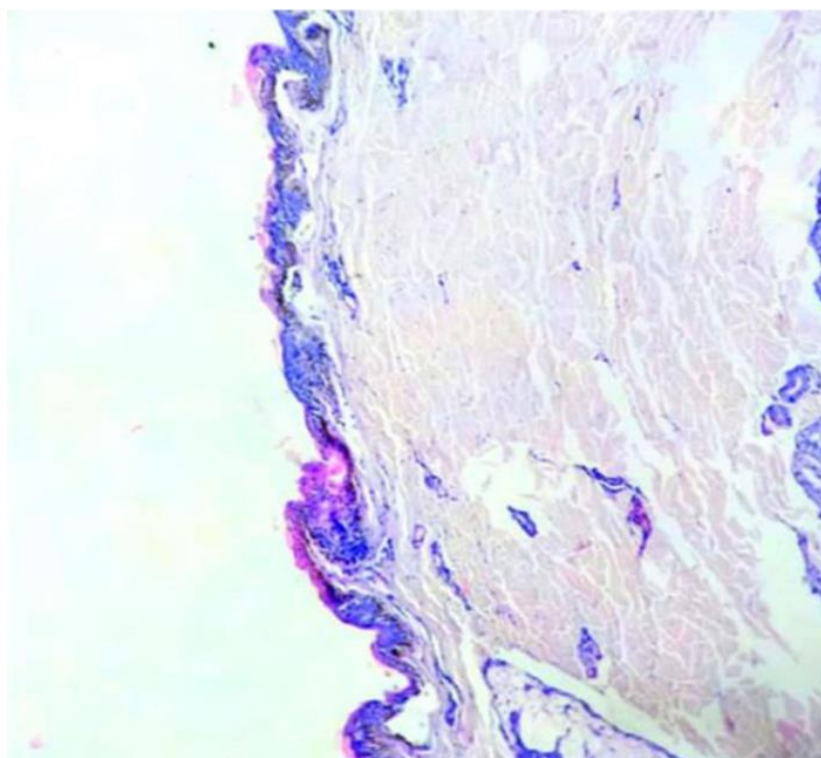
**Discussion**

The present prospective study was carried out during medico-legal autopsies on the cases of deaths due to hanging and ligature strangulation conducted in the Department of Forensic Medicine and Toxicology, PGIMS, Rohtak. The ligature mark in hanging and strangulation was examined extensively in detail. Inspection, palpation and internal examination followed by histopathological examination have to be carried out in an orderly manner.

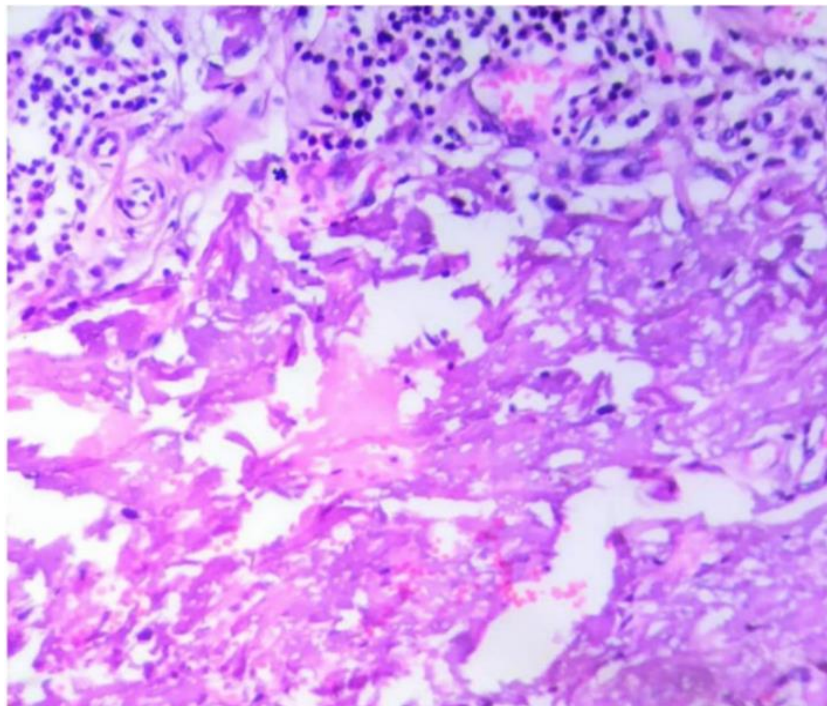
It is observed that on histopathological examination of skin of ligature mark, compression was present in 59 (98%) cases, breaking was present in 58 (96%) cases, wrinkling was present in 55 (92%) cases, and all three were present in 53 (88%) cases of hanging. All three features were also present in 04 (100%) cases of strangulation (**Figure 1**). The presence of these alterations in the skin, either alone or in various permutations and combinations, suggests that mechanical compression of neck has taken place. The various features of mechanical cutaneous changes are highly suggestive to determine antemortem aspects since these histopathological features indicate that the violent compression of neck took place. It was further observed that the microscopic changes were positive irrespective of ligature mark being complete / incomplete or faint / obvious. Yadav et al. 2009 observed compression (43.95%), breaking (35.10%), wrinkling (46.15%) in cases of hanging. Chandrakanth et al., 2012 observed compression (67.5%), wrinkling (40%), breaking (30%) in cases of hanging.

These findings were observed in larger percentage of cases in this study. In cases of strangulation, similar findings of compression (100%) were observed by Yadav et al., 2009 and Chandrakanth et al., 2012. Other findings are showing differences because these findings were observed in a smaller number of cases in these studies and in this study also.

This study depicts that on histopathological examination of subcutaneous tissues beneath the ligature mark, congestion was present in 51 (85%) cases, infiltration was present in 38 (63%) cases, haemorrhage was present in 34 (57%) cases and all three were present in 25 (41%) cases of hanging. All three features were also present in 04 (100%) cases of strangulation. A portion of the skin and deeper tissue in relation to the ligature mark are examined microscopically for evidence of tissue reaction. The changes are observed as congestion, cellular infiltration and haemorrhage in subcutaneous tissues of ligature mark (**Figure 2**). Presence of these changes indicates antemortem hanging. The absence of tissue reaction and lack of congestive changes however cannot be taken as evidence that the body was hanged after death. Similar findings were observed by Yadav et al., 2009 in cases of hanging while Chandrakanth et al., 2012 observed only congestion in 85% cases of hanging. Similar findings were observed by Yadav et al., 2009 and Chandrakanth et al., 2012 in 100% cases of strangulation except infiltration which was observed in 66.6% cases by Yadav et al., 2009 while it was observed also in 100% cases in this study.



**Figure 1: Showing skin under ligature mark showing compression, wrinkling and breaking (10x)**



**Figure 2: Subcutaneous tissues under ligature mark showing congestion, haemorrhage and infiltration (40x)**

## Summary

In the present study, most common histopathological finding of skin beneath the ligature mark is compression of skin in cases of both hanging (98%) and strangulation (100%). All three features i.e. compression, wrinkling and breaking were present in (88%) cases of hanging and (100%) cases of strangulation. Most common histopathological feature of subcutaneous tissues beneath the ligature mark in cases of hanging is congestion (85%) followed by infiltration (63%). All three parameter i.e. congestion, infiltration and haemorrhage were present in (41%) cases of hanging and in all (100%) cases of strangulation.

## Conclusion

In this study, on histopathological examination of skin of ligature mark, overlapping of one or more histopathological findings is a common feature in cases of hanging and these findings are present in all cases of strangulation. It is a useful tool in faint ligature mark in both hanging and strangulation where microscopic changes are positive irrespective of ligature mark being complete/ incomplete or faint/obvious.

The present study emphasizes the implementation of histopathological examination of skin in all the cases of asphyxial death where compression of neck took place, as a routine procedure. It concludes that a detailed evaluation of the gross and histopathological findings of the neck structures, if undertaken as a routine would be more conclusive in establishing the cause and manner of death to aid the administration of justice.

In present study, using the histopathological examination of the skin and subcutaneous tissues of ligature mark to decide the antemortem or postmortem nature is not of conclusive value. Hence, this gives wide scope of other methods like enzyme histochemistry and immune histochemistry markers which could play a vital role in deciding the nature of ligature mark as antemortem and postmortem.

## Data Availability

Data would be available upon reasonable request by the corresponding author.

## Conflicts of Interest

The authors have no conflict of interest

## Funding Statement

Not Applicable

## Authors' contributions

All authors equal contribution.

## References

- [1] Young B, O Dowd G, Woodford P. Wheater's Functional Histology: A Text and Colour Atlas. 6<sup>th</sup> ed. Philadelphia: Elsevier; 2014.
- [2] Vij K. Textbook of Forensic Medicine and Toxicology. 5<sup>th</sup> ed. New Delhi: Elsevier; 2011.
- [3] Sharma N, Shrivastava A, Vyas PC. A study of morphology and histopathology of ligature marks in asphyxial deaths by compression of neck in Jodhpur region, Rajasthan. *J Medi Sci and Clinical Res.* 2018;6(6):923-929.
- [4] Modi JP. Deaths from Asphyxia, In: Kannan K, Mathiharan K (eds). *A Textbook of Medical Jurisprudence and Toxicology.* 24<sup>th</sup> ed. Gurgaon: Lexis Nexis; 2012.p.448.
- [5] Yadav A, Gupta BM. Histopathological changes in skin and subcutaneous tissues at ligature site in cases of hanging and strangulation. *J Indian Academy of Forensic Medi.* 2009; 31(3):200-204.
- [6] Chandrakanth HV, Pramod Kumar GN, Arun M, Shetty S, Patel S and Balaraj BM. Compression injuries of neck: a microscopic analysis of skin and subcutaneous tissues. *Indian J Forensic Medi and Pathol.* 2012;5(1):5-8.



**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated

otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2024