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MACROSCOPIC AND HISTOPATHOLOGICAL EXAMINATION OF WOUND VITALITY IN CASES OF LIGATURE NECK COMPRESSION.

Forensic Medicine

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ABSTRACT

This study based on wound vitality within the context of ligature neck compression incidents. Analyzing a sample size of 30 cases, we explore the macroscopic and histopathological facets of these events, shedding light on potential associations and implications. The demographic profile of cases reveals a prevalence of individuals aged 21-40 years (60%) and a majority of male subjects (73.3%). Socio-economic categorization places the highest number of cases within lower middle class III (43.3%) and upper middle class II (30.0%). Through meticulous examination, we unearth patterns in ligature mark characteristics, identifying predominance of oblique marks (100%), reddish-brown hues (76.7%), and knot impressions (60%). Histopathological analysis exposes significant presence of extravasated red blood cells (60%) and detectable neutrophils (70%), while fibrosis is less prevalent (13.3%). Associations emerge between microscopic findings and both the duration of survival and the pattern of ligature marks, affirming the interplay between physiological responses and the nature of the incident. These findings underscore the vital importance of understanding the diverse aspects of wound vitality in ligature neck compression cases for accurate forensic interpretations and informed medical interventions.

KEYWORDS

Ligature Neck Compression; Wound Vitality; Macroscopic Analysis; Histopathological Examination

INTRODUCTION

Asphyxia and neck compression resulting in death are common in forensic practice. In India, hanging is the most prevalent form of asphyxial death caused by the suspension of the body with a ligature around the neck. Hanging can be classified based on the mode (suicidal, homicidal, accidental, judicial), degree of suspension (complete or partial), and position of the knot (typical or atypical).[1]

Differentiating between antemortem and postmortem ligature marks can be challenging. Histopathology, immunohistochemistry (IHC), and enzyme studies are used to determine vitality. Hanging damages, the neck and surrounding structures, and assessing the vitality of ligature marks is crucial in forensic investigations.[2]

During autopsy, the appearance of ligature marks depends on the ligature material and body weight. Soft materials may cause redness, while nylon ropes or wires can leave abrasions. However, the presence of a reddened hyperemic zone at the wound margins, previously considered a sign of vitality, is now questionable.[1,2]

Hanging causes rapid hypoxic brain damage and death, limiting subsequent wound reactions. Histopathology reveals classic signs of vitality, such as extravasations of red blood cells and hemoglobin. Inflammatory cell infiltration, particularly polymorphonuclear neutrophils (PMN), helps differentiate recent pre-mortem wounds from post-mortem injuries.[3]

This study aims to investigate histopathological changes in tissues subjected to ligature neck compression using conventional staining techniques. Understanding the vitality of wounds through histopathology and IHC plays a crucial role in forensic investigations.

MATERIAL AND METHOD: -

This descriptive cross-sectional study was conducted at the mortuary of Lok Nayak Hospital to investigate the histopathological characteristics of ligature neck compression cases. Thirty cases were selected based on inclusion criteria, excluding those with decomposed or charred bodies. Written informed consent was obtained from legal guardians, and routine autopsies were performed on cases of hanging and strangulation. External morphological features of ligature marks were documented, followed by the collection of tissue specimens from the ligature mark, peri-ligature area, and undamaged skin. Hematoxylin and eosin staining, along with Masson's trichrome staining, were performed on the specimens. Microscopic examination using a light microscope was conducted, and expert pathologist opinions were sought in case of discrepancies. Data analysis employed IBM SPSS-25 software and Microsoft Excel, utilizing appropriate statistical tests. This study contributes valuable insights to the field of forensic pathology by enhancing our understanding of histopathological changes in ligature neck compression cases.

Ethical Considerations:

Informed consent was obtained from relatives of the deceased at the time of post-mortem examination. Ethical committee approval was obtained from Institutional Ethical Committee.

RESULTS:

In this study of ligature neck compression, a total of 30 cases were examined to understand the various aspects related to wound vitality, ligature mark characteristics, histopathological findings, and their associations.

Demographic And Macroscopic Analysis:

Among the 30 cases, the majority (60%) fell within the age group of 21-40 years, with 18 cases. The age group of less than 20 years accounted for 20% of the cases (6 cases). The mean age of all cases was calculated to be 31.8 years. In terms of gender distribution, males constituted 73.3% of the cases (22 cases). Socio-economic classification revealed that 43.3% of cases (13) belonged to class III, signifying a lower middle socio-economic status. Class II, indicating an upper middle socio-economic group, represented 30% of the cases.(Table No 1)

Characteristics Of Hanging:

In all 30 cases, suicide was determined to be the alleged cause of hanging. Complete hanging was observed in 83.3% of cases (25), while the rest were categorized as incomplete hanging. The primary ligature material employed was cotton rope in 66.7% of cases (20),

followed by plastic rope or wire in 13.3% (4).

Ligature Mark Characteristics:
Ligature marks were consistently present in all cases. The most common type of ligature mark observed was oblique. The location of the ligature mark was predominantly above and over the thyroid in 90% of cases (27). The pattern of the ligature mark was clear in 60% of cases (18) and faint in 23.3% (7). Parchmentization or dryness of the ligature mark was noted in 70% of cases (21). The ligature mark color was predominantly reddish-brown (76.7% - 23 cases), and knot impressions were found in 60% of cases (18). (Table No 2)

Histopathological Findings:
On hematoxylin and eosin staining, 60% of cases (18) exhibited extravasated red blood cells. Neutrophils were detectable in 70% of cases, while mast cells were present in 26.7% of cases. Congested vessels were observed in 43.3% of cases. Fibrosis was identified in only 13.3% of cases, as seen on Masson's Trichrome staining, whereas it was absent in the majority (86.7%). (Table No 3)

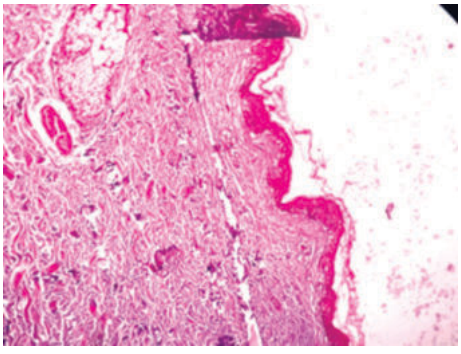

Figure 1 On H&E Stain showing congestion and RBC's Extravasation

Association Of Microscopic Findings:
Mast cells and fibrosis displayed a significant association with the duration or period of survival. Mast cells were most prevalent (37.5%) in cases with over 5 days of survival, followed by 12.5% in cases with survival periods of 3-5 hours and 3-5 days. Fibrosis was observed in 25% of cases surviving 3-5 days and in 75% of cases surviving more than 5 days.(Table 4)

Microscopic Findings And Ligature Mark Characteristics:
Microscopic findings did not show significant associations with the completeness of the ligature mark, the color of the ligature mark, or its location relative to the thyroid. However, the presence of neutrophils was significantly associated with parchmentization/dryness (p-value 0.05). Moreover, the color of the ligature mark was notably associated with the presence of neutrophils (p-value 0.01), as well as congested vessels (p-value 0.01). Neutrophils and extravasated red blood cells demonstrated significant associations with knot impressions (p-value 0.01). (Table 5.1 to 5.5)

Microscopic Findings And Ligature Pattern:
Microscopic changes were most prominent in cases with a clear ligature pattern, showing significant associations with the presence of mast cells (p-value 0.011) and congested vessels (p-value 0.002).(Table 6)

Microscopic Findings And Fibrosis:
Fibrosis identified through Masson's Trichrome staining was observed in cases with grooving and patterned ligature patterns. This association was statistically significant (p-value <0.01). (Table 6)

These findings collectively shed light on the macroscopic and histopathological aspects of wound vitality in ligature neck compression cases, highlighting potential correlations and implications for forensic investigations and medical interventions.

DISCUSSION

In a comprehensive exploration of the subject, several studies have contributed to the understanding of ligature neck compression. Yadav's et al[4] study highlighted age distribution, with the highest cases occurring in the 21-30 age group, followed by 11-20 and 31-40 groups. Similarly, Sharma et al.'s[5] investigation showed a preponderance in the 21-30 age group (44.23%), followed by 31-40 years (27.88%) and 11-20 years (15.38%), noting 16 years as the least represented age. Shalender Kumar et al.[6] study similar pattern with the 20-29 age group exhibiting the highest frequency. The present study, encompassing 30 cases, revealed a majority (60%) within the 21-40 age group, followed by those below 20 years (20%), with a mean age of 31.8 years. These findings were consistent with our study.

In terms of gender distribution, Shalender Kumar et al. [6] study indicated a male predominance. Our study aligned with this trend, with 73.3% of cases being males. Socio-economic classification showed the highest proportion (43.3%) in class III, indicative of lower-middle status, followed by 30.0% in the upper-middle class.

Regarding the nature of hanging, findings from Sharma et al.'s[5] research and our study consistently confirmed suicide as the primary cause, with our autopsy studies confirming this unequivocally. Notably, a significant proportion of cases (46.7%) demonstrated a probable survival time of less than an hour, followed by 30.0% in the 1-3 hour range.

Our study and those from Sharma et al[5] and Shalender K et al[6] underscored hanging's prevalence. Complete hanging was prominent, accounting for 83.3% in our study, aligning with 81% in the Sharma et al[5] study and 91.56% in the Shalender K et al[6]. Ligature materials varied, with cotton rope (66.7%) and plastic rope/wire (13.3%) being the most common in our research.

Microscopic examination further enriched the findings. Extravasated red blood cells (60%) and detectable neutrophils (70%) were prominent, while fibrosis was observed in 25% and 75% of cases with survival durations of 3-5 days and over 5 days, respectively. Mast cells were notably associated with survival duration, with the majority being present (37.5%) in cases surviving more than 5 days. The presence of neutrophils and extravasated RBCs significantly correlated with knot impressions. All these findings were consistent with studies done by Yadav A et al[4], Balazic J et al[7], Kara S et al[8], Capatina Co et al[9] and Betz P et al[10].

CONCLUSION:

In conclusion, this study meticulously investigated the intricate aspects of ligature neck compression cases, contributing to the growing body of knowledge in the field of forensic medicine. The study's findings resonated with and extended existing research, shedding light on age distribution, gender disparities, socio-economic dynamics, ligature mark attributes, hanging characteristics, and microscopic changes. The prevalence of cases within the 21-40 age group, predominantly among males, underscores the vulnerability of this demographic to such incidents. The socio-economic patterns observed hint at potential external stressors that could contribute to these unfortunate occurrences. Ligature mark characteristics, including shape, color, and presence of knot impressions, provide crucial insights into the mechanics of hanging.

Table 1: Distribution of cases according to socio demographic characteristics (N = 30).

Socio demographic charecteristics	Number of cases	Percentage (%)
Age groups		
<20	6	20.0
21-40	18	60.0
41-60	5	16.7
>80	1	3.3
Total=	30	Mean Age(years)-31.8
Sex of the case		
Male	22	73.3
Female	8	26.7
Socio-economic status		
Lower (V)	1	3.3
Upper Lower (IV)	7	23.3
Lower Middle (III)	13	43.3
Upper Middle (II)	9	30.0

Table 2: Distribution of cases according to details of hanging. (N = 30)

Particulars	Categories/types	Number of cases (%)
Manner of hanging	Suicide	30 (100.0%)

Type of hanging	Complete	25 (83.3%)
	Incomplete	5 (16.7%)
Ligature material	Cotton rope	20 (66.7%)
	Chunni	2 (6.7%)
	Dhoti cloth	1 (3.3%)
	Gamccha	1 (3.3%)
	Nylon rope	1 (3.3%)
	Plastic rope/wire	4 (13.3%)
	Saree	1 (3.3%)
Ligature mark	Present	30 (100.0%)
Type of ligature mark	Oblique	30 (100.0%)
	Horizontal	0
Location of ligature mark w.r.t Thyroid	Over	3 (10.0%)
	Over and above	27 (90.0%)
Pattern of ligature mark	Clear	18 (60.0%)
	Faint	7 (23.3%)
	Grooving	3 (10.0%)
	Patterned	2 (6.7%)
Parchmentisation/ Dryness	Present	21 (70.0%)
	Absent	9 (30.0%)
Color	Pale	7 (23.3%)
	Reddish brown	23 (76.7%)
Knot impression	Present	18 (60.0%)
	Absent	12 (40.0%)

Table 3: Distribution of cases according to presentation on hematoxylin & eosin staining. (N = 30)

H & E staining		Number of cases (%)
Neutrophil	Present	21 (70.0%)
	Absent	9 (30.0%)
Extravasated RBCs	Present	18 (60.0%)
	Absent	12 (40.0%)
Mast cells	Present	8 (26.7%)
	Absent	22 (73.3%)
Congested vessels	Present	13(43.3%)
	Absent	17(56.7%)
Masson's trichome	Fibrosis Present	4(13.3%)
	Fibrosis Absent	26(86.7%)

Table 4: Association of probable time of survival with microscopic findings. (N = 30)

Time duration	Microscopic changes				p-value
		Present	Absent	Total	
<1 hour	Neutrophils	9(42.9%)	5(55.6%)	14(46.7%)	0.60
1-3 hours		5(23.8%)	4(44.4%)	9(30.0%)	
3-5 hours		2(9.5%)	0(0.0%)	2(6.7%)	
3-5 days		2(9.5%)	0(0.0%)	2(6.7%)	
>5 days		3(14.3%)	0(0.0%)	3(10.0%)	
<1 hour	Extravasated RBCs	9(50.0%)	5(41.7%)	14(46.7%)	0.14
1-3 hours		4(22.2%)	5(41.7%)	9(30.0%)	
3-5 hours		2(11.1%)	0(0.0%)	2(6.7%)	
3-5 days		0(0.0%)	2(16.7%)	2(6.7%)	
>5 days		3(16.7%)	0(0.0%)	3(10.0%)	
<1 hour	Mast cells	0(0.0%)	14(63.6%)	14(46.7%)	<0.01
1-3 hours		1(12.5%)	8(36.4%)	9(30.0%)	
3-5 hours		2(25.0%)	0(0.0%)	2(6.7%)	
3-5 days		2(25.0%)	0(0.0%)	2(6.7%)	
>5 days		3(37.5%)	0(0.0%)	3(10.0%)	
<1 hour	Congested vessels	6(46.2%)	8(47.1%)	14(46.7%)	0.41
1-3 hours		3(23.1%)	6(35.3%)	9(30.0%)	
3-5 hours		2(15.4%)	0(0.0%)	2(6.7%)	
3-5 days		0(0.0%)	2(11.8%)	2(6.7%)	
>5 days		2(15.4%)	1(5.9%)	3(10.0%)	
<1 hour	Fibrosis	0(0.0%)	14(53.8%)	14(46.7%)	<0.01
1-3 hours		0(0.0%)	9(34.6%)	9(30.0%)	
3-5 hours		0(0.0%)	2(7.7%)	2(6.7%)	
3-5 days		1(25.0%)	1(3.8%)	2(6.7%)	
>5 days		3(75.0%)	0(0.0%)	3(10.0%)	

Table 5.1: Association of type of ligature mark with microscopic findings. (N = 30)

		Microscopic changes			p-value
		Present	Absent	Total	
Complete	Neutrophil	18(85.7%)	7(77.8%)	25(83.3%)	0.48
Incomplete		3(14.3%)	2(22.2%)	5(16.7%)	
Complete	Extravasated RBCs	15(83.3%)	10(83.3%)	25(83.3%)	0.68
Incomplete		3(16.7%)	2(16.7%)	5(16.7%)	
Complete	Mast cells	7(87.5%)	18(81.8%)	25(83.3%)	0.59
Incomplete		1(12.5%)	4(18.2%)	5(16.7%)	
Complete	Congested vessels	12(92.3%)	13(76.5%)	25(83.3%)	0.26
Incomplete		1(7.7%)	4(23.5%)	5(16.7%)	
Complete	Fibrosis	4(100.0%)	21(80.8%)	25(83.3%)	0.46
Incomplete		0(0.0%)	5(19.2%)	5(16.7%)	

Table 5.2: Association of location of ligature mark with microscopic findings. (N = 30)

Location w.r.t Thyroid		Microscopic changes			P value
		Present	Absent	Total	
Over	Neutrophil	2(9.5%)	1(11.1%)	3(10.0%)	0.67
Over and above		19 (90.5%)	8(88.9%)	27(90.0%)	
Over	Extravasated RBCs	2(11.1%)	1(8.3%)	3(10.0%)	0.65
Over and above		16 (88.9%)	11 (91.7%)	27 (90.0%)	
Over	Mast cells	1(12.5%)	2(9.1%)	3(10.0%)	0.62
Over and above		7(87.5%)	20(90.9%)	27(90.0%)	
Over	Congested vessels	1(7.7%)	2(11.8%)	3(10.0%)	0.60
Over and above		12 (92.3%)	15(88.2%)	27(90.0%)	
Over	Fibrosis	0(0.0%)	3(11.5%)	3(10.0%)	0.64
Over and above		4 (100.0%)	23(88.5%)	27(90.0%)	

Table 5.3: Association of Parchmentization/dryness of ligature mark with microscopic findings. (N = 30)

Parchmentisation/ Dryness		Microscopic changes			P value
		Present	Absent	Total	
Present	Neutrophil	4(13.3%)	5(16.7%)	9(30.0%)	0.05
Absent		17(56.7%)	4(13.3%)	21(70.0%)	
Present	Extravasated RBCs	4(13.3%)	5(16.7%)	9(30.0%)	0.23
Absent		14(46.7%)	7(23.3%)	21(70.0%)	
Present	Mast cells	1(3.3%)	8(26.7%)	9(30.0%)	0.21
Absent		7(23.3%)	14(46.7%)	21(70.0%)	
Present	Congested vessels	2(6.7%)	7(23.3%)	9(30.0%)	0.13
Absent		11(36.7%)	10(3.3%)	21(70.0%)	
Present	Fibrosis	0(0.0%)	9(30.0%)	9(30.0%)	0.21
Absent		4(13.3%)	17(56.7%)	21(70.0%)	

Table 5.4: Association of color of ligature mark with microscopic findings. (N = 30)

Color		Microscopic findings			P value
		Present	Absent	Total	
Pale	Neutrophil	2(6.7%)	5(16.7%)	7(23.3%)	0.014
Reddish brown		19(63.3%)	4(13.3%)	23(76.7%)	
Pale	Extravasated RBCs	2(6.7%)	5(16.7%)	7(23.3%)	0.068
Reddish brown		16(53.3%)	7(23.3%)	23(76.7%)	
Pale	Mast cells	0(0.0%)	7(23.3%)	7(23.3%)	0.084
Reddish brown		8(26.7%)	15(50.0%)	23(76.7%)	
Pale	Congested vessels	0(0.0%)	7(23.3%)	7(23.3%)	0.010
Reddish brown		13(43.3%)	10(33.3%)	23(76.7%)	
Pale	Fibrosis	0(0.0%)	7(23.3%)	7(23.3%)	0.323
Reddish brown		4(13.3%)	19(63.3%)	23(76.7%)	

Table 5.5: Association of knot impression with microscopic findings. (N = 30)

Knot Impression		Microscopic changes			P value
		Present	Absent		
Present	Neutrophil	5(23.8%)	7(77.8%)	12(40.0%)	0.01
Absent		16(%)	2(22.2%)	18(60.0%)	
Present	Extravasated RBCs	2(11.1%)	10(83.3%)	12(40.0%)	0.01
Absent		16(88.9%)	2(16.7%)	18(60.0%)	

Present	Mast cells	4(50.0%)	8(36.4%)	12(40.0%)	0.396
Absent		4(50.0%)	14(63.6%)	18(60.0%)	
Present	Congested	1(7.7%)	11(64.7%)	12(40.0%)	0.002
Absent	vessels	12(92.3%)	6(35.3%)	18(60.0%)	
Present	Fibrosis	3(75.0%)	9(34.6%)	12(40.0%)	0.163
Absent		1(25.0%)	17(65.4%)	18(60.0%)	

Table 6: Association of ligature pattern with microscopic findings. (N = 30)

Ligature Pattern	Neutrophils			p-value
	Present	Absent	Total	
Clear	14(46.7%)	4(13.3%)	18(60.0%)	0.061
Faint	2(6.7%)	5(16.7%)	7(23.3%)	
Grooving	3(10.0%)	0(0.0%)	3(10.0%)	
Patterned	2(6.7%)	0(0.0%)	2(6.7%)	
	Extravasated RBC			p-value
Clear	13(43.3%)	5(16.7%)	18(60.0%)	0.071
Faint	2(6.7%)	5(16.7%)	7(23.3%)	
Grooving	1(3.3%)	2(6.7%)	3(10.0%)	
Patterned	2(6.7%)	0(0.0%)	2(6.7%)	
	Mast cells			p-value
Clear	4(13.3%)	14(46.7%)	18(60.0%)	0.011
Faint	0(0.0%)	7(23.3%)	7(23.3%)	
Grooving	2(6.7%)	1(3.3%)	3(10.0%)	
Patterned	2(6.7%)	0(0.0%)	2(6.7%)	
	Congested vessels			p-value
Clear	11(36.7%)	7(23.3%)	18(60.0%)	0.002
Faint	0 (0.0%)	7(23.3%)	7(23.3%)	
Grooving	0 (0.0%)	3(10.0%)	3(10.0%)	
Patterned	2(6.7%)	0(0.0%)	2(6.7%)	
Fibrosis on Masson's trichome				p-value
Clear	0(0.0%)	18(60.0%)	18(60.0%)	<0.01
Faint	0(0.0%)	7(23.3%)	7(23.3%)	
Grooving	2(6.7%)	1(3.3%)	3(10.0%)	
Patterned	2(6.7%)	0(0.0%)	2(6.7%)	

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