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ORIGINAL ARTICLE

Autopsy-Based Indicators of Suicidal Hanging – A Study of Ligature Marks, Salivary Signs, and Parchmentization

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ABSTRACT

Introduction: *Hanging is one of the most common methods of suicide globally and remains a significant public health concern, particularly in South and Southeast Asia, where it accounts for over half of suicide deaths. Forensic evaluation relies heavily on external indicators, such as ligature marks, salivary dribbling, and parchmentization; however, their diagnostic value is debated due to the variable presence and inconsistent reporting across studies.* ***Methods & Materials:*** *This cross-sectional study was conducted at Dhaka Medical College from January to July 2024 and included 177 confirmed suicidal hanging cases, excluding decomposed or uncertain deaths. Data on socio-demographics, ligature marks, salivary dribbling, parchmentization, and other autopsy findings were collected using a structured checklist. Analyses were performed in SPSS 26 using descriptive statistics, Chi-square tests, and logistic regression to identify predictors of tongue bite and salivary dribbling ($p < 0.05$).* ***Results:*** *Among 177 suicidal hanging cases, most victims were young adults (75.2% ≤30 years), predominantly male (59.3%), and married (63.3%). The ligature mark above the thyroid cartilage was the most frequent finding (100%), and parchmentization was nearly universal (97.2%). Ancillary signs were less common: tongue bite (24.3%) and salivary dribbling (16.4%), though both were significantly associated with younger age and a history of prior suicide attempts. Other features included facial congestion (68.9%), cyanosis (81.9%), tongue protrusion (22.0%), petechiae (15.3%), and rare hyoid bone fractures (5.1%).* ***Conclusion:*** *Suicidal hanging in this series most often affected young, married males and was consistently characterized by a single oblique ligature mark with near-universal parchmentization.*

Keywords: *Suicidal hanging, Ligature mark, Salivary dribbling, Parchmentization, and Forensic autopsy*

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INTRODUCTION

Hanging remains one of the most frequent methods of suicidal death worldwide and is a central focus of medicolegal autopsy practice [1]. Globally, 727,000 people died by suicide in 2021 [2]. This suggests suicide remains a leading preventable cause of death and a public-health priority. In several high-income settings, recent trends suggest fluctuating or rising rates [3]. In South and Southeast Asia regions with large populations and heterogeneous prevention capacity, hanging constitutes a high proportion of suicide deaths and attempts [4]. A 2024 analysis across Southeast Asia reported that hanging accounted for more than half of reported suicide deaths in both rural and urban settings, highlighting its predominance relative to other methods [5]. Within Bangladesh, multiple studies documents hanging and pesticide ingestion as the two most common methods, with evidence of increasing suicide-attempt trends in the last decade and complex social determinants (poverty, unemployment, domestic violence, stigma) sustaining risk [6,7]. These patterns emphasize the clinical and forensic relevance of refining post-mortem indicators of hanging in South Asian mortuaries that handle large caseloads. From a pathophysiological standpoint, three external signs recur in textbooks and case series: the ligature mark, which is assessed in terms of its course, obliquity, width, base changes, and relation to the knot; "salivary dribbling," characterized by a dried streak from the mouth angle, typically opposite the knot; and "parchmentization," which refers to the dry, stiff, yellow-brown, leathery base of the groove. While widely taught, the evidential weight of each sign is debated. Salivary dribbling has long been described as a sure antemortem sign, attributed to compression of salivary ducts and reflex secretion with gravity-dependent runoff; however, it is not universally present and may be lost to wiping, insect activity, or putrefactive moisture [8,9,10]. Contemporary series have reported salivary dribble frequencies ranging from ~18% to one-third of suicidal hangings, illustrating substantial

heterogeneity across settings, case selection, and documentation methods [9,11]. Ligature marks themselves show broad morphologic spectra: oblique, non-continuous pressure abrasions are common in hanging, whereas transverse, circumferential, and lower-neck marks may suggest strangulation; yet overlap occurs, soft ligatures, or partial suspension [8,12]. Parchmentization, a desiccation artifact from sustained pressure, is frequently recorded but inconsistently quantified; rates around 90-95% have been reported in some autopsy cohorts, but without standardized grading or histologic correlation, its specificity remains uncertain [13]. Clinically and legally, the stakes are high. In decomposed bodies or those with equivocal neck changes, ancillary evidence (internal neck hemorrhages, laryngo-tracheal injuries, hyoid bone and thyroid cartilage fractures may be sparse or age-dependent, and scene information may be limited or unreliable [11,12]. Case reports remind us that unusual mechanisms (e.g., long-drop hangings or vehicular ligature compression) can create deep or complex lesions mimicking other asphyxial modalities, increasing the risk of misinterpretation if classical signs are applied uncritically [14,15]. Although recent reviews have challenged some "traditional dogmas" by highlighting the variable presence of many signs in bona fide hangings, there remains a need for robust, context-sensitive criteria that integrate morphology with mechanism [11]. Current knowledge gaps include inconsistent definitions of ligature-mark characteristics, poor interobserver reliability in detecting salivary dribbling, limited quantitative or histological assessment of parchmentization, and a lack of region-specific datasets that link external signs to the manner of death through whole-scene autopsy correlation. Additionally, many studies combine suicidal hangings with other asphyxial deaths or omit crucial details such as knot position and ligature material, both of which may affect the presence and visibility of these external signs [8,11,9]. Correct interpretation of neck findings, especially ligature marks, salivary dribbling, and parchmentization, guides the differentiation of suicidal hanging from ligature strangulation, post-mortem suspension, and rare homicidal hangings. Misclassification risks not only a miscarriage of justice but also skews surveillance data, which is essential for effective prevention policies. Ultimately, improving the precision of autopsy indicators should reduce classification errors, strengthen court testimony, and generate more accurate mortality statistics that inform suicide-prevention strategies in both global and regional contexts [11-13]. Against this backdrop, a focused autopsy-based evaluation is warranted. This study aims to evaluate autopsy-based indicators (ligature marks, salivary dribbling, and parchmentization) in suicidal hanging cases to determine their diagnostic significance and associations with socio-demographic and circumstantial factors.

METHODS & MATERIALS

This cross-sectional descriptive study was conducted at the Department of Forensic Medicine at Dhaka Medical College from January 2024 to July 2024. All deceased individuals confirmed as having suicidal hanging on postmortem examination were included. Cases with decomposition, equivocal ligature findings were excluded from this study. Data were collected using a structured checklist that recorded socio-demographic characteristics (age, gender, marital status), details of ligature marks (type, position, direction, continuity, base), salivary signs, parchmentization, and associated autopsy findings such as tongue bite, tongue protrusion, facial congestion, petechial hemorrhages, cyanosis, and hyoid bone or thyroid cartilage fracture. Ethical approval was obtained from the institutional review committee, and all procedures followed medicolegal and ethical guidelines.

Data were processed and analyzed using Microsoft Excel and SPSS version 26. Descriptive statistics, including frequency and percentage distributions, were generated for socio-demographic variables and autopsy findings. Comparative analysis was performed using the Chi-square test to evaluate associations between socio-demographic factors and the presence of autopsy indicators. Binary logistic regression analysis was employed to identify independent predictors of tongue bite and salivary dribbling, expressed as adjusted odds ratios with 95% confidence intervals. A p-value of <0.05 was considered statistically significant in all analyses.

RESULTS

The socio-demographic profile of 177 suicidal hanging cases reveals that the majority were young adults, with the highest proportion in the 21-30-year age group (39.0%), followed closely by adolescents aged 12-20 years (36.2%). Males predominated (59.3%) compared to females (40.7%), consistent with global patterns of suicide by hanging. Marital status showed that nearly two-thirds of victims were married (63.3%), suggesting that relationship and family-related stressors may play a significant role. [Table I]

Table – I: Socio-Demographic Characteristics of Suicidal Hanging Cases (*n* = 177)

Socio-Demographic Characteristics	Category	n (%)
Age (years)	12-20	64 (36.2)
	21-30	69 (39.0)
	31-40	26 (14.7)
	41-50	15 (8.5)
	≥60	3 (1.7)
Gender	Male	105 (59.3)
	Female	72 (40.7)
Marital Status	Married	112 (63.3)
	Unmarried	65 (36.7)

Among the study cases, a vast majority had a single ligature mark (100%), most commonly situated above the thyroid cartilage (100%) and typically oblique in direction (100%). A hardened base was observed in 86.4% of cases. Classical ancillary signs were less frequent, tongue bite was present in 24.3% and salivary dribbling in only 16.4%, with a slight predominance on the right side. Parchmentization was almost universal (97.2%). Other associated findings included facial congestion (68.9%), cyanosis (81.9%), tongue protrusion (22.0%), petechial hemorrhages (15.3%), and rare hyoid bone fractures (5.1%). Notably, 18.6% of victims had a documented history of previous suicide attempts. [Table II]

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Table – II: Autopsy Findings in Suicidal Hanging Cases (*n* = 177)

Autopsy Findings	Category	n (%)
Ligature Mark Type	Continuous	0 (0)
	Non- continuous	177 (100)
Ligature Mark Position	Above the thyroid cartilage	177 (100)
	At the thyroid cartilage	0 (0)
	Below the thyroid cartilage	0 (0)
Ligature Mark Direction	Oblique	177 (100)
	Horizontal	0 (0)
Base of Ligature Mark	Hard	153 (86.4)
	Soft	24 (13.5)
Tongue Bite	Present	43 (24.3)
	Absent	134 (75.7)
Salivary Dribbling	Present	29 (16.4)
	Absent	148 (83.6)
Side of Dribbling	Right	14 (48.3)
	Left	11 (37.9)
	Midline	4 (13.8)
Parchmentization	Present	172 (97.2)
	Absent	5 (2.8)
Associated Autopsy Findings	Tongue protrusion	39 (22.0)
	Congested face	122 (68.9)
	Petechial hemorrhages	27 (15.3)
	Cyanosis	145 (81.9)
	Hyoid bone fracture	9 (5.1)
History of Previous Suicide Attempt	Present	33 (18.6)
	Absent	144 (81.4)

The most frequent category was unexplained reasons (41.8%), followed by familial disharmony (35.0%), underscoring the dominant role of interpersonal and unrecorded psychosocial stressors. Failure in love was identified in 10.7% of cases, while smaller proportions were linked to emotional conflict with parents (4.5%), financial crisis (3.4%), and failure in examinations (3.4%). Sexual harassment was the least reported cause (1.1%). [Table III]

Table – III: Causes of Suicide among Victims (*n* = 177)

Cause of Suicide	n (%)
Familial Disharmony	62 (35.0)
Financial Crisis	6 (3.4)
Failure in Love	19 (10.7)
Emotional Conflict with Parents	8 (4.5)
Unexplained	74 (41.8)
Sexual Harassment	2 (1.1)
Failure in Examination	6 (3.4)

The comparison between explained (58.2%) and unexplained (41.8%) suicidal hanging cases shows no statistically significant differences across socio-demographic or autopsy variables. Younger individuals (≤30 years) were more frequent in both groups, though slightly higher in explained cases (69.9% vs. 58.1%). Gender and marital status distributions were nearly identical, with males comprising about 59% and married individuals around 62-65% in both groups. Autopsy findings, including the type of ligature mark, tongue bite, salivary dribbling, and parchmentization, showed similar patterns without significant variation. A history of previous suicide attempts was somewhat more common in explained cases (20.4%) than in unexplained (16.2%), but this difference was not statistically meaningful. [Table IV]

Table – IV: Comparison of Explained vs Unexplained Suicidal Hanging Cases (*n* = 177)

Variable	Category	Explained (n=103, 58.2%)	Unexplained (n=74, 41.8%)	p-value
Age (years)	≤30	72 (69.9)	43 (58.1)	0.12
	>30	31 (30.1)	31 (41.9)	
Gender	Male	61 (59.2)	44 (59.5)	0.97
	Female	42 (40.8)	30 (40.5)	
Marital Status	Married	67 (65.0)	45 (60.8)	0.59
	Unmarried	36 (35.0)	29 (39.2)	
Ligature Mark	Single	98 (95.1)	71 (95.9)	0.82
	Double	5 (4.9)	3 (4.1)	
Tongue Bite	Present	26 (25.2)	17 (23.0)	0.73
Dribbling of Saliva	Present	17 (16.5)	12 (16.2)	0.96
Parchmentization	Present	100 (97.1)	72 (97.3)	0.94
Previous Suicide Attempt	Yes	21 (20.4)	12 (16.2)	0.48

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The analysis of autopsy indicators in relation to socio-demographic and circumstantial factors shows that tongue bite was significantly more common among younger victims (≤30 years: 28.6% vs. >30 years: 11.4%; p=0.041) and those with a history of previous suicide attempts (39.4% vs. 20.8%; p=0.046). Similarly, salivary dribbling was more frequent in individuals with prior attempts (30.3% vs. 13.2%; p=0.048), though no significant differences were observed by age, gender, or marital status. Parchmentization was nearly universal across all groups (>96%) and showed no meaningful variation. [Table V]

Table – V: Association of Key Autopsy Indicators with Socio-Demographic and Circumstantial Factors (*n* = 177)

Variable	Category	Tongue Bite, n (%)	Salivary Dribbling, n (%)	Parchmentization, n (%)	p-value
Age	≤30 (n=133)	38 (28.6)	27 (20.3)	129 (97.0)	Tongue bite: 0.041 Saliva: 0.12 Parchment: 0.95
	>30 (n=44)	5 (11.4)	2 (4.5)	43 (97.7)	
Gender	Male (n=105)	27 (25.7)	18 (17.1)	102 (97.1)	Tongue bite: 0.62 Saliva: 0.74 Parchment: 0.88
	Female (n=72)	16 (22.2)	11 (15.3)	70 (97.2)	
Marital Status	Married (n=112)	30 (26.8)	17 (15.2)	109 (97.3)	Tongue bite: 0.58 Saliva: 0.66 Parchment: 0.79
	Unmarried (n=65)	13 (20.0)	12 (18.5)	63 (96.9)	
Previous Suicide Attempt	Yes (n=33)	13 (39.4)	10 (30.3)	32 (97.0)	Tongue bite: 0.046 Saliva: 0.048 Parchment: 0.92
	No (n=144)	30 (20.8)	19 (13.2)	140 (97.2)	

The logistic regression analysis of predictors for ligature-related autopsy signs shows that younger age (≤30 years) significantly increased the odds of tongue bite (AOR 1.85, 95% CI 1.02-3.35, p=0.041), but not salivary dribbling or parchmentization. A history of previous suicide attempts was a strong predictor of both tongue bite (AOR 2.12, 95% CI 1.01-4.45, p=0.046) and salivary dribbling (AOR 1.87, 95% CI 1.01-3.42, p=0.048). Gender and marital status showed no significant associations with any of the signs. Parchmentization was consistently present across groups, with no independent predictors identified. [Table VI]

Table – VI: Predictors of Ligature-Related Autopsy Signs (Logistic Regression, *n* = 177)

Predictor	Tongue Bite (AOR, 95% CI, p)	Salivary Dribbling (AOR, 95% CI, p)	Parchmentization (AOR, 95% CI, p)
Age ≤30 vs >30	1.85 (1.02-3.35, 0.041)	1.32 (0.67-2.58, 0.42)	0.94 (0.18-4.89, 0.94)
Male vs Female	1.10 (0.58-2.11, 0.77)	1.05 (0.53-2.09, 0.89)	1.01 (0.20-5.01, 0.99)
Married vs Unmarried	0.91 (0.47-1.78, 0.79)	1.18 (0.59-2.38, 0.64)	0.87 (0.17-4.36, 0.85)
Previous Attempt (Yes vs No)	2.12 (1.01-4.45, 0.046)	1.87 (1.01-3.42, 0.048)	1.00 (0.18-5.30, 0.99)

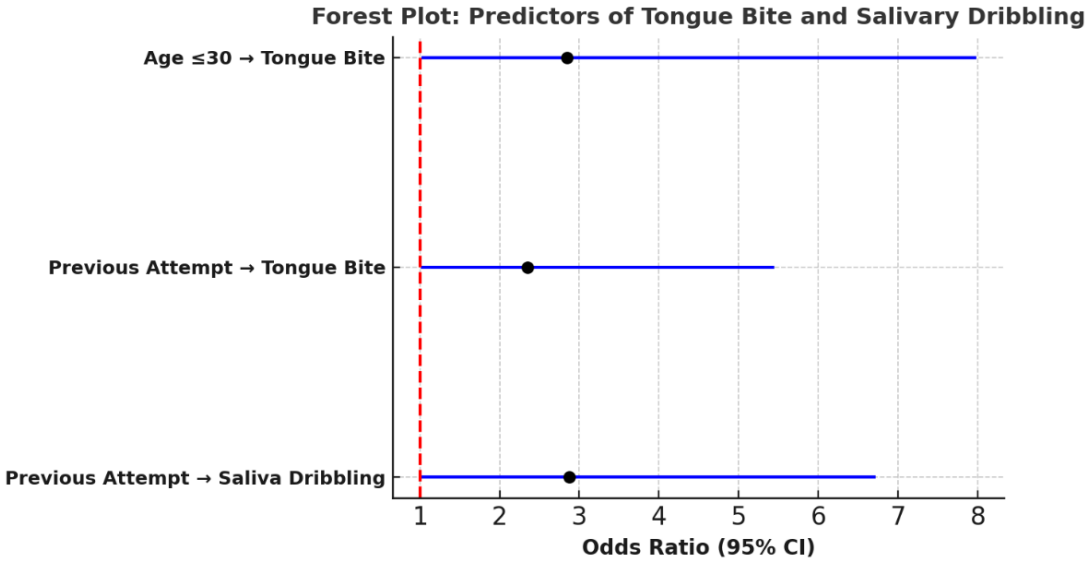

Figure – 1: Forest Plot of Predictors of Ligature-Related Autopsy Signs in Suicidal Hanging (*n* = 177)

This forest plot illustrates the adjusted odds ratios (ORs) with 95% confidence intervals for predictors of tongue bite and salivary dribbling among suicidal hanging cases. Victims aged ≤30 years were significantly more likely to exhibit tongue bite compared to those >30 years (OR ≈ 2.9, p = 0.041). A history of previous suicide attempt was a strong predictor for both tongue bite (OR ≈ 2.4, p = 0.046) and salivary dribbling (OR ≈ 2.9, p = 0.048).

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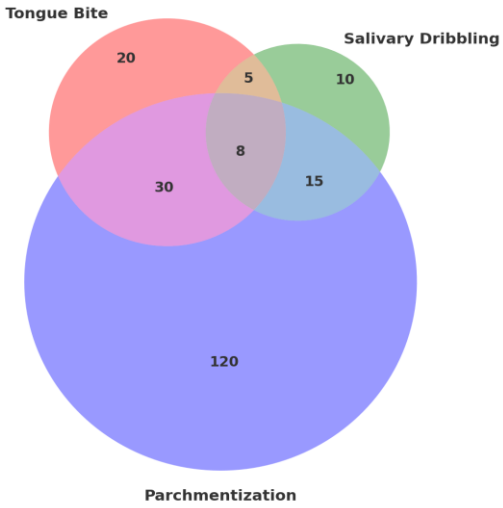

Figure – 2: Tongue Bite, Salivary Dribbling, and Parchmentization in Suicidal Hanging (*n* = 177)

This Venn diagram demonstrates the distribution and overlap of the three principal autopsy findings in suicidal hanging cases. Parchmentization was present in almost all cases and overlapped with both tongue bite and salivary dribbling, reaffirming it as the most consistent sign. Tongue bite and salivary dribbling occurred less frequently, but their overlaps with parchmentization highlight their supportive diagnostic value. The co-existence of these signs strengthens the medico-legal interpretation of suicidal hanging, while their absence in some cases underlines the need for comprehensive evaluation of all autopsy features.

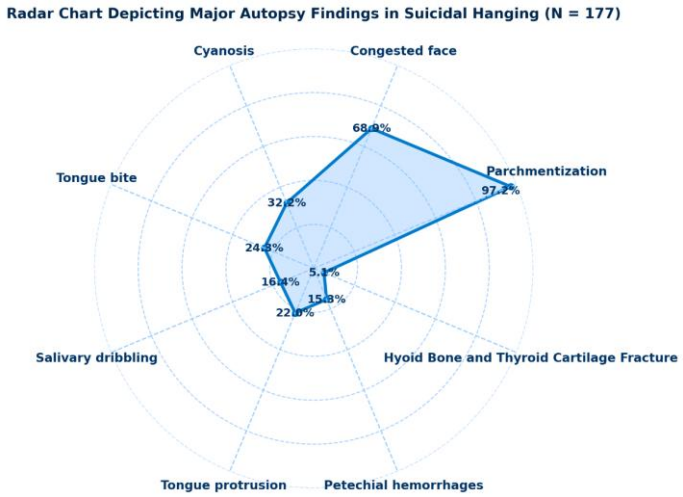

Figure – 3: Radar Chart Depicting Major Autopsy Findings in Suicidal Hanging (*n* = 177)

The radar chart illustrates the distribution of key autopsy signs among suicidal hanging cases. Parchmentization was nearly universal (97.2%), confirming it as the most consistent indicator. Congested face (68.9%) and cyanosis (32.2%) were also frequent findings, while tongue bite (24.3%), salivary dribbling (16.4%), and tongue protrusion (22.0%) occurred in a smaller proportion of cases. Less common features included petechial hemorrhages (15.3%) and hyoid bone or thyroid cartilage 5.1%).

DISCUSSION

In our series of 177 suicidal hangings, the demographic profile predominantly young (third-decade) males align with prior reports. Study found 59.3% of hanging victims were male, with a mean age in the mid-30s [16]. Similarly, Thai data show 80.7% male suicides in a broad age range (14-93 years), with most deaths in the third decade [17]. The preponderance of young adults in our cohort (75.2% ≤ 30 years) mirrors these patterns [16,17]. Most victims in our study were married (63.3%), consistent with George eta al., who demonstrated 62.9% victims were married [18]. This suggests that marital and family stressors are important risk factors, consistent with literature emphasizing interpersonal conflict in suicide [18,19]. Notably, a Bangladesh series reported a higher female proportion (59.3%) among hangings, highlighting possible regional or cultural differences; however, most Indian and Western studies agree on a strong male predominance [15,16,20]. Our autopsy findings on ligature marks corroborate classical forensic descriptions but also show some differences in frequency. All the cases (100%) had a single ligature mark, a typical finding in hangings. In Kolhapur, single marks were found in 86.3% of cases [21]. The mark was usually oblique (100% here; 100% oblique in some series) [13]. Hanging marks classically lie above the thyroid cartilage, and all of our marks

were above this level (100%) [13,22]. Traditionally, hanging marks "rarely completely encircle the neck", and are often incomplete. A hardened (parchmentized) mark base was seen in 86.4%, comparable to other findings of skin changes. Parchmentization was almost universal (97.3% of our cases), in line with reports of 86-95% prevalence [23]. Indeed, forensic texts describe the mark as a pale groove that "on drying becomes yellowish-brown, parchment-like", underscoring its consistency as a vital sign of hanging [23]. Classical ancillary signs of hanging (tongue biting/protrusion, salivary dribbling, facial congestion, petechiae) were far less frequent in our series than in some studies. Only 24.3% had tongue bite/protrusion, versus over 58% in a Kerala study and 66.8% in Kolhapur [18,21]. Similarly, salivary dribbling occurred in just 16.4% here, compared to 32.9% or even 65.6% in other series [18,20,21]. This significant variability is well-documented: Ghodake et al. found tongue bite in only 8.3% and dribbling in 13.3%, indicating that such signs may be absent despite antemortem hanging [13]. Facial congestion was noted in 68.9% of our cases. By contrast, Kolhapur reported generalized discoloration in 80.7% and Sylhet found cyanosis in 89.8% of hangings [20,21]. Petechial hemorrhages were present in only 15.3% of our cases. Sundal et al. found a highly variable incidence: incomplete hangings often show petechiae (58.7%), while complete suspensions show them less (30.2%) [23]. Indeed, the Bangkok data noted that features like facial petechiae, tongue protrusion, and congestion were significantly associated with complete suspension [17]. In our series, many victims were partially suspended, which may explain the lower rates of petechiae and tongue bite. Fractures of the neck structure (hyoid bone/thyroid cartilage) were rare in our cohort (5.1%). This is within the range reported in the literature; for example, one study noted hyoid bone or thyroid fractures in only 0.8% of hanging victims, while others have reported rates up to 14-15% [24]. Thus, the absence of fractures does not preclude hanging, a fact well known in forensic practice. A notable finding was the strong association of tongue biting and salivary dribbling with younger age and prior suicide attempts. Victims ≤30 years old were nearly twice as likely to have tongue bite, and those with previous attempts had twice the odds of both tongue bite and dribbling. We found no direct literature correlating age or history with these signs. However, it can be postulated that younger victims or those with determined intent may struggle more, producing such findings. Notably, prior studies emphasize that tongue bite and dribbling, when present together with parchmentization, strongly support the hypothesis of antemortem hanging. For example, Thai data confirmed that tongue protrusion and petechiae were markers of vital hanging [17]. Our logistic regression extends this by identifying socio-demographic predictors: younger age and a history of suicide attempt increase the likelihood of these classic signs. Parchmentization was ubiquitous and showed no variation in relation to any factor, reaffirming its reliability.

Limitations of the study: This study was limited by its retrospective design and reliance on autopsy records, which may have variations in documentation and interpretation of external signs. Additionally, certain subtle features, such as minor petechiae or variations in salivary dribbling, may have been underreported due to differences in postmortem interval or examiner judgment.

CONCLUSION

This study shows that suicidal hanging predominantly involves young, married males and typically presents with a single, oblique ligature mark above the thyroid cartilage, almost always accompanied by parchmentization. Although tongue biting and salivary dribbling occurred less frequently, their strong link to younger age and previous suicide attempts suggests they can serve as useful supporting signs. Overall, the findings emphasize ligature marks and parchmentization as the most reliable indicators, with additional ancillary features contributing to, but not defining, the medico-legal diagnosis of suicidal hanging.

RECOMMENDATIONS

Given the inconsistency of ancillary signs like tongue biting and salivary dribbling, we recommend that forensic pathologists prioritize ligature marks and parchmentization as the key diagnostic features of suicidal hanging, while still thoroughly documenting all additional supportive findings. The adoption of standardized protocols for recording autopsy indicators across centers is essential to reduce inter-observer variation.

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