

## A prospective study of the pattern of ligature marks and its correlation with the manner of death

Anil Shandil<sup>1</sup>, Shiv Ranjan Kumar<sup>2</sup>, Shabbir Ahmad Choudhary<sup>3</sup>, Sanjeev Kumar<sup>4\*</sup>, Mukesh Prasad<sup>5</sup>

<sup>1</sup>Associate Professor, Forensic Medicine & Toxicology, Patna Medical College, Patna, Bihar, India

<sup>2</sup>Assistant Professor, Forensic Medicine & Toxicology, Patna Medical College, Patna, Bihar, India

<sup>3</sup>Post Graduate student (3rd year), Forensic Medicine & Toxicology, Patna Medical College, Patna, Bihar, India

<sup>4</sup>Post Graduate student (2nd year), Forensic Medicine & Toxicology, Patna Medical College, Patna, Bihar, India

<sup>5</sup>Assistant Professor, Forensic Medicine & Toxicology, IGIMS, Patna, Bihar, India

Received: 10-07-2021 / Revised: 11-08-2021 / Accepted: 26-09-2021

### Abstract

**Background:** Deaths resulting from hanging show features amongst which the ligature mark in the neck is considered to be decisive. **Aim:** To study the pattern of ligature marks and to correlate the ligature mark with the manner of death. **Materials and Methods:** The sample for this study consisted of 80 cases of hanging which were reported during the study period along with detailed information regarding the deceased and the circumstances of death was collected from the police and relatives. **Results:** Maximum number of suicidal hangings occurred in the age group of 20 to 29 years (mean=24.5). Numbers of hanging deaths in the men were more than the women. **Conclusion:** A distinct ligature mark furrow/groove of the width and pattern of the material used is observed in cases where a narrow and tough or hard ligature material is employed. Also in cases of complete hanging prominent ligature marks are observed.

**Keywords:** Hanging, Ligature mark, Asphyxial deaths, Ligature material, Unnatural deaths.

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### Introduction

A violent asphyxial death is one of the most important causes for unnatural deaths amongst which hanging and strangulation are commonly encountered in day to day autopsy. Hanging is that form of asphyxia, which is caused by suspension of the body by a ligature around the neck, the constricting force being the weight of the body [1]. Deaths resulting from hanging show features amongst which the ligature mark in the neck is considered to be decisive. The ligature mark is a pressure abrasion on the neck at the site of the ligature which appears as a groove. Character of the ligature mark depends on various factors like the nature of the ligature, body weight, length of time the body has remained suspended and the number of turns of the ligature round the neck. The course of the ligature mark depends on whether a fixed or running noose has been used. However variations in the ligature marks like faint / absent ligature mark, ligature mark artefacts (ex: ant bite marks) and other variables like a circular mark if the material is tied round the neck are encountered in day to day autopsies. Sometimes there may be double ligature marks. It may be due to slippage of the ligature. If the ligature is tied two or three times round the neck and then goes up to the knot, in addition to encircling marks, there is an inverted V shaped mark. This

is confusing to those not familiar with the combination of such marks who may associate the lower (horizontal) marks with ligature strangulation and the upper one with hanging. The ligature mark may be faint if a soft material is used or if the ligature is cut immediately after the hanging. It is easy to diagnose hanging when one finds the classical features. However all features are seldom present together. The application of pressure on the neck often results in findings, which are quite variable. Thus the ligature mark around the victim's neck constitutes an extremely precious piece of evidence to arrive at a conclusion as to cause of death and manner of death.[2]

Therefore, this study was conducted with an aim to study the pattern of ligature marks and to correlate the ligature mark with the manner of death.

### Materials and methods

The present study was carried out in the Department of Forensic Medicine and Toxicology, at Patna Medical College and Hospital, Patna. The study was approved by the institutional ethical and research committee. The study was conducted over a period of 02 years from January 2019 to December 2020.

A sum total of 80 cases were selected in this prospective study. Detailed information regarding the deceased and the circumstances of death was collected from the police and relatives. In some of the instances, this information was supplemented by either, visit to scene of occurrence or from the photographs of scene of occurrence.

### Inclusion criteria

All the cases brought with a history of hanging.

### Exclusion criteria

Decomposed bodies where the ligature mark is masked.

The hanging victims were classified on various characteristics as follows:

\*Correspondence

Dr. Sanjeev Kumar

Post Graduate student (2nd year), Forensic Medicine & Toxicology, Patna Medical College, Patna, Bihar, India.

E-mail: [coolsanjurk@gmail.com](mailto:coolsanjurk@gmail.com)

Type of suspension:

1. Complete.
2. Partial.

Type of ligature mark produced:

1. Typical.
2. Atypical.

Observations made during the autopsy included external examination and internal examination of the deceased. The ligature material was studied, whenever the ligature material was in situ. The ligature

materials were classified into two groups: Hard ligature materials and soft ligature materials. Ropes, metallic chains, etc were considered as hard. While saree, dupatta, lungi and towel etc were considered to be soft ligature materials.

External examination of the neck was conducted to study the ligature mark/s. Skin over the ligature mark was sent to department of Pathology for histopathological examination to note the nature of ligature mark as antemortem or postmortem.

**Table 1: Classification of ligature marks based on the topographical location of the highest level of the ligature mark is as below**

Table 1: Topographical location of the ligature mark	
Level I	Right front of neck.
Level I, II	Below right ear.
Level II	Right back of neck.
Level II, III	Center of back (occipital, typical ligature mark)
Level III	Left back of neck.
Level III, IV	Below left ear.
Level IV	Left front of neck.

## Results and Discussion

### Age and Sex distribution in the study population

It is observed from the above table that maximum number of hangings in the study population are seen in the age group 20-29 years (38%) followed by 10-19 years (25%) and 30-39 years (23%). In the sex distribution pattern males accounted for 47 cases (59%) as compared to 33 cases (41%) in females. Table 1 & 2.

Table 2: Age			
Sl. No	Age (years)	No. of cases	%
1	10-19	20	25
2	20-29	30	38
3	30-39	18	23
4	40-49	7	9
5	50-59	3	4
6	> 60	2	1
	Total	80	100

Table 3: Sex			
Sl. No	Sex	No. of cases	%
1	Male	47	59
2	Female	33	41
	Total	80	100

The influencing factors for the above distribution being unemployment, love disappointment, marital disharmony, financial problems, dowry harassment etc.

Similar findings were observed in the studies conducted by B.K. Sen Gupta[3], Gary. P. Paparo and Siegel. H[4], Andrew Davison and Marshall T.K.[5], Ryk James and Paul Sillock s[6], A. Momonchand, Th. Meera Devi and L.Fimate[7] G.A. Sunil Kumar Sharma, O.P. Murthy, T.D. Dogra[8].

It is in contrast to the findings observed by James L. Luke,[9] David A.L.L Bowen[10]. For these studies were done in developed countries, where in there is ample employment opportunities, westernized culture and good governmental support programmes.

### Distribution in the study population according to the type of hanging

In the present study it is observed that complete suspension were noted in 63 cases (79%) as compared to 17 cases (21%) of partial suspension. Table 4

Atypical ligature mark were noticed in 69 cases (86%) as compared to typical ligature mark in 11 cases (14%). Table 5

Table 4: Degree of Suspension			
Sl. No	Degree of Suspension	No. of cases	%
1	Partial	17	21
2	Complete	63	79
	Total	80	100

Table 5 : Ligature Mark			
Sl. No	Ligature mark	No. of cases	%
1	Typical	11	14
2	Atypical	69	86
	Total	80	100

The above observations were similar to the findings observed by Andrew Davison and Marshall T.K.[5] Jorn Simonson,[11] Elfawal M.A, O.A. Awad,[12]Feigin Gerald,[13].The influencing factors being the majority of the study population were adult individuals who had committed suicides and hence more number of complete hanging. The position of the knot or any intervening object like clothings, bony projections (angle of the jaw), long plaits in Indian women and also the beard accounted for the majority of the mark being atypical. It is in contrast to the findings observed by Gary P. Paparo,[4] I. Morild,[14] Jonathan P. Wyatt, Wyatt P.W., Squires T.J., Busuttil A[15]. Balabantaray J.K[16].The reasons being that their study population was restricted to victims of lower age group, who had been either victims of accidental hanging or homicidal hanging.

#### Distribution in the study population with respect to the ligature material used

In the present study in 44 cases (55%) soft ligature material like lungi, duppatta, saree etc. were used and in 36 cases (45%) hard ligature material like nylon rope in 12 cases, electric cord in 3 cases, coir rope in 20 cases, plastic binder in 1 case. Table 6

TABLE 6: Ligature Materials Used			
Sl. No	Materials used	No. of victims	%
1	Soft	44	55
2	Hard	36	45
	Total	80	100

Similar findings were observed in the studies conducted by G.A. Sunil Kumar Sharma, O.P. Murthy and T.D. Dogra[8], Jitendra K. Balabantaray,[16] B.K. Sen Gupta[3]. Because the suicidee uses readily and easily available ligature material.

It is in contrast to the findings observed by Jonathan P. Wyatt, Wyatt P.W., Squires T.J., and Busuttil A.[15], Feigin Gerald,[13] the reasons being usage of dogs lead, dressing gown cord, electric cable, suit case webbing, telephone cord, shoes strings, Bath robe belt etc. were used as ligature materials.

#### Distribution in the study population according to the position and type of the knot

In the present study it is observed that in 23 cases (28%) the knot was in the right occipital region, in 19 cases (23%) it was below the right ear, in 18 cases (22%) it was in the left occipital region, in 14 cases (18%) occipital knot, in 5 cases (8%) below the left ear and in 1 case (1%) below the chin. Right and left and occipital positioning of knot were considered as posterior hangings, knot marks on the left and right anterior aspect of the neck below the ears were considered anterior hangings. Table 7

Table 7 : Position of the knot			
Sl. No	Position of the Knot	No. of victims	%
1	Right occipital	23	28
2	Below the right ear	19	23
3	Left occipital	18	22
4	Occipital	14	18
5	Below the left ear	5	8
6	Below the chin	1	1
7	Others	0	0
	Total	80	100

In 44 cases (55%) running noose with a slipping knot were used and fixed knot in 36 cases (45%). Similar findings were observed in the studies conducted by Nikolic Slobodan, Micic Jelena, Atanasijevic Tatjana, Djolic Vesna, Djonic Danijela[17], Betz P. and Eisenmenger.w.[18] Jorn Simonson,[11] Jitendra K. Balabantaray[16] Table 8

Table 8 : Type of Knot			
Sl. No	Type of knot	No. of victims	%
1	Slipping	44	55
2	Fixed	36	45
	Total	80	100

#### Distribution in the study population with respect to the fracture of thyroid cartilage and hyoid bone

In the present study it is observed that in 77 cases (97%) there was no fracture of the thyroid cartilage and only in 3 cases (3%) there was a fracture of the superior horn on the left side of the thyroid cartilage. The victims being in their 4th and 5th decades of life. The reasons being complete suspension of the victim, ossification increasing with the age after 30 years, pressure over the horns exerted on to the spine because of greater traction. Similar findings were observed in the studies done by Nikolic Slobodan, Micic Jelena, Atanasijevic Tatjana, Djolic Vesna, Djonic Danijela.[17], Betz P. and Eisenmenger. S[18], Feigin Gerald,[13] Jitendra Balabantaray[16]. H. Green, James R.A., Gilbert J.D., and Byard R.W.[19], Ryk James,[6] Jorn Simonson,[11] Gary. P. Paparo.[4] Table 9

Table 9: Fracture of thyroid cartilage			
Sl. No	Fracture of thyroid cartilage	No. of victims	%
1	Present	3	4
2	Absent	77	96
	Total	80	100

In the present study in 78 cases (98%) no fracture was detected and only in 2 cases (2%) showed fracture of the greater cornu on the right side of the hyoid bone. The age of the victim more than 60 years. The reason being the fracture increases with the age, seen commonly in typical and complete hanging, in cases of highest level of ligature mark on the back of the neck, increased duration of suspension and with a thin hard ligature material. Table 10

Similar findings were observed in the studies done by A. Momonchand, Th.Meera Devi and L.Fimate[7], Ryk James,[6] C.B. Jani and B.D.Guptha,[20] M.P. Sarangi[21], Betz.P. and Eisenmenger.S.[18], Nikolic Slobodan, Micic Jelena, Atanasijevic Tatjana, Djokic Vesna, Djonic Danijela[17], Feigin Gerald,[13] I. Morild[22].

Table 10: Fracture of Hyoid bone			
Sl. No	Fracture of Hyoid bone	No. of victims	%
1	Present	2	3
2	Absent	78	97
	Total	80	100

### Conclusion

Atypical ligature marks with complete hanging out numbered typical ligature mark with partial hanging.

Soft ligature materials were commonly employed with posterior knot positioning and the type of knot commonly employed being slipping knot. A distinct ligature mark furrow/groove of the width and pattern of the material used is observed in cases where a narrow and tough or hard ligature material is employed. Also in cases of complete hanging prominent ligature marks are observed. With softer and broader ligature materials a less distinct mark is observed. Features of antemortem hanging i.e. dribbling of saliva mark, Le facie sympathique were noticed externally and in some cases the skin with ligature mark was sent for histopathological examination however the results were not conclusive regarding the nature of the ligature mark as antemortem or postmortem. All the deaths due to hanging studied were concluded as suicidal in manner based on the history, circumstantial evidence, examination of ligature material, ligature mark characters like a single, interrupted, oblique mark above the level of thyroid cartilage with slipping of the ligature mark, periligature injuries and other internal findings on dissection of the neck tissues.

### References

- C.K. Narayan Reddy. "The essentials of Forensic Medicine and Toxicology". 26<sup>th</sup> ed. Medical Book Company. Hyderabad; 2006: 296.
- Parikh C.K. "Parikh's textbook of medical jurisprudence, Forensic Medicine and Toxicology for classrooms and courtrooms". 6<sup>th</sup> edition, CBS publishers and distributors, New Delhi; 1999: 3.33-4.10.
- Sen Gupta B.K. "Studies on 101 cases of Death due to Hanging". Journal of Indian Medical Academy, 1965; 45(3): 135-139.
- Paparo G.P. and Siegel H. "Neck markings and fractures in suicidal hangings". Forensic Science International 1984; 24:27-35.
- Davison A and Marshall T.K. "Hanging in Northern Ireland- A Survey." Medicine Science and Law, 1986; 26(1): 23-28.
- Ryk James and Paul Silcocks. "Suicidal Hanging in Cardiff- A 15 Year Retrospective Study." Forensic Science International 1992; 56:167-175.
- Momonchand A., Meera Devi Th., Fimate L. "Violent asphyxial deaths in Imphal." Journal of Forensic Medicine and Toxicology, 1998; 15(1):60-64.
- G.A. Sunil Kumar sharma, O.P. Murthy, T.D. Dogra. "Study of ligature marks in asphyxial deaths of hanging and strangulation". International Journal of Medical Toxicology and Legal Medicine 2002; 4(2):21-24.
- Luke J.L. "Asphyxial Deaths by Hanging in New York City, 1964-1965." Journal of Forensic Science 1967; 12(3):359-369.
- Bowen D.A.L.L. "Hanging - A review". Forensic Science International 1982; 20: 247-249.
- Simonsen J. "Patho-anatomic findings in neck structures in asphyxiation due to hanging: a survey of 80 cases". Forensic Science International 1988; 38:83-91.
- Elfawal M.A. and Awad O.A. "Deaths from Hanging in the Eastern province of Saudi Arabia." Medicine Science and Law, 1994; 34(4):307-312.
- Feigin G. "Frequency of neck organ fractures in hanging". American Journal of Forensic Medicine & Pathology 1999; 20(2): 128-130.
- Luke J.L., Reay D.T., Eisele J.W. and Bonnell H.J. "Correlation of Circumstances with Pathological Findings in Asphyxial Deaths by Hanging: A Prospective Study of 61 cases from Seattle, WA". Journal of Forensic Sciences 1985; 30(4): 1140-1147.
- Wyatt J.P., Wyatt P.W., Squires T.J. and Busuttil A. "Hanging Deaths in Children." The American Journal of Forensic Medicine and Pathology 1998; 19(4): 343-346.
- Balabantaray J.K. "Findings in Neck Structures in Asphyxiation due to Hanging." Journal of the Indian Academy of Forensic Medicine, 1998; 20(4): 82-84.
- Nikolic Slobodan, Micic Jelena, Atanasijevic Tatjana, Djokic Vesna, Djonic Danijela. "Analysis of Neck Injuries in Hanging [Case Report]" The American Journal of Forensic Medicine and Pathology 2003; 24(2): 179-182.
- Betz P. and Eisenmenger W. "Frequency of throat-skeleton fractures in hanging". The American Journal of Forensic Medicine & Pathology 1996; 17(3): 191-193.
- Green H., James R. A., Gilbert J. D. and Byard R. W. "Fractures of the hyoid bone and laryngeal cartilages in suicidal hanging". Journal of Clinical Forensic Medicine 2000; 7(3): 123-126.
- Jani C.B. and Gupta B.D. "An autopsy study of parameters influencing injury to osteocartilaginous structures of neck in hanging". International Journal of Medical Toxicology & Legal Medicine 2002; 5(1): 4-7.
- Sarangi M.P. "Ligature Mark/s- In Forensic Pathologist's Perspective." Journal of Forensic Medicine and Toxicology 1998; 15(1): 99-102.
- Morild I. "Fractures of neck structures in suicidal hanging". Medicine Science and Law. 1996; 36(1): 80-84.

**Conflict of Interest: Nil Source of support: Nil**