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LIGATURE MARK ON NECK: HOW INFORMATIVE?

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ABSTRACT

Many a times, a ligature mark may be the only evidence available in cases of asphyxial deaths due either to hanging or strangulation. A through examination of the ligature mark and analysis of the information provided by it, is therefore, a must to arrive at the most probable cause of death and differentiate between hanging and the ligature strangulation. A retrospective study was conducted at the Department of Forensic Medicine and Toxicology, Government Medical College & Hospital, Chandigarh, between 1997 to 2004 to assess the information provided by a ligature mark in such cases. We found that deaths due to hanging constituted 3.4% of the total unnatural deaths subjected to medicolegal autopsy; young adults, of the age group 21 to 25 years accounted for the maximum cases, 27%; and the male: female ratio was 2:1. Chunni was the most common ligature material used. Majority of the victims preferred multiple knots (61%) and fixed knots (58%) and a single loop (93%). The mark was obliquely placed (98% cases) above the larynx (85% cases). In all the cases of ligature strangulation, the mark was transverse, below the level of thyroid cartilage. Imprint over the groove when present, corresponded with the ligature material used in all the cases. It was concluded that a thorough, scientific examination of the ligature mark, though not conclusive, but is the most important part of the postmortem examination of deaths due to hanging and ligature strangulation.

Keywords: Ligature mark, Strangulation, Asphyxial deaths

INTRODUCTION

Hanging is asphyxia due to constriction of neck as a result of suspension in such a manner that the weight of the body or a part of the victim's body pulls upon the ligature. The factor of suspension differentiates hanging from strangulation by ligature, the later being caused by the application of a ligature to the neck in such a way that the force acting upon it is other than the weight of the body [1]. Both, in hanging and ligature strangulation, a ligature mark may be produced by local damage to the skin of the neck due to pressure that may be associated with an additional lateral rubbing action resulting into associated abrasion. This ligature mark on the neck is of crucial diagnostic importance and requires detailed inspection with regard to its course, depth and width. Sometimes the groove retains the pattern of the ligature material (as for example, a spiral weave of the rope). Vice versa, the examination of the ligature material is an indispensable part of the autopsy [2].

The ligature mark appears as a furrow on the skin whose direction is determined by the point of suspension (knot). Depending upon the duration of suspension, the furrow is initially pale or yellow parchment like area with a rim that is congested or with slight punctiform haematomas. With time, the furrow dries & becomes brownish [3]. The narrower the ligature and the harder its material, and also, the longer the suspension time, the more detectable is the ligature mark on the skin. However, for record purposes, the contrast between the reddish and paler bands of skin can be accentuated in a properly taken photograph. To obtain this result, a number of photographs should be taken, each at a different exposure times - a technique called 'bracketing' or color saturation.

The line of congestion or the hemorrhages, which may be seen along the course of a furrow, is of interest with regards to its significance. This line was interpreted as a vital reaction by Polson [4] but

not unquestionably so by Simpson [5]. Casper [6], in an attempt to ascertain the diagnostic value of a ligature mark, experimentally suspended or strangled cadavers for varying periods of time and produced markings of different shades of yellow or brown. In some instances, these colors, along with the parchment-like changes in the skin, appeared within a few minutes after the body was suspended. In order to make the noose tight in these cases, the bodies were forcibly depressed by pressure on shoulders or by strong pulling at the feet. In one case of ligature strangulation, the mark was bluish. In no instances did he describe any reddish or pink discoloration of the skin at the ligature site.

Streaks or bands of reddened or pink tissue, distinct and apart from the natural color of the skin, when seen in cases of hanging, can be interpreted as an intra-vital reaction. These streaks and bands, in and of themselves, are not sufficient to establish a diagnosis of ante-mortem hanging. However, if in a particular case of hanging, the following three characteristics are shown by neck markings, the diagnosis of ante-mortem hanging can be made with a high degree of probability, in the absence of strong proof to the contrary [7]. This triad of characteristics consists of:

1) Streaks or bands of reddened or pink tissue;
2) A pattern that reveals the imprint of ligature; and
3) Canting or sloping of the markings upwards towards the back of neck.

An additional and corroborating quantum of proof would be the demonstration, by microscopic examination, of engorgement in the reddened and pinkish area in contrast to the adjacent non-engorged and non-hemorrhagic areas. However, it must be stressed that without the presence of reddened or pink colored neck markings, differentiation from post-mortem hanging is not possible [7]. Furthermore, the histological findings in hanging and ligature strangulation marks have mainly been studied under the aspect of vitality [8]. In this context, the significance of skin blisters has been discussed controversially [9]. In recent times, most authors have agreed that blisters in the periphery of skin marks can also be formed postmortem, especially in cases of prolonged suspension small sub- and intra-epidermal blisters filled with serous fluid and fat may form on wide skin ridges between ligature turns or at the margin of the groove. This is obviously the result of local skin compression that forces the tissue fluid not only into the depth but also towards the skin surface. In view of the vulnerability of the blisters, it is not surprising that the thin epidermal wall may easily rupture thus contaminating the ligature with serous fatty fluid. The abraded epidermal scales attached to the ligature material mostly consist of horny material derived from stratum corneum but sometimes basal layers containing cell nuclei can also be found. This can be subjected to DNA-typing [10].

It is also said that the ligature mark being mainly a post-mortem phenomenon, any inner neck structure injury indicating ligature mark intra-vitality is to be identified to establish the ante-mortem hanging [1]. However, the frequency and distribution of injury to the inner neck structures caused by hanging is not always forthcoming and the doctor conducting autopsy has to rely upon the ligature mark and the circumstantial evidence that may be misleading at times. The present study evaluates neck markings to determine whether these, in and of themselves, demonstrate characteristics suitable for a diagnosis of ante-mortem hanging.

MATERIAL & METHODS

A retrospective study of asphyxial deaths due to hanging and ligature strangulation, subjected to medicolegal autopsy by the department of Forensic Medicine, Government Medical College Hospital, Chandigarh, between 1997-2004, was carried out with a view to assess the information that a ligature-mark can provide in such deaths. History regarding the incident, age, sex, distribution of postmortem staining, absence/ presence and the material used as the ligature, the particulars of the knot and the ligature mark, etc, were obtained from the hospital records.

OBSERVATIONS

A total of 2668 medicolegal autopsies were conducted by the department during the period under study, of which 91 (3.4%) were deaths due to hanging and 04 (0.15%) were due to ligature

strangulation. The year-wise percentage of hanging cases in relation to the total autopsies was almost constant at 3% with a slight variation from 2% - 5%.

Table 1

Year-wise distribution of cases

Year	Total autopsies		Cases of hanging	
	No.	%	No.	%
1997	264	09.90	10	03.79
1998	287	10.76	09	03.14
1999	352	13.19	13	03.69
2000	387	14.51	14	03.62
2001	383	14.36	11	02.87
2002	338	12.67	07	02.07
2003	288	10.80	15	05.21
2004	369	13.83	12	03.25
Total	2668	100	91	03.41

Young adults, of the age group 21-25 years, accounted for the maximum number cases, 25 (27%); followed by the 16-20 yrs age group - 20 (22%) cases and the 26-30 yrs group - 17(19%) cases. In males, the 21-25 yrs group [17 (27%)] was followed by the 31-40 yrs group [14 (23%)] in contributing towards the maximum cases; while in females, it was the 16-20 yrs group [9 (31%)], followed by the 21-25yrs group [8 (28%)], there being no cases in the 31-40 yrs age group. 79% of female deaths occurred in the age group 16-25 yrs. Overall, males accounted for 68% cases, the male: female ratio being 2:1.

Table 2

Age and sex-wise distribution of cases

Age-Group (Yrs)	Males		Females		Total	
	No.	%	No.	%	No.	%
0-10	00	00	00	00	00	00
11-15	02	100	00	00	02	02.20
16-20	11	55	09	45	20	21.90
21-25	17	68	08	32	25	27.40
26-30	11	65	06	35	17	18.60
31-40	14	100	00	00	14	15.40
41-50	06	55	05	45	11	12.10
51-60	01	100	00	00	01	1.20
>60	00	00	01	100	01	1.20
Total	62	68.1	29	31.9	91	100

The ligature material was not present in 36 (40%) cases. In those cases, where it was present [55 (40%) cases], "chunni" was the most commonly used ligature material, 17 (31%) cases; followed by nylon rope, 10 (18%) cases and bed-sheet, etc., 09 (16%) cases. Shawl, 01 (02%) cases, was the least used ligature material.

Table 3

Ligature material

Ligature material	Cases (N=91)	
	No.	%
Absent	36	39.56
Present	55	60.44
a) Nylon rope	10	18.18
b) Jute rope	07	12.73
c) Chunni	17	30.90
d) Bed sheet, etc.	09	16.36
e) Newar	04	07.27
f) Cable wire	04	07.27
g) Electric wire	03	05.46
h) Shawl	01	01.82

Of the 55 cases in which the ligature material was present, the type of knot used was not mentioned in 19 (35%) cases. In the rest, the ligature material was tied either with a single knot, 14 (39%) or multiple knots, 22 (61%) cases. Again, the knot used was a 'Slip knot' in 17 (42%) cases and 'Fixed knot' in 19 (58%) cases.

The position of the knot, was similarly, not mentioned in 6 (11%) cases. In the rest [49 (89%) cases], the most common side was the left side neck, 21 (43%) cases; followed by the right side neck, 15 (31%) cases. Front of neck was the least preferred position for the knot, 01 (2%) cases.

Table 4

Particulars of the knot

Knot particulars	Cases (N=55)	
Type of knot	**No.**	**%**
Not mentioned	19	34.55
Mentioned	36	65.45
(a)Multiple	22	61.11
Single	14	38.89
(b) Slip	17	42.22
Fixed	19	58.78
Position of knot		
Not mentioned	06	10.90
Mentioned	49	89.09
a) Right side, neck	15	30.61
b) Left side, neck	21	42.86
c) Back, neck	12	24.49
d) Front, neck	01	02.04

The ligature mark was complete in 15 (17%) cases, there being a single loop round the neck in 85 (93%) cases. The level of the mark was above the larynx in maximum cases, 77 (85%) and below the larynx in the least no. of cases, 02 (02%), while, it was not mentioned in 07 (08%) cases. The ligature mark was obliquely placed in 89 (98%) cases. However in all the 4 (100%) cases where ligature strangulation was reported as cause of death, the ligature mark was transversely placed, below the thyroid cartilage. There were no imprints on the ligature mark, corresponding to the ligature material used, in 65 (71%) cases; however, they were present in 16 (18%) cases. There was no mention of any imprints in 10 (11%) cases.

Table 5

Particulars of the ligature-mark

Ligature mark	Cases (n=91)	
Mark	**No.**	**%**
Complete	15	16.48
Incomplete	76	83.52
Loops		
Single	85	93.41
Multiple	06	06.59
Level		
Above larynx	77	84.62
At the level of larynx	05	05.50
Below larynx	02	02.20
Not mentioned	07	07.69
Position		
Obliquely placed	89	97.80
Transversely placed	02	02.20
Transversely placed, below thyroid cartilage	04	100
Imprints		
Absent	65	71.43
Present, corresponding to ligature material	16	17.58
Not mentioned	10	10.99

DISCUSSION

The mark on the neck is the principal external sign of hanging and ligature strangulation that requires detailed inspection, bearing in mind, the possibility of coincidental signs of strangulation. The appearance of ligature mark at autopsy naturally depends on the nature and texture of the ligature material. When there is a pronounced pattern, such as the weave of a cord or plaiting of a thong, the same pattern may be imprinted into the skin. In homicide where the ligature has been removed by the perpetrator, such a pattern may be of great value in tracing its origin. When a fabric, such as a scarf, chunni, or towel has been used, the marks on the neck may be difficult to interpret. A broad flat band may leave no mark whatsoever, but it usually leaves one or more, often discontinuous, linear marks on the skin of the neck. This sharply defined mark may be misinterpreted as being caused by a narrow cord or wire because when a broad piece of cloth is tightly stretched, one or more bands appear that are under greater tension than the rest. These marks, though less well demarcated at the edges than that of a cord or rope, can cause confusion [11].

The geometry of the mark is important in interpreting the events. In hanging, the mark of a fixed loop takes the form of a groove, which is deepest opposite the knot. Here the width of the groove is about or rather less than the width of the

ligature. Skin in the groove is pale or it may be yellowish brown, and is not infrequently hard, like parchment. Any well-defined pattern in the ligature is likely to be reproduced in the groove. A thin red line of congestion or hemorrhage is likely to be present above and below the groove at some points, if not throughout the course, in case the hanging is ante-mortem. The groove nearly always lies above the larynx and its course is to be traced round the neck, although the mark is rarely as clear at the nape as at the front or sides of the neck. It takes an upward course in the region of the knot to form an inverted 'V', the apex of which corresponds with the site of the knot. In case of ligature strangulation, normally, the mark is a groove, of about the same width and about half of the thickness of the ligature in depth, which takes a horizontal course round the neck, more prominent at the front and sides than at the back, at a level which lies on or below the 'Adam's apple'. The course of the mark may be interrupted and an abrasion in the gap indicates the position of the knot [12].

A ligature, which is wound more than once round the neck will impart a corresponding complexity to the grooving, usually with red linear bruising between the grooves, where the skin has been pinched between the strands. Multiple turns thus produce a complex mark in which it may be possible to trace the number of turns but a complex ligature composed of several pieces knotted together may yield a mark that suggests multiple turns when in fact there was only one. Furthermore, any departure from the running noose or a noose fixed by a granny or reef knot calls for special care in interpretation.

Occasionally, when the ligature is still in position when the body is examined, it may appear to be deeply embedded in the skin, sometimes almost out of sight, and on its removal a deep groove may be seen in the skin. This embedding may be accentuated by edema of the tissues, especially above the ligature. Presumably, some passive transudation of tissue fluid continues even after the circulation has stopped, and as such, edema may continue to develop to some extent even after death, accentuating the depth of the groove.

There may be additional marks by way of bruising and abrasion in both hanging and strangulation, which may result either from manual strangulation, or attempted manual strangulation prior to hanging or strangulation by a ligature. Alternatively, the victim may produce them in an attempt to slacken the ligature, or rarely they may be a result of unskilled attempts at resuscitation. Furthermore, a mark may appear on the neck of an obese subject as a result of hypostasis, the skin in the natural folds of the neck remaining pale by contact flattening and hypostasis ending abruptly on each side of the fold. When the neck is extended, the resulting appearances superficially resemble those produced by a ligature. The 'mark' however, can easily be seen to coincide precisely with folds in the neck. Tight neckwear, through contact flattening, may also yield a mark that superficially resembles that of a ligature. Putrefaction, by causing swelling of the tissues, can yield appearances, which simulate strangulation by a ligature; however, if death had been due to strangulation the mark on the neck is not necessarily obliterated by putrefaction. On the contrary, the compressed skin in the mark tends to be better preserved than the skin beyond it, and even when obscured, subcutaneous hemorrhages in relation to the mark may still be found. Obviously, in these cases, the interpretation must be made with utmost care.

CONCLUSION

A careful forensic examination in asphyxia involving pressure on the neck is of great importance, even in the cases of hanging supposed to be suicidal, with the aim of ascertaining the antemortem character of the lesion and the physio-pathological mechanism of death and to exclude the possibility of murder dissimulation. Furthermore, the furrow being mainly a post-mortem phenomenon, any inner neck structure injury indicating ligature mark intravitality is to be identified to establish the antemortem hanging. However, the frequency and distribution of injury to the inner neck structures caused by hanging is not forthcoming on many occasions and the doctor conducting autopsy has to rely upon the ligature mark and the circumstantial evidence that may need to be interpreted very carefully to arrive at a possible conclusion.

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