

A Forensic Analysis of Ligature Material in Suicidal Hangings

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Abstract

Background: Suicide is one of the commonest causes of death worldwide and has a great public health effect. The cause of suicide is found to be multi-factorial in which biological, psychological, social and environmental factors act together. The choice of method depends on the accessibility and availability of the means on the spot at the time of act.

Objective: To find the choice of ligature material used by the victims, type of hanging in relation to the point of suspension and other related factors.

Materials and Methods: The present study is a retrospective analysis of 122 cases of suicidal hanging received for examination at Regional Forensic Science Laboratory, Northern Range, Dharamshala, India during five year period from September 2009 to December, 2014.

Results: Male (68.85%) outnumbered females (31.15%) in committing suicide by hanging. Most commonly used ligature material was rope (43.44%) followed by chunni/dupatta (40.16%). The nature of ligature material was soft in 52.45% cases while hard material was used in 47.54% cases. Most victims had complete suspension (83.60%). 74.59% victims preferred indoor sites. Most commonly used suspension point was iron guider (23.77%). The position of knot was observed on left side of neck in 50% cases followed by right side of neck in 23.77% cases. The ligature mark was oblique shaped in 95.08% cases.

Conclusions: The commonly used ligature was a rope with guider, ceiling fan and tree branches as the point of suspension. Rope is easily available in almost every house and is more frequently used for domestic purposes like fetching fodder, drying clothes, tying domestic animals and pets, harvesting purposes and other activities. Social, cultural and economic values must be strengthened to help reduce incidence of suicide.

Keywords: Suicidal hanging; Ligature material; Ligature points; Place; Ligature mark

Introduction

Hanging is one of the 10th leading causes of death in the world accounting for more than a million deaths annually [1]. The hanging deaths are one of the most important asphyxial types of death which are encountered in day to day life by forensic Pathologists [2]. It is a form of violent mechanical asphyxial death in which force applied to the neck is derived from a gravitational drag of the body or part of the body [3]. In India, hanging is one of the common methods of committing suicide along with poisoning, burning and drowning [4] and constituted 41.8% cases of suicides in 2014 [5]. A review of data of 56 countries found that hanging was the most common method in most of the countries, accounting for 53% of the male suicides and 39% of the female suicides. According to WHO, highest incidence of hanging was found to be 90.6 % in Kuwait and 83.1% in Lithuania among the total number of suicide cases [6,7].

Asphyxia in hanging results from compression or constriction of the neck structures by a noose or other kind of structure around the neck tightened by the weight of the body [8]. Hanging may be complete or partial depending on the position of the body at the time of hanging. In a hanging from high point of suspension when the body completely suspends above without touching the ground is called complete hanging while in a hanging from low point of suspension sometime some part of the body touches the ground is called incomplete or partial hanging. The type and position of knot play an important role in the causation of death in hanging [9].

The biological, psychological, socio-cultural, economic, and environmental factors are responsible for the causation of hangings all over the world. These factors contribute to the opportunities and limitations of choice of ligature material to be used by the person for committing suicide. Rapid urbanization, industrialization and emerging nuclear family systems are resulting in social upheaval and distress [10]. Modern period has been a period of significant development and gradual changes were noticed in the society all over the world. The traditional methods of suicide did not change with the introduction of new technologies and advancement in the society in India and vary across country. In the modern era, internet usage is growing exponentially which is not only shaping our lives but altering our brain also. The applications of Wikipedia, blog, or social networking are being used extensively and the web postings have become the interactive and self-initiated medium to acquire information about changing suicide trends in relation to methods used. In India saree, chunni, plastic rope, belt,

muffler, ropes are commonly available at home which can be used to hang themselves at any place and any time and table, stool, chair and cot were commonly used to reach the site of suspension. There are unique patterns of suicide methods in India that markedly differ from those of the West. This may be due to cross-cultural differences. In Western countries, dog chain, belt, electric cable, scarf, tie, dressing gown cord, shoe lace, etc., are used as ligature materials, which are not usually used in our country [11].

People of Himachal Pradesh are known for their peace loving nature, but now with the change in lifestyle and exposure to outer world, especially after tourism boom in the last few decades, increasing family problems are forcing people for taking such extreme steps [12].

The present study was conducted with the objective to study the choice of ligature material preferred for hanging and the type of hanging in relation to the point of suspension and other associated factors.

Materials and Methods

Data Collection

The study was conducted in a retrospective manner in the Biology and Serology Division, Regional Forensic Science Laboratory, Northern Range, Dharamshala, Himachal Pradesh, India. The study is based on the cases of suicide by hanging received for examination from three districts (Kangra, Chamba and Una) of Himachal Pradesh over an interval of five years from September 2009 to December 2014. A total of 122 cases were examined and analysed with regard to type of ligature material used, direction of ligature mark, place of occurrence, ligature points, type of hanging/suspension, localization of the knot, and fracture of hyoid bone. The cases of hanging fatalities of suicidal origin were selected and confirmed on the basis of history, police forwarding requisition, inquest report, first information report, autopsy reports and related information. The details were entered on a semi-structured questionnaire developed by the researchers after a review of the related literature.

Statistical Analysis

The computation of data was done with the help of Microsoft excel and SPSS programme in tabular forms and observations were recorded, analysed, and discussed. In addition, comparison of results of the present study was done with similar studies conducted in different parts of the world.

Results

Out of 122 cases of hanging, 84 (68.85%) were male and 38 (31.15%) were female indicating a male: female ratio of nearly 2: 1 (Table 1).

Sex Wise Distribution

Name of Author	Ligature material	Ligature point	Male & Female	Place of occurrence	Degree of suspension
Sen Gupta [30] (1965)	Sari = 20 (19.80%) Dhoti= 20 (19.80%) Rope= 41(40.59%) Napkin = 12 (11.88%) Wrapper = 3 (2.97%) Electric wire= 1 (0.99%) Belt= 1(0.99%) Chadder = 1(0.99%) Lungi = 2 (1.98%)	--	Male=72%	--	--
Bowen [58] (1982)	--	Banisters, door knobs, clothes hooks on doors	--	Almost always at home	--
Luke, et al. [29] (1985)	Rope or clothes line =52% Leather belt =13% Soft belt or tie =11% Sheet or cloth= 10%	--	Male=84%	--	Completely suspended=33% Chair or other initial elevating device = 73%
Davison and Marshall [55] (1986)	Rope =51% Electric flex =8% Belts =8% Baler twine =7% Washing line =6%	Rafter, joist, or beam =44% Nails, hooks and brackets =13% Banister =9% Trees =9%	--	At home=71%, In the open=10% In hospital=7%	Feet touching the ground =53%
Guarner and Hanzlick [28] (1987)	Ropes and belts=50% Sheets, electric cords, shirts, towels, linen, clothes hanger =50%	--	Male =90%	At home=43% Jail=27% Wooded areas=9% Hotels=7% Health care facilities=5% Work= 4% Other=5%	--
Simonsen [26] (1988)	Packing twine or electric cord= 46 (58%) Rope= 20 (25%) Linen= 5 (6%) Belt= 5 (6%) Other =4 (5%)	--	Male=48 (59%)	--	Completely suspended =38% (both feet off the ground)
Shaw [33] (2003)	Bed clothes=56% Shoelaces=13% Items of clothing =9% Belts=4%	Window bars =48% Bed=11%, Cell fittings (lights, pipes, cupboards, sinks, toilets)= 13% Door =5% In two cases a healthcare center curtain rail was used	--	--	--

James and Silcocks [3] (1992)	Rope, wire, chain, flex, belts and various soft ligatures	--	Male=92%	--	--
Elfawal and Awad [27] (1994)	Plastic clothes line=41 (67%) Cotton cloth=14 (23%) Leather strap =1 (1.63%) Silk cloth =1 (1.63%) Rubber hose =1 (1.63%) Electric cable =3 (4.91%)	--	Male=80%	At home=95% (Indoors= 53) Outdoors =5) Place of work=5%	Complete suspension=48 (79%) Partial suspension =13 (21%)
Cooke, et al. [25] (1995)	Rope= 59%	Rafter of a roof, ceiling or verandah= 47% Tree =16% Door or door frame =9% Cell bar=4% Shower rail or rose =4% Stair rail=2% Curtain rail=1% Ceiling hook =1% Manhole =1%	Male= 88%	In around home= 71% (In a room=28% carport or veranda=13% Shed or garage=21% Garden=8% Basement=1%) In custody= 4% (police and jail) In a medical setting= 6% (including nursing home and hostel)	Completely suspended (both feet off the ground) =41% Kneeling=8% Sitting= 8% Lying= 1%
Morild [24] (1996)	--	--	Male=73%	--	Completely suspended (both feet off the ground)=51%
Kosky and Dundas [23] (2000)	--	--	Male =87%	Home = 57% Public place = 34% Prison=3% Police cells= 1% Hospital= 1%	--
Nowers [22] (2001)	Scarf, shoelaces, electric flex, wire cable, electric cable	Window of room, door handle, window of toilet, attic rafters (home), tree in hospital grounds	Male =83%	Home=73% Public places=14% Hospital or on leave from hospital=9% In custody=2%	--
Leigh, et al. [18](2003)	Shoe/boot laces =32% Shirt/pullover/jacket/trousers =24% Cord from jacket/trousers & shorts = 20% Blanket/sheet =15% Belt=5% Paper suit=3%	Hatch (bolt hole) =52% Door/door hinge=26% Others (pipes, frames of bed, light fitting, cistern, toilet button) =22%	Male= 92% in All custody deaths	--	--

	Bandages=1%				
Gunnell, et al. [57] (2005)	Ropes, belts and flex	Beams, banisters, hooks, door knobs, and trees	--	Persons' home in three quarters of the cases, In custody and hospitals =10% Remainder occur in public places	Around 50% of hanging suicides are not fully suspended
Ahmad and Hossain [42] (2010)	Orna/dopatta= 51 (35.17%) Jute rope=48 (33.10%) Shari=25 (17.24%) Nylon rope=12 (8.27%) Towel=7 (4.83%) Kamij=1 (0.69%) Electric wire=1 (0.69%)	--	Male=60 (41.37%) Female=85 (58.62%)	Indoor (living rooms)= 97.93%	Complete suspension= 97.24% Partial suspension= 2.75%
Meera and Singh [19] (2011)	Cloth=48 (57.14%), Rope =36 (42.86%)	--	Male= 65 (77.38%) Female= 19 (22.62%)	Indoors=62 (73.81%) Outdoors =22 (26.19%)	Complete =74 (88.10%) Partial= 7 (8.33%)
Momin, et al. [15] (2012)	Chunni =31 (31.96%) Nylon rope =28 (28.87%) Sari=15 (15.46%) Cotton rope=15 (15.46%) Shirt=1 (1.03%) Handkerchief=2 (2.06%) Metal wire=2 (2.06%) Not known=3 (3.09%)	--	Male=65 (67.01%) Female=32 (32.98%)	--	Complete=25 (25.77%) Incomplete=72 (74.22%)
Patel, et al. [20] (2012)	Bed sheet=32 (10%) Dupatta=216 (67.5%) Saree =4 (1.25%) Piece of cloth =4 (1.25%) Electric wire =4 (1.25%) Rope=60 (18.75%)	--	Male= 192 (60%) Female=128 (40%)	Open place=12 (3.75%) Closed place=308 (96.25%)	Complete=316 (98.75%) Partial =4 (1.25%)
Pradhan, et al. [8] (2012)	Rope =21 (47.72%) Shawl=14 (31.81%) Sari =4 (9.09%) Bed sheets = 2(4.54%) woolen muffler = 2(4.54%) Belt = 1 (2.27%)	--	Male =19 (43.18%) Female=25 (56.81%)	--	Complete=19 (43.18%), Partial =25 (56.81%)
Bhosle, et el. [21] (2014)	Nylon rope=44 (53.01%) Long handkerchief =5 (6.3%) Jute rope=03 (3.61%) Cotton material=03 (3.61%) Sari=03(3.61%)	--	Male=78.57%	Home =58 (69.88%) Farm=11 (13.25%) Public place= 04 (4.82%) Forest=06	Complete=32 (38.10%) Incomplete= 52 (61.90%)

	Coconut rope=01 (1.19%) Shawl=01 (1.21%) Towel = 01 (1.21%) Electric wire=01 (1.21%) Not ascertained =16 (19.28%)			(7.23%) Other place=04 (4.82%)	
Ambade, et al. [2] (2015)	Nylon rope =80 (63%) Odhni/chunni =13 (10.2%) Jute rope= 8 (6.3%) Dupatta= 7 (5.5%) Sari =7 (5.5%) Cotton rope= 4 (3.1%) Electric wire =2 (1.6%) Water pipe =2 (1.6%) Shirt/lungi/bed sheet =3 (2.4%) Machine belt-cotton =1 (0.8%)	Ceiling fan = 13 (10.2%) Ceiling Hook =26 (20.5%) Beams =39(30.7%) Tree =42 (33.1%) Ventilator grills= 6 (4.7%) Door bars= 1(0.8%)	Male =107 (84.25%), Female= 20 (15.74%)	Home =81 (63.8%) Hostel= 2 (1.6%) Farm =20 (15.7%) Barren land =12 (9.4%) Forest= 8 (6.3%), Hospital=2 (1.6%) Police station/prison= 2 (1.6%)	Complete =86 (67.7%) Partial =41 (32.3%)
Rawat and Rodrigues [31] (2015)	Rope = 44 (43.56%) Chunni/dupatta =23 (22.77%) Bed sheet =12 (11.88%) Sari= 11 (10.89%) Pant/pajama/loongi =8 (7.92%) Electric wire/cable =3 (2.97%)	--	Male =79 (78.22%) Female =22 (21.78%)	Indoor =72 (71.29%) Outdoor =29 (28.71%)	Complete = 85.15% Incomplete = 14.85%
Ahmad, et al. [41] (2015)	Orna(dopata)=237 (41.28%) Jute rope=195 (33.97%) Sari=42 (7.32%) Nylon rope=28 (4.88%) Lungi/dhoti =25 (4.35%) Kamiz=21 (3.68%) Electric wire=3 (0.52%) Other material=23 (4 %)	--	Male= 159 (27.71%) Female =415 (72.29%)	Indoor =93.45% Outdoor = 6.45%	--
Udhayabanu, et al. [14] (2015)	Nylon =25 (16.12%) Cotton rope=6 (3.87%) Metal wire =2 (1.29%) Cable wire=1 (0.64%) Synthetic saree =74 (47.74%) Cotton saree=4 (2.58%) Dhoti =21 (13.54%) Lungi=4 (2.58%) Synthetic dupatta=17 (10.96%)	--	Male =109 (70.32%) Female=46 (29.67%)	--	--

	Cotton dupatta=1 (0.64%)				
Kumar, et al. [32] (2016)	Hard=40 (51.94%) Soft=37 (48.05%)	--	Male=52 (67.53%) Female =25 (32.47%)	Indoors =71 (92.21%) Outdoors=6 (7.79%)	Complete =68 (88.32%) Partial= 9 (11.68%)
Present Study (2017)	Hard = 58 (47.54%) Rope=53 (43.44%) Electric wire/ clutch wire= 2 (1.63%) Niwar=1 (0.83%) Rubber pipe=1 (0.83%) Plastic strap/ band= 1(0.83%). Soft = 64 (52.45%) Chunni/dupatta=49 (40.16%) Stole=1 (0.83%) Parna/nylon cloth=6 (4.91%) Shirt=3 (2.45%) Salwar=1 (0.83%) Towel=1 (0.83%) Turban/pagri=1 (0.83%) Muffler=2 (1.63%)	Iron guider=29 (23.77%) Ceiling fan= 28 (22.95%) Tree =23 (18.85%) Beam=19 (15.57%) Ceiling hook= 16 (13.11%) Ventilator= 3 (2.45%) Iron grill/rod=2 (1.63%) Stair=1 (0.83%) Window =1 (0.83%)	Male=84 (68.85%) Female=38 (31.15%)	Indoors= 91 (74.59%) (own-house, hotel, hostel, shop, office, cowshed and rented house), Outdoors =31 (25.41%), (forest, rivulet/nullah, fields &orchards)	Complete= 102 (83.60%) Partial =16 (13.11%) Not mentioned =4 (3.27%)

Table 1: Comparison of results of the present study with similar studies conducted in different parts of the world.

Place of Occurrence

74.59%) victims preferred indoor sites and 31 (25.41%) outdoor sites for hanging (Table 1).

Type of Hanging

Complete hanging was observed in 102 (83.60%) cases and partial hanging in 16 (13.11%) cases (Table 1).

Features of Ligature Material

The ligature material most commonly used for hanging was soft material in 64 (52.45%) cases and hard material in 58 (47.54%) cases (Table 1).

Ligature Points

Most commonly used ligature point was iron guider in 29 (23.77%) cases followed by ceiling fan in 28 (22.95%) cases and trees in 23 (18.85%) cases. The other ligature points were ceiling hook, beams, ventilators, stairs, windows, and iron grills/rod (Table 1).

Ligature Material Used

Rope (synthetic and jute/sunn) was the most common ligature material used in 53 (43.44%) cases followed by chunni/dupatta in 49 (40.16%) cases and *parna*/cloth piece/nylon cloth in 6 (4.91%) cases. Electric wire, clutch wire, shirt, muffler, salwar, towel, stole, and rubber pipes were other ligature materials used for hanging (Table 1).

Position of knot

The knot was observed on left side of neck in 61 (50%) cases and on right side of neck in 29 (23.77%) cases. The knot was situated on front of neck in 7 (5.73%) cases and nape of the neck/backside in only 5 (4.09%) cases while no knot was observed in 2 (1.63%) cases. The data was not available in 18 (14.75%) cases (Table 2).

Direction of ligature mark

The ligature mark was placed obliquely around the neck in 116 (95.08%) cases, while it was not mentioned in 6 (4.91%) cases (Table 2).

Factor	No. of cases	Percentage
Position of knot		
Left side of neck	61	50%
Right side of neck	29	23.77%
Front of neck below chin	07	5.73%
Nape of neck/backside	05	4.09%
No knots	2	1.63%
Not mentioned	18	14.75%
Direction of ligature mark		
Oblique	116	95.08%
Horizontal	06	4.91%
Fracture of hyoid bone		
Fractured	37	30.32%
Not fractured	85	69.97%

Table 2: Incidence of other relevant factors.

Fracture of hyoid bone

The fracture of hyoid bone was observed in 37 (30.32%) cases while hyoid bone was intact in 85 (69.97%) cases (Table 2).

Discussion

Hanging is one of the most common causes of suicide deaths in India. The present study revealed that majority of hanging deaths were contributed by male (68.85%) followed by females (31.15%) indicating a male: female ratio of nearly 2:1, which was consistent with observations made by Ambade, et al. [2], James and Silcocks [3], Pradhan, et al. [8], Kumar, et al. [13], Udhayabanu, et al. [14], Momin, et al. [15], Mukherjee, et al. [16], Yadukul, et al. [17], Leigh, et al. [18], Meera and Singh [19], Patel, et al. [20], Bhosle, et al. [21], Nowers [22], Kosky and Dundas [23], Morild [24], Cooke, et al. [25], Simonsen [26], Elfawal and Awad [27], Guarner and Hanzlick [28], Luke, et al. [29] and Sen Gupta [30]. The findings of current study were in accordance with those made by Rawat and Rodrigues [31] who reported 78.22% cases of male and 21.78% cases of female with male to female ratio of approximately 3:1 and Kumar, et al. [32] wherein male to female ratio was about 2.1:1. Consistent with our results, studies in other parts of the world also showed male predominance in suicides like in Cork City in South Carolina, USA and in Geneva [33,34]. However, a literature search showed that while men are known usually to commit suicide successfully, women have outnumbered men in non-fatal unsuccessful suicidal attempts [1,33,35]. Mohanty, et al. [36] revealed that males were the major sufferers (54.15%) with average

male to female ratio of 1.18:1. The results of our study were in contrast to a study conducted by Muninarayana, et al. [37] whose results indicated almost equal distribution among male (53%) and females (47%). On the other hand, our findings were contrary to the observations made by Saisudheer and Nagaraja [38], Rastogi and Kochar [39], Banerjee, et al. [40], Ahmad, et al. [41] and Ahmad and Hossain [42] wherein female predominance was reported. Many studies have shown male predominance [43-47]. Males were four times more affected in Australia [48], whereas the male: female ratio was low in Hong Kong and Singapore [49]. The results of the current study were similar to that shown by Nadesan [50] in a study from Malaysia. India being a patriarchal society, the male predominance is primarily due to increase in male population and secondly the male preponderance could be explained as males are expected to shoulder the responsibility and burden of life during the productive years of life. Socio-cultural, economic, environmental and religious factors may also contribute for the variation.

Most death were due to asphyxia by using different ligature material, one end of which was tied with the point of suspension inside the house or branch of a tree outside the house or other point, and another end encircled the neck with a knot using a chair or table or stool as the base for standing, later on push them away by feet [51]. In our study, the ligature material most commonly used for hanging was soft material in 64 (52.45%) cases and hard material in 58 (47.54%) cases. Similar observations were made by Saisudheer and Nagaraja [38], Patel, et al. [20] who reported soft material like cloth followed by a firm material like rope as the preferred choice of ligature material for hanging. Dupatta was most commonly used among soft ligature material in 49 (40.16%) cases and rope was the commonest hard ligature material used (43.44%) in the current study. Our study was consistent with a study by Yadukul, et al. [17], where soft material (77%) was the most commonly used ligature material. The results of the present study were contrary to the observations made by Ambade, et al. [2] wherein hard material was used in 70.9% cases and soft material in 23.6% cases, Rawat and Rodrigues [31] who reported hard material in 53.46% cases and soft material in 46.53% cases and Sahoo, et al. [52], wherein hard material was used in 51.95% cases and soft material in 48.05% cases. Naik and Patil [53] observed that soft ligature like scarf, napkin, sari, bed sheet etc. and hard ligature like jute, plastic or nylon rope, electric wire etc were used as ligatures. Kumar et al [32] showed that hard material like jute rope, plastic rope and electric wire was used by 51.94% victims and soft ligatures like dupatta,

saree and lungi by 48.05% victims. Sharma, et al. [54] in their study at Chandigarh reported chunni/dupatta as the most common ligature material used (40%) followed by nylon rope (31%), bed sheet etc. (16%). Shawl was the least used ligature material (2%). This is in variance with the present study where rope came out to be used most commonly.

The present study revealed that the commonest type of ligature material used for hanging was synthetic and jute/sunn rope in 53 (43.44%) cases followed by chunni/dupatta in 49 (40.16%) cases. Similar findings were reported by Pradhan, et al. [8] (47.72%), Bhosle et al. [21] (53.01%), Rawat and Rodrigues [31] (43.56%) and Ahmad and Hussain [42] (35.17%). Synthetic saree (47.74%) was the most common ligature material used for hanging in a study by Udhayabanu, et al. [14]. Dupatta was the most common used ligature material in study by Momin, et al. [15] (31.96%), Kumar, et al. [32], Ahmad, et al. [41] (41.28%), and Sharma, et al. [54] (30.90%). The present study revealed that rope was the most commonly used ligature material as it is commonly available at home. A study by Meera and Singh [19], the ligature material used was ropes in 42.86% cases. Sen Gupta [30] reported sari, dhoti, rope, napkin, wrapper, electric wire, belt, chaddar, and lungi. Other ligature materials used in the current study were nylon cloth/parna, shirt, salwar, towel, turban/pagri, niwar, electric/clutch wire, muffler, stole, rubber pipe/band, and plastic strap. These are also basic things that are normally present at home, but are less conventional and reliable than rope. In Western countries belt, electric cable, scarf, tie, dressing gown cord, shoe lace, curtain cord, telephone cord, shower lead etc. are used as ligature materials, which are not so used in our country [11] and this may be due to cultural-geographical factors. The current study was compared with the other studies conducted in other parts of the world in relation to various incidences surrounding suicidal hanging. The results of the present study were contrary to the observations made by Nowers [22] who reported scarf, shoe laces, electric flex, wire cable and electric cable as ligature material, Cooke, et al. [25] noticed rope as ligature material in 59% cases, James and Silcocks [3] reported rope, wire, chain, flex, belts and various soft ligatures, Simonsen [26] reported packing twine, electric cord, rope, linen, belt and others, Elfawal and Awad [27] observed plastic clothes line, cotton cloth, leather strap, silk cloth, rubber hose, and electric cable, Guarner and Hanzlick [28] reported ropes and belts, sheets, electric cords, shirts, towels, and linen clothes hanger, Davison and Marshall [55] reported rope, electric flex, belts, baler twine, and washing line, Luke, et al. [56] noticed, rope or clothes line, leather belt, soft belt or tie,

sheet or cloth, and Gunnell, et al. [57] reported ropes, belts and flex as ligature materials. The deviations in the choice of ligature material can be explained as rope is used more frequently for domestic purposes like fetching fodder, tying domestic animals and pets, drying clothes, fetching water from well, harvesting purpose and other household activities in the area of study. The traditional culture influence the method choice and the victim uses whatever material is easily available in the house or nearby during that particular period of time. The rope was mostly used for hanging due to its cheapness, convenience and availability in almost every household in northern India.

As far as the places of occurrence are concerned, house was the commonest place of hanging. In our study, 91 (74.59%) victims preferred indoor sites for hanging as compared to outdoor sites in 31 (25.41%) cases which is consistent with the observations made by Kumar, et al. [13] (94.0%), Udhayabanu, et al. [14] (93.45%), Bhosle, et al. [21] (69.88%), Rawat and Rodrigues [31] (71.29%) and Mohanty, et al. [36] (72.81%). The results of current study were in agreement with Patel et al. [20] who reported 96.25% cases from indoor places like home, workplaces, hotel room and custody barrack. Kumar, et al. [32] reported 92.21% preferred indoor locations of which maximum were residence. Bowen [58] reported that most of suicidal hanging took place inside home which is in line with the present study. However, these observations were contrary to those made by Nowers [22] who reported home, public places, hospital, and in custody, Kosky and Dundas [23] wherein home, public place, prison, police cells, and hospital were locations, Cooke, et al. [25] who reported in around home and in custody, Elfawal and Awad [27] who reported at home and outdoor, Guarner and Hanzlick [28] who reported home, jail, wooded areas, hotels, health care facilities, work and others, Davison and Marshall [55] who reported home, open and hospital, Bowen [58] noticed always at home and Gunnell, et al. [57] reported home, hospital, prisons, and public places as place of occurrence. The reason for high indoor incidences may be easy accessibility of means and idea of victims not to be noticed by others, non-interference in the process and fear of guilt or shame in case of recuperation.

The ligature point is a fixed structure to which the other end of ligature material is tied to hang. As far as the ligature points are concerned, the commonest point of suspension was iron guider in 29 (23.77%) cases followed by ceiling fan in 28 (22.95%) cases and trees in 23 (18.85%) cases in the current study. Our findings were in accordance with Vijayakumari [59] who reported

ceiling fans, beams and grills as the common ligature points. In a study by Ambade, et al. [2], trees were the commonest ligature points followed by beams, ceiling hooks/fans. Leigh, et al. [18] reported that the hatch/bolt hole to the cell door was used as the ligature point in over half (52%) of the cases of suicide committed by hanging in police cells in England and Wales. The door or door hinge were used in about one-quarter of the cases (26%) and other (pipes, frame of bed, light fitting, cistern, and toilet button) in 22% cases. In England and Wales, cell window bars were the suspension point used in nearly half of prison suicides (48%) followed by bed (11%), other cell fittings, i.e., lights, pipes, cupboards, sinks or toilets (13%) or the door (5%). In 2 cases, a healthcare center curtain rail was used [60,61]. This is because the victims who have committed indoor suicide by hanging had an option of iron guider/ceiling hooks/fans, beams, as ligature points. But, if the victims committed outdoor suicide by hanging, trees are the mostly available ligature points. Nowers [22] reported window of room, door handle, window of toilet, attic rafters, and tree in hospital grounds, Cooke, et al. [25] noticed rafter of roof, ceiling of verandah, tree, door or door frame, cell bar, showers rail or rose, stairs rail, curtain rail, ceiling hook, and manhole, Davison and Marshall [55] reported rafter joist or beam, nails, hooks, brackets, banister and trees, Bowen [58] observed banister, door knobs, clothes hooks on doors, and Gunnell, et al. [57] reported beams, banisters, hooks, door knobs and trees as ligature points.

The direction of ligature mark plays an important role in describing cause of death and differentiates between hanging and strangulation. The direction of the ligature mark was known from the position of the knot. The present study revealed that the knot was observed on left side of neck in 61 (50%) cases, on right side of neck in 29 (23.77%) cases, on front of neck in 7 (5.73%) cases and nape of the neck/backside in 5 (4.09%) cases which is consistent with a study by Sharma, et al. [54], wherein position of knot was most commonly observed on left side of neck in 43% cases followed by right side of neck in 31% cases. Front of neck was the least preferred position of knot in 2% cases. Similar were the observations made by Ali, et al. [62] who showed that the knot was on left side of neck in 60.8% cases, on right side of neck in 27.8% cases and on back of neck in 11.4% cases, Ambade, et al. [2] wherein knot was commonly placed over back of neck in 37 % cases, on left side of neck in 33.9% cases and right side of neck in 24.4% cases, Rawat and Rodrigues [31] who found knot on right side of neck in 60.30% cases, on left side of neck on 32.67% cases, on front of neck in 0.9% cases and on back of neck in 5.94% cases, and Ahmed et al. [41] wherein knot was situated on right side of the neck

in 48.95 % cases followed by left side in 40.94% cases and nape of the neck in 8.71% cases. In a study by Sahoo, et al. [52], the position of knot was present at occipital region of the neck in 42.86% cases followed by left mastoid region of the neck and least over right mastoid region of the neck.

Ligature mark in the neck is the principal external sign in hanging depending on body suspension from ligature point. The ligature mark was placed obliquely around the neck in 116 (95.08%) cases in the current study, similar were the observations made by Momin, et al. [15] (92.79%), Bhosle, et al. [21] (98.81%), Ahmed, et al. [41] (88.68%), Sharma, et al. [54] (97.80%), and Rao [63] (87.88%). Our findings were close to the observations made by Rawat and Rodrigues [31] wherein ligature mark was placed obliquely in 100% cases. In hanging deaths, complete hanging predominates over the partial hanging [27,64] and these findings were well correlated with the present study where complete hanging was observed in 102 (83.60%) cases and partial hanging in 16 (13.11%) cases. Our study was in concordance with the observations made by Patel et al. [20] wherein complete hanging was observed in 99% of total cases studied, Sasudheer and Nagaraja [38] wherein complete hanging was reported in 64% cases and partial hanging in 36% cases, Sahoo, et al. [52] who observed complete hanging in 88.32% and partial hanging in 11.68% cases, Naik and Patil [53] who reported that out of 232 cases of hanging, 15 victims died due to partial hanging where some parts of victims were touching the ground and 217 victims died due to complete hanging, and Rao [63] who observed complete hanging in 88% cases and partial hanging in 12% cases. The results of the present study were in agreement with Ambade, et al. [2], wherein complete hanging was seen in 67.7% cases and partial hanging in 32.3% cases, and Rawat and Rodrigues [31] who observed atypical complete hanging in 81.19% cases. However, the results of current study were close to the observations made by Morild [24] who reported complete suspension in 51 % cases, Cooke, et al. [25] who noticed complete suspension in 41% cases, kneeling in 8%, sitting 8% and lying in 1% cases, Simonsen [26] wherein complete suspension was reported in 38 % cases, and Elfawal and Awad [27] who observed complete suspension in 79% and partial in 21% cases. Similar observations were made by Meera and Singh [19] who observed complete hanging in 88.10% cases and partial in 8.33% cases, Patel et al. [20] who noticed complete hanging in 98.75% cases and partial hanging in 1.25% cases, Kumar, et al. [32], wherein nature of suspension was complete in 88.32% cases and partial in 11.68% cases, Ahmed, et al. [41] wherein complete suspension

was observed in 82.23% cases and partial hanging in 17.77% cases, Rahman, et al. [51] who observed 83% cases of complete hanging, Der, et al. [65] who found complete hangings in 98.6% cases, and Singh et al. [66] wherein complete hanging was noticed in 68.57% cases. While authors from other country like Charoonnate, et al. [67] observed higher number of incomplete hanging cases (55%) as compared to complete hanging cases (45%) in a study at Thailand. This is sharp contrast to the present study wherein complete hanging was seen in 83.60% cases. The results of present study were contrary to the observations made by Davison and Marshall [55] who reported partial suspension in 53% cases, Luke et al. [56] wherein complete suspension was seen in 33% cases and chair or other initiating elevating device were used in 73% cases, and Gunnell, et al. [57] who reported 50% hangings not fully suspended. Thus, it was concluded that in the present study, majority of the hanging cases victim's body was not touching the ground. Our observations in this regard were consistent with Rao [63] who highlighted the regional influence, life style and to a certain extent the type of residence responsible for these variations.

Hyoid fractures of great importance in distinguishing asphyxia deaths due to hanging, throttling and manual strangulation. Fracture of hyoid bone has been ascribed to many factors like level of application of ligature or magnitude of constricting force, height of suspension (long drop or short drop suspension), age and sex of victim. Opinion varies regarding the frequency of fracture of hyoid bone. Estimate ranges from 0 to 60%, but the average is 15 to 20%. According to Morild [24] increased duration of suspension is said to be a factor for increased frequency of fracture of hyoid bone and thyroid cartilage. The present study highlighted the fact that the fracture of hyoid bone was observed in 37 (30.32%) cases. Our findings were close to the observations made by Bhosle, et al. [21] wherein fracture of hyoid bone was observed in 15.47% cases, Mukherjee, et al. [16] who observed fracture of hyoid bone in 24.67% cases, Ahmed, et al. [41] who reported fracture of hyoid bone in 81(14.11%) cases. Our findings were in line with Rawat and Rodrigues [31] who observed fracture of hyoid bone in 2.97% cases and Rao [63] who noticed that hyoid bone was damaged in 6.06% cases. The findings of the present study were in concordance with Reddy [68] (10-20%), Nikolic, et al [69] (68%), Nandy [70] (5-10%), and Betz [71] (67%). According to Modi [72] fractures of hyoid bones were rare. Whereas the study conducted by Smith and Fiddes [73] and Mukherjee [74] never found any fracture.

Conclusions

This study has systematically highlighted the choice of ligature material used for hanging and type of hanging in relation to point of suspension. A careful examination of ligature mark caused by ligature material is very important while formulating opinion regarding hanging deaths. The prevalence of hanging deaths is alarming, therefore stringent measures should be taken for its prevention and control. Public education campaigns should be evaluated to increase the public awareness and change attitudes to reduce suicide and suicidal behaviors. The Non-Governmental organizations (NGOs) educational, cultural, community groups and stakeholders should come forward to raise awareness to give moral, social support and to educate communities to identify the target groups and respond to warning signs associated with suicide which may help prevent persons with suicidal tendencies to move from suicidal thoughts to action. As media has played a significant role in spread of knowledge and practices of suicide so media should focus more on modifying portrayals. Alcohol and illicit drug abuse in the home should be checked which may have demonstrated positive impact on public mental health resulting in lower risk of suicidal behaviour.

Ethical Approval

Ethical guidelines were respected.

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Conflict of Interest

The authors declare no conflict of interest.

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