International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Forensic Analysis of Shoe lace Used in Hanging A Rare Case of Custody Death

Keshav S Kapgate[1], Vijay J Thakre[2], Renuka V Phadke[3], Amulya A Pande[4]

[1,3]Assistant Chemical Analyser, Regional Forensic Science Laboratory, Dhantoli, Nagpur, Maharashtra.
[2]Joint Director, Directorate of Forensic Science Laboratory, Mumbai, Maharashtra
[4]Assistant Director, Regional Forensic Science Laboratory, Dhantoli, Nagpur, Maharashtra.

Abstract:

Background: Custody deaths are a serious problem for the law enforcement agencies. Most of the reported custody death cases are by hanging using different available ligature material. Present forensic investigation of custodial death is focused on the detailed fiber analysis comprising of microscopic examination, nature of fiber, spectrophotometric analysis and thermal analysis of the samples sent by medical officers and investigating authorities. The present paper shows application of modern analytical techniques that can be successfully applied in sensitive cases of hanging, especially in cases of custody death. In this way, the importance of involvement of forensic science in custody death cases along with the opinion of medical officers is highlighted.

Case Presentation: In the present rare case of hanging, a shoe lace was used by an accused in police custody. This case was submitted to the forensic science laboratory for comparison of the fibers of the shoe lace and fibers found on the ligature mark obtained from the neck and both the hands. All possible analytical techniques such as microscopy, thermal methods and spectrophotometric analysis were used and results successfully revealed that the characteristics of the seized lace in the shoe matched with the ligature material. Similarly, microscopic examination of shoe lace fibers tallied with fibers like material lifted on transparent cello tape during post mortem.

Conclusion: This case highlighted the fact that a shoe lace can also be the reason for suicide of accused in police custody and thus added one more preventive measure to be taken by the concerned authorities. In addition to the opinion of medical officers, the role of the forensic examination report is equally important.

Keywords: custody death, ligature material, shoe lace, forensic instrumental analysis.

1. Background:

Custodial death is the death of the person in police custody or judicial custody while undergoing trial or serving a sentence. A prisoner while in the custody of police is entitled to all rights under Article 21 of the Indian Constitution. The law gives basic rights like the right to life, liberty, and dignity to everyone in society and also to the person who is in the police custody and hence they must be protected. Natural death of a prisoner may occur when in prison or hospital during treatment. But when a prisoner dies in custody, the matter comes under the screening of the National Human Rights

Commission to see whether it is suicide or prevention of violation of human rights. In such cases, medical officers have to follow the guidelines given by the National Human Rights Commission while conducting post-mortem[1].

It is seen that the common way of committing suicide in custody is by hanging. In this context, a literature study found that any item readily available or present nearby could be used for execution. General literature on hanging showed that the type of ligature material used for hanging is - 63% nylon rope, followed by odhani (10.2%), jute rope (6.3%), dupatta and sari (5.5% each) [2]. It is seen that nylon rope is used as the most common ligature material[3,4,5, 6]. The ligature materials used for hanging in custody death mainly include cotton rope, bedsheet, electric wire/cable, water pipe, shirt, lungi, and machine belt, where saree and dupatta are mostly used by female [1,2]. A surprising custody death case is reported where two prisoners who were under treatment in the hospital used a cotton bandage for suicide. Such cases of custody death by hanging guide the need to prevent any loose material that may be a possible way of committing suicide[1].

In a similar context of custody death, a prisoner used a shoe lace for suicide. Present forensic investigation of custodial death is focused on the detailed fiber analysis comprising of microscopic examination, nature of fiber, spectrophotometric analysis and thermal analysis of the samples sent by medical officers and investigating authorities. Application of forensic analytical techniques helps in successful and full-proof fiber comparison and supports the judicial system in such cases.

Case history

A dead body of a twenty-two-year-old male accused in a murder case was found hanging in the toilet. On examination of the scene, it was found that the accused used a shoe lace for hanging. Articles submitted in this case were as follows:

Articles collected by medical officer:

1. Shoe Lace (dark blue coloured) used for hanging - Ligature material around the neck
2. Cello tape impression from right hand
3. Cello tape impression from left hand
4. Transparent cello tape

Articles collected by investigating officer:

5. Shoe (Blue colour with orange coloured insole) having a dark blue lace

2. Material and Methods

2.1 Sample preparation for fiber comparison: Fibers of shoe lace in exhibit (1) and (5) were lifted separately by pulling the surface of lace lightly and forcefully with the help of transparent cello tape. These lifted fibers on cello tape were stuck on a glass slide. The slides prepared in this way were used for microscopic examination in fiber comparison with the transparent cello tape impressions in exhibits (2), (3), and (4) sent by the medical officer.

2.2 Microscopic examination:

Microscopic examination of fiber was performed using Zeiss Axioscope 40 microscope and comparison microscope (make -Leica Microsystems)

2.3 Flame test:

Nature of fibers of lace in exhibits (1) and (5) (whether synthetic or cotton) was preliminarily determined using flame test.

2.4. Spectrophotometric analysis:
Dye of the lace in exhibits (1) and (5) was extracted in A. R. Grade N, N-Dimethylformamide (DMF). Dark blue colored DMF extract of exhibits (1) and (5) were analyzed using Analytic Jena S600 spectrophotometer in the visible range.

2.5.Simultaneous Thermal Analysis:
The STA was performed using NETZSCH STA 449. About 3-5 mg sample was taken in an aluminum crucible with a pierced lid. Sample used in this study was heated in the range of 50-600 °C at the rate of 20K/min. in nitrogen atmosphere as purged gas at a flow rate of 40 ml/min and 60 ml/min. Data was analyzed using NETZSCH STA 449 Protease software.

3. Results

3.1 Preliminary examination

Lace in exhibit (1) is shown in Figure 1 while shoe with lace in exhibit (5) is shown in Figure 2. Lace in exhibit (1) and lace in exhibit (5) as presented in figure (3) were dark blue colored with transparent aglets. Exhibit (1) was 132 cm long and 0.6 cm broad while lace in exhibit (5) was 122 cm long and 0.7 cm broad. Fibers of the lace of the exhibits (1) and (5) float in chloroform and sink in ethanol. When few fibers of lace in exhibits (1) and (5) were held on flame, they shrink, melt and form beads. They burn with a non-sooty flame with a blue edge.

3.2 Microscopic examination:

Glass slides of fibers prepared from exhibits (1) and (5) as discussed in section 2.1 were observed under the microscope and compared with the cello tape fibers mounted on glass slides. The results are presented in Table 1.

Table 1- Results on microscopic examination of fibers

Exhibits	Source	Colors of fibers observed under the microscope
1.	Shoe Lace used for hanging	Bluish, bluish-grey, reddish-orange, transparent fibers
2.	Transparent cello tape	Bluish, bluish-grey, transparent fibers like material
3.	Cello tape impression from the right hand	Bluish, bluish-grey, reddish orange, yellowish, transparent fibers like material
4.	Cello tape impression from the left hand	Bluish, bluish-grey, reddish orange, yellowish, transparent fibers like material
5.	Shoe lace	Bluish, bluish-grey, reddish-orange, transparent fibers

Fibers of lace in exhibits (1) and (5) tally with each other in respect of wavy pattern, colour of fibers when observed under comparison microscope as presented in Figure (4)

3.3 Spectrophotometric analysis: DMF extract of exhibits (1) and (5) was taken in a cuvette having a 1 cm path length and scanned in the visible region (400-800 nm) using DMF as blank reagent. The

absorption maxima for exhibits (1) and (5) were observed at 595.1 nm and 595 nm respectively. The results are depicted in Figure 5.

3.4 Simultaneous Thermal analysis (STA)

3.4.1 Thermogravimetry:

Thermal analysis of exhibits (1) and (5) shown in Figure (6) indicates decomposition temperature in the range of 380 to 500 °C with mass change of 87.23% and TG onset for Ex no. 1 and 5 are in the range of about 433°C to 434.1°C.

3.4.2 Differential Scanning Calorimetry: The Figure 7 shows two DSC curves at temperatures of 223.5 to 224 ℃ and 460.4 to 461.9℃. The perfect matching temperatures of Ex no. 1 and 5 indicate the same composition of fibers of lace in exhibits (1) and (5).

4. Discussion

4.1 Comparison of shoe lace in exhibit (1) and (5)

Normally, a pair of laces used in a pair of shoes have similar characteristics. In the present case, a lace missing from one shoe was supposed to be used for hanging purpose while the other lace was intact in another shoe. Hence, the comparison of characteristics of lace in exhibits (1) and (5) was done.

Preliminary examination of the shoe lace in exhibits (1) and (5) shows resemblance in their hue, behaviour in flame, weaving pattern as per comparison microscope and similar response towards flame test. Flame test performed for fibers of lace in exhibits (1) and (5) show that the lace is synthetic.

When the dimension of the laces is considered, the length of the shoe lace in exhibit (1) used for hanging was about 10 cm longer as compared to the length of the lace in the shoe in exhibit (5). Similarly, shrinkage in the breadth of lace in exhibit (1) (0.6cm) as compared to the breadth of lace in exhibit (5) supports the fact that the lace in exhibit (1) has been used for hanging purpose and hence stretched.

Solubility of fiber and dye in lace was checked and it was found that fibers of lace float in chloroform and sink in ethanol, showing that the density of fiber was greater than ethanol and less than chloroform. The dye was soluble in hot DMF and showed a dark blue colour. The spectrophotometric examination supports and confirms the similar wavelength of absorbance maxima (591 nm) of the dye in exhibits (1) and (5) indicating the same dye has been used in laces.

4.2 Microscopic examination:

In hanging cases, the transparent cello tape is used for lifting the ligature fibers from the ligature mark (neck) and the cello tape is then stuck to the glass slide. These glass slides should be sent by a medical officer for comparison of fibers with seized or suspected ligature material. Microscopic examination of fibers is most important in hanging cases, hence, instead of only cello tape, if the cello tape is stuck over the glass slides, it becomes easy to observe the slide under the microscope. Fibers from the suspected ligature material are similarly taken with the help of cello tape and stuck on a glass slide. In this way, the comparison of fiber is done. Very thin and tiny bluish, bluish-grey, reddish orange, yellowish, transparent fibers like material were observed on cello tape in exhibits (2), (3), and (4). On microscopic examination, those fibers tallied with fibers derived from lace in exhibits (1) and (5). Though the hue of the fibers tallies among themselves, but other characteristics such as nature, spectrophotometric analysis, and thermal properties, etc. of fiber-like material observed in cellophane in exhibits (2) to (4) cannot be given.

4.3 Thermal analysis

Thermogravimetry measurements mainly provide information on the thermal stability of the material. In

forensic analysis, information derived from such methods helps determine the nature of the fiber, whether it is cotton or synthetic. This method includes both thermogravimetry (TG) and differential scanning calorimetry (DSC). The results of thermogravimetry and differential calorimetry are compared with the literature values of different fibers. TG onset for nylon according to the literature value is at about 434°C -444°C[7].

The DSC results show the melting peak of synthetic fibers. Polyester fibers show an endothermic peak at 249°C and nylon fiber show at 221.5°C and 158.8°C respectively[6]. However, synthetic fiber shows decomposition peak at 455.8°C for polyester and at 464°C - 468°C for nylon fibers[7].

Thermal analysis shows that the lace is made up of synthetic fibers, specifically nylon fibers. Thus, all the above observations support that the lace in exhibits (1) and (5) constitute a pair of lace. Tensile strength of synthetic fibers such as nylon is very high and hence it does not easily break if a heavy weight is suspended by it. This supports the incidence of hanging by shoe lace.

5. Summary

Careful observation and analysis is needed in custody death cases. In the present case, all possible parameters were incorporated for comparison of the Shoe Lace used for hanging in exhibit (1) and the lace of the shoe in exhibit (2) and are summarized in Table 2.

Table 2: Summary of Different Studied Parameters

Sr. No.	Parameter	Exhibit 1	Exhibit 5
1	**Colour**	Blue	Blue
2	**Flame Test**	burn with a non-sooty flame with a blue edge	burn with a non-sooty flame with a blue edge
3	**Weaving Pattern by Comp. Microscope**	Wavy	Wavy
4	**UV- Visible wavelength**	595.00 nm	595.00 nm
5	**Mass Change in TG**	- 87.23 %	- 87.23 %
6	**Onset in TG**	433 °C	434.1 °C
7	**Melting Temp. in DSC**	223.5 °C	224 °C
8	**Degradation Temp. in DSC**	460.4 °C	461.9 °C

Conclusion:

In any hanging case, the opinion of the medical officer plays a major role. Medical officer observes and notes the type of injury of the deceased and gives a valuable remark in the post mortem report. During post mortem of hanging cases, the nature of injury or ligature mark around the neck is observed by the medical officer to decide whether the case is suicidal, accidental or homicidal. In addition to the opinion of medical officers, the role of forensic examination is equally important. Literature available in the cases of hanging mainly focused on the legal aspect about the type of material used for hanging, nature of injury on the neck by various ligature material, and also on the statistical data of the hanging cases. The present paper shows application of modern analytical techniques that can be successfully applied in sensitive cases of hanging, especially in cases of custody death.

Acknowledgement: The authors are thankful to The Director and Director General (Legal and technical), Directorate of Forensic Science Laboratory Home Department, Maharashtra State, for his encouragement and support.

Abbreviations
STA: Simultaneous Thermal analysis
TG: Thermogravimetry
DSC: Differential Scanning Calorimetry
DMF: N, N- Dimethylformamide

Funding
The authors received no specific funding for this work.
Ethics approval and consent to participate
Not applicable
Consent for publication
Not applicable
Competing interest
The authors declare that they have no competing interests.

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