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Original Research Article

Histopathological Alterations in Suprarenal Glands in Asphyxial Deaths: A Forensic Study

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Abstract

Introduction: Asphyxial deaths induce distinct histopathological changes in the suprarenal glands. Diagnosing hanging proves challenging when ligature marks are faint or absent. These glandular alterations assist in authenticating antemortem hanging, drowning, and other asphyxia mechanisms. This study examines detail histopathological changes of suprarenal glands in confirmed antemortem asphyxia cases. **Materials and Method:** The study utilized suprarenal glands which were obtained from the medico-legal autopsies of 55 cases of deaths due to asphyxia brought to the Mortuary of the Department of Forensic Medicine, Assam Medical College & Hospital, Dibrugarh, by the investigating authorities. The specimens were collected over a period of one year, from 1st January 2022 to 31st December 2022. **Results:** The microscopic examinations revealed that the suprarenal haemorrhage in 37 out of 55 (67.3%) asphyxia death cases. No haemorrhage was observed in the remaining 18 (32.7%) cases. **Discussions:** Roymedhi BC (1986-87) found definite histopathological changes in 44.29% of asphyxia deaths cases. The changes observed by Roymedhi BC were in the form of congestion and dilatation of blood vessels in the gland. The changes were both observed in the capsule and the substance of the glands. In some cases there was partial autolysis of the glands along with histopathological changes.

1. Introduction

Asphyxial deaths, including suicidal hanging, impose severe stress on the suprarenal glands during the agonal death. This leads to characteristic gross and histopathological changes in the glands.¹ Histopathology examines the cytological and tissue-level alterations in the diseased states. In asphyxia deaths, these histopathological changes in the suprarenal glands² aid forensic investigations.

Hanging ranks as a leading suicide method globally, causing over one million deaths annually and ranking among the top 10 causes of death worldwide. In India, it is the second most common method after poisoning. Incidence of suicide is rising over the past 30 years, particularly among young adults due to easy access to ligature materials and ligature points.³

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It is sometimes employed as a secondary method after failed attempts of throat-cutting or ingestion of poison.^{4, 5}

Sometimes there may be faint ligature mark in the neck of the deceased due to hanging. In such cases positive findings in the suprarenal glands may be considered while deciding the cause of death. The histopathological findings of suprarenal gland will thus also provide a lead to the investigating authority. This study investigates histopathological changes in the suprarenal glands from antemortem asphyxia deaths.

Changes on Suprarenal Glands in Asphyxial Deaths:

J.M.B. Bloodworth (1965), while discussing the response of the adrenal cortex to the stimulation of stress i.e. mental agony, found that within 18 to 24 hours, there occurs rapid loss of lipid from outer cortex of the gland. If the person survives there will be redeposition of lipid within next few days and if the stress continues hyperplasia of the cortex occurs. If the body cannot overcome the mental agony or stress, the patient within first few hours dies with a normal sized, lipid depleted brown cortex. If the stress continues for two to three weeks, first redeposition of lipid followed by nodular hyperplasia and then secondary loss of lipid will occur, resulting in moribund condition of the patient (called as “stage of exhaustion of Sclye). This secondary loss of lipid will accompany the microscopic hemorrhages and focal cortical cell death resulting mottled appearance of cortex with irregular foci of residual yellow lipid. Throughout these changes due to stress, the medulla remains unchanged. The finding of exhaustion appears at any time after 10 days to two weeks.⁴

I. Nakasono *et al* (1983), in the study of “Strangulation and adrenocortical secretion”, found that there was increase in the level of 17-hydroxycorticosteroids (17-OHCS) from the adrenal gland just before death by ligature strangulation. This study was conducted on anaesthetized dogs. He also observed that the secretion of 17-hydroxycorticosteroids was markedly decreased in condition when strangulation was made by rope around neck

under resting of stressful condition. It will be remained at extremely low levels until death. In case of constriction of neck by a rope only for a short period and on removal of the rope, it was found that there was a marked increase in the adrenal secretion of 17- OHCS. He said that the decrease of 17- OHCS was probably due to a blockage of endogenous supply of adrenocorticotropin (ACTH) to the adrenal gland by constriction of neck.⁶

Dysregulation in the Hypothalamic-pituitary-adrenal (HPA) axis contributes substantially to depression and suicidal behaviour. Szigethy *et al* compared postmortem adrenal gland weight and morphology between suicide victims and nonpsychiatric sudden death controls. Suicides exhibited significantly greater combined left-right adrenal weight, driven by left adrenal enlargement due to cortical hypertrophy. Left-right adrenal weight asymmetry in suicides aligns with hypotheses of lateralized HPA axis dysfunction from higher control centers.⁷

Hypothalamic-pituitary-adrenal (HPA) axis dysfunction plays major role in depression and suicidal behaviour. In a study by Eva Szigethy *et al*, the weight and morphology of postmortem adrenal glands were compared between suicide victims and sudden death, nonpsychiatric controls. The mean adrenal weight of the combined left and right glands was significantly higher in the suicide group; this difference was accounted for specifically by increases in left adrenal weight of suicides compared with the control group. It was observed that the increase in weight of the adrenal gland was due to cortical hypertrophy. The finding of left-right adrenal weight asymmetry in suicides is consistent with the hypothesis of abnormal lateralized input from higher control centres of the HPA axis.⁷

B.C. Roymedhi has studied the effect of hanging on histopathology of suprarenal glands and cervical lymph nodes during the period from February 1986 to March 1987. Out of 70 cases of death due to hanging, 31cases (44.29%) showed definite histopathological changes in suprarenal glands and in 51 (72.86%) cases there was histopathological changes in cervical lymph nodes.⁸

Lee et al. (1987) assessed hypoxia effects

(8% O₂ in N₂) on nor-epinephrine and epinephrine turnover in the heart, adrenal gland, submaxillary gland and stomach. The study reported that the effects of hypoxia on the activities of sympathoadrenal system differ in different organs, like there is increased activity in the heart and adrenal gland, decreased on the submaxillary gland and elicited no changes in the stomach.⁹

A study was done by Cheng WT *et al* (2008) in West China School of Preclinical and Forensic Medicine, Sichuan University to analyse the relationship between adrenal haemorrhage and the cause of death, age and gender. 82 cases of adrenal hemorrhage were statistically analysed. It was found that adrenal hemorrhage occurred mostly in cases of death which are sudden, or occurred from infection, trauma and asphyxia.¹⁰

2. Materials and Method

Population and sample collection: Suprarenal glands were obtained from medico-legal autopsies of 55 asphyxial death cases referred to the Mortuary of Department of Forensic Medicine, Assam Medical College & Hospital, Dibrugarh, by investigating authorities. The specimens were collected over a period of one year from 1st January 2022 to 31st December 2022.

Inclusion and Exclusion criteria

- Inclusion: Mechanical asphyxia deaths; drowning cases with asphyxia as the cause of death.
- Exclusion: Postmortem interval > 24 hours.

Data Collection and Autopsy Procedure: Epidemiological data (age, sex, religion, occupation, socioeconomic status, and circumstances of death) were extracted from the inquest reports, dead body challans, and through detail interviews with relatives, neighbours, eyewitnesses and police officials. A detail and thorough postmortem examinations were performed on all cases. Institutional ethics committee's approval was also obtained from the Assam Medical College & Hospital Institutional Ethics committee.

Microscopic and Histological Processing: Suprarenal glands were examined microscopically (intact and longitudinal sections) for congestion, haemorrhage, colour changes and other pathological conditions. The suprarenal

glands were collected in wide-mouthed labelled glass bottles (including tissue name, postmortem number, collection date and serial number) containing 10 % formalin solution and transferred from the mortuary to the laboratory for processing, staining and examination for histopathology under the microscope.

Data Analysis: Postmortem (gross and microscopic) findings were categorized, tabulated, graphically represented and statistically analysed using Microsoft excel.

3. Results

This study examined suprarenal glands from 55 medico-legal autopsies of asphyxia deaths (**Table 1**). **Table 2** showed that suprarenal hemorrhage occurred in 31/44 (70.5%) hanging deaths; the remaining 13/44(29.5%) exhibited no histopathological changes. It is also observed from the **Table 3** showed that 30 (96.78%) cases showed bilateral hemorrhage in the substances of suprarenal gland and one (3.22%) case showed unilateral hemorrhage in the substances of suprarenal gland. **Table 4** revealed suprarenal gland enlargement and congestion in 70.7 % hanging deaths and the remaining 29.5% showed no gross changes.

Table 1: Total number of deaths due to asphyxia (n=55)

Death due to Asphyxia	Number (n)
Hanging	44
Drowning	10
Strangulation	1

Table 2: Total number of Suprarenal Hemorrhage

Total number of hanging cases studied	Suprarenal Hemorrhage seen	Hemorrhage not seen
44	31	13

Table 3: Unilateral and bilateral hemorrhages

Total number of hanging cases studied	Suprarenal hemorrhage seen	Unilateral hemorrhage seen		Bilateral hemorrhage seen	
		n	%	n	%
44	31	1	3.22	30	96.78

Table 4: Changes in the Suprarenal glands

Gross changes in the glands	Number (n)	Percentage (%)
Glands enlarged and congested	31	70.45
Glands showing no gross changes	13	29.55
TOTAL	44	100.00

Plate 1: Hemorrhagic areas seen in the suprarenal gland in case of a death due to hanging

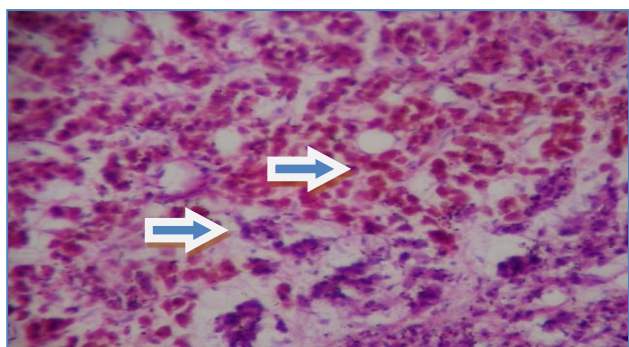


Table 5: Histopathological changes (microscopic hemorrhagic area) seen in death due to asphyxia (n=55)

Death due to asphyxia	Number (n)	Cases with suprarenal hemorrhage	
		n	%
Hanging	44	31	56.36
Drowning	10	5	9.09
Strangulation	1	1	1.80
TOTAL	55	37	67.27

One case of ligature strangulation was studied. The victim was a male of age 35 years. The suprarenal glands were found to be enlarged and congested, and petechial hemorrhage was found over the surface of the glands. The substance of both the glands showed a hemorrhagic area under microscope (**Plate 1**).

Table 5 represents the distribution of suprarenal hemorrhage among different types of asphyxia death. Out of the total number of 55 cases, hanging constituted 44 cases, out of which 31(56.36%) showed suprarenal hemorrhage on microscopic examination. Drowning accounted for 10 cases, with 5(9.09%) demonstrating suprarenal hemorrhage. A single case of strangulation was recorded, which also exhibited suprarenal hemorrhage (1.80%). Overall, suprarenal hemorrhage was observed in 37 cases (67.27%) of asphyxia deaths.

4. Discussion

It is seen from present study that in 70.45% cases of death due to hanging the suprarenal glands were enlarged and congested and 29.55% cases shows no gross changes in suprarenal glands. In these cases with enlarged and congested gland, hemorrhagic areas were found in substance of the gland. In all the cases the histopathological changes were bilateral except one case where unilateral histopathological changes were found.

There was also congestion and dilatation of capillaries of the glands. Roymedhi BC (1986-87) found definite histopathological changes in

44.29% of cases. The changes observed by Roymedhi BC were in the form of congestion and dilatation of blood vessels in the gland. The changes were both observed in the capsule and the substance of the glands. In some cases there was partial autolysis of the glands along with histopathological changes.^{8,9}

In the present study it was also observed that some of the individual cells undergo necrosis and dropout of tissue framework, sinusoids becomes dilated and congested, and small hemorrhages, in the extra glandular space seen.¹⁰ The colour of the cortex becomes mottled brown and red. Bloodworth JMB (1975) also found similar finding in the suprarenal glands.⁴ Innovative studies may facilitate further newer advancing knowledge in the field.^{11,12}

In deaths due to hanging out of 31 cases with microscopic hemorrhage in the substance of suprarenal glands, 25 (80.65%) cases showed hemorrhage only in the cortex, no cases showed hemorrhage only in the medulla and 6 (19.35%) cases showed hemorrhage in both cortex and medulla.¹³⁻¹⁶ In deaths due to drowning, out of 5 cases with microscopic hemorrhage in the substance of suprarenal glands, 4 (80%) cases showed hemorrhage only in the cortex, no cases showed hemorrhage only in the medulla and in one case (20%) hemorrhage was seen in both cortex and medulla.¹⁷⁻²⁰

5. Conclusion

The present study demonstrates that definite histopathological alterations occur in the suprarenal glands in substantial proportion of asphyxia deaths, with suprarenal hemorrhage observed in 62.27% of cases. Among the different types of asphyxia, all cases of hanging in this study were suicidal in nature. It is noteworthy that in certain instances of hanging, external signs such as ligature marks on the neck may be faint. In such circumstances, positive histopathological findings in the suprarenal glands may provide supportive evidence in determining the cause of death.

Furthermore, the observations suggest a possible association between mental stress or agony preceding death and its impact on the suprarenal glands, thereby offering additional supportive evidence alongside other autopsy

findings in the diagnosis of asphyxia deaths. Hanging emerged as the most common form of asphyxia death and remains a predominant method of suicide. The findings of this study may aid in correlating histopathological changes in the suprarenal glands with the gross features of hanging, thereby enhancing the accuracy of medico-legal importance.

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