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The Morphometric Analysis of Human Adrenal Glands of Hanging and Poison Suicidal Death Cases in Different Age Group

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ABSTRACT

Introduction: Suicide is complex interactions of mood disorders and which has been around for as long as since the birth of human society and is one of the leading causes of death in India and all around the world. Adrenal glands are a pair of endocrine glands and target structure of the Hypothalamic Pituitary Adrenal axis and stress system. Stress plays an important role in affecting adrenal gland structure and function which may have a connection with suicidal behaviour in depressed individuals.

Objective: To analyze the morphometric changes in length, breadth, thickness and weight of human adrenal glands in hanging and poison death autopsy cases in different age groups.

Methods: Sample Size: 186 adrenals from 93 cadavers (52 hanging and 41 poison cases).

Study Design: Analytical –observational Study.

Study setting: The samples were collected from Post mortem centre at Sri Venkateswara hospital, Chittoor district and divided into three age groups like 20-30, 30-40, 40-50 years. A study was done at Peoples Education Society Institute of Medical Sciences and Research, Kuppam. Chittoor District. The length, breadth, thickness and weight of the samples were measured and results were compared between hanging(sudden death) and poison death(delayed death) autopsy cases.

Sampling Technique: Simple random sampling

Inclusion Criteria: Both genders of Hanging and poison death cases, 3 Age group 20-30 years, 30-40 years and 40-50 years and time of autopsy in between 12-24 hours after death were included.

Exclusion Criteria: The Adrenal abnormalities, Chronic debilitating illness, Decomposed autopsy cases, Pregnant women, Accident cases, Burns cases, Age group less than 20 and more than 50 years, Commence of autopsy less than 12 hrs and more than 24 hrs were excluded.

Results: In our study, we found that the length and breadth of right and left adrenal glands were significantly different in the 31-40 years group when compared to the other two groups. There was a significant difference in thickness of the right adrenal gland when compared with the left adrenal in the group of 31-40 years. When compared to the weight of right adrenals, there was a significant difference in the weight of the left adrenal in the age group of 31-40 years.

Conclusion: The length, breadth, thickness and weight of the left and right adrenal glands were significantly different in the 31-40 years age group and the values of parameters in hanging cases were high compare with poison cases in overall estimation.

Key Words: Adrenal gland, Hanging, Poison, Stress, Suicide

INTRODUCTION

Suicide is the outcome of complex interactions of biological,

psychological, and environmental factors. It is an enormous public health problem in the United States and all around the

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world. Each year over 30,000 people in the United States and nearly 900,000 people worldwide die by suicide, making it one of the leading causes of death.^{1,2}

It is the leading cause of death among teenagers and adults 15 to 49 years of age ranked among the top 13 causes of death for individuals of all ages worldwide by World Health Organization (WHO)³ and the National Safety Council rates it sixth in the United States.⁴

Eighty-four per cent of suicides occur only in India and China in the world.⁵ The World Health Organization reported that about 170,000 people die from suicide in India. However, India's National Crime Records Bureau (NCRB) – which report official suicide rates based on police reports – estimated only 135,000 suicides in the year 2017.⁵ Worldwide, more than 9 million deaths are annually reported of suicide, 20% are Indians, for 17% of the world population. Suicide is one of the three leading causes of death among people aged between 15–44 years in some countries and the second-leading cause of death aged between 10–24 years; these figures do not include the suicide attempts, which are up to 20 times more frequent than completed suicide.⁶

Adrenal glands (AG) are a pair of endocrine glands yellowish-brown in colour due to their content of lipids which are important for the sustainability of life to provide the general physiological organization of the organism in the body. AG also being known as adrenals, suprarenal or suprarenal gland is just due to its locations related to the kidneys.^{7,8}

AG are triangular-shaped endocrine glands located on the posterior wall of the abdomen on the antero-superior aspect of the upper end of each kidney at the L1 vertebrae level. Each gland measures 5 cm in length, 3 cm in breadth, 1 cm in thickness and 5 gm weight.⁹⁻¹¹ Right adrenal gland (RAG) is a pyramid-shaped gland that is located close to the inferior vena cava (IVC) which connected by the right adrenal vein and is in strong contact with the uncovered area of the liver. The left adrenal gland (LAG) is semilunar shaped and slightly longer and wider compared to the right one. It is neighbored by the abdominal aorta and the cardiac end of the stomach. The anterior surface of the gland is related to the pancreas, splenic artery and with spleen partially in the Lower part

The shape and structure of the glands can change due to many diseases. Clinical studies have shown that stress plays an important role in affecting adrenal gland structure and function. In particular, adrenal gland size is partially regulated by adrenocorticotrophic hormone (ACTH) stimulation¹², which is known to regulate stress corticosterone levels during the hypothalamic-pituitary-adrenal (HPA) axis activation due to acute physical or mental stress.¹³ Elevation of plasma cortisol level and enlargement of adrenals have been found in those who suffer from chronic stress and in depressed pa-

tients¹⁴, and increases in adrenal weight have been found in individuals who have committed suicide.¹⁵

The present study aims to analyze the morphometric changes in the dimensions of adrenal glands such as length, breadth, thickness and weight in hanging which belongs to chronic stress sudden death and poison which belongs to chronic stress and delayed death after intake of poison. This study will be useful for forensic surgeons, Forensic Pathologist and the Medico-legal fraternity to determine the changes in adrenals.

MATERIALS AND METHODS

The analytical comparative study was done after approval by the institutional human ethical committee at PES institute of medical sciences and research, Kuppam, Chittoor district. A total of 186 suprarenal glands obtained from 93 autopsy cadavers those belongs to hanging (52 cases) and poison (41 cases) and age between 20 to 50 years were included in this study and divided into three age groups such as 20-30 yrs (43 cases), 31-40 yrs (26cases) and 41-50 yrs (24 cases) when undergone postmortem examination in Sri Venkateswara hospital, Tirupati, Chittoor district, Andhra Pradesh in the years 2018 and 2019. The usual dissection kit was used to clean and dissect the adrenal gland specimens after stored in 10% formalin for preservation and fixation for up to twelve to twenty-four hours to prevent autolysis, to reduce the shrinkage and distortion (IHEC no-21).

The length, breadth, thickness of the right and left adrenal glands were measured with Vernier calliper and the weight of the glands were checked with a digital weighing machine with an accuracy of 0.1mg (Shimadzu AY220 Analytical balancer max 220gm min 10mg, Mettler-Toledo India Private Limited Mumbai e=1mg d=0.1mg) after dissecting the suprarenal glands meticulously by removing the surrounding fat and fascia. The lengths of both right and left adrenal glands were measured at the base of the gland (Figure 1), the part which is related to kidneys. The breadth of the right adrenal gland was measured from apex to base (Figure 2). The breadth of the left adrenal gland was measured at the level of the middle of the gland. The thickness of the glands was measured at the level of the hilum of both glands to maintain the uniformity where the suprarenal vein is coming out of the glands (Figure 3). The weight was measured with the digital weighing machine with an accuracy of 0.1mg (Figure 4).

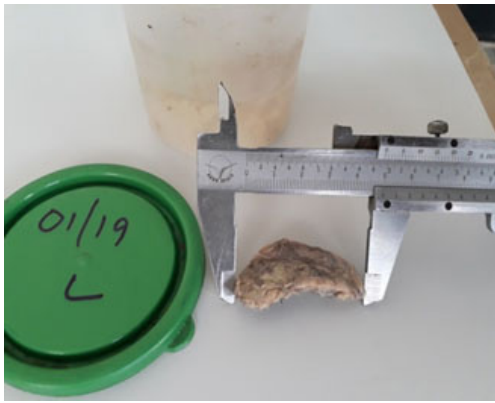


Figure 1: Measurement of Length.



Figure 2: Measurement of Breadth.



Figure 3: Measurement of Thickness.



Figure 4: Weight of the Adrenal Gland.

Inclusion Criteria

Both genders of suicidal (Hanging and poison) death cases

3 Age group 20-30 years, 30-40 years and 40-50years

Time of autopsy in between 12-24 hours after death

Exclusion Criteria

Adrenal abnormalities

Chronic debilitating illness

Decomposed autopsy cases

Pregnant women

Accident cases

Burns

Age group less than 20 and more than 50

Commence of autopsy less than 12 hrs and more than 24 hrs.

Statistical Analysis

An Independent t-test was performed using the Statistical Package for Social Sciences (SPSS) for Window version 21.0 software. Values of $p < 0.05$ was considered to be significant.

RESULTS

Data depicted in Table-1 represent the age-wise distribution of suicidal and accidental hanging and poisoning cases. Among the 93 cases, 43 were 20-30 years, -26 were 31-40 years and 24 were 41-50 years. The age Grade representing (20-30 years) has the highest incidence of suicidal cases (Hanging 31% and Poison 15%) accounting for (46%) in the younger age group, the 2nd highest incidence of suicidal cases (Hanging 16 % and Poison 12%) accounting to (28%) in the age group 31-40 years and least incidence of suicidal cases in older age group i.e. 41 to 50 years.

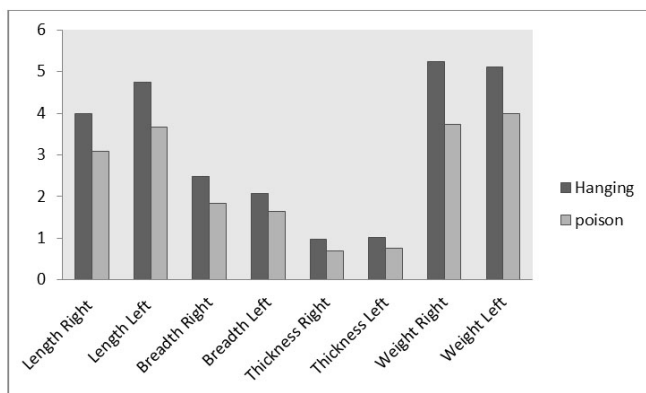
Table 1: Age distribution of death cases

Age limit in years	Suicide type		Percentage
	Hanging	Poison	
20-30	29(31%)	14(15%)	43(46%)
31-40	15(16%)	11(12%)	26(28%)
41-50	8(9%)	16(17%)	24(26%)
Grand Total	52(56%)	41(44%)	93(100%)

Table 2 and graph 1 shows the length, breadth, thickness and weight of right and left adrenal glands of both hanging and poison suicidal cases. It is evident that the number of hanging suicidal case is high, maximum in the younger age group and the 2nd highest incidence in poison suicidal case, maximum in the older age group

Table 2: The comparison of length, breadth, thickness and weight of right and left adrenal glands of hanging and poison suicidal cases in 20-50 years and 12-24hours after death, values are expressed as Mean±SD in CMs and weight in gms

Parameter	Type	N	Mean ± SD	P-value
AG Length Right	Hanging	52	4.0 ± 0.55	0.001
	Poison	41	3.09 ± 1.69	
AG Length Left	Hanging	52	4.74 ± 0.55	0.001
	Poison	41	3.66 ± 1.97	
AG Breadth Right	Hanging	52	2.48 ± 0.48	0.001
	Poison	41	1.83 ± 1.03	
AG Breadth Left	Hanging	52	2.07 ± 0.33	0.002
	Poison	41	1.63 ± 0.95	
AG Thickness Right	Hanging	52	0.97 ± 0.22	0.001
	Poison	41	0.70 ± 0.43	
AG Thickness Left	Hanging	52	1.01 ± 0.22	0.001
	Poison	41	0.75 ± 0.42	
AG Weight Right	Hanging	52	5.23 ± 1.35	0.001
	Poison	41	3.72 ± 2.18	
AG Weight Left	Hanging	52	5.1 ± 1.0	0.003
	Poison	41	3.99 ± 2.4	



Graph 1: The comparison of length, breadth, thickness and weight of right and left adrenal glands of hanging and poison suicidal cases in 20-50 years. Y axis represents values in cm.

Table 3 shows the length of the right and left adrenal gland in different age group, the young age groups (20-30 years) show a higher length than the other two age groups. The right and left adrenal length of suicidal death cases were compared age-wise. There was a significant difference in the 20-30 years age group (P < 0.001) and 41-50 years age group (P < 0.001) of both hanging and poison suicidal cases. There was no significant difference in the 31-40 years age group.

Table 3: Length of right and left adrenal gland in different age group

Age Group	Parameter	Type	N	Mean ± SD	P-value
20-30	AG Length Right	Hanging	29	4.04 ± 0.60	0.001
		Poison	14	1.8 ± 1.94	
	AG Length Left	Hanging	29	4.92 ± 0.57	0.001
		Poison	14	2.16 ± 2.33	
31-40	AG Length Right	Hanging	15	3.93 ± 0.53	0.08
		Poison	11	2.99 ± 1.95	
	AG Length Left	Hanging	15	4.44 ± 0.43	0.09
		Poison	11	3.44 ± 2.17	
41-50	AG Length Right	Hanging	8	2.01 ± 2.09	0.001
		Poison	16	3.98 ± 0.5	
	AG Length Left	Hanging	8	2.33 ± 2.42	0.001
		Poison	16	4.76 ± 0.44	

Table 4 shows the breadth of the right and left adrenal gland in different age group, the middle age groups (20-30 years) of the right adrenal show a higher breadth than the other two age groups. The right and left adrenal breadth of suicidal death cases were compared age-wise. There was a significant difference in both right and left adrenal in the 20-30 years age group (P < 0.001) and 41-50 years age group (P < 0.004 & P < 0.001) respectively, of both hanging and poison suicidal cases. But there was no significant difference in the 31-40 years age group.

Table 4: Breadth of right and left adrenal gland in different age group

Age Group	Parameter	Type	N	Mean ± SD	P-value
20-30	AG Breadth Right	Hanging	29	2.43 ± 0.49	0.001
		Poison	14	1.17 ± 1.26	
	AG Breadth Left	Hanging	29	2.08 ± 0.32	0.001
		Poison	14	0.86 ± 0.93	
31-40	AG Breadth Right	Hanging	15	2.58 ± 0.51	0.34
		Poison	11	1.61 ± 1.04	
	AG Breadth Left	Hanging	15	2.05 ± 0.51	0.26
		Poison	11	1.7 ± 1.15	
41-50	AG Breadth Right	Hanging	8	1.23 ± 1.31	0.004
		Poison	16	2.3 ± 0.49	
	AG Breadth Left	Hanging	8	1.04 ± 1.1	0.001
		Poison	16	2.15 ± 0.42	

Table 5 shows the thickness of the right and left adrenal gland in different age group, the younger age groups (20-

30 years) shows a higher thickness than the other two age groups. The right and left adrenal thickness of suicidal death cases were compared age-wise. There was a significant difference in both right and left adrenal in the 20-30 years age group ($P < 0.001$) and the 41-50 years age group ($P < 0.001$) of both hanging and poison suicidal cases. But there was no significant difference in the right adrenal glands when compared to the left adrenal in the 31-40 years age group.

Table 5: Thickness of right and left adrenal gland in the different age group

Age Group	Parameter	Type	N	Mean ± SD	P-value
20-30	AG Thickness Right	Hanging	29	1.05 ± 0.23	0.001
		Poison	14	0.4 ± 0.48	
	AG Thickness Left	Hanging	29	1.02 ± 0.22	
		Poison	14	0.47 ± 0.51	
31-40	AG Thickness Right	Hanging	15	0.87 ± 0.18	0.17
		Poison	11	0.69 ± 0.46	
	AG Thickness Left	Hanging	15	1.0 ± 0.25	
		Poison	11	0.71 ± 0.45	
41-50	AG Thickness Right	Hanging	8	0.42 ± 0.45	0.001
		Poison	16	0.9 ± 0.23	
	AG Thickness Left	Hanging	8	0.46 ± 0.49	
		Poison	16	0.93 ± 0.18	

Table 6 shows the weight of right and left adrenal gland in different age group, the older age groups (40-50 years) shows a lower weight than the other two age groups. The right and left adrenal weight of suicidal death cases were compared age-wise. There was a significant difference in both right and left adrenal in the 20-30 years age group ($P < 0.001$) and the 41-50 years age group ($P < 0.001$) of both hanging and poison suicidal cases. But there was no significant difference in the left adrenal glands when compared to the right adrenal in the 31-40 years age group.

Table 6: Weight of right and left adrenal glands in the different age group

Age Group	Parameter	Type	N	Mean ± SD	P-value
20-30	AG Weight Right	Hanging	29	5.29 ± 1.25	0.001
		Poison	14	2.19 ± 2.46	
	AG Weight Left	Hanging	29	5.34 ± 1.11	
		Poison	14	2.34 ± 2.79	
31-40	AG Weight Right	Hanging	15	5.29 ± 1.72	0.02
		Poison	11	3.45 ± 2.33	
	AG Weight Left	Hanging	15	4.8 ± 0.97	
		Poison	11	4.03 ± 2.77	

Table 6: (Continued)

Age Group	Parameter	Type	N	Mean ± SD	P-value
41-50	AG Weight Right	Hanging	8	2.47 ± 2.63	0.002
		Poison	16	4.86 ± 1.13	
	AG Weight Left	Hanging	8	2.38 ± 2.5	0.001

DISCUSSION

In our study, we found that the right and left adrenal length and breadth have significantly differed in the 31-40 years group when compared to the other two groups. There was a significant difference in thickness of the right adrenal gland when compared with the left adrenal in the group of 31-40 years. When compared to the right weight of the adrenal, there was a significant difference in the left weight of adrenal in the age group of 31-40 years.

Probably, the reason or maximum sufferers in the age group of 31-40 years is due to a sudden emotional outburst, early marriage, frustration, failure to cope with stress and strain of life at middle age, poverty, unemployment etc. HPA and sympathetic adrenomedullary axis are the systems mainly involved in maintaining homeostasis during the stress response, and the adrenal is essential to the stress responding organ common to both systems.

Dorovini-Zis K and Zis AP had done an investigation on the expanded adrenal gland in casualties of suicide among the Canadian population, and adrenal gland weight was significantly higher in victims of violent suicide than those who died suddenly from an accidental cause. The mean±SD joined weight of both adrenal glands was fundamentally higher for the suicidal group (9.77±1.74 g) than for the accidental group (7.74±0.82g).¹⁶ These results have a resemblance with our study results which analyzed individually.

Szigethy E et al. had examined ‘Adrenal weight and morphology in victims of suicide’ and their outcomes demonstrated a positive relationship like our study between’s adrenal weight and total cortical thickness in both left and right glands, giving direct proof that expanded adrenal weight in suicide victims is because of cortical hypertrophy.¹⁷ Previous studies have shown that more patients with depression had increased plasma cortisol level and enlargement of adrenals.¹⁸⁻²⁰ Depression is a stress-related disorder and it is one of the common cause of suicide. Many depressed patients have altered Hypothalamic Pituitary Adrenal (HPA) axis physiology that is characterized by increased HPA axis functional activity²¹ and enlargement of adrenal glands.²²

Many studies showed that this increase in adrenal weight is associated with the increased size of the adrenal cortex²³, and

many depressed patients have exaggerated cortisol responses after ACTH administration. Furthermore, the level of glucocorticoids has been connected with the severity of depression which indicating that alterations in structure and function of the HPA axis may also be relevant and these alterations have a connection with depression and suicidal thoughts.²⁴ Arpita Sarkar et al found in their study that the adrenal glands on the right side had a mean weight for suicide group 9.57 grams and accidental group 6.64 grams, and adrenal gland of left side had mean weight for suicide group of 10.06 grams and in the accidental group was 7.13 grams. The mean and the standard deviation for the weight of right and left adrenal glands were significantly higher for the suicide group than the control group which corroborates with the findings of this study.²⁵

CONCLUSION

Considering the basic role of adrenalin coping up with stress, the human model of morphological study of the adrenal gland has been taken up to correlate the morphological (Adrenal length, breadth, thickness and weight) features in the confirmed suicidal cases. There was a significant difference in right and left adrenal length and breadth in the 31-40 years group. There was a significant difference in the right thickness of the adrenal gland when compared with the left adrenal in the group of 31-40 years. When compared to the right weight of the adrenal, there was a significant difference in the left weight of the adrenal in the age group of 31-40 years. Further works in this regard are needed in showing more light on the medico-legal problems occurring from time to time. Thus this present study concludes that there was a difference in length, breadth, thickness and weight in the age from 31-40 years.

Ethical approval and consent to participate: The ethical approval obtained from the institutional human ethical committee at PES institute of medical sciences and research and consent from blood relatives of deceased during the autopsies (IHEC no-21)

Consent to publish: Applicable

Author's contribution: Project development, data collection and management, data analysis and manuscript writing¹ data analysis, manuscript editing and overall supervision²., Data analysis and manuscript editing³., Data analysis and manuscript editing⁴., Collection of samples, data analysis, manuscript editing⁵., Statistical analysis.⁶ All authors have read and approved the manuscript.

Availability of Data and materials

Please contact the author for data request (Manivannan- e-mail Address: maniroopaa@gmail.com)

Declaration of Competing Interest: The authors have declared that they have no competing interests.

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