Histomorphometric Study of the Proportion of Cortex and Medulla of the Adrenal Gland-A Postmortem Study

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Abstract

Background: The human adrenal gland shows a distinct proportion of two histological zones, named the cortex and the medulla, from outer inwards, in its histological appearance with differences in its cellular components and functions. Objective: The present study aims to see the variation in the proportion of the cortex and the medulla of the adrenal glands with age in a Bangladeshi population. Methods: A cross-sectional, descriptive study was done in the Department of Anatomy, Dhaka Medical College, Dhaka, from July 2008 to June 2009, based on collection of 140 postmortem human adrenal glands from 70 unclaimed dead bodies, in the Department of Forensic Medicine, Dhaka Medical College, Dhaka. The samples were divided into four age-groups including A (11-20 years), B (21-30 years), C (31-40 years) & D (41-60 years). Histological slides were prepared by using routine haematoxylin and eosin stain (H & E). Five best prepared slides from each group were examined under light compound microscope with low magnification. The thickness of adrenal cortex and medulla were measured by using ocular and stage micrometer and then converted into percentage volume. Results: The mean volume of the right adrenal cortex were found 83.64±3.71% in group A, 83.90±1.75% in group B, 83.74±5.78% in group C, 84.80±3.82% in group D, while the mean volume of the corresponding medulla were found 18.16±3.23% in group A, 15.70±2.71% in group B, 16.26±3.97% in group C, 16.20±4.04% in group D. The mean volume of the left adrenal cortex were found 84.64±3.49%, 84.90±1.75%, 84.20±3.40%, 85.44±2.66% in group A, B, C and D respectively, while the mean volume of the corresponding medulla were found 17.26±3.84%, 17.00±2.37%, 16.00±3.20% and 14.36±2.33% in group A, B, C and D respectively. The differences among the groups were not statistically significant. Conclusion: No difference was found in the proportion of the cortex and the medulla of adrenal gland in different age-groups.

Key wards: Human adrenal gland, Adrenal cortex, Adrenal medulla.

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Introduction

The adrenal gland is composed of two distinct portions: an outer cortex (mesodermal origin) and an inner medulla (neuroectodermal origin)1. The medulla is completely enclosed by the cortex, except at the hilum2. The collagenous connective tissue capsule that covers the adrenal gland sends thin septa to the interior of the gland as trabeculae1,2. The stroma consists of rich network of the reticular fibres that support the secretory cells1. The central portion of the adrenal gland, the medulla, is composed of endocrine parenchymal cells i.e. chromaffin cells, along with connective tissue, numerous blood vessels and nerves1. The chromaffin cell, named for the yellow-brown colour imparted to its epinephrine containing granules by chromatic salts, is the major cell type in adrenal medulla3. Chromaffin cells are rounded or polygonal and arranged in nests or cords1-3. However, when specific immunostains are used, chromaffin cells have been found in the human adrenal cortex and cortical cells have been found in the adrenal medulla, which provides a cellular basis for potential intraadrenal interactions4. Hence, controversies prevail in the accurate histological proportion of the cortex and medulla in adrenal gland. Therefore, a sound knowledge on proportion of cortical and medullary regions of the adrenal gland is essential for clinical decision making in endocrinology, pathology, radiology and surgery for better diagnosis and management of diseases of this essential organ. The present study aims to see the variation in the proportional volume of the cortex and the medulla of the adrenal glands with advancing age in a Bangladeshi population and compare with the previous studies and available text references.

Materials and methods

A cross-sectional, descriptive study was done in the Department of Anatomy, Dhaka Medical College, Dhaka, between July 2008 and June 2009, to see the variation in the proportion of the cortex and the medulla of the adrenal glands in different age-groups in a Bangladeshi population. The study was based on collection of 140 postmortem human adrenal glands collected from 70 unclaimed dead bodies which were in the morgue under examination in the Department of Forensic Medicine, Dhaka Medical College, Dhaka. All the samples were collected within 24-36 hours of death without any sign of putrefaction and taken from medicolegal cases excluding poisoning, any cutting or crushing injury to the adrenal glands, and adrenal glands found in one side and diseased. Grouping of the Sample: For convenience of description of various changes of the adrenal gland in relation to age, the collected samples were divided into four groups including A (11-20 years), B (21-30 years), C (31-40 years) & D (41-60 years), according to Kangarloo et al.5.

Procedure of histological study: The tissue blocks of the adrenal glands were fixed in 10% formol saline in a plastic container. The tissues were washed in running tap water, dehydration was done with ascending grades of alcohol, cleared with xylene, infiltrated and embedded in paraffin. Paraffin blocks were cut at 5μm thickness and were stained with routine Harris’ Haematoxylin and Eosin (H & E) stain. All the measurements were taken by using an Olympus CHB light microscope, made in Tokyo, Japan. At first, the thickness of the adrenal cortex and medulla were determined (Fig. 1). For measuring the thickness of cortex and medulla of adrenal gland 5 best prepared slides were selected from each group.
Hence, a total of 20 slides were examined low magnification (10 objectives, 10 eyepiece). Three different fields were chosen for measuring the thickness from each slide. The thickness was measured by using a stage micrometer and an ocular micrometer.

**Fig. 1.** Photomicrograph of the human adrenal gland showing the extent of cortex and medulla, taken from group B (21-30 years), (×100 magnification) (H & E stain).

Three measurements were taken for each slide and the average was recorded. The stage micrometer calibration was focused under the objective to be used and the ocular micrometer calibration was superimposed on them in such a way that starting mark on the ocular micrometer matched exactly with a starting mark on the stage micrometer. Then the marker on the stage and ocular micrometer that corresponds to each other most closely was noted. Then determination of how many of the smallest division of the ocular micrometer corresponded with how many smallest division of the stage micrometer was done, according to Nurunnabi et al.6. After getting the thickness in µm, it was converted into percentage proportion which signifies percentage volume of cortex and medulla as well.

**Statistical processing of data:** The data collected were processed and statistical analyses were done by using SPSS version 13.0. The comparison between the right and the left was done by unpaired Student’s ‘t’ test and in between different groups by One-way ANOVA.

**Ethical Clearance:** The present study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

**Results**

Proportion (percentage volume) of the right and left adrenal cortex: In the present study, the mean percentage volume of the right adrenal cortex were found 83.64±3.71% in group A, 83.90±1.75% in group B, 83.74±5.78% in group C, 84.80±3.82% in group D (Table 1, Fig. 2). Besides, the mean percentage volume of the left adrenal cortex were found 84.64±3.49%, 84.90±1.75%, 84.20±3.40%, 85.44±2.66% in group A, B, C and D respectively (Table 1, Fig. 2). The difference between the groups was not statistically significant (P>0.05).

Proportion (percentage volume) of the right and left adrenal medulla: The mean percentage volume of the right adrenal medulla were found 18.16±3.23% in group A, 15.70±2.71% in group B, 16.26±3.97% in group C, 16.20±4.04% in group D (Table 2, Fig. 2). Besides, the mean percentage volume of the left adrenal medulla were found 17.26±3.84%, 17.00±2.37%, 16.00±3.20% and 14.36±2.33% in group A, B, C and D respectively (Table 2, Fig. 2). The difference between the groups was not statistically significant.
Table 01: Percentage volume of right and left adrenal cortex in different age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>Right Mean±SD</th>
<th>Left Mean±SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (11-20 years)</td>
<td>83.64±3.71 (78.20-88.00)</td>
<td>84.64±3.49 (79.00-88.20)</td>
<td>&gt;0.50ns</td>
</tr>
<tr>
<td>B (21-30 years)</td>
<td>83.90±1.75 (82.00-85.50)</td>
<td>84.90±1.75 (83.00-86.50)</td>
<td>&gt;0.10ns</td>
</tr>
<tr>
<td>C (31-40 years)</td>
<td>83.74±5.78 (74.00-88.20)</td>
<td>84.20±3.40 (79.00-88.50)</td>
<td>&gt;0.50ns</td>
</tr>
<tr>
<td>D (41-60 years)</td>
<td>84.80±3.82 (79.00-88.50)</td>
<td>85.44±2.66 (82.00-88.20)</td>
<td>&gt;0.50ns</td>
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</tbody>
</table>

Table 02: Percentage volume of right and left adrenal medulla in different age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>Right Mean±SD</th>
<th>Left Mean±SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (11-20 years)</td>
<td>18.16±3.23 (15.00-22.00)</td>
<td>17.26±3.84 (14.00-21.80)</td>
<td>&gt;0.50ns</td>
</tr>
<tr>
<td>B (21-30 years)</td>
<td>15.70±2.71 (13.50-18.00)</td>
<td>17.00±2.37 (14.50-20.00)</td>
<td>&gt;0.50ns</td>
</tr>
<tr>
<td>C (31-40 years)</td>
<td>16.26±3.97 (12.00-21.00)</td>
<td>16.00±3.20 (13.50-21.00)</td>
<td>&gt;0.50ns</td>
</tr>
<tr>
<td>D (41-60 years)</td>
<td>16.20±4.04 (12.00-21.00)</td>
<td>14.36±2.33 (22.00-28.00)</td>
<td>&gt;0.50ns</td>
</tr>
</tbody>
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Figures in the parentheses indicate range. Comparison between right and left side done by unpaired Student’s ‘t’ test and comparison between different age groups done by One-way ANOVA (PostHoc), ns = not significant.
Discussion

According to Kopin7, adrenal medulla constitutes 5%-10% and cortex constitutes 90%-95% of the gland. Fawcett8 and Nussey & Whitehead9 mentioned that the outer cortex accounts for about 80%-90% and inner medulla for 10%-20%. According to O’Brien3 and Aron et al.10, the outer cortex comprises 90% and the inner medulla constitutes 10% of the total glandular volume. Barrett et al.11 mentioned that the cortex constitutes 72% and the medulla is 28% of the mass of the adrenal gland. Hall12 reported that the adrenal medulla constitutes the central 20% and the outer cortex is about 80% of the gland. Roy13 stated that the adrenal cortex is bright yellow (90%) and much thicker than the medulla (10%), which is reddish brown. According to Gartner & Hiatt14, the outer cortex accounts for about 80%-90% and medulla for 10%-20% of the volume of the adrenal glands. In the present autopsy-based study, on an average the volume of cortex and medulla were found 83.64-85.44% and 14.36-18.16% respectively in human adrenal glands. Our findings are similar to those reported by Fawcett 8, Nussey & Whitehead9, Hall12 and Gartner & Hiatt14, but slightly deviated from as described by Kopin7, O’Brien3, Aron et al.10 and Roy13 and much lower than that of Barrett et al.11. However, there is no previous study in our country on proportion of the cortex and the medulla of human adrenals, as to compare with the present study.

Conclusion

No difference was found in cortex and medulla of adrenal gland in different age-groups. To our knowledge, this is the first ever study in our country on determining the proportion of cortex and medulla of the adrenal gland. However, further studies with larger samples and advanced stereological techniques are recommended. The results of the present study can be used as a standard reference for the adrenal glands of Bangladeshi people and to determine the abnormal evidence in pathological cases.
Acknowledgement

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References