Estimation of Pineal Gland Volume for Normal Adult Sudanese Using MRI

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Abstract: In present study, we established the volume of the pineal gland and it shapes in normal Sudanese adult using Magnetic Resonance Imaging. 159 consecutive patients scanned for Brian with MRI to pineal region by use MRI machine 1.5T the sequence was 3D-T1. Detailed Demographic Information of Population including: age, gender, weight, height, and BMI was recorded. The Disk Summation Method (DSM) used to measure the normal pineal gland in normal individuals, and the shape of pineal gland were evaluated in Axial & Sagittal images. The results shows that the pineal gland volume shows slightly difference between the gender were the female 0.135±0.0063 cm3 and for the male 0.137±0.0063 cm3, using analysis of variance test for the age with body mass index BMI and the pineal gland volume were the p value show there is significant difference between the body mass index 0.000 and pineal gland volume 0.037 with age. The distribution of shape of pineal gland showed three different shape pear, fusiform and cone shape were the pear shape found in 22 case with percentage 13.8%, the fusiform shape found in 61 case with percentage 38.4% and the cone shape in 76 case with percentage 47.8%. The pineal gland volume can be estimated using the following linear equations: pineal gland V = 0.0004 (Age/lys) + 0.1262, pineal gland V= 0.0012 (BMI) + 0.1104 in our study, the mean ± S.D pineal gland volumes using Disk Summation Method were found to be 0.136 ±0.007 cm3 also the different morphologic Characteristics of the pineal gland were found three shapes in normal Sudanese adult pear shape 14%, fusiform shape 38% and cone shape 48% from total sample.

Keywords: Pineal gland volume, Disk Summation Method, morphologic Characteristics of pineal gland

1. Introduction

The pineal gland also called the pineal body, epiphysis cerebri, epiphysis or the “third eye: is a small reddish-grey pine cone-like endocrine gland of a major regulatory importance located in between the superior colliculi. It is inferior to the splenium of the corpus callosum from which it is separated by the telachoroidea of the third ventricle and the contained cerebral veins. The pineal is about 8 mm long. Septa extend into the pineal gland from the surrounding pia mater [1].

To the present day, the functions of the pineal gland are not fully understood. Unlike most parts of the brain, it lies outside the blood-brain barrier and is not separated from the bloodstream. Current knowledge indicates that by secretion of melatonin, the pineal gland plays an important role in the regulation of the sleep-wake cycle and of reproductive function (e.g. onset of puberty) [2], with melatonin also acting as a neuroprotector or antioxidant [3, 4]. Anatomically, the pineal gland is a rounded or crescent-shaped structure like a pine cone and it is attached by the stalk to the diencephalon and the stalk lines the pineal recess whose inferior lip links the pineal gland to the posterior commissure, and superior lip to the habenular commissure [5]. It has been stated that the pineal gland grows in size from birth until two years of age and then remains constant between 2 to 20 years of age [6]. Formerly, it was believed that the pineal gland played an important functional role in the onset of puberty [7, 8].

The size is individually variable and the average weight of pineal gland in human is around 150 mg [9], the size of a soybean. Pineal glands are present in all vertebrates [10]. Pineal-like organs are also found in non-vertebrate organisms such as insects [11-13]. It appears that the sizes of pineal glands in vertebrates are somehow associated with survival in their particular environments and their geographical locations. The more harsh (colder) their habitat, the larger their pineal glands are. A general rule is that the pineal gland increases in size in vertebrates from south to north or from the equator to the poles [14].

Recent advances in MRI imaging have led to the development of novel gradient echo (GRE) imaging techniques such as SWMR, which is based on magnetic susceptibility and sensitive to materials distorting the local magnetic field. SWMR allows for a reliable differentiation of calcifications from tissue artifacts, hemorrhage and other causes of susceptibility differences by using T2. Diagnostic accuracy of SWMR for the evaluation of pineal gland calcification weighted magnitude and GRE filtered-phase information to generate a unique contrast [15-19].

Some of radiological studies of the pineal gland have been mainly conducted by computed tomography (CT) on pineal calcification over different populations of healthy subjects [20, 21]. There have been a few studies about pineal volume estimation using different methods such as elliptic approaches and ROI on MRI [22–23].

2. Material and Methods

159 consecutive patients (male=93, Female 66) their ages were between (19-31) years who had undergone 3D-T1 Brian MRI Scan were obtain at period (11) Months between July/2017 to June/2018 for study purpose. Excluded Patients were those who had mid brain & endocrine diseases. Detailed Demographic Information of Population including: age, gender, weight, height, and BMI was recorded.
MRI machine Toshiba ™ 1.5 T as used at Al-Mouleem Hospital, the sequence Were: Ultrafast Gradient Echo 3D with preparation Pulse T1W (3D-FEE) SENSE + head Coil ;Specific Absorption Rate =0.3199, Flip Angle 30 degree, ETL=1 Echo No.=1, Slice Thickness =1.6mm, Gap Between Slice = 50%.TR=0.8ms / TE = 2.6ms.Matrix 256 px X 256 px.

The Disk Summation Method (DSM) used to measure the normal pineal gland in normal individuals. In DSM the measurement is dependent on the picture element (pixel-px), by counting the total number of pxs per Area (ROIs which the pineal gland appear excluding the rest of FOV) and is representing in (px)².that was done by multiplying the (px)² by conversion factor. Than multiplying the product by slice thickness in (mm), which represents slice height an Z-axis, and consequently the product is unit of volume (mm)³ for single slice. Than dividing the value in (mm)³ over 100 to convert to (cm)³.

\[ A_{(mm)^2} = px^2 \times \text{conversion factor} \]
\[ \text{Volume in (cm)^3} = \frac{A_{(mm)^2} \times \text{Slice Thickness (mm)}}{1000} \]

The pineal gland shape was evaluated in Axial & Sagittal image plane for ALL including patients. The shape describe as pear shape: tapered at the top and wider at bottom, fusiform shape: like spindle wider in the middle and tapering lowered the ends. And cone shape: smoothly from a flat base to appoint called apex or vertex.

Variables including height ; which was measured in (cm) ; weight in (Kg), Age (yrs), and gender (Male and Female) were evaluated, For measuring dependent variable Body Mass Index (BMI) Calculate by use :

\[ BMI= \frac{\text{weight}}{(height)^2} \times 100 \]
Figure 3: Different shapes of the pineal gland seen through magnifying glass (1. pea shaped, 2. fusiform shaped, and 3. cone shaped)

Figure 4: The Axial (a) and Sagittal (b) MRI showed the Pear shape (c) of pineal gland

Figure 5: The Axial (a) and Sagittal (b) MRI showed the fusiform shape (c) of pineal gland

Figure 6: The Axial (a) and Sagittal (b) MRI showed the cone-shape (c) of pineal gland
3. Result and Discussion

This study adopts analytic cross-sectional design focuses on measure the volume of pineal gland and describes shape using MR images.

Table 1: Statistical descriptive for all patients:

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>STD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>24.98</td>
<td>25</td>
<td>2.92</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>High</td>
<td>177.98</td>
<td>177</td>
<td>8.63</td>
<td>159</td>
<td>195</td>
</tr>
<tr>
<td>Weight</td>
<td>69.71</td>
<td>70</td>
<td>9.41</td>
<td>51</td>
<td>93</td>
</tr>
<tr>
<td>BMI</td>
<td>21.89</td>
<td>22</td>
<td>1.42</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Volume</td>
<td>0.136</td>
<td>0.136</td>
<td>0.007</td>
<td>0.123</td>
<td>0.159</td>
</tr>
</tbody>
</table>

Table 1 shows statistical description for demographic information and volume for all patients as mean, median, standard deviation, minimum and maximum. For the age the mean ± standard deviation was 24.98±2.92, for patients high, weight, body mass index and the PINEAL GLAND volume was 177.98±8.63 cm³, 69.71±9.41 kg, 21.89±1.42 kg/cm² and 0.136±0.007 cm³ respectively.

Table 2: Show correlate the gender with pineal gland volume and patients information:

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Female</td>
<td>23.48</td>
<td>2.731</td>
<td>.341</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>25.96</td>
<td>2.589</td>
<td>.267</td>
</tr>
<tr>
<td>BMI</td>
<td>Female</td>
<td>21.36</td>
<td>1.384</td>
<td>.173</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>22.27</td>
<td>1.321</td>
<td>.136</td>
</tr>
<tr>
<td>Volume</td>
<td>Female</td>
<td>.134672</td>
<td>.0063130</td>
<td>.0007891</td>
</tr>
<tr>
<td>cm³</td>
<td>Male</td>
<td>.137690</td>
<td>.0064676</td>
<td>.0006671</td>
</tr>
</tbody>
</table>

In table 2. Presented compare the gender with pineal gland volume and patients information for the age the mean of female was 23.48 years and for male 25.96 years, the body mass index and the pineal gland volume shows slightly difference between the gender were the female 21.36 kg/cm² and the male 22.27 kg/cm², the pineal gland volume for female 0.135 cm³ and for male 0.137 cm³.

Table 3: Show the ANOVA test of BMI with volume of pineal gland

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>Between Groups</td>
<td>82.635</td>
<td>6.357</td>
<td>3.917</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>235.327</td>
<td>1.623</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>317.962</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 show ANOVA test for the body mass index and the pineal gland volume with age were the p-value show there is significant difference between the body mass index and the pineal gland volume with age.

Table 5: Show frequency and percentage distribution of shape of pineal gland:

<table>
<thead>
<tr>
<th>Shapes</th>
<th>Cases</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pear Shape</td>
<td>22</td>
<td>13.8</td>
</tr>
<tr>
<td>Fusiform Shape</td>
<td>61</td>
<td>38.4</td>
</tr>
<tr>
<td>Cone Shape</td>
<td>76</td>
<td>47.8</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>100</td>
</tr>
</tbody>
</table>

The distribution of shape of pineal gland showed three different shape, pear, fusiform and cone shape were the pear shape found in 22 case with percentage 13.8%, the fusiform shape found in 61 case with percentage 38.4% and the cone shape in 76 case with percentage 47.8%.

Figure 7: Show correlate between the pineal gland volume with patients age

Figure 7. show correlate between the pineal gland volume with patients age, and found that the volume increase with rate 0.0004 for each year.
Equation for the regression values between following linear equations:

The with percentage 47.8%. The case with percentage 38.4% and the cone shape in 7 case with percentage 13.8%
fusiform and cone shape were the pear shape found in 22 shape of pineal gland showed three different shape pear
volume were the p.

Some studies have found correlation between pineal volume and age (B. Sun et al 2009). In this study showed a significant difference between the Age and Pineal gland volume (P < 0.037). Also the results of (Niyazi Acer et al 2011) determined significant correlations between pineal volume and age.

(B. Sun et al -2009) was reported that pineal volume was 94.2 ± 40.65 mm³ in healthy young adults, (Nolte et al 2009) found that the pineal gland volume was 125 ± 54 mm³, (G. Bersani et al 2002) reported the pineal volume was 64.05 ± 20.69 mm³ for schizophrenics and 74.62 ± 33.53 mm³ for controls. In the present study, the mean ± S.D pineal gland volumes for Disk Summation Method were found to be 0.1364 ± 0.00655 cm³. From the present study notice the volume was higher than Nolte et al-2009, B. Sun et al -2009 and G. Bersani et al-2002 and this difference comes from the measurement methods for each studies.

For the pineal gland shape Kelly W et al 1984 the pineal gland is cone-shape while Berkovitz 1988 and Rogers et al 1992 found it as fusiform and pea shapes respectively.

4. Conclusion

Estimation of volume and shape of the pineal gland in normal adults, were the pineal gland volume shows slightly difference between the gender were the female 0.135±0.0063 cm³ and for the male 0.137±0.0063 cm³, using ANOVA test for the age with body mass index BMI and the pineal gland volume were the p. value show there is significant difference between the body mass index 0.000 and pineal gland volume 0.037 with age. The distribution of shape of pineal gland showed three different shape pear, fusiform and cone shape were the pear shape found in 22 case with percentage 13.8%, the fusiform shape found in 61 case with percentage 38.4% and the cone shape in 76 case with percentage 47.8%.

The pineal gland volume can be estimated using the following linear equations:

Equation for the regression values between pineal gland volume and patients age and body mass index:

$$y = 0.0012x + 0.1104$$

Pineal Gland Volume cm$^3$ = 0.0004 (Age/ys) + 0.1262

Pineal Gland Volume cm$^3$ = 0.0012 (BMI) + 0.1104

References


