International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Estimation of Pineal Gland Volume for Normal Adult Sudanese Using MRI

Mazin B. A. Hassib[1, 2], M. E. M. Garelnabi[1, 2], Ahmed B. A. Hassib[1], Suhaib Alameen[2]

[1]Faculty of Radiology and Medical Imaging Sciences - National University, Sudan-Khartoum

[2]College of Medical Radiologic Sciences- Sudan University of Science and Technology, Sudan-Khartoum

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 1.5 T 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 cm3and 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/ys) + 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 habitant, 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 T_1W (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 $(px)^2$.than the $(px)^2$ were converted into units of Area in $(mm)^2$.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 1000 to convert to $(cm)^3$.

This step above was applied to each separate slice to final the total volume of pineal gland. As shown in following equations:

$$A\ (mm)^2 = px^2 (Number\ of\ pixel\ with\ ROIs)\ X\ convert\ factor.$$

$$Volume\ in\ (cm)^3 = A(mm)^2 X\ Slice\ Thickness\ (mm)/1000.$$

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 :

$$BMI = weight / (height)^2 X\ 100$$

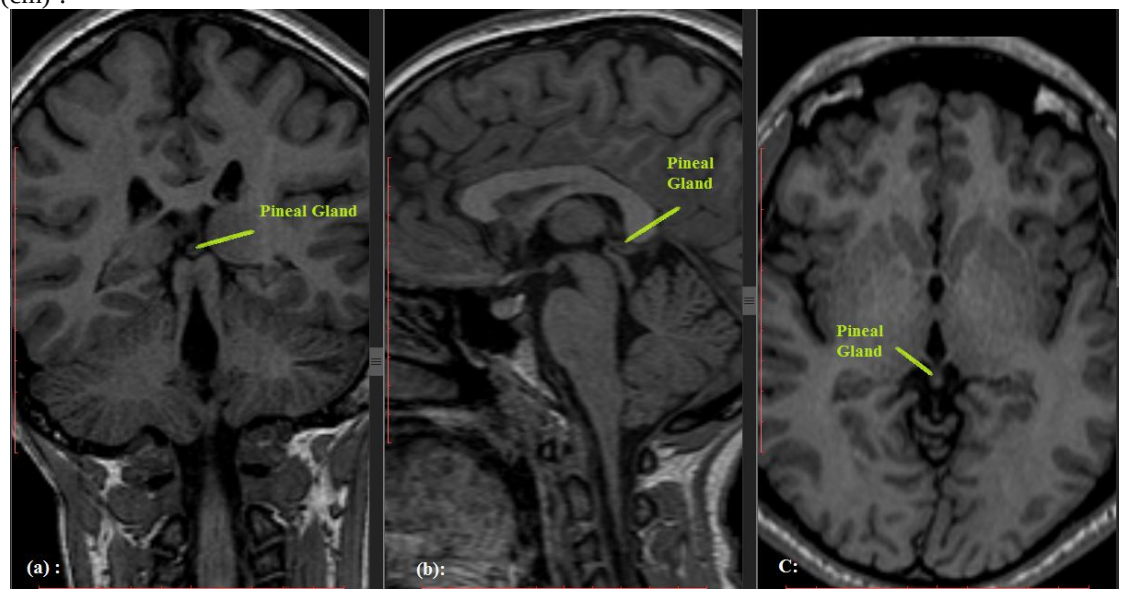

Figure 1: MRI brain scan 3D-T_1 W with Axial, sagittal and coronal demonstrates pineal gland.

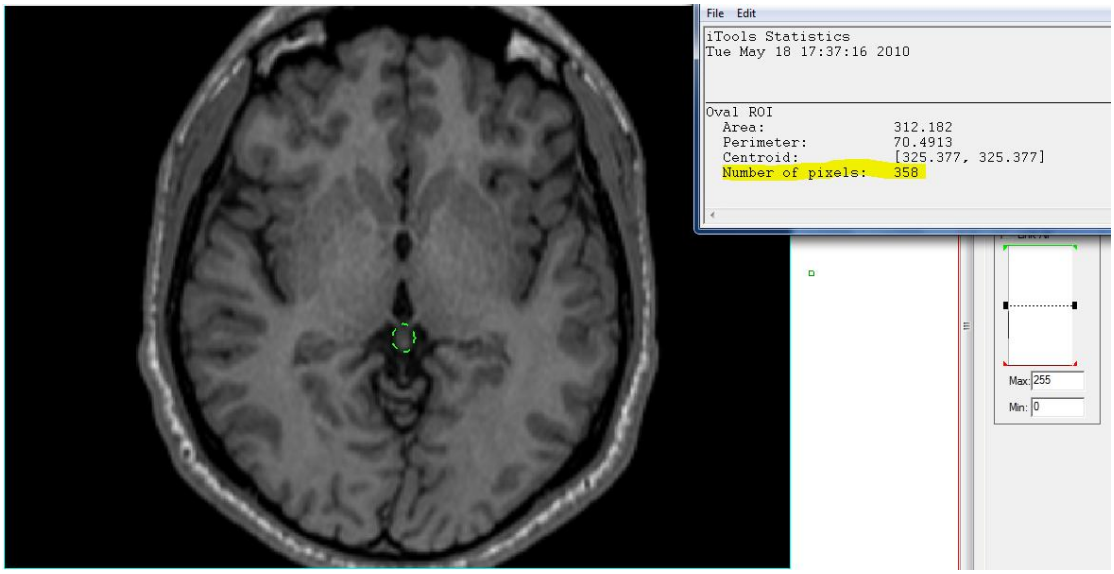

Figure 2: MRI 3D-T_1 W with Axial demonstrates pineal gland method of contouring and pixel accounting polygon

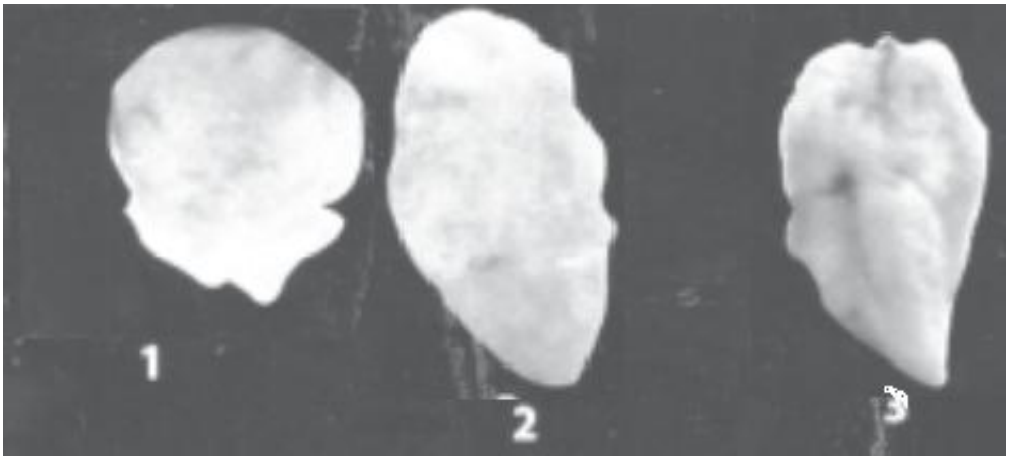

Figure 3: Different shapes of the pineal gland seen through magnifying glass (1. pea shaped, 2.fusiform shaped, and 3. cone shaped

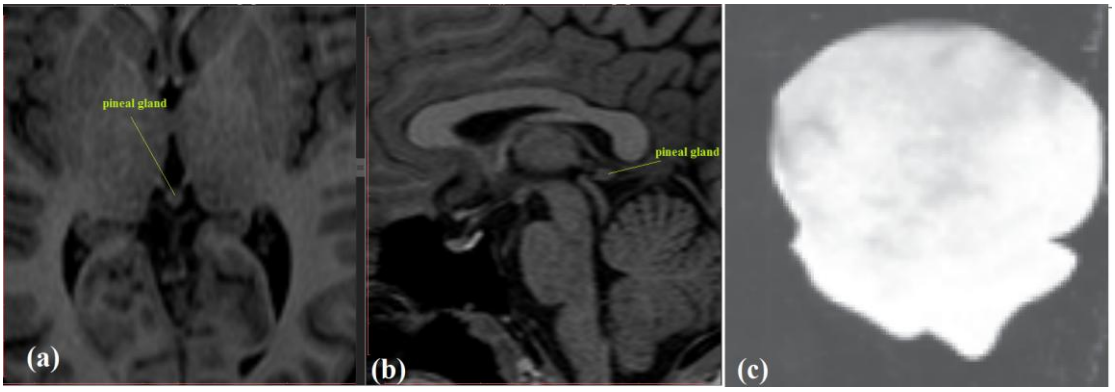

Figure 4: The Axial (a) and Sagittal (b)MRI showed the Pear shape(c) of pineal gland

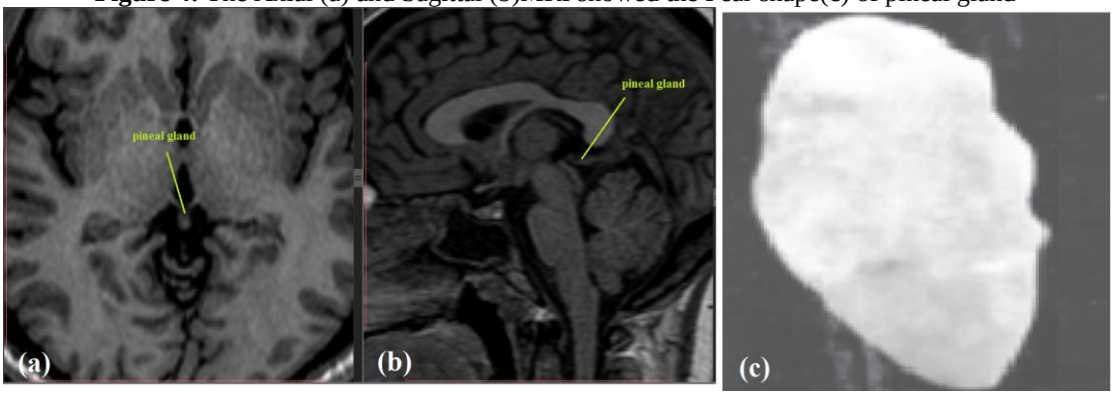

Figure 5: The Axial (a) and Sagittal (b) MRI showed the fusiform shape(c) of pineal gland

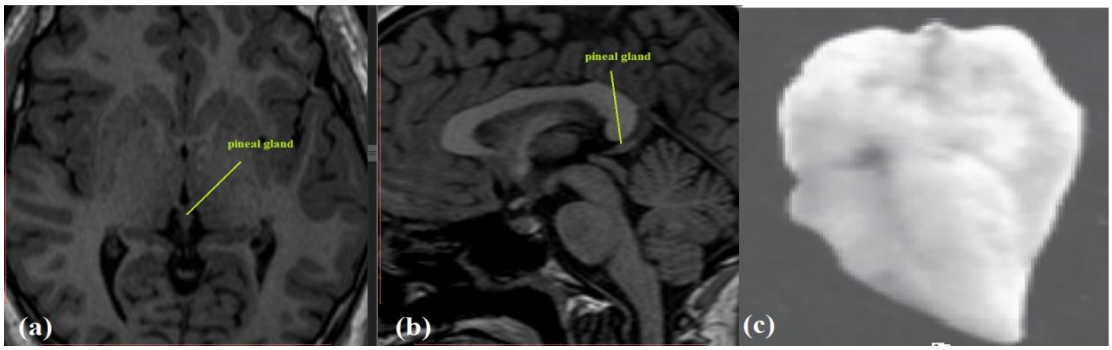

Figure 6: The Axial (a) and Sagittal (b) MRI showed the cone-shape(c) of pineal gland

3. Result and Discussion

This study adept 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:

	Mean	Median	STD	Min	Max
Age	24.98	25	2.92	19	31
High	177.98	177	8.63	159	195
Weight	69.71	70	9.41	51	93
BMI	21.89	22	1.42	19	25
Volume	0.136	0.136	0.007	0.123	0.159

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 cm, 69.71±9.1 kg, 21.89±1.42 kg/cm^2 and 0.136±0.007 cm^3 respectively.

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

	Gender	Mean	Std. Deviation	Std. Error Mean
Age	Female	23.48	2.731	.341
	Male	25.96	2.589	.267
BMI	Female	21.36	1.384	.173
	Male	22.27	1.321	.136
Volume cm^3	Female	.134672	.0063130	.0007891
	Male	.137690	.0064676	.0006671

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/cm^2 and the male 22.27 kg/cm^2, the pineal gland volume for female 0.135 cm^3 and for male 0.137 cm^3

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

		Sum of Squares	Mean Square	F	Sig.
BMI	Between Groups	82.635	6.357	3.917	.000
	Within Groups	235.327	1.623		
	Total	317.962			
Volume cm3	Between Groups	.001	.000	1.876	.037
	Within Groups	.006	.000		
	Total	.007			

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:

Shapes	*Cases*	*Percentage %*
Pear Shape	22	13.8
Fusiform Shape	61	38.4
Cone Shape	76	47.8
Total	***159***	***100***

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%.

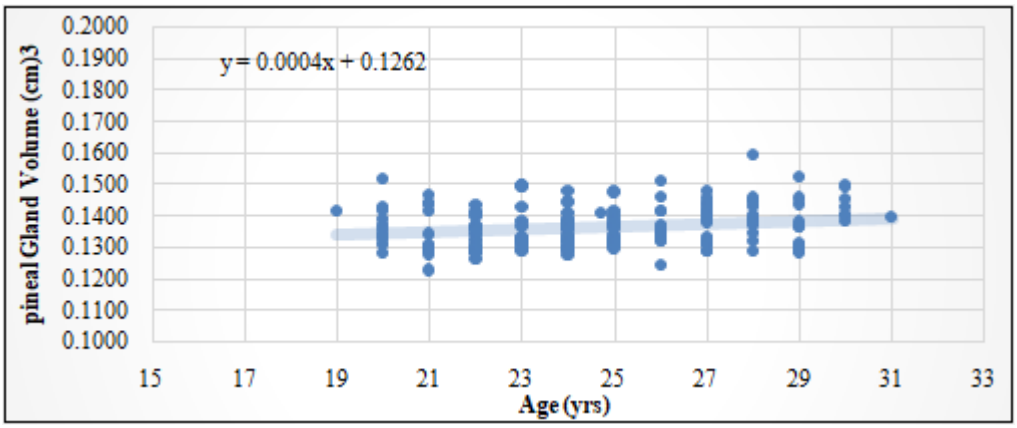

Figure 7: Show correlate between the pineal gland volume with patients age

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.

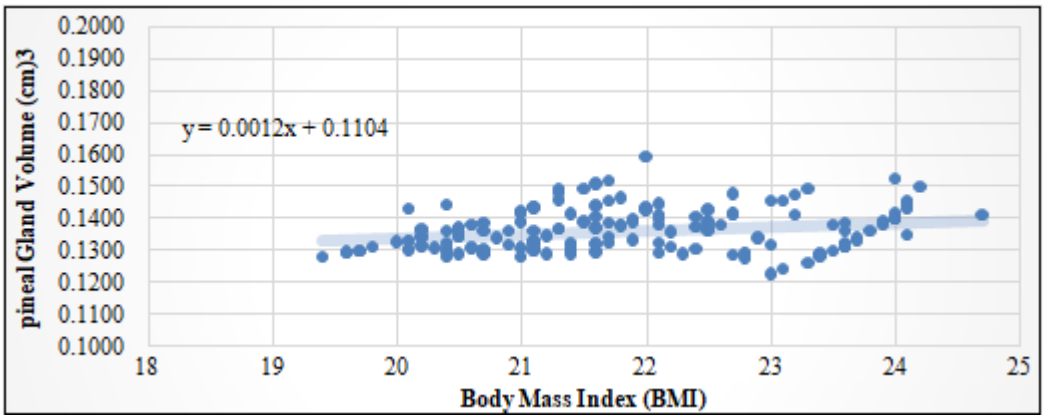

Figure 8: Show correlate between pineal gland volumes with body mass index

Figure 8. show correlate between pineal gland volume with body mass index were the volume was increase with rate 0.0012 for each (kg/cm^2) unit from body mass index

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 mm^3. *(G.Bersani et al 2002*) reported the pineal volume was 64.05 ± 20.69 mm^3 for schizophrenics and 74.62 ± 33.53 mm^3 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 cm^3. 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 glandis 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 cm^3 and for the male 0.137±0.0063 cm^3, 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*:*

Pineal Gland Volume cm^3= 0.0004 (Age/ys)+ 0.1262
Pineal Gland Volume cm^3= 0.0012 (BMI) + 0.1104

References

[1] Drake RL, Vogl AW, Adam WM. Gray's Anatomy for Students. 2nd ed. ASIN: B004LGYXQQ. London: Churchill Livingstone; 2009.
[2] Rocha CS, Rato L, Martins AD, Alves MG, Oliveira PF. Melatonin and male reproductive health: relevance of darkness and antioxidant properties. Current molecular medicine. 2015; 15(4):299–311. PMID: 25941822
[3] Mahlberg R, Walther S, Kalus P, Bohner G, Haedel S, Reischies FM, et al. Pineal calcification in Alzheimer's disease: an in vivo study using computed tomography. Neurobiology of aging. 2008; 29(2):203–9. doi: 10.1016/j.neurobiolaging.2006.10.003 PMID: 17097768
[4] Srinivasan V, Pandi-Perumal SR, Brzezinski A, Bhatnagar KP, Cardinali DP. Melatonin, immune function and cancer. Recent Pat Endocr Metab Immune Drug Discov. 2011; 5(2):109–23. PMID: 22074586
[5] H.M.Duvernoy, B.Parratte, L.Tatu, andF.Vuillier, "The human pineal gland: relationships with surrounding structures and blood supply, " *Neurological Research*, vol. 22, no. 8, pp. 747–790, 2000.
[6] M. Sumida, A. James Barkovich, and T. Hans Newton, "Development of the pineal gland: measurement with MR, " *American Journal of Neuroradiology*, vol. 17, no. 2, pp. 233– 236, 1996.
[7] J. I. Kitay, "Pineal lesions and precocious puberty: a review, " *Journal of Clinical Endocrinology and Metabolism*, vol. 14, pp. 622–625, 1954.
[8] R. J. Wurtman and M. A. Moskowitz, "The pineal organ. I, " *The New England Journal of Medicine*, vol. 296, no. 23, pp. 1329–1333, 1977.
[9] Golan, J.; Torres, K.; Sta´skiewicz, G.J.; Opielak, G.; Maciejewski, R. Morphometric parameters of the human pineal gland in relation to age, body weight and height. Folia Morphol. **2002**, 61, 111–113.
[10] Tan, D.X.; Manchester, L.C.; Fuentes-Broto, L.; Paredes, S.D.; Reiter, R.J. Significance and application of melatonin in the regulation of brown adipose tissue metabolism: Relation to human obesity. Obes. Rev. **2011**, 12, 167–188. [CrossRef] [PubMed]

[11] Hintermann, E.; Jenö, P.; Meyer, U.A. Isolation and characterization of an arylalkylamine N-acetyltransferase from Drosophila melanogaster. FEBS Lett. **1995**, 375, 148–150. [CrossRef]
[12] Itoh, M.T.; Hattori, A.; Sumi, Y.; Suzuki, T. Day-night changes in melatonin levels in different organs of the cricket (Gryllus bimaculatus). J. Pineal Res. **1995**, 18, 165–169. [CrossRef] [PubMed]
[13] Vivien-Roels, B.; Pevet, P.; Beck, O.; Fevre-Montange, M. Identification of melatonin in the compound eyes of an insect, the locust (Locusta migratoria), by radioimmunoassay and gas chromatography-mass spectrometry. Neurosci. Lett. **1984**, 49, 153–157. [CrossRef]
[14] Ralph, C.L. The pineal gland and geographical distribution of animals. Int. J. Biometeorol. **1975**, 19, 289–303. [CrossRef] [PubMed]
[15] Haacke EM, Mittal S, Wu Z, Neelavalli J, Cheng YC. Susceptibility-weighted imaging: technical aspects and clinical applications, part 1. AJNR Am J Neuroradiol. 2009; 30(1):19–30. PubMed Central PMCID: PMC3805391. doi: 10.3174/ajnr.A1400 PMID: 19039041
[16] Mittal S, Wu Z, Neelavalli J, Haacke EM. Susceptibility-weighted imaging: technical aspects and clinical applications, part 2. AJNR Am J Neuroradiol. 2009; 30(2):232–52. PubMed Central PMCID: PMC3805373. doi: 10.3174/ajnr.A1461 PMID: 19131406
[17] Chen W, Zhu W, Kovanlikaya I, Kovanlikaya A, Liu T, Wang S, et al. Intracranial calcifications and hemorrhages: characterization with quantitative susceptibility mapping. Radiology. 2014; 270(2):496–505. PubMed Central PMCID: PMCPMC4228745. doi: 10.1148/radiol.13122640 PMID: 24126366
[18] Buch S, Cheng YN, Hu J, Liu S, Beaver J, Rajagovindan R, et al. Determination of detection sensitivity for cerebral microbleeds using susceptibility-weighted imaging. NMR in biomedicine. 2016.
[19] Nandigam RN, Viswanathan A, Delgado P, Skehan ME, Smith EE, Rosand J, et al. MR imaging detection of cerebral microbleeds: effect of susceptibility-weighted imaging, section thickness, and field strength. AJNR American journal of neuroradiology. 2009; 30(2):338–43. PubMed Central PMCID: PMC2760298. doi: 10.3174/ajnr.A1355 PMID: 19001544
[20] S. A. Schmitz, I. Platzek, D. Kunz, R. Mahlberg, K. J. Wolf, and J. O. Heidenreich, "Computed tomography of the human pineal gland for study of the sleep-wake rhythm: reproducibil- ity of a semi-quantitative approach, " *Acta Radiologica*, vol. 47, no. 8, pp. 865–871, 2006.
[21] A. T. Turgut, H. M. Karakas¸, Y.Ozsunar et al., "Age-related changes in the incidence of pineal gland calcification in Turkey: a prospective multicenter CT study, " *Pathophysiology*, vol. 15, no. 1, pp. 41–48, 2008.
[22] G. Bersani, A. Garavini, A. Iannitelli et al., "Reduced pineal volume in male patients with schizophrenia: no relationship to clinical features of the illness, " *Neuroscience Letters*, vol. 329, no. 2, pp. 246–248, 2002.
[23] B. Sun, D. Wang, Y. Tang et al., "The pineal volume: a three-dimensional volumetric study in healthy young adults using 3.0 T MR data, " *International Journal of Developmental Neuroscience*, vol. 27, no. 7, pp. 655–660, 2009.