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FREQUENCY AND POSITION OF PINEAL GLAND CALCIFICATION IN A JAPANESE POPULATION

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松果体石灰化について：日本人における出現率，頭蓋内の位置

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日本人の松果体石灰化の出現率は過去の研究によると、欧米に比較して低い率を示している。これは人種、生活環境、その他が影響していると言われている。本研究は525正常例について検討し、成人に於て41.6%の出現率を認めた。これは

過去の日本人の成績と比較すると最も高い率を示している。頭蓋内の位置の測定はVastine-Kinney法を使用した。日本人の場合には多少正範囲を移動させる必要を認めた。

INTRODUCTION

The value of benign intracranial calcifications as indicators of space occupying intracranial lesions has long been recognized. Of these, pineal gland calcification is the most commonly used. Vastine and Kinney¹ were among the first investigators who compiled tables to show normal position of the pineal gland for clinical roentgenology. Their study

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also determined the prevalence of pineal gland displacement by various intracranial tumors. In the Western literature, the incidence of pineal calcification has been reported variously from 40% to 60% in patients over 20 years of age²⁻⁶. This relatively high incidence of pineal calcification renders plain skull roentgenograms more valuable since its displacement may indicate the presence of tumor or atrophic change. Robertson⁷ found that the falx truly indicated the skull midline, but that it is less readily displaced than the pineal in cases of intracranial masses. Also, the falx is often not visualized if the skull is slightly rotated. Fray⁸ used skull specimens with lead markers to observe the effect of rotation on pineal calcification. He considered 15 degrees to be the maximum rotation ordinarily encountered as a technical error in examination of patients, and found that a rotation of 12 degrees from the true lateral or saggital projection can be tolerated without invalidating the observation of pineal displacement. He also pointed out that on the saggital projection a 2 mm. difference in the distances from the pineal to each inner table is within normal limits.

Vastine and Kinney¹ measured the skull's greatest anteroposterior (AP) diameter from the inner table of the frontal bone to the inner table of the occipital bone and vertical diameter from the inner table at the vertex to the opisthion. They measured the distance of the pineal gland from the frontal bone and vertex.

To refine the normal location indices, Fray⁹ subsequently designed an elastic band imprinted with the normal pineal range for determining skull diameters and pineal position. He pointed out that the Vastine and Kinney study considered the relationship of the pineal gland to only one inner table margin in each diameter, and that his method considered the pineal in relation to both margins of each diameter. He suggested that false normals could thereby be reduced. After using this method for 5 years, he reported that such a reduction of false normals had thereby been accomplished, and then devised an additional method of skull measurement using "cranial angle" to correct for the various skull shapes. He later pointed out that an intrinsic error existed in methods of measurement where it was assumed that the pineal gland calcification was centrally located, and that a pineal located at the normal borderline would require more than 1 cm. displacement through the normal zone before indicating the presence of a tumor on that side¹⁰. He stated that his proportional method of measurement by an elastic band corrected for such false normals in his later analysis.

In a review of 3000 consecutive skull examinations, Dyke¹¹ reported 51% pineal calcification incidence for all ages, and 59% in patients over 20 years of age. He tried to correct the Vastine and Kinney normal range by moving it 4 mm. anteriorly.

Stauffer¹² cited the importance of recognizing habenular calcification as distinct from pineal gland calcification. He reviewed 285 randomly selected normal cases and found 187 with pineal calcification, 40 with habenular calcification only, and 49 with both pineal and habenular calcification. He calculated that the average separation between the calcification in the habenular nucleus and pineal gland was 5.8 mm. He pointed out that the two locations of calcification were not distinguished in earlier reports; that normal habenular

calcification may be at or above the normal limits of the Vastine and Kinney tables, and that when Dyke moved the Vastine and Kinney values anteriorly by 4 mm. perhaps the habenular nucleus calcification was not considered. Stauffer thought the habenular nucleus a more constant reference point than the pineal gland, particularly for prefrontal lobotomy.

Smith¹³ studied frontal and superior projections of the formalin fixed brains of 75 males and 48 females, 20-80 years of age, and found habenular calcification in 50% of all cases with pineal calcification. In his series, habenular nucleus calcification did not occur without pineal gland calcification.

Nakagawa¹⁴ reviewed 1104 Japanese skull examinations and found an overall 23.3% average incidence of pineal gland calcification, and 28.7% in patients over 20 years of age. Chiba and Yamada¹⁵ in a study of 522 cases found a pineal calcification incidence of 16.1% in males and 7.3% in females over 21 years of age. They felt that due to the relatively low incidence, pineal calcification had less value as a diagnostic aid in Japan.

Wada¹⁶ reviewed 1987 skull examinations and detected pineal calcification in 26.3% of males and 17.5% of females. Ishihara¹⁷ studied 180 normal subjects and 52 cases of intracranial tumors, all with pineal calcification on the lateral skull examination, and he devised a new method for pineal calcification orientation. He found that the Vastine and Kinney tables could not be applied to the Japanese population without modification.

Pineal calcification rates reported for the studies in Japan and major studies elsewhere are compared in Table 1.

Table 1 Comparison of Rates of Pineal Calcification

Investigator	Cases	Rate of Pineal Calcification (%)		
		All Ages	<20 Years	20+ Years
Vastine, J.H. ¹¹ .	616	47.9	—	59.2
Dyke, C.G. ¹¹ .	2724	51.0	20.7	59.0
Naffziger, H.C. ⁹ .	215	45.0	15.5	58.0
Lilja, B. ⁵ .	769	34.0	—	40.0
Chiba, M. ¹⁵ .	522	9.9	3.2	13.7
Nakagawa, K. ¹⁴ .	1104	23.3	12.4	28.7
Wada, T. ¹⁶ .	1987	23.5	—	—
Present Study	525	33.1	9.6	41.6

PRESENT STUDY

All skull roentgenograms of 525 normal patients were reviewed for the presence of calcification in the pineal gland and habenular nucleus, and for skull measurements. The age distribution of the patients by sex are shown in Table 2. Although the female group from 0-9 years of age, and both sexes from 20-29 years of age had fewer subjects, the overall distribution is relatively even.

The AP and vertical skull measurements were determined from the lateral skull roentgenograms of each patient, according to the Vastine and Kinney method.

Table 2. Number of Subjects by Sex and Age

Age	Male	Female	Total
0-9	48	24	72
10-19	44	41	85
20-29	27	24	51
30-39	37	64	101
40-49	31	45	76
50-59	36	33	69
60+	36	35	71
Total	259	266	525

Table 3. Mean Horizontal and Vertical Skull Measurements in Centimeters by Sex and Age Groups

Age	Male			Female			Total		
	Num-ber	Horizontal cm M±2σM	Vertical cm M±2σM	Num-ber	Horizontal cm M±2σM	Vertical cm M±2σM	Num-ber	Horizontal cm M±2σM	Vertical cm M±2σM
0-9	48	16.85±0.50	14.46±0.38	24	16.18±0.48	14.15±0.40	72	16.63±0.38	14.35±0.28
10-19	44	18.27±0.24	15.61±0.26	41	17.70±0.26	15.24±0.24	85	17.99±0.20	15.43±0.18
20-29	27	18.90±0.38	16.21±0.34	24	17.97±0.36	15.31±0.34	51	18.46±0.28	15.80±0.26
30-39	37	18.97±0.28	15.94±0.20	64	18.28±0.20	15.23±0.18	101	18.53±0.18	15.49±0.14
40-49	31	18.94±0.34	15.77±0.22	45	18.34±0.24	15.23±0.20	76	18.58±0.20	15.45±0.16
50-59	36	19.01±0.26	15.67±0.22	33	18.22±0.22	15.11±0.22	69	18.63±0.20	15.39±0.18
60+	36	19.21±0.24	15.69±0.30	35	18.47±0.28	15.17±0.24	71	18.85±0.20	15.43±0.20
Total	259	18.49±0.16	15.55±0.12	266	18.00±0.12	15.12±0.10	525	18.24±0.10	15.33±0.08

Skull Measurements Horizontal, from inner table of frontal bone to inner table of occipital bone. Vertical, from inner table of vault to inner table of base.

T test...Horizontal, total male > total female (p < 0.01)
Vertical, total male > total female (p < 0.01)

Table 3 shows the mean horizontal and vertical skull measurements by age groups for each sex and for both sexes.

The rates of calcification of the pineal gland and habenular nucleus are shown in Table 4. Under 20 years of age, the rates of pineal calcification were 13% for males and 4.6% for females. Above 20 years of age, the rates increased abruptly in both sexes. Over 60 years of age, they were 72.2% for males and 34.3% for females. Males had a significantly greater pineal calcification rate than females at all ages. The pineal calcification rate, age and sex combined, was 41.6%. Over 20 years of age, the rates were 54.5% for males and 33.8% for females. These rates are considerably higher than those previously reported in Japan, and they approximate the incidence reported elsewhere (Table 1).

Table 4 also shows the rates of calcification of the habenular nucleus. These were relatively low in all age groups in both sexes. A suggestive difference was seen by sex and in four age groups. In the group over 60 years of age, the rates were 16.7% for males and 2.9% for females. Under 20 years of age, habenular calcification was only seen

Table 4. Number and Proportion of Calcification; Pineal and Habenular, by Sex and Age

Age	Male			Female			Total		
	Calcification			Calcification			Calcification		
	Present	Absent	%	Present	Absent	%	Present	Absent	%
Pineal									
0—19	12	80	13.0	3	62	4.6	15	142	9.6
20—39	30	34	46.9	29	59	33.0	59	93	38.8
40—59	35	32	52.2	27	51	34.6	62	83	42.8
60+	26	10	72.2	12	23	34.3	38	33	53.5
Total	103	156	39.8	71	195	26.7	174	351	33.1
20+	91	76	54.5	68	133	33.8	149	209	41.6
Habenular									
0—19	—	92	—	1	64	1.5	1	156	0.6
20—39	2	62	3.1	3	85	3.4	5	147	3.3
40—59	5	62	7.5	4	74	5.1	9	136	6.2
60+	6	30	16.7	1	34	2.9	7	64	9.9
Total	13	246	5.0	9	257	3.4	22	503	4.2
20+	13	154	7.8	8	193	4.0	21	347	5.7

Table 5. Mean Distances (cm) of Pineal Calcification from Inner Table Horizontal and Vertical, by Sex and Age

Age	Male			Female			Total		
	Num-ber	Horizontal M±2σM	Vertical M±2σM	Num-ber	Horizontal M±2σM	Vertical M±2σM	Num-ber	Horizontal M±2σM	Vertical M±2σM
0—9	1	10.70	8.40	—	—	—	1	10.70	8.40
10—19	11	10.46±0.32	8.36±0.22	3	10.70±0.24	8.80±0.70	14	10.51±0.26	8.45±0.24
20—29	9	10.78±0.44	8.80±0.22	5	9.84±0.62	8.36±0.44	14	10.44±0.42	8.64±0.24
30—39	21	10.62±0.16	8.57±0.20	24	10.28±0.18	8.28±0.20	45	10.44±0.12	8.41±0.14
40—49	16	10.51±0.30	8.48±0.26	18	10.38±0.18	8.26±0.18	34	10.44±0.16	8.36±0.16
50—59	19	10.56±0.24	8.43±0.26	9	10.26±0.34	8.03±0.24	28	10.46±0.20	8.30±0.20
60+	26	10.75±0.22	8.48±0.18	12	10.36±0.28	8.23±0.18	38	10.62±0.18	8.40±0.14
Total	103	10.62±0.10	8.50±0.10	71	10.30±0.12	8.26±0.10	174	10.49±0.16	8.40±0.08

Horizontal : Total Male > Total Female (p < 0.01)

Vertical : Total Male > Total Female (p < 0.01)

in 1 female. At all ages, the incidence was 5.0% for males and 3.4% for females; over 20 years of age, 7.8% for males and 4.0% for females. The age and sex combined rate was 5.7%.

The mean horizontal and vertical distances of the pineal calcifications from the inner table are shown by age groups for each sex and sexes combined in Table 5. Measurements were made from the center of the calcifications. Values are not given for females less than 10 years of age because of the low rate of calcification in this age group.

The mean distance between pineal and habenular calcifications was between 4 mm. and 5 mm. This approximates the distance reported by Stauffer¹². All case of habenular calcification occurred in patients who had pineal calcification, in accordance with the earlier

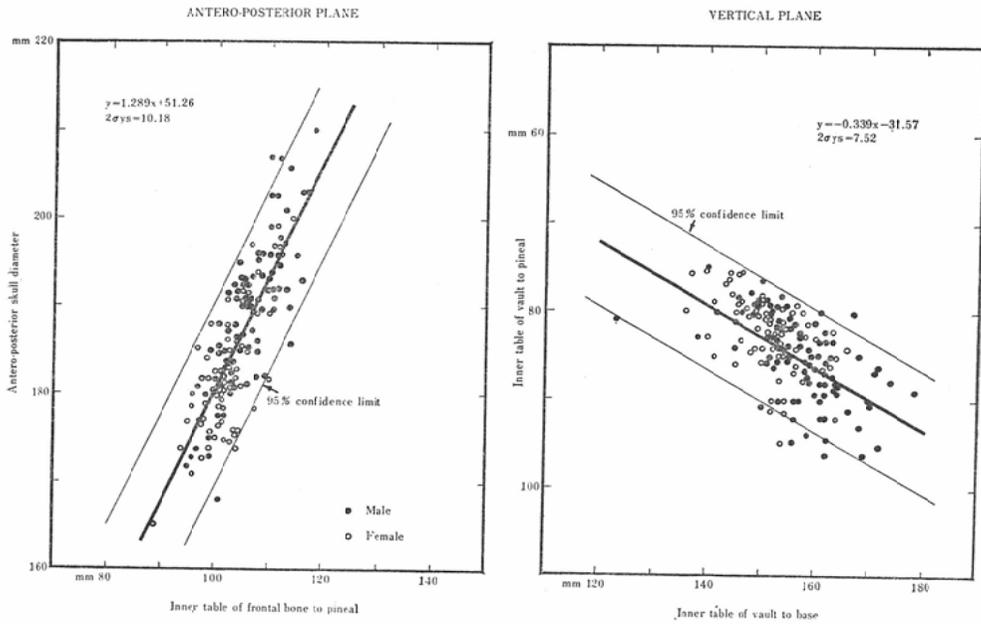


Figure 1 Pineal Localization

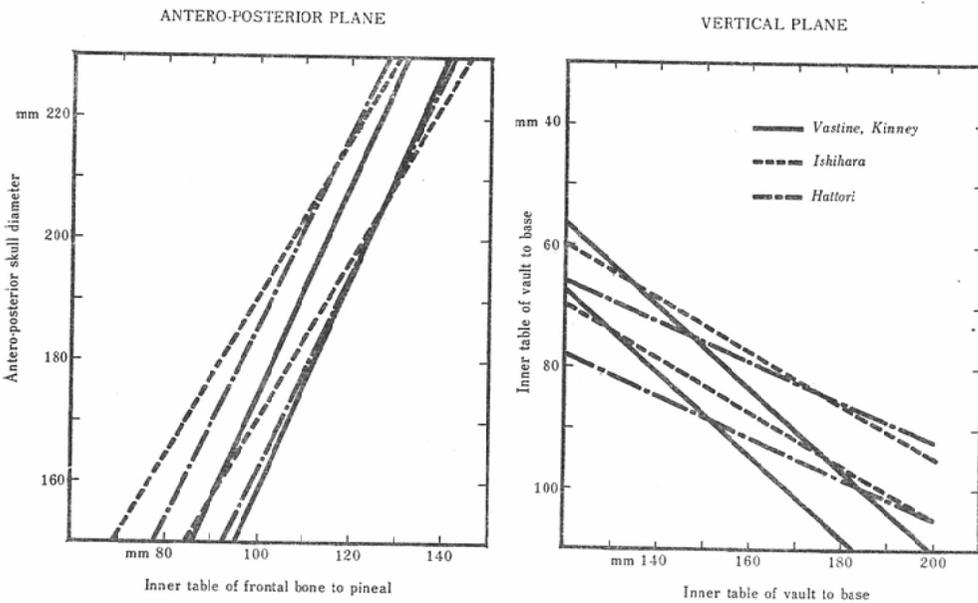


Figure 2 Comparison of Pineal Localization

report of Smith¹³.

From the measurements shown in Table 2 and Table 5, graphs were compiled to describe the normal location of the pineal gland according to skull size for Japanese males and females 20 years of age and over (Figure 1). They describe the location of the calcification in the gland, in millimeters from the inner table, according to the Vastine and

Kinney system. The mean values and the normal range are shown.

Figure 2 compares the data compiled in the present study with those of Vastine and Kinney and Ishihara¹⁷. For the present study, horizontal measurements lie between those of the latter investigators with maximum differences of 6 and 8 mm. respectively from their values. The present measurements indicate that pineal calcification in the Japanese is located slightly anterior to the location as determined by Vastine and Kinney. In the present study, habenular calcification is distinguished from pineal calcification to avoid erroneously shifting the normal range anteriorly. The vertical measurements indicate that pineal calcification did not shift more inferiorly with increasing vertical skull dimensions, as was found by Vastine and Kinney, and Ishihara.

DISCUSSION

The pineal calcification rates in this study are considerably higher than those previously reported in Japan. This indicates that such calcification in this population may be of greater importance in routine skull roentgenograms as an indicator of space-occupying lesion, than was previously considered. This rather frequent rate of calcification permitted the compilation of graphs showing the normal location of pineal calcification with a fair degree of accuracy. Contrary to reports by other investigators, the present study indicates that the pineal calcification rate in Japan is similar to that in other countries. The habenular calcification rates are less than those reported elsewhere, but they are included in this study because of the importance of differentiating between habenular and pineal calcification in determining the location of the pineal calcification.

The values for normal location of the pineal gland in this study were significantly different from those of Vastine and Kinney and to a lesser extent, from those of Ishihara. Thus, one must conclude that the values for other populations in other countries cannot be applied to the Japanese population.

SUMMARY

A review of all skull roentgenograms of 525 normal patients was conducted to determine the incidence of pineal gland and habenular nucleus calcification, and to compile normal values for pineal gland calcification in a Japanese population. These data are presented as tables and graphs for use in roentgenological interpretation.

Charts showing the normal range of pineal location, based on the present study, are available on request from the Editorial Office, ABCC.

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