

UNIVERSITY OF NAIROBI  
DEPARTMENT OF DIAGNOSTIC RADIOLOGY

THE INCIDENCE OF NORMAL PINEAL GLAND  
CALCIFICATIONS IN SKULL X-RAYS OF  
KENYAN AFRICANS

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April, 1981.



DECLARATION

This Dissertation is my original work and has not been presented for a degree in any other University.

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This Dissertation has been submitted for examination with my approval as University Supervisor.

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PROFESSOR L.R. WHITTAKER

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CALCIFICATION IN SKULL X-RAYS OF  
KENYAN AFRICANS.

S U M M A R Y

A retrospective study was carried out to determine the incidence of pineal gland calcification in routine skull X-rays of Kenyan Africans. The study consisted of 506 adult skull X-rays.

The incidence was found to be 6.52% with a sampling error of  $\pm 2.2$  (Table 1). This finding compares very well with the Nigerian figure of 5.04%<sup>(1)</sup> and contrasts very much with the figure of 43% given by Poltera et al<sup>(9)</sup> in Ugandans.

Both the Nigerian and Kenyan figures are far below the percentage of pineal gland calcification in the Caucasians<sup>(1,9,10,13)</sup>.



I N T R O D U C T I O N

The Radiological importance of the calcified pineal shadow lies in the fact that it can be a guide to the presence of an intracranial space occupying lesion. In other words, shifts of the pineal shadow in the anterior-posterior and lateral views can help in localisation of space occupying lesions (2,3,8,11). The calcification may indicate a pineal larger than normal and hence a tumour of the pineal itself.

Displacement of the pineal shadow after a head injury may be an important pointer to the presence of a haematoma and to the side on which it lies. When, therefore, there are clinical grounds for suspecting that a haematoma is present, demonstration of the position of a calcified pineal can be of great value. Likewise, in the lateral view the pineal may be displaced upwards, downwards, forwards or backwards (with or without lateral displacement in one of the other projections). For example, an upward displacement of the pineal is occasionally due to a local tumour but more commonly the result of reversed tentorial herniation or an upward displacement of the whole brain-stem. The commonest cause being probably a tumour extending into the mid-line anterior to the pons in the tentorial opening.

Considering, therefore, the ever increasing number of road traffic accidents and other craniocerebral trauma in a developing country like Kenya, simple

skull Xrays can be carried out before one considers radiological procedures which later often means transporting the patient over long distance to a well equipped centre. In Kenya the resources are relatively scarce and therefore this useful diagnostic aid for the detection of intracranial space occupying lesion should be correctly looked for.

But it is interesting how few cases of pineal gland calcification one sees in the African skull Xrays in sharp contrast to the Caucasians where in a general population, after the age of 40, over half the skull X-rayed show a calcified pineal (1,9,10,13). The author has therefore carried out the study to give the incidence of pineal gland calcification as it is seen in routine skull Xrays of Kenyan Africans.

Although the purpose of this paper is to give the incidence of pineal gland calcification, the author feels it appropriate to mention briefly the anatomy, biochemistry and physiology of the pineal gland.

The human pineal gland is a flattened, conical organ which lies beneath the posterior border of the corpus callosum and between the superior colliculi. It originates embryologically as an evagination of the ependyma which lines the roof of the third ventricle and remains connected to this region by the pineal

stalk. The adult gland weighs about 120 mg and its dimensions are 5 to 9 mm in length, 3 to 6 mm in width and 3 to 5 mm in thickness.

Melatonin (5-methoxy-N-acetyl tryptamine) which is a derivative of serotonin - the biosynthesis occurring by a reaction of acetyl CoA with serotonin - is widely distributed in very large quantities in the mammalian pineals<sup>(12,13)</sup>.

Melatonin reverses the effect of MSH (Melanocyte Stimulating Hormone) by stimulating aggregation, rather than dispersal of melanin granules within melanocytes causing lightening of skin colour. But in human beings melatonin appears to have no effect on the melanocytes which are responsible for the normal skin pigmentation.

It has been reported that there is evidence that of the functions of the mammalian pineal might be to mediate some of the endocrine effects of light<sup>(13)</sup>. Environmental lighting conditions exert several important effects on the mammalian neuroendocrine apparatus. Light acts as an "inducer" that modifies the rate of sexual maturation; girls who have been deprived of light from birth show early pubescence. The sequence of day and night also acts to generate some 24-hour biologic rhythms and to synchronise other rhythms which are produced by signals arising from within the body.



One of the mechanisms, for example, for regulation of gonadotropin activity appears to be of pineal in origin<sup>(12)</sup>. Hence there are reports that melatonin has or exerts a retarding influence on the oestrous cycle in females.

Tumours which originate within the pineal gland usually become clinically manifest because of symptoms which arise from their location. For example, internal hydrocephalus, elevated C.S.F. pressure and oculomotor signs such as paralysis of upward gaze or Parinaud's syndrome. Less frequently, the patient's family seek medical attention because of the development of precocious puberty<sup>(13)</sup>. About one-third of all boys below the normal age of sexual maturation who have pineal tumours develop precocious puberty and for unexplained reasons, pineal tumours are much less common among girls and are not associated with precocious menarche<sup>(13)</sup>.

About 10 to 15% of all reported pineal tumours are teratomas and like other mid-line teratomas, they are often malignant. The remainder of pineal tumours have been vascular or glial origin<sup>(13)</sup>.

Fortunately, parenchymal pinealomas, frequently show a good clinical remission following irradiation of 3,000 to 5,000 rads<sup>(13)</sup>.

M A T E R I A L S   A N D   M E T H O D S

Envelopes containing skull X-rays were randomly picked from the shelves of the X-Ray Department's Records Office, Kenyatta National Hospital. The Kenyatta National Hospital is a teaching as well as a reference hospital serving the whole of Republic of Kenya. This random selection covered those skull radiographs taken in 1977 and 1978.

Only skull Xrays of African patients were included in the review. Also from the request forms, that is for radiological examinations, it was possible to tell the sex of the patient. Age in most cases was simply given as "Adult" or "Child". It was easy to exclude children readily by looking at the teeth, i.e., whether the molar teeth had erupted or not. And as a matter of interest, the skull radiographs of these children were also looked at for any possible pineal calcification, but were omitted from the study. Indeed none showed a calcified pineal shadow<sup>(2)</sup>.

Underexposed radiographs were rejected for the simple reason of missing a pineal shadow in such light films. On the other hand, very dark films were examined using bright light. Technicality of radiography such as Focal Film Distance (FFD) or from which X-ray rooms the radiographs were taken was not considered essential as long as the radiograph was acceptable by

any standards<sup>(5)</sup>. In the measurement of the pineal gland by cranio-angle and proportional methods as described below, focal film distance is immaterial as the measurements are not modified by the FFD<sup>(5)</sup>.

Two standard views of the skull were routinely obtained; lateral and antero-posterior. The Towne's view is not taken routinely at the Kenyatta National Hospital.

The pineal shadow was accurately identified. Other shadows that might have been misinterpreted for pineal were also noted although ignored in the study. For example, the calcified shadows of the habenular commissure, calcified choroid plexus and any other pathological calcifications, were ignored.

A shadow identified as that of pineal in origin and in the right anatomical area, was further subjected to measurements according to Lusted et al<sup>(5)</sup>.

Enclosed are radiographs taken of dry skull demonstrating how the cranio-angle and proportional methods are used in the measurement of the pineal gland (Appendix I, II & III).

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R E S U L T S

These are summarised in table form below.

Table 1

The incidence of pineal gland calcification in Kenyan Africans tabulated.

SAMPLE SIZE	NUMBER OF VISIBLE SHADOWS IN SKULL X-RAYS	PERCENTAGE %	SAMPLING ERROR
506	33	6.52	+ 2.2

Table 2

Table showing the variation with sex of pineal gland calcification.

SEX	NUMBER	NUMBER POSITIVE	PERCENTAGE	SIGNIFICANCE
Females	128	9	7.03	P > 0.1
Males	378	24	6.35	
	506	33		

Where P is Probability.

Table 3

The pattern of indication of Age on X-ray Request forms by the referring clinicians at the Kenyatta National Hospital.

	NUMBER	PERCENTAGE
Age Given	190	37.55%
Age not Given	316	62.45%
TOTAL	506	100%

DISCUSSION

Human pineal gland calcification which was reported in autopsy specimens about 300 years ago, was first described in the plain skull Xrays in 1918 by Schuller, who remarked that the gland "very often shows a calcium deposit from the third decade and occasionally seen in children"<sup>(1)</sup>.

Subsequent workers confirmed Schuller's observation and established the influence of age on the incidence of pineal gland calcification although the calcification is not necessarily indicative of atrophy<sup>(13)</sup>. From a summary of these workers according to Adeloje et al<sup>(1)</sup>, the estimated frequency of pineal shadows was found to be 2% in those 3 to 12 years of age; 46% from 13 to 40 years; and 69% after the age of 40. All these studies were carried out mainly in the Caucasians and racial differences were not mentioned.

As far as the racial differences are concerned, Adeloje et al<sup>(1)</sup> determined the incidence of normal pineal gland calcification of Black and White Americans. This was found to be 9.7% for Blacks and 16.0% for the Whites. This figure for the White Americans is extremely low as is already mentioned above for the Caucasians, that is, the frequency of pineal shadows being 69% after the age of 40. And indeed, the

literature elsewhere gives the frequency to be over 50% in the Caucasian population<sup>(1,2,6,8,9,10)</sup>.

In the Far East, a much lower incidence has been reported. This was found to be 9.9% in Japanese; 15.6% in *Fijians* and 19.2% in *Indians*<sup>(1,6)</sup>.

In Africa, one of the first hints on low incidence was made in Nigeria in a study of brain tumours at the University College Hospital, Ibadan<sup>(1)</sup>. In the study which involved Xrays of the skull, the workers mentioned a surprising rarity of pineal shadow in the West Africans.

The impression of the above workers was confirmed in Nigeria by other workers<sup>(1)</sup>. In a study which included 952 normal skull Xrays obtained in Nigerians in Lagos, the pineal gland calcification was found to be 5.04%.

In East Africa, Murphy, a radiologist at Mulago, Kampala, was the first to make the impression that the pineal gland calcification was an uncommon finding in Africans according to the literature<sup>(7)</sup>. He found only two patients with pineal shadows in a series of 100 consecutive skull Xrays obtained from 88 East Africans, 9 Asians and 3 Europeans between 17 and 62 years. And although he did not identify the racial origin of the two patients, any mode of mathematical manipulation



would still make the incidence remarkably low in East Africa.

Poltera et al<sup>(9)</sup> in their study gave the impression that the frequency of pineal gland calcification is high in the Africans. This involved a radiological study of 200 isolated pineal glands which were formalin fixed from the postmortems on Ugandan Africans. So according to Poltera et al, 43% of pineal glands should be radiologically detectable in the adults.

At the Kenyatta National Hospital, an irrelevant but considerably similar study has been carried out by Lobo<sup>(4)</sup> on placental calcification. In the study it had been noticed that plain radiographs in the obstetric practice of African patients at the hospital did not demonstrate placental calcification. In order to assess whether this was due to a faulty radiographic technique or relative absence of demonstrable calcification, it was decided to radiograph a series of post-delivery placentas. This study concluded that 58% calcifications could be demonstrated in the post-delivery placentas as opposed to 2% only detectable antenatally.

This study by Lobo is very similar in practice to what Poltera et al carried out. And indeed, a second point which makes the author against the findings by Poltera et al, is that of another pathological study carried out in Nigeria<sup>(1)</sup>. In this recent pathological

study, it was showed that microscopic pineal gland calcification occurs in Nigerians in every decade from the first to the ninth. The Nigerian workers could not explain the paradoxical rarity of the gross roentgenographically visible pineal glands.

The author feels and is convinced that the incidence figure of pineal shadows of 6.52% for the Kenya African really reflects what is seen radiologically in the normal routine X-rays. It is possible that the African pineals although calcified have calcifications too small or are not dense enough to be radiologically detectable in the routine skull X-rays, and this could be the explanation for the paradoxical rarity found in the Nigerians and that found by Lobo with regard to placental calcification. Since in the African patient pineal calcification is not marked, the value of pineal calcifications as a sign of tumour is diminished. But it is beyond the scope of the present study to explain why in the Caucasians, pineal shadows are present in over 50% of the adult population whereas this is very low in the African race including the Black Americans.

Most of reports of pineal gland calcification have underlined a male preponderance. Vastine et al<sup>(11)</sup> found that in every decade from the second on, males predominated with an overall incidence of 58%. Dyke<sup>(3)</sup> reported a male incidence of 54%. A higher male incidence was found among Japanese and Indians whereas among Fijians and Nigerians i

Lagos<sup>(1,6)</sup> slightly more females were found to have calcified pineal gland. Adeloye et al<sup>(1)</sup> found that the sex distribution was about even in their study. The author did not observe any sex variation of pineal gland calcification in the sample ( $P > 0.1$ ) (Table 2).

The absence of Age on the Xray request forms in 62.45% (Table 3) of the sample, precluded further breakdown to show whether the incidence of calcification increased with the age. It is very bad for the clinicians not to state the age, if not approximately, of their patients. For a teaching hospital, which like any others, being research orientated this cannot be overemphasised.



C O N C L U S I O N S

The pineal in the African patient calcifies but to a lesser degree than in the Caucasians. The paradoxical rarity in the African skull X-rays is still not easy to explain. Hence the value of assessment of a pineal shift made possible because of visible calcification is diminished and likewise the value of assessment of the size of the pineal in pineal tumours by visualisation of a large pineal is also likely to be less in the African. In conclusion, the author ends up by the remark that this present work on pineal gland calcification really shows that the calcification is indeed rare in the Africans.

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A P P E N D I X ICRANIO-ANGLE METHOD (A)To determine displacement along Vertical Diameter.

The vertex of an  $8^{\circ}$  angle is placed at the posterior margin of the foramen magnum, the main base line extending through the bregma. Pineal bodies that are normal in position fall within the two lines forming the angle.

A P P E N D I X      IICRANIO-ANGLE METHOD (B)

To determine displacement along Antero-Posterior Diameter.

The vertex of an  $11^{\circ}$  angle is placed at the base of the anterior clinoids or top of tuberculum sellae. The main base extends through the lambda. A pineal body located in normal position falls within the two lines forming the angle.



A P P E N D I X      I I IPROPORTIONAL METHOD

This method incorporates the use of an elastic cord upon which are placed markers defining zones for both the long and vertical diameters of the skull. The elastic cord is prepared by selecting a length which, when slightly stretched, will just span the smallest skull to be measured. Points A and B are indicated on the elastic cord. These points are 55 and 60% of the distance from the beginning and to the end marker; and by stretching the elastic localiser so that the beginning or zero marker is at the inner table of the frontal bone and the end-point is at the occipital bone, the centre of the pineal will fall within the marked normal zone in the long and vertical diameters of the skull.



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