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The degree of calcification and the weight of pineal glands in Ugandan Africans

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Summary

Two hundred formalin fixed, isolated pineal glands from Ugandan Africans have been X-rayed in consecutive unselected post mortems using a laboratory X-ray machine. The degree of calcification has been divided into four stages and according to this up to 43% of all pineal glands after the age of 10 years are likely to be detected in an ordinary skull X-ray. In females the pineal glands have been more often calcified and heavier than in males, however the stalk of pineal glands in males has shown more frequent calcifications than in females. The average weight per decade has been almost constant throughout the life span. In Ugandan Africans the pineal glands were significantly lighter than in Caucasians and possible reasons for this feature are discussed.

Résumé

C'est une analyse de poids et de calcification de deux cents épiphyses qui furent prélevées à l'autopsie et ensuite radiographiées au laboratoire. Le degré de calcification radiologique fut divisé en 4 stages et selon un simple contrôle il est vraisemblable que jusqu'à 43% de toutes les épiphyses audessus de l'âge de lo ans devraient être reconnues sur une simple radiographie de la tête. Chez les femmes les épiphyses sont plus lourdes et plus souvent calcifiées que chez les hommes. Le poids moyen par décennie est presque constant pendant toute la vie. Chez l'Africain Ougandais l'épiphyse est plus légère que le poids rapporté pour l'homme blanc et cette différence est brièvement discutée.

Introduction

Because the pineal gland is frequently calcified, radiologically it is used to detect any of the brain due to intracranial space occupying lesions. At the Pan-African symposium on tumours of the nervous system (Nairobi, 1972) it was generally agreed that the pineal gland was not a useful landmark in the African because of its infrequent calcification. The purpose of this paper is to report the degree of pineal gland calcification in Ugandan Africans.

Material

Pineal glands were collected from 230 consecutive routine post mortems performed in the Department of Pathology, Makerere University, Kampala. No selection for chronic and acute illness or malignancy was made.

Methods

The pineals were removed from the brain and initially they were resected as near as possible to the third ventricle. However, early, during the study, stalk calcification was observed macroscopically, and from then onwards a more generous resection of the pineal gland area was performed, including the thalamus and postero-superior portions of the third ventricle. The glands were fixed in 10% formalin for at least 2 days. They were then dissected, by stripping off the meninges and removing the surrounding brain tissue but leaving the stalk with its superior and inferior laminae attached to the pineal gland.

The pineal glands were X-rayed using a Watson 50 kV 50 mA laboratory X-ray machine. The tube distance was 64 cm, exposure time 30 s at 30 kV and 20 mA. Fine grain film (Microtex, Kodak) was

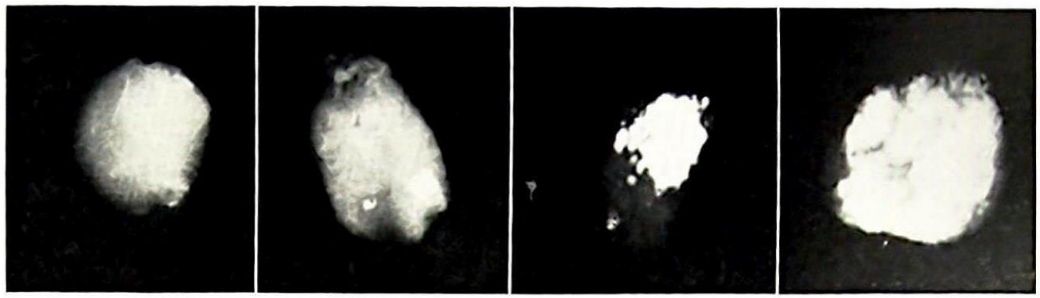

FIG. 1. Degree of calcification as used for classification (from left to right). Degree 0, no calcification. Degree I, minimal calcification. Degree II, moderate calcification. Degree III, marked calcification.

used and developed in undiluted Developer D76. The films were examined for calcification and divided into four categories according to the amount of opacity detected (Fig. 1).

Degree 0. No calcification seen on X-ray.

Degree I. Minimal calcification thought to be not detectable in an ordinary skull X-ray.

Degree II. Moderate calcification thought to be most likely detectable in an ordinary skull X-ray.

Degree III. Marked calcification thought to be easily detectable in an ordinary skull X-ray.

To evaluate the degree of calcification that would be apparent in a clinical radiograph of a skull, examples of the four degrees of calcification indicated by pins were placed on an X-ray film cassette with the authors skull superimposed, and clinical radiographs taken (Tube distance 1 m, 85kV, 72mA, 0·21 s). The stalk was removed from the pineal gland and the pineal was blotted dry with filter paper. The weight of the pineal gland was then determined to the nearest milligram using an electric balance (Mettler Type H3). The weight was transformed into cube roots for convenient comparison with previous studies.

Results

Two hundred pineal glands were accepted for final analysis and the age and sex distribution is given in Fig. 2. There is a usual male predominance in the post mortems and as the study was a consecutive one, no attempt was made to correct this proportion which stands at 2·1 : 1 for males (136 : 64). The tribes were grouped into geographical regions: eighty-six were from the south, thirty-three from the west, sixteen from the north and ten from the east of Uganda. Thirty-one were from Rwanda Burundi, seven were from other African territories, no tribe was given in seventeen cases.

The weight of the pineals was expressed as a cube root of its weight in milligrams. The mean cube root per decade and sex is given in Fig. 2, showing that it varied between 3·7 and 4·7. The mean pineal weight in females was higher than in males, apart

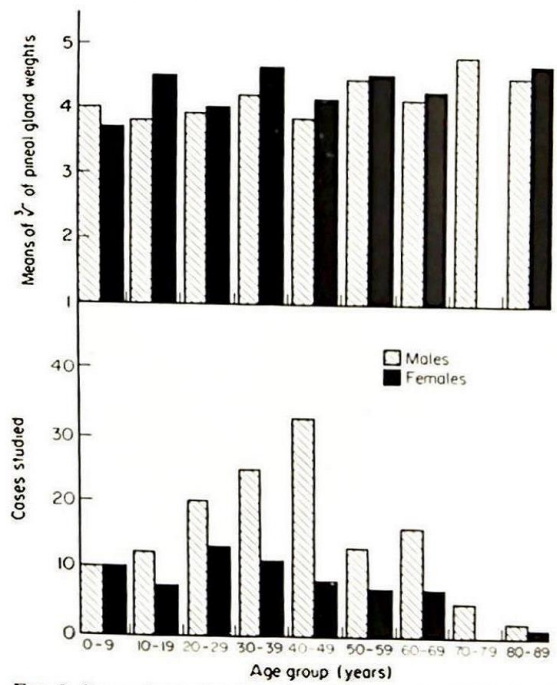

FIG. 2. Sex and age distribution of 200 cases in which pineal glands were analysed. The upper histogram shows the average weight in milligrams expressed in cube roots for the same groups.

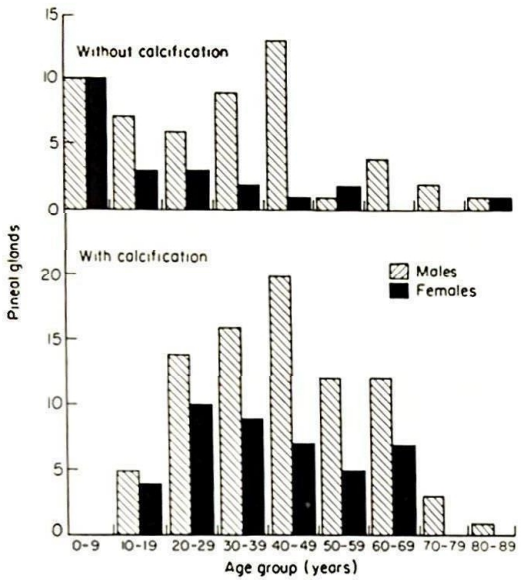

FIG. 3. The 200 pineal glands grouped according to sex and age with relation to presence or absence of calcification.

from those in the first decade. The average cube root for all ages was higher in females than in males and stands at 4·2 to 4·1. Figure 3 shows the presence or absence of calcification in 200 pineal glands correlated to age and sex. There were 125 calcified pineal glands, seventy-five showed no radiologically detectable calcification. In the first decade no calcification was observed in either sex, this group was consequently excluded from the following comparative figures. The calcification gradually increased subsequently. The sex ratio of the calcified pineals was 1·9:1 for the males (83:42) whereas in noncalcified pineals, it was 3·5:1 (43:12). There was therefore a significant excess of non-calcified pineal glands in males compared to females or in other words the pineal glands of females were more often calcified.

The site of pineal gland calcification varied. Figure 4 shows that calcification can occur either in the pineal gland or in the stalk or in both. Of the 110 stalks examined, sixty-five (= 59%) showed calcifications of which twelve had stalk calcification alone. Thus fifty-three had both stalk and pineal gland calcification. The sex ratio of these 110 was 2·6:1 (80:30) for the males. The sex ratio for those with stalk calcification was 3·6:1 (51:14) and for those without 1·8:1 (29:16) for the males. Therefore males showed more often stalk calcification than females.

Figure 5 shows the degree of pineal gland calcification in relation to sex and age decades. From this it is evident that the maximum calcification is not reached in both sexes in the second decade, however, it is present from the third decade, with exceptions made for the fourth decade in males and the sixth decade for females, which both show a total absence of degree III.

Figure 6 summarizes the percentage of degree of calcification in all decades in relation to sex and compared to the number of calcified pineal glands and to the total number of pineal glands. From this it is evident that the pineal glands in females are more heavily calcified than in males, 21% to 12% for degree III among all calcified glands and 16% to 7% for degree III if compared to the total number of pineal glands examined. If the sexes are not considered and the degree of calcification is

FIG. 4. Type of calcification in pineal glands (from left to right). (1) No calcification in gland or in stalk. (2) Marked stalk calcification. (3) Marked stalk and gland calcification. (4) Marked gland calcification alone.

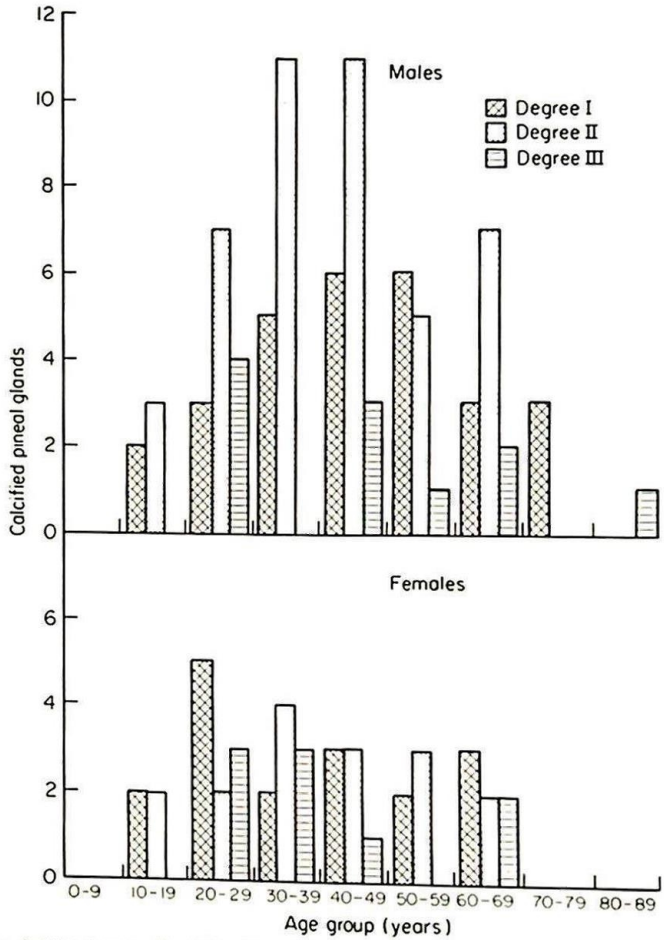

FIG. 5. The degree of calcification of 125 pineal glands in relation to age and sex.

compared to the total number of pineal glands the following results are obtained: 25% for degree I, 33% for degree II and 10% for degree III. In other words 32% of all pineal glands excluding the first decade are free of calcification (degree 0) and 57% (degree 0 plus degree I) are likely to be inapparent on a clinical radiograph. Up to 43% (degree II plus III) are likely to be detected in a skull X-ray.

To check objectively whether this type of staging of pineal gland calcification is useful both authors had skull X-rays performed with the four pineals shown in Fig. 1 superimposed. The routine X-ray apparatus of Mulago Hospital was used for this purpose. The pineals were placed on the X-ray film cassette marked by pins. The heads of the authors were superimposed and X-rayed in posterior-anterior way. The X-ray film was developed in an automatic developing machine used for all the X-ray films in Mulago Hospital. Fig. 7 demonstrates that degree II and degree III were detectable by ordinary X-ray techniques.

Discussion

Although it has been stated that calcareous concretions are constantly present in the pineal body

after the seventeenth year (Davies & Coupland, 1967), 32% of the present series showed no calcification, in 68% calcification was demonstrated in isolated pineal glands. The degree of calcification was graded and according to these results a radiologist could expect up to 43% of all pineal glands to be detectable in an ordinary skull X-ray in Ugandan Africans, showing that in intracranial space occupying lesions this simple diagnostic method still has a place. Considering the ever increasing number of road accidents and craniocerebral trauma in African developing countries this method of a simple skull X-ray should be carried out before one considers the application of an angiogram which often implicates the transport of the patient over long distances.

Recent studies on human pineal glands draw attention to its weight and possible relationship to malignancy (Rodin & Overall, 1967; Tapp & Blumfield, 1970) but the results are contradictory the first authors found that the pineals were larger and heavier, whereas Tapp & Blumfield (1970) found that the weights were lighter in malignancy. Tapp & Huxley (1971) showed the weights of pineal glands in humans are not affected by malignant disease. If the mean cube roots of pineal weights for all ages and all cases of these three studies (5·1 for Rodin & Overall, 1967; 5·4 for Tapp & Blumfield, 1970; 5·4 for Tapp & Huxley, 1971) are compared to the present series (4·1) it is evident that the pineal glands of Ugandan Africans are lighter than those of Caucasians. However, the four studies agree that the weight of the pineal glands is maintained into old age.

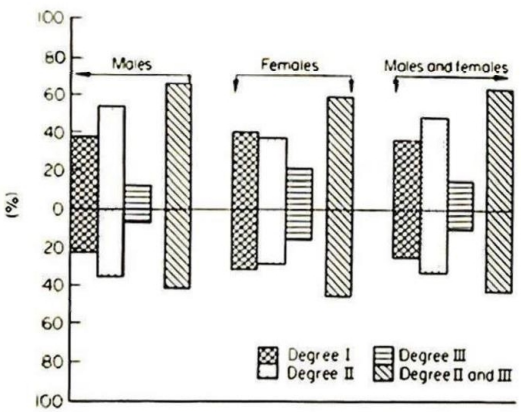

FIG. 6. The percentage of the degree of calcification per sex and per calcified pineal glands (above) and per total pineal glands (below) for all age groups excluding the first decade.

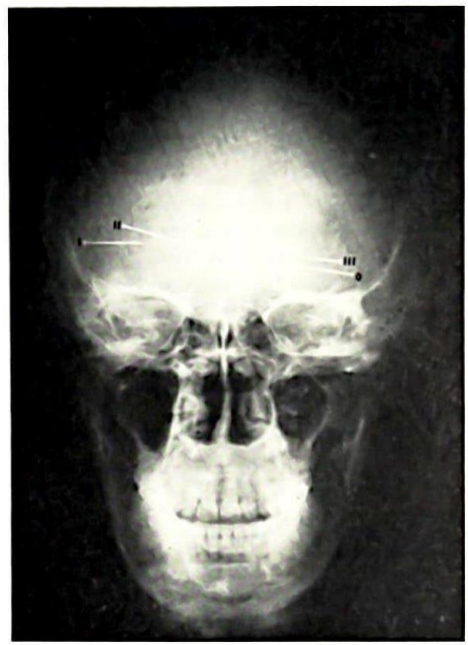

FIG. 7. Skull X-ray of one of the authors (S.G.M.) with the four pineal glands shown in Fig. 1 superimposed and marked by pins. Degree II just recognizable and degree III definitely visible.

Tapp & Huxley (1971) found that the pineal glands of females below the age of 60 years were considerably heavier than those of males, they suggested that this fact could be explained by their higher calcium content. The present study similarly confirms that the pineal weight of females during their reproductive age is higher than in corresponding males and that the degree of calcification is more marked in females. However, the stalks of pineal glands were found to be more often calcified in males.

Studies in experimental pathology showed that the pineal gland is partly a light depending organ which is biochemically depressed by light and activated by darkness (Klein & Weller, 1970). The production of melatonin (pineal hormone) persists in continous darkness but is suppressed by continuous light exposure (Ralph *et al.*, 1971). Abundant light exposure interferes with the pineal function and results in dimunition in pineal weight

(Fiske, Pound & Putnam, 1962). There is now good evidence for an antigonadotropin effect of the pineal gland in male hamsters (Reiter, Sorrentino & Hoffman, 1970; Eichler & Moore, 1971) and in female rats (Dickson, Benson & Tale, 1971; Vaughan, Norris & Vaughan, 1971; Ota, Hsieh & Obara, 1971).

From pinealomas in man it is known that the destructive type is associated with a delayed menarche in girls and that the functional type is associated with precocious puberty in boys, thus proving a sex-related function (Russel & Sachs, 1943; Netter, 1965) however Cole (1971) postulated that the critical site for premature puberty occurring in pinealomas appears to be in the posterior part of the hypothalamus.

Is light responsible for the low average weight found in the present series, thus giving rise to an earlier puberty which is known to occur in sun-exposed countries? Only further studies in humans will answer the real function of the pineal gland.

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References

COLE, H. (1971) Tumours in the region of the pineal. *Clin. Radiol.* **22**, 110–117.

DAVIES, D.V. & COUPLAND, R.E. (1967) *Gray's Anatomy*. 34th edn, pp. 1587–1589. Longmans, Green & Co. Ltd, London.

DICKSON, K., BENSON, B. & TALE, G. (1971) The effect of blinding and pinealectomy in unilaterally ovariectomized rats. *Acta Endocr. (Kbh.)*, **66**, 177–182.

EICHLER, V.B. & MOORE, R.Y. (1971) Pineal hydroxyindole-O-methyltransferase and gonadal responses to blinding of continuous darkness blocked by pineal denervation in male hamsters. *Neuroendocrin. (Basel)*, **8**, 81–85.

FISKE, V.M., POUND, J. & PUTNAM, J. (1962) Effect of light on the weight of pineal organ in hypophysectomized, gonadectomized and adrenalectomized or thiouracil fed Rats. *Endocrinology*, **71**, 130–133.

KLEIN, D.C. & WELLER, J.L. (1970) Indole metabolism in the pineal gland. A circadian rhythm in N-Acetyltransferase. *Science*, **169**, 1093–1095.

NETTER, F.H. (1965) Endocrine system and selected metabolic diseases. *The Ciba collection of Medical Illustrations*, **4**, 36–37.

OTA, M., HSIEH, K.S. & OBARA, K. (1971) Absence of gonadotropin inhibiting substance in the urine of pinealectomized rats. *Endocrinology*, **88**, 816–820.

RALPH, C.L., MULL, D., LYNCH, H.J. & HEDLUND, L. (1971) A melatonin rhythm persists in rat pineals in darkness. *Endocrinology*, **89**, 1361–1366.

REITER, R.J., SORRENTINO, S. & HOFFMAN, R.A. (1970) Early photoperiodic conditions and pineal antigonadal function in male hamsters. *Int. J. Fert.* **15**, 163–170.

RODIN, A.E. & OVERALL, J. (1967) Statistical relationships of weight of the human pineal to age and malignancy. *Cancer (Philad.)*, **20**, 1203–1214.

RUSSEL, W.O. & SACHS, E. (1943) Pineoloma. A clinico-pathological study of seven cases with a review of the literature. *Arch. Path.* **35**, 869–888.

TAPP, E. & BLUMFIELD, M. (1970) The weight of the pineal gland in malignancy. *Brit. J. Cancer*. **24**, 67–70.

TAPP, E. & HUXLEY, M. (1971) The weight and degree of calcification of the pineal gland. *J. Path.* **105**, 31–39.

VAUGHAN, M.K., NORRIS, J.T. & VAUGHAN, G.M. (1971) Inhibition of compensatory ovarian hypertrophy in mice by melatonin, 5-hydroxytryptamine and pineal powder. *J. Endocr.* **50**, 171–175.

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