Fatty-Acid Analysis of Meningiomas by Gas-Phase Chromatography*

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Cushing and Eisenhardt¹ have classified morphologically the meningiomas into eight major categories, each of which has two or three subtypes. In general, whenever possible, morphologic classifications have been based upon histogenesis. However, the meningioma may not be a tumor of a single histogenetic origin for on malignant transformation some tumors⁹ eventuate either as a fibrosarcoma or as a malignant hemangioma or a malignant hemangiopericytoma⁴ or as a malignant meningothelioma. Embryologically,⁵,¹⁰ it appears that the meningioma is a complex tumor containing both mesodermal and ectodermal elements in varying proportions. Kepes⁶ described and compared the ultrastructure of different morphologic types of meningiomas and observed that all the tumors examined had the same basic ultrastructural pattern. In addition, the meningothelial cell appeared to be able to produce collagen.

Morphologically, a small percentage of meningiomas have cellular atypia and increased mitotic activity and are morphologically classed as malignant. However, it is difficult in many situations to anticipate either local recurrence or diffuse malignancy on the basis of morphology alone. In general, extension into the overlying hyperostotic bone does not necessarily impair the prognosis, for if the involved bone is removed, an equally favorable prognosis persists.¹,²

In an effort to seek other criteria of cellular growth or histogenesis samples of tissue from a series of tumors were studied biochemically for the distribution of fatty acids from C14 (myristic) to C20:4 (arachidonic). The results of these studies were superimposed on a review of the morphology and clinical course of these patients.

Material and Methods

At the time of exploratory surgery, portions of 8 meningiomas were obtained (Table 1). Samples of the leptomeninges, from the lateral aspect of the right cerebral hemispheres, and from the midline including the arachnoid granulations, were obtained from 4 necropsies as controls. Similarly, samples of the dura mater from the lateral aspect of the cerebral hemispheres were obtained from 3 necropsies.

Utilizing a method established previously,³,⁸ the methyl esters of fatty acids in fresh tissues were obtained by direct methylation of the total lipids. Fresh brain tissue was placed in 15 ml of a solution of 98 per cent methyl alcohol and 2 per cent concentrated sulfuric acid by volume and refluxed for 2 hours. The tissue was broken apart by a glass rod, refluxed for an additional 2 hours, and filtered into a separatory funnel. This solution was washed with 10 ml of distilled water and shaken. The water layer was transferred to another separatory funnel and washed with 10 ml of n-hexane. The water layer was discarded. The two n-hexane layers were combined and washed three times with distilled water. This solution was filtered through 1 gm. anhydrous sodium sulfate (Na₂SO₄) into a 125 ml Erlenmeyer flask. The sodium sulfate was washed with 5 ml of n-hexane. The total n-hexane filtrate was evaporated on a water respirator to obtain proper concentration of methyl esters to be analyzed by gas-phase chromatography. Although other lipids soluble in n-hexane were present in the filtrate in addition to the methyl esters of fatty acids, they created negligible interference upon injection into the column for analysis.

The methyl esters were analyzed on a Barber-Coleman Model No. 10 gas chromatograph. Separations were carried out by the use of diethylene glycol succinate polyester, 15.4 per cent by weight, on 80–100 mesh, acid washed, Chromosorb, W, supplied by Applied Science Laboratories, Inc. The column was maintained at 170° and the rate of flow of argon was 2.5 cc/sec. The total running time for each prepared sample was 90 min.

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The machine was standardized daily with NIH methyl ester standard. Reproducible results within 1.5 per cent of actual composition were obtained. Each fatty-acid peak was identified by comparison of retention times with methyl ester standards supplied by Applied Science Laboratories. The peaks on each chromatogram were designated as follows: C14 (myristic acid), C16 (palmitic), C16:1 (palmitoleic), C18 (stearic), C18:1 (oleic), C18:2 (linoleic), and C20:4 (arachidonic). The fatty acids C20:2 (eicosadienoic) and C20:3 (eicosatrienic) were inferred by their relative times of retention. Further identification was carried out by bромination of the methyl esters and precipitation of aldehydes by 2,4-dinitrophenylhydrazine. These aldehydes, designated X1, X2, and X3, were tentatively identified as palmitaldehyde, stearaldehyde and oleylaldehyde, respectively, by inference from the relative time of retention.

The percentile composition of fatty acids was calculated by measuring the area under each peak by triangulation and equating the sum of the areas to 100 per cent.

**Results**

In Table 1 the pertinent morphologic and clinical findings of these tumors are given. The percentile distribution of fatty acids for C14 (myristic) to C20:4 (arachidonic) of individual tumors is given in Table 2 and they may be compared with similar studies of leptomeninges (Table 3) and dura mater (Table 4) from non-neoplastic controls.