THE TYPE CELL OF THE SO-CALLED DURAL ENDOTHELIOMA.*

F. B. MALLORY, M.D.

(*From the Pathological Laboratory of the Boston City Hospital.*)

Introduction. — At the present time the only feasible principle on which to classify tumors is that used for normal tissues. It is based on the histological differentiation of the cells and their intercellular products. According to this method the members of each definite group of tumors, whether they are growing slowly or rapidly, are built up from a type cell and named accordingly: for example, fibroblast, fibroblastoma; glioblast, glioblastoma.

The so-called dural endotheliomata form a fairly common and important group of tumors which are not recognized and classified on this basis, but on their place of occurrence and on a frequent and fairly characteristic arrangement of their cells, namely, whorl formation and, rarely, palisade grouping of the nuclei. The result is that the possible variations of this type of tumor are not recognized, and its relation to another group of tumors, while more than once suspected and suggested, has never been demonstrated. The tumors referred to are those frequently involving the central and peripheral nerves and known clinically, when abundant and subcutaneous, as multiple fibromatosis or as von Recklinghausen's disease. The fact that both varieties of tumors may occur at one and the same time in the same individual strongly suggests a close relationship.

Present conception of the so-called dural endothelioma. — It is generally taught that the dural endothelioma arises from the dural endothelium, which according to universal agreement normally lines the inner surface of the dura and the outer surface of the arachnoid, — in other words, the subdural space. The tumor usually occurs as a flattened to more or

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less spherical nodule which often attains a considerable size. Multiple dural endotheliomata are not uncommon. As the new growth enlarges it forces the brain tissue away before it and often invades the dura at its base. Rarely it penetrates through the skull into the soft tissues outside. I know of no case in which it has invaded the pia or the brain tissue. It may grow slowly or rapidly.

Microscopically the tumor is characterized by being composed of cells which are usually large and more or less flattened, but are sometimes spindle-shaped. They often show a marked tendency to wrap themselves around each other or around strands of connective tissue or around blood vessels, so that variously sized, concentrically arranged masses of cells (whorls) are formed. A second tendency which they sometimes exhibit to a certain extent in stained sections is a palisade effect, owing to an orderly grouping of the nuclei in more or less parallel columns. The stroma is as a rule small in amount except where the tumor is invading the dura.

The general tendency, which I have personally followed, has been to classify the cellular tumors as endotheliomata and the fibrous ones as fibromata. Ribbert and Borst favor grouping both types of tumors with the connective tissue new-growths.

The type cell of the dural endothelioma. — The study of a fairly large number of these tumors derived both from post-mortem examinations and especially from surgical operations led me to believe that the type cell out of which they are built is not so lacking in distinguishing features as is generally supposed. It was not, however, until a perfectly typical example of the growth was obtained from an operation by Dr. E. H. Nichols that the nature of the type cell could be definitely demonstrated. The tumor formed a flattened spherical mass which weighed one hundred and sixty grams. Thin slices of it were fixed in Zenker's fluid within five minutes after removal. Paraffin sections were stained in four different ways, with eosin-methylene blue, phosphotungstic acid

hematoxylin, aniline blue stain for collagen, and Weigert's iron-resorcin-fuchsin for elastic fibers.

The eosin-methylene blue stain showed that the tumor was a typical rapidly growing so-called dural endothelioma. Cells in mitosis were easily found. Numerous whorls were present: some consisted of only a few cells, others of large concentrically arranged masses of them. In addition there were fibrous whorls which often occurred in large clumps. A palisade grouping of nuclei was present in places but was not a marked feature. The tumor was invading the dura, and in this region exhibited a distinct alveolar arrangement. Elsewhere the stroma was composed of blood vessels and a loose connective tissue meshwork infiltrated with lymphocytes.

The aniline blue stain demonstrated abundant collagen in the stroma and in the fibrous whorls, and in addition a small amount in the form of very delicate, poorly developed and faintly staining fibrils everywhere between the tumor cells. The phosphotungstic acid hematoxylin stain, however, showed the real nature of the neoplasm. Each cell was surrounded by numerous fine fibroglia fibrils, without question produced by the tumor cells. They were better developed in those places where growth was less rapid, but they were everywhere present and were more prominent than the collagen fibrils.

Now the production of fibroglia and collagen fibrils is the distinguishing characteristic of the type-cell known as the fibroblast. This observation, therefore, strongly suggests that the dural endothelioma, so-called, is in reality some form of fibroblastoma.

The problem is further complicated by the results obtained with the elastic tissue stain. Many of the more or less fibrous whorls contain networks of elastic fibrils. The fibrils are found also in abundance in the walls of the larger blood vessels and in the dura, and in places between the tumor cells which are near the dura, but not between these cells elsewhere.

The histological results obtained from this tumor led to a careful investigation of a series of dural endotheliomata and of related new growths, and finally to a careful study of the

development and differentiation of the dura and arachnoid and of their relation to each other.

Histology of a series of dural endotheliomata. — There were available for study thirty tumors obtained from various sources, many through the kindness of Dr. Harvey Cushing. The majority of them came from surgical operations and had been preserved in Zenker's fluid immediately after removal. Sections were stained in the four different ways already mentioned.

The tumors form a series running from very cellular types up to those which are dense and fibrous. Some exhibit, at least in places, a distinct concentric arrangement of the cells, so that cellular and fibrous whorls of various sizes, and occasionally in great numbers, are found; others show no such formations. A palisade grouping of the nuclei is occasionally noticeable, but as a rule is absent. In the cellular neoplasms the cells are comparatively large and more or less flattened; in the fibrous growths they approach the spindle shape.

The tumor cells show a marked tendency to invade the dura, spreading its bundles of fibrils, and occasionally the individual fibrils, widely apart. They also occasionally invade the connective tissue and the walls of the blood vessels in the stroma.

Many of the tumors which had been preserved immediately after removal show the tumor cells surrounded by delicate fibroglia fibrils which, however, are not so well developed as in the tumor first described. Often the fibrils can be seen only when viewed on end.

Collagen fibrils are also present. In the cellular growths they are few in number, but in the denser ones they are numerous and form a conspicuous feature in the sections stained with aniline blue. It is noticeable, however, that they do not seem to stain so intensely as the collagen in the dura and around the blood vessels. This may be due to a difference in chemical composition, to the fact that they are mixed in with red staining fibroglia fibrils and are thus obscured, or because they are not packed closely together.

The elastic tissue stain gives results which have been puzzling to interpret. Elastic fibrils may be present in abundance or entirely absent. They occur in the dura, in the fibrous whorls, in the walls of blood vessels, in the stroma, and often diffusely between the tumor cells. The various pictures presented can best be discussed under the next heading.

Stroma. — In epithelial organs and tumors it is a simple matter to distinguish the parenchyma from the stroma. The same is true of a glioblastoma because the neuroglia fibrils belonging to the cells can be stained differentially so that they stand out in marked contrast with the collagen fibrils of the stroma. With the fibroblastoma this is not so. The intercellular substances of the stroma and those produced by the tumor cells are identical. The same is true of the so-called dural endotheliomata. On this account it has proved exceedingly difficult to interpret correctly the results obtained by the elastic tissue stain, as will appear from what follows.

As already stated, these tumors arise in and tend to invade the dura extensively, so that the latter forms a coarse stroma to this part of the growth. In addition, the cells of the dura are stimulated to activity so that they commonly produce much more elastic tissue than is normally present. They also proliferate and accompany the blood vessels to form the new stroma which sometimes divides the tumor cells into alveolar masses, at other times spreads diffusely between them.

With this explanation in mind it is possible to interpret some of the appearances already described.

In three of the neoplasms, which are growing rapidly enough to show occasional mitotic figures, elastic tissue is present in large amounts. It occurs as a fine to coarse reticulum which is distributed fairly evenly everywhere between the cells. The stain of the fibrils varies. It is intense in those which are fully developed but grades downwards to almost nothing in those which are newly formed. This variation in intensity of stain and character and distribution of the fibrils indicates that they are the product of the tumor cells.

In another rapidly growing endothelioma which lies almost entirely within the separated strands of the dura the cells of the latter have been stimulated to produce a large amount of elastin. In many places the tumor cells have penetrated between these fibrils so that at first sight it would seem as though they had produced them. In other places, however, there are masses of tumor cells with no elastic fibrils present. The irregular distribution of these fibrils, their direct connection with the dura, and their intense stain show very definitely that they are not the product of the tumor but are a part of the dura which forms the stroma, and owe their position to invasion by the cells of the new growth.

Many of the other endotheliomata show elastic fibrils here and there between the tumor cells, but only when the latter are in or near the dura or abundant stroma. They are evidently not produced by the tumor cells.

Whorls. — The cells of these tumors often show a distinct concentric arrangement, forming whorls of two types, the cellular and the fibrous.

The cellular whorls are composed of tumor cells and of the intercellular substances to which they have given rise. The amount of these substances corresponds to that found elsewhere in the tumor. The whorls are of various sizes, from a few cells up to hundreds.

The fibrous whorls are of two sorts. Some are due to cellular whorls having formed around connective tissue strands of dura or stroma, or around blood vessels, and may contain collagen or elastic fibrils or a combination of the two. The bundles of fibrils and the blood vessels can often be traced into and out of such whorls, and are irregularly disposed in them.

In the second type of fibrous whorls, the more common variety, the intercellular substances form successive layers concentrically arranged around a central point. It is self-evident that they can not be old fibrils rolled up into spheres. On the other hand, the amount of collagen and elastin in these whorls is greatly in excess of that produced elsewhere in the

tumor. Moreover, these whorls are always most common and abundant near the dura or the stroma. They are evidently due to fibroblasts which have been included in cellular whorls of the tumor and have been stimulated to unusual activity. Occasionally the two types of fibrous whorls are combined, and thus produce a rather confusing picture.

The fibrous whorls often become calcified, and in this way form the so-called psammoma bodies.

A palisade arrangement of the nuclei, due to their occurring in regularly disposed rows or clumps, is not common in the cellular dural endotheliomata. In the fibrous types it is more noticeable. It is not peculiar to this type of tumor, although more or less common, because it is occasionally found in the leiomyoma.

The so-called dural endothelium. — The dural endothelium according to general agreement is not genetically identical with the endothelium lining the blood and lymph vessels but is differentiated from the mesenchyma at a later period of embryonic development. In embryos four to five months old the arachnoid appears as a definite layer two to five cells in thickness. The cells stain differently from the adjoining fibroblasts in consequence of having more cytoplasm and less intercellular substance. They are surrounded by delicate fibroglia and a small number of collagen fibrils. Elastic fibrils are lacking at this stage of development.

The arachnoid and pia early separate from each other to a certain extent: in some places not at all, in others more or less extensively to form the so-called subarachnoid space composed of intercommunicating clefts of which the largest have received the name of cisternae. The important point is that this space is not lined by endothelium but by the fibroblasts themselves.

At a later period the arachnoid separates completely from the dura, leaving the inner surface of that membrane bare without a lining of endothelium as is universally taught. In other words, there is no dural endothelium.

The cells of the arachnoid, with their intercellular products of collagen and to a slight extent of elastin, form the thin non-vascular layer known as the arachnoid membrane. Its distribution follows that of the inner surface of the dura; hence it does not dip into the sulci. The arachnoid early exhibits two characteristics which seem to be peculiar to it. Its free surface towards the dura develops a layer of cells resembling endothelium, the so-called dural endothelium. These cells instead of multiplying evenly all over the surface usually proliferate in foci, so that groups of dozens or even hundreds of cells occur here and there. They may form focal layers up to a dozen or more cells in thickness. As these cells get older they develop fibroglia, collagen and occasionally elastic fibrils. This method of growth of the arachnoid leads to irregular thickening of the membrane.

The second peculiarity of the arachnoid is that the collagen fibrils are not very abundant in comparison with the number of cells, and that they do not form compact strands but remain more or less separated from each other. In other words, the arachnoid cells are not so highly differentiated fibroblasts as those which form the dura.

Arachnoid villi: Pacchionian bodies. — The surface cells of the arachnoid exhibit early in life, in the focal areas where they proliferate, a marked tendency to invade the dura. These invading cells are pictured by Ribbert in his book on tumors as normal dural endothelium. The young multiplying cells infiltrate first; then they produce intercellular substances and thus force themselves apart, in this way exerting pressure on the fibers of the dura and separating them. Thus the arachnoid villi are formed. They always remain covered with endothelial-like cells just as the arachnoid itself does. On the surface of these villi other masses or buds of proliferating cells are formed, and they invade the dura in various directions and again produce their collagen and elastic fibrils. The process is very much like that displayed by the cells of the roots of a plant as it penetrates the soil and spreads

through it. The enlarged arachnoid villi so evident in adult life are usually called Pacchionian bodies.

Two things are noticeable about the arachnoid villi. The collagen fibrils in them are always loosely arranged, not in compact strands like those in the dura. In addition there are numerous spaces in the villi, probably for the passage of lymph, and they are lined by fibroblasts only, not by endothelium.

Another point of interest in connection with invasion of the dura by the arachnoid is the stimulating effect which the arachnoid tissue has on adjoining dural fibroblasts in causing them to produce much more elastic tissue than they do under normal conditions. This is the same effect that is evident when a tumor arising from the arachnoid invades the dura.

The arachnoid cells are less differentiated than the fibroblasts of the dura. Sometimes, instead of forming distinct collagen and elastic fibrils, the cells in the growing buds form a homogeneous network which takes the elastin stain in varying degrees of intensity. Later this network changes to distinct collagen fibrils, with elastic fibrils here and there among them. As a rule the elastic tissue in the villi is small in amount and does not stain so intensely as that in the dura.

The cells in the proliferating buds on the surface of the arachnoid and of its villi often show a concentric arrangement, or whorl formation. The whorls may be of the cellular type or fibrous in character, owing to the inclusion in them of one or more fibroblasts from the dura. Occasionally these whorls undergo classification forming so-called psammoma bodies.

Rarely some of the Pacchionian bodies undergo necrosis, become calcified and then by organization of the lime salts by adjoining fibroblasts are replaced by true bone, in this way forming the so-called osteophytes of the dura, as seen most frequently in the falx.

The invasion of the dura by the arachnoid cells corresponds exactly to the invasion of normal tissue by a malignant tumor. It is not surprising, therefore, that the normally invading cells should occasionally take on malignant properties and grow as a tumor. The new growth would seem to arise from cells

belonging to the dura which already forms a stroma for them and which of necessity must furnish the blood vessels because the arachnoid itself possesses none.

In view of the foregoing statements of the nature and origin of the arachnoid membrane and of the peculiar character of the cells lining its outer surface it seems fairly evident that the tumor known as dural endothelium is incorrectly named. It should be recognized in the future as one type of fibroblastoma and named accordingly — arachnoid fibroblastoma. The principle is the same as is shown in the recognition of various types of epithelial tumors; thus we speak of "liver-cell" carcinoma, "epidermoid" carcinoma, "hair-matrix" carcinoma.

One noticeable feature of the arachnoid fibroblastoma is, that, although it always invades the dura and may extend to the skull and even the soft tissues outside, it apparently never invades the brain. To do so it would have to penetrate the non-vascular arachnoid from which it arose, and this for some reason it does not do.

Perineurial fibroblastoma. — The determination of the true nature of the type cell of the so-called dural endotheliomata led naturally to a study of the tumors involving the central and peripheral nerves, to find if possible their relation to the arachnoid fibroblastoma on the one hand and to the ordinary fibroblastoma on the other.

The central and peripheral nerves and their subdivisions are surrounded by one to several layers of thin, flat cells which form a sheath known as the perineurium. The cells differ to some extent from the adjoining fibroblasts of the epi- and endoneurium, so that with the various stains they stand out in moderate contract with them. They have slightly more cytoplasm, numerous very delicate fibroglia fibrils and a moderate number of collagen fibrils.

Between the layers of cells are numerous very faintly staining elastic fibrils which form a delicate meshwork. The perineurium reaches its highest development in the laminated sheaths of the nerve endings in the Pacinian corpuscles.

The perineurium is probably not an extension of the arachnoid along the nerves, but an analogous differentiation of the mesenchyma around them. Unlike the arachnoid, it has no surface layer of undifferentiated cells to which the power of growth is limited, and the layer is not separated by clefts from the tissues on either side of it.

The perineurium frequently gives rise to tumors which are often multiple and occasionally very numerous. They are known under various names, such as neurofibroma, false neuroma, fibroma molluscum, plexiform neurofibroma, von Recklinghausen's disease. Many of these tumors resemble to some extent the more differentiated ones which arise from the arachnoid.

The more or less distinctive peculiarities of these tumors are as follows: They show two types of growth. In one the moderate amount of collagen which goes with the cells is loosely arranged and often edematous, sometimes even to the extent of suggesting a myxoblastoma. In the other type of growth the cells and their intercellular products are clumped together in masses which correspond apparently to the whorls of the arachnoid fibroblastoma, but they contain more collagen. These masses contain no blood vessels unless they have grown around them. A palisade appearance is usually marked in these masses owing to the regular grouping of nuclei and collagen. A tumor may show either type of growth, but as a rule contains both in various proportions. The blood vessels and the stroma accompanying them run in the loose-meshed part of the growth.

The cells of a perineural fibroblastoma produce fibroglia and collagen fibrils in moderate numbers, never to the amount seen in the ordinary fibroblastoma, and some of them also give rise to elastic fibrils which may be quite numerous and which occur in the form of a delicate network. It is noticeable that the collagen fibrils do not seem to take so deep a stain with aniline blue as those in the surrounding connective tissue. This may be due, as stated under the arachnoid fibroblastoma, to a chemical difference in the fibrils or be

apparent only and caused by the presence among them of numerous red stained fibroglia fibrils.

In one respect the perineural fibroblastoma differs radically from the arachnoid variety. It quite regularly invades the adjacent nerve tissue. In fact it sometimes extends markedly in it and its subdivisions, in this way giving rise to the so-called plexiform neurofibroma. At other times it invades the tissue outside of nerves, spreading through connective tissue, surrounding the coil glands of the skin and not infrequently invading fat tissue. These tumors sometimes grow rapidly and spread by infiltration.

Tumors of the nervus acusticus. — The common tumor of the nervus acusticus and of the central nerves is a perineurial fibroblastoma. It usually contains numerous more or less concentrically arranged masses of cells and collagen fibrils with palisade arrangement, while the loose-meshed type of growth with the blood vessels in it forms a sort of stroma for these attempts at whorl formation. The tumors may be rapidly growing, cellular, and contain mitotic figures, or fibrous with numerous fibroglia and collagen fibrils lying between the tumor cells and produced by them.

The fact that neuroglia fibrils and nerve fibers are sometimes formed in these tumors is easily explained because they exist normally in the nerve and may persist after it has been invaded by the new growth. It is a well-known fact that neuroglia tissue often extends out from the central nervous system into nerves some little distance, from a few millimeters to a centimeter or more.

Summary and conclusions. — There is no dural endothelium; the inner surface of the dura is bare except for fibroblasts.

The arachnoid differentiates early in embryonic life out of the mesenchyma surrounding the brain and cord, and divides the pia from the dura. It separates first here and there from the pia by the formation of intercommunicating clefts to form

the subarachnoid space, which is lined or limited by fibroblasts only.

For a while the arachnoid remains closely attached to the inner surface of the dura, to the distribution of which it corresponds exactly. Then it separates completely from it leaving it bare. The cleft between the two is known as the subdural space.

The arachnoid appears first as a single layer of cells, but soon thickens to two to five cells. It becomes noticeable because the cells composing it have more cytoplasm and less intercellular substance than the adjoining fibroblasts. Its fibroglia fibrils are very delicate, and the collagen fibrils relatively few in number. After the arachnoid is separated from the dura the cells on its outer surface form a layer of endothelial-like cells which really are undifferentiated but potential fibroblasts on which the future growth and thickening of the arachnoid depend. With advancing age these surface cells multiply, usually not uniformly, but here and there in foci, and form cellular masses or buds which occasionally exhibit a concentric arrangement (whorl formation). Occasionally one or more dural fibroblasts are included in one of these whorls; then fibrous whorls containing numerous elastic fibrils result. After a time the cells in these buds differentiate and form fibroglia, collagen and elastic fibrils. In this way the arachnoid is thickened, sometimes uniformly, more often irregularly in foci.

These foci or buds of proliferating arachnoid cells show a marked tendency to invade the dura, penetrating in every direction and pressing strands of fibrils apart. In time, the cells secrete intercellular substances, and in this way form the arachnoid villi (Pacchionian bodies) which regularly show on their surface other cellular buds.

The growing cells of the arachnoid frequently give rise to tumors which go under various names, — dural endothelioma, psammoma, fibroma, fibrosarcoma. The best term for the entire group of tumors would seem to be "arachnoid fibroblastoma." The neoplasm is sufficiently different from the

ordinary fibroblastoma to deserve a distinctive title, just as we recognize different varieties of epithelial tumors according to the type cell forming each of them. The tumor may grow rapidly or slowly, and contain numerous cellular and fibrous whorls or none at all. The cells, if growing slowly enough to give time for differentiation, may produce fibroglia, collagen and elastic fibrils. Sometimes the intercellular substance appears in the form of a reticulum which takes the elastic stain with more or less intensity.

The fibrous whorls of the tumor may be due to cellular whorls surrounding strands of collagen or elastic fibrils or blood vessels belonging to the dura or the stroma, or more often to the inclusion of fibroblasts derived from the same source and stimulated to produce numerous elastic fibrils.

The arachnoid fibroblastoma derives the blood vessels and connective tissue of its stroma from the dura. It can invade the dura, the skull and the soft parts outside, but it cannot pass through the arachnoid, from which it has arisen, and invade the brain.

The perineurium is either an outgrowth of the arachnoid or more probably an analagous differentiation of the mesenchyma around the nerves. It has no undifferentiated layer to which its growth is restricted, and is not separated by any clefts from either the epi- or the endo-neurium. It reaches its highest development in the layered sheath around the nerve endings in the Pacinian corpuscles.

Tumors frequently arise from the perineurium, occasionally in great numbers, and are known under various names, neurofibroma, false neuroma, fibroma molluscum and, when multiple, as von Recklinghausen's disease. They differ from the ordinary fibroblastoma in producing a relatively smaller number of collagen fibrils. Elastic fibrils are sometimes formed. Many of these tumors exhibit a striking and to some extent characteristic appearance, owing to the production, apparently after the manner of the whorl formation in the arachnoid fibroblastoma, of more or less spherical nonvascular masses of cells and fibrils which often show a palisade grouping of the nuclei.

The tumors arising from the perineurium differ distinctly from the arachnoid fibroblastoma in one respect, — they show a marked tendency to invade the nerve tissue and occasionally to extend along it to such a degree as to form the so-called plexiform neurofibroma. These tumors had best be grouped under the term " perineurial fibroblastoma," although their close relationship to the arachnoid fibroblastoma is evident.

The common tumor of the nervus acusticus and of other central nerves is a perineurial fibroblastoma. Nerve fibers and neuroglia fibrils are sometimes found in it because the tumor invades the nerve in which both of these tissues are normally present. Examination of normal acoustic nerves shows that neuroglia tissue may extend out to a distance of a centimeter or more from the medulla.

[The expenses of this investigation have been defrayed in part from a gift received from the " Committee of the Permanent Charity Fund Incorporated."]

DESCRIPTION OF PLATES.

PLATE XXX., FIG. 1. — Arachnoid fibroblastoma; case of Dr. E. H. Nichols. The tumor cells have numerous fibroglia fibrils. x 1000.

FIG. 2. — Same tumor: one cellular whorl: one fibrous whorl containing many elastic fibrils. x 1000.

PLATE XXXI., FIG. 3. — Same tumor: several cellular whorls: also several fibrous ones containing elastic fibrils. x 300.

FIG. 4. — Arachnoid fibroblastoma. Cellular whorls surrounding separated strands of dura. x 1000.

PLATE XXXII., FIG. 5. — Arachnoid fibroblastoma. Cellular whorls are involving strands of the dura and stimulating the production of elastic fibrils. x 1000.

FIG. 6. — Arachnoid fibroblastoma. The stroma consists of a reticulum which stains with the elastic tissue stain. x 1000.

PLATE XXXIII., FIG. 7. — Arachnoid fibroblastoma. A large whorl present, standing out in marked contrast with the rest of the tumor. x 125.

FIG. 8. — Arachnoid villi over cerebrum in a child four years old. Growth cellular in places. x 300.

PLATE XXXIV., FIG. 9. — Arachnoid villus. Three cellular buds on surface. x 125.

FIG. 10. Cellular bud on surface of arachnoid: is penetrating dura which shows slightly on the right. x 500.

PLATE XXXV., FIG. 11. — Cellular bud of arachnoid projecting into blood vessel of dura: shows tendency to whorl formation. x 500.

FIG. 12. — Cellular bud of arachnoid growing in dura. Cells show whorl arrangement. x 1000.

PLATE XXXVI., FIG. 13. — Cellular bud on surface of arachnoid villus: contains a fibrous whorl in which is much elastic tissue. x 1000.

FIG. 14. — Cellular bud of arachnoid growing in dura. Contains a fibrous whorl in which are a few elastic fibrils. x 1000.

PLATE XXXVII., FIG. 15. — Cellular bud on surface of arachnoid villus. Is forming a reticulum which takes the elastic tissue stain. x 500.

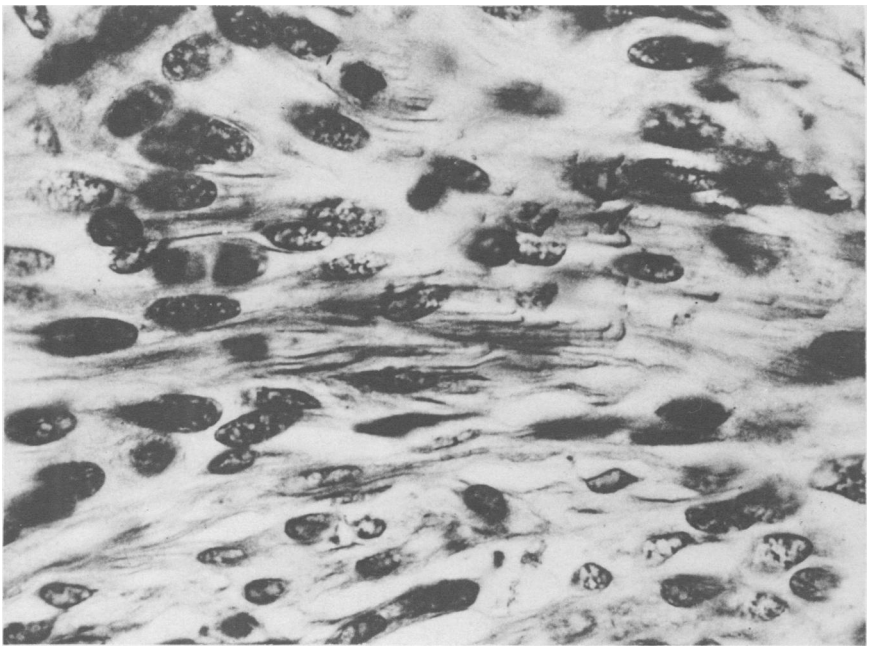
FIG. 16. — Arachnoid villus surrounding two strands of dura of which the cells are stumulated to produce an increased amount of elastic tissue. x 500.

PLATE XXXVIII., FIG. 17. — Perineurium of peripheral nerve and small tumor-like nodule within it, derived, perhaps, from the perineurium. x 1000.

FIG. 18. — Perineurial fibroblastoma; loose-meshed; contains blood vessels but no whorls. x 200.

PLATE XXXIX., FIG. 19. — Perineurial fibroblastoma: loose-meshed and vascular on left; whorl formation on right. x 200.

FIG. 20. — Perineurial fibroblastoma: shows loose-meshed tissue in which lie denser structures (whorls) without blood vessels, and showing a tendency to palisade arrangement of the nuclei. x 200.



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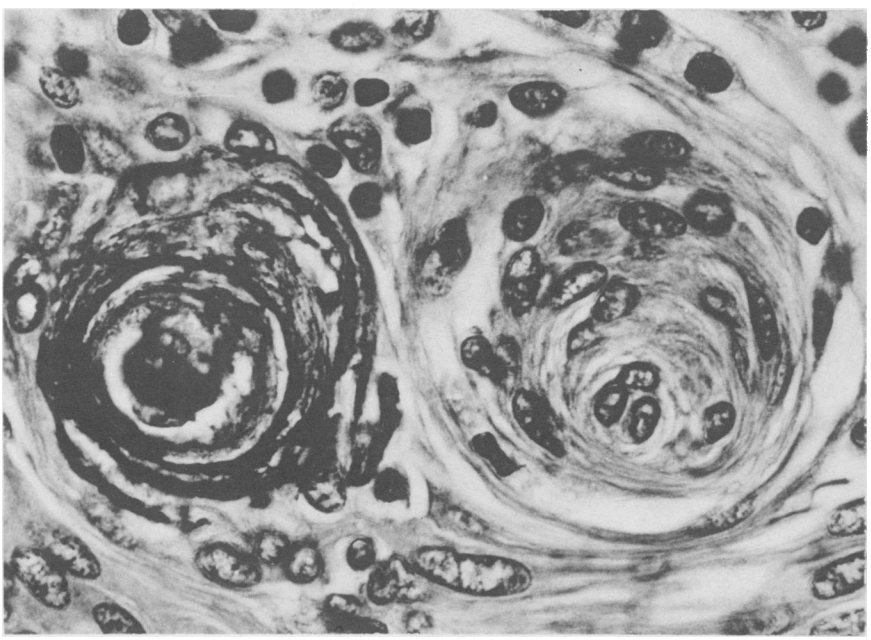

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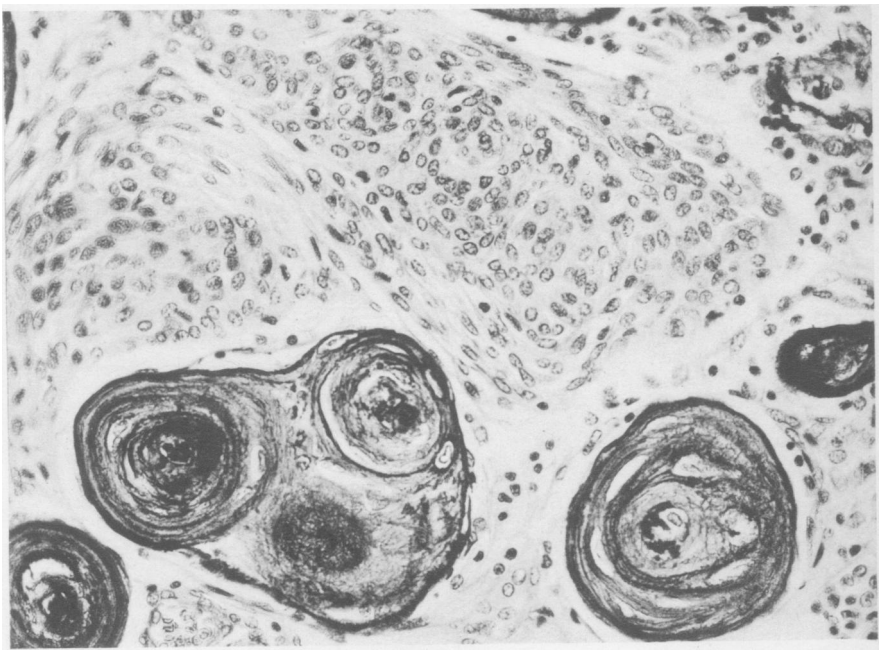
Mallory. Dural endothelioma.



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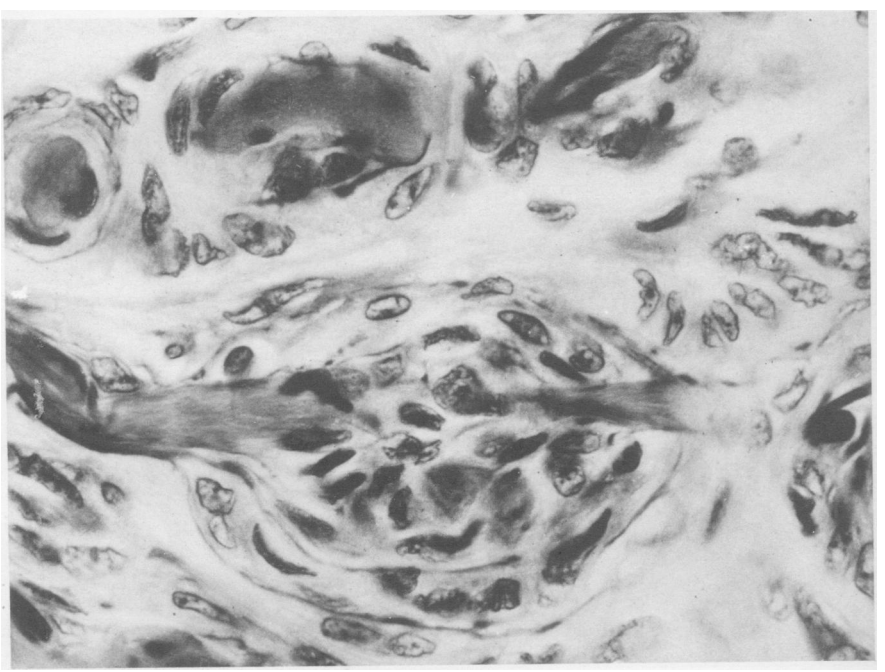

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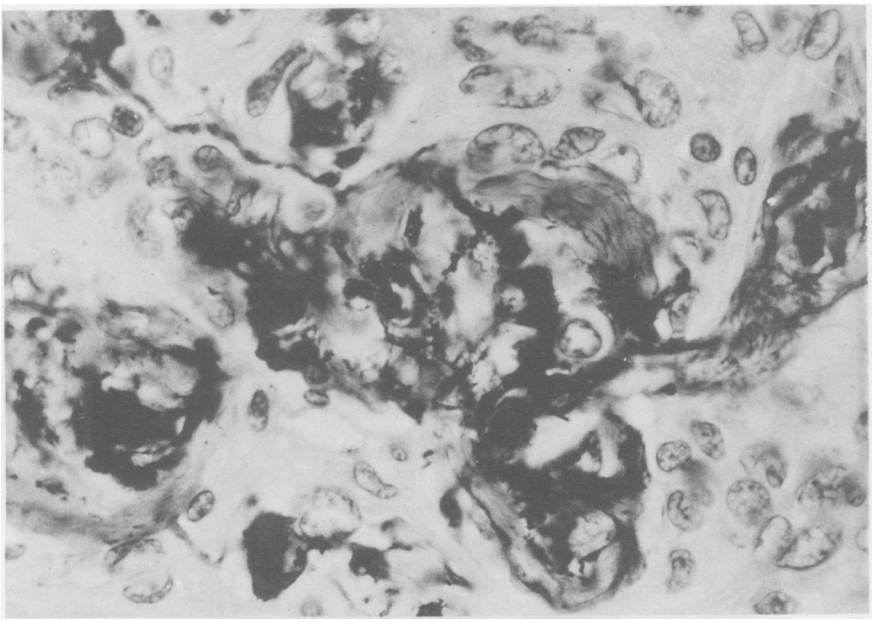
Mallory. Dural endothelioma.



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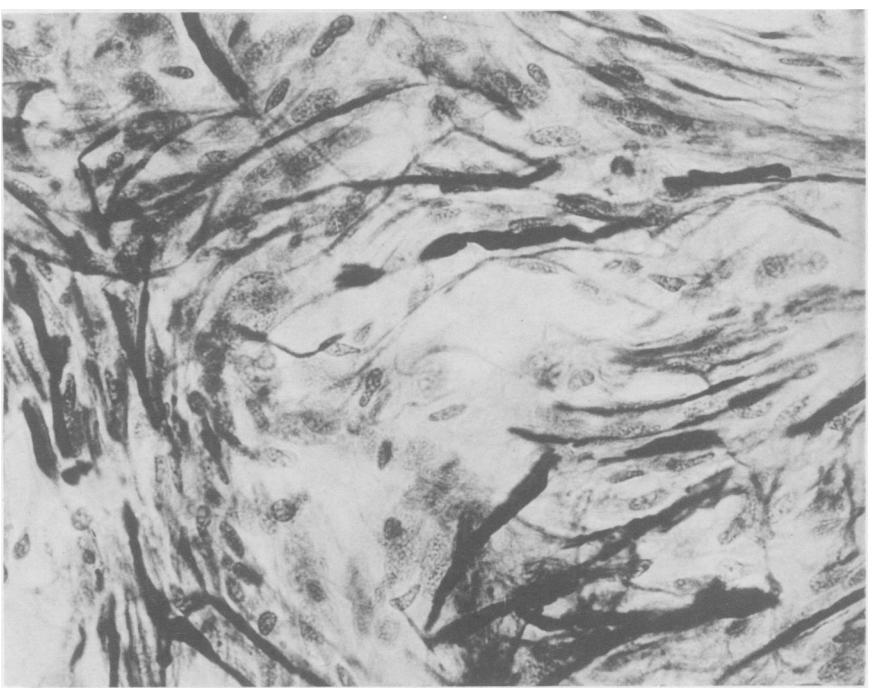

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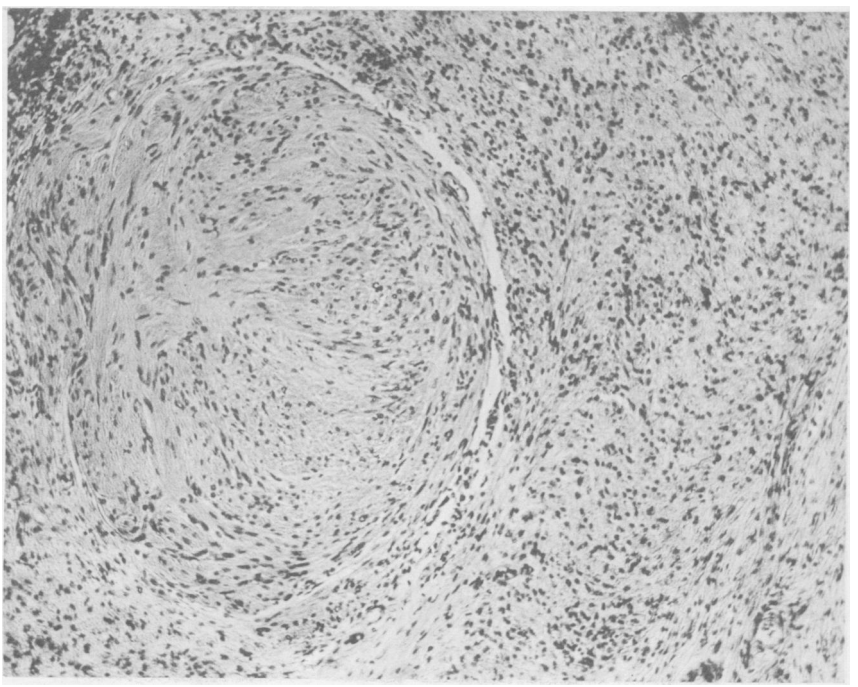
Mallory. Dural endothelioma.



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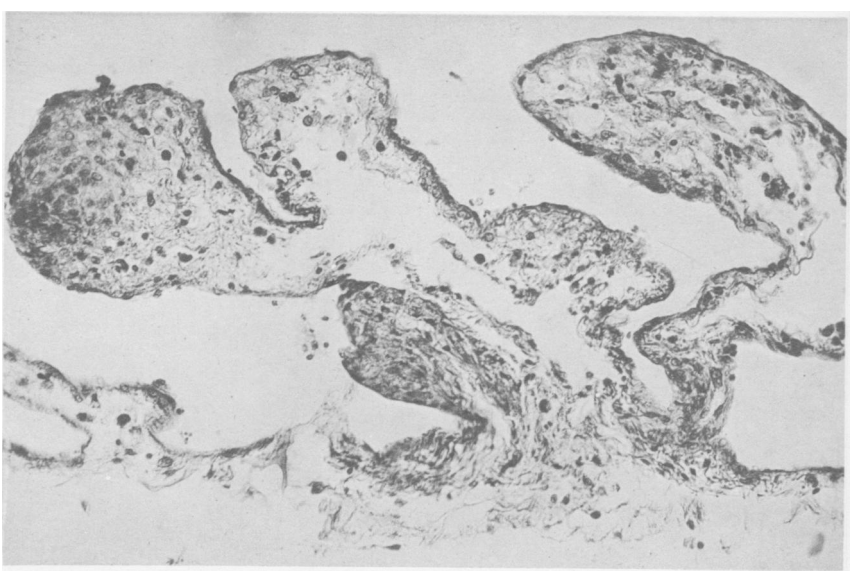
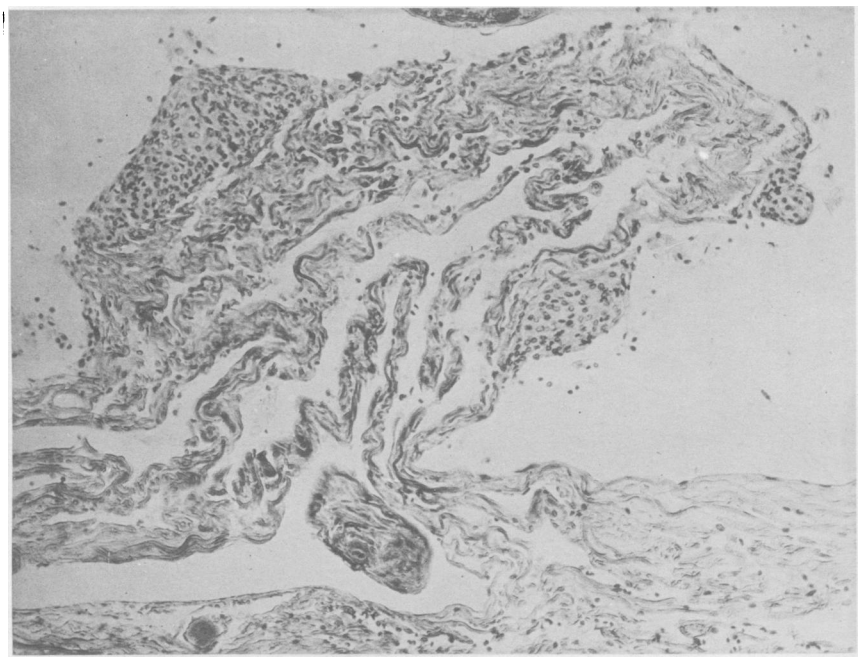


8

Mallory.

Dural endothelioma.



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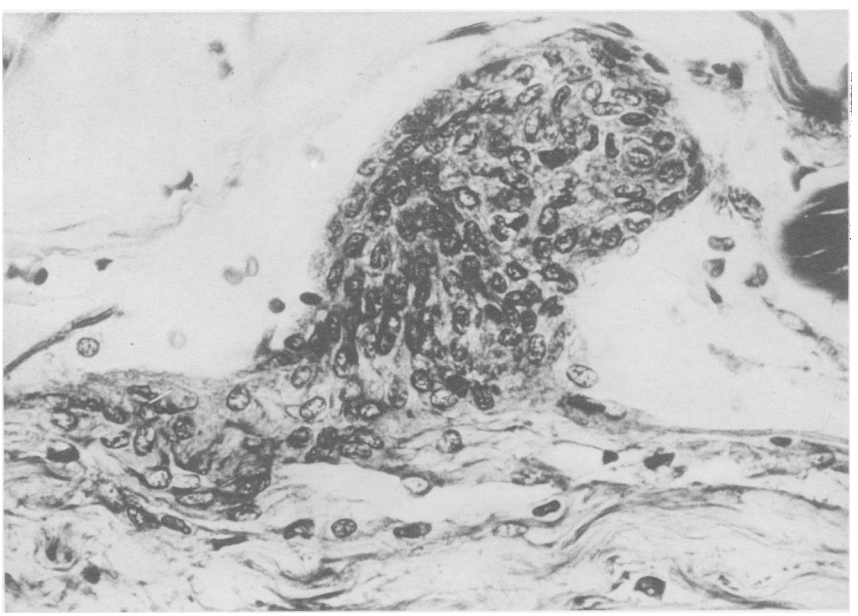

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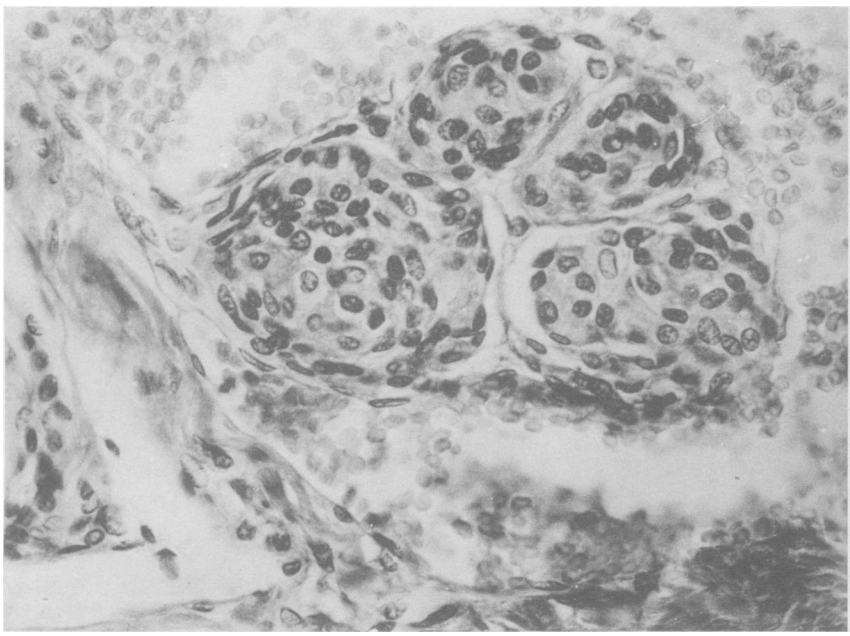

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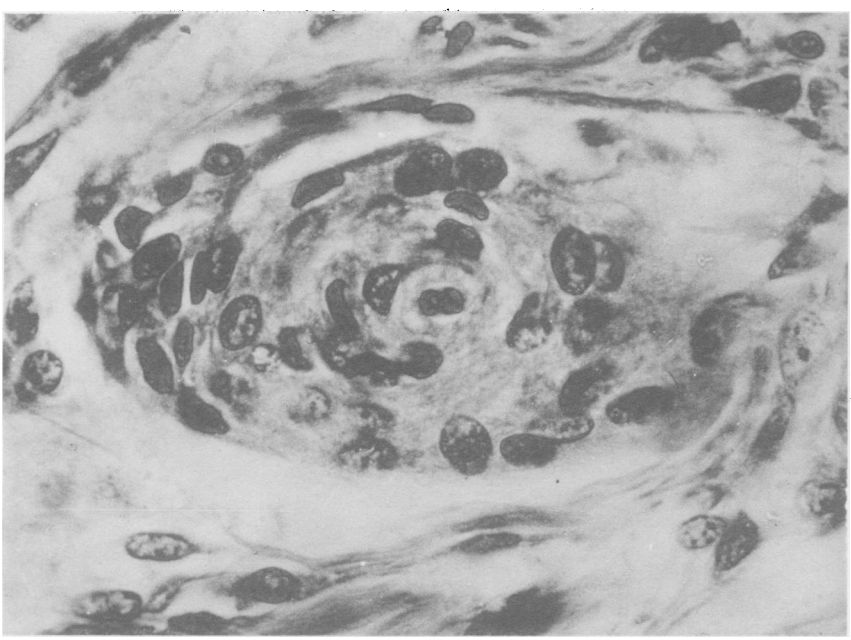
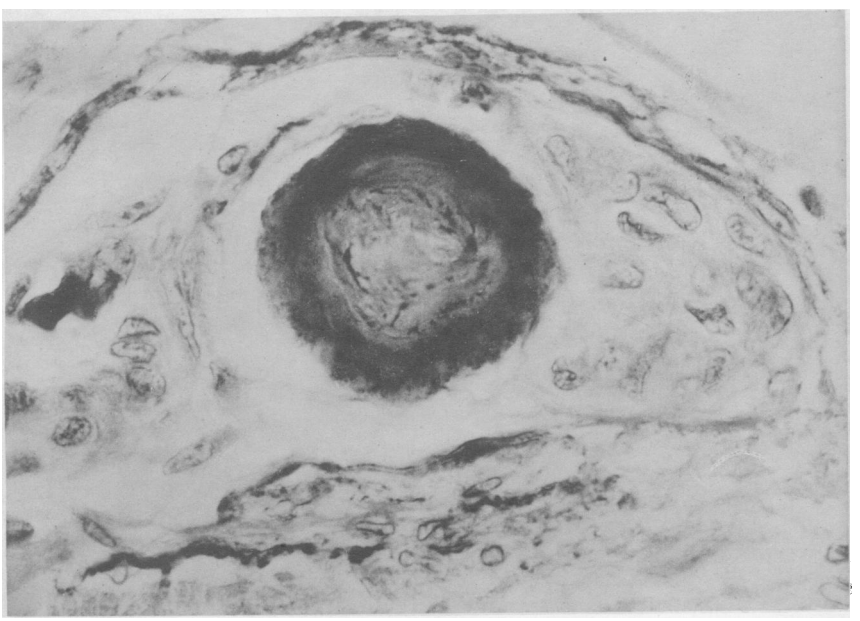


12

Mallory. Dural endothelioma.

13



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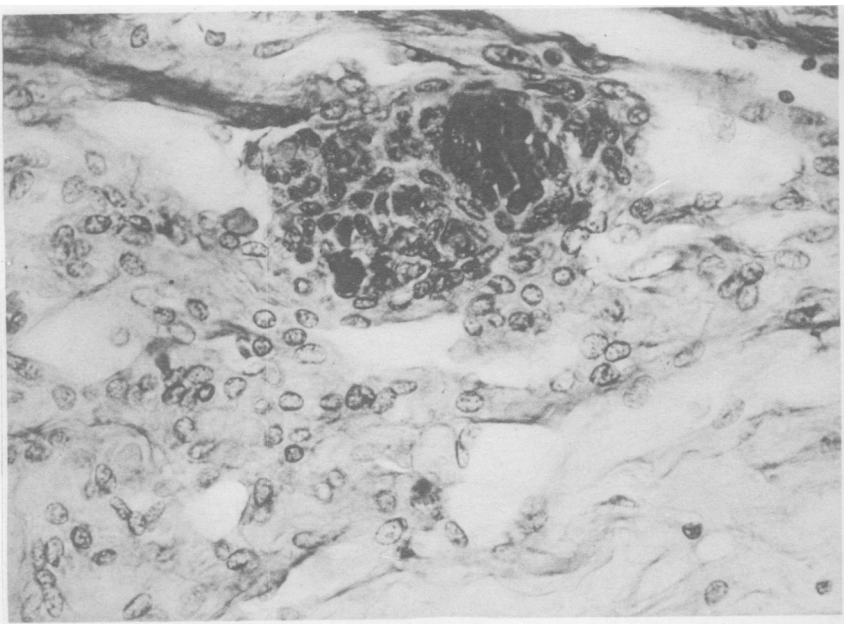

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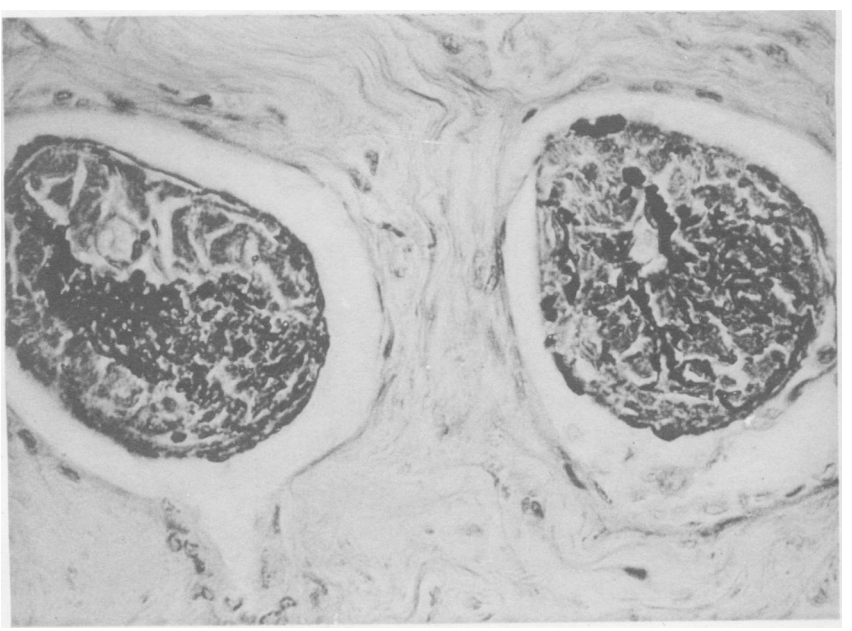

16

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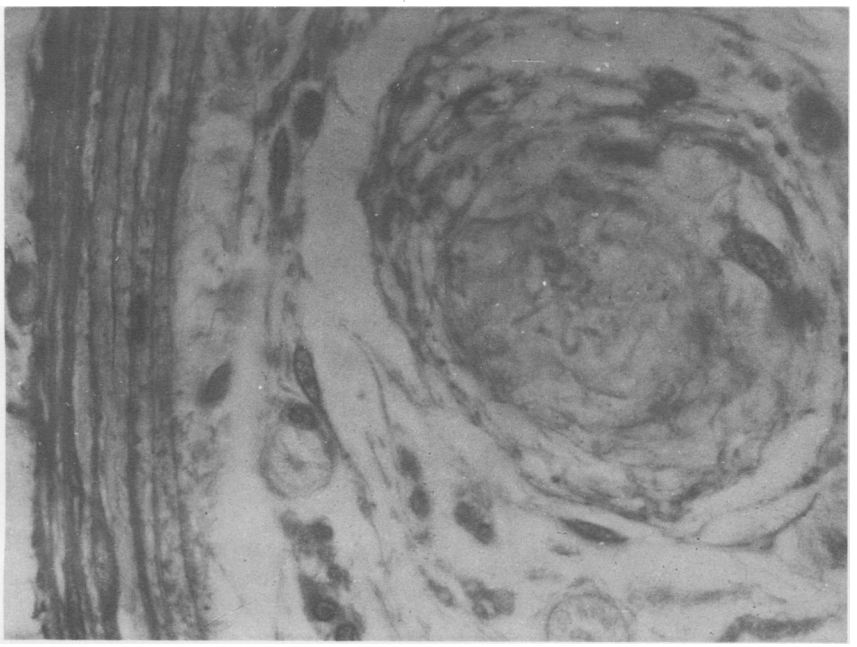
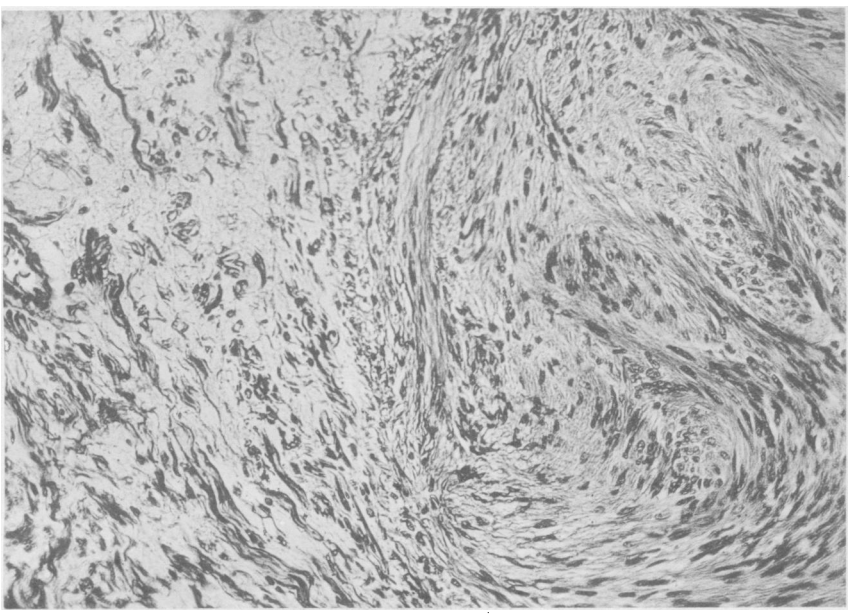


17

18

Mallory.

Dural endothelioma.



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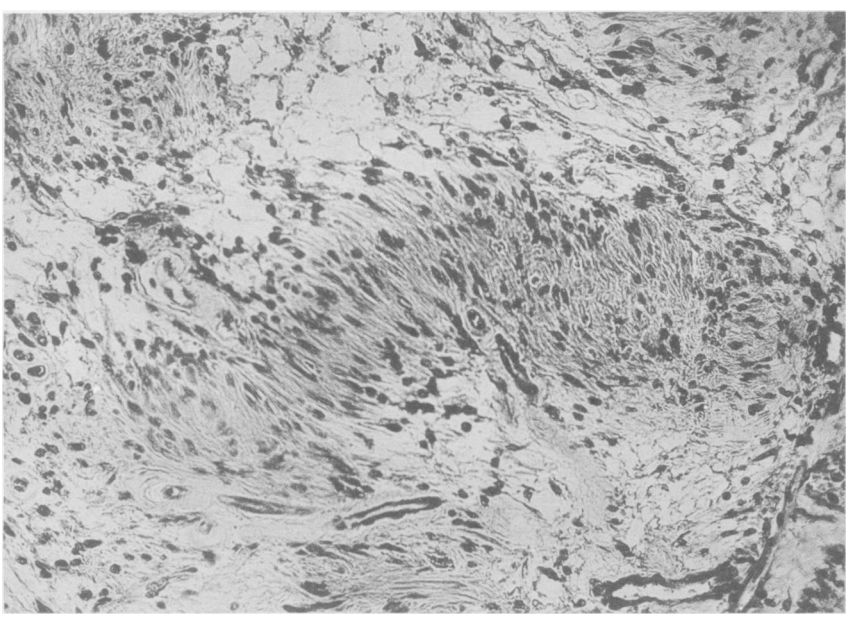

20

Mallory

Dural endothelioma.