Nasal Gliomas: A Report of Five Cases with Electron Microscopy of One*

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Nasal glioma has been defined by Black and Smith as:
"a mass of glial tissue of congenital origin that occurs intranasally and/or extranasally at or near the root of the nose. It may or may not be connected to the brain by a pedicle of glial tissue, but it does not contain a fluid-filled space connected with either the ventricles or the subarachnoid spaces of the brain."

Other terms that have been used to describe the lesion are glioma (astrocytoma), ganglioma, filroglioma, encephalochoristoma, and encephaloma. Frank encephalocoele or encephalomeningocele, as has been pointed out by Davis and Alexander, are readily recognizable as a neurological problem. The recognition of the less obvious nasal glioma is not so easy and requires the cooperation of rhinologists and neurosurgeons to assure proper diagnosis and treatment. This report reviews some of our cases together with those in the literature, a description of the pathological specimens, including electron microscopy of 1 case, and our conclusions regarding the management of nasal gliomas.

Case Reports

Case 1. D.P.C., a 6½-month-old white boy, was admitted to the Ear, Nose and Throat Service of Dr. Joseph Ogura at St. Louis Children’s Hospital on Feb. 7, 1961 with a history of progressive right nasal obstruction and occasional clear nasal discharge for 3 months.

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Examination revealed a large right parasephalic mass which was firm, pink, and covered by normal mucosa, extending down to within a centimeter of the right nasal opening. The child otherwise was normal. Roentgen-ray studies revealed no definite bony defects, even with laminography. A biopsy was performed on Feb. 8, 1961 which revealed glial and fibrous tissue with no neurons seen.

The child had no rhinorrhea and was discharged on antibiotics.

He was re-admitted and transnasal excision of the lesion was carried out on March 1, 1961. The mass was seen to extend upward through a defect in the cribriform plate. Escape of cerebrospinal fluid was noted and the patient was transferred to the Neurosurgery Service.

Right frontal craniotomy was performed 3 hours later. The dura mater was adherent to the right cribriform plate. A band of gliotic tissue extended from the frontal lobe along an hypertrophied olfactory bulb through a hole, 5 mm. X 10 mm. in size, in the cribriform plate and dura mater. This tissue was cut across and the portion extending into the nose was excised. The dural defect was closed with a dural flap and a patch of muscle. The bony defect was filled with methacylate and covered with Gelfoam.

Pathological specimens showed disorganized glial tissue covered by nasal epithelium and glands and infiltrated with inflammatory cells. Glial tissue merged imperceptibly with cerebral cortex in the proximal portion of the specimen.

The child did well postoperatively with no meningitis or rhinorrhea. He was given antibiotics for 10 days, and discharged to return for final excision of residual nasal tissue on May 17, 1961. This was done without complication. Only chronic inflammatory tissue was present in this specimen. The child has had no further difficulties.

Case 2. M.M., a 3-year-old girl, was hospitalized on the Ophthalmology Service in February 1952 because of right esotropia which had been noted first at the age of 6 months. The right eye was amblyopic and there was right microphthamos. A muscle-recession operation was performed, and was repeated 13 months later, with good result.

In September, 1956, she was admitted to the
Ear, Nose and Throat Service with a firm mass in the right nostril. Roentgenograms showed a soft-tissue mass in the right ethmoid region and nasal fossa, with deviation of the septum to the left. The right maxillary and ethmoid sinuses were small.

Biopsy of the nasal mass revealed only chronic inflammation and fibrosis.

Three days later meningitis developed. Cultures of spinal fluid yielded no growth. Tuberculin test was positive. Rapid clearing of the meningitis followed vigorous antibiotic therapy, and she was discharged 2 weeks later.

Fullness of the right side of the nose remained unchanged over the next several years. Lamina-grams in June 1959 revealed slight thinning of the right cribiform plate which was considered to be compatible with the congenital hypoplasia of the right maxillary and ethmoid sinuses.

In January 1962, the child (now 13 years old) was re-admitted to the Ear, Nose and Throat Service because of slight increase in the right nasal mass. Repeated roentgen-ray studies showed no significant changes. Spinal fluid was normal. Pneumoencephalography showed no air in the olfactory cistern. Because of the bout of meningitis occurring after intranasal biopsy of the tumor in 1956, craniotomy was thought to be the procedure of choice.

A right frontal craniotomy was done, using a coronal incision of the scalp. The dura mater was adherent to the medial wall of the orbit and cribiform plate. Two defects in the bone were found—one in the cribiform plate and the other in the medial inferior portion of the orbit plate. Through these defects extended gliotic tissue in direct continuity with the frontal cortex. Portions of this tissue were removed, the bony defects were packed with methacrylate, and the dura mater was closed.

The patient did well postoperatively. She was given antibiotics and had no meningitis or rhinorrhea. She returned 2 months later for excision of the intranasal tumor. Specimens from both operations revealed glial tissue with a few neurons present. Her course has been uncomplicated.

Case 3. K.C., a 6-week-old girl, was admitted to the Otolaryngology Service on Oct. 30, 1962 with a complaint of a polyloid mass presenting in the right nostril since birth (Fig. 1). She had no respiratory difficulty, and no rhinorrhea had been noted. The mass had not changed in size. The child ate well and was developing normally. Roentgenograms revealed no bony defect in the nasofrontal area.

An intranasal biopsy was performed on Nov. 1, 1962. The mass was adherent to the nasal cavity laterally as well as medially. When a probe was passed upward a defect was palpable in the cribiform plate.

After the biopsy the patient was transferred to the Neurosurgery Service and a right frontal craniotomy was performed immediately, using a coronal incision. A defect was found in the dura mater and right cribiform plate. There was grey tissue lying in the bony defect but no definite connection between this tissue and the brain could be demonstrated. The dura mater was sutured and methacrylate was placed in the bony defect.

The specimens contained glial tissue with a few neurons.

Four days postoperatively there was some purulent discharge from the nose and fever developed. Spinal fluid on Nov. 5, 1962, revealed 2 cells with protein of 57 mg. per cent and sugar 56 mg. per cent. Aspiration of the scalp yielded 40 cc. of sanguinopurulent material, cultures of which were found to contain paracolon bacilli. The subgaleal pus was very similar to that draining from the nose.

On Nov. 9, 1962, secondary craniotomy was performed with drainage of subgaleal, extradural and subdural pus, cultures of which yielded paracolon bacilli sensitive to penicillin and kanamycin.

Following this procedure antibiotics were injected through two catheters using 10,000 units of penicillin and 10 mg. of kanamycin daily for 4 days. Subsequently the wound healed without further complication. There was no rhinorrhea and the patient was discharged on Nov. 26, 1962.

She returned on Feb. 14, 1963, and the following day the mass remaining in the right nostril was removed. At this transnasal operation, Dr. Ogura was able to visualize the undersurface of the methacrylate plate and on palpation found it to be immovable, with no evidence of any leakage. Sections of the mass removed from the nose revealed it to be similar to the specimen removed intracranially. The patient was discharged on Feb. 16, 1963, with no neurologic abnormalities.
The tissue consisted of many astrocytes with gliosis and inflammation. Some neurons were present. Electron microscopy of this specimen is described later in this paper. The patient did well with no meningitis or rhinorrhea.

Case 5. D.K., a 35-year-old woman, was born with a long, misshapen head but this abnormality regressed spontaneously. She had noted rhinorrhea from the right nostril since childhood. At age 13, and again at age 23, she had bouts of pneumococcal meningitis. Just before her admission on April 1, 1958, the fluid from her nose was analyzed by her physician and found to contain sugar and protein. Therefore neurosurgical treatment was recommended.

Findings on examination were completely normal except for rhinorrhea when she bent forward. Roentgenograms, including pneumoencephalogram, revealed no abnormality.

A right frontal craniotomy was performed on April 4, 1958, and a tongue of right frontal lobe extended through the dura mater and was stuck to the anterior part of the cribiform plate, which contained two small defects. These defects were plugged with wax and the dura mater was closed. No tissue was taken for examination.

The patient did well and has had no further rhinorrhea or meningitis. While this cannot be called a nasal glioma because there was no intranasal, or even any extracranial extension of neural tissue, this case is presented because it may represent a forme fruste or demonstrate the first stage in the development of a nasal glioma.

Pathology

Light Microscopy. Although nasal gliomas vary in histologic details, all are similar basically. They are formed of small or large aggregates of fibrous or gemistocytic astrocytes and their interdigitating processes (Fig. 3). Occasional phagocytic cells are present. Fibrous connective tissue is wrapped about the blood vessels and sometimes extends out to form broad or narrow collagenous septae partially isolating groups of astrocytes one from another (Fig. 3). The capsule of nasal gliomas is formed of processes of fibrous astrocytes that are inter-

Fig. 2. Case 4. Photograph of nasal glioma removed. That portion of the mass to the left of the arrow was within the frontal sinus; that to the right was within the cranial cavity and continuous with the frontal lobe.

Case 4. A.M., a 54-year-old man, was in good health until July 1961, when he noted drainage of clear fluid from the right nostril. There was no history of trauma, headache, meningitis, or intranasal instrumentation. Suspecting that the patient might have infection of the sinus, his local physician treated him with antihistaminic preparations without effect. After a few weeks drainage shifted from the right to the left side of the nose. He consulted Dr. Ogura late in January 1962. No intranasal mass was found. Samples of draining fluid revealed 97 mg. per cent sugar and hospitalization was advised. However, drainage ceased spontaneously and it was not until it recurred that he entered Barnes Hospital on March 31, 1962.

Findings on examination were negative except for anosmia on the left and clear sugar-containing fluid escaping from the left nostril. No intranasal mass was seen. Roentgenograms, including laminagrams and pneumoencephalogram, showed no tumor or defect in the nasofrontal region. The ventricular pattern was normal. However, on manipulation of the head to the brow-up position during the air study, air disappeared from the left anterior horn and the patient felt air escaping from his nose. Spinal fluid was normal.

A bifrontal craniotomy was performed. A hole was found in the roof of the left frontal sinus, measuring 1 × 1.5 cm., through which extended a yellowish mass of tissue which was connected to the frontal lobe by a stalk. The stalk was amputated and a mass of tissue, 3 cm. long by 1 cm. wide, was pulled up out of the frontal sinus (Fig. 2). The bony defect was repaired with methacrylate and the dura mater was closed using a pericranial graft.

Fig. 3. Light micrograph of a nasal glioma to indicate foci of neuroglial tissue that are interconnected by glial fibers (upper right). At the upper left is a connective-tissue band within which is a small blood vessel. Hematoxylin and eosin, ×400.

Fig. 4. This micrograph indicates the close relationship of glands of the nasal mucosa (GL) to the margin (M) of the mass of neuroglial tissue. Hematoxylin and eosin, ×400.
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spersed with or surrounded by fibroblasts and collagen to form either loose or dense connective tissue. Occasionally the margin of the glial tissue is seen closely apposed to nests of nasal mucosal cells (Figs. 4 and 5). Scattered neurons, normal or undergoing degeneration, may be present (Fig. 6). In some nasal gliomas there were prominent zones of granulation tissue (Fig. 7).

Mitotic figures were absent as were bizarre nuclear forms. However, occasional huge gemistocytic astrocytes possessed multiple nuclei. The over-all picture was that of reactive gliosis, not of neoplasia.

**Electron Microscopy.** At the time of surgical removal small pieces (approximately 1 mm. across) of both the intranasal and intracranial portions of the nasal glioma from Case 4 were placed in Dalton's chrome-osmium fixative. After 1 hour of fixation the blocks were dehydrated rapidly and embedded in either methacrylate or Epon. Thin sections were mounted on copper grids and stained with lead acetate. Methacrylate sections were sandwiched with a layer of colloidion after staining. Sections were examined in an EMU 2E or 3F electron microscope.

The capsule in some regions was formed of
loose connective tissue and in others by collagenous fibers and fibroblasts interspersed amongst fibrous astrocytes and their processes. In some areas the capsule was a compact meshwork of dense fibrous astrocytic processes. Scattered macrophages with lipid-filled cytoplasm were present. Much of the lipid in these glomer cells had been dissolved out during preparation so that only irregularly rounded empty spaces remained rimmed by narrow bands of cytoplasm.

Scattered droplets of osmiophilic material, also probably lipid-containing, were interspersed among the large empty vacuoles (Fig. 8). The outer margins of these cells were closely surrounded by fibrous astrocytic processes. In some areas the collagen-containing extracellular space was separated from the neuroglial tissue by a basement membrane. If one wishes to consider that the pia mater is no more than a basement membrane, then this mass of tissue may be said to be covered by pia mater. This is, however, an artificial justiﬁcation of the term, for in most places ectoderm, including neuroectoderm, is set apart from mesoderm by a basement membrane. Therefore, in the absence of arachnoid, to term a basement membrane pia mater because it encloses neuroglial tissue seems to us to be stretching a point.

Plasma cells were frequent and recognized readily by their distended but orderly ergastoplasmic sacs (Fig. 9). The blood vessels were surrounded by a distinct connective-tissue space, outlined on both sides by basement membrane and containing fibroblasts (Fig. 10), collagen and inflammatory cells. The outer basement membrane was covered on its external surface by astrocytic processes filled with delicate fibrils. Where extracellular space was abundant, gliosis was anisomorphic with no directional orientation of the fibrous astrocytic processes. In these loosely organized regions astrocytes were the principal type of cell and often were gemistocytic. Their electron-microscopic picture was remarkably similar to that observed by light microscopy as can be seen by comparing Figs. 11 and 12. Cytoplasm of the gemistocytic astrocyte contains relatively few intracellular organelles and even these often are pushed to the margins of the cell. Mitochondria are small. The ergastoplasm is rarely linear, usually being composed of small vesicles with free particles of ribonucleoprotein. The hyaline appearance of the cytoplasm of gemistocytic astrocytes now can be seen to be caused by the mat-like organization of short dense tonofilaments that ﬁll the cytoplasm at the expense of other cellular organelles (Fig. 13). The usual ﬁbrillary astrocyte is a smaller cell with relatively scant cytoplasm extending out into branching processes giving it its classic stellate shape in Cajal stains. Fibrils are rare in the perinuclear cytoplasm of these cells in contrast to the feltwork within gemistocytic cells.

In regions of anisomorphic gliosis most of the tissue is formed by the interlacing glial processes, and although extracellular space is abundant, many processes are arranged tightly (Fig. 14). Plasma membranes are thin and distinct. Cellular processes are of two types. The more common is relatively less dense and is ﬁlled with delicate tonofilaments arranged in the longitudinal axis of the process. When seen in cross section these tonofilaments appear as tiny dot-like structures. Mitochondria and rare vesicles are present. The less common type of astrocytic process is narrow and more dense (Fig. 15). Fibrils are more numerous and crowded together rather than of a different

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Fig. 5. Capsule of the nasal glioma shown in Fig. 1. The outer margin is at the upper left. It is composed of bands of fibrous astrocytes interspersed with fibroblasts, phagocytic cells, and occasional inflammatory cells. Hematoxylin and eosin, X300.

Fig. 6. Several residual neurons are evident within this nasal glioma. Hematoxylin and eosin, X400.

Fig. 7. This micrograph is from a zone of inﬁammation and granulation-tissue formation in a nasal glioma. Polymorphonuclear leukocytes are prominent as are the capillaries and ﬁbroblasts. Hematoxylin and eosin, X600.
Fig. 8. Electron micrograph of a phagocytic cell in the nasal glioma. The cytoplasm is distended by droplets of lipid, most of which have been dissolved so that they appear as vacuoles. The nucleus is seen at "N." ×8,000.

Fig. 9. Parts of plasma cells are evident among fibrous astrocytic processes (arrow). The cell in the middle of the field has dilated ergastoplasmic sacs, whereas those in the cell at the right are arranged closely. ×4,500.

Fig. 10. A fibroblast; parts of prolongations of nearby fibroblasts and collagen are evident. ×8,000.
nature. These are the processes that helped to form the capsule. They often become narrowed along their course and tend to curve gently although arranged in a more nearly straight course than the larger less dense fibers seen in Fig. 13. These dense fibers are common in zones of isomorphous gliosis where they are oriented in one direction. If the extracellular space is minimal the fibril-filled glial processes may be associated intimately with neural processes, some of which contain vesicles of the type seen in synaptic endings (Fig. 15).

There was no apparent ultramicroscopic difference between the intracranial and intranasal portions of the mass. Myelinated axons (Fig. 16) were still recognizable in both portions, some with well preserved axons and some in which degenerative changes had occurred.

Discussion

Schmidt first used the term "nasal glioma" in November 1900. However, Clegg and Moore described the same type of lesion somewhat earlier as ganglionic neuroglioma. Black and Smith excluded all frank encephaloceles and reported 2 cases of completely extracranial nasal gliomas. They reviewed 34 cases before 1950 and approximately 55 cases have appeared in the literature since then. It is generally accepted that these lesions have the same mode of origin as encephaloceles. The embryology has been described fully. At the stage of 28 segments (3–5 weeks) the anterior neuropore is open in the human embryo and is connected to the nasal area by a cord of epithelial cells. Herniation of brain may occur along this potential pathway. The meninges and cranium then may close behind this herniation leaving an isolated mass of neuroectoderm. If the closure is incomplete there may be a defect in the cribriform plate and a fibrous or glial stalk may remain connected to the dura mater or frontal cortex through this defect. Various sites of encephaloceles

Fig. 11. Oil-immersion light micrograph of a Masson-stained gemistocytic astrocyte in a nasal glioma. The classical picture of a cell with abundant hyaline-like cytoplasm extending out into delicate processes and an eccentric nucleus is clearly portrayed. Masson, X2,000.
Fig. 19. Low-power electron micrograph of a gemistocytic astrocyte. The resemblance of this cell to that in Fig. 11 is striking. The eccentric nucleus is at the left. Delicate fibrils fill the cytoplasm, whereas other organelles are scant. X5,000.

have been portrayed by Gerlach. Other cases of heterotopic glial tumors may be explained by an analogous mechanism, e.g., the nasopharyngeal heterotopids, a case of glial tumor of the cheek, occipital glial rests, and multiple glial nodules of the scalp. The fact that only 10 per cent of reported nasal gliomas contained neurons does not rule out the theory of encephalocele because many authors have described true encephaloceles which contained only gliotic tissue with no neurons. The lack of neurons has been ascribed to insufficient supply of blood and oxygen to support them, or to lack
of differentiation from the embryonic neuroectoderm in the isolated glioma.

Other theories of origin which have been postulated but generally rejected are: teratoma,\textsuperscript{1,5,36} true astrocytoma or spongiosblastoma,\textsuperscript{30,42} and olfactory neuroglial heterotopia.\textsuperscript{5,14} Teratomas containing only neuroglial tissue have not been described elsewhere. Nasal gliomas may recur after excision and may enlarge slowly but they never
Fig. 14. A smaller fibrous astrocyte which has scant cytoplasm as compared to the swollen gemistocytic cells. Even here, however, the nucleus is eccentric. Closely packed astrocytic processes crammed full of delicate glial fibrils dominate this micrograph. These are the paler processes referred to in the text as the more common type. In cross section the fibrils are seen as tiny dots. X15,000.
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**Fig. 15.** The other type of fibrous astrocytic process is denser and narrow (arrow). The filaments appear similar so that the increased density is probably a factor of packing rather than a fundamental difference in the filaments. ×10,000.

**Fig. 16.** Section from the intranasal portion of the mass. Residual axons, degenerating myelin and numerous cellular processes containing vesicles reminiscent of synaptic vesicles are present. ×15,000.
are invasive and do not behave like glial tumors of the brain. Of 93 cases reviewed, the lesion persisted in only 11 or recurred after operation and all but 1 of these 11 patients were cured at the second operation. The theory of olfactory heterotopia does not explain the extranasal cases, which are the most common. The theory of encephalocele seems to be the best explanation for the formation of nasal gliomas. The present series of cases gives some concrete evidence in favor of this theory, because of microscopic appearance and the demonstrated connections with the cerebrum.

In the collected cases, the age of occurrence has been at birth in 38 of 48 in which the age is known. The other 10 were discovered at the ages of 1 to 50 years, and only 2 of these were extranasal. There is no sexual prevalence. The gliomas occur extranasally over the bridge of the nose (almost always off the midline) in 60 per cent of the cases; intranasally in 30 per cent; and both intranasal and extranasally in 10 per cent. Fourteen of the gliomas were demonstrated to be connected to the intracranial contents through a cranial defect in or near the cribriform plate. Four of these patients had cerebrospinal-fluid rhinorrhea and in 1 meningitis developed. In 1 patient without rhinorrhea "encephalitis" developed after surgery.10 In the patient with facial glioma29 cerebrospinal-fluid fistula and meningitis developed postoperatively. Roentgen-ray findings have been unremarkable in most cases in which they were reported, and even in retrospect we could not be sure of demonstrable defects in our cases either on plain films or laminograms. Air studies have been performed rarely and only in our Case 4, and 1 of Low et al.,29 have they given positive information (and this was indirect).

The differential diagnosis of tumors in the nasofrontal area of infants is between angiomas (sinus pericranii), dermoids, neurogenic tumors such as neurocytomas, olfactory neuroepitheliomas and esthesioneuroepitheliomas (these are probably similar tumors38), encephaloceles, and nasal gliomas.16 Ordinary nasal polyps are almost unheard of below the age of 5 years13,35 and therefore should not be considered in infancy until other entities are ruled out. Cassidy and Wahl4 have described a "Furstenberg test" for determination of connection of a tumor with the intracranial contents. This involves compression of the homolateral jugular vein and observing the tumor for swelling or pulsation. This test has not been evaluated in the cases we have reviewed. Other diagnostic measures which have been used are aspiration with needle and incisional biopsy. These may not be conclusive and can lead to cerebrospinal-fluid fistula or infection. Inspection and palpation usually reveal the gliomas to be firmer than the encephaloceles. However, the only sure method of diagnosis is surgical exploration.

The management of patients with tumors of the bridge of the nose or intranasal polypoid lesions must be determined after careful rhinological, ophthalmological, neurological and radiological examinations. Patients who have congenital intranasal tumors, or who have had cerebrospinal-fluid rhinorrhea or meningitis, or who have congenital extranasal tumors with any indication of an intracranial connection should have roentgenographic studies and neurosurgical exploration. A frontal or bifrontal craniotomy should be performed and the cribriform area should be explored thoroughly in the intranasal cases or any other with any indication of connection with the intracranial contents. Small firm lumps that are entirely extranasal and have no indication of connection to deeper structures may be excised via an external incision, but the operator should be prepared for the possibility of an intracranial connection. If one is found and there is any cerebrospinal-fluid leak or dural defect, a craniotomy should be carried out immediately to prevent formation of fistula or meningitis. In any doubtful case the rhinologist or plastic surgeon should be in immediate contact with a neurosurgeon.

In the entire series of nasal gliomas only 2 patients had meningitis develop after transnasal operations, so the risk of this is not great in gliomas without connection to the intracranial contents. However our Case 4 and Browder's7 could easily have had men-
ingitis if they had not had primary cranio-
tomies. Our Case 1, Kristensen’s case,26 and 
Cuthbert’s12 first case are the only ones in 
which cerebrospinal-fluid rhinorrhea oc-
curred after surgery and meningitis did not 
develop (our patient had immediate cranio-
tomy after intranasal exploration, and 
Kristensen’s had pre- and postoperative 
penicillin). The real danger lies in the trans-
nasal exploration of encephalocoeles35,41 and 
those few nasal gliomas that connect to the 
brain or meninges. Before the antibiotic era 
such procedures almost always led to fatal 
meningitis, and even with antibiotics, cere-
brosplinal-fluid fistula and meningitis can be 
catastrophic. Occasionally a patient with 
a lesion that has no connection to the brain or 
meninges may be subjected to craniotomy 
but this is preferable to the risk of infection 
from intranasal excision.7,13,35,41

Summary

Five cases of nasal gliomas have been 
presented with a review of 88 cases in the 
literature. These tumors are considered to be 
developmental anomalies with the same 
pathogenesis as nasofrontal encephalocoeles. 
They have no true neoplastic characteristics, 
but may enlarge more rapidly than surrounding 
tissues and sometimes may persist or 
recur after operation. By light microscopy 
the nasal glioma is composed of rare neurons 
and numerous reactive astrocytes sur-
rrounded by fibroblastic scar tissue. Electron 
microscopy of a nasal glioma has shown it to 
be made up of fibrous and gemistocytic 
astrocytes and their processes. Rare myeli-
nated axons were present in the intranasal 
portion of the mass.

In the diagnosis and therapy of masses of the 
nasofrontal area, it is important to be 
prepared for a connection with the intra-
cranial contents. Craniotomy should be 
carried out in children with intranasal 
tumors extending upward and in cases with a 
history of cerebrospinal-fluid rhinorrhea or 
meningitis. In any case of extranasal tumor 
which is thought to have an intracranial con-
nection, craniotomy should be done.

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