Staff Meeting Bulletin
Hospitals of the » » »
University of Minnesota

Roentgenologic Diagnosis of Brain Tumors

Volume IX Thursday, March 10, 1938 Number 20

STAFF MEETING BULLETIN
HOSPITALS OF THE . . .
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Volume IX | Thursday, March 10, 1938 | Number 20

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Published for the General Staff Meeting each week
during the school year, October to May, inclusive.

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William A. O'Brien

I. LAST WEEK

Date: March 4, 1938

Place: Recreation Room
Nurses' Hall

Time: 12:15 to

Program: Movie: "Lonesome Ghosts"

Leukemia Cutis
Francis Lynch

Discussion: Philip D. Kernan
Hal Downey
K. W. Stenstrom
F. W. Lynch
Harold A. Dahl
Henry E. Michelson

Present: 120

Gertrude Gunn,
Record Librarian

II. MOVIE

Title: "Forest Gangsters"

The Struggle to Live Series

Released by: R-K-O

III. ANNOUNCEMENTS

1. LECTURE

The annual William W. Root lecture sponsored by Alpha Omega Aopha will be given March 10, 1938 at 8:00 P.M. in Medical Sciences Amphitheatre. Dr. Irving S. Cutter, Dean of Northwestern Medical School, will speak on "The Life and Contributions of Edwin James." Dr. James was a pioneer army surgeon and explorer in the midwest. Please invite your colleagues and members of the general public. Physicians who expect to be called during the lecture should direct such calls to Main 8177, Extension 575.

Wallace Armstrong, Secretary.

2. LECTURE

Dr. Clarence Cooke Little, Managing Director of the American Society for the Control of Cancer, will address a public meeting in the Music Hall Auditorium Friday, March 11, at 8:00 P.M. His subject will be "Essential Steps in the Control of Cancer." The meeting is held under the auspices of the Minnesota State Medical Association, Medical School of the University of Minnesota, and the Women's Field Army of the American Society for the Control of Cancer. The public is cordially invited. Dr. Little enjoys a splendid reputation both as a scientist and public leader. Former President of the University of Maine and the University of Michigan, he attracted nation-wide attention when he left administrative duties for scientific and public health fields. He has a special research institute on an island near Bar Harbor, Maine, where he is doing work in genetics with a colony of mice which he has been breeding since he was a schoolboy.

3. GUEST

Dr. Alfred W. Adson is our guest today. The Professor of Neurosurgery at the Mayo Foundation, he is widely known for his work in this field. He will discuss the contribution of Drs. Peterson and Truog. This afternoon at 2:00 o'clock he will address the medical students, and at 4:30 today he will lead a round-table discussion at the Center for Continuation Study for the 27 physicians who are attending the institute on Traumatic Surgery. His annual visit to our meetings is always anticipated with pleasure because of his enthusiastic interest in his specialty.

4. ENDOCRINOLOGY

The next medical institute at the Center for Continuation Study will be from April 4 to 9 on endocrinology and disorders of metabolism. Among others we will have as our guest Dr. Sevringhaus of the University of Wisconsin.

IV. ROENTGENOLOGIC DIAGNOSIS OF BRAIN TUMORS

Harold O. Peterson
Clarence P. Truog

The diagnosis of intracranial tumors requires careful, precise and painstaking investigation. This demands the combined efforts of the neurologist, radiologist, neurosurgeon and pathologist. There are two distinct problems: (1) It is first necessary to determine the presence or absence of a space consuming lesion within the cranial cavity and (2) If a tumor is present it must be localized before a rational therapeutic approach can be expected. Every available diagnostic procedure capable of lending aid must be employed. Of considerable and increasing value is the roentgen examination.

Cushing in the introduction to his book which reviewed 2000 verified cases of intracranial tumors, states that the chief contributory elements to our advance in the diagnosis and treatment of brain tumors have been three: "(1) the development of a highly specialized surgical technique, (2) more precise localizing diagnoses, and (3) a better understanding of the life history of tumors of different types based on their histogenesis. Sometimes one, sometimes another of these three factors is in the lead. Technical skill is of little avail if one cannot make a correct diagnosis. Dandy's ventriculography placed localization at a point where neurological studies scarcely seemed longer necessary."

While such a statement is unquestionably an exaggeration, nevertheless it indicates well the importance of roentgenology in the diagnosis and localization of brain tumors.

The history of the development of roentgen diagnosis of brain tumors as presented by Sosman and Putnam (1925) is of considerable interest. They state that Krause in discussing a case presented by Gottschalk in 1907 before the German Roentgen Society expressed a doubt as to whether a cerebral tumor ever had been shown or would be shown by roentgen rays in which statement he was supported by the majority of roentgenologists present. Obici and Ballici (1897) proposed to take a roentgenogram of a patient with symptoms of a brain tumor but the patient died while the apparatus was being prepared. They took a postmortem film, however, which showed a homogenous shadow in the right temporo parietal region. This proved to be a "sarcoma" at autopsy and in all probability was what we now call a meningioma.

Pfahler showed roentgenologically two cases in 1902, both "sarcomas," attached to the dura and in one of these he described the bony changes in the skull which have since become so characteristic. As late as 1921, however, Souques in reporting a case of "psammoma" located roentgenographically remarks nevertheless that "radiology gives no direct information as to the location of cerebral tumors in general.' This is in striking contrast to the concluding statement in Sosman's recent paper on Roentgenographic Signs of Intracranial Tumor. He says, "In summary we may expect to be able to locate 50% and identify 25% of all intracranial tumors and if ventriculography is resorted to we should be able to locate practically all of the intracranial tumors large enough to give symptoms.

Before beginning the discussion on the roentgen diagnosis of brain tumors a classification of these lesions should be given. The classification which we have followed is the one originated largely by Bailey to which modifications have been made by our neuro-pathologist, Dr. Baker.

(I) Encephalic Tumors
1. Medulloblastoma
2. Glioblastoma Multiforme
3. Astroblastoma
4. Astrocytoma
5. Ependymoma
6. Oligodendroglioma
7. Spongioblastoma polare
8. Pinealoma

(II) Tumors of Meninges
1. Fibroblastoma
2. Endotheliomata
3. Whorl type
4. Psammomatous
5. Melanoblastic
6. Lipomatous
7. Osteochondromata

(III) Hypophyseal Tumors
1. Pituitary
2. Ratke pouch

(IV) Vascular Tumors
1. Angioma
2. Angioblastoma

(V) Miscellaneous Group
1. Teratoid Cyst
2. Pearly Tumors (Cholesteatoma)
3. Chordoma
4. Neurofibroma (8th nerve tumors)
5. Colloid Cyst of 3rd Ventricle

A list of the various signs of intracranial tumer as shown on the plain roentgenograms of the skull is as follows:

1. Deformation in and about the sella turcica.
2. Convolutional atrophy or digital markings.
3. Calcification of the tumor.
4. Separation of the sutures.
5. Localized bone erosion.
6. Localized hyperostosis.
7. Localized increased vascularity.
8. Displacement of the pineal gland.

1. <u>Deformation in and about the sella turcica.</u>

This is the most common finding in brain tumors occurring in 64.6% of 446 cases reported by Kornblum. If associated with a large pituitary tumor the appearance of the sella is almost pathognomonic.

The diameter of the sella is increased and the floor bulges down into the sphenoid sinus. The dorsum sellae and posterior clinoids are displaced backwards and markedly thinned but their outline is retained. The anterior clinoids are often elevated. A symptom producing pituitary tumor may be present however without any roentgen signs.

If the sellae changes are due to generalized increased pressure the dorsum sellae and posterior clinoids are almost always decalcified and show varying degrees of erosion, depending to a certain extent on the proximity of the tumor; the closer the lesion is to the sella the greater the bony destruction will be. The enlarged sella due to increased intracranial pressure is usually of the long, shallow type, the enlargement being chiefly in the antero-posterior diameter. Kornblum and Osmund report changes in the sella which are of localizing value in 50% of suprasellar, temporal, and parietal tumors. For tumors in other locations the appearance of the sella is of little localizing value.

2. <u>Convolutional Atrophy or Increased Digital Markings</u>

These changes are due to a generalized increase in the intracranial pressure and require considerable time to develop, probably about 4 months. The increased markings are supposedly due to the pulsations of the convolutions of the brain on the inner table of the calvarium causing atrophy of the bone. The picture is seen most often with cerebellar tumors. The markings will become normal following relief of the increased pressure. Kopylov states that these changes will not occur as long as there is a thin layer of fluid over the surface of the brain but rather a diffuse decalcification results.

3. <u>Calcification of the Tumor</u>

Camp reports calcification in 7.6% of 781 verified brain tumors at the Mayo Clinic and Kornblum gives the figure of 6.5% in 446 cases. Gliomas calcify in from 5% to 11% of cases with calcification, being relatively most frequent in the oligodendrogliomas and astrocytomas. Calcification in meningiomas is common and Sosman has reported calcification in 71% of 35 verified cases of cranio-pharyngiomas. Calcification in hemangiomas often has a rather typical appearance.

4. Separation of the Sutures

This is seen primarily in children and most often associated with a cerebellar tumor. When the sutures separate it is possible to get a rather marked increase in intracranial pressure without choked discs. Also in children the convolutional markings are unusually prominent normally so that in the absence of separation of the sutures it is often difficult to evaluate the significance of the digital markings. Increased digital markings, separation of the sutures and non-characteristic sellar changes are all signs of generalized pressure. However, it is possible to have very large tumors present in the cerebrum without any of the roentgen signs of increased pressure.

It is also possible to have marked signs of increased intracranial pressure as evidenced by choked discs with a normal roentgenogram. This occurs most often with rapidly growing lesions in which there has not been long enough time elapsed for the roentgen signs of increased pressure to develop.

5. Localized Bone Erosion

This occurs occasionally with gliomas which are situated immediately under the dura, often with meningiomas in which cases the destruction is usually due to actual invasion of the bone by the tumor. Localized thinning of the skull similar to the generalized markings of increased pressure may be found associated with cysts and porencephaly. Tumors of the 8th cranial nerve and other cerebello-pontine angle tumors produce characteristic erosion of the medial end of the petrous pyramids.

6. Localized Hyperostosis

This occurs almost solely with meningiomas when it is associated with a tumor. A benign hyperostosis of the inner table of the skull is a very common finding especially in the frontal bone of women 40 years of age and over and this must not be confused with the changes due to a tumor. Kornblum and Osmund report only 6 cases of 81 verified meningiomas showing this change. This figure seems a little low. In reviewing 95 verified cases of meningioma Sosman reports 47 or 49.3% showing recognizable changes characteristic of the tumor. The hyperostosis may show definite spicules which sometimes project from the outer surface of the skull and occasionally a definite osteoma is associated with a meningioma.

7. Localized Increased Vascularity

This is also most commonly associated with meningiomas in which cases it may be very typical, consisting of small worm-like vessels surrounding an area of bone erosion, frequently disappearing in small, perfectly circular holes where the vessel perforates the bone. Increased vascularity is associated with other tumors also, notably the gliomas and hemangiomas. Increased vascularity which is noted on both sides of the skull is usually of no significance, being a normal variation.

8. Displacement of the Pineal Gland

The pineal is calcified in from 50 to 60% of adults and because it normally lies in the midline in the a.p. & p.a. views its displacement is easily seen and is of great significance.

Films in which the head is accurately centered must be obtained in order to avoid mistakes in the interpretation of this displacement, however. Vastine and Kinney have drawn a graph plotting the normal position of the pineal in the lateral view in 200 cases without evidence of intracranial disease, and by means of this chart and the taking of pineal measurements it is possible to obtain fairly definite information concerning pineal displacement in the antero-posterior and occipito-vertex directions. In practically every case of pineal displacement as seen in the antero-posterior view it is safe to assume that there is a space consuming lesion on the side from which the pineal is displaced. Occasionally in hemiatrophy of the brain the pineal is drawn towards the side of the atrophy in the absence of a tumor on the other side.

From the above described findings as seen on plain roentgenograms of the skull, it is possible to localize a large percentage of brain tumors. Sosman, in a group of 157 verified tumors seen in 1 year on Dr. Cushing's service, was able to localize 73 or 47% of them without the use of either ventriculography or encephalography. Hodges reports the plain films sufficient for localization in 30% of 167 cases.

Ventriculography and Encephalography

A very high percentage of brain tumors which escape localization by neurological and plain film examination can be accurately placed by ventriculography and encephalography. Neither of these two methods is totally without danger and both may be associated with marked discomfort to the patient. Therefore they should not be employed unless definitely indicated.

Ventriculography refers to the injection of air directly into the ventricles following trephining, which is usually done in the parieto-occipital region. This procedure was first described by Dandy in 1918. Various methods are employed in various clinics, some preferring to allow the ventricular fluid to drip out one needle while air enters through the other, and some prefer to aspirate the ventricle and inject air. In most clinics they attempt to remove nearly all the ventricular fluid and replace it with air and this is certainly the more desirable procedure from the radiological standpoint. When too little fluid is withdrawn and thus too little air enters the ventricles, the resulting ventriculograms are highly unsatisfactory, oftentimes being useless or actually misleading. The amount of air necessary to give a satisfactory roentgenogram varies according to the size of the ventricles. Whereas 10-15 cc. is sufficient in relatively normal ventricles, 50-60 cc. and more may be necessary in cases with marked hydrocephalus. As a general rule the examination has been rather unsatisfactory in our experience where only 10-15 cc. of air has been injected.

There is however a definite risk attending ventriculography. Riggs reports 140 cases with 12 deaths (8.1%). He preferred the single trephine method and stated that nearly all the patients had nausea, headache, vomiting, and in some a rise in temperature. 43 of his cases had severe reactions, becoming stuporous, and most of the patients dying had supratentorial lesions. Grant had 10 deaths in 160 cases, or 6.2%, and later reported 32 deaths in 392 cases, or 8.2%. Dandy however reports 500 ventriculograms with only 3 deaths. Many of the patients dying following ventriculography however were extremely poor risks to begin with, having large tumors and high degrees of pressure. At the present time the tendency is to operate immediately following the ventriculogram on those cases showing a definite lesion and it is probable that the mortality which can be attributed directly to the ventriculography will be greatly reduced.

The indications for ventriculography are:

1. To determine whether the signs and symptoms of increased presure are due to a tumor or some other cause.

2. To localize the lesion in patients with definite increased intra-cranial pressure where it is otherwise impossible.

3. To further confirm the localization of a tumor in order to be absolutely certain of its location before subjecting the patient to a major operation.

Encephalography consists of draining the cerebrospinal fluid from the spinal canal usually in the lumbar region and replacing it with air which then rises up to fill the ventricles. Here again various methods are used to inject the air and much stress is put on the technique of injection and manipulation. Some authors, especially Pendergrass and Pancoast, believe all the available fluid should be withdrawn and replaced with air in sufficient amounts to keep the pressure constant. They also believe in extensive manipulation and pounding of the head while taking the films to assure of proper filling of the ventricles. Dyke on the other hand uses as little air as possible and feels that manipulation of the head is of no value.

There is some risk associated with encephalography also. Pancoast in a survey of the literature including 1529 encephalograms in this country and abroad, found 20 deaths or 1.2%. He states that most of the deaths occurred abroad and were in poor risks. More recently Dyke reports only 8 deaths in 3200 encephalograms at the Neurological Institute of New York.

The indications for encephalography are the same as for ventriculography with certain reservations which are listed under the contraindications. Encephalography is also used extensively in cases with epilepsy, atrophy, and other non-neoplastic lesions within the skull.

The contraindications to encephalography are:

1. Spinal fluid pressure over 20 mm. Hg., the pressure being recorded in the horizontal position.

2. Any obstruction of aqueduct or 4th ventricle.

3. Encephalography should not be done as a short cut to diagnosis.

Occasionally (about 10%) following lumbar injection of air the ventricles will fail to fill in normal cases and all the air will be seen in the subarachnoid spaces. There is no good explanation for this and it has often been observed that the re-examination 24 hours later will show the air to be in the ventricles.

By encephalography the subarachnoid spaces and the various cisterns can be visualized whereas by ventriculography these spaces are not filled with air. The roentgenograms obtained by the two methods are otherwise essentially alike.

The interpretation of these films requires considerable experience plus a knowledge of the anatomy of the ventricular system, but is nevertheless relatively simple in that the pictures obtained depend entirely on the shifting position of the fluid and air as the patient's head is placed in various positions. Tumors are localized most often by the displacement or deformity they produce in the ventricles. Less often it is possible to see the actual tumor protruding into the ventricle. Cystic tumors which connect with the ventricles fill with air and are obvious and oftentimes cysts which do not communicate with the ventricles may be tapped during ventricular puncture and air injected, making their localization easy. It is possible, however, to have even fairly large tumors with normal appearing encephalograms as was reported by Savitzy in 9 cases. On the other hand, both Sosman and Hodges cite figures indicating that by encephalography and ventriculography in large series localization can be done correctly in as high as 96% of the cases.

Other Contrast Media

Various gasses have been used including carbon dioxide, nitrogen, helium, oxygen, acetylene, nitrous oxide and ethylene. Of these ethylene has produced the best results. It is much more soluble than air and consequently absorbed sooner, making for a quicker recovery from the undesirable symptoms. According to Newman this rapid absorption of ethylene is its only advantage over air and he states there is no appreciable anesthetic effect and that the initial complaints are just as marked with ethylene as with air. One half of the ethylene is absorbed in 3 hours. The roentgen examination must be done immediately therefore because of this rapid absorption.

Lipiodol has been injected directly into the ventricles and ascending lipiodal into the spinal canal, but these methods have not proved satisfactory largely due to the small amounts used (2-3 cc.). It is stated however that the patients tolerated it well.

Arterial Encephalography has apparently been successful in the hands of Moniz. He injects 6-7 cc. of 22-25% sodium iodide into the common carotid, occluding the external carotid with pressure during the injection. He reports 200 arterial encephalograms in 100 patients with no bad results. The tumor is demonstrated either by outlining its accessory circulation or by showing displacement of the normal cerebral circulation.

We have done one arterial encephalogram using thorotrast with some small degree of success in a case of arteriovenous aneurysm.

Lipiodol has also been injected into the cerebral arteries, venous sinuses, cystic cavities, osseous canals and convolutions and fissures of the brain by Haguenan and Gally.

Analysis of University of Minnesota Hospitals Cases

All the cases discharged from the University of Minnesota Hospitals during the 6 year period, 1932 through 1937, with a recorded diagnosis of brain tumor have been reviewed. It is very likely that some cases have escaped this investigation since only recently a case has come to our attention of a probable craniopharyngioma in which the chart cannot be located. It is also probable that some cases have not been recorded correctly and would therefore be left out. Many of the pituitary tumors have never had surgical exploration or hospitalization and consequently the number of tumors in this group is unusually low. On the other hand we have 3 pinealomas and 4 craniopharyngiomas, which is an unusually large number for such a small series. It is therefore quite evident that the cases listed do not give a true representation of the frequency of the various types of tumors.

A total of 150 cases were studied. Of this group 92 were undisputably verified and with few exceptions microscopic diagnoses were available. Most of the histologic slides have been reviewed by Dr. A. B. Baker and grouped according to his classification. Our study has been directed primarily toward this group of 92 proven cases since it was felt that any critical analysis of the other 58 cases would be of little value. A brief mention will be given, however, regarding the smaller series of unverified cases.

Chart No. 1

An analysis of the 58 unverified cases shows:

1 case tumor found but microscopic unsatisfactory for diagnosis
21 negative explorations for localization of tumor

- 8 on clinical diagnosis alone
- 8 on clinical and x-ray diagnosis
- 5 on x-ray diagnosis alone
  - 1 called a meningioma on plain films
  - 2 poor fillings with air
  - 2 with suitable air filling

4 cases had ventriculograms but no exploration
(1 probably normal, 2 considered posterior fossa tumor, and 1 considered a mid-brain tumor)
4 cases had encephalography but no exploration
(1 normal, 2 questionable, 1 unsatisfactory)
8 cases had definite localizing signs on plain films and no exploration
(3 calcified lesions
(2 displaced pineals
(1 definite meningioma overlooked
(1 pituitary tumor
(1 hemangioma with bone erosion
20 cases had no localizing signs on plain films
(8 entirely negative
(12 had signs of increased pressure

58 Total

The following table is an analysis of the 92 verified cases, the tumors having been classified according to their histo-pathologic structure. A similar grouping of slightly over 2000 verified cases reported by Cushing in 1932 is given for comparison. The percentage of pituitary tumors in Cushing's series is unusually high. A rough estimate as to the relative frequency of all brain tumors is probably as follows: 50% gliomas, 25% meningiomas, and 25% all other tumors.

Chart No. 2

An analysis of the 92 verified cases shows:

	University of Minnesota Hospitals		Cushing's Series	
Encephalic or Gliomas		50		874
Medulloblastoma	2		86	
Glioblastoma Multiforme	15		208	
Astroblastoma	4		35	
Astrocytoma	21		255	
Ependymoma	4		37	
Oligodendroglioma	1		27	
Unclassified Gliomas	3		175	
			Others 37	
Hypophyseal Tumors		7		452
Pituitary	3		360	
Craniopharyngioma	4		92	
Vascular Tumors		4		41
Angioblastoma	3		25	
Angioma	1		16	
Tumors of Meninges		18		271
Pinealomas		3		14
Metastatic		3		85
Miscellaneous		7		38
Congenital Cyst	2			6
8th Nerve Tumor	1			176
Chordoma	1		and Teratoma	6
Cholesteatoma	1		and Dermoids	15
Colloid Cyst of 3rd Ventricle	1			
Tuberculoma	1		and Syphiloma	45
Total		92		2000+

A comparison of the clinical and roentgenological diagnoses has been attempted on the 92 proven cases not with the idea of pitting one method against the other but rather to determine which method is likely to be more accurate should the two not agree. Since the clinical diagnosis was often not definitely indicated until after a positive roentgen examination of surgical exploration, and since these cases were all counted as correct clinical localizations, the number of accurately localized lesions by neurological methods alone is probably high. The roentgen findings were, on the other hand, always definitely indicated and there was little difficulty in interpreting the reports. It may be said that some of the roentgen reports were made with a knowledge of the clinical findings and this is true in many of the cases. However, if this information should aid the roentgenologist in some cases it would also lead him astray in others.

The roentgenologist should be familiar with the history at least in every examination of the skull. To attempt to interpret roentgenograms of the skull or any other part of the body without some knowledge of the clinical manifestations is analogous to an attempt on the part of the clinician to interpret the results of his physical examination without any knowledge of the history.

Chart No. 3

Comparison of Clinical and X-ray Diagnoses

	Clinical Alone	X-ray Alone
Correct	53	49
Definitely Wrong	24	6
No Localization	15	35 (28 had plain films alone. (5 Diagnoses present and overlooked. 2 No films
Totals	92	92

From the above chart it will be seen that 6 cases were incorrectly localized roentgenologically and they are listed below.

2 - called meningiomas incorrectly on plain films.

4 - misinterpreted ventriculograms

(1 - glioma of occipital pole placed in parietal lobe
(1 - 3rd ventricle tumor placed subtentorial
(1 - glioma of left frontal put in parietal lobe
(1 - glioma of right frontal put at base of brain

24 cases were localized incorrectly by clinical methods and they are as follows. From the literature and from our series it is evident that the greatest difficulty lies in the differentiation of frontal and cerebellar, and temporo-parietal and cerebellar lesions.

Types of Cases Incorrectly Localized Clinically

6 - Cerebellar tumors placed supratentorial.
8 - Supratentorial placed in cerebellum.
2 - Left frontal placed in right frontal.
1 - Left frontal called sagittal sinus thrombosis.
1 - Midline large tumor called no brain tumor.
1 - Meningioma of left wing of sphenoid called senile dementia.
1 - Occipital lobe put in parietal.
1 - Midline and left-sided tumor placed on right.
1 - Temporal lobe placed in parietal.
1 - 3rd ventrical tumor placed in cerebello-pontine angle.
1 - Left frontal placed in left temporal.

24 - Total

Combining all methods of examination the accuracy of localization is as follows. A group of 190 proved cases similarly classifed by Hodges is also given.

	University of Minnesota Hospitals		Hodges'	
	No.	%	No.	%
Clinical Diagnosis 25 confirmed by X-ray - (15 plain films (10 air injection	53	57.6%	98	51.6%
Plain films added	8	8.7%	24	13.0%
Ventriculograms added	15	16.3%	48	25.0%
Encephalograms added	1	1.1%	10	4.8%
Undiagnosed	15	16.3%	10	5.6%
Total	92	100.0%	190	100.0%

An analysis of the 15 cases not localized from a roentgenological standpoint shows that:

No films were taken	2
No air injections	8
Air injected (2 unsatisfactory (2 incorrectly interpreted (1 no deformity or displacement	5

Other roentgen findings of interest are:

1. Changes in and about sella 68 out of 90 cases
2. Increased markings 32 out of 90 cases
3. Plain films entirely negative 12 out of 90 cases
4. Pineal calcification 56 out of 147 cases
5. Pineal displaced 17 out of 147 cases
6. Choked disc and negative x-rays for increased pressure - 11
7. X-rays positive for increased pressure and no choke - 6

Because the end results were available in so many of the cases they will be presented although they have no bearing on the problem of roentgen diagnosis.

Results

Known dead - 73
No data - 6 months or more - 6
Alive within last 6 months - 13

Alive less than one year - 65.
One supra sellar astrocytoma alive 4 years now with no head complaints.
One glioma of septum pellucidum alive 3 years now and is O.K.
Longest survival was 65 months, with olfactory groove meningioma.

Conclusions

1. The literature since 1925 has been reviewed with regard to the Roentgen Diagnosis of Brain Tumors.

2. Approximately 30-50% of all brain tumors can be localized on the plain roentgenograms of the skull.

3. By resorting to ventriculography and encephalography approximately 95% of all brain tumors may be localized.

4. There is apparently an increasing tendency for ventriculographic localization, and ventriculographic confirmation of neurologic localization before operation.

5. 150 cases from the records of the University of Minnesota Hospitals in the past 6 years suspected of having brain tumors have been reviewed.

6. 92 of these were verified tumors and 58 were not.

7. The tumors were localized correctly in 83.7%.

8. Atrophy and decalcification of the posterior clinoids and dorsum sellae were noted in 6 cases with verified tumors and absent choked discs.

9. An attempt has been made to evaluate the relative accuracy of localization by clinical and roentgenologic methods.

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