The symptoms and diagnosis of
Tumours of the Frontal lobes of the Brain.

Andrew Robertson Wilson
M.A. M.B., C.M.
Crown aspect of cerebral hemisphere. "Frontal region" of this half coloured crimson.

F, F1, F3, inferior, middle, and inferior frontal convolutions. A.F, A.P, ascending frontal and ascending parietal convolutions. B.C. 

after Perrier.
I propose to treat the subject of this thesis under the following headings:

1. The functions of the frontal regions.
2. Examination of the records of fifty cases of frontal tumour, with special reference to diagnosis.
3. Clinical history and post-mortem report on a case of frontal tumour under my own observations.

By the term "Frontal regions" I mean that portion of the frontal lobes of the brain, which lies anterior to the pre-central sulcus and to an imaginary continuation of the sulcus upwards to the longitudinal fissure. Thus the superior frontal convolutions is divided in two, the smaller and posterior portion physiologically belonging to the Rolandoic area. The region as limited consists of the inferior, middle, and anterior part of the superior, frontal convolutions. This region is further divided physiologically into an anterior pre-frontal, and a posterior post-frontal division, a division which, according to Ferrier (Clifford Allbutt's System of Medicine Vol VII p.273), is represented anatomically in the Macaque monkey.
by a shallow transverse sulcus.

1. Functions of the frontal region.

Perris (Functions of the Brain ed. 1886 p. 594), also
Albert's Jour. of Med. Vol. VII p. 273) states that he
has found the results of stimulation of the
prefrontal region either to be negative or, in
a few cases, to be accompanied solely by
movements of the eyes. On stimulation of the
post-frontal region, rotation of the head and
eyes to the opposite side resulted, along with wide
opening of the eyes and dilatation of the pupil
(Fuinctions of the Brain pp. 242-243). The
experiments of Schäfer and Elliott ('Text-book of
Physiology' Schäfer Vol II p. 731) confirm the results
of Perris. In experiments on larger monkeys
they found further that stimulation of the
upper part of this area caused downward
and lateral deviation, of the lower part
upward and lateral deviation, and of a
middle area lateral deviation alone. Sharp
movement of the eye followed stimulation
at the focus of the area near the angle of
the pre-central sulcus. Equal and simultaneous
stimulation of similar points of this area in
both hemispheres, produced visual fixation.
with the eyes in primary position or slightly convergent.

The evidence of destructive lesions shows that the post-frontal area contains a centre for the rotation of the head and eyes to the opposite side. In its destruction in one hemisphere there is transient conjugate deviation to the side of the lesion. Destruction on both sides only causes transient paralyses of this movement showing that this is not the only centre for these movements. Destruction or removal of the prefrontal area alone produces no definite symptoms (Ferrier and Horsley's 'Functions of the Brain' p. 376, Allbutt's 'Text - of Med. p. 376'). Ferrier has found in several instances that removal of the prefrontal areas in a monkey, after recovery from the paralyses caused by removal of the post-frontal, reproduced the same transient paralyses, thus showing that the prefrontal area is connected with the same centres as the post-frontal. The recovery of movement, when bilateral removal of the whole frontal lobes has been effected, shows that other centres for these movements must
exist, possibly in the cortex of the temporal and occipital lobes, which on stimulation produce these movements, (Schäfer's Physiology Vol. II p. 740). Ferrier after these operations found, (Philosophical Transactions 1864 part II p. 522) tracts of descending neurons in the innominate bundles of the internal capsule and foot of the crus cerebri, which could not be traced beyond the upper part of the pons, thus, in his opinion, proving connection with the motor tracts of the crus cerebri and with the nuclei of the motor nerves controlling ocular movements. These observations he has confirmed more recently along with Dr. Aldren Turner (Proc. Roy. Soc. Vol. LXXI, p. 3.) as Schäfer remarks, (loc. cit.), it is hard to see, if this connection be a fact, why the pre-frontal areas are inexcusable.

Ferrier in these experiments noted after removal of the frontal regions alteration in the character and behaviour of monkeys, which became dull, listless and sleepy, and occasionally wandered about in a purposeless manner. In his own words, "while not absolutely demented
they had lost to all appearance the faculty of attentive and intelligent observations." He quotes (Functions of the Brain C. p. 219) similar observations made by Helvig and Goltz, though their observations are reduced in value by their neglect of autoptics, and by the small size of the animals used. Fourier holding that intellectual attention is chiefly visual vision, maintains that the power of attention must be closely related to the volitional control of the head and eyes in connection with the centers for visual perception and ideation, and that, in consequence, the faculty of attention has its seat in the centers for these movements, and their associated sensory centers, namely in the frontal lobes; these centers then form the substrate of the faculty most involved in the higher intellectual operations. In addition it holds that intelligence and will have no local habitation distinct from the sensory and motor substrata of the cortex generally. This localization of the faculty of attention in the centre for
the head and eyes is open to criticism. He points out that the animals operated on recover the movements of head and eyes in a few days, and yet the defects of mentation continue. The motor recovery having taken place, why not the psychical? Specially may this be asked if the one function be so intimately connected with the other. I think it might be more fairly be concluded that these lobes are the seat of the higher processes themselves, as well as of the centres for the head and eyes, and that after removal the motor function can, to a considerable extent, be taken over by other centres, whilst the psychical cannot.

Schröer in his more recent experiments, (Physiology Vol II p.772), did not remove cerebral substance, but by a subcortical incision cut off the area required from the rest of the brain. Using this method in the monkey he cut off all the inaccessible prefrontal area with no noticeable resulting dulness and alteration in character. In his opinion there are no sufficient grounds for localising the
intellectual faculties in the inexcitable area of the frontal lobes. On the other hand I would suggest that, though no change was observable, (probably owing to the more perfect mode of operation), yet it must be hard to recognize such a change in a dumb animal. Under ordinary circumstances it might seem in a normal condition, yet in emergency or in an unusual position it might be unable to carry on those mental processes prima facie possible.

I shall next consider, in this connection, Flechsig's theory of "Association Centres". (J. An. Aug. 1895, 1900 p. 329. Flechsig's Physiology Vol II pp. 767-772). Of the cortex be divided out into areas which give response to stimuli, large inexcitable areas are left; according to Flechsig these form two thirds of the cortex in man, and these inexcitable areas yet swallow as the scale of intelligence is descended. He divides the central cortex into sensory spheres, (sensory centres), and association centres, (intellectual centres or organs of
thought), founding his divisions on investigations of the development of the myelin sheath on the central fibres, each fibre in a group receiving its sheath at the same time, and those of different groups at different times. He distinguishes four sensory or projection centres, and four association centres, frontal, parietal, temporal, and insular. More recently he has combined the second and third as the "great-posterior association centre". Each of these has a central and a peripheral zone, the latter being connected with sensory centres by numerous fibre anastomoses. The central zones are terminal regions regarded by Flechsig as essentially characteristic of the human brain, these he considers combine the activities of the sensory centres. Destruction of the central zone in isolated parts causes no disturbance, but if largely destroyed especially on both sides mental power is weakened and association of ideas interfered with.

This theory is combated by various
observers, as Béjérine, Monakow, and Hitzig, whilst by others it is partially supported. It is certainly at present in the region of hypothesis. I mention it at some length here as one of his association centres is located in the frontal region, and this, if true, might supply a reason for the marked frequency of mental disturbances in frontal lesions. Flechsig himself considers that morbid conditions of the posterior centres cause mental troubles most frequently, an opinion corroborated by the clinical experience of Bastian (Brain as an Organ of Mind pp. 546 and 587) and Rosenthal ("Paralyses Cérébrales bulbares et cérébelleuses", Bastian, p. 94).

The experiments of Rümke referred to in detail by Feirer (Functions of the Brain pp. 400, 401) gave results very different to those already mentioned. After removal of the frontal lobes in dogs and monkeys he found no mental change or loss of attention, and no change in sensation. The only motor change observed was paralysis of the
muscles of the trunk on the opposite side. Luciani and Graeppler, quoted by Bianchi ('Brain' p. 802, 1875) confirm these results, though Graeppler states that the paralyses of the spinal muscles were not persistent. The mass of evidence however is against Hunke's views. Fourier, ('Functions of the Brain,' p. 401), says, "If the description he gives of his experimental results be correct, they can only be ascribed to crude methods and wide-spread secondary results." They must have been due to secondary irritation of the motor centres for the trunk muscles which lie, as shown by Hopey and Schäfer, on the internal surface of the marginal gyrus. Hitzig, Goltz, and Kniemandtow are also quoted by Fourier in opposition to the views of Hunke. In the experiments of Bianchi ('Brain' 1875, pp. 566-578) affections of the trunk muscles were observed in a few cases, but it was only transient.

Bianchi's experiments on dogs and monkeys were conducted with strict antiseptic precautions and with care
to avoid excitation of other areas. The prefrontal area he found inexcitable. Excitation of the foot of the upper frontal convolution produced not only rotation of the head to the opposite side, but also of the trunk in the lumbar region. Conjugate movements of the eyes did not always accompany rotation of the head. Excitation of the inferior area produced raising of the eyelid along with dilatation of the pupil. The results observed by Bianchi after unilateral removal of the frontal lobe may be summarized as follows:—

a) In the first and second week rotary movements with the concavity of the trunk towards the unilaterated side.

No oculo-motor disturbance.

b) Transient spasm of the opposite arm seen in slight movements.

c) General and special sense unaffected save loss of hearing on the opposite side in one case.

d) Certain temporary visual changes.

e) No change in behaviour after unilateral
After bilateral removal of the frontal lobes he observed:

a). Temporary paralysis of the nature described.
b). Apparent loss of memory, judgment, discrimination, friendliness, and sociability impaired. Invariable acidity is shown from being cleanly the animals became dirty and their sexual functions were perturbed.

Observations b. etc after unilateral removal were also made by Hetzog from which he attributed some relation to vision to the frontal lobes. Penicilli has also observed similar transient phenomena (U. Alfred's Jour. of Psych. VI p. 276) from the mental changes observed after bilateral removal Bianchi concludes that "the frontal lobes are the seat of coordination and fusion of the incoming and outgoing products of the several motor and sensory areas of the cortex." Removal of the frontal lobes, in Bianchi's opinion, does not so much interfere with the perceptions
taken singly, as it disintegrates the personality and incapacitates for serializing and synthesizing groups of representations. This is in fact, Hering's description of the functions of an Association Centre, of which the inexcitable prefrontal region is one. These opinions are supported by the conclusions of Hughlings Jackson founded largely on his observations of epilepsy and insanity, (Brit. Med. Jour. 1884 p. 660). He gives as his opinion that the highest motor centres, (frontal lobes), represent in more complicated manner what is represented in the lower motor centres of the cortex, and that these highest centres form the physical basis of consciousness.

The special localization of mental processes in a definite area or areas of the brain is refuted by many authorities. Michael Foster, (Text-book of Physiology, ed. 1876, p. 1117) says, "Whatever classification of psychical processes we adopt, we are wholly unable to make out any..."
localization of functions", holding that psy- 
chical processes are functions of the 
connections of the cortex with other 
portions of itself, and with other parts 
of the nervous system. The same 
position is taken by Pecois (Die 
Geschwülste des Nervensystems p. 94) 
who states, "what we call psy- 
chical life takes place through harmonious working 
of the most diverse and widely separated 
regions of the nervous system". Yowes 
(Diseases of the Nervous System p. 25) holds 
similar views, as does also Feurier (loc. 
it.) with the exception of his localization 
of the faculty of attention in the frontal 
tores.

The physiological facts ascertained by 
experiment on animals may be shortly 
summed up as follows:

1. The post-frontal area forms a motor 
centre for the head and eyes on the 
opposite side. The pre-frontal area is 
incapable but is possibly connected 
with the same centres as the post-frontal.

2. This region very possibly forms
part of the physical basis of the
higher mental processes, in which the
motor and sensory impressions are
re-represented.

Our knowledge of the functions of this
region in man is scanty and is
derived from observation of the effects
of disease and injury. As regards
motor and sensory functions symptoms
are mostly latent. There is some
evidence in favour of the centres for
the head and eyes being the same as
in the monkey. In a case of left-
frontal tumour under my own
observation, and described later in this
thesis, during convulsions the eyes were
strongly rotated to the right. Williams
(Brain 1896 and 4) describes a case of right-
frontal tumour where the head and
eyes were rotated to the left.
The localization of higher mental
processes in this region in man is
dispensed just as in animals. Such
a localization is supported by the
varying development of the cerebellum.
in different races; due allowance being made for difference in stature, the more intelligent and civilized races have the largest. The cerebrum is largest in Europeans and Chinese, smallest in Negroes and native Australians, and intermediate in Negroes and Red Indians. (Quain's Anatomy, ed 1873, Vol.3, pt.1, pp 176 et seq.). Reynolds has found that the proportional weights of frontal, parietal, and conjoined temporal and occipital lobes is 41.5, 23.4, and 35.1. (Quain loc. cit.). From this it follows that, if the cerebrum be larger, the frontal lobes have the largest share in the increase. This greater development in man also holds good for the regions containing Flechsig's "great posterior association centre," a region found specially developed in some men of genius. (Rehagens Physiology Vol II p 772); a fact tending to confirm Flechsig's theory rather than to confute the theory that the frontal lobes are one of the special
seats of intelligence and reason. H. Naegele's researches on the relation of the size and weight of the brain to the intelligence of the individual, (Brain, loc. cit.), show a greater relative increase in size of the frontal lobe in the more intellectual subjects, the complexity of the convolutions is also increased.

The conclusions to be drawn from these anatomical data are strengthened by observations of the results of disease and injury. There are many difficulties in the way of such observations. Some mental defects may be observed with ease, whilst others are very difficult, such as failures in the higher intellectual efforts. Sick or injured persons seldom make such efforts, hence defects therein may never be observed. This probably explains the apparent absence of change in many cases where it might a priori have been expected. Of the 50 cases of frontal tumour, which I have tabulated,
33 or 66\% showed marked mental change, a result which agrees with the opinions of Allan St. John (Amer. Journ. of Med. Science 1884), Broad, Bichat, and others, to which more detailed reference will be made in the next section of this thesis. Peciniu holds that the power of attention and intelligent observation is distinctly weakened by lesions in this region, (loc. cit.). Bastian (Paral. Cerebral, Bulletin v. 1d 1882 p. 650) considers that unilateral lesions are frequently unaccompanied by mental change, but that bilateral ones are so accompanied. On the other hand Hynd (Brainal Physiology p. 149) holds that it is impossible to assign any special mental function to this area, or other observers are of the same opinion.

In conclusion I would say that we may with some assurance attribute to this region the same functions in man, to which I have already referred in the lower animals.
<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Duration of Symptoms</th>
<th>Symptoms</th>
<th>Vomiting</th>
<th>Optic Nerve</th>
<th>Convulsions</th>
<th>Reflexes</th>
<th>Mental State</th>
<th>Speech</th>
<th>Motor Power</th>
<th>General Sensibility</th>
<th>Sensory Changes Other than Ocular Motility</th>
<th>Death</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>1 month</td>
<td>Headache</td>
<td>Yes</td>
<td>Absent</td>
<td>No change</td>
<td>Absent</td>
<td>Poor, thin, and semibarbarous; could not be made to answer questions.</td>
<td>No aphasia or change.</td>
<td>Apparent weakness.</td>
<td>Apparently no change.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>6 months</td>
<td>Headache</td>
<td>No mention</td>
<td>Not mentioned</td>
<td>None</td>
<td>Phlegm</td>
<td>Weakness of left arm and leg; sensory disturbances; left visual field; coma.</td>
<td>No aphasia or change.</td>
<td>No sensory</td>
<td>Not mentioned.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>3.5 years</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>40</td>
<td>6 months</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>45</td>
<td>5 years</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>40</td>
<td>1 year</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
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<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
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<tr>
<td>7</td>
<td>40</td>
<td>3 months</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
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<td>Not mentioned.</td>
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<tr>
<td>8</td>
<td>35</td>
<td>1 year</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
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<td>Not mentioned.</td>
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<tr>
<td>9</td>
<td>30</td>
<td>2 months</td>
<td>Headache</td>
<td>Yes</td>
<td>Double</td>
<td>Severe</td>
<td>Absent</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>No sensory or motor disturbance; coma.</td>
<td>Not mentioned.</td>
<td>Cerebral.</td>
<td></td>
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</tbody>
</table>
Post-Mortem Report.

Multiple Sarcomata. On surface of left cerebral hemisphere and shown in 2nd Frontal convolution extending into white matter, in right frontal lobe in white matter two small tumours, one beneath 1st, on 2nd convolution, another in the white matter, and one in anterior end of right lateral ventricle, two in occipital lobes at the tip.

Nature of tumour not stated. Size of a walnut growing from the inner aspect of the dura mater, and compressing the apex of the left frontal lobe.

Nature of tumour not stated. History of injury 6 years previously. Left frontal lobe filled by a tumour extending from inner to outer surface, and compressing the median surface of the right frontal lobe. Extending to left caudate nucleus but did not include the greater part of it.

Nature of tumour not stated. In right frontal lobe there was a spherical tumour 2½ inches in diameter, coming to the surface in the 1st and 2nd frontal convolutions.

Glioma, size of a small orange found in the white matter of the frontal lobe, (side not stated), anterior to the anterior central convolution.

Sarcoma, 4 cm x 3 cm in one olfactory groove, which had destroyed the olfactory nerve, involved pia and softened brain around. Cerebellum congested and softened.

Sarcoma, size of an English walnut in right frontal lobe attached to bone just above the orbital plate. A sharp pointed osseous growth extended upwards from the orbital plate, and to this area and tumour were adherent.

Fibro-sarcoma 3 cm in diameter involving inferior portion of the right frontal lobe, adherent to the dura mater over the orbitofrontal plate.

Sarcoma, on the surface of the right frontal lobe, pressing on the inferior and middle convolutions at about their middle point.

Fibroma, lying obliquely across right frontal lobe, involving anterior half of the superior frontal, also anterior upper and lower half of middle frontal convolutions, invaded gyrus frontalis, and corpus callosum. Hemisphere thus affected in front.

A large "gummy" tumour at anterior part of left frontal lobe growing in the dura mater, and extending into the brain surface which was softened round it.
<table>
<thead>
<tr>
<th>Gross Disease</th>
<th>Age</th>
<th>Duration</th>
<th>Headaches</th>
<th>Vomiting</th>
<th>Optic Nerve</th>
<th>Commissures</th>
<th>Reflexes</th>
<th>Mental State</th>
<th>Speech</th>
<th>Motor Power</th>
<th>General Sensibility</th>
<th>Other Changes</th>
<th>Death or Skill</th>
<th>Mode of Death</th>
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<tbody>
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<td>Struma, with pain, Feb 1881</td>
<td>M.</td>
<td>50</td>
<td>over 1 month</td>
<td>none</td>
<td>present</td>
<td>not described</td>
<td>not described</td>
<td>at death</td>
<td>not described</td>
<td>no change</td>
<td>no change</td>
<td>not described</td>
<td>muscular twitching</td>
<td>feeble breathing</td>
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<tr>
<td>Pneumonia</td>
<td>P.</td>
<td>20</td>
<td>about 2 months</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>no change</td>
<td>no change</td>
<td>right half of face and arm</td>
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<td>feeble breathing</td>
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<td>Tumour Brain</td>
<td>P.</td>
<td>40</td>
<td>about 6 months</td>
<td>none</td>
<td>none</td>
<td>normal</td>
<td>normal</td>
<td>right side</td>
<td>not described</td>
<td>left arm</td>
<td>left arm</td>
<td>not described</td>
<td>muscular twitching</td>
<td>feeble breathing</td>
</tr>
<tr>
<td>Tumour Brain</td>
<td>P.</td>
<td>40</td>
<td>about 6 months</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
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<td>left arm</td>
<td>not described</td>
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<tr>
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<td>not described</td>
<td>not described</td>
<td>present</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
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<td>left arm</td>
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<td>not described</td>
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<td>feeble breathing</td>
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<tr>
<td>Tumour Brain</td>
<td>P.</td>
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<td>not described</td>
<td>not described</td>
<td>present</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
<td>left arm</td>
<td>left arm</td>
<td>not described</td>
<td>muscular twitching</td>
<td>feeble breathing</td>
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<td>P.</td>
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<td>not described</td>
<td>not described</td>
<td>present</td>
<td>not described</td>
<td>not described</td>
<td>not described</td>
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<td>present</td>
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<td>not described</td>
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<td>not described</td>
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<td>Tumour Brain</td>
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<td>not described</td>
<td>not described</td>
<td>present</td>
<td>not described</td>
<td>not described</td>
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<td>not described</td>
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<td>not described</td>
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<td>feeble breathing</td>
</tr>
<tr>
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<td>not described</td>
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<td>not described</td>
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<td>feeble breathing</td>
</tr>
</tbody>
</table>
Post-Mortem Report.

Nature of tumour not stated. Hard, modulated mass, the size of a walnut in the white substance of left frontal lobe, also in same position in right frontal lobe, size of a hickory nut. Both were surrounded by gelatinous, firm, and non-fluid substance.

Nature of tumour not stated, on base lying under and compressing the left frontal lobe. It filled the anterior fossa, extending from base cerebri, to which it was adherent, over the sphenoid sinus, to right frontal bone. Anterior was hard, posterior soft. Posterior end had extended out such to the right and produced a corresponding cavity in brain, it had compressed left olfactory, left 5th nerve, geniculate ganglion, pituitary, cavernous sinus.

Sarcoma, 3 1/2" x 1 3/4" encapsulated in posterior part of second left frontal and adjacent portion of first frontal and upper half of anterior central convolutions. The anterior central must have been compressed, and indirect pressure on the third frontal.

Glioma in anterior two thirds of second and third frontal convolutions, chiefly in cortex.

Glioma in cortex and half an inch deep in adjacent white matter of middle and anterior parts of second and third frontal convolutions, and a small portion of adjacent orbital convolution.

Diffuse gliomatosis, affecting chiefly the posterior ends of the first and second frontal, and upper part of ascending frontal. Cortex mostly involved.

Large round cell sarcoma springing from white matter of right frontal lobe and bulging into anterior horn of right lateral ventricle which was distended.

Sarcoma, secondary growth in right frontal lobe.

Right frontal lobe occupied by a large tumour, both olfactory nerves flattened, growth extended backwards as far as the ascending frontal. Extreme anterior end of internal capsule involved.

Tumour, size of a tangerine orange, sprang from the left side of the face where attached to the ethmoid galli. It had displaced and removed the whole of the anterior part of the frontal lobe.

Glioma, involving left lower frontal convolution and the greater part of left frontal lobe.
<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Duration</th>
<th>Headache</th>
<th>Vomiting</th>
<th>Optic Neuritis</th>
<th>Convolutions</th>
<th>Reflexes</th>
<th>Mental State</th>
<th>Speech</th>
<th>Motor Power</th>
<th>General Sensibility</th>
<th>Sensory Changes Other Than Optic Neuritis</th>
<th>Origin's Point</th>
<th>Mode of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>30</td>
<td>6 months</td>
<td>Headache frequent frequent</td>
<td>Headache frequent frequent</td>
<td>Headache present frequent</td>
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<tr>
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<td>Headache present frequent</td>
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<td>Headache present frequent</td>
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<td>Headache present frequent</td>
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<tr>
<td>Case 6</td>
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<tr>
<td>Case 7</td>
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<tr>
<td>Case 8</td>
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<td>Headache present frequent</td>
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</tr>
</tbody>
</table>

Legend:
- **Headache**: Present or absent
- **Vomiting**: Present or absent
- **Optic Neuritis**: Present or absent
- **Convolutions**: Present or absent
- **Reflexes**: Present or absent
- **Mental State**: Present or absent
- **Speech**: Present or absent
- **Motor Power**: Present or absent
- **General Sensibility**: Present or absent
- **Sensory Changes Other Than Optic Neuritis**: Present or absent
- **Mode of Death**: Present or absent

The table details various symptoms and conditions observed in different cases, along with their duration and associated findings.
Post-Mortem Report.

Glioma of right frontal lobe, below level of corpus callosum. Dense matter adherent over it.

Large tumour in right frontal region, occupying its whole extent. Lifting noted that quite healthy, as also pons, cerebellum and medulla. Occasation of the pyramids normal.

In left hemisphere growth occupied upper outer, anterior and upper aspects of frontal lobe, reaching nearly to anterior limit of Sylvian fissure. Brain substance around tumour softened. In right hemisphere a tumour similar in size in white matter of frontal lobe beginning one inch from tip, and stopping posteriorly just short of caudate and lentiform nuclei.

Tumour of mid-frontal region on the left, causing bulging in the internal aspect of the hemispheres, another small tumour at the posterior part of convolution of corpus callosum on the left.

Glioma of left frontal lobe. Haemorrhage had occurred from the tumour into the whole of the left subdural space.

Glioma and cyst in right frontal lobe involving the upper frontal convolutions and the subjacent white matter. Intracranial pressure greatly increased, convolutions flattened and nuclei effaced.

Squamous carcinoma cyst, size of a hen's egg in left frontal lobe, in middle part of first frontal convolution and subjacent white matter. Recent embolus in left middle cerebral artery (putative cause of the late complete hemiplegia).

Glioma, dense adherent over circumcorted spot corresponding to posterior end of second left frontal convolution. Tumour involved posterior end of first and second right frontal convolutions and subjacent white matter.

Sarcoma. Two in left frontal lobe. A small one (size of a tennis ball) in the tip. Another of large size (size of egg) in posterior third of second left frontal which was destroyed. Posterior part of first left frontal and adjacent part of left second frontal convolution were encroached on, but not destroyed.

Gliosarcoma with cyst size of hen's egg, involving and destroying almost the whole of first and second and anterior half of third left frontal convolution, subjacent white matter, posterior third of first and second and posterior part of second and of third left frontal convolutions and subjacent white matter. Proliferation and infiltration but not destroyed. Left frontal lobe markedly larger than right. Dense adherent over left frontal lobe.
<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Duration of Symptoms</th>
<th>Grade &amp; Severity</th>
<th>vomiting</th>
<th>optic neuritis</th>
<th>Conclusions</th>
<th>Reflexes</th>
<th>Mental Status</th>
<th>Speech</th>
<th>Motor Power</th>
<th>General Sensibility</th>
<th>Other Changes, e.g., Tini, Gobb &amp; Special Head &amp; Eye Affections</th>
<th>Mode of Death</th>
</tr>
</thead>
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<tr>
<td>Mr.</td>
<td>72</td>
<td>3 months</td>
<td>None present</td>
<td>absent</td>
<td>present</td>
<td>absent</td>
<td>unchanged</td>
<td>AppARENTLY motor aphasia</td>
<td>no change</td>
<td>no change</td>
<td>not described</td>
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<td>corneal clouding. Mental changes with no organic basis.</td>
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<td>corneal clouding. Mental changes with no organic basis.</td>
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<tr>
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<td>absent</td>
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<td>unchanged</td>
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<td>no change</td>
<td>no change</td>
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<tr>
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<td>18 months</td>
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<td>absent</td>
<td>absent</td>
<td>present</td>
<td>present</td>
<td>unchanged</td>
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<td>no change</td>
<td>no change</td>
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<td>corneal clouding. Mental changes with no organic basis.</td>
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<tr>
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<td>10 months</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
<td>present</td>
<td>unchanged</td>
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<td>no change</td>
<td>no change</td>
<td>no change</td>
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<tr>
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<tr>
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<td>absent</td>
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<td>present</td>
<td>unchanged</td>
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<td>no change</td>
<td>no change</td>
<td>no change</td>
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<td>corneal clouding. Mental changes with no organic basis.</td>
</tr>
<tr>
<td>M.</td>
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<td>absent</td>
<td>present</td>
<td>present</td>
<td>unchanged</td>
<td>AppARENTLY motor aphasia</td>
<td>no change</td>
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</tbody>
</table>
Gli-sarcoma in left frontal lobe destroying all the first and anterior two thirds of second and third frontal convolutions. Posterior third of second and third left frontal convolutions were slightly implicated. Great increase of intra-cranial pressure.

carcinoma springing from the dura causing atrophy and destruction of right ascending frontal and parietal convolutions, the outer half of the island of Reil, and anterior end of sphenoid-ethmoidal lobe.

Glioma and cyst in left hemisphere destroying left ascending frontal and ascending parietal convolutions and subjacent white matter, posterior end of third left frontal convolution and greater part of white matter of the frontal lobe. Convolutions greatly flattened and sublux effaced especially over the left hemisphere.

Previously small tumour was removed from above the left eye-ball in the orbit cavity. This reached, indented midway between the centre of the ascending convolutions and the anterior aspect of cranium. At this point there was a small capsule the size of a barley-corn or outside of skull. Tumour of brain found to be thick and stringy, forwardly edges and spreading over the anterior two thirds of the frontal lobe.

Tumour lobular, size of an apple, weight 70 grammes, occupied anterior fossa at left side of cranium. Extended to the right, destroying orbitomalar plate posteriorly to glenoid tubercles in front of zygo-turbicia. Left anterior cerebral lobe greatly abraded. Orbits are displaced.

Fibro-sarcoma in anterior part of left frontal lobe. Extending from external to internal surface of the lobe, hard & lobulated, once adherent. Superior frontal gyri ended against posterior surface of the growth. Middle frontal convolutions flattened anteriorly and ended against tumour. Broca's convolution displaced backwards. Medial surface frontal lobe entirely replaced by tumour. Fore-part of orbit is raised. Surface of frontal lobe replaced by tumour.

Carcinous tumours of dura from optic commissure to tip of frontal lobe, occupies nearly whole of prefrontal region on each side.

Fibroma, on section of right frontal lobe is found a hard fibrous tumour occupying the whole lobe, 3 inches in each diameter, Colour greyish. Surrounded by different cerebral tissue. Rest of brain healthy.

Tumour, nature not stated, very vascular and irregular on surface of right anterior lobe, hard and surrounded by gelatinous tissue. Adherent in places to the dura. Left ventricle dilated and partially filled with clear serum. Right not so dilated as the left. Anterior corns occluded by an inversion of the septum. Tumour also external to dura at spot corresponding to right olfactory bulb. Destroying olfactory lobes of the frontal bone, and crista galli of the ethmoid.

Round and spindle-celled sarcoma, very vascular. Hard tumour on surface of right frontal lobe over first frontal convolution, 2 ½ in x 2 in. Posterior edge of tumour was one inch in front of ascending frontal convolution. Dura adherent to middle of tumour. Surrounding part of cerebral cortex was softened, and cerebral substance surrounding right cornua radiata was soft and jelly-like. Softening extended to the basal ganglia on right, and involved the fibres of the internal capsule.
<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Race</th>
<th>Marital Status</th>
<th>Religion</th>
<th>Education</th>
<th>Occupation</th>
<th>Income</th>
<th>Living Arrangement</th>
<th>Health Status</th>
<th>Medical Conditions</th>
<th>Medications</th>
<th>Allergies</th>
<th>Social History</th>
<th>Family History</th>
<th>Medical History</th>
<th>Mental State</th>
<th>Speech</th>
<th>Motor Power</th>
<th>Sensory Function</th>
<th>General Condition</th>
<th>Manner of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>M</td>
<td>W</td>
<td>Single</td>
<td>Protestant</td>
<td>High</td>
<td>Businessman</td>
<td>Low</td>
<td>In a hospital</td>
<td>Poor</td>
<td>Heart disease</td>
<td>Metformin</td>
<td>None</td>
<td>Smoking history</td>
<td>Alcohol history</td>
<td>Hypertension</td>
<td>Poor</td>
<td>Good</td>
<td>Normal</td>
<td>None</td>
<td>Recent history</td>
<td>Unknown</td>
</tr>
<tr>
<td>60</td>
<td>F</td>
<td>W</td>
<td>Married</td>
<td>Catholic</td>
<td>High</td>
<td>Teacher</td>
<td>Medium</td>
<td>Living with spouse</td>
<td>Fair</td>
<td>Diabetes</td>
<td>Insulin</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Hypertension</td>
<td>Poor</td>
<td>Good</td>
<td>Normal</td>
<td>None</td>
<td>Recent history</td>
<td>Unknown</td>
</tr>
<tr>
<td>70</td>
<td>M</td>
<td>W</td>
<td>Single</td>
<td>Orthodox</td>
<td>High</td>
<td>Engineer</td>
<td>Low</td>
<td>Living alone</td>
<td>Fair</td>
<td>Asthma</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Hypertension</td>
<td>Poor</td>
<td>Good</td>
<td>Normal</td>
<td>None</td>
<td>Recent history</td>
<td>Unknown</td>
</tr>
<tr>
<td>80</td>
<td>F</td>
<td>W</td>
<td>Married</td>
<td>Jewish</td>
<td>High</td>
<td>Retired</td>
<td>Low</td>
<td>Living with spouse</td>
<td>Poor</td>
<td>Lung cancer</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Hypertension</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>None</td>
<td>Recent history</td>
<td>Unknown</td>
</tr>
<tr>
<td>90</td>
<td>M</td>
<td>W</td>
<td>Widowed</td>
<td>Baptist</td>
<td>High</td>
<td>Doctor</td>
<td>Low</td>
<td>Living alone</td>
<td>Poor</td>
<td>Stroke</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Hypertension</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>None</td>
<td>Recent history</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Post-Mortem Report

Tumor. Anterior superior half of second frontal and anterior superior and inner half of first frontal, anterior segment of gyrus formicatus, and anterior half-inch of corpus callosum.

Tumor, one and a half inches in diameter in the left anterior frontal lobe, involving the middle portions of the first and second frontal convolutions and white substance beneath them, almost to the orbital surfaces. White matter softened posterior to the tumor, adherent to the floor lobe.

Glioma. Frontal convolutions flattened. Brain substance loosely, cortex grey and medullary substance reddish white. Corpus callosum arched upward. Lateral ventricles enlarged in posterior horns. Tumour in medullary substance of both frontal lobes, springing from septum and radiating towards parietal lobes, almost filling both anterior lobes, and apparently adhering to walls of ventricles. At base extended backwards full extent of frontal lobe.

Glioma, extending from dura matter into the brain substance at the anterior portion of the anterior lobe of the left hemisphere. Brain substance softened around tumour. Left ventricle dilated and filled with fluid.

Pterosarcoma, involving inferior portion of right anterior lobe. The first and second pair of nerves were involved but no others.

Cholesteatoma, growing from pia matter at the base between both frontal lobes extending to anterior margin of the corpus callosum and to optic chiasma.

Nature of tumour not stated. Under left anterior lobe and extending from front calcar to which it was adherent, over the olfactory plate of the ethmoid involving the left olfactory nerve, backward and diagonally across the sella turcica to right parietal bone where it passed on fifth nerve of right side at its point of exit. Pressed upon optic chiasma.

Very vascular glioma. At present left hemisphere was so front matter but at two years' post-mortem to relieve symptoms tumour was found increasing on second frontal and behind merged into the Rolandic area. Boundary between was not defined but Broca's convolution was intact. Tumour palpable, consistent firm, no capsule present. Extraction impossible. The operations greatly relieved in symptoms excepting the blindness.
2. Examination of the records of fifty cases of Fronto-Temporal Tumours.

These cases I have tabulated carefully, but it was difficult in some cases to decide whether a symptom was absent or merely not described. After making some progress with the work, I found that the same ground had been previously covered by Williamson (Brain 1876), to whose paper I have been considerably indebted.

On examination of the table the following results were obtained.

Sex. In 5 cases no statement was made as to the sex of the patient. In 26 cases the patient was a male and in 20 a female. This series of cases bearing out the usual statement that cerebral tumours are more common in the male than in the female.

Age. Of the 42 cases in which a statement was made of the age of the patient, 31 occurred between the ages of 20 and 49, only 3 under 20, and only 5 over 50 years of age. This confirms the
statement that, with the exception of tubercular tumours common in childhood, intracranial growths occur with greatest frequency in persons of adult age, and less frequently in old age.

Nature of Tumour.

Not Stated in 16 cases

Fibroma 3 "
Glioma 6 "
Rancoma 16 "
Gumma 4 "
Cerebral 2 "
Cholesteatoma 1 "
Cystic 1 "

The striking feature is the large proportion of rancomata. Among these the point to be noticed is, that of the 14 cases, in which the age of the patient is given, 10 occur between the ages of 30 and 50. Among the 8 cases of glioma 4 out of 6 cases, in which the age is mentioned, are under 30 years of age. In both classes of tumour these results confirm those

**Duration of Symptoms.** The figures under this head cannot be by any means accurate, for symptoms may have been, and in many cases certainly were, present unobserved for a longer period than stated. It is of interest, however, to note that of 35 cases, in which any statement is made, 19 showed symptoms from 6 months to 2 years, only 5 under 6 months, and 5 between 2 and 5 years.

**Symptoms.**

Giddiness or Vertigo. Sudden attacks of vertigo are recorded in two cases, in one case momentary blindness occurred at the same time. Giddiness or dizziness occurred in 10 cases, in 4 of the cases being probably due to paralyses of some of the ocular muscles which was also present, in the remainder to some interference with the cerebral circulation.

Headache. This was present in 39
of the 50 cases, in eleven it was either absent or not mentioned. The site of the headache varied as follows.

Recorded simply as headache: 20 cases.
- Frontal headache: 9
- Frontal and occipital: 6
- Frontal and vertical: 3
- Temporal: 1
- Vertical and temporal: 1

Headache is thus seen to have been a prominent symptom, and to have been in nineteen cases distinctly localised. Headache in the frontal region, or in the frontal and some other region, was the commonest, 17 of the 19 cases being at any rate partially frontal. Of the five cases in which it was frontal and occipital in one it was first frontal then occipital, and in another the reverse occurred. The occurrence of occipital headache in frontal tumours is striking, in as much as frontal headache on the opposite side has been observed in tumours of the lateral eise of the cerebellum. (Furrow, Donald in loco.)
(Hop. Reports Vol III p.460.) being probably due to some affection of the fibres connecting the frontal region with the lateral lobe of the cerebellum on the opposite side, through the superior cerebellar peduncle.

Tenderness on percussion or pressure was present in seven cases. In one of these there was general tenderness over the head, in the remaining six cases it was localized on the same side as the tumour, in three cases frontal, two occipital, and one temporal, and was consequently of great diagnostic value. In five of these seven cases the tumour was cortical, and in two it was confined to the white matter, showing that whilst tenderness on percussion of the skull is most frequent in cortical tumours, yet it is not an infallible rule.

Vomiting. Present in 20 cases.

Nausea 2 ".

Not mentioned or about 28 ".

This symptom does not appear to have
been so frequent or so severe as it generally is in tumours further back, especially in sub-cortical tumours.

**Optic Neuritis.**

Not mentioned or absent in 10 cases

Present but no details given 14 "

Double 15 "

Double most marked on the side of the lesion 4 "

Double most marked on the side opposite to the lesion 1 "

On side of the lesion only 1 "

On one side, lesion on both 1 "

In the following cases there is no mention of optic neuritis, but the affection of vision is so striking that it probably was present:

Right lost in both eyes, 2 cases

Right weakened in both eyes, 2 cases

Including all ocular changes above recorded optic neuritis was present in 40 out of the 50 cases, which is about the usual percentage. In 8 of these 40 cases the optic neuritis was more marked unilaterally. In 6 of the 8
cases, the severity of the Optic Neuritis may be said to have aided in diagnosing the side of the lesion. Dr. J. M. Martin (Lancet July 10th. 1897), found the same in 8 out of 10 cases of frontal tumour, all having optic neuritis most marked unilaterally. It also confirms the opinion of Marcus Gunn (Brain 1898 p. 387), that one-sided optic neuritis, or marked difference suggests the cerebrum, and is, on the whole, in favour of the tumour being on the same side as the excess of neuritis, when there are other reasons for localizing one in the front of the cerebrum. These observations are further confirmed by Newton Pitt, Beevor and Charley (Brain 1878) and by Williamson (Brain 1878 p. 387).

**Convulsions, including convulsive movements and petit-mal attacks.**

Not mentioned or absent in 19 cases.

General convulsions at some point 17 "

Unilateral " " " 5 "

Unilateral and General Convulsions 4 "

General convulsions with Petit Mal. 3 "

Petit-mal attacks. 1 "
Tonic spasms in neck and forearm 1 case
Choreic movements of arms 1 case

In 8 of the 31 cases, where convulsions were observed, they were the first or an early symptom of the lesion. Except in these cases, where they were unilateral, or where they began by movements of a certain group of muscles, they were of no value as a localizing symptom. The petit-mal attacks recorded in 3 cases have been observed in various cerebral tumours and are in no way characteristic. Tonic spasms in the neck and forearm occurred in one case. It is interesting to note that Hinchliffe, Jackson, Jones on this as a special symptom of tumours of the middle lobe of the cerebellum, (Albatt's Med. of Scot. Vol IV p. 376.)

Reflexes. Knee-jerk.
Knockles normal in 5 cases.
Exaggerated on both sides 6 cases.
Exaggerated, most marked on side of the tumour.
Absent on one side palpable on the other.

{Hinchliffe on both sides}
Abcent on both sides in 3 cases.

Table on side opposite to

the tumour

Not described in 33... .

The condition of the sense-jerks in these cases is interesting as it has been pointed out that there is marked resemblance between the effect on them of tumours of the cerebellum and of the frontal region. In either case they may be normal, increased, diminished or absent. When the lesion is in the motor area, the rule is for the sense-jerks on the paralyzed side to be increased. In these cases of frontal tumour it was feebler or less marked, in 2 cases, on the side opposite to the tumour, it was almost altogether in 2 cases, & on one side in 1 case. The sense-jerks were mentioned in only 16 cases, in most of the earlier records, they were unfortunately not described.

Aupole Alarms was only mentioned in two cases, in one it was slight on both sides, and in the other it was marked.
Skin Reflexes were described in five cases only, and the statements are not sufficient to draw any conclusions. The following Table shows what was recorded.

- Plantar reflex more marked on side opposite to tumour
- Plantar reflex increased
- Plantar reflex normal
- Epigastric, Abdominal and Iliac reflexes absent on side opposite tumour. Plantar normal
- Skin reflexes increased on side of tumour, plantar increased

Mental Condition

I have already described the results obtained by various observers, after extirpation of the frontal lobes, and have pointed out that in my opinion the weight of evidence is in favour of certain mental changes being so produced. Certain clinical observers, well in particular, maintain that mental change is not characteristic of frontal tumour. The result of my examination of fifty
cases is entirely opposed to his views, and supports the experimental results above referred to, and the opinions of clinicians such as Fisiac Russell, Stansley, Hewson Pitt, Sevier, Brahamwell and many others.

The following table shows the conditions present in the cases examined.

<table>
<thead>
<tr>
<th>Mental Condition</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental dulness, loss of memory, progressively getting worse, loss of attention, sleepy or semi-comatose in many cases.</td>
<td>18</td>
</tr>
<tr>
<td>Mental dulness, loss of memory, irritable, morose, or emotional.</td>
<td>7</td>
</tr>
<tr>
<td>Apathetic.</td>
<td>1</td>
</tr>
<tr>
<td>Noninclent.</td>
<td>2</td>
</tr>
<tr>
<td>Quieter than formerly.</td>
<td>1</td>
</tr>
<tr>
<td>Violent, and delusions of suspicion, more demented later, memory impaired in one case, sometimes denial, two cases unreasonably hilarious.</td>
<td>3</td>
</tr>
<tr>
<td>Mental dulness, and delusions, Later acute mania</td>
<td>1</td>
</tr>
<tr>
<td>Drowsy, irritable when awake</td>
<td>1</td>
</tr>
</tbody>
</table>
In this series I find that 33 cases out of 50 show marked mental change, that 4 show some slight change, that 4 show no noticeable change, and that in 9 no change is mentioned, (presumably, if any, it was so slight as to be imperceptible). This mental change does not appear to have been associated with great increase of intracranial pressure, or with other conditions likely to cause mental symptoms apart from the position of the tumour. In five cases some marked mental change was an early symptom, and in the majority of cases where it was noted it was one of the most, if not the most conspicuous symptoms. Mental feebleness and dulness, with failure of memory and the power of attention, and great drowsiness or tendency to sleep were the most commonly observed characteristics of the mental state, in

Brunner (loc. cit.), states that in his cases memory was not affected, these quite differing from the majority of observers. An inevitable mental state, and the possession of delusions was not so common in these cases, and I could find no constant connection between tumours of the orbital surface and an inevitable condition of mind as described by Helg (quoted by Williamson Brain 1896 p. 360).

Brunn (die Geschwülste des Nervensystems p. 94), along with Jastrowitz and Oppenheim, considers that a propensity to make jokes or puns, "witgelaucht", which is in marked contrast to the objective appearance of the patient, is characteristic of tumours in this region. In two of the cases I investigated undue cheerfulness was noted, in one there were frequent bursts of meaningless laughter, in the
other the patient was "unreasonably
terrible." In both these cases there were also
delusions of suspicion. In both there was
a glioma affecting chiefly the cortex of the
upper frontal convolutions.
In one other case there were delusions of
suspicion, the tumour being cavernous on
the orbital surface of the dura, and occupying
nearly the whole of the frontal region on
each side.
In three cases visual hallucinations were
recorded (Shanks' Brain 1895 p. 327). There
been unable to find any record of this
having been observed in any other case.
In one case, (Park \\
(\ A. 1400), "automatically talking" was a
prominent mental symptom, the patient
leaving the hospital under some irresistible
impulse, of which he had no subsequent
recollection.
In several cases slowness in answering
questions was recorded the "increase of
the time reaction of cerebration" by Lloyd
(quoted by Williamson Brain 1904). A
condition probably due, in my opinion, to
the mental attitude, and difficulty in fixing the attention.

Authorities differ on the question of whether mental symptoms are most marked in an extra-medullary or an intra-medullary tumour. Bucov, (Brain 1878 p. 958.), maintains that they are more marked in the latter, i.e. intra-medullary. H Art, (Brain Surgery p. 232), that they are more so in the former, quoting Griffith and Sheldon in support of his view. In the cases which I have collected the details given are not sufficient to give a definite opinion on the matter, though it appears that mental symptoms were especially well marked when the lesion was cortical or mostly cortical. On the other hand in several cases, where the cortex was largely affected, the mental symptoms were slight or none.

Many authorities state that bilateral tumours cause much more marked mental symptoms, but in six cases of this series, where both frontal lobes were involved, whilst mental symptoms were marked, they do not
appear to have been more specially so than in many other cases.

**Changes in Speech.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not mentioned</td>
<td>16</td>
</tr>
<tr>
<td>No change in speech</td>
<td>6</td>
</tr>
<tr>
<td>Aphasia</td>
<td>2</td>
</tr>
<tr>
<td>&quot;Inability to speak&quot;</td>
<td>2</td>
</tr>
<tr>
<td>Speech slow or less fluent</td>
<td>2</td>
</tr>
<tr>
<td>Speech slow and stammering</td>
<td>2</td>
</tr>
<tr>
<td>Stammering and making mistakes</td>
<td>1</td>
</tr>
<tr>
<td>Indifference towards close</td>
<td>1</td>
</tr>
<tr>
<td>&quot;Explosive speech&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Difficulty in speaking and in understanding what is said</td>
<td>1</td>
</tr>
<tr>
<td>Difficulty in recalling names of objects</td>
<td>1</td>
</tr>
</tbody>
</table>

In fifteen cases it is definitely recorded that there was no change in speech, and in the sixteen cases, where there is no mention of it, presumably there was either no change or it was imperceptible. In 9 of the 19 cases, where a change is recorded, it consisted of a slowness with some sort of impediment, such as stammering, stammering, or loss of fluency. Aphasia
was only present in four cases, in three of which it was particularly described as "motor aphasia"; it was doubtful in one case, where it possibly occurred early in the course of the illness. In one case "inability to speak" is recorded, possibly this too might be included in the cases of aphasia of these five cases of aphasia all were caused by left sided tumours, but in only two instances was the posterior third of the third left frontal convolution distinctly recorded as affected. Of the 14 other cases with recorded change in speech, 7 had a left frontal tumour, in 1 it was on both sides, in 4 on the right, and in 2 the side was not stated. Absence of change in speech is no proof that the tumour is not on the left, for 6 cases showing no change there were 13 instances of tumour of the left frontal lobe. A considerable proportion of these changes in speech seem to be a result rather of the dulled mental condition and loss of attention, which is no characteristic of lesions in this region, than of any direct interference
with the speech mechanism of the brain.

Motor Symptoms.

Not mentioned in 9 cases.

No change recorded 12 ".

Paresis on the side opposite 17 ".

No tumour at some time.

Paralysis on opposite side 3 ".

Paresis on the same side 2 ".

Paralysis on the same side 1 ".

Rigidity 1 ".

Some motor change, indefinite 5 ".

or not fully described

Paresis of face, arm, or leg, or of all three, or paresis passing into paralysis, on the side opposite to the tumour was present in 20 of the cases examined, but was not generally a prominent feature in the clinical picture, and in many of the cases did not appear till considerably after other symptoms had well developed. These motor symptoms are of the greatest value in the localization of the tumour, though even when they are present there is a possibility of error in diagnosis. They are due either to direct involvement-
of some part of the Rolandic area in the tumour, or to secondary changes, of the nature of softening, affecting that region or the fibres passing from it in the corona radiata. In one case there was complete hemiplegia on the same side as the tumour, (Brain 1878 p. 319), the right side, the left motor tract was healthy in its whole course, and no reason could be found for this condition. In two other cases there was paresis on the same side with no observable pathological cause. Blewett (Brain 1878 p. 293) mentions a similar case. These three cases must prepare one for possible errors in diagnosing the side on which the tumour lies, because with motor symptoms of a localized nature one would be inclined to speak with assurance on this point. In one case rigidity of the muscles of the neck with retraction of the head is mentioned, a symptom also characteristic of cerebellar tumours, it was associated with occipital and frontal
headache, a condition described by Bruns (Die Geschwülste des Nervensystems p. 98).

Affections of Gait "Frontal Ataxia."
Löweness of Gait 1 case.
Stumbling or tottering 4"
Tottering with tendency to fall 9 cases
Tendency to fall backwards 1"

In only 10 cases was any affection of gait mentioned, and in 9 of these there was some form of ataxia. A striking point is that in 4 cases there was a tendency to fall away from the side on which the tumour lay, this may however possibly be explained by slight paralysis of that side as a result of involvement of the central convolutions. Recently Bruns (Die Geschwülste p. 95 et seq.), has insisted on the importance of ataxia as a localizing symptom of frontal tumours. This ataxia is similar to that occurring in cerebellar tumours, and in the experience of Bruns has led to error in diagnosis from ignorance of these facts. Hitzig
also reports a similar case, a cerebellar tumour having been diagnosed, and a glioma and cyst found post-mortem in the frontal region. (Medical Annual 1901 p. 135). The cause of the ataxia he considers to be mainly interference with the cortical centres for the muscles of the trunk, which he considers to be in this region, or with the fibres passing from them in the Corona Radiata, but that partially it may be due to pressure directly backwards affecting the cerebellum, or to interference with the tracts connecting the frontal lobes with the cerebellum.

**Affections of Sensibility**

(apart from tenderness on the side of headache).

- Not described in 21 cases.
- No change 19.

Anesthesia or numbness
- Partial or entire on side 6.
- Opposite to tumour
  - Numbness or anesthesia 2
  - on the same side.
Spinting on opposite side 1 case.
Anesthesia of conjunctiva 1 ... 
Pain on movement 1 ... 

From this table we see that in 5 of the 10 cases, where there was some recorded change, there was either lessened sensibility or complete loss of sensation on the side opposite to the tumour. In one of the cases with impairment on the same side, it occurred along with hemiplegia on the same side as the tumour.

**Ocular Changes, other than Optic Neuritis.**

Impairment of ocular movements in 11 cases.

- Hypesthesia 3 ... 
- Pupils unequal 1 ... 
- Pupil on opposite side larger 5 ... 
- Pupil on same side larger 1 ... 

Pupils dilated 2 ... 

Pupils react slowly and unequally 3 ... 

Pupils react slowly or not at all 2 ... 

From deficient description it was, in many cases, impossible to determine what was the exact nature of the ocular paralyses, though probably paralyses of the sixth nerve was
the commonest, which result agrees with Beard's opinion (loc. cit. p. 97).

Nystagmus was present in 3 cases, which seem to confirm Beard's statement that
nystagmus occurs mostly in cases where
the tumour is intra-medullary, (Brain loc. cit).
The dilatation of the opposite pupil in 5 cases
is worthy of note, as is the interference with
the reactions of the pupil in 4 cases.

Affections of Smell and Taste.

Not mentioned in 42 cases.

Impairment or loss of smell in 8 cases.

Taste was lost as well as smell in 2 of these
8 cases. In 4 of the 8 cases one or both
olfactory nerves were either involved by,
or directly pressed on by the tumour. In
the remaining four cases the position and
size of the tumours were such as certainly
would interfere with the functions of the
nerves.

Termination of Case.

Not mentioned in 16 cases.

Coma 14

Convulsions 14

Exhaustion 14
"Sudden" 4 cases
Pyrexia 2
Recovery after operations 2
Death resulting from operation 2
Other causes 2

Coma is seen to be much the commonest termination, and the others differ in no way from the generality in cases of cerebral tumours.

Diagnosis of Tumours in the Fovotal Regions.
The diagnosis is often extremely difficult and may even be impossible, a certain number of cases running their course either any symptoms. Of the fifty cases I have investigated two were never suspected of suffering from such a condition, and the tumour was only found post-mortem.
The symptoms, apart from the general symptoms of cerebral tumour, which would lead to the diagnosis of a tumour of this region are:
1. Headache, generally frontal, or frontal and occipital, in the latter case sometimes rigidity of the neck may be associated.
2. Tenderness on Percussion or Pressure, over the frontal region with sometimes a sympathetic note on percussion.

3. Optic Neuritis, if this be more marked on one side, it aids in the diagnosis of a tumour of the cerebrum, and of the side on which it lies.

4. Convulsions, either general or Jacksonian.

5. Reflexes, diminution or absence of knee-jerks.

6. Mental condition, early onset of mental symptoms and anosmia.

7. Motor Functions, frequently hemiparesis or monoparesis in the later stages, later motor aphasia.

8. Ataxia.

9. Paresis of 6th or 3rd nerves unilaterally.

10. Anosmia.

11. Unilateral exophthalmos, a very rare symptom due to pressure on the orbit.

These symptoms could rarely be all present but the presence of a fair proportion would probably lead to a correct diagnosis. Those of special localising value are numbers 1, 2, 5, 6, 8, 10, and 11.
Differential Diagnosis from Cerebellar Tumours

The difficulty of this phase already mentioned.

The main points of distinction are,

1. In cerebellar tumours the headache is generally occipital, but may also be frontal. It is often more severe and is more frequently associated with vomiting, giddiness, and slowing of the pulse than in frontal tumours.

2. Localized tenderness on percussion is rarer in cerebellar tumours. Localization over the frontal region would point to frontal tumour.

3. Optic neuritis is an earlier symptom in cerebellar tumours and is always bilateral and intense in degree.

4. Convulsions general or localized are rarer in cerebellar than in frontal tumours.

5. Mental symptoms and stupor are a late symptom in cerebellar tumours, but are frequently early in the other.

6. Hemiparesis or monoparesis is very rare in cerebellar tumours, and there is never motor aphasia. Rigidity of the muscles of the neck is more character
of cerebellar tumour.

7. In cerebellar tumours, paralysis of 
the eye muscles is frequently nuclear 
and is less commonly unilateral 
than in frontal tumours. Frequently 
other cranial nerves, the 7th and 8th 
especially, are affected by cerebellar 
tumours.

8. Anosmia or unilateral exophthalmos 
would point to frontal tumours. 
Differential Diagnosis from tumours of 
the motor area.

1. The site of headache, and of areas of 
tenderness on percussion would aid diagnosis 
2. Diminution or absence of knee-jerks 
would point to frontal tumours.

3. Early onset of mental symptoms, and their 
proximity in the case would lead to 
diagnosis of frontal tumour, for in 
tumours of the motor area they are slight 
or absent till the later stages.

4. Early onset of paresis passing into paralysis 
characterizes tumours of the motor area, 
whilst in frontal tumours this is slight 
or absent till the later stages.
5. Ataxia, Arrowsia, or unilateral exophthalmos would point to frontal tumour.

Clinical History and Post-mortem report of a case of Frontal Tumour under my own observations.

J.P., aged 47, labourer, married with a healthy family.

Previous history good, no history of syphillis, or of any nervous disorder. No history of serious illness save attacks of Bronchial asthma during the winter.

Family history good, no history of syphillis or of nervous disease.

Present illness. The patient was at work on October 17th 1898 and felt quite well. He returned home soaked with rain, but refused to bed in his usual health. Shortly after midnight his wife was awakened by his strident breathing, when she found him quite unconscious and convulsed every few minutes. On my arrival about 1 a.m. I found the patient lying in bed inclined towards the right side, his face was
cyanosed and his breathing stertorous, he was quite unconscious. Every few minutes he became convulsed, the right fore-arm first twisted and then flexed and extended at the elbows, the fingers twitching all the time. After the arm was in strong clonic spasm, the right leg and both sides of the face became convulsed nearly simultaneously. "Picrotoxantonicus" was most marked. During this time the left arm and leg remained flaccid and motionless. During the spasm the teeth ground and mucus rattled in the throat. The pupils were equal and dilated in the spasms, but equally pinpoint in the intervals, they did not react to light and the conjunctival reflex was faint. During the spasms the eyes were strongly rotated to the right (the convulsed side), between them occasionally there was nystagmus. Urine was passed involuntarily in bed, twice there was watery, free, something. The pulse was irregular in rhythm and degree of expansion, the tension was high, in rate it varied between 100 and 120 per
minute, there was slight thickening of the vessel walls. In the intervals between the spasms, the breathing was of Cheyne-Stokes character. The convulsions gradually became less frequent and more severe. Three hours after the first convulsion the left arm and leg also began to show clonic spasms, but they were neither so long continued nor so severe as on the right side, nor did they appear till two and a half minutes after the right side had been in spasm. After a moderate administration of chloroform there was some improvement, and a longer interval between the spasms. Between 4 a.m. and 10 a.m. there were more attacks. The patient could not be moved, but was now restless and several times attempted to get out of bed. He moved his head uneasily when I tried to open his eyelids. Gross managed to obtain a sample of his urine, which was deep brown in colour, and had a fine deposit of urates. A0. 4q. 1028. Strongly acid, no albumen, no sugar,
no blood, were 9 grains per ounce.
In the afternoon he was struggling more,
and had had two convulsions since 10 a.m.
He now opened his eyes and looked around
without any recognition of his relatives;
his pupils were still contracted. He made
no attempt to speak, and did not seem
to understand if he was spoken to.
Between 2 p.m. and 5 p.m. he had one
more convolution. He recognized his family
and spoke faintly. He was still restless,
struggling often to get out of bed. He
drank some milk and water, but had
great difficulty in swallowing it. He
had by now regained control of his
bladder. The following day his temperature
rose to 100.5°F., but he was otherwise well.
From this time he made a good recovery,
though his speech continued indistinct,
and he had difficulty in swallowing for
some time.
On examining his eyes with the ophthalmic
scope, I found the fundus of both in a
healthy condition, the movements of both
eyes were perfect, and the pupils reacted
normally. The deep and superficial reflexes were normal, and there was no change in sensation. The circulatory, respiratory, and digestive systems were all in a healthy condition.

**Subsequent History.** The patient remained well until December 1896, when he had several fits in succession, and was as before unconscious in the intervals. As in the previous attacks the right side was more strongly convulsed than the left. After a hypodermic injection of ½ grain of Morphia the fits ceased. After this attack he complained of persistent occipital headache and severe rendering pains in the spine. Bromides failed to relieve him, but large doses of lodide of Potassium were more successful. Occasionally during January 1897, without any warning, he was seized with attacks of faintness and loss of speech, these left him in a dazed condition, and he had no memory of them afterwards. On January 29th he got a sudden start, and at once fell on the floor
in a severe fit of the old character, after which he was unconscious for several hours, but had no recurrence of convulsions. Under treatment with bromides he remained at light work in a green-grocer's shop. At intervals of about ten days he had attacks of the 'petit-mal' type already described. He was able to help in the work, but his memory became vacillating, and he was unable to remember messages. During the spring he became very silent, frequently not speaking for hours; his temper, formerly good, became irritable, especially to his wife and children, to whom he had been devotedly attached. His strength failed gradually, and he moved about with increasing difficulty, but there was no unsteadiness in his gait. He now complained of intense headache in the left frontal region, which was only relieved by morphia. There was some tenderness on percussion over this area.

Till this time I had regarded the case
as one of epilepsy of 'grand mal' type with occasional attacks of 'petit-mal', but I now began to suspect the presence of a cerebral tumour, though the absence of optic neuritis and of distinct localising symptoms made me hesitate.

On June 14th his heart's action suddenly failed and he became cold and collapsed. The pulse became rhythmically irregular, and weak in tension and force of expansion. The irregularity of the pulse had no reference to respiration, and the course of irregularity was too long to demonstrate on an ordinary sphygmograph. After three days treatment with digitalis there was marked improvement both in tension and strength of the pulse, though some degree of the same irregularity remained. His speech, which had since the first been slow and deliberate, about this time became much more affected, and was "slurring" in character. He could understand and simple questions, and would comment
to reply, but failed to recall words, which he could pronounce quite well if suggested to him. His memory was now so bad that he could never say when he had seen me last, being quite uncertain whether it was one or five days before. The knee-jerks were now hard to elicit, especially on the left side. His skin reflexes were now also faint. The eye reflexes were healthy; save that the right pupil was permanently slightly larger than the left, and that its reactions were a little sluggish. The patient's digestion was very bad, the breath had a foul acid odour, the tongue was thickly coated, and the bowels were very constipated. At this time he had full control of his bladder and rectum.

On June 26th he had another attack of faintness, and his pulse again became weak and irregular. On this day he had some irregular twitching of his right arm and leg, but his face was unaffected.

From now onwards he got steadily worse, and lay for hours in a condition of
Super, from which he could be roused by questions put to him in a slow, clear voice. His intelligence grew weaker so that it was difficult to get replies even to the most simple questions, yes and no were the only replies, and often these were wrongly given; the difficulty of utterance was also increased. He gradually developed an intense dislike to his wife, even though she devoted herself to him in every way. On July 6th in company with an ophthalmic surgeon I examined the fundus of both eyes, when again no change was to be detected in disc, vessels, or anything else. By this date both knee-jerks had completely disappeared. On July 7th the patient ceased to have control of bladder and rectum, and never regained it; the obstinate constipation still persisted. His death grew deeper, and occasionally Cephaloic respiration was observable. He continued in this condition getting gradually very emaciated till July 21st, when he developed right basal pneumonia, from which he
Area of flattening on the surface of the cerebrum lying over the thalamus.
(See also Brodie.)

Section of left frontal lobe
showing the position of the thalamus.
died on July 26th.

Report of Post-Mortem on July 26th.

Permission to examine the brain was alone obtainable.

The dura mater was slightly thickened, no blood was found in the longitudinal sinuses. There was a considerable quantity of serous fluid in the subarachnoid space.

The brain tissue was very soft. On superficial examination flattening was observed on the left lobe of the cerebrum on an area 2½ in × 1½ in over the superior and middle frontal convolutions extending nearly to the pre-central nucleus. On the left side the sulci were greatly flattened out and the vessels contained less blood than on the right side. Over the flattened area the brain was softer than elsewhere. No other changes were to be observed on cerebrum, cerebellum, fons and medulla.

On section of the left lobe an ovoid, greyish, gelatinous, tumour was found in the white matter, about 2 in × 1½ in. This projected spherically on the roof of
Semi-diagrammatic drawing of section of the Tumour, showing cells with fine fibrillar processes interlacing to form a network, also nuclei of various sizes and shapes, and in varying positions in the cells. One cell contains two round nuclei. *x600.*

Drawing of section of the Tumour showing cells with deeply stained nuclei. Between the cells is a confused meshwork of fine fibrils. *x600.*

Photograph of Section of the Tumour, (x480), showing fibrillar structure and deeply stained nuclei.
the anterior horn of the lateral ventricle. There was a corresponding depression on the floor of the ventricle. There was no distension of the ventricles. There was no other change observable nor any sign of degeneration in Cerebrum, Cerebellum, Pons or Medulla.

Unfortunately the lower parts of the brain and the spinal cord were almost deficient.

I am indebted to Dr. J. A. Maclay, who prepared microscopic sections of the tumor for me.

On examination with a high power of the microscope the tumor is found to be a glioma. Few blood vessels are visible. The cells contain one or two oval or round deeply stained nuclei surrounded by a small quantity of protoplasm. A few of the cells have a larger quantity of homogeneous looking protoplasm around the nucleus. From the cells extend numerous fine processes, which interlace and form a closely felted mass of fibrils.
Critical Discussion of this case.

The age of the patient, 47, and the duration of the symptoms, 9 months, are both of unusual character according to my investigation. The sudden onset of illness with convulsions, in the absence of any previous symptom, is striking, but in several cases of the series convulsions were, as here, the first symptom. The convulsions, as described, began in the right hand, forearm, and arm before becoming general on the right side.

This indicates some irritation affecting first the arm and hand centres in the left motor area, and then spreading till all the left motor area was affected. The greater affection of the right side of the body than of the left in the second series of convulsions, and the twitching of the right side in the later stages should be noted in this connection.

The absence of paralytic symptoms shows that the left motor centres were not actually involved in the growth. The position of the tumour, which extended
Back to the pre-central nuclei at the level of the second frontal convolution sufficiently explains these symptoms. The ultimate spread of convulsions in lesser degree to the left side of the body shows merely a further extension of irritation. The rotation of the eyes to the right in the convulsions is a confirmation of the existence of centres for eye-movements to the opposite side being situated in this region. Bianchi found dilatation of the pupils follows stimulation of the lower part of the post-frontal area, hence it is interesting to note the occurrence of dilatation of the pupils during the convulsions, and of dilatation of the right pupil in the later stages. 'Petit-mal' attacks were described in these other cases investigated. In this case the affection of speech in these attacks would point to a left-sided lesion, as would also the indistinctness of speech, its 'scanning' character in the later stages, and the slight degree of motor aphasia. The headache
at first—occipital and later frontal
should be noted in connection with my
remarke on the sides of headache in
frontal and cerebellar tumours.
The absence of optic neuritis is one of
the unusual features of the case, and
the one which caused me most difficulty
in diagnosis. Spinal change becoming
a marked and striking symptom
in less than three months from the
onset of symptoms is a very character-
istic point. The nature of the change
is not unusual, taciturnity, loss of
memory, and lethargy being common;
the irritability and the change in
natural affections are less common. Thi
stuporose conditions and loss of control
of bladder and rectum are common
in most cerebral tumours in their
later stages. The gradual diminution,
and final loss of the knee-jerks is, and
pointed out, very characteristic of
tumours of this region and of the
cerebellum, and forms a strong point
of distinction from tumours of the motor
area.
The symptoms of localising value in this case are:
1. The frontal and occipital headache.
2. Tenderness on percussion over the left frontal area.
3. The mental condition.
4. The changes in speech.
5. The diminution and loss of keen-joke.
6. The occurrence of convulsions at an early stage, and their relation to the arm combined with the rotation of the eyes to the right.