

GENERAL STAFF MEETING  
UNIVERSITY HOSPITALS  
UNIVERSITY OF MINNESOTA

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I. ABSTRACTS:TUMORS OF THE SPINAL CORDRef. A.

Tumors of the spinal cord rank first among those neoplasms, which if diagnosed and removed early in their development, can be permanently cured.

Note: 25% intramedullary, 75% extra-medullary. Group about 1/6 as frequent as brain tumors.

Ref. B.First Cure. 1887.

A certain captain of the British Army made the rounds of the physicians of the Kingdom, because of pain in his back. His manner was so persistent and his complaints were so singular that he was eventually crowned a neurasthenic, and even thought to be insane. At the end of the third year of his pursuit, fortune led him to consult those two eminent physicians, Sir William Gowers and Sir Victor Horsley. Gowers made a clinical diagnosis of tumor of the spinal cord, and Horsley removed the tumor, the first of the kind ever removed. One year later the patient was well.

Ancient History.

The ancient Chinese, whose medicine dates from the reign of Hoan-ti, 2687 B.C. believed that the spinal cord neded in the testicles and that its function was to conduct semen. A truly remarkable degree of knowledge of the anatomy and physiology of the cord was current as early as 167 A.D. Galen knew that the cord could be cut lengthwise without producing paralysis; that section of one side of the cord would result in paralysis below that point on the same side of the body; that cutting the cord at progressively higher levels would cause correspondingly higher paralysis, and that section between the third and fourth cervical segments would abolish respiration entirely and thus cause death. Galen supposed that the brain had something to do with intellect, but he was a cautious as well as a wise physician, for he remarked, parenthetically, that an ass has brains.

1811.

The modest and profound investigator,

Sir Charles Bell, found that he could cut across the posterior roots without convulsing the muscles of the back, but that on touching the anterior roots with the point of a knife, the muscles of the back were immediately convulsed. He demonstrated for the first time that the anterior roots were motor in function.

Brown-Sequard Syndrome

As in compression of the spinal cord one side is usually affected a little before the other, the sign manual of this type of disturbance is an approach to the Brown-Sequard syndrome. The cardinal features of this syndrome are: (1) homolateral paralysis below the given level, due to involvement of the pyramidal tract; (2) impairment of pain and temperature sensibilities of the opposite side below the level in question; and (3) preservation of tactile sensibility on both sides.

Segmental or Longitudinal Diagnosis

In order to determine very accurately the level of a lesion one must pay close attention to the distribution of the sensory, motor and reflex disturbances.

The segmental distribution of cutaneous sensation is very orderly. If one pictures a man as walking on all fours and maps out on him the various fields of sensation supplied by the different segments of the cord, he would appear very much like a zebra with the stripes succeeding each other from in front backward, running in long bands down the arms, in circles around the trunk, in bands down the legs, and ending in concentric rings around the anus. Actually these segments overlap each other like shingles on a house, so that two or three adjacent roots must be destroyed before an area of anesthesia can be demonstrated. A point of great importance is the fact that in man, after the third month of intrauterine life, the cord grows more slowly than the vertebral column. At birth the lower end of the cord lies opposite the third lumbar vertebral body; by the time maturity is reached, it has moved upward to the lower end of the first lumbar vertebra. The root of a given segment, however, runs downward in the canal and emerges from the spine at the

corresponding vertebra.

### Kocher's rule:

may be applied, if the anesthesia due to a cord lesion is so intense that the level across the back can be ascertained. The spine is divided into equal thirds; if the level of anesthesia runs through the upper third, one counts upward three spinous processes to the site of the cord lesion; if the level runs through the middle third, one counts upward five processes, and if through the lower third, seven processes.

### Ref. C.

#### Diagnosis

#### Pain

The earliest and commonest complaint is pain. In more than 300 proved cases of tumor of the spinal cord at the Mayo Clinic, pain was present in approximately 80%. The average duration of the symptom was well over 2 years. (Frazier 28 months). The pain may be in the spine at the site of the tumor; it may be referred to the lower extremities (even when the tumor lies high in the canal) but usually it is referred along the distribution of a posterior root, when it is known as a root pain. It is the peripheral radiation of root pain and its various qualities, such as aching, squeezing or piercing, that so frequently suggests disease of the pericardium and pleura; of the biliary, urinary and gastro-intestinal tracts; of the peripheral nerves, and of muscles and bones.

Fortunately, root pains have certain characteristics. They are segmentally distributed; that is, lengthwise in the arms and legs and circularly in the trunk. Then, since tumors grow, the pain becomes more and more intense and adjacent roots become involved; unilateral sciatica becomes bilateral sciatica, and unilateral trunk pain has added to it a complementary pain on the opposite side, completing the so-called girdle. Since there are usually no diseased organs at the site of the pain, there is, as a rule, no local tenderness. Coughing, sneezing, compression of the jugular veins, or in short, anything which suddenly increases the pressure of the spinal fluid aggravates the pain. Root pains have a habit of awakening the patient from sleep at 3 or 4 o'clock in the morning. He discovers that relief may be obtained

by walking, or by sleeping in a chair. In both of these positions the spine becomes relatively shorter. A helpful test consists in flexing the head sharply on the thorax; this simple maneuver often elicits or accentuates the pain. The explanation is probably to be sought in the resulting traction on the cord and dura, and in the increased congestion within the head which displaces the cerebral fluid into the spinal canal. A blue pencil, which Richard Bright referred to as "the most useful instrument of the physician," will be found helpful. It is important to know the precise site of the pain, which may be marked on the patient. The dates of its appearance and its radiation should be recorded.

#### Disturbances of Motility.

By and by the patient may become aware of clumsiness in running, or of outright muscular weakness. As a rule, the weakness is slowly progressive. The weakness is usually due to injury of the corticospinal pathway, pyramidal tract, or upper motor neuron. The homolateral muscles below the level of the tumor, although they retain their bulk, become weak and spastic; the tendon reflexes are increased, and scratching the sole of the foot results in extension of the great toe. Inspection of the tips of the patient's shoes may show a decided difference in wearing.

Sometimes the paralysis is due to direct injury of the contiguous anterior horn cells or ventral roots, which together constitute the lower motor neuron. If this occurs, the segmentally related muscles fibrillate and become atrophied, weak and toneless, and their reflexes become correspondingly feeble. By consulting suitable charts, the level of the nerve cells that innervate muscles so paralyzed may be determined. This type of paralysis is the best of localizing signs.

Some patients collapse suddenly, arise, and wonder why they fell; this often happens in case of dumb-bell-shaped tumors which lie partly within and partly without the spinal canal, and may be due to transitory compression of the cord. Other patients who become suddenly weak may have suffered from hemorrhage or softening of the cord

incidental to the tumor.

### Disturbances of Sensibility.

Subjective sensory disturbances appear sooner or later. The patient may complain that his underwear is unbearably irritating; the feet may be "dizzy"; the limbs may move to unanticipated positions; there may be burning, tingling, or a wooden sensation. These disturbances result from interference with the posterior roots or conducting tracts in the cord.

### Disturbances of Sphincteric Control.

Disturbances in the sphincteric and sexual spheres may add to the discomfort of the patient. These complaints do not vary greatly with the situation of the tumor.

Following spinal puncture, aggravation of all symptoms is common; a neurologic examination may then enable one to establish a level of disturbance with ease when it was impossible before.

TABLE I.

Frequency and order of appearance of four cardinal symptoms of intramedullary, extramedullary, intradural and extradural tumors involving the spinal cord.

<u>Complaint</u>	<u>1st Symptom</u>	<u>Total Incid. %</u>
<u>Intramedullary:</u>		
Pain	58	65
Weakness	18	73
Paresthesia	18	52
Incontinence	3	32
<u>Extramedullary, intradural:</u>		
Pain	68	78
Weakness	16	68
Paresthesia	12	60
Incontinence	6	28
<u>Extradural:</u>		
Pain	64	88
Weakness	16	84
Paresthesia	28	88
Incontinence	0	38

Note: Progression most marked in all except pain (which progresses least in intramedullary, more in intradural extramedullary, most in extradural).

### Spinal Puncture.

On the basis of experimental evidence, Sachs concluded that the spinal fluid is

practically without circulation. The slightest change in pressure at any situation is, however, transmitted throughout the remainder of the fluid. Because of the limited space in the spinal canal, a growing tumor eventually interrupts the continuity of the fluid in the subarachnoid space. Such blocking may in most cases be demonstrated by a simple maneuver described by Queckenstedt (1916). Should the tumor lie low in the canal, the needle may pierce the tumor and a dry tap result, or the needle may enter the canal above the tumor. When this occurs, block may sometimes be demonstrated by injecting a saline solution into the epidural space by way of the sacral hiatus, and noting the result produced in the manometer.

The fluid obtained from the canal below a tumor is often yellow. The fluid may also be yellow above the tumor, but the color here is usually lighter than below. The content of globulin in the fluid is almost invariably increased. The total content of protein in the fluid, in cases of tumor is usually high, whereas that of fluid loculated by adhesions, in which a block may also exist, usually approaches normal. The removal of 7 cc. of fluid normally results in lowering the basal pressure of fluid about half; when the fluid is loculated, the fall in pressure is usually great.

### Roentgenography.

Roentgenography occasionally reveals erosion of bone produced by a tumor, or even a calcified tumor itself. Roentgenography is also one of the most certain methods of excluding metastatic tumors and other diseases of bone. The introduction of an opaque medium, such as iodized oils, into the subarachnoid space through cisternal or lumbar puncture usually does not help a difficult situation. When the block due to tumor is sufficiently complete to arrest the oil in its descent, the situation of the tumor usually can be determined without its use; when block is not so complete, the oil may sometimes be seen by the aid of the fluoroscope to deviate from its course. Its use in differential diagnosis is limited, and iodized poppy-seed oil 40 per cent, which is the preparation commonly used, is somewhat irritating to the meninges.

### Differential Diagnosis.

The differential diagnosis may be difficult. Various inflammatory (suppurative, nonsuppurative, parasitic, granulomatous) malignant and post-traumatic involvements of the cord, membranes, roots, and spinal column come into question, as do degenerative diseases of the cord. Multiple sclerosis deserves special mention, since it may be suggestive of a transverse lesion of the cord and since tumors high in the vertebral canal may simulate multiple sclerosis. Syringomyelia may be difficult to distinguish from intramedullary tumor, and the two may be present in the same case. The spinal cord and roots may be compressed in hypertrophic osteitis and hypertrophic arthritis of the spinal column and in Paget's disease. Spina bifida occulta may be associated with traction and compression bands that lead to progressive paralysis and even with tumor. Spondylolisthesis, or slipping forward of one vertebra on the other, usually the fifth lumbar on the sacrum, may be detected without difficulty by means of roentgenography.

The occasional loss of the patellar reflexes in cases of tumor sometimes leads to the erroneous diagnosis of tabes. Root pains cause the greatest confusion, particularly when disease of the gall-bladder, or of the genito-urinary or gastro-intestinal tracts, is associated with tumor of the cord. Retroperitoneal and mediastinal tumors, particularly aneurysms, and leukemic and lymphoblastomatous infiltrations of the cord, provide pitfalls when short-cuts in the examination are attempted. Sometimes edema of the lower extremities is so prominent a feature that cardiac or renal insufficiency is diagnosed.

Repeated examinations may be necessary in order to establish a diagnosis. Occasionally exploratory laminectomy is advisable, particularly if progressive involvement of the cord makes further delay perilous. However, exploration without definite indication of the correct level of disturbance is almost certain to result in disappointment.

### TABLE 2.

#### Metastasis of Malignant Tumors to the Spine.

Total Number	136
X-ray, Positive	98
Negative	37
Pain: Root	103
Spine	6
None	27
Cord Lesion	21
Primary:	
Breast	62
Prostate	27
Stomach	6
Large Bowel	6
Sarcoma	4
Lymphosarcoma	2
Bones	3
Uterus	3
Hypernephroma	3
**Other Organs	10
Unknown	12

The primary growth may have been removed eight or more years before, as in the breast. Carcinoma of the prostate metastasizes most frequently to the lower part of spine and pelvis; carcinoma of the breast and gastro-intestinal tract seems to involve any level of the spine indifferently. The spinal cord involvement may be complete within two days; often the paralysis is progressive for two or three months; ten or more months may be required before the paralysis is complete.

\*\*Includes palate, nasopharynx, skin, parotid (mixed tumor) thyroid, melanoma of skin, sarcoma of chest wall (3 cases), myeloma, lungs (primary), testis, labia.

#### Metastasis

of malignant tumors to the central nervous system is a derelict encountered in our diagnostic lanes. The tumors may arise from some recess as hidden as the nasopharynx. Fortunately, the roentgenogram usually gives a warning. The symptoms may be the same as those of any benign cord tumor, except that the progress of malignant growth is usually more rapid. Carcinomas of the breast and prostate head the list. Since carcinoma of the prostate may not produce local symptoms, a rectal examination should be made as a routine.

Hypertrophic pachymeningitis is among the various diseases encountered that may be difficult to distinguish from tumor. In this disease, the dura becomes thickened, usually in the cervical region; by pinching off the nerve roots, it causes pain, atrophy, and sensory disturbances of the arms, and by compressing the cord, it causes impairment of function below.

Meningomyelitis may remain localized. There is often a history of antecedent trauma or infection. As a rule, the examination does not disclose a Brown-Sequard syndrome; the upper level of anesthesia is usually indistinct, and all qualities of sensation are equally affected, possibly because the inflammation penetrates the cord.

Note: Cervical rib complication in our case.

Ref. A.  
Approach.

Laminectomy can be performed by several different methods. Mechanical removal of the spine and laminae is not so important as close observation of the tissue removed. The texture of the removed bone should be carefully scrutinized for evidence of any changes, either of absorption or of overgrowth. Then the epidural space requires a critical survey for signs of neoplastic or inflammatory changes. If the exploration has been negative up to this point, then the dura should be carefully examined for any abnormalities of pulsation. Absence of pulsation means one of two conditions: either the compression is above the laminectomy opening or the exposed dura lies just over it. Gentle palpation of the dura rules out the latter condition, and if there are no signs of compression, the laminectomy must be carried cephalad until there is definite pulsation of the dura. During the operation, it must be kept in mind that accurate as the localization has been, there is always danger that the level of the abnormality, as determined before operation, may be one segment lower than the actual compression of the cord.

After it has been demonstrated that the cause of compression is not extradural, and the pulsating dura has been exposed, operation should proceed by incising the dura longitudinally. Should

no cause of compression be evident, and the operator be at a loss to explain the absence of pathologic change, then a silver probe or soft rubber catheter should be gently inserted intradurally to eliminate the possibility of an obstruction either above or below. The cause of the compression may lie anteriorly to the spinal cord and perhaps can be exposed only after the cord has been rotated by means of the dentate ligament.

Lesions within the spinal cord may cause compression. The majority of these lesions involves a discouraging prognosis yet cysts have been evacuated, benign tumors have been completely removed, and recovery has resulted from the decompression incidental to the laminectomy.

Complicating the preoperative pathologic diagnosis of tumors of the spinal cord are inflammatory lesions which develop insidiously, and which simulate such tumors so definitely that a differential diagnosis can be made only at operation. Pachymeningitis due to tuberculosis, syphilis, or other chronic inflammatory lesions may prove to be the cause of compression. Chronic cystic arachnoiditis may be encountered when the dura is opened. Varicosities of the meningeal vessels may simulate tumors, although such a condition may be found adjacent to tumors, making the diagnosis of varicosity possible only after the presence of a tumor has definitely been excluded. The surgical and pathologic aspects of compression of the spinal cord are so closely interwoven that until a complete examination of the vertebrae, meninges and cord has been carried out, the operation should not be terminated nor the diagnosis completed.

TABLE 3.Tissue Changes that Cause Compression of the Spinal Cord (Non-Traumatic).Note: Modified by us.

Extramedullary	(Arch of vertebrae	(Hypertrophic osteitis (Giant cell tumor (Osteoma (Chondroma
	(	
	(	
	(	
	(Body of vertebrae	(Carcinoma, metastatic (Osteogenic Tumor (Benign, Malignant) (Giant cell tumor
	(	
	(Intervertebral disk	(Chondroma (Benign, malignant)
	(	
	(	(Lipoma
	(Extradural fat	(Lymphosarcoma (Hodgkin's, Leukemia) (Fibrosarcoma, metastatic (Hypernephroma, metastatic
Meningeal	(	
	(Spinal nerves	( <u>Neurofibroma</u>
	(	
	(	(Hemangioma
	(Blood vessels	(Hemangioendothelioma (Hemangioblastoma)
	(	
	(	(Tuberculoma
	(Extradural	(Fibroma (Pachymeningitis
	(	
	(	(Endothelioma (Leptomeningioma)
(Intradural	(Hemangioma ( <u>Neurofibroma</u> (Cystic arachnoiditis (Varicosity of vessels	
Medullary	(	
	(	
	(	
	(	
	(Cord	(Fibroma ( <u>Glioma</u> (Angioma (Endothelioma
	(	
	(	
	(	(Cysts, including syringomyelia (Abscesses (Malignant metastatic growths
	(Intramedullary	
	(	

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## II. CASE REPORT

### INTRADURAL EXTRAMEDULLARY NEUROFIBROMA (MENINGIOMA?) OF CERVICAL CORD.

The case is that of a white female, 38 years of age, admitted to the University Hospitals 8-11-31 and discharged 8-16-31 (5 days); readmitted 11-15-31 and died 12-21-31 (38 days). Total stay - 43 days.

#### 4 years ago Pain

1927 (About) - Patient noticed very severe pain in the left suprascapular region and as far down as the tip of the acromion process. The pain was severe. To be able to sleep patient first used aspirin, then veronal, and for the last three years amytal. Accompanying this pain, there was a tingling of the first and second fingers of the left hand and a purplish color and coldness of the left arm. Sometime later the two fingers began to feel stiff and numb. Later the stiffness and numbness spread to the third finger and distal second phalanges of the fourth and fifth fingers. There was an area about the size of a dollar in the palm of the hand which was numb and had a cold feeling. These above symptoms lasted for about two years (until 1929). Patient was quite well until about Jan. 1931.

#### Weakness - left arm

1- -31 - The symptoms again returned and became much more severe. Patient has had trouble in shuffling cards with her left hand, picking up objects, and turning pages of a book. Each morning patient has had to go through a limbering up process to get rid of soreness in the neck and stiffness of fingers, usually taking about two hours.

#### Weakness - right arm

4- -31 - Patient notices some sagging of the left shoulder and arm. The right arm has been weaker. No position of the left arm relieved the pain. Patient held her head to the left, holding it quite stiff. This process seemed to relieve the pain to some extent.

#### Trauma?

Past History: Fall on ice with severe trauma to vertebral column about

three weeks before the first symptoms appeared. Bone cyst of the mandible removed four years ago.

#### Sensory changes

7-17-31 - Dispensary. Neurological examination - left pupil larger than right. Reflexes - Biceps, right and left 2+; triceps, normal; supinator, normal; upper, middle, and lower abdominal, normal; cremaster, normal; knee and ankle jerks, normal; Babinski, Chaddock, Oppenheim, and Gordon, normal. Sensibility - paresthesia of left thumb and second finger and index finger up to the wrist. Findings are only subjective, but probably definite. Conclusion: Negative neurologically except slight sensory changes in the ulna and radial, (peripheral nerve distribution).

#### Cervical ribs, arthritis

7-21-31 - Dispensary. X-ray of lower cervical spine - there is marked elongation of both transverse processes of the 7th cervical vertebra constituting practically a bilateral cervical rib in this region. There is marked hypertrophic change about the transverse articulation of all the cervical vertebrae. Conclusions: Bilateral cervical ribs. Hypertrophic arthritis, cervical spine.

In the Dispensary, patient was given about fifteen treatments of arthritis vaccine.

#### No tenderness

8-11-31 - Admitted to University Hospitals. Physical examination: Heart - B.P. 112/68 (both sides): pulse 90. There is no tenderness on palpation or percussion over the back.

Laboratory: Blood - Hb. 80%, wbc's 7,450, Pmn's 69%, L 27%, E 4%.

#### Operation

8-13-31 - Preoperative diagnosis - bilateral cervical rib, most pronounced symptoms on the left side. Anesthesia - local infiltration. Procedure - through a transverse incision about 2 cm. in length, the anterior scalenus muscle was exposed and dissected. This exposed the brachial plexus in the vertebral line just medial to the cut muscle. The phrenic was retracted laterally from the surface of the muscle as it was cut.



Pulse 90. Temperature 99.

8-16-31 - Patient had no special complaints. Discharged.

No better - worse

11-15-31 - Readmitted to University Hospitals. Note on interval history: The patient has not been relieved of her symptoms. In fact, she states that they are worse. The pain in the back of her neck and left upper shoulder region is very severe. In the interval she has been taking arthritic vaccine treatments with no particular relief.

Progressive lesion

Neurological note: Patient began to have pains in the upper cervical vertebrae, three years ago, which has grown worse and extended down both arms, most to the left. The cranial nerves are negative except for bilateral nystagmus. There is tenderness in the upper cervical vertebrae on percussion. Deep reflexes are markedly increased; left knee and ankle jerks were increased more than the right; left Babinski + ; right Babinski questionable; definite redness in left leg; abdominal reflexes are equal but decreased. Vibratory sense is decreased in the lower extremities and probably position sense. Sensory examination was unsatisfactory but there appears to be a hyperaesthesia in the upper cervical nerve distribution. Complained of dropping articles - probably has asteriognosis with some sensory disturbances in the hands and arms, but not certain. Impression: High cervical cord pathology. Laboratory: Blood - Hb. 72%, wbc's 9,100, rbc's 3,340,000, Pmn's 66%, L 29%, M 3%, E 2%. Progress: Patient complained of pain in the left side of the neck. Sodium amytal gr. vii, sodium amytal gr. iii.

Pain

11-19-31 - Complains of a great deal of pain in her shoulder. Luminal gr. 1-1/2, three times daily. Sodium amytal gr. v, twice daily. X-ray - cervical spine: Bilateral cervical ribs are shown of rather rudimentary character. No other evidence of pathology could be made out. Conclusions: Negative cervical and upper dorsal spine. Bilateral cervical ribs. Spinal fluid - clear, colorless, pressure 100/200, cells 300 rbc's, Noguchi negative, Wernicke negative, Colloidal gold 0000011000, Wassermann negative. Pulse

and temperature normal.

X-ray

11-20-31 - X-ray - skull: There is some bridging of the sella and a localized hyperostosis in the left frontal region. There is likewise a little hyperostosis in the region of the vertex of the skull. Conclusions: Bridging of sella. Slight localized hyperostosis.

11-27-31 - The patient complains of pain. Luminal gr. 1-1/2, three times daily. X-ray - Chest, Diaphragms, mediastinum, heart and pleura are normal. Lungs show no evidence of pathology. Conclusions: Negative chest.

Lipiodol - tumor

12-17-31 - Cisternal puncture for lipiodal injection done. Lipiodal - X-ray of cervical spine: Plates of the lumbar spine following lipiodal injection into the cisterna still show a small amount of lipiodal within the cisterna itself. There is likewise an accumulation in the upper part of the spinal column just above the level of the second cervical vertebra. At the level of the second cervical, there is a rounded filling defect outlined by the lipiodol which is quite characteristic of a cord tumor. Plate taken about three hours later shows but little change in the position of the lipiodol, practically none having passed down the spine. Conclusions: Lipiodol injection of cisterna. Spinal cord tumor at level of second cervical vertebra. Temperature to 100.2. Pulse to 88.

12-18-31 - Complains of pain along spine and neck. Pyramidon gr. x. Phenacetin gr. v. Morphine sulphate gr. 1/4. X-ray - Plates made 12-18-31 show practically the same findings in the cervical region. The outline of the tumor is very well shown. There is a very small amount of lipiodol at the end of the spine indicating that the obstruction is incomplete. Urine examination - negative.

Operation - Exitus.

12-21-31 - Operation: Began at 8:25, ended at 10:50. Preoperative diagnosis - tumor at the level of the second cervical vertebra. Anesthesia - local was to be used but the patient could not be put in the proper position on the table under local because of the pain which it caused

her. This pain was due to the tumor.

Ethylene and gas inhalation was used. A vertical incision from the external occipital protuberance down to the fifth cervical vertebra in the midline.

Findings - There was a diffuse enlargement of the cord in the region of the second vertebra. Its maximum enlargement apparently was at the second, but it also extended up to the first and down to the third. This very tightly filled the dura. The dura itself was somewhat thickened in this region. It seemed to be a soft tumor, probably cystic, intramedullary tumor.

The tumor partially extruded itself from the cord after the pial was opened.

Procedure - the muscles were dissected free from the occiput and retracted laterally. The first, second and third vertebral arches were exposed. Trephine openings were then made in the dura and the inferior portion of the occipital bone removed, removing a portion of the foramen magnum. The posterior arches and posterior tubercle of the first cervical vertebra were then removed and the spinous process and arches of the second, or epistropheus. The third spinous process was also removed and also was opened the fourth. The dura was then opened and what was thought to be tumor (This later at postmortem proved to be the compressed cord only.) The arachnoid was opened after the dura had been opened. There was no fluid in the region of the tumor but a flow of fluid both above and below in the area of the tumor. There was pulsation above the tumor. As we were about to explore the region of the cord in which the tumor was lying, the patient ceased to breathe. Her pulse up to this time had been 75 and blood pressure 150. The wound was quickly closed, the skin only being closed, and with the patient turned on her face, 2 cc of 1 to 10,000 adrenalin was injected into the heart. Artificial respiration was given and after a period of about ten minutes the pulse returned. In the meantime, the patient's color was that of a cadaver and there was no heart beat that could be heard with the stethoscope. The pupils were partially dilated when examined in the interval before her pulse returned. When the pulse did return, the blood pressure was taken to be 150, rate about 85. The patient did not regain consciousness and was put in the Drinker respirator. At 11:25 patient was put in the Drinker respirator. Was very cyanotic.

Pulse 78. 11:50 A.M. - pulse 108 and of good quality. Respirations 24. 2:20 P.M. - pulse 100 and weaker. Patient opened her eyes every few seconds accompanied by muscular twitchings of the face and neck. 4:00 P.M. - temperature 103.6. Pulse 138 and irregular. 6 P.M. - patient expired.

Only a partial AUTOPSY was permitted - examination of the operative incision and cord.

The body is that of a well-developed and well-nourished, white female, 38 years of age, measuring about 162 cm., and weighing approximately 152 lbs. There is no edema nor jaundice. There is slight cyanosis of the finger-nails and lips. There are no scars nor any marks on the body. There is a recent operative incision from the external occipital protuberance to the fifth cervical vertebrae in the midline. This is opened and the cord exposed. The anterior nerve root and dentate ligament was isolated and cut in the region of the second cervical vertebra and immediately half of the tumor slipped out on the right side. There was a great deal of blood that welled up in the incision but it seemed that this tumor was antero-lateral in position and was attached to the nerve roots or dura on the right side. It was entirely free except for a small slip-like attachment. The tumor itself was wedge-shaped, measuring 5 cm. in its long diameter, 2 cm. in its transverse diameter, 1 cm. thick in its most lateral portion, tapering down to a sharp edge in its medial portion. A section of the cord is taken. The tumor is of very soft consistence and in one area (inspecting from the outer surface) looks as if it contains some blood and is of a cystic nature. However, on cut section, it seems very soft and the surfaces are quite white and homogenous except for a few small portions where it hemorrhaged.

#### Diagnoses:

1. Intradural extramedullary tumor (neurofibroma or meningioma) of cervical cord.
2. Respiratory failure (clinical).

### III. CASE REPORT

#### INTRAMEDULLARY SPONGIOBLASTOMA MULTIFORME OF THE CERVICAL CORD.

The case is that of a white male, 17 years of age, admitted to the University Hospitals 7-10-29 and died 7-15-29 (5 days).

Past History: Usual diseases of childhood. No serious illness or accidents up to present. Frequent attacks of tonsillitis. Father had paralysis of right arm (stroke).

#### Injury

4-25-29 - Patient was injured in a basketball game. Hurt neck and right elbow. Injury on right elbow was dressed.

#### Paresthesia

4-26-29 - Noticed numbness and tingling in fingers of right hand. Latter was thought due to injured elbow.

#### Paralysis (right)

5-2-29 - Under observation at a local clinic for the past week. During this time, the right arm became paralyzed.

#### Numbness (left)

5-9-29 - Returned home and noticed numbness of left hand. Patient is left-handed and he found himself unable to hold a pen or pencil. Left arm did not become paralyzed until two days before admission to the Hospitals.

#### X-ray

5-12-29 - X-ray of cervical vertebra. Fracture was thought to be present. This was later changed to "stiff neck". He was then taken to a chiropractor for a series of treatments but with no improvement.

#### Night Pain

6-28-29 - Swelling on patient's neck. Would awaken several times at night. (Note this.) Mother would massage neck and he would sleep again. Throughout this time the only pain experienced was in neck.

#### Paresis

7-1-29 - Difficulty in walking (right leg). Mother became concerned and de-

ecided that he should go to a hospital.

#### Left arm paralyzed

7-8-29 - Condition becoming progressively worse. Immediate hospitalization advised. Left arm paralyzed.

#### Total paralysis

7-10-29 - Left his home and was brought to Hospital by automobile. Left leg became paralyzed as well as right leg on way down. Did not complain of difficulty in breathing until brought into the institution. 7:20 P.M. - Rescue squad of fire department called. Schaefer method of artificial respiration was administered continuously. Oxygen given.

#### Cord Tumor

Neurological consultation: 11 P.M. - Patient is conscious and clear mentally. Undergoing artificial respiration. Can phonate with help of pressure on chest. Total paralysis of all extremities and chest muscles. Cranial nerves are all normal. If told to breathe, he would use the sternocleidomastoids only. Rapidly became cyanotic when artificial respirations had stopped. Total anesthesia up to level of fifth cranial nerve distribution. Deep and abdominal reflexes abolished. Babinski + on right, no response on left. Spinal fluid shows clear, colorless fluid under very low pressure which does not increase on jugular compression. X-ray - of cervical spine - negative. Diagnosis of spinal cord tumor about the level of the 4th or 5th cervical segment made. Laminectomy advised.

#### Laminectomy

Operation done without an anesthetic as he experienced no pain. Laminectomy extending from 1st to 5th vertebrae was done and the cord exposed. About cutting the dura, the tumor bulged into the operative field and appears to be composed of very soft and friable tissue, resembling a glioma. Artificial respiration was necessary throughout the entire procedure. Patient survived the operation without difficulty but artificial respiration was continued in order to keep him alive.

#### Paralyzed

7-11-29 - Laboratory: Urine - specific

gravity 1.018, negative. Blood - Hb. 90%, rbc's 4,850,000, wbc's 16,650, P 86%, L 14%. 9:30 A.M. - neurological findings are the same except that now he talks a little easier and the right knee jerk is present. Fluids forced. Pulse 84. Catheterized, 250 c.c. urine obtained. Adrenalin 1 c.c. (H). Continuous Schaefer artificial respiration. Oxygen tank used. 3:55 A.M. - catheterized, 400 c.c. urine obtained. Very cyanotic and distressed. Later was relieved. Artificial respiration continued today with good results.

7-12-29 - Condition same. Pulse 72 and strong. Takes fluids poorly. No feeling in arms or legs. Seems somewhat better. Involuntary. Temperature normal. Pulse 70.

#### Bed Sores

7-13-29 - Temperature rose to 105 (R). Rubber drain removed, no drainage. Catheterized, 500 c.c. urine obtained. Involuntary bowel movements. Seems quite responsive and cheerful. Developed a bed sore on back. Thinks there is some feeling in shoulders and legs. Comfortable. Reddened area on end of spine. Given caffeine sodium benzoate gr. 7-1/2, Oxygen, Tincture digitalis 2 c.c.

#### Emesis

7-14-29 - Air hunger. Condition slightly worse. Nauseated. Almost continual emesis. Color poor. Dozes at intervals. Still responds to questions. Incontinent. Developing progressive edema of lungs. Not getting enough air. Temperature rising to 104 again. Blood pressure on right leg approximately 100 systolic. Vomiting has become definitely projectile in character with considerable blood. Oxygen given. Irrational at times. Pulse shallow. Refuses fluids.

#### Exitus

7-15-29 - Much worse. Pulse hardly perceptible. Unconscious. Artificial respiration continued. Gradually growing worse. Expired at 1:55 A.M.

Death took place after 134 hours and 35 minutes of continuous artificial respiration done by the Fire Department Squad and student volunteers from the University of Minnesota.

#### Autopsy

The body is that of a fairly well-developed and fairly well-nourished, white youth measuring 178 cm. in length and weighing approximately 160 lbs. Rigor is present. Hypostasis is purplish and posterior. The entire body surface has a peculiar bluish-red discoloration. This is patchy over the anterior chest wall. A slight edema of the chest wall is present. Cyanosis is generalized. No jaundice. Negative pupils. There is a gaping operative wound in the posterior cervical region.

The subcutaneous fat over the anterior abdominal wall is moderate in amount. No excess Peritoneal fluid. The Appendix is negative.

The diaphragm is at the third inter-space on the right, fourth rib on left. There are few hemorrhages in the Pleural Cavities. The Pericardial Sac is normal.

The Heart weighs 250 grams. The surface is smooth. The muscle shows slight softening and cloudiness. The valves, mural endocardium, and coronary arteries are negative. There are a few reddish-yellow plaques at the base of the mitral valve, mitral leaflet of the aortic valve, and Root of the Aorta. The balance of the aorta is negative.

The Right Lung weighs 530 grams, Left 460 grams. Both show small patches of emphysema and a few hemorrhages. The lower lobes are relatively airless. On section, deep congestion and moderate edema is seen. There is suggestive beginning consolidation of pneumonia. The bronchi are congested, hemorrhagic, and contain mucus.

The Spleen weighs 100 grams. The capsule is slate-colored. On section, the pulp is dark red and soft.

The Liver weighs 1750 grams. The surface is smooth. On section, slight cloudy swelling is seen.

The Gall-Bladder, Pancreas and Adrenals are normal.

The Gastro-Intestinal Tract shows slight gaseous distension of the stomach.

Each of the Kidneys weigh 125 grams. The capsules strip easily showing cloudy surfaces. On section, slight softening is seen. The pelves are slightly dilated and a few hemorrhages are present. The ureters are not dilated.

The Bladder is distended with urine. The mucous membrane is hemorrhagic.

The External Genitalia are normal.

The Aorta shows a few yellowish plaques in the lumbar portion.

The Lymph Nodes at the hilum are slightly enlarged.

The Cervical Cord is removed and an intramedullary soft hemorrhagic tumor about 2.5 cm. in diameter is found at the 3rd and 4th levels. It distends the cord at this point. Sections show spongioblastoma multiforme.

#### Diagnoses:

1. Spongioblastoma multiforme.
2. Respiratory paralysis.
3. Decubitus ulceration.
4. Pulmonary congestion and edema.
5. Acute bronchopneumonia.
6. Operation wound.
7. Hemorrhages and abrasions.

#### IV. COMMENT ON CASE I.

Ref.E. Spinal cord tumors according to Schlesinger make up 2% of all new growths. Females usually predominate, 2 to 1. In another series females constituted 70%. It is rather difficult to fix the age appearance of these new growths as they are frequently present for years before diagnosis or treatment. 0-10 (0), 10-21 (1), 20-30 (5), 30-40 (18), 40-50 (11), 50-60 (19), 60-70 (5), 70-80 (0), not stated (1).

#### Location

Level incidence of all spinal-cord tumors is cervical 20%, dorsal 52%, lumbo-sacral and caudal 28%. Sixty meningiomas showed the following distribution: Cervical 13%, dorsal, 63%, lumbo-sacral and caudal 23%. As to the position in the spinal canal anterior (2 - 7%), antero-lateral (11 - 19%), posterior (12 - 37%), postero-lateral (37 - 67%). The high and the low figures represent the extremes reported by different observers in a series of 140 tumors (57 in one and 83 in the other).

#### Cause

In 60 cases, trauma preceded appearance of tumor in only 3. In only 1 was the blow at the same level. In the course of a laminectomy for cord tumor, chronic inflammation may be encountered. It is possible that some of these growths arise on an inflammatory basis.

#### Size

The size of the growth varies within wide limits (largest in cervical and caudal regions). When it extends beyond the spinal canal, it may assume an irregular shape. Commonly, the growths are 20 to 35 mm. in length, from 10 to 20 mm. in the broadest axis, and 10 to 15 mm. in the flattened portion. Growths measuring from 20 cm. to the entire length of the spinal canal have been reported. Tumors are usually dull grayish-white, at times necrotic, cystic, and hemorrhagic. They are usually adherent to the dura and this piece should always be removed. Nerve roots may also be included. With the exception of the dura, the tumor does not filtrate surrounding structures although it may be difficult to separate from the spinal cord.

#### Structure

The cellular structure shows flattened types with compression and elongation (tendency toward spindle-cell form), palisading, sometimes alveolar arrangement. Nuclei are small and altered by the compression. Occasional giant cells and mitoses are seen (mitoses in our case). The stroma varies with the activity of the growth and fibroglia can be demonstrated by special stains. There is a remarkable tendency to hyaline change and whorl formation. Calcareous degeneration is seen in the majority of the older tumors (sand bodies). Although the origin of these tumors is in doubt, most people today follow Mallory's lead in ascribing their origin to arachnoid cells.

#### Cervical

Leptomeningiomas in the cervical region have many interesting features. Large specimens may extend from the foramen magnum into the skull and involve the last four cranial nerves and medulla. Postoperative deaths due to edema (high) have been described. When the level of the tumor causes spastic paralysis of the arms, pendiculation or yawning accompanied by the movement of the arms is seen. Differences in the size of the pupils has been observed. Falst localizing signs may arise from high growths (lower extremity involvement). Pain is the first and may be for a long time the only symptom. As a general

rule, no bladder disturbances are noted in cervical lesions. Block of the spinal fluid may or may not be present. Lipiodal is frequently the method of clinching the diagnosis and locating the growth.

### Treatment

Leptomeningiomas lend themselves readily to removal. As a general rule, the tumors do not display even local signs of malignancy. Nerve roots may have to be sacrificed. In 31 patients at the Mayo Clinic, the immediate operative mortality was 10% (usually in advanced cases). Degree of restoration of function depends on several features. In early cases, return is usually rapid and complete. Even in cases with paralysis of one years duration, some return may be expected. Sometimes the effect is immediate and it has been known to occur after as long an interval as 18 months. Vesical and rectal control usually come first (if they have been impaired), next muscular power and finally sensation (usually incomplete).

### Impression:

Our case resembled the cellular type (spindle-cell) with little degeneration in the section examined. Pennington suggests that some of these growths may be solitary, perineural fibromas (single form and not generalized type seen in von Recklinghausen. This was considered in the present case but apparently it is better to classify it with the meningiomas. The unfortunate location of the tumor made the outlook bad. Most interesting is the presence of cervical ribs which was thought to account for the symptomatology (but did not). Cervical ribs as far as symptoms are concerned are still a debatable chapter. As a general rule, although present throughout life, symptoms do not appear until late. Only favorable cases find their way into the literature. As the result of a large number of x-ray examinations of the chest, cervical ribs must be seen with increasing frequency. It would be interesting to study these cases and find the actual number giving symptoms.

### V. COMMENT ON CASE II.

Ref. F. Case II was a typical spongioblastoma multiforme of the cord. Intramedullary tumors have been recently reviewed by Kernohan, Woltman, and Adson.

### Material

Fifty-one cases in which sufficient material was removed for examination. Excluding caudal tumors, intramedullary tumors are more common in males. Average duration of symptoms 5 years (considerably longer than any other group). It is often impossible to predict the position of the growth prior to or during operation. Dissociated, waistcoat type of sensory disturbance and marked difference in levels of various sensory disturbances suggest intramedullary tumor. In the present series, lower motor neuron involvement was found in 40%, root pain 48% (less common than others), spinal pain 72% (more common - note our case), tract pains 6% (about the same).

### Classification

In only a few could the tumor be removed completely. Splitting the cord and partial removal resulted in relief in many. There were 91 tumors of this type but in only 51 could a histological examination be made. In the other 40, decompression was done. A satisfactory classification does not exist in the literature and is not reviewed. An attempt is made in the present study to group them after the Bailey, Cushing method. Results are: 1. Ependymomas (21) with three sub-types (6 - 8 - 7). The incidence of 42% is much more than similar tumors in the brain. The third type resembles a neuro-epithelioma. 2. Spongioblastoma (7), less common than brain tumors. All of this group were the mixed type and classified with difficulty. 3. Unipolar spongioblastoma (2). 4. Spongioblastoma multiforme (4). Although these tumors make up one-third of all brain tumors, they are uncommon in the cord but may be reported under different names in the literature. Our case is an example of this type. 5. Astroblastoma (2). 6. Oligodengrogloma (2). 7. Medulloblastoma (4) - with remarkable tendency to differentiate. 8. Ganglioneuroma (1). 9. Hemangioblastoma (4). 10. Fibroblastoma (1). 11. Lipoma (1). 12. Tuberculoma (1), solitary type with later development of generalized tuberculosis.

### Discussion

Springomyelia was looked for in

10 cords which were later removed. It was found in 5. An attempt was made to correlate the duration of symptoms with the type of growth but this did not prove helpful, with the exception of the spongioblastoma multiforme which had a definitely shorter history (see our case). The longest history was found in the ependymomas, while the medulloblastomas contrary to the findings in the brain did not have short history. There were many cases in which the differentiation was made with difficulty due to the complexity of the tumors (exception - astroblastomas, astrocytomas and oligodendrogliomas). The authors suggest that in spite of the small series that an attempted classification of cord tumors after the Bailey-Cushing method seems feasible.

## VI. END RESULTS

Ref. G. and H.

Older mortality figures were very high. ~~Yo~~ Kohlisch in a collection of cases from 1896-1905 gave an operative mortality of 46%. Harte of same period 47%. "Sammelreferat of Stiudby - 44%; Krause, 37%; DeMartel, 45%.

Recent years much smaller:  
Frazier - 14 cases, 1 death.  
Adson - 14% mortality.

### Mortality in 100 operations for verified spinal cord tumors.

	No.	Recov- ered	Died	Op. Mort. %
Extramedullary	55	51	4	7 %
conus and cauda	12	9	3	25 %
extradural	20	19	1	5 %
intramedullary	13	11	2	15 %
Total	100	90	10	10 %

Most deaths occurred in patients with inoperable or irremovable tumors.

### Immediate and Final Results

Total number patients	100
Tumor completely removed	78 - 78%
Tumor partially removed	10 - 10%
Tumors irremovable	12 - 12%

Prognosis after operation will depend upon whether tumor is removed, partly removed, or irremovable, and upon the stage of disease in which patients are operated upon. A patient with an irremovable growth will have some relief following operation but sooner or later symptoms will be aggravated.

A patient with a removable tumor usually comes to operation before compression of cord has been of such long duration, and there is an excellent chance for recovery to be complete or almost complete. The longest period of spinal tumor symptoms before operation, followed by complete recovery, was 3 years; but in the majority of instances, it was from 1 to 2 years. Thus, of the patients from whom extra-medullary tumors were removed, followed by complete recovery, 6% gave a history dating back 3 years, 9% less than 1 year, 85% from 1 to 2 years.

In extradural tumors that can be completely removed, the outlook for recovery is just as good as in intradural growths, although there may be recurrence of the disease after a number of years.

A better idea can be gained of outlook for recovery if one considers duration of paralysis. A spastic paralysis of one or both lower limbs, even of many months duration, can be completely relieved in ~~two~~ a few weeks or months. If spastic paraplegia has lasted more than 2 years however, complete recovery is rare and a considerable spasticity is apt to remain. In flaccid paralysis as result of long standing tumor chance of improvement is small.

Root pain due to direct pressure of tumor on root usually disappears at once after operation. Occasionally because of neuritis, root pain will persist for weeks or months, so author generally divides root at operation.

- Ref. E.    On Leptomeningiomas (Endotheliomas) of the Spinal Cord.  
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