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SUPERIOR PULMONARY SULCUS TUMOR

TUMOR CHARACTERIZED BY PAIN, HORNER'S SYNDROME, DESTRUCTION OF BONE AND ATROPHY OF HAND MUSCLES

CHAIRMAN'S ADDRESS

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Medicine is not and cannot be an exact science because of the complexity of the human element involved. Roentgenology is the youngest branch of the specialties and is a study of living pathology. Even pathology is subject to many changes through experience, progress in investigation and study. This is one of the factors concerned in changes in roentgenology, and presumably for its betterment, through greater exactitude, further investigations, added experience and the acknowledgment of and correction of mistakes. In 1924, when a group of roentgenologists were on trial for possible acceptance as a new section in the American Medical Association, I presented a paper [1] before the Section on Miscellaneous Topics, in which were reported three cases of what seemed to be a new entity among intrathoracic tumors. I have selected this subject again for the chairman's address as one slight means of showing that roentgenologists are genuinely alive to the necessity for accuracy in diagnosis, as are the members of any of the other special branches of medicine.

The tumors in question seemed to occur at a definite location at the thoracic inlet, were characterized clinically by pain around the shoulder and down the arm, Horner's syndrome and atrophy of the muscles of the hand and presented roentgenographic evidences of a small, homogeneous shadow at the extreme apex, always more or less local rib destruction and often vertebral infiltration. Death occurred as a result of what seemed to be a comparatively trivial growth without detectable metastases roentgenologically. The tumors were differentiated from other neoplasms occurring in the neighborhood, such as apical primary lung carcinoma and sarcoma of the ribs, by the absence of one or more of the foregoing characteristic manifestations. It has been found necessary, since then, to add other conditions to this list.

It has been found advisable to discard the name of "apical chest tumor" as a designation for this growth, because it has proved to be confusing and has permitted the inclusion of other more common tumors in the upper part of the thorax. The name of "superior pulmonary sulcus tumor" has been given to it because this term implies its approximate location and a lack of origin from the lung, pleura, ribs or mediastinum. It is possible that this new designation may be changed again with a better knowledge of the histopathology of the growth.

I wish to review briefly the three cases previously reported, to add four additional ones which have come under my observation more recently and to comment further on the histologic, anatomic, clinical and roentgenologic characteristics of the group.

Read before the Section on Radiology at the Eighty-Third Annual Session of the American Medical Association, New Orleans, May 11, 1932.

1. Pancoast, H. K.: Importance of Careful Roentgen-Ray Investigation of Apical Chest Tumors, J. A. M. A. 83:1407 (Nov. 1) 1924.

REPORT OF CASES

CASE 1 (previously reported).—A. C., a man, aged 52, was admitted to the University Hospital on the services of Dr. Spiller and Dr. Frazier, Sept. 21, 1921, suffering with intense burning pain high in the left axilla and extending down the inner side of the arm, of eleven months' duration, and later with associated muscular weakness and wasting in the hand. Horner's syndrome was quite evident on admission. Roentgen examination showed a shadow in the extreme left apex of the chest and destruction of the posterior portions of the second and third ribs and corresponding transverse processes. The patient was operated on, the tumor exposed and a section removed for biopsy. Radium was implanted (2,375 mg. hours); subsequently external roentgen irradiation was given, without response or relief, and the patient died. The pathologic report by the late Dr. A. J. Smith was endothelioma of the diffuse infiltrating type resembling carcinoma.

Recently a slide of the tumor in this case was found. It has been reviewed by Dr. Joseph McFarland, and he has passed judgment on the histopathology as carcinoma spinocellulare, with groups of typical prickle cells. This alters the entire situation as to the histology of the tumor and its probable point of origin. This opinion appealed to me because I could not understand why an endothelioma of the pleura in this particular location would always infiltrate bone and rarely if ever do so elsewhere in the pleura.

CASE 2 (previously reported).—H. N., a man, aged 36, was admitted to the University Hospital, on Jan. 22, 1922, on the service of Dr. Stengel. His chief complaint was a dull aching pain of four months' duration, confined chiefly to the inner border of the left scapula, high in the axilla and down the inner side of the arm. These are typical locations. Horner's syndrome was manifest by a contracted pupil and ptosis of the lid. Roentgenograms of the chest and later of the shoulder were regarded as negative at the time, but both were found on subsequent review to show a slight localized shadow at the left apex. Rib erosion was doubtful. Subsequent clinical study, March 28, showed a considerable loss in weight, more marked sympathetic paralysis and the addition of unilateral sweating. Roentgenograms now showed partial destruction of the first and second ribs and erosion of the second transverse process. This tumor was exposed at operation and was 75 mm. long; it was found extending around the posterior aspect of the upper thoracic cavity and lying on the transverse processes. Biopsy showed carcinoma. Radium implantation and external irradiation by roentgen rays failed to check the growth. In July, six months after admission and ten months after the onset of symptoms, the third rib was involved and the sides of the

first, second and third thoracic vertebrae were beginning to erode. The patient died in about one year after the onset of symptoms.

Case 3 (previously reported).—W. S., a man, aged 60, was referred for examination by Dr. Kopelka and Dr. Riesman, Dec. 22, 1923, because of pain around the right shoulder. The roentgenogram of the shoulder was regarded as negative, but a review later showed a faint localized shadow in the right apical region. By the following September the pain had extended down the inner arm and forearm to the wrist, and Horner's syndrome was noted. In November, Dr. Manges examined him and found a right apical tumor causing a diffuse shadow and destruction of the posterior portion of the first rib and the adjacent transverse process and the lateral portion of the second rib. The patient died in January, 1924, despite deep roentgenotherapy. There was no biopsy or necropsy.

Case 4.—*History.*—W. B. C., a man, aged 55, was admitted to the University Hospital on the service of Dr. Spiller, Nov. 29, 1925. About five years before he began to have a sense of discomfort in the lower cervical and upper thoracic region. This was not relieved by several osteopathic treatments given during February, 1925. In April, 1925, the pain began to settle posteriorly under the lateral border of the right scapula, and later radiated anteriorly in the third interspace and

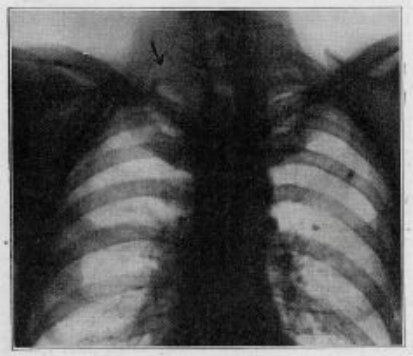

Fig. 1 (case 4).—Roentgenogram of the chest, showing slight increase in density in the extreme right apex and slight erosion of the second and third ribs. The neck of the second is involved but not the transverse process.

subsequently throughout the right axilla. A roentgen examination made elsewhere of the right shoulder showed a calcification indicative of so-called subacromial bursitis. Unfortunately the spine and ribs were not included in this examination. The pain next radiated, first, down the arm to the elbow and, later, down the inner aspect of the forearm to the wrist and fifth finger. On admission Horner's syndrome was observed, with a contracted pupil, a narrowed palpebral fissure, enophthalmos and slight atrophy of the side of the face. There was no unilateral sweating, and the pupil reacted to light and in accommodation. The only important clinical finding in the chest was an impaired percussion note over the right upper part of the thorax posteriorly. The liver was not palpable. The right triceps and biceps reflexes were absent.

Roentgen Examination.—December 2, the chest (fig. 1) showed a slight increase in density in the extreme right apex and slight erosion of the second and third ribs. The diagnosis was made, on this exposure, of apical chest tumor, conforming with what is now termed an upper pulmonary sulcus tumor, although it was confirmed by spinal examination.

Case 5.—*History.*—F. G., a janitor, aged 62, a native of Porto Rico, was admitted to the Philadelphia General Hospital Jan. 16, 1932, on the service of Dr. Schnabel. He first noticed numbness and tingling in the fossa of the right elbow, May 5, 1931. This continued and become more widespread and spread to the inside of the arm. On admission he had lost 40 pounds (18.1 Kg.) in weight. He had no cough, hemoptysis or dyspnea.

Physical Examination.—Examination showed Horner's syndrome, with a contracted right pupil, which did not react to light, a narrowed palpebral fissure and lack of sweating on the right side. There was impairment to percussion over the right apex. The liver was enlarged and extended 1.5 cm. below the costal margin. There were pain over the right upper part of the chest and down the inside of the right arm, weakness of the right arm and loss of power in the right arm; the right biceps and triceps reflexes were absent. The patient was transferred to the roentgenologic service.

Roentgen Examination.—Jan. 21, 1932, roentgenograms of the chest showed an increased density in the right apex and some rib destruction. The posterior exposure of the spine showed destruction of the entire first rib and the posterior two thirds of the second and beginning erosion of the posterior portion of the third. The adjacent transverse processes of the first and second thoracic vertebrae were destroyed, and there was beginning erosion of the side of the body of the second. The condition resisted all efforts at irradiation treatment. A second examination, March 15, showed no increase in the apical shadow, but there was more destruction of the third rib. The patient died about April 1.

Case 6.—*History.*—Mrs. A. M., a widow, aged 52, was admitted to the roentgenologic service of the Philadelphia General Hospital, May 6, 1930. During October, 1929, she noticed that her left hand and arm were slightly swollen and there was a prominence in the left supraclavicular region posteriorly. In December she noticed that her left eyelid drooped and that her left arm was becoming cold and numb, with tingling. In January, 1930, she noticed beginning weakness of the arm; on admission she could not move her fingers, and her arm was used with difficulty. She had slight dyspnea on exertion and an occasional cough which was slightly productive.

Physical Examination.—The chest and abdomen were normal. The left pupil was contracted and did not react to light, and the palpebral fissure was narrowed. The left arm was larger than the right. There was normal motion of the shoulder and elbow, but there was loss of power in the fingers. There was a firm mass the size of a hen's egg at the base of the neck, which was quite tender.

Neurologic examination by Dr. Ornsteen was reported as follows: "A succulent paralysis of the left hand in the ulnar and median distributions. There was an area of hyperalgesia on the ulnar side of the forearm. Left oculosympathetic palsy and lack of sweating of the left side of the face. In part, this is a Klumpke's paralysis."

Roentgen Examination.—May 7, 1930, roentgenograms of the chest showed a small area of shadow in the left extreme apex. The proximal half of the first rib was missing. The patient received external irradiation treatment. July 24, the roentgenograms showed a portion of the destroyed area of rib partly recalcified. By October, the first rib was almost normal in appearance and the shadow was fainter. There had been no vertebral involvement.

Comment.—It is interesting to note that this patient was treated by radium for a carcinoma of the cervix uteri at another hospital, Dec. 24, 1926, receiving a dosage of 2,400 mg. hours. There was no recurrence. This led to a preliminary diagnosis of metastatic carcinoma, but in the absence of other evidences of metastases and in view of the rather typical clinical characteristics and roentgen findings and the length of time following the uterine treatment, I was strongly inclined to regard this growth as a primary upper pulmonary sulcus tumor. The patient did respond well to irradiation for a time, but later she grew worse and died Nov. 26, 1930. There was no autopsy, and no biopsy was made. The cause of death remains uncertain in the light of the comparatively small growth.

CASE 7.—*History.*—Mrs. E. P., aged 32, was admitted to the roentgenologic service of the Philadelphia General Hospital, Aug. 17, 1929. In November, 1927, at a previous admission, a carcinoma of the cervix uteri, stage 3, was discovered during a routine examination for supposed pellagra. This was successfully treated by cautery, intracervical radium implants, extracervical radon implants and external roentgenotherapy. There was no local recurrence. The history obtained on the

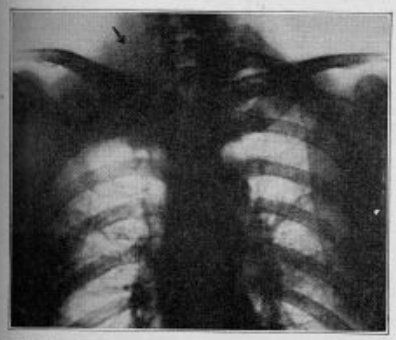

Fig. 2 (case 5).—Roentgenogram of the chest, showing an increased density in the right apex and some rib destruction.

patient's second admission brought out the fact that two months before she began to have pain in the left scapular region, numbness of the left hand and forearm and weakness of the hand.

Physical Examination.—Examination on admission revealed the following relevant clinical data: a small, hard and tender nodule at the base of the neck on the left side; numbness of the left hand and forearm and loss of grip in this hand; muscular atrophy of the shoulder girdle; distended veins of the neck, left upper part of the chest, shoulder and upper third of the arm, and diminished reflexes on this side. The left pupil was contracted and the left lid ptosed. It is interesting to note here that shortly before death, two months later, and during a severe chill followed by a temperature of 106.5 F., the left side of the face was very pale and the rigid side flushed, with a rather sharp line of demarcation between. This disappeared after the chill. The chest on admission gave an impaired percussion note on the left side above the scapula and down to the first rib anteriorly.

Roentgen Examination.—Roentgenograms of the chest, Aug. 14, 1929, revealed no evidence of metastases in the lungs or mediastinum, but showed a circumscribed shadow in the left apical region extending down to the lower border of the first rib (fig. 3). There was no evidence of bone involvement. A second examination, particularly for the shoulder and ribs, September 27, showed partial destruction of the first rib, especially the head and neck. There was probably some destruction of the transverse process of the seventh cervical vertebra. Another examination, October 16, showed more destruction of the first rib and of the sides of the bodies of the sixth and seventh cervical and first thoracic vertebrae. The tumor shadow appeared larger. There was still no lung metastasis. The patient died October 29. Autopsy and biopsy were flatly refused. Brain metastasis was a probable cause of death.

Comment.—At the time this was regarded as another independent upper pulmonary sulcus tumor similar to the others. While the uterine carcinoma did not recur locally, the condition in this case might have been a metastatic process, but I was inclined to believe, at the time I saw the patient, that it was not.

DIFFERENTIAL DIAGNOSIS

All the foregoing cases have seemed to present clinical and roentgenographic characteristics which would warrant the inclusion of the tumors in a group which could be recognized as a pathologic entity. Prominent among the clinical phenomena were pain around the shoulder and down the inner side of the arm, and often the ulnar side of the forearm, loss of power and wasting of the muscles of the hand, Horner's syndrome and signs mainly of dulness in the apex of the chest. The roentgenographic appearances were a comparatively small and circumscribed shadow in the apex due to lung displacement, and destruction of the posterior portions of one or more ribs and the adjacent articular and transverse processes and possibly a little of the sides of the bodies of one or more vertebrae. There was a striking lack of intrathoracic metastasis. Practically all these characteristics are essential for the diagnosis of the lesion. The shoulder pain was mostly posterior and high in the axilla, and sometimes but not always preceded the extension down the inner side of the arm and the ulnar aspect of the forearm. Wasting or weakness of the hand was recorded in three cases (1, 6 and 7). Horner's syndrome was noted in every case and is an essential manifestation. It was variable as to the time of onset. In cases 6 and 7 it was noted two months after the onset of pain, and in case 3 it became evident nine months after the patient was first seen. The apical shadow was known to precede any bone involvement in cases 2, 3 and 7. The number of ribs involved varied from one to three, always the first, second or third. Destruction sometimes began in the first and sometimes in the second. The vertebrae were involved in five of the seven cases. Five of the seven patients were males. Both females gave a history of previous uterine carcinoma. The left side was involved in four cases and the right in three.

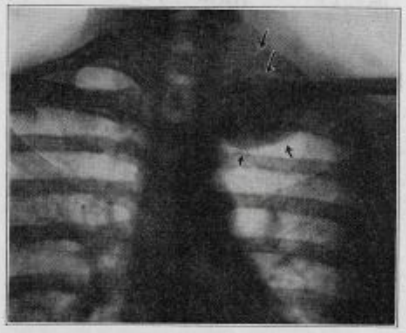

Fig. 3 (case 7).—Roentgenogram of the chest, showing the circumscribed apical shadow. Note the upper arrows pointing to the second rib and to the head and neck of the first rib, both of which are intact.

Because of the comparative rarity of this tumor, those who are not entirely familiar with it are apt to confuse it with other conditions which present only portions of the diagnostic complex. On the other hand, the condition is often overlooked because of incomplete roentgenologic studies, especially in examining only the shoulder for causes of shoulder pains. I have made it a routine to examine fluoroscopically the neck and chest

of every patient who comes for an examination of a shoulder because of pain.

The common association of apical shadows and shoulder and arm pain in cases of primary lung tumors of the upper lobe, tuberculosis or certain mediastinal tumors is frequently ascribed to this tumor. For example, Henderson [2] has reported eight cases with apical chest tumors in which shoulder and arm pains were outstanding symptoms, physical signs were not prominent, the Horner syndrome was absent and the roentgenograms showed an apical shadow, often far more extensive than any of the cases in this collection, and without bone involvement. In my previous communication, I showed that a proved apical primary lung carcinoma could produce extreme pain even when scarcely detectable roentgenographically. Ribs may be involved by metastasis in these cases, as illustrated in the following example:

Case 8.—*History.*—L. S. T., a man, aged 47, was admitted to the University Hospital, Aug. 4, 1928, on the service of Dr. Gabriel Tucker. A dry cough started in October, 1927. In December, he began to have pain in the right shoulder and

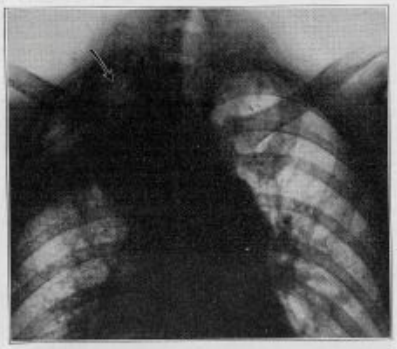

Fig. 4 (case 8).—Probable primary carcinoma of the upper portion of the right upper lobe with destruction of the posterior part of the third rib and metastasis to the mediastinum. This is an oblique view to show the mediastinal mass to better advantage.

upper right part of the chest. In June, 1928, he first noticed a sense of pressure in the upper part of the chest and began to be dyspneic. The cough then became productive and the sputum was blood streaked.

Examination.—There was complete paralysis of the right vocal cord and loss of tension in the left. The base of the neck showed considerable enlargement on the right side, and there seemed to be a mass projecting upward through the thoracic inlet. There was an impaired percussion note over the upper right part of the chest posteriorly, with almost absent breath sounds and evidences pointing to obstruction of the right upper lobe bronchus. Lung or mediastinal tumor was suspected.

Roentgen Examination.—There was evidence of a lesion involving the upper right part of the thorax, casting an indefinite homogeneous shadow extending down to the second interspace and outward along the axillary aspect of the thorax at this level. There was complete destruction of the posterior portion of the third rib adjacent to this shadow (fig. 4). The irregular density below suggested an infiltrating neoplastic process or tuberculosis. There was evidence of an old tuberculous lesion in the left apex, and slight local obstruction was noted in the adjacent portion of the esophagus.

Bronchoscopic Study.—There were compression of the trachea from the right, partial obstruction of the right bronchus and flattening of the carina. The mucosa around the upper lobe orifice was granular and bleeding. Carcinoma of the lung with mediastinal metastasis was suggested.

Comment.—While this patient had an apical neoplasm and destruction of a rib with associated pain around the shoulder, he did not have Horner's syndrome. Moreover, there was a bilateral recurrent laryngeal nerve paralysis. This combination was not characteristic of upper pulmonary sulcus tumor, and the roentgen appearances correlated with bronchoscopic observations indicated a probable primary lung cancer metastasizing to the mediastinum and the rib.

Osteogenic sarcomas in the apex of the chest may produce similar roentgenographic appearances and cause a variety of symptoms, as in the following instance:

Case 9.—This case is reported with the permission of Dr. J. B. Carnett and Dr. F. H. Leavitt. I never saw the patient and did not see his roentgenograms until the time of writing this report. His condition had been diagnosed as an "apical chest tumor," but a study of the symptomatology and the roentgenograms has plainly indicated that this case cannot be included in this group.

History.—E. H., a man, aged 79, was first seen by Dr. Leavitt, Jan. 10, 1932. He had been in a normal state of health until three weeks before that time, when he noticed subjective paresthesia of the lower extremities. A week later, these extended up to a girdle below the nipple level, with marked hyperesthesia above. There was no loss of bladder or bowel control, and the patient had no pain referable to either shoulder or arm. He was blind in one eye and almost blind in the other as a result of glaucoma. No mention was made in the history of Horner's syndrome.

Roentgen Examination.—A series of roentgenograms was made at the Graduate Hospital, February 8 to 12, after an injection of iodized rape seed oil into the cisterna. These showed evidence of a block between the first and third thoracic segments of the cord. The report stated that the roentgenograms showed evidence of an infiltrating tumor at the apex of the right lung which had eroded the second rib, the lamina and part of the bodies of the second and third thoracic vertebrae and had encroached on the spinal canal posteriorly.

Subsequent Course.—The patient rapidly became worse, and developed complete paralysis beyond the lesion, both motor and sensory, and loss of bladder and bowel control. He died about March 10.

Comment.—I do not believe that this growth can be classed as an upper pulmonary sulcus tumor as it was supposed to be. The clinical characteristics are entirely different, in the absence of shoulder pain and Horner's syndrome and the presence of a complete paraplegia. From the roentgenographic appearance I should regard the lesion as probably an osteogenic sarcoma primary in the third rib and not the second. It might be a metastatic carcinoma or myeloma. The third rib showed evidence of an expanding tumor just anterior to the seat of its complete destruction. Where destruction was complete there was a considerable amount of calcification within the tumor. The tumor apparently did involve the transverse process, articular process and lamina, and had entered the spinal canal. Such a growth would be away from the spinal roots, common trunk divisions and cervical sympathetic plexus and its supply until late. An osteogenic sarcoma can spread from one bone to another in such a locality, where there are practically fixed articulations. The progress of the growth was far too rapid for pulmonary sulcus tumor. This is an interesting case for differential diagnosis.

2. Henderson, W. F.: Roentgen Study of Apical Chest Tumors, Am. J. Surg. 8: 414 (Feb.) 1930.

Pulmonary tuberculosis may simulate an upper pulmonary sulcus tumor under certain circumstances, in producing a similar shadow and Horner's syndrome. Such a case is illustrated by the following example:

CASE 10.—*History.*—M. T., a woman, aged 59, had a cough of fifteen years' duration. One year before her admission to the University Hospital a roentgenologist diagnosed her condition as "a malignant tumor, possibly an endothelioma in the apex of the right lung connected with the mediastinum," and she was treated for this supposed condition. Our roentgenologic examination, made a year later, showed the same apical shadow and the same interpretation was made, although it was incorrect. The patient was operated on, and a definite firm mass was found in the apex of the lung. It proved to be tuberculous. This case has been reported by Kornblum and Ellison[1] as one of tuberculous atelectatic cirrhosis of the lung. There was no reason for a diagnosis of upper pulmonary sulcus tumor.

COMMENT

1. *Location of Tumor.*—Practically the exact point of origin and location of the tumor under discussion have been determined in three ways: by operation, by roentgenographic examination and by a study of the progression of symptoms. There were no autopsies.

(*a*) *Operation:* Two patients were operated on. The findings in case 1 were of no more value than the roentgenographic localization. In case 2, the entire growth was exposed and was found extending round the posterior aspect of the upper thoracic cavity with its inner extremity between the transverse processes of the first and second thoracic vertebrae. It was thought to be an endothelioma of the pleura, but was not removed.

(*b*) *Roentgen Examination:* This showed an apical shadow and destruction of the upper ribs and transverse processes and occasionally the sides of the bodies of the vertebrae. The ribs were primarily involved for a considerable distance on their posterior aspects. The growth began in the first rib in four cases and in the second and third in two others. It was known to have been preceded by the apical shadow in two instances and may have been in others, possibly all. Rib involvement began from three to nine months after the onset of symptoms. Transverse processes were infiltrated in five cases, but not always the one corresponding to rib involvement. Erosion of the bodies of the vertebrae occurred in three of the cases and was a late manifestation.

(*c*) *Progression of Symptoms:* Of the prominent neurologic signs, posterior shoulder pain was due apparently to involvement of the origin of the posterior divisions of the first and possibly the second thoracic common trunks (fig. 5). Pain high in the axilla was caused by involvement of the branch of the first thoracic not involved in the formation of the brachial plexus and a branch of the intercostohumeral nerve. The upper arm pain corresponded to the supply of the intercostohumeral from the second thoracic and the lesser internal cutaneous from the first thoracic. Pain on the ulnar aspect of the forearm suggested the supply of the internal cutaneous from the eighth cervical and first and second thoracic nerves. Muscular wasting involved the interosseous muscles and those of the hypothenar eminence and the web of the thumb. This would correspond to an ulnar supply from the eighth cervical and first thoracic nerves. Horner's syndrome would place the lesion in the region of the common trunks from the eighth cervical and the first thoracic at least. In cases 3 and 4 this phenomenon appeared several months after the onset of symptoms.

This neurologic localization narrows the actual seat of the lesion to a comparatively small area.

2. *Histologic Origin of Tumor.*—Even with the meager histopathologic data at hand, one is obliged to consider this tumor as epithelial in origin. A review of the slides in case 1 showed spinocellular carcinoma. The original pathologic report on case 2 was carcinoma; no further biopsies were obtained. If the growth were endothelioma of the pleura, why should such a growth in this one location always infiltrate bone and seldom or never occur elsewhere? One can practically rule out primary lung cancer. Certainly it does not produce Horner's syndrome as an early manifestation. The type of cell in case 1 is not so likely to be found in an apical lung lesion so far away from the larger bronchi, according to Dr. McFarland.

It occurred to me that this tumor as a distinct entity might take its origin in an embryonal epithelial rest. The chromaffin bodies were suggested as a possibility

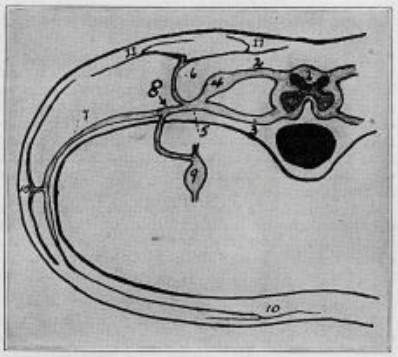

Fig. 5.—Diagram of the formation and division of the spinal nerves and approximate location of the superior pulmonary sulcus tumor: *1*, spinal cord; *2*, *3*, posterior and anterior roots; *4*, spinal ganglion on posterior root; *5*, common trunk, at the convergence of anterior and posterior roots just before emergence from foramen; *6*, posterior primary division, coming off from the common trunk just after emergence and supplying the muscles and integument of back; *7*, anterior primary division, supplying the lateral and anterior aspect of the lower neck and trunk and upper extremity; *8*, approximate location of the tumor; *9*, sympathetic ganglion; *10*, lateral and anterior branches of the anterior primary division supplying the integument; *11*, cutaneous branches of the posterior primary division.

by Dr. Bothe, especially as death from a small tumor without detectable metastases might be due to some unusual disturbance in the chromaffin system. Dr. McFarland has emphatically stated, however, that the type of cell in case 1 was not compatible with this origin.

The next thought was a possible origin from an embryonal rest similar to those of branchiogenic carcinomas. According to Dr. McFarland this would be compatible with the cell type of case 1. Certainly I have not been able to refute such a theoretical origin. A brief résumé of the formation of the branchial arches and clefts will serve to explain this suggestion to better advantage. After the formation of the cephalic portion of the neural tube in the embryo, a series of five parallel bars or visceral arches appears on either side of the

1. Kornblum, K., and Ellison, R. T.: Tuberculous Atelectatic Cirrhosis of the Lung, Am. J. Roentgenol. 25: 629 (May) 1931.

head above the heart tubes (Piersol [4]) with furrows between on the outside and corresponding pharyngeal pouches within. It is the latter that are of particular interest. The first pharyngeal pouch develops into the eustachian tube and middle ear; the second shows its persistence in the fossa of Rosemüller; the third and fourth are concerned in the formation of the thymus and the thyroid body. According to Keibel and Mall,[5] the development of the fifth pharyngeal pouch, long overlooked and disputed, is worthy of consideration. A process from it becomes converted into the ultimobranchial body. This may migrate variously, or it may be enclosed in the thyroid body or go elsewhere to unknown locations. In all vertebrates below mammals it remains as an independent structure. In higher mammals it usually fuses with the middle thyroid anlage, but has been found as an independent body. It can be said to have a variable behavior throughout the mammalian series. What really becomes of it in man, should it exist, is uncertain. However, this or some similar embryonal rest might be the origin of this tumor. It is hoped that the way is paved for a correct solution of the problem in the future as opportunity arises.

3. *Prognosis.*—So far this tumor has resisted all efforts at irradiation treatment. It is obviously not subject to surgical removal, although it is accessible. It is rather rapidly fatal. In cases 1 to 6, death ensued in from eleven to fourteen months after the onset of symptoms. In the more or less doubtful case 7 it occurred in four months. The cause of death is uncertain. There must have been metastases somewhere, but none was found in the lungs or mediastinum. In one case the liver was enlarged. Unfortunately there were no autopsies.

4. *Treatment.*—In the light of present knowledge, the only possible benefit would be irradiation carried out as in any other spinocellular carcinoma. This means ten or more erythema doses delivered by external irradiation plus radon implants after surgical exposure.

SUMMARY

1. Seven cases are reported of a peculiar neoplastic entity found in the upper portion of the pulmonary sulcus of the thorax. Three cases were previously reported and four more recent ones are added.

2. The tumor is evidently epithelial in its histopathology, but its exact origin is uncertain. It seems likely that it may arise from some embryonal rest.

3. Its point of origin is always the same, and it produces constant and characteristic clinical phenomena of pain in the eighth cervical and first and second thoracic trunk distribution, wasting of the muscles of the hand and Horner's syndrome.

4. The roentgen observations are typical, consisting of a small, sharply defined shadow in the apex of the thorax, destruction of one or all of the upper three ribs in their posterior aspects and the adjacent transverse processes, and sometimes slight vertebral body erosion.

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AN IMPROVED CONCENTRATION TEST OF RENAL FUNCTION

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In a previous paper,[1] the value of the specific gravity of the urine as a test of kidney function was discussed. It was pointed out that if the specific gravity of the urine is to be employed as a functional test, certain conditions must be fulfilled: First, a sufficient amount of solid wastes must be presented to the kidneys for excretion. This was obtained by a special diet. Second, the amount of water available for the excretion of these wastes must be limited. This condition was observed by restricting the fluid intake. The purpose of these conditions was to impose maximal strain on the kidneys and to secure the most concentrated urine possible.

Under these conditions it was found that normal individuals were able to concentrate the urine to a specific gravity of 1.026 or above. Diseased kidneys were unable to concentrate to 1.026. The more severe the renal damage was, the lower the specific gravity attained.

There were certain practical objections to this test: First, the subjects were confined to bed for a three day preparation period. This requirement was inconvenient for many patients and consequently precluded the use of the test by many physicians. Second, the amount of food in the diet was often too great for ill patients to consume.

The purpose of the studies reported here was to surmount these difficulties, to simplify the test and to increase its reliability.

Several combinations of different conditions were tried. The conditions finally accepted were as follows: At 10 p. m. of the night preceding the test, all fluid and food, except a special diet, were withheld for thirty-eight hours. From 8 a. m. the following morning until 8 a. m. twenty-four hours later, all urine was collected as one specimen, specimen 1. During this twenty-four hour period the special diet (table 1) was taken. No other food or fluid was allowed during the remainder of the thirty-eight hour period. Specimen 2 was collected at 10 a. m., ending the thirty-sixth hour of the "water fast." Specimen 3 was collected at 12 noon, ending the thirty-eighth hour of the "water fast." The subjects were allowed either their usual activity or bed rest.

The specific gravity of each of these three specimens was determined. This was done at 25 C. by the weight method, weighing bottles of about 5 cc. capacity being used. The Tycos micro-urinometer was employed conjointly with the weight method. If one determines the proper place to read the meniscus by checking with distilled water, this instrument is accurate enough for clinical purposes and is simple to use.

Albumin of the urine was determined quantitatively by the Folin gravimetric method.[2] Since albumin raises the specific gravity of urine, a correction of the observed specific gravity was made for its presence.

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