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PATHOLOGIC CHANGES OF BONE IN CHRONIC FLUORINE POISONING

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The pathologic effects of chronic fluorine poisoning have been observed chiefly in experimental animals. In man, except for noting the formation of mottled enamel in the teeth of growing children, few opportunities have existed for the study of pathologic changes in other organs as a consequence of the prolonged ingestion of fluorides. Flemming Møller and Gudjonsson (1) observed an increased density of the bone shadows by roentgen ray in a number of cryolite workers which they concluded were due to fluorides, but direct examination and chemical analysis of the bones were not possible at the time because none of their patients had died. The death of a patient in the Pennsylvania Hospital in whom similar roentgenographic changes were observed by one of us (P.A.B.) made direct examination of the bones and chemical analysis possible, thereby confirming Flemming Møller and Gudjonsson's observations. As a previous report of this case from the radiologist's viewpoint has been made by one of us (2) and as the chemical studies will be reported in detail elsewhere, the present report will dwell mainly upon the pathologic findings.

REPORT OF CASE

Clinical Abstract: A colored man 48 years of age, who had worked for eighteen years in a fertilizer factory handling finely ground rock phosphate—a sample of which contained 3.88 per cent. fluorine—was treated on the service of Dr. David L. Farley over a period of three years because of syphilitic aortitis and myocardial failure. During the course of roentgen ray examinations, an unusual density of the bones was observed which suggested that produced by skeletal metastasis from primary carcinoma of the prostate. This organ, however, was not enlarged or firm on rectal examination, and he never had symptoms of urinary obstruction. He had no anemia or a history of gastric disturbances—conditions observed by Flemming Møller and Gudjonsson in their series. With the exception of slight limitation of motion of the lower lumbar spine he had no arthritic symptoms. Death was entirely due to cardiac failure resulting from syphilitic aortitis and widespread arteriosclerosis.

Review of roentgenograms taken during life: The essential changes were: an increase in bone density without alteration of the normal bone structure, a lack of normal sharpness of the bone outlines, and an extension of calcification into the ligamentous attachments. The greatest density according to the roentgenograms existed in the spongy bodies of the vertebrae and sternum, then to a lesser degree in the ribs, scapulae, pelvis and long bones of the extremities. In the films this density varied from the marked "milky white opacity" to the "fleecy thickening of the bone laminae" of Flemming Møller and Gudjonsson. Indistinct margins of the bone shadows and increased shadows in the interosseous spaces suggested an extension of calcification beyond the bones into the soft tissues. These changes can be seen in figures 1 to 4.

*Pathologic Findings:** (1) Syphilitic aortitis with slight involvement of the aortic valve. (2) Widespread arteriosclerosis. (3) Marked hypertrophy and dilatation of heart. (4) Myocardial scarring. (5) Endocardial thrombus in left ventricle. (6) Thrombus in right auricular appendage. (7) Pulmonary infarcts. (8) Chronic passive congestion of lungs, liver, spleen and kidneys. (9) Ascites. (10) Pulmonary edema. (11) Acute bronchitis. (12) Slight chronic nephritis. (13) Subpelvic abscess of kidney. (14) Old pleural adhesions, bilateral. (15) Old peritoneal adhesions. (16) Cholelithiasis.

No changes were seen in the viscera which could be ascribed to fluorine. There were a few insignificant calcified areas microscopically in the smaller bronchial cartilages within the lung, in the kidney and in the choroid plexus. Several scarred glomeruli; a thickening of walls of the smaller arteries and arterioles; some tubular degeneration; and several microscopic abscesses beneath the pelvic epithelium, were seen in the kidney. The lungs contained some anthracoid pigment but no fibrosis or areas suggesting silicosis. There was an apparent increase in lymphocytes in the submucosa of the stomach, but no ulceration. The thyroid and parathyroids were not examined.

Bones: The entire skeleton could not be examined at necropsy, but several ribs, the sternum, some of the thoracic and lumbar vertebrae, the right humerus and femur, the upper halves of the right ulna, radius, tibia and fibula, and part of the skull were obtained for pathologic and chemical examination. In general the cortical portions of the bones were thicker than usual. This was particularly noticeable in the ribs, where it encroached upon the marrow spaces (Fig 11). The bones seemed firmer than usual, cutting with difficulty. The spongy portions of the vertebral bodies and the manubrium of the sternum were more compact than usual. Osteophytes extended upward and downward from the anterior margins of the vertebral bodies and were fused in places to form bridges over the intervertebral cartilages (Fig. 10). Many exostoses were present along the tendinous insertions of the muscles to the long bones (Fig. 6). Behind the olecranon at the insertion of the triceps was a thickened, roughly triangular exostosis with the

* A. 5256 Performed by Dr. Joseph B. Vander Veer, 48 hours after death.

apex projecting upward (Fig. 5). The tuberosity of the radius; the lateral and medial epicondylic ridges and the greater tubercle of the humerus; the lateral aspect of the greater trochanter and the margins of the popliteal plane between the epicondyles of the femur; the medial aspect of the tibia (Fig. 7) where the sartorius, gracilis and semitendinous muscles were inserted:—all were quite rough with spicules of bone radiating outward in the general direction of the muscular attachments. The interosseous ridges of the tibia and fibula (Fig. 6) were prominent and roughly serrated. Plaques of thin cortical bone extended over the anterior surface of the body of the sternum along the chondral articulation of the ribs (Fig. 8). Ossification of the costal cartilages was scattered about.

The surface of the bones had irregular chalky white patches (Fig. 5) which were probably identical with those described in the bones of hogs by Kick and others (3).

Teeth: No mottling of the enamel was seen. The teeth were in bad condition, however, probably because of neglect. Many cavities were present; the crowns of the bicuspids were worn down more than usual; and a thickening of the apical portions of the roots was noted which suggested healed abscesses.

Microscopic Examination: A cross section of one of the ribs showed a marked increase in the width of the cortex and a thickening of the trabeculae, with encroachment upon the marrow spaces. This increase in compact bone compressed the Haversian canals in places (Fig. 11). Young osteoid tissue was not seen, but a little bone proliferation had occurred along the periosteum. Widespread deposits of calcium in the form of coarse granules and clumps throughout an irregular organic matrix such as Roholm (4) described, were not seen.

The marrow, moderately reduced in amount appeared otherwise normal. There was no evidence of inflammation.

Chemical Analysis: Bones were freed of non-osseous tissue, broken into small pieces and extracted successively with pure neutral ethyl alcohol and anhydrous ether in a Soxhlet apparatus. The dry, fat-free bones were finely powdered and stored in a desiccator for analysis. Ash was determined by ignition at 650°C. in an electric furnace. Fluorine in this ash was distilled from perchloric acid according to the method of Willard and Winter (5) and titrated with thorium nitrate in the presence of alizarin as suggested by Armstrong (6). These analyses were made on samples from the skull, femur, rib, manubrium, vertebra and one of the osteophytes attached to a lumbar vertebra.

The results of the analyses are shown in Table I.

The values for ash, calcium, phosphorus and carbon dioxide were essentially normal. That of fluorine was from 10 to 20 times the normal value (7, 8).

TABLE I

Fluorine Content of Human Bones in Chronic Fluorine Poisoning

Bone	Fluorine in Per Cent. of Dry Fat-free Bone
Vertebra	0.70
Manubrium	0.69
Osteophyte from lumbar vertebra	0.68
Rib	0.56
Skull	0.38
Femur (midshaft)	0.29

Discussion

The excellent reviews of DeEds (9) and McClure (10) should be consulted for the literature concerning the physiological effects of fluorine. In the human body the sites of maximum deposits are said to be the teeth and bones, the latter containing normally between 0.01 per cent. and 0.03 per cent. fluorine. The values which we obtained from the bone (0.29 to 0.70 per cent. fluorine), therefore represent a marked increase.

Experimentally, Kick and others (3) have noted the following pathologic changes in the bones after the prolonged ingestion of sodium fluoride or substances containing fluorine: the bones were thick, rough, chalky white and lusterless; exostoses were numerous; an increased amount of subperiosteal bone and a lack of uniformity in converting this into compact bone were noted; and fragility was occasionally increased. The pathologic changes therefore, in our case, are in many respects similar to those produced experimentally. Roholm (4) also reported similar changes in the human bones of two cryolite workers who died of intercurrent infections.

Roentgenographic changes in the bones of rats after prolonged fluoride ingestion consisted of increased density when the calcium intake was adequate (Sutro (11)) but he reported no exostoses or calcification of the interosseous membranes. These changes which were first observed roentgenographically by Flemming Møller and Gudjonsson in man have since been seen in roentgenograms of the bones of the inhabitants of phosphate regions in North Africa who suffer from "darmous," a disorder of

the teeth, probably identical with mottled enamel (Spéder (12) and Spéder and Fournier (13)). They noted that bone proliferation occurred along the periosteum and the tendinous insertions in young subjects who had been exposed for a short time to fluorides, while osteopetrosis in addition developed with increasing age and exposure. The changes in ours are similar, so that it is reasonable to assume that fluorine was the cause.

It is noteworthy that in our case, the extent of the osseous changes, roentgenographically and pathologically was directly proportional to the fluorine content.

Although our patient had syphilis for which he refused treatment, it is doubtful whether this disease was responsible for the osseous changes.

As fluorine affects the teeth during the growing stage of man and animals, and there was an absence of gross dental changes, further studies of the teeth were not made.

Summary

The pathologic changes in the bones of a patient exposed for years to phosphate rock containing about four per cent. fluorine are described and correlated with roentgenograms and fluorine determinations. The studies of others in animals and man indicate that the prolonged ingestion of small amounts of fluorine produces exostoses, an increased density of bones, and a calcification of the interosseous membranes and tendinous insertions of the muscles which may be readily detected by roentgen ray examination.

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DESCRIPTION OF PLATES

Plate 19

Fig. 1. Homogeneous density of vertebral bodies and the presence of large osteophytes, in chronic fluorine poisoning.

Fig. 2. Increased density of pelvic bones in chronic fluorine poisoning.

HYPERPARATHYROIDISM RELIEVED BY REMOVAL OF A PARATHYROID TUMOR*

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One hundred and thirty-five proved cases (1) of hyperparathyroidism have been reported since Mandl's (2) first successful operative removal of a parathyroid tumor for the disease in 1925. However, the condition is still sufficiently rare to warrant the report of an additional case.

The parathyroid glands have a relatively brief history. Perhaps due to their diminutive size, they succeeded in escaping the attention of anatomists until 1880 when Sandström (3) first described them. Their importance began to be appreciated with the development of thyroid surgery and it was soon learned that tetany and death followed their complete removal. DeSanti (4) in 1900 was apparently the first to recognize a tumor of the parathyroid glands and Askanazy (5) in 1904 was the first to suspect a relationship between a tumor of the glands and skeletal disease. MacCallum (6) in 1905 found a parathyroid tumor at necropsy in a patient who died from uremia and chronic nephritis. However, it was not until 1925 that two almost simultaneous discoveries, one clinical and one of an investigative nature, opened the way to a rapid development in our knowledge of the function of these glands. Collip (7) in 1925 isolated an active extract of the parathyroid glands, which was capable of maintaining life and controlling the tetany of animals from which the glands had been removed, and which would raise the serum calcium of normal animals to a level incompatible with life. Mandl (2) in 1926 after first attempting to treat a case of generalized osteitis fibrosa cystica by grafting normal parathyroid glands, explored the cervical region and found a parathyroid tumor which he removed with subsequent cure of the patient. Since then there has been a rapidly increasing number of reports of the successful treatment of hyperparathyroidism by removal of parathyroid adenomas.

Successful cases have been reported from most European countries and from the United States, the largest series being

* Reported before the Section on General Medicine of the College of Physicians of Philadelphia, March 23, 1936.

that of Churchill and Cope (8), who reported 30 cases from the Massachusetts General Hospital in Boston. Wilder and Howell (1) comment upon the large proportion of cases from New England and the Scandinavian countries. They suggest that the deprivation of vitamin D may be a factor in the development of these tumors. To our knowledge there have only been two cases reported from Philadelphia of the successful treatment of hyperparathyroidism by the removal of a parathyroid tumor. In 1931 Quick and Hunsberger (9) reported a case of far advanced hyperparathyroidism which was successfully treated by the removal of parathyroid tumors. In 1936 Elsom, Wood and Ravdin (10) described a case of hyperparathyroidism with renal insufficiency in which removal of an adenoma relieved the patient of her symptoms, but had no striking effect on the renal lesion. In addition to these two reports of successful removal of parathyroid adenomas, two cases of hyperparathyroidism have been treated surgically in Philadelphia. Shallow (11) in 1931 reported a case of osteitis fibrosa cystica in which no parathyroid tumor was found at operation but in which a small tumor of the thyroid gland, about 1 cm. in diameter, was removed, together with a normal parathyroid. The pathological report describes the tumor as thyroid tissue, but the history of this case suggests that this may have been a parathyroid tumor. In 1932 Hitzrot and Comroe (12) presented a case of hyperparathyroidism which was improved by partial parathyroidectomy although no parathyroid tumor was found at operation.

The following is an account of our case with illustrations of the tumor removed. As the pathology of the parathyroid gland in hyperparathyroidism has been so admirably and adequately described by Castleman and Mallory (13), no detailed discussion of the pathologic changes are given.

Report of Case

O. A., a colored man aged 60 years, entered the Pennsylvania Hospital in July, 1927, because of an enlarged prostate and urinary retention. He had had increasing frequency of urination for three years and nocturia for two months prior to admission. Acute retention of urine had occurred two weeks before admission, and he had been catheterized twice daily since then. The blood pressure was 95 over 65. There was some distention of the bladder and both lobes of the prostate were enlarged, firm and smooth. The urine was acid, specific gravity 1.015, and contained a trace of albumin, no sugar, and many pus cells. Phenolsulphonephthalein elimination was 25 per cent.

in a specimen obtained by catheterization at the end of two hours. The blood urea nitrogen was 13 mg. and creatinine 1.4 mg. per 100 cc. The blood Wassermann reaction was negative. The bladder was drained by suprapubic cystostomy. A week later a suprapubic prostatectomy was performed, which was followed by an uneventful convalescence. Examination of the excised prostate showed no stones or deposition of calcium.

He was readmitted to the hospital in December, 1929. His frequency had decreased considerably since prostatectomy and he had felt very well until about two months before admission. At this time he stopped working as an elevator operator because of vague joint pains, especially in his ankles and knees. About two weeks before admission he noticed a swelling of his right clavicle which was hard, tender and painful. The pain was worse on elevation of the arm.

On physical examination a firm egg-shaped enlargement in the middle of the right clavicle was noted. There was marked bowing of the legs (Fig. 1) and the patellar reflexes were very sluggish. The blood pressure was 124 over 62. The urine was acid, specific gravity 1.016, contained no albumin, sugar, pus cells, red blood cells or casts. The hemoglobin was 15 gm. per 100 cc., erythrocytes 5.1 million and leucocytes 11,300 per cu. mm. The blood urea nitrogen was 13 mg. and creatinine 1.2 mg. per 100 cc. The blood Wassermann reaction was again negative. Cysts of both clavicles (Fig. 2) were diagnosed by roentgenograms. He was operated upon and on removal of the outer shell of bone overlying the cysts soft granular tissue was exposed. This tissue was curetted out of the cysts of both clavicles and the wounds packed open with vaseline gauze. A clinical diagnosis of sarcoma was made from the appearance of the tissue. Eight days after operation the vaseline gauze was removed and 2900 milligram hours of radium were given to each wound. The pathological report upon the tissue removed at operation was: bilateral giant cell tumor of the clavicles (Fig. 3). Because of the reported association of multiple giant cell tumors with hyperparathyroidism, the pathologist recommended a determination of the serum phosphorus and calcium. The calcium was 12.5 and the phosphorus 2.8 mg. per 100 cc. These abnormal values raised the question of parathyroid tumor but nothing further was done about it until December, 1931, when the patient was seen in the surgical follow-up clinic of the out-patient department, and the calcium and phosphorus determinations were repeated (Chart 1). Because of the persistence of the abnormal findings, other portions of the skeleton were then examined by roentgenograms, and lesions were found in the ilium (Fig. 4), the right tibia and femur near the knee, the ribs and the phalanges. In addition to these cystic areas there was a generalized decalcification of the skeleton. There were no lesions in the skull. A parathyroid tumor was then suspected, and the patient was seen at intervals throughout the next eighteen months. In December, 1932, he began to complain of pain in his knees and ankles. In June, 1933, he had almost constant pain in both knees, which was worse on the right side, and parathyroidectomy was advised. The patient wanted to defer operation until the fall. In September the pain in his knees had increased and he consented to operation. His only symptom was pain in both knees, especially on the right side. The pain was increased

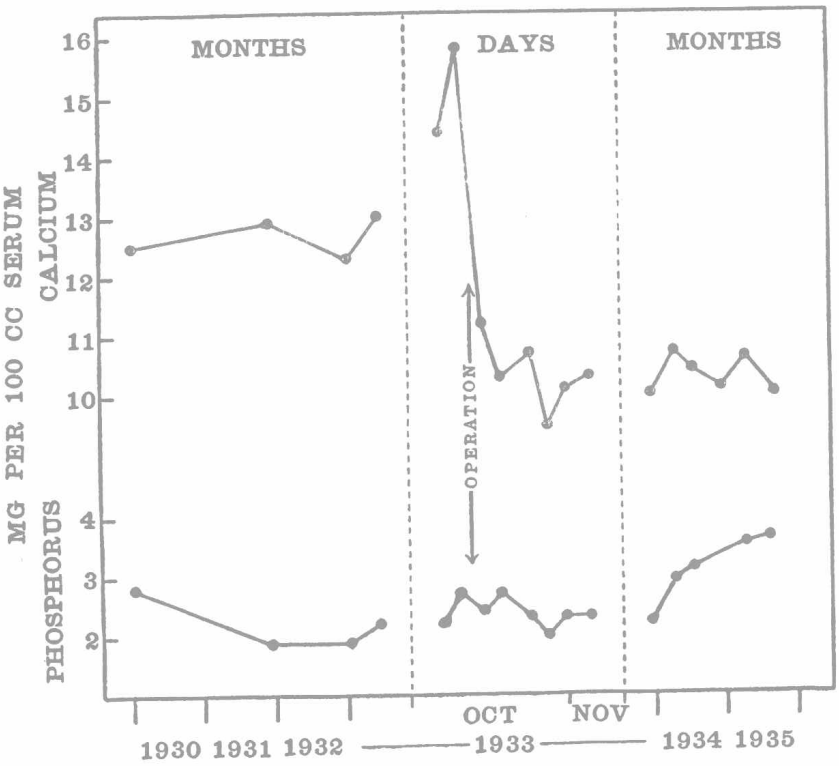

CHART 1. Serum calcium and phosphorus values over a period of five years; three before and two after the removal of the parathyroid adenoma.

by walking, but was also present when resting at night. There were no gastro-intestinal symptoms. His bowels were regular and moved once daily. He had to urinate two or three times at night and sometimes as often as every two hours during the day. Fatigue on slight exertion had been present for the past three years, although he had not been working for five years. He had noticed slight bowing of the legs since he was fifteen years old, but during the past two years he said this had become quite marked. The physical examination was essentially negative. He had kyphosis of the thoracic spine and bowing of the legs (Fig. 1). There was diminution of the Achilles and patellar reflexes. There was no palpable tumor of the neck. The urine was clear, acid, specific gravity 1.020, contained no albumin, red blood cells or casts. There were a few pus cells. Roentgenograms showed slight curvature of the trachea to the left in the neck (Fig. 5). The serum calcium figures were higher than before (Chart 1).

He was operated upon (by J. B. F.) under tribromethanol (avertin) anesthesia in October, 1933. A yellowish brown tumor (Fig. 6) measuring 4 by 2 by 2½ cm. was found in close relation to the lower pole of the right lobe of the thyroid, corresponding to the position of displacement of the

trachea to the left. The tumor was completely removed. No attempt was made to demonstrate the other parathyroid bodies. After operation the serum calcium fell promptly to normal levels, but the serum phosphorus remained low (Chart 1). He was given calcium lactate and viosterol for a number of days after operation, and at no time developed signs of tetany. The tissue removed showed a small area of normal parathyroid tissue with a few oxyphile cells (Fig. 7). The rest of the tissue was composed of a chief cell tumor of the glandular and cystic type (Fig. 8). Since operation he has been relieved of the pain in his knees, and no longer becomes easily fatigued. Over a period of two years his serum calcium has remained at a normal level and the serum phosphorus has gradually increased to approximately normal values (Chart 1). He still has some frequency and nocturia, which has not changed since operation. There has never been any evidence of urinary calculi from symptoms or roentgen ray examination of the urinary tract. Some of the cystic areas in the skeleton have become denser since operation (Fig. 9).

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DESCRIPTION OF PLATES

PLATE 24

FIG. 1. Photographs of patient in fall of 1933, showing general body stature with bowing of legs, kyphosis and apparent increase in the length of the upper extremities.

SPONTANEOUS RUPTURE OF THE ESOPHAGUS REVIEW OF LITERATURE AND REPORT OF ONE CASE

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Our knowledge of so called spontaneous rupture of the esophagus dates from 1724, when Boerhaave reported the strange death of Baron Wassenaar. Fitz (1) accepted very few cases reported as such prior to 1877. In 1914 Walker (2) thoroughly reviewed the subject and summarized those cases which, in his judgment, were attributed to spontaneous rupture. His summaries, brief but comprehensive, are listed in Table I (cases 1 to 22 inclusive). Beyond an occasional consideration of original reports we have accepted Walker's review of those cases occurring prior to 1914.

Before reviewing the cases since 1914, a brief discussion of etiology is appropriate. The possible causes of this condition considered are:—

(1) Congenital weakness of the lower end of the esophagus.
(2) Acute ulceration.
(3) Digestive action of regurgitated gastric juice.
(4) A sudden increase in intra-esophageal pressure.

Congenital weakness of the esophagus seems a most unlikely cause, as spontaneous rupture of the esophagus is exceedingly rare in childhood and infancy when congenital defects are especially prone to cause trouble and when vomiting is frequent. Menne and Moore (3) asserted that only three cases of spontaneous rupture of the esophagus had been reported in children in two hundred years. Furthermore there were no gross or microscopic evidences of thin muscular coats in the reported cases.

The second, third and fourth possibilities cannot be accurately evaluated. A small acute linear ulcer of the lower esophagus, acted upon by digestive enzymes and acid from the stomach, could produce weakening of the esophagus with rupture ensuing under the stress of violent retching or vomiting. The symptoms and

signs would be essentially the same as those in a case of a rupture of a normal esophagus and the pathological changes about the margins of the rent occurring in the interim before death could not be distinguishable from those occurring prior to the actual perforation.

We believe that an increase in the intra-esophageal pressure is the most important though probably not the only factor in precipitating perforation in these cases. Many of the perforations have occurred in alcoholics. This historical fact is very likely of importance only in so far as it is related to vomiting. However, the possibility that alcohol has a deleterious effect upon the mucous membrane of the lower esophagus rendering it more liable to ulceration and digestion, or that it exerts some effect upon the involuntary muscles of the esophagus which results in forceful contractions or spasms thereby influencing the course of events, cannot be overlooked. Eighteen of the 35 cases, see Table I, gave a positive alcoholic history, 7 denied its use and in 10 either no statement was made concerning the use of alcohol or it was questionable whether significant amounts had been taken. Only 5 of the 35 cases occurred in females and 25 occurred during the third, fourth and fifth decades of life.

In view of the uncertainty of the relative etiologic importance of several factors, it seems unjust to reject cases with fairly typical clinical and necropsy findings merely because of the presence of some additional lesion which may have been partly responsible for the sequence of events. This is well exemplified in Myer's case (Table I, Case 4) in which a stricture of the esophagus, which has been present for 35 years, obstructed the passing of a piece of sausage. The sausage became impacted in the esophagus and during violent efforts to dislodge it the esophagus was ruptured. We accept, therefore, the term, "spontaneous" to mean that the perforation is caused principally by an increase in the intra-esophageal pressure. In accepting and rejecting cases the problem resolves itself into the evidences which represent an expression of, or the result of this force. The history of a sudden onset of severe pain with ensuing subcutaneous emphysema is important. The clinical demonstration of pneumothorax with recovery of gastric contents from the pleural cavity and the finding of mediastinal emphysema, pneumothorax with pulmonary collapse, and the nature of the perforation with gastric contents in the pleural cavities are important at necropsy.

We feel that the term "spontaneous rupture of the esophagus" should be reserved for those cases in which a review of the history and necropsy findings discloses definite circumstantial evidence that a sudden increase in intra-esophageal pressure occurred at the time of perforation.

In reviewing the cases reported since 1914, we have adopted Walker's plan. Instances of perforation of the esophagus in which foreign bodies, external trauma, or damage inflicted during esophagoscopy or intubation were implicated are excluded. The six cases reported by Masten and Bunts (4), in which definite cerebral lesions were present and perforation occurred presumably while the patients were in coma are rejected because the spontaneous element was certainly of minor importance. The second and third cases reported in Gott's (5) article also fall in this category. The fourth of Gott's cases is also rejected because the history and necropsy failed to show convincing evidence of sudden increase in intra-esophageal pressure as a causative factor in the perforation, and also because of the multiplicity of complicating factors such as evidence of pre-existing disease of the esophagus, possible duodenal ulcer, pneumonia, and intubation of the stomach. The reports of Glass and Freeman, (6) were rejected because there is no evidence that there was an increased intra-esophageal pressure and necropsy revealed syphilitic lesions of the esophagus. In both of these cases the posterior mediastinum contained black coffee-ground material but there was no mention of perforation into either pleural cavity or of mediastinal or subcutaneous emphysema. Hemorrhage, evidently, was the predominant feature.

Walker's cases and additional ones which we feel are acceptable are summarized in Table I.

Report of Case

P. S., a 34-year-old male Russian Jew, was admitted to the Pennsylvania Hospital on the evening of April 24, 1936. His health had been excellent before the evening of admission. Immediately prior to the onset of symptoms he had eaten large helpings of spaghetti and drank many glasses of wine and beer. His illness began with a sudden, excruciating precordial pain radiating to the left side and to the back but not to the arms, neck or abdomen. The patient stated that "he felt something pushing up on his heart."

On admission the physical examination revealed a well-nourished adult man markedly dyspneic and cyanotic. His extreme restlessness and constant moaning made the examination unsatisfactory. He was perspiring profusely

but his skin was cold. His temperature was 99.2° F. (by rectum), pulse rate 88, and his blood pressure 104/70. The pupils were contracted. His chest was emphysematous, the respiratory movements were diminished and the breath sounds distant. The heart sounds could not be heard.

A tentative diagnosis of coronary occlusion was made by the resident physician.

The patient received ½ grain of morphine sulphate and became less restless but complained of pain in his right chest. The blood pressure was 80/60 at 9 A. M. (April 25th) when the patient's condition was obviously worse. He was placed in an oxygen tent to combat the increasing cyanosis. At this time (9 A. M.) subcutaneous emphysema was noted in the neck and upper chest. It was also noted that the left side of the chest expanded less than the right and that the trachea was shifted to the right side. These signs suggested the presence of a pneumothorax.

The patient was seen by one of us (G. G. D.) at 11 A. M. when the left chest was immobile and there was marked hyperresonance approaching tympany over the upper anterior left chest with flatness in the left posterior axillary region. (The patient was not turned for examination of the back because of the agonizing pain.) The cardiac dullness was obliterated. The heart and breath sounds were obscured by the patient's groans. The abdomen was tense and the liver was slightly enlarged on percussion.

Dr. Paul A. Bishop's report on the radiographic examination was as follows:—"There is no visible left lung shadow but there is a dense shadow at the left base. The heart is markedly displaced toward the right side. Extravasation of air can be seen between the cervical muscles and beneath the skin in the cervical region. Conclusion : Subcutaneous emphysema, massive pneumothorax with a fairly large collection of fluid in the left pleural cavity."

The electrocardiogram, interpreted by Dr. Joseph B. Vander Veer, failed to reveal evidence of a coronary occlusion.

At 11.30 A. M. a thoracentesis was done and 200 cc. of dirty brown, strongly acid and practically odorless fluid containing many food particles were withdrawn.

The patient's pulse rate remained between 115 and 126, the blood pressure dropped to 60/40, the temperature was 101.5° F. and the respirations varied from 36 to 56 per minute. There was no leukocytosis. He died at 11.40 A. M. (April 25).

The final clinical diagnosis was spontaneous rupture of the esophagus with air and gastric contents in the left pleural cavity, and subcutaneous emphysema.

The subcutaneous emphysema, the air and gastric contents in the left pleural cavity rendered the diagnosis relatively certain. Clinically the cause of the rupture was obscure. No history of vomiting, retching or external violence could be obtained from the patient or from others who were with him at the onset of his final illness. Over-distension of his stomach with food and alco-