Though carcinoma of the stomach is one of the most common malignant tumors of adult life, bony metastases from this source are infrequent. The total number of cases showing bone involvement is variously stated as from 1.0 to 22.0 per cent of the total (Schinz, Fraenkel) though the usual figure is under 6 per cent (Müller, von Glahn, Colwell, Symmers). The reported incidence depends obviously upon whether the author’s observations have been made at the autopsy table or roentgenographically and, in either case, upon the thoroughness of the search. In any event, metastatic involvement of the bones is certainly relatively low in gastric cancer as compared, for example, to that in carcinoma of the breast and prostate.

We have found in the literature 143 apparently authentic cases, with a case or two of direct invasion and one doubtful case. To these we add three cases with roentgen evidence of osseous involvement and two found at autopsy, bringing the total number to 148.

**Case Reports**

Case I. J. A. T., male, aged thirty-two, entered the University Hospital July 5, 1932, on the service of Dr. C. Van Epps, complaining of pain under each shoulder blade, nausea, vomiting, weakness, and loss of weight. The family history was negative, and the past history irrelevant. The present illness dated from January 1932, having begun with severe pain under the right rib margin. The pain was occasionally relieved by alkalis but not by food or vomiting. Roentgen examination elsewhere, in May 1932, showed no lesion of the stomach. In June the patient first noticed pain under the scapulae, and vomiting occurred for the first time. Blood in the vomitus was observed in July. The weight had fallen from 237 to 185 lb. (107.7 to 84.1 kg.), a loss of 52 lb. (23.6 kg.). Except for relative emaciation and a suggestion of anemia, physical examination revealed no evidence of a gross pathologic process.

The blood Wassermann reaction was negative. The blood count, July 5, showed hemoglobin 75 per cent, red cells 4,250,000, white cells 6,550. The red cell count had fallen to 3,750,000 on July 17 and to 3,150,000 on July 19; the white cell count on these dates being 3,000 and 2,700 respectively. The differential count showed 45 per cent neutrophils, 2 per cent eosinophils, 15 per cent lymphocytes, 9 per cent monocytes, 17 per cent basket cells, and 12 per cent abnormal monocytes.

The urine showed a trace of albumin but no Bence Jones protein.

The serum calcium was 18.5 mg. per cent, serum phosphate 4.6 mg. per cent, serum protein 6.3 mg. per cent. The spinal fluid calcium was 6.3 mg. per cent and phosphorus 1.2 mg. per cent.

The gastric test meal revealed anacidity and much blood.

Roentgenographically the stomach showed a marked deformity of outline which was interpreted as a primary cancer. Roentgen studies of the skeleton showed osteolytic lesions involving the pelvis, femora, spine, and ribs. A diagnosis of carcinoma of the stomach with extensive bone metastasis was made. Because of the extent of osseous involvement malignant lymphoma was also considered.
Deep roentgen therapy was given for relief of pain but without success. The patient became rapidly worse and died July 19. Autopsy showed adenocarcinoma of the stomach with metastasis to the regional lymph nodes, ribs, and ileum. Other bones were not examined.

CASE II: R. W., male aged thirty-six, entered the hospital Oct. 23, 1933, on the medical service. There was no family history of cancer and the patient's past history was not significant.

The present illness dated back two years, to October 1931. It began with epigastric pain which was aggravated by food and slightly relieved by alkalis. Vomiting occurred frequently, shortly after meals; the weight had fallen from 155 to 122 lb. (70 to 55.4 kg.), a loss of 33 lb. (14.6 kg.), and there was a history of increasing weakness.

In July 1932 the patient had suffered severe pain in the right chest, and pain had first occurred in the right femur in September 1932. An injury to the back was sustained in September 1933, and it had continued to be painful. For the past three months there had again been pain over the eighth rib and for six months small nodules over the skin of the abdomen.

The patient was poorly nourished, emaciated, and weak, with extreme pallor. In the epigastrium was a palpable mass, firm and fixed but not tender, and extending down to the level of the umbilicus. There were palpable nodules in the skin near the umbilicus and a tender fixed mass over the eighth rib on the right side.

The blood Wassermann reaction was negative; hemoglobin 92 per cent; red cell count 4,940,000; white cell count 6,950. The differential count showed 77 per cent neutrophils, 1 per cent eosinophils, 2 per cent basophils, 4 per cent lymphocytes, 5 per cent monocytes, 4 per cent unclassified, and 7 per cent basket cells.

There was no record of a test for Bence Jones protein.

The biopsy report on the lesion over the right eighth rib was "colloid" carcinoma. Roentgen examination of the stomach showed filling defects on both greater and lesser curvatures, interpreted as carcinoma. Roentgen examination of the chest revealed osteolytic lesions involving the eighth rib on the right side, with pathologic fracture. No treatment was given.
Case III: J. S., male aged twenty-two, entered the medical service on Nov. 23, 1933. Since an appendectomy in 1932, he had had periods of gastric distress. In June 1933 he had had abdominal cramps not associated with pain. One week following the onset of these he fainted and shortly after this a tarry stool was passed. The patient was then taken to a hospital and while there had three gross hemorrhages and received five blood transfusions. Roentgen examination at that time showed a duodenal deformity, and ulcer treatment was instituted, followed by some improvement. Shortly afterward some
teeth were extracted, following which the right side of the face began to swell. There was gradual loss of sensation in the right upper lip and along the side of the nose. Several days later sharp pain occurred over the right half of the face, becoming worse in the course of a few days. During this time a hard nodule appeared, lateral to the right eye, and this had increased in size.

The patient was poorly nourished, cachectic, and pale. There were a hard mass lateral to the right orbit, and right exophthalmos with some edema of the lids. The blood Wassermann reaction was negative. Examination on Nov. 23, 1933, showed hemoglobin 65 per cent, red cells 4,020,000, white cells 8,250; on Dec. 5, hemoglobin 40 per cent, red cells 2,230,000, white cells 10,300. The differential count was: polymorphonuclears 69 per cent, lymphocytes 17 per cent, unclassified 11 per cent, monocytes 3 per cent.

The urinary findings were not significant. The stool showed evidence of blood on six examinations.

The total blood protein was 6.05 mg. per cent, fibrinogen 0.416 mg. per cent, albumin 2.96 mg. per cent, globulin 2.67 mg. per cent, blood calcium 12.4 mg. per cent, phosphorus 4.2 mg. per cent.

Roentgen examination of the skull showed small areas of decreased density, suggesting an osteolytic neoplasm. Myeloma was first considered. X-rays of the chest and pelvic region were negative, except for a lesion in the neck of the femur.

The nodule on the right side of the head increased in size and right proptosis became more pronounced. Biopsy was attempted but no tissue was obtained. Death was due to gastric hemorrhage.

Autopsy revealed scirrhous carcinoma of the stomach, with metastases to the lymph nodes, ribs, fourth lumbar vertebra, upper end of the right femur, parietal bone, and lesser wing and body of the sphenoid.

Case IV: J. M., aged fifty-eight, male, complained of gradual loss of weight and distress on eating. X-ray examination of the gastro-intestinal tract was unsatisfactory but apparently negative. Autopsy revealed scirrhous carcinoma of the stomach and recent bone metastases. No roentgen studies of the bones were made.

Case V: F. J., female, aged sixty-eight, had continuous pain over the sacrum, with tenderness. She had no complaints referable to the gastro-intestinal tract, but had very dark stools. The roentgen findings in the fifth lumbar and first sacral segments were interpreted as inflammatory or neoplastic, because of sclerosis and destruction.

FIG. 5. CASE I: ROENTGENOGRAM SHOWING INVOLVEMENT OF LOWER PELVIS AND FEMORA
Autopsy revealed adenocarcinoma of the stomach 10 cm. from the pylorus, rather undifferentiated, with little acinus formation. The body of the fifth lumbar and the cartilage between the fifth lumbar and first sacral segments were destroyed by carcinoma.

Discussion

As stated above, bone metastasis in gastric carcinoma is rare. Moore examined 1,600 cases of gastric cancer without finding evidence of bone involvement, Winiwarter had 903 cases without osseous metastasis, and Joll could find no instances of bone lesions secondary to gastric cancer in the museums of London.

In small autopsy series percentages as high as 22 (Miyachi) or 20 (Fraenkel) have been reported. In our own series of 123 cases diagnosed roentgenologically as carcinoma of the stomach, 3 (2.4 per cent) had demonstrable bone lesions.

In a series of 916 cases of carcinoma reported by Nisnjewitsch as found at autopsy, 104 showed bone metastases. Though 309 of the series represented gastric carcinoma, these accounted for only 8 of the instances of bone metastasis.

Blood Picture: The association of a marked anemia of the primary type with carcinoma of the stomach that has metastasized to bone was stressed by Frese in 1900 and has since been emphasized by Kurpuweit (1903), Arueth (1904), Schleip (1906), Parmentier and Chabrol (1909), Harrington and Teacher (1910), Ellermann (1923), Bucci (1931), and others. Harrington and Teacher report an interesting case which is typical of those found to have marked blood changes.

The patient was a woman of sixty-four, who complained of pain in the back, legs and shoulder. She gave a history of constipation followed by melena. Once she had
FIG. 8. CASE II: PHOTOMICROGRAPH OF RIB NODULE SHOWING TYPICAL SIGNET-RING CARCINOMA

FIG. 9. CASE III: PHOTOMICROGRAPH OF GASTRIC LESION
vomited brownish material. At autopsy a carcinoma of the stomach was found with metastases in the ribs, femur, and spine. Death occurred thirty-seven days after admission. Blood examination had shown 1,600,000 red cells, 14,000 white cells, 35 per cent hemoglobin, and a color index of 1.06. The red cells showed anisocytosis, poikilocytosis, polychromatophilia and granular basophilia; normoblasts were present, and myelocytes were as high as 6 per cent. Myelocytes and megaloblasts were constantly present in the peripheral circulation.

From this case and others which they had seen, Harrington and Teacher conclude (1) that carcinoma with bone metastasis is followed in most instances by the appearance of a large number of myeloblasts, myelocytes and erythroblasts and a high color index, (2) that when carcinoma is suspected, the above blood findings should suggest bone metastasis, (3) that bone pains also point to metastasis but are not as significant as the blood findings, (4) that the blood picture is due to stimulation of bone marrow by the metastasis, and (5) that destruction of marrow by tumor causes hypertrophy of the marrow of the long bones, which in the adult has usually become fatty.

Kurppuweit also had a patient with marked anemia, with 11 per cent neutrophilic myelocytes. He believes that with a severe anemia and a large number of myelocytes, where no primary tumor can be found, the diagnosis of malignant tumor with bone metastasis can be made. Carcinomatous cachexia alone will not give the same blood changes. None of our cases showed the blood changes emphasized by Harrington and Kennedy and others, although Case I showed 17 per cent basket cells and 12 per cent abnormal monocytes; Case II, 17 per cent basket cells and 4 per cent unclassified; Case III, 3 per cent myelocytes.

In a recent article, Lawrence and Mahoney call attention to an unusual manifestation in carcinoma of the stomach with bone metastasis. Their patient had thrombopenic purpura with marked decrease in platelets, 4 per cent normoblasts, a coagulation time of twelve to sixteen minutes, a bleeding time up to twenty-nine minutes, and an icterus index of 6. At autopsy, tumor cells were found in the sternum, femur, and spine. They ascribe the low platelet count to the invasion of the marrow by large numbers of tumor cells.

Site of Metastasis: Warwick found the frequency of metastasis from 176 cases of carcinoma of the stomach examined at autopsy to be as follows: liver 38 per cent; perigastric nodes 36 per cent; retroperitoneal nodes 28 per cent; peritoneum 20 per cent; omentum 13 per cent; lungs 12 per cent; mesentery 9 per cent; bronchial nodes 9 per cent; pleura 8 per cent; pancreas 7 per cent; adrenals 5 per cent; kidneys 3 per cent; ribs 2 per cent, and spine 0.6 per cent. Of the 153 instances in which the affected bone was mentioned in the series we have gathered together, the order of frequency of involvement was as follows: spine 28.8 per cent; ribs 19 per cent; femur 15.7 per cent; sternum 9.8 per cent; pelvis 7.2 per cent; humerus and skull each 5.85 per cent; sacrum 2.6 per cent; clavicle, tibia, scapula each 1.3 per cent; radius 0.65 per cent, and entire skeleton 0.65 per cent. According to Stout, the bones closest to the primary lesion are the most frequently affected. Stiasny also found the spine, ribs, pelvis and femur most frequently
**FIG. 10.** CASE III: OSTEOLYTIC LESIONS IN PARIETAL BONES AND SPHENOID RIDGE

**FIG. 11.** CASE III: ROENTGENOGRAM SHOWING DEFINITE INVOLVEMENT OF SPHENOID RIDGE ON RIGHT (COMPARE WITH LEFT SIDE)
involved. Of the cases we have found in the literature, 8 had metastases in bones of the extremities without involvement of bones of the trunk, whereas the spine was involved alone in 17 cases.

*Type of Metastasis:* The cases in which the type of metastasis was mentioned, in this series, were about evenly divided between those showing bone formation and those with bone destruction. In the series of Sutherland, Decker and Cilley all the vertebral lesions showed increased density, whereas the pelvic lesions were osteoclastic. Zade's case showed both osteoclasia and osteoplasia, while Warren's group all showed osteoclastic lesions. Schinz believes that destruction of bone

![Image](image.png)

**Fig. 12. Case III: Photomicrograph Showing Carcinoma in Sphenoid Bone**

is brought about through pressure and new bone is formed as a result or irritation. Laubmann attributes the production of bone to an irritating chemical, while Perlmann states that only in individuals who have a tendency to new bone formation will osteoplastic metastases occur.

*Type of Primary Lesion:* Few writers have expressed an opinion regarding the relation of the size or position of the gastric lesion to osseous metastases. Harrington and Teacher state that most of the cases arise in small circumscribed pyloric lesions. Matthews says that bone metastases occur in small indurated lesions, but that the rapidly growing tumor usually causes death before there is time for metastasis. We do not try to reconcile these two statements. A careful study of
the recorded cases convinces us that the size of the primary lesion, its site, and its general type have no bearing on the probable occurrence of metastasis to bone. In cases reported by Bucci, Jack and Teacher, Grunenwald, Dupont and Lievre, Schleip and Stiasny, the primary lesions were "large." Zade, Kurpuweit, Frese and Brun reported primary carcinomata which were "small" or "very small," while in Rösner's case a small lesion produced such extensive osseous metastases that primary bone disease was considered.

Method of Metastasis: Whether bone metastasis in gastric carcinoma takes place by way of the blood or the lymph stream is not easy to determine. Piney states that dissemination is probably through the blood stream, since (1) there are no lymph channels in bone marrow and (2) since carcinoma cells are found in the marrow vessels together with red cells. v. Recklinghausen has attributed the frequency of bone metastasis to the rich capillary network of the bones and the slowness of the blood flow in the capillaries. This allows time for the sedimentation of the carcinoma cells, which find good conditions for growth in the marrow. The fact that the bones most frequently involved were those relatively near the stomach would seem to favor direct extension through the lymphatics, but it is also true that blood-borne metastases might be expected to occur more frequently in these locations since they are the site of red marrow. Stiasny also believes that metastasis is probably by way of the blood stream to the marrow. Müller states that metastasis is by arterial emboli. Parkes Weber had a case in which metastasis was to the humerus only, but the humerus was full of red marrow at the time of autopsy. The consensus of opinion seems to be that metastasis from gastric carcinoma to bone occurs by way of the blood stream. A study of the cases in relation to concomitant metastases to the lungs and elsewhere would indicate that this is probably the correct interpretation.

Age of Patient: The oldest patient in our series was seventy-one, while the youngest was fourteen years. Twenty-one of the patients were under forty years and 38 were forty years or older. The average age of patients with osseous metastasis (in which the age was stated) was 45.6 years as compared with 61 years for the whole group of gastric carcinoma. Bone involvement, therefore, seems to be more likely to occur in the relatively young patient with gastric cancer. This is probably because there is relatively more red marrow in younger individuals and because the primary tumor is prone to spread more rapidly.

Summary

1. Bone metastasis from carcinoma of the stomach is a relatively uncommon finding.
2. One hundred forty-three reported cases have been collected and five additional ones have been added to the series.
3. Metastasis to bone is most frequent at the sites of the red marrow—spine, ribs, femur, sternum, and pelvis.
4. Metastases are either osteoplastic, osteoclastic, or both, without regard to the characteristics of the primary lesions.
5. The site, size, and type of the primary tumor seem to have nothing to do with the appearance of osseous involvement.
6. Bone metastasis is more frequent in the relatively young, although it may occur at any age.
7. Dissemination is probably through the blood stream.
8. Some cases show an anemia which morphologically can not be distinguished from a primary type and which may show a large percentage increase in immature cells of the myeloid series.

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NOTE: Many of the earlier cases referred to in the text are listed in the table accompanying Jenkinson's paper (Am. J. Roentgenol. 11: 411, 1924), with references to the original reports, and a repetition of these has not been thought necessary. The present bibliography covers the later cases and includes also references to earlier work not cited by Jenkinson.

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