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ORIGINAL MEMOIRS.

MYOSITIS OSSIFICANS TRAUMATICA.*

A REPORT OF THREE CASES ILLUSTRATING THE DIFFICULTIES OF DIAGNOSIS FROM SARCOMA.

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CASE I.—*Myositis ossificans traumatica of quadriceps extensor.*—J. B. N., the patient, a boy of nineteen, had always been in good health up to November 17, 1906, when he received an injury to his right thigh while playing football. There was no external evidence of the injury noticeable that night, but the next day there was some swelling; two to three days later the leg became stiff, and the stiffness seemed to be confined to the region of the quadriceps muscle, greatly limiting the flexion at the knee. There was no pain at any time, but the swelling steadily increased in size. The patient at first believed the swelling to be in the muscle rather than the bone. The swelling slowly began to get hard and contract; the patient's general condition remained unimpaired. He was examined by a number of prominent surgeons and all agreed that the trouble was sarcoma, and amputation was advised. My opinion was asked by letter, and I replied that if the trouble was sarcoma I would advise a brief course of the mixed toxins treatment before amputation. Thereupon the toxins were administered for about four weeks with little reaction and no apparent effect on the size of the tumor. I declined to give further advice without seeing the patient, and he

* Read before the New York Surgical Society, December 11, 1912.

was referred to me early in April, 1907, by Dr. Wm. D. Haggard, of Nashville, Tenn. Physical examination showed a tumor situated in the middle and lower thirds of the anterior portion of the shaft of the left femur. The consistence of the tumor was extremely hard, much harder than usual in periosteal sarcoma. The X-ray photograph showed a sharp line of demarcation between the tumor and the shaft of the femur along the periosteal line, with no indentations in the periosteum. I made the diagnosis of myositis ossificans and under ether removed a piece of the tumor for microscopical examination, and advised no further treatment. The patient has continued in good health up to the present time, 5¾ years later. The specimen was examined by Dr. Jas. Ewing, Professor of Pathology at Cornell University Medical School. This report reads as follows:

April 12, 1907: Material received consists of several small masses of bony tissue. After hardening in Müller-formol and decalcifying, sections were stained in eosin and hæmatoxylon. The tissue is composed of numerous trabeculæ of bone, round, elongated, branching, and anastomosing, as in cancellous tissue. These masses are usually well calcified, but some are deficient in ossification, in the centres where the material stains bluish. They are often surrounded by numerous large osteoblasts which are evidently in the process of bone formation. In a few areas there are scanty giant osteoblasts, lying in lacunæ or at some distance from the bone tissue. Between the bony trabeculæ the tissue is composed of cellular connective or of fat. The connective tissue is very cellular and appears to be of new formation. The fat tissue is inflamed, infiltrated with new cells, chiefly lymphocytes, and the fat is being absorbed. There are no traces of muscle tissue in the section.

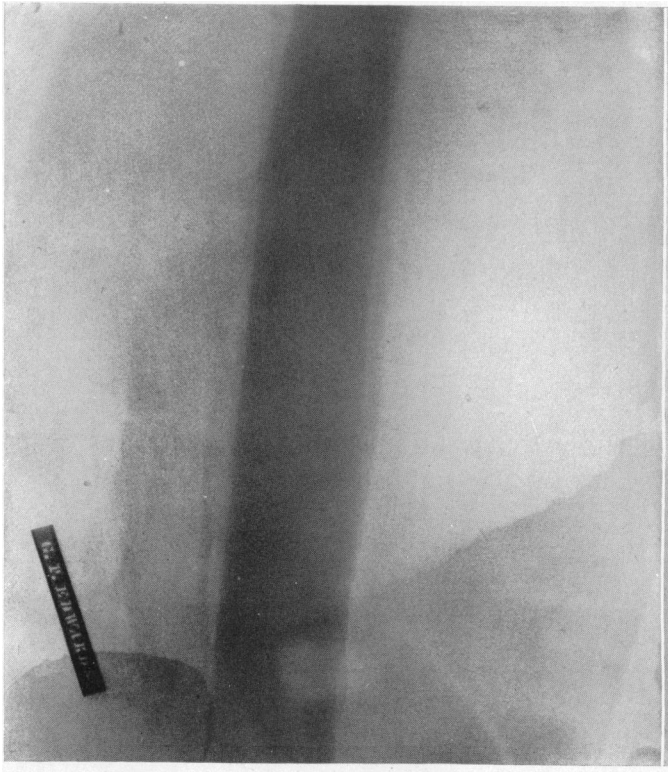
Dr. Ewing stated that the condition was one usually termed myositis ossificans traumatica, though chronic productive osteitis might be a better term.

Under date of November 13, 1912, the patient writes:

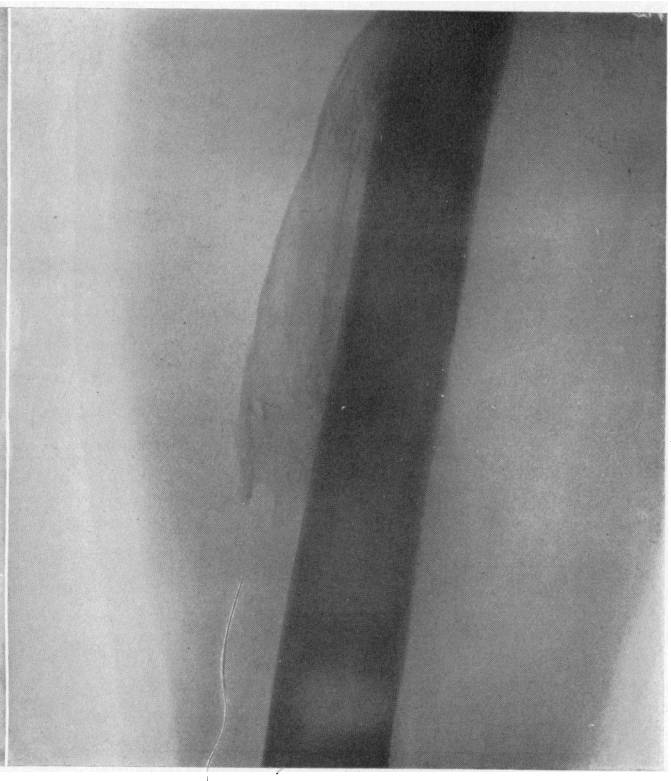
"On palpation I cannot notice much reduction in size of the growth. The interference with movement is very slight, being able to almost completely flex my leg. It gives me no trouble at all, save for an occasional slight uneasiness just sufficient to attract one's attention. My general health is good."

The first X-ray illustration shows the condition prior to operation.

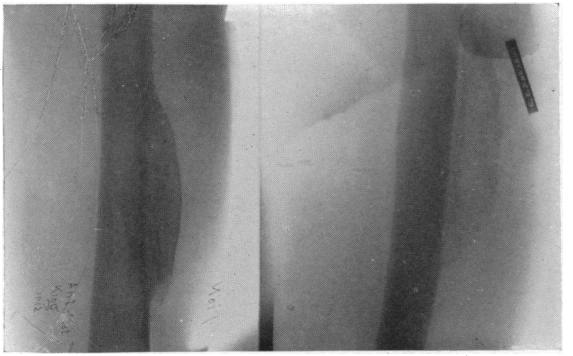
The second X-ray photograph, taken by Dr. A. F. Holding,



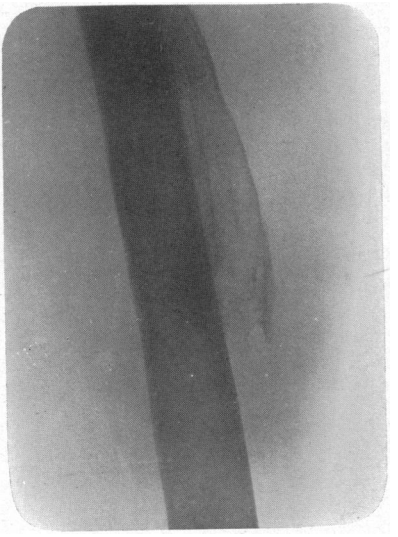
Myositis ossificans, 1907. (Case I.)



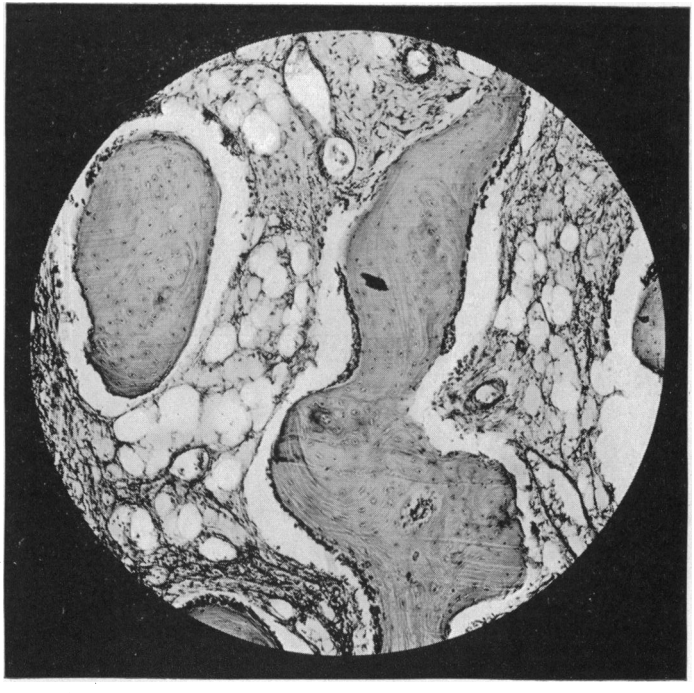
5¾ years later, December 1912. (Case I.)



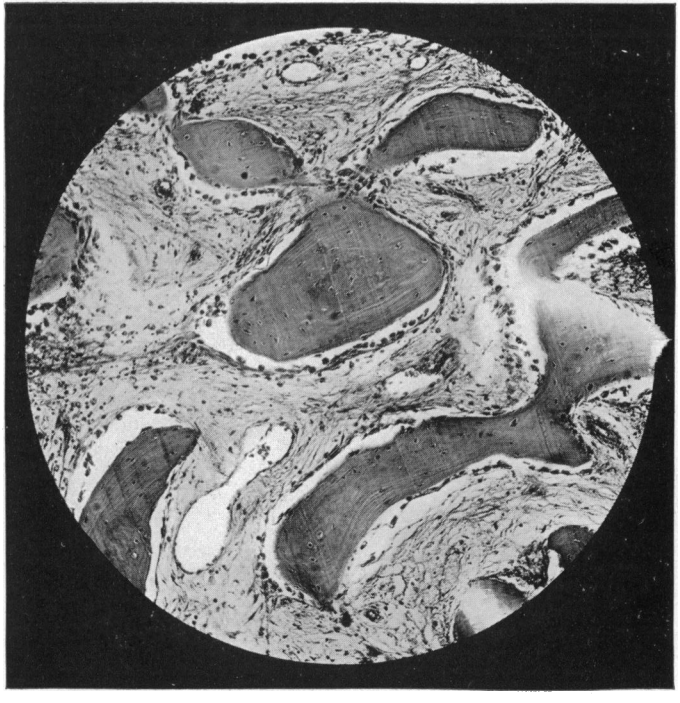
Myositis ossificans. (Case I.)



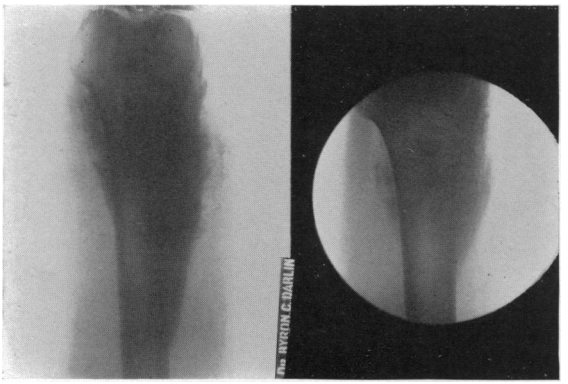
Myositis ossificans. (Case I.)



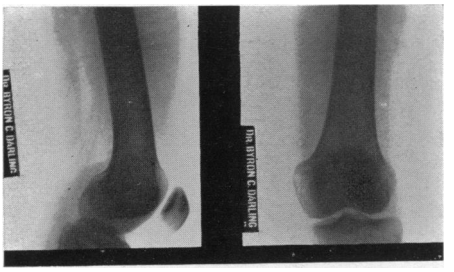
Myositis ossificans, 1907. (Case I.)



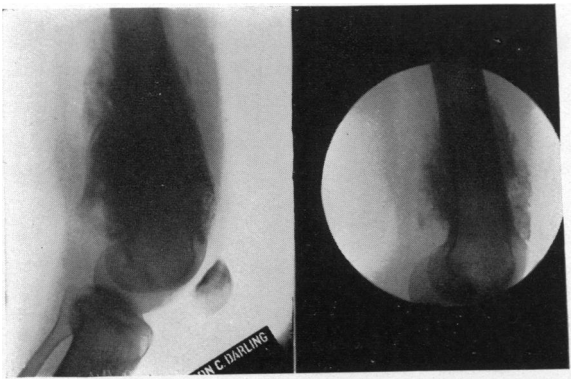
Myositis ossificans, 1907. (Case I.)



Interval, 2 years 2 months—May, 1909–July, 1911. (Case II.)



Normal knee. (Case II.)



Interval, 2 years 2 months—May, 1909–July, 1911. (Case II.)

December 11, 1912, shows the condition almost identical with the second radiograph of Mr. Makins's case, taken six years afterward. It shows that much of the original bony tumor has been absorbed.

NOTE.—The patient, now a physician, was shown before the New York Surgical Society Dec. 11, 1912.

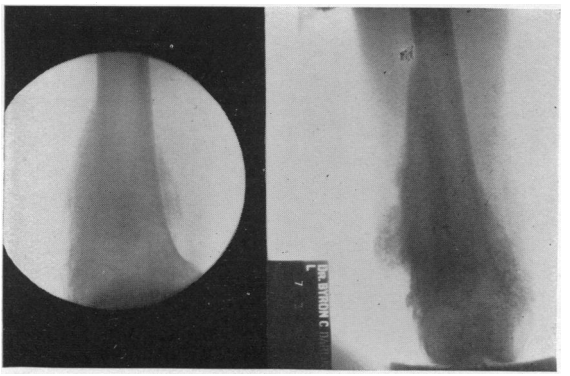
CASE II.—*Myositis ossificans of muscles and ligaments, lower end of femur, becoming sarcoma six years later.*—The patient, Miss A., aged twenty-six, had always been in good health; negative family history. Seven years ago she was thrown from a carriage in a runaway accident, and received a very severe blow on the lower and outer part of the left thigh, just above the knee. After the immediate effects of the contusion had subsided she noticed nothing unusual until about two years later, when, on bathing, she saw that the left thigh just above the knee was somewhat larger than the right. There was no pain, no soreness, no lameness, the increase in size being the first sign she noticed. She consulted a physician who found a slight bony enlargement above the outer condyle of the left femur and an X-ray photograph was taken at that time, which showed a small bony tumor projecting about half an inch beyond the normal border of the shaft of the femur, not extending to the joint. This increased in size very slowly, was not painful and caused her no trouble. On February 9, 1909, the patient consulted a very prominent surgeon of the Middle West, who pronounced it subperiosteal sarcoma and advised hip-joint amputation. She was made very nervous by this decision and went abroad for two months to get in better physical condition. On her return, on May 3, she again consulted another very prominent physician of Chicago, who stated that she was suffering from a fibrosarcoma of the femur of periosteal origin. He stated that there was no possible doubt of the diagnosis and advised immediate amputation below the trochanter and urged this being done without a day's delay. She was brought to me for advice on May 5, 1909, by her family physician, Dr. Mary Spark of Indianapolis. Physical examination showed the patient in good general condition; examination of the left thigh showed a hard, bony tumor in the lower third of the left femur, smooth in outline, extending upward about two and a half inches, most marked on the outer side. Although it extended apparently nearly around the bone, the skin was perfectly normal in appearance and there were no enlarged veins. Comparison between the X-ray taken

a year ago and that of a few days ago showed some increase in size and extension across toward the other side of the femur; no involvement of the joint, and interior of bone not involved.

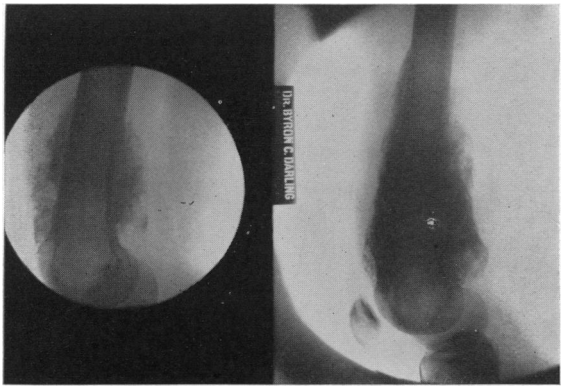
In both these cases there was a well-defined sharp line of demarcation between the bone and the tumor, differing strikingly from the irregular indentation almost always present in the case of sarcoma. The consistence of the tumor, too, was much harder and more bony in character than in true sarcoma. I believed the tumor to be some type of myositis ossificans originating from the trauma, and not sarcoma. I advised an exploratory incision under general anæsthesia and removal of a section of the tumor for microscopic examination. This was done on May 7. An incision three inches in length was made over the external condyle, the most prominent part of the tumor; on cutting through the fascia overlying the muscles and separating the latter, no periosteum could be recognized, a hard, bony tumor was found in close proximity to, and infiltrating, the muscles. A portion of this was removed with a chisel. Macroscopically it had every appearance and the consistence of cancellous bone tissue, deep red in color and in no way resembling the grayish-white appearance of sarcoma. This was sent to Dr. James Ewing, Professor of Pathology at Cornell University, who, after decalcification, made a careful examination and reported as follows:

May 17, 1909: Seven different portions of the material received are under examination. In none of them is there the slightest trace of any form of sarcoma. The tissue shows chronic osteitis and myositis, such as commonly arises after traumatism to the bone or periosteum. The changes in the muscle are not those typical of myositis ossificans and yet new bone appears to be forming in close proximity to the atrophying muscle. I should prefer to give the diagnosis of chronic formative osteitis.

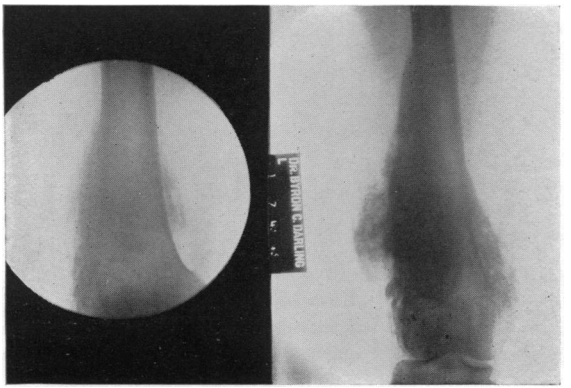
The history of this case thus far was related in my paper on "A Plea for More Conservative Treatment of Sarcoma of the Long Bones" (*Jour. of the Am. Med. Ass'n*, Jan. 29, 1910), but it is the later history of the case that has proved of particular importance and which makes it, as far as my own search of the literature goes, an entirely unique case.



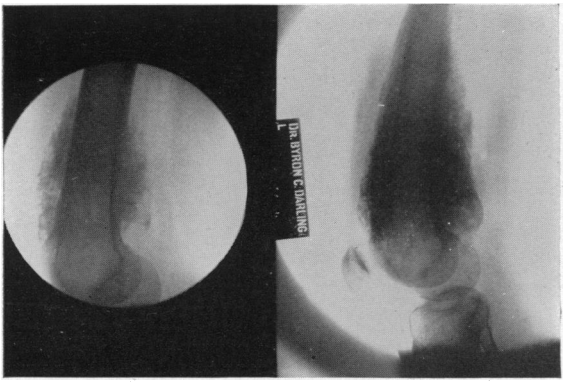
Interval, 2 years 5 months—May, 1909–October, 1911. (Case II.)



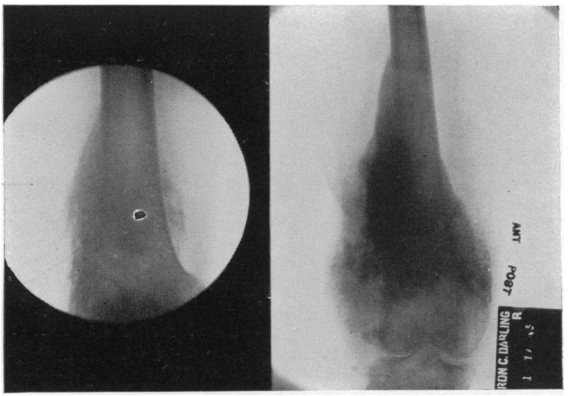
Interval, 2 years 5 months—May, 1909–October, 1911. (Case II.)



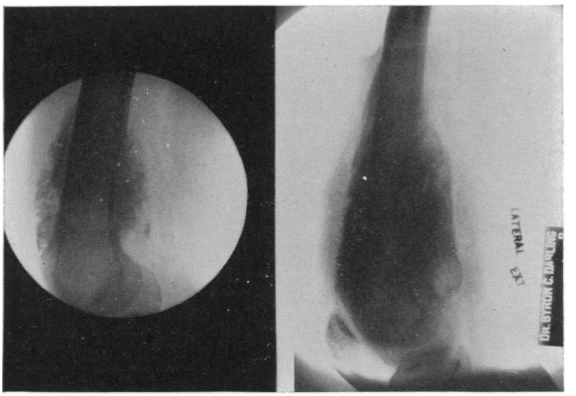
Interval, 2 years 8 months—May, 1909–January, 1912. (Case II.)



Interval, 2 years 8 months—May, 1909–January, 1912. (Case II.)



Interval, 2 years 11 months—May, 1909–April, 1912. (Case II.)



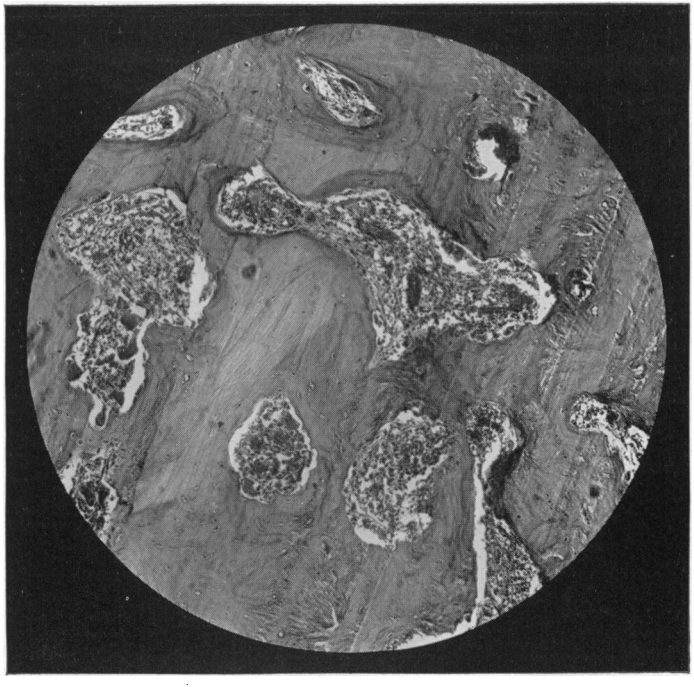
Interval, 2 years 11 months—May, 1909–April, 1912. (Case II.)

The wound healed by primary intention, and at the end of two weeks the patient returned to her home in the Middle West. She continued to enjoy perfect health and was able to ride horseback and play golf without any inconvenience. Two years later, in June, 1911, she called upon me while passing through the city and I examined the knee carefully. Physical examination showed a slight increase in the bony enlargement at the outer and posterior side of the femur and some thickening of the entire lower end of the shaft, just above the joint surface. There was very slight limitation in motion of the joint, and her general health was excellent. The tumor seemed to be of bony hardness, entirely different in consistency from the ordinary sarcoma. There was practically no change in its appearance from that of two years ago, except the slight increase in size already noted. An X-ray taken at this time by Dr. Darling and compared with the X-ray taken two years before also showed some increase in size and a less sharply defined periosteal line. I advised the patient to see me again in the fall on her return from the country, in order to have another examination made and X-ray taken. Owing to my absence in Europe, I did not see her until January, 1912. At this examination the enlargement seemed even more appreciable than it had been in June and I strongly advised another exploratory operation, thinking that possibly some change had taken place in the nature of the tumor. On January 8, assisted by Dr. Wm. A. Downes, my associate, I made an incision six inches long over the outer aspect of the lower end of the femur, and found a very hard, bone-like swelling, firmly fixed to the femur, in its upper portion, but in its lower portion there seemed to be a mass about the size of an olive that was slightly movable. This proved to be a bony tumor of typical cancellous structure, so hard that it could be cut only with a chisel. It was in no way connected with the periosteum or the femur, but apparently originated in the fascial portion of the adductor muscles just above their insertion, very closely attached to yet distinct from the larger bony mass which was continuous with the shaft of the femur. The smaller tumor was removed and the larger tumor mass was chiseled off on the anterior, lateral, and posterior portions, down to the level of the normal line of the femur. Nearly half a teacupful of bony material was removed, which, macroscopically, had the appearance

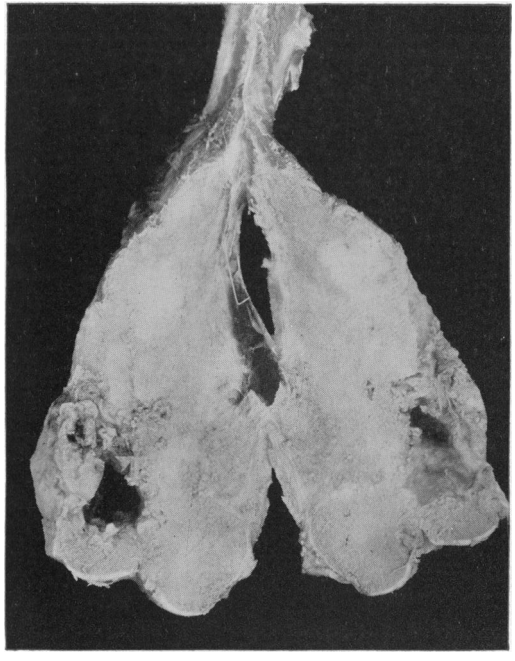
of healthy red normal cancellous bone, and in no place was there anything in any way resembling or even suggesting sarcomatous growth. All the material was sent to Dr. Jas. Ewing, Professor of Pathology at Cornell University Medical School, who, after careful examination, made the following report:

Feb. 15, 1912: The tissues in the case of Miss A. show the usual and some unusual changes of myositis ossificans. The process begins with fibrosis and atrophy of the muscle-fibres and the production of dense connective tissue. This is then followed by increased vascularity, and many islands of bone and some of cartilage are deposited. In the new connective tissue there are many very cellular areas with giant-cells which resemble those seen in giant-cell sarcoma. I do not think the process can be regarded as a tumor in all respects, but these cellular areas explain why it is persistent and progressive. It is on this evidence also that many assume that myositis ossificans is a true tumor process. At any rate I do not like the presence of these large cell groups. In all other respects the case is typical of active myositis ossificans.

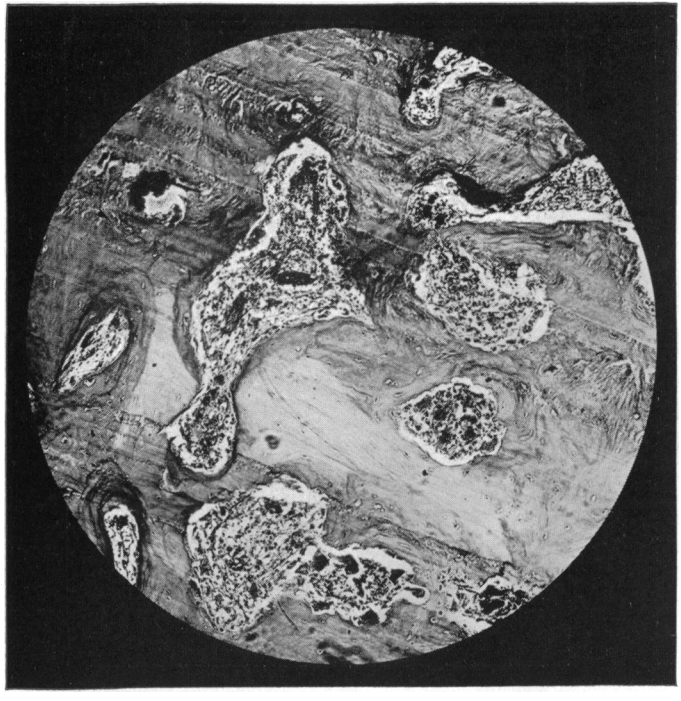
The skin wound was closed, with a gauze packing into the cavity which was of considerable size. The wound healed without any suppuration, and after ten days the patient was allowed to get up and rest upon a couch. A small drain was kept in the cavity for about six weeks, and finally the opening closed entirely. At the end of eight weeks the patient was allowed to go about on crutches. She seemed to have less power in the leg than was to have been expected, and there were occasional attacks of pain which had never occurred before. Two days before the patient's departure for home, there suddenly appeared a moderate effusion in the joint. The latter was strapped and bandaged and she was instructed not to use the leg for a few days, after which the swelling nearly subsided. She then (February 22, 1912), returned to her home in the Middle West, but the pain continued, she developed a slight temperature, 99°–100°, and a swelling appeared over the central portion of the incision at the site of the drainage opening. This swelling increased daily, the pain became more severe, and becoming somewhat nervous about her condition, she returned to New York on March 20. Physical examination at this time showed a marked protuberance over the whole line of incision, greatest at the central point, amounting to a projection of 1–1½ inches over the normal surface. The skin was smooth in outline, slightly purplish from enlargement of superficial veins, and semifluctuat-



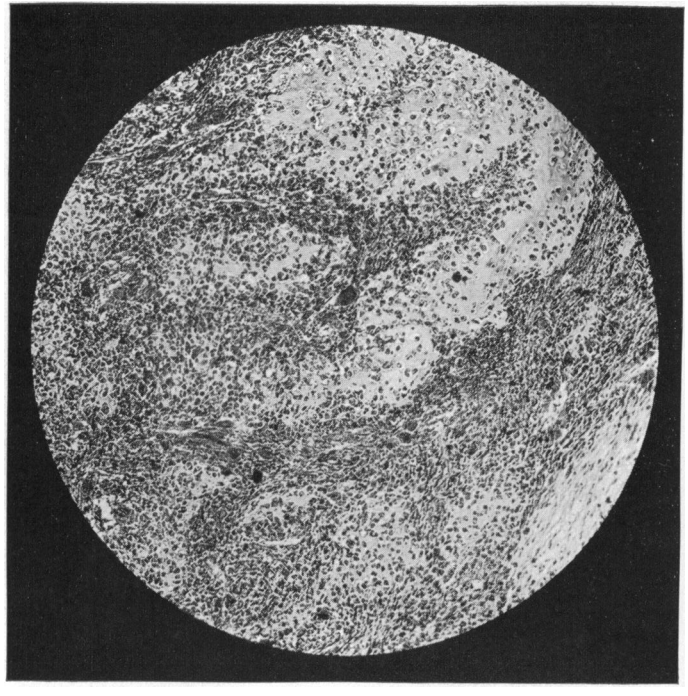
Myositis ossificans. Microscopical section, May, 1909. (Case II.)



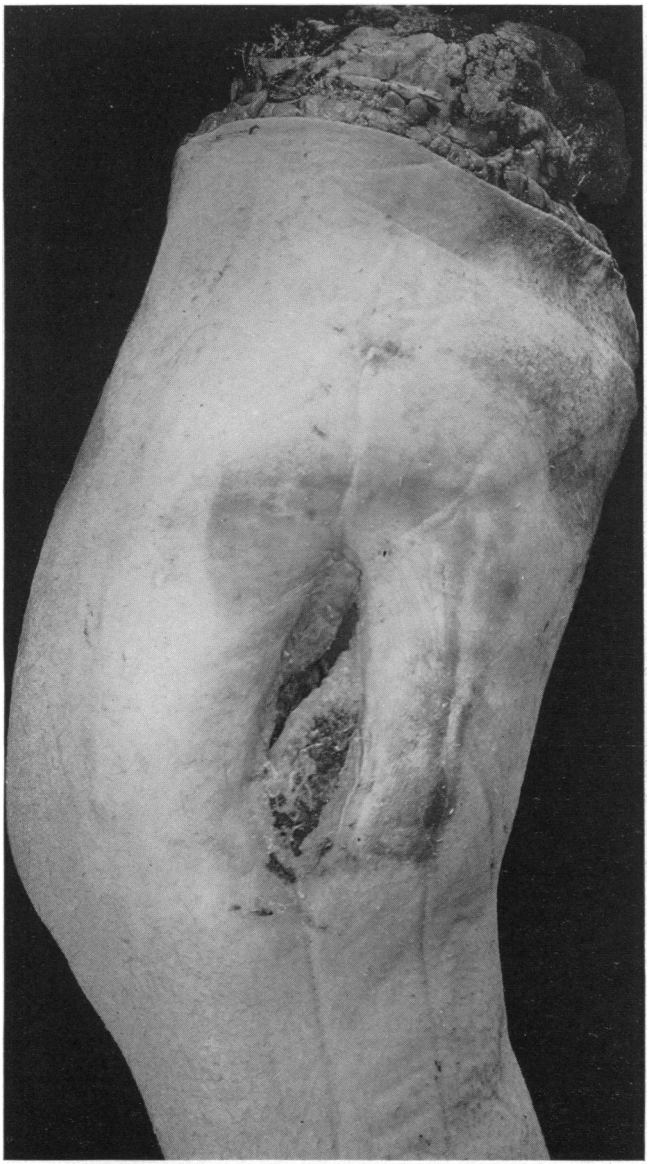
Central portion ivory-like bone. Giant-celled sarcoma at lower and external portion, March, 1912. Death from metastases in pelvis and spine, January 12, 1913. (Case II.)



Myositis ossificans, January, 1912. (Case II.)

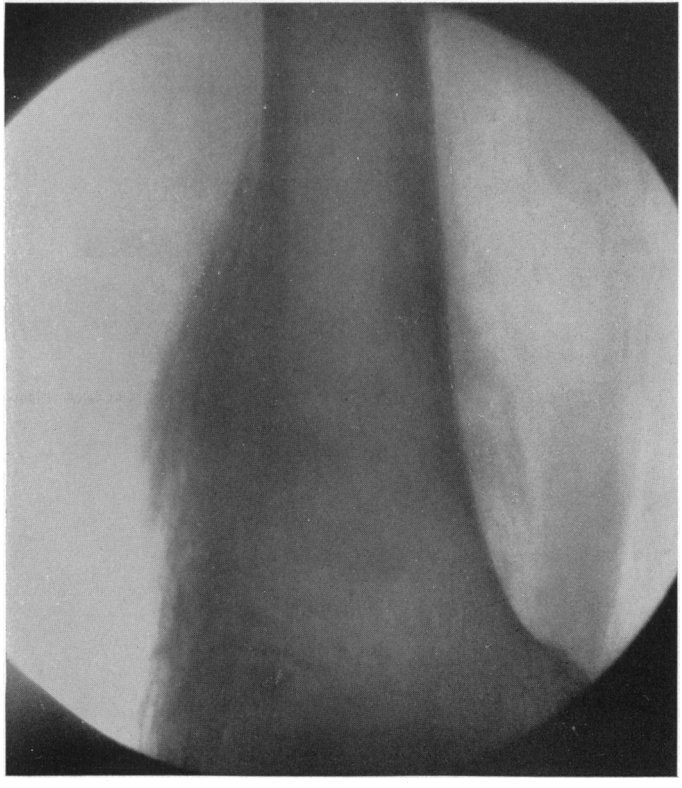


Giant-celled sarcoma, March, 1912. (Case II.)

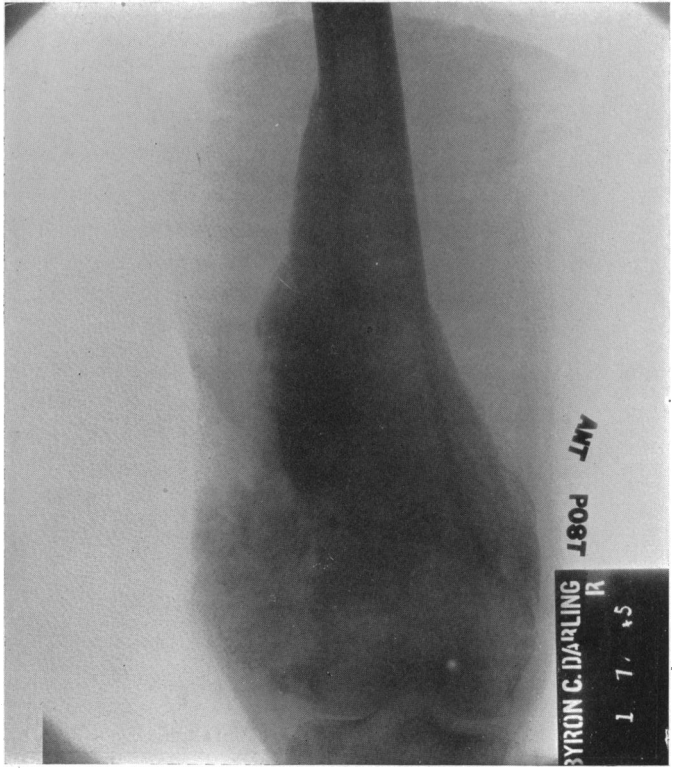


Myositis ossificans. Fungating sarcoma developing at site of exploratory incision. March, 1912. (Case II.)

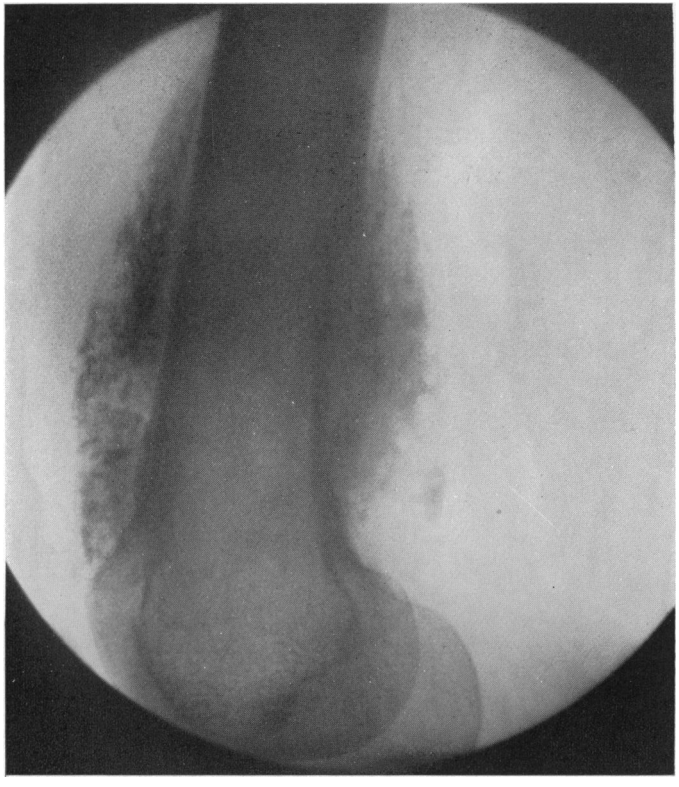
Longitudinal section showing central ivory-like bone, March, 1912. (Case II.)



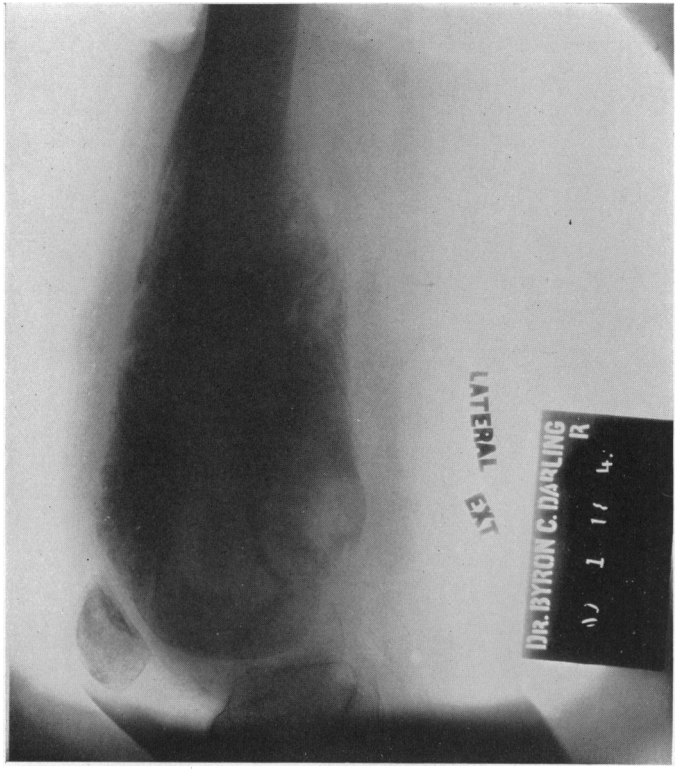
Myositis ossificans. May, 1909. (Case II.



Myositis ossificans having become sarcoma. March, 1912. (Case II.)



Myositis ossificans. May, 1909. (Case II.)



Myositis ossificans having become sarcoma. March, 1912. (Case II.)

ing over the central area. In other words, the character of the tumor had entirely changed, and the clinical appearance was absolutely typical of a rapidly growing sarcoma. The introduction of a needle drew only blood. The swelling had come on so suddenly and was so soft as to be almost fluctuating, that the possibility of an accumulation of blood or serum in the old cavity was considered though not regarded as probable. Under cocaine I immediately made a small incision and curetted ½ oz. of soft grumous material, which, clinically, had every appearance of sarcoma. This was examined by Dr. Ewing and pronounced giant-celled sarcoma. His report reads as follows:

April 15, 1912: The sections of the myositis ossificans have been completed. They show areas of ordinary myositis ossificans grading into very cellular areas and finally into sarcoma of giant-cell type. There is no doubt that sarcoma is the final expression of the myositis process. As you know, these giant-cell sarcomas are not always very malignant, and I am inclined to think that this one is not, but as it occurs in a peculiar condition I would prefer not to offer any prognosis.

Dr. V. P. Gibney and Dr. Wm. A. Downes were called in consultation, and after careful deliberation it was decided best to try the effect of the toxins for 2–3 weeks before sacrificing the leg. The patient's general condition had greatly deteriorated within the last few weeks; she was extremely nervous and apprehensive, and unable to bear more than minute doses of the toxins, not sufficient to cause any marked reactions. As there was no retardation of growth noticeable at the end of two weeks, it was decided to amputate. Accordingly, on April 22, 1912, I amputated the leg 5 inches below the trochanter. The wound healed by primary union, but the patient recovered her strength very slowly. It was intended to continue the toxins as a prophylactic against recurrence after the wound had healed, but her general condition was so poor that it was considered unwise to do so.

It should be mentioned that for a number of years she had had enlarged glands in both cervical regions; these glands increased somewhat in size during the last year, but whether they represent metastatic growths or are the result of an old tuberculous process it is impossible at present to say. During November she developed very severe sciatic pains and pain in pelvis and back, accompanied by gradual loss of strength. She contin-

ued to grow worse and at present there is no doubt that she is suffering from metastases.

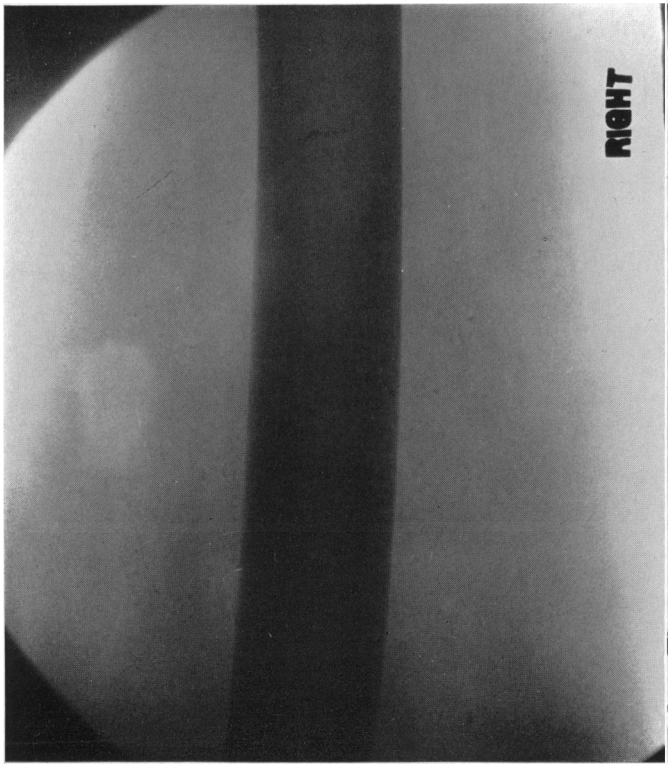
NOTE.—She failed rapidly and died January 12, 1913. A letter from her physician, Dr. Carleton B. McCullock, stated that she had undoubtedly metastases in the lumbar and dorsal vertebræ.

CASE III.—*Myositis ossificans of the quadriceps extensor muscle.*—C. H., 16 years of age. Patient had always been well until the beginning of November, 1912, when, while playing football he received a severe blow in the left quadriceps muscle, which knocked him down. He did not notice anything until the next day when he found the leg very stiff and swollen, being one inch larger in circumference than the right; he could not bend the knee at all; there was no ecchymosis. Patient was referred to me by Dr. B. H. Whitbeck. Physical examination, December 19, 1912, shows a hard, bony swelling, fusiform in shape, occupying the anterior and middle portion of the left femur, most protuberant in its central portion, firmly fixed, measuring eight inches in length. The skin is normal in appearance and not adherent; motion at the knee is very greatly limited, extension normal, flexion very slight, not over 15°–20°. The bony tumor seems to lie just beneath the skin and apparently involves the quadriceps muscle. Measurement over the most protuberant part of thigh, left: 17½ in.; right: 16⅜ in. There is no pain; walk somewhat unstable, the leg occasionally giving way; general health good. Examination of the X-ray photograph taken six weeks after the injury shows a fusiform tumor, apparently projecting about one inch beyond the periosteal border. The outline of the periosteum is distinctly marked; there are no indentations as ordinarily observed in sarcoma. In other words, the picture is almost identically the same as that shown in Case I. The photograph was taken by Dr. Byron C. Darling.

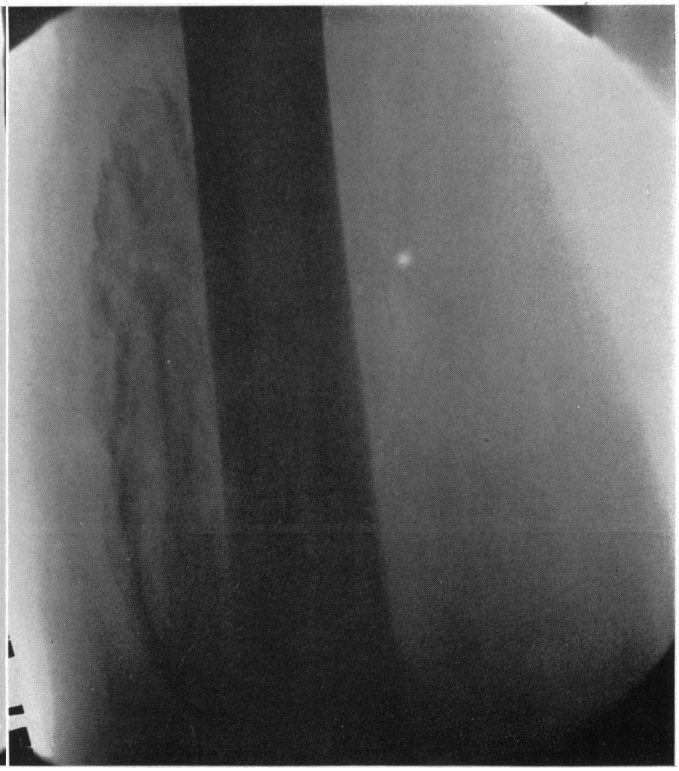
NOTE.—This case was observed the week following the reading of my paper and was kindly referred to me by Dr. Whitbeck, who made the diagnosis, having noticed its striking similarity to my cases just reported at the Surgical Society.

A careful study of 120 cases of sarcoma of the long bones, personally observed, has led me to the following conclusion:

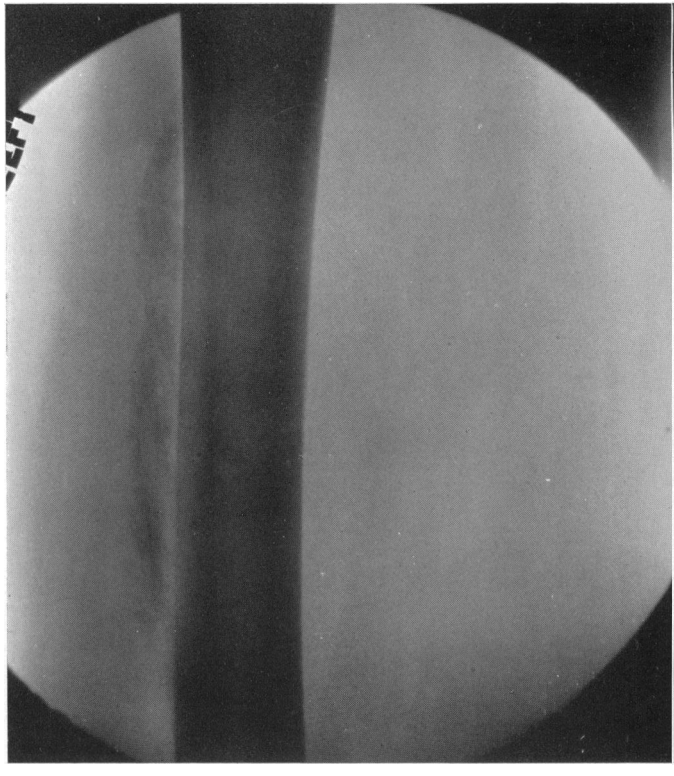
The diagnosis of sarcoma of the long bones in the majority



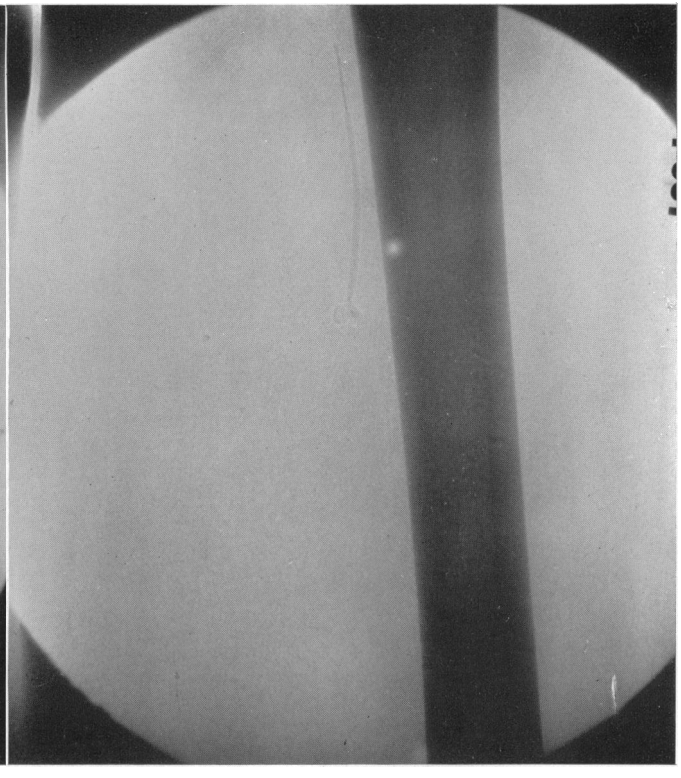
Sound femu (lat.-int. view). (Case III.)



Myositis ossificans, 6 weeks after injury (lat.-int. view). (Case III.)



Myositis ossificans. (Case III.)



Sound leg. (Case III.)

of cases can be correctly made from a careful clinical history of the case; a thorough clinical examination combined, if possible, with a good radiograph. In most cases it is wiser to do an exploratory operation and remove enough of the tumor for microscopical examination, in order to render the diagnosis beyond question. This is important—no matter what form of treatment be advocated. If the toxins of erysipelas and *Bacillus prodigiosus* are to be used before operation in the hope of avoiding an amputation, it is important that the nature of the tumor be settled beyond doubt, as it would be unwise to subject the patient to a long and none too agreeable course of toxin treatment if the disease were not sarcoma; and if it is sarcoma, and the patient recovers without the sacrifice of the limb, the value of the case from a scientific point of view is greatly enhanced if the diagnosis has been further confirmed by a miscroscopical examination. If amputation or even resection be the treatment decided upon, there is still stronger reason for having the diagnosis previously confirmed by microscopical examination.

Many objections have been raised against the wisdom of exploratory operations in malignant tumors in general, and particularly in sarcoma of the long bones. These objections have greater weight with English surgeons than with American. Some of these objections it must be granted are well taken, *e.g.:*

(1) The exploratory operation itself may cause grave risk, setting free, tumor cells in the circulation, thereby favoring general metastasis. While this result may possibly occur, long experience has shown it to be largely a theoretical objection rarely supported by clinical facts. A sufficient answer would be that the gain of having the diagnosis confirmed without question greatly outweighs the very slight and even problematical risk of general dissemination.

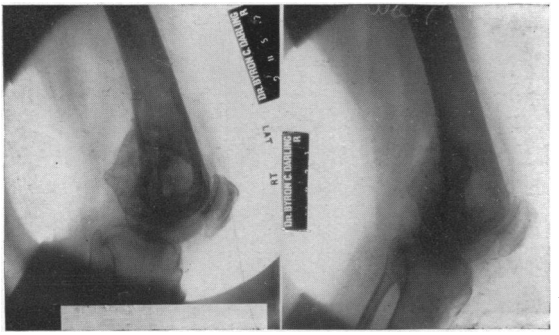
(2) Another objection and one that I think has more weight is, that the exploratory operation is often a very difficult one, especially in sarcoma of the lower end of the femur, particularly if situated posteriorly in the neighborhood

of the popliteal vessels. I have seen serious hemorrhages in several such cases, and in two cases found it very difficult to control them. However there is another objection which I consider of greater importance, and that is:

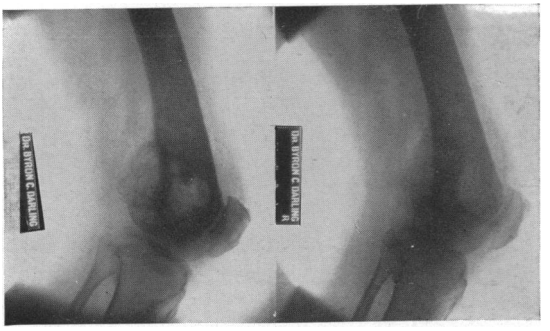
(3) The danger that such a deep wound may never heal; and if it does not heal it almost inevitably becomes infected, and the lack of good drainage may cause such severe septic intoxication, that amputation may have to be performed.

I will here cite two cases which well illustrate the dangers from exploratory operation in not easily accessible regions:

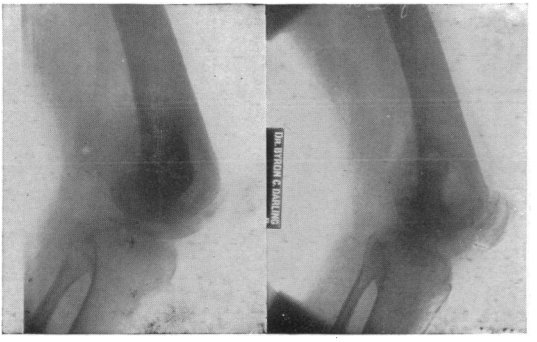
CASE IV.—*Central sarcoma of the femur, giant-celled type.*—A. J. M. C., male, aged forty-one years. Family history negative. Previous personal history unimportant. States that he had some pain in the knee in October, 1909. November 1 stumbled while going upstairs and injured right knee, which immediately became badly swollen and caused a good deal of pain; was treated as acute synovitis; unable to walk for a day or two. Under electrical treatment and massage for two weeks there was marked improvement, and he was able to walk without a cane. The swelling, however, never disappeared. In the spring of 1910, at the Massachusetts General Hospital he was operated upon, a 3½-inch exploratory incision over the internal aspect of the patella being made. No disease was found. Two days later an incision was made over the outer side of the patella and a tumor was found occupying the lower portion of the outer condyle. The wound was packed with iodoform gauze and bismuth paste; a sinus remained which never closed. His general condition remained good. The mixed toxins were started immediately after the operation. His weight increased from 190 pounds to 203 pounds. The first six injections with the toxins caused no reaction; the seventh produced a severe chill, followed by a temperature of 104°. After twelve injections, he returned home and had the treatment continued there. Two months later an X-ray plate was taken and as there was apparently some increase in size, amputation was strongly advised. Six weeks after this two other X-rays were taken and again amputation was strongly urged. The patient was brought to me by his brother, who is a physician, on January 23, 1911.



Interval, 3 months—March, 1911–June, 1911. Central sarcoma of femur controlled by the mixed toxins for nearly one year, *vid.* text. (Case IV.)



Interval, 6 months—March, 1911–September, 1911. (Case IV.)



Interval, 1 year 2 months—January, 1910–March, 1911. (Case IV.)

Examination at this time showed very slight enlargement of the lower end of the femur, chiefly in the region of the knee-joint; there was slight fluctuation in the joint and some redness of the skin. There was a scar about 3½ inches long on the inner side of the knee, and an unhealthy looking sinus above the joint from which there was a profuse discharge of pus of a greenish tinge. There was a small enlargement of the lower end of the femur itself, most marked over the outer condyle. Measurements 9 inches above the patella are the same on both sides, showing that there is no atrophy of the muscles. I had an X-ray photograph made at this time, which, compared with the earlier photographs, showed little if any increase in size. In view of the previous diagnosis of sarcoma of the giant-celled type, it seemed to me unwise to amputate the leg without a more thorough trial with the toxins. The patient was sent to the General Memorial Hospital and a few days later, in order to establish better drainage, I made an incision over the old sinus and curetted out a considerable amount of tumor tissue, mixed with pus and bismuth paste. Microscopical examination showed it to be sarcoma of the giant-celled type. I found it extremely difficult to control the hemorrhage, and only succeeded by introducing gauze packing very tightly. A very severe attack of toxæmia followed, with a temperature of 104°–105°. The patient was in a serious condition for two or three days. On recovering from this, I at once put him on the mixed toxins, beginning in small doses, and gradually working up to the point of getting a reaction of 102°–103°. The wound was drained with a large tube. After a short time the patient's condition became normal; he was sent home and the treatment continued by his brother, with occasional intervals of rest. During the treatment, X-ray photographs were taken every four or five weeks to determine whether or not there was any increase in the growth; none could be made out and there was apparently a decrease of tumor tissue with substitution of normal bone (vid. illustration).

The patient's general health remained perfect in every way; he weighed more than he ever did; he went about comfortably with a cane; the sinus remained open, however. In the beginning of January, 1912, after about one year's treatment, a portion of the rubber tube became broken off in the wound, causing infection of the sinus followed by a severe attack of toxæmia.

His condition became so serious that in the mind of Dr. C. A. Porter of Boston and the other physicians attending him, it seemed necessary to amputate the leg in order to save his life. Examination of the tumor after operation showed little or no increase had taken place during the year of treatment.

I am just in receipt of a letter from Dr. C. A. McCarthy, the patient's brother, who states:

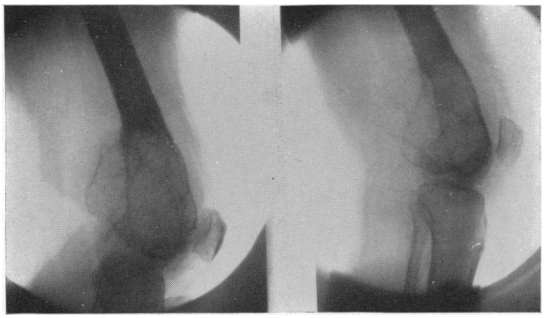
"My brother's health is excellent; he has an artificial limb and walks splendidly."

Specimen was examined by Dr. J. H. Wright, whose report reads:

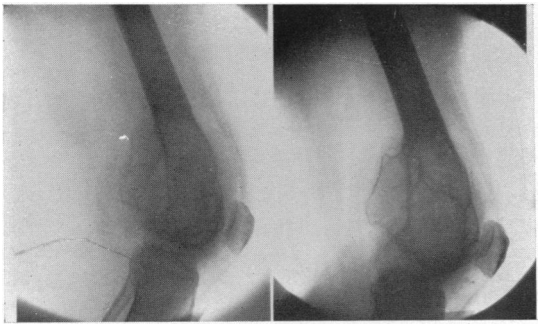
"Specimen consists of the lower half of the femur and some other adjacent parts. In the epiphysis is an irregular-shaped cavity of about the total volume of a small hen's egg. Partially bounding this cavity is a layer of white fibrous-like tissue 1 or more cm. thick in places, and attached to the cortical bone, and to the bone underlying the joint surface. At the upper extremity of the cavity and replacing the marrow of the shaft of the bone for a length of 3 or 4 cm. is a red, moderately firm tissue. This tissue is rather sharply demarcated from the layer of white fibrous-like tissue above described. Microscopical examination of sections from this red tissue shows a typical giant-cell sarcoma."

At almost the same time, another patient of about the same age, with exactly the same type of tumor, also in the right leg, came under my care:

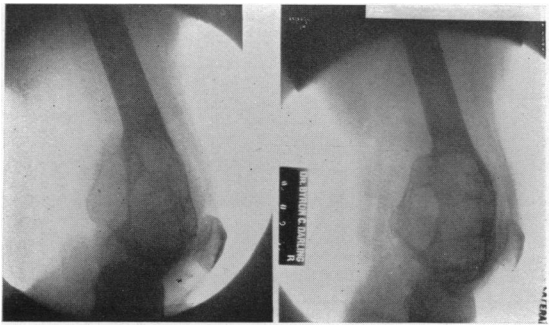
CASE V.—*Central sarcoma of the femur, giant-celled type.*—G. H. S., male, aged forty-seven years, resident of Detroit, Michigan. Family history negative. Personal history: three years before in the beginning of 1908, had fallen upon the ice injuring the lower end of the right femur. An X-ray was taken, and the bone was said to have been cracked. The condition was called by the surgeon a dislocation of the knee. One year later he had another fall; again the knee was said to have been dislocated. In February, 1910, he had a third fall, injuring the same knee. The swelling which had appeared shortly after the first injury had never subsided, and after the third injury began to increase rapidly in size. The series of X-rays taken within the preceding six months showed marked diminution in density of the lower three inches of the right femur and expansion of



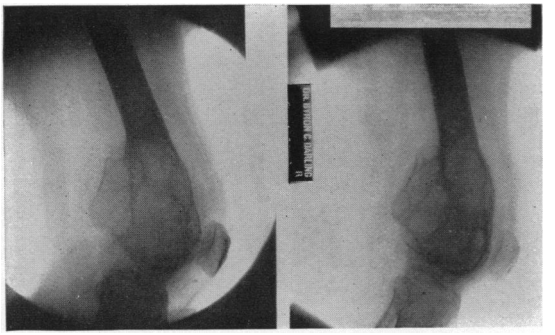
Interval, 3 months—December, 1910–February, 1911. Central sarcoma of femur controlled by toxins for nearly one year, *vid.* text. (Case V.)



Interval, 1 month—February, 1911–March, 1911. (Case V.)



Interval, 4 months—February, 1911–June, 1911. (Case V.)



Interval, 1 year 1 month—February, 1911–March, 1912.
(Case V.)

the femur, with a sharply outlined, tumor-like formation, projecting about an inch beyond the normal outline of the bone. The tumor occupied chiefly the posterior or popliteal region of the femur, although the bone was enlarged in all directions; the joint was not involved. Various diagnoses had been made by a number of leading surgeons and X-ray experts. Nearly every one had given a different diagnosis. One of the most prominent surgeons of Chicago, who had seen it, believed it to be a cyst of the bone, non-malignant; another believed it malignant and advised amputation. My own diagnosis was, that it was unquestionably a sarcoma of central origin, probably giant-celled. On February 23, under ether anæsthesia, an incision six inches long was made over the inner condyle of the right femur, cutting down to the periosteum, pushing the vessels to one side in order to explore the popliteal region. A tumor about the size of a goose egg, apparently situated beneath the periosteum, was found. On opening this and passing through a thin shell of bone, a mass of partly broken-down, soft material was encountered, reddish-gray in color, and having the appearance of a vascular sarcoma; the finger passed into the cavity of the bone; the joint was not involved. Here again there was severe hemorrhage which it was found difficult to control. It was finally stopped by packing, as in the preceding case. Microscopical examination showed the tumor to be a sarcoma of the giant-celled type. The patient was immediately put upon the mixed toxins and remained under my care for two months, after which the treatment was carried out by Dr. J. W. Vaughan, of Detroit. The patient proved to be extremely susceptible to the toxins and was unable to take more than 3–4 minims, which were followed by severe reactions, the temperature rising in some instances, to 105°–106°. At the end of four months' treatment his susceptibility had increased instead of diminished and he was unable to take more than 1–2 minims.

In this case, as in the preceding, a series of X-ray examinations were made every four or five weeks, and these were carefully compared with the pictures taken before the operation. Physical examination July 27, 1911, showed much less discharge from the sinus, which has persisted since the operation. Measurements over the middle of the patella showed a decrease of one inch, from 18½ before operation to 17½ now. January 5, 1912, I again examined the patient, and found his condition better than

at any time I had seen him; his weight had increased from 192 pounds in February, 1911, to 219 pounds. At this time the discharge had become very much diminished. The X-ray photograph taken the day before showed apparent diminution in size of the tumor with replacement of new bone; no extension of the disease could be made out in any direction; ability to use the leg better than before; general health perfect. The toxins were kept up in moderate doses, with occasional intervals of rest. In February, 1912, suddenly, while walking without any unusual exertion, spontaneous fracture occurred, with very profuse extravasation of blood into the surrounding soft parts, requiring almost immediate amputation. The patient recovered from the operation.

It might be concluded from these two cases that the use of the toxins preliminary to the amputation was an unwise procedure. Yet before forming an opinion one should consider the fact that there are now on record a comparatively large number of cases of sarcoma of the long bones, in which the use of the toxins has not only saved the life of the patient but the limb as well. I myself have had 9 patients, 4 of which I showed before the Clinical Congress of Surgeons of North America, November 14, 1912, well from five to fourteen years.

I believe had it not been for the exploratory incision and the consequent infection, that in all probability the sarcomatous disease would have been entirely controlled by the toxins, and the leg thereby, in one case at least, saved from an amputation. The X-ray photograph and subsequent operation by Dr. Porter in one case showed little if any increase in the size of the tumor during the year or more in which the toxins were used, and the general health of the patients remained perfect. Had the toxins not been used at all, amputation would have been performed 1½ years earlier. I feel that had one been satisfied in these two cases with the probable diagnosis, instead of insisting upon an exploratory operation and microscopical examination, the patients' welfare, which should always be the primary consideration, would doubtless have been better served. Were I

again called upon, in a similar case, to decide the question of an exploratory operation, I am inclined to believe that I would not advise an exploration in a sarcoma so deeply situated and so difficult of access, in view of the dangers just described. I would trust to the clinical diagnosis confirmed by the X-ray examination and try the toxins for a brief period before amputation, and if no improvement was noted at the end of two to three weeks then decide upon an amputation or resection.

As a general rule I would not amputate a limb for sarcoma unless the clinical diagnosis had previously been confirmed by exploratory operation and a microscopical examination. Yet, there are important exceptions to this rule. I have amputated an arm at the shoulder-joint without any exploratory operation for a tumor the size of a closed fist, that had developed in three weeks. The dilated veins, general appearance and consistence of the tumor made me certain of the diagnosis. I have also amputated the leg for a very large sarcoma of the tibia and fibula; again, for a large sarcoma of the fibula. In addition I have twice performed total excision of the clavicle for sarcoma without previous microscopical examination to confirm the diagnosis. In all of these instances, the very rapid development of the tumor after trauma (within three weeks in three instances) and the clinical features characteristic of sarcoma, made the diagnosis absolutely clear. In these cases the dangers and disadvantages far outweighed the advantages of an exploratory operation, and justified immediate amputation without a microscopical diagnosis.

(4) Still another objection, and a very strong one, is that the tissues removed at the exploratory operation may not represent the typical structure of the tumor and, therefore, lead to a negative report on the part of the pathologists. The incision may not have been sufficiently deep and the portion removed may show evidence only of osteitis or productive inflammation, and the pathologist must give a negative report. In the face of such negative report, the surgeon feels it difficult

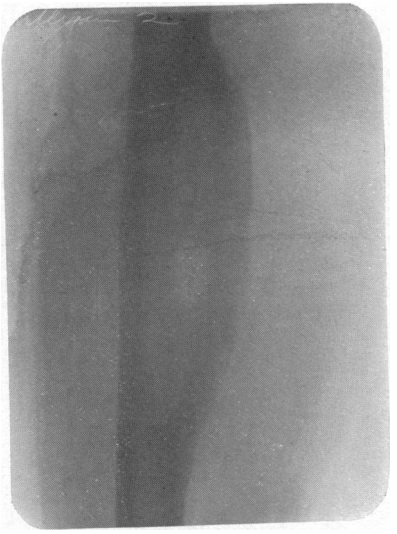
to determine the best course of action. The situation is well illustrated by the following case recently observed by the writer:

CASE VI.—Mrs. G. M., twenty-seven years of age; in May, 1912, first noticed pain in leg, which was treated for rheumatism for two months, without improvement. There was 14 pounds loss in weight. An X-ray was taken and on basis of same a diagnosis of periosteal sarcoma was made and immediate amputation was strongly urged, without any further examination. The patient was two months' pregnant, and in preparing for the amputation the uterus was emptied. Her husband was told that there was no possible alternative to amputation. The patient was referred to me on September 19, 1912. Examination at this time showed a hard, fusiform enlargement 7 by 8 inches in length, apparently of bony origin in the upper and middle thirds of the femur, gradually shading off into the normal outline of the bone. Largest circumference 19½ inches; skin normal; no enlarged veins.

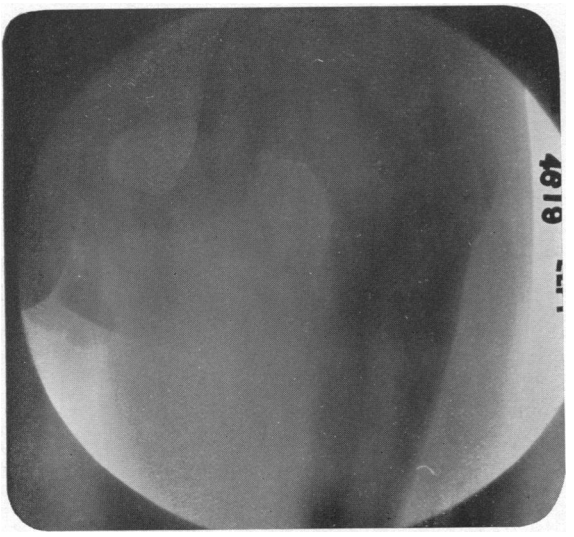
The patient entered the General Memorial Hospital and was put upon the mixed toxins. Wassermann examination of the blood proved negative. At the end of a week I made an exploratory incision in about the middle of the tumor, and on cutting down found a fusiform enlargement of the femur of the consistence of a periosteal sarcoma. The tumor extended about ½ inch beyond the normal line of the bone. A wedge-shaped portion was removed; there was no trace of any inflammatory exudate and no infiltration of the surrounding tissues. Clinically it had the typical appearance of a periosteal sarcoma, originating in the shaft of the bone, and the consistence and gross appearance of the specimen confirmed this view. The specimen was sent to Dr. Ewing, who reported as follows:

September 28, 1912: The tissue shows very little if any specific process and does not permit of a diagnosis. There is infiltration of the vessels with large round cells, suggesting sarcoma, but which might very well be tuberculous. I ought not to express any opinion on the data received and I would not amputate without further information.

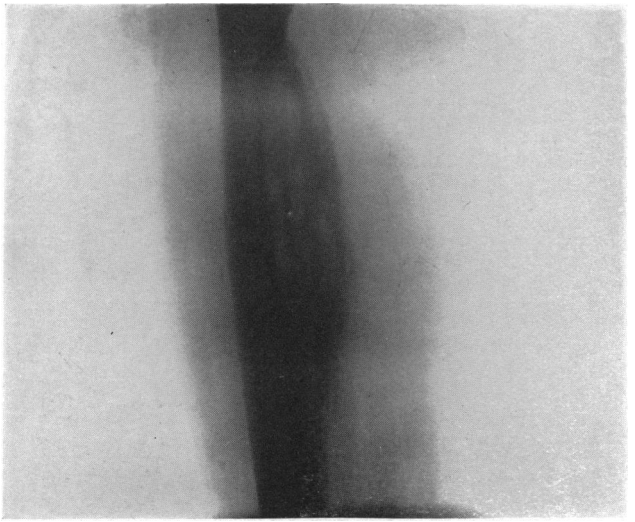
On entrance to the hospital, the measurements over the upper, middle, and lower part of the cicatrix, representing the upper, middle, and lower end of the original tumor, were as follows:



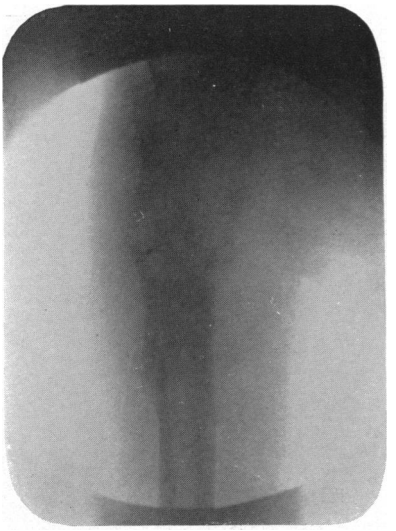
Periosteal sarcoma of femur (clinical diagnosis), 2 months later. (Case VI.)



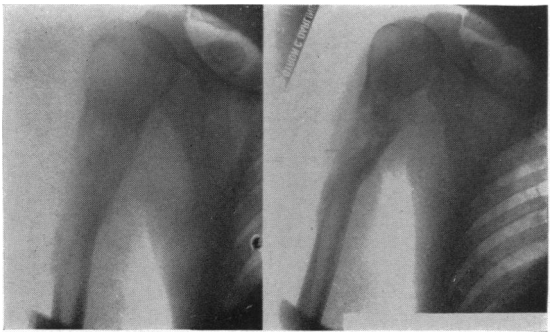
Sarcoma of femur mistaken for osteomyelitis. Death from lung metastasis three months later.



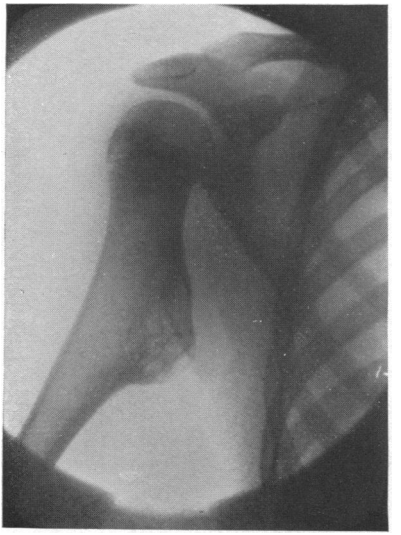
Periosteal sarcoma of femur (clinical diagnosis). (Case VI.)



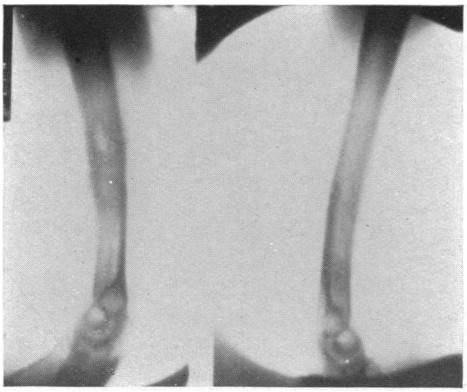
Periosteal sarcoma of humerus—site of recent fracture. (June, 1910.) (Case VII.)



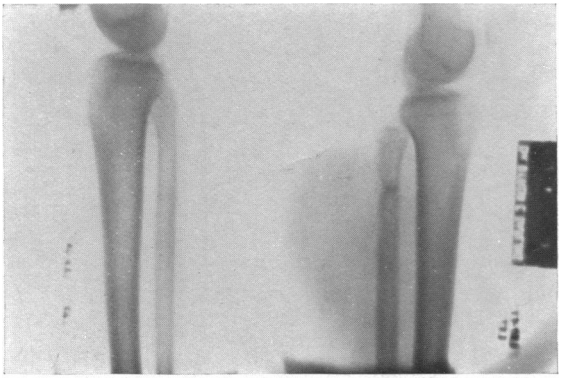
Sarcoma of humerus developing at site of recent fracture. Partial disappearance under toxin treatment. Interval, 5 months—July, 1910–December, 1910. Recurred December, 1910. Amputation shoulder-joint. Large recurrent tumor removed from pectoral region few months later. Patient in perfect health, February, 1913, nearly two years later. (Case VII.)



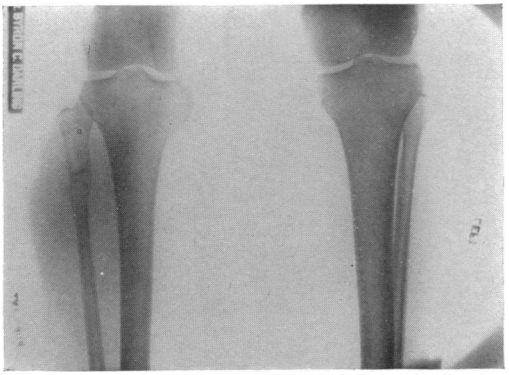
Osteoma of humerus. Differs both from sarcoma and myositis ossificans. (Case VIII.)



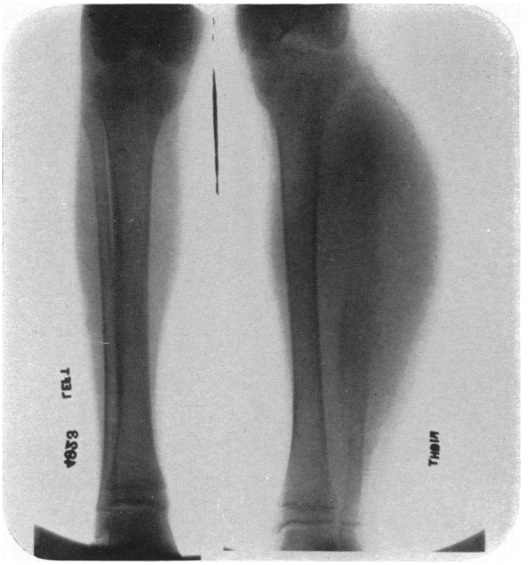
Osteomyelitis, humerus. Normal humerus. (Case IX.)



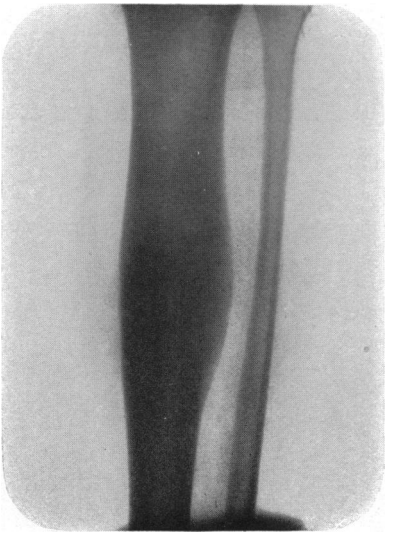
Sarcoma of fibula, periosteal. (Case X.)



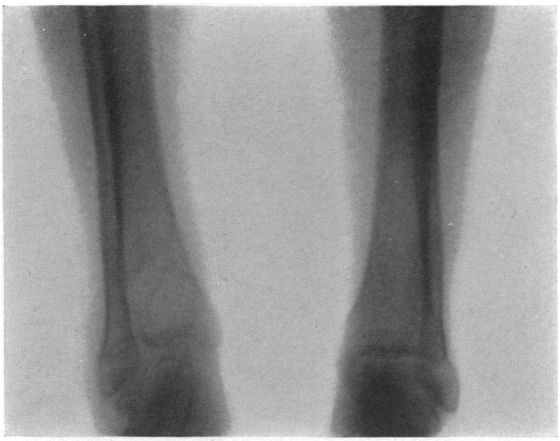
Sarcoma of fibula, periosteal. (Case X.)



Sarcoma of fibula (amputation). Without preliminary microscopical examination. (Case XI.)

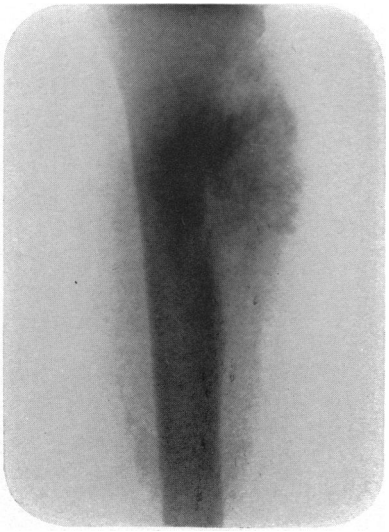


Osteitis, non-malignant. Exploratory operation. (Case XII.)

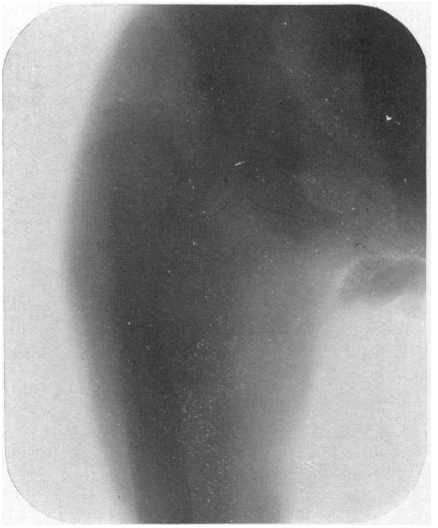


a *b*

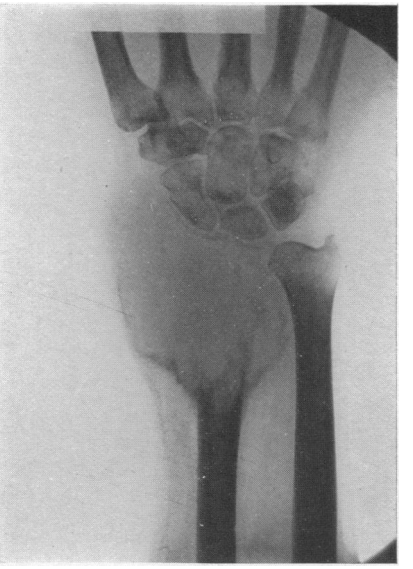
a, bone cyst of tibia; *b*, normal tibia. (Case XIII.



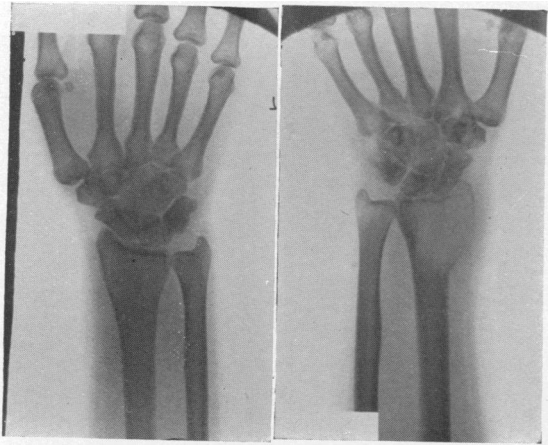
Periosteal sarcoma of femur. (Case XIV.)



Sarcoma of femur, periosteal. (Case XV.)



Sarcoma of radius, amputation 8 years ago. Toxin treatment after operation. Permanent cure. (Case XVI.)



Normal for comparison Sarcoma of radius.
Cured by the mixed toxins of erysipelas and B. prodigiosus without amputation. (Case XVII.)

Right, 16 in.; 18½ in.; 19½ in. Left, 15½ in.; 17½ in.; 18¼ in.

November 7, right, 14½ in.; 16½ in.; 17¾ in. Left, 14½ in.; 16¾ in.; 18 in.

November 26, right, 14¾ in.; 16¾ in.; 18¼ in.

The toxins were continued four to five times a week and the dose gradually increased from 0.5 minim to 6 minims. At the end of two weeks there was marked diminution in the circumference of the thigh. In view of the lack of certainty of Dr. Ewing's diagnosis and the rapid improvement under the toxin treatment, it was deemed very important to make a second exploratory incision, and on November 1 I made another incision ½ inch away from the first, 5 inches in length, and cut down upon the tumor. The latter was found considerably smaller in size, projecting only about ¼ inch from the shaft of the bone. An opening was chiseled into the central portion of the bone and several pieces of periosteal as well as central growth were removed and sent to Dr. Ewing. Clinically the tumor had every appearance of a partially necrotic sarcoma, a condition frequently seen as a result of the use of the toxins. Three X-ray photographs have been taken since by Drs. L. G. Cole and Holding, who believed the condition to be periosteal sarcoma. Dr. Ewing's report of the last specimen, dated November 1, 1912, reads:

> Five sections from five different parts of the tissue received fail to show any signs of sarcoma. There is suppurative inflammation in an area lined with granulation tissue. The periosteum and bone show an active productive and rarefying osteitis. I find no signs of syphilis or tubercle. The condition suggests to me a pyogenic infection of the periosteum or osteomyelitis.

The clinical history and macroscopic appearance at the time of operation make it impossible to regard it as an osteomyelitis.

Subsequent History.—The tumor slowly subsided under the toxin treatment and at the end of six weeks the circumference of the thigh became nearly normal. The patient has had the toxins continued at home for the reason I did not believe it wise to place too implicit faith in a negative pathological report from small portions of material removed at an exploratory operation. She has gained 10 pounds in weight.

January 6, 1912, examination shows the tumor has been in-

creasing in size the last three weeks, but the general health is still good. I still believe the condition to be periosteal sarcoma.

NOTE.—February 16, 1913. Under larger and more frequent doses of the toxins the tumor is again decreasing in size.

Though we may never know the exact nature of the tumor in question, the conditions show very clearly the difficulties of diagnosis as well as of treatment. This case might be cited to prove the wisdom of not amputating a limb for sarcoma except the diagnosis be established beyond question.

On the other hand the case (Case II) that furnished the inspiration for the present paper, already described at length, might be said to prove the opposite contention, viz., that it would be wiser to operate on the clinical diagnosis alone, even in the face of a negative report of the pathologist. In said case we have a tumor of the femur of 2½ years' duration, pronounced by a number of experienced clinicians as positively sarcoma, and an equal number of X-ray experts confirm this diagnosis. Believing it a possible case of myositis ossificans, I advised an exploratory operation, reserving the method of treatment to be decided by the result of the microscopical examination. The macroscopical appearance of the material removed was perfectly characteristic of new bone, in no way resembling sarcoma. The report of the pathologist was myositis ossificans, no trace of sarcoma. Two and a half years later, as shown by the history given, there seemed to be a slight increase in the size of the original tumor, which was confirmed by the X-ray. A second exploratory operation was determined upon and a much more extensive removal of the growth was made for microscopical examination. Again the structures showed myositis ossificans, and again on the strength of the report I refrained from a more radical operation, which later events proved would have been the wiser plan.

There are two theories which may be advanced in explanation of this most obscure case: First, that we were dealing with an original traumatic myositis ossificans which, after several years, degenerated and changed into an osteosarcoma.

In support of this theory may be cited the well-known fact that not infrequently benign tumors of the breast, cysts, cyst-adenomas or fibromas, do undergo malignant degeneration and become carcinoma. Likewise do chronic inflammatory conditions often undergo similar degeneration in course of time. Old fractures offer favorable sites for the development of sarcomata.

The second view is that soon after the accident a sarcoma developed in the bruised and strained portion of the periosteum, the sarcoma remaining of very slow growth and almost latent for nearly six years, and then suddenly, and possibly aggravated by the trauma of the second exploratory operation, lighted up and grew with great rapidity.

Dr. Ewing accepts the latter view as the true one, and believes that the careful microscopical examination gives evidence of its correctness.

I incline to believe the first view, namely, that the sarcoma was of comparatively recent origin, developing from the site of an old myositis ossificans, to be more in accord with the clinical history and known facts. If the tumor was sarcoma from the first, then it was sarcoma at the time of my first exploratory operation, nearly three years later. The specimen removed was not superficial, but extended down fully an inch into the growth and was carefully removed with a chisel. Clinically it had every appearance of new bone; it was absolutely unlike sarcomatous tissue. Microscopical examination by Dr. Ewing himself failed to show any trace of sarcoma. Again, 2½ years later, the clinical appearance was the same, except for the very slight increase in size. The second exploration was far more extensive than the first, and a large amount of the growth covering an area of 3 inches in circumference and 1½ inches in depth was chiseled and cut away. This material was macroscopically precisely the same as at the first operation, and was again regarded as myositis ossificans by Dr. Ewing. It is true, there were some cells of peculiar type found at the second operation which he could not fully explain, and which in the light of later evidence were probably cells beginning to undergo sarcomatous

changes. The complete and rapid change in the clinical appearance of the tumor two months later would seem to show a corresponding change in its real nature. This was further confirmed by the microscopical examination of the tissues removed at this time.

If we accept Dr. Ewing's view, and his opinion is entitled to more weight than my own, we are forced to the unwelcome conclusion that we can place very little reliance upon the pathologist's report of a specimen removed by an exploratory operation in tumors of the long bones.

In my first case, the negative report of the pathologist saved the patient from an amputation which otherwise would have been performed. In the second case, the negative report prevented an amputation which would otherwise have been done three years ago, with a greater prospect of saving the life of the patient. No matter how we interpret these two cases, we are forced to conclude that the diagnosis of tumors of the long bones is extremely difficult and in certain cases, though happily rare, it may be impossible, even with the advantage of every known aid, to make a diagnosis early enough to save the life of the patient.

The only type of sarcoma which could simulate the condition found on amputation, is the type designated by Gross as osteoid sarcoma, and it must be admitted that there is some similarity. He describes one case in which the ossified portion of the growth proved a huge mass which looked like spongy bone, and another, in which the appearance was that of dense ivory-like bone. Yet, the history of these very cases cited by Gross, makes it difficult to accept Ewing's theory that the case in question was sarcoma from the beginning. Gross collected 45 cases of the osteoid type of sarcoma, and from a study of these cases, he concludes that "not only are osteoid sarcomas locally infectious, but they are next to the pure periosteal spindle-celled, the most malignant of all the neoplasms of the osseous system, since 65.62 per cent. of all cases died of metastasis." In other words, this type of tumor is extremely malignant, and that means a short duration of

life. In fact, in the seven cases which ended in death, without surgical interference, the average duration of life was 16 months, so that it would seem extremely improbable that the tumor in my own case—which had existed for nearly six years before it began to affect the general health of the patient—should have been of this type. Furthermore, in my own experience, based upon a personal observation of 125 cases of sarcoma of the long bones, I have never seen a case of six years' duration, or even three years' duration, without operation.

MYOSITIS OSSIFICANS.—There are three well-recognized types of myositis ossificans which have been described from time to time and which have been receiving more and more attention since the introduction of the X-ray made it possible to study them more accurately.

The first type, known as myositis ossificans progressiva, goes on involving one muscle or group of muscles after another until all the muscles of the body are involved. It usually starts in the trapezius muscle or latissimus dorsi.

The second type is single instead of multiple, and is the result of some chronic irritation or of a series of traumas, instead of a single trauma, well illustrated by the simple osseous formation that occurs in certain muscles so situated as to be liable to irritation or injury, *e.g.*, the pectoral muscle in soldiers, as a result of the kicking of the musket. (Hassen found 18 osteomas in 600 conscripts.) Again, this type is found in the muscles of the calf of the leg in cavalrymen and the heel of dancers.

The third and rarer variety is the one with which we are dealing in the present paper, and one seldom recognized before the admirable papers of Binnie (ANNALS OF SURG., Sept., 1903) and Robert Jones (*Arch. of the Röntgen Ray and Allied Phenomena,* 1905–1906). Binnie reported a most interesting personal case and collected all the other cases he was able to find in the literature up to that time. Cahier (*Rev. de Chir.,* 1904) collected 257 cases of myositis ossificans

traumatica, including the second and third varieties, but not the progressive type.

Most statistics, up to the time of Strauss, grouped together, under the general head of myositis ossificans traumatica three or four different conditions. The term should properly apply only to those resulting from a single trauma. It is interesting to know that Strauss collected 127 such cases. Of these 43 occurred in the quadriceps femoris, 13 in the adductors of the thigh, 64 in the flexors of the upper arm; the remainder were scattered over various muscles of the body. The best papers in recent years are that of Finney (*Transaction of the Southern Surgical Society,* 1909), and that of Lapointe (*Revue de Chirurgie,* Nov., 1912).

Finney reported six cases, three observed by himself, three others seen in consultation, four occurred in football players; one came to operation; all recovered.

To emphasize the point which I shall discuss more fully later, that the disease may closely simulate sarcoma, it is stated that the diagnosis of subperiosteal sarcoma had been made in all three of Finney's cases. One case, operated upon twice, recurred, necessitating three operations. Amputation at the hip-joint had been recommended and was about to be performed in one case, when first seen by Finney. In another case quoted by Finney (Whitelock) amputation of the thigh was performed under the mistaken idea that the condition was a periosteal sarcoma.

Finney states that males are almost invariably the subjects of this affection, only two cases in woman having been thus far reported. This is probably explained by the fact that men are much more liable to severe injuries, which are the exciting causes. The disease is much more common since the introduction of football. Of Finney's cases two were due to the kick of a horse, four to injuries received while playing football.

The most recent and elaborate study of the pathology and treatment of myositis ossificans, or "myostéomes traumatiques" as the French characterizes the disease, is that of

Lapointe, published in the *Rev. de Chir.*, in November, 1912. Lapointe reports one case of his own, of the quadriceps extensor, very closely resembling my own cases and that of Mr. Makins. This case occurred in a man twenty-one years of age who attributed the trouble to a fall three weeks before. A tumor apparently springing from the anterior and middle portion of the femur, 17 cm. in length, had developed within the short period of 24 days after the injury. Extension was normal, flexion markedly limited. An interesting feature which I have not noted in other cases, was a temperature of 99°–100°. Lapointe states that he made a grave error in diagnosis. The very close fusion with the diaphysis of the femur, the slight dilatation of the superficial veins, the temperature, all seemed typical of a periosteal sarcoma. The radiograph which should have corrected the error only emphasized it by reason of the use of an imperfect plate. The radiographer took a second plate which gave an identical result. Before proposing to the patient such a mutilating operation as amputation at the hip-joint, he decided to wait a short time. In 15 days the supposed sarcoma, instead of increasing in size, had diminished. Another radiograph, taken a month later, showed the same characteristic appearance of myositis ossificans as I have observed in my own cases. Lapointe operated on May 26, 1911, 66 days after the injury, and removed an elliptiform tumor 17 x 5 x 3 cm. Muscular fibres completely surrounded it except at its point of attachment to the femur over an area 6 cm. long and 2 cm. broad. A fragment of periosteum detached from the femur adhered to the internal aspect of the osteoma. The patient made a good recovery, but had a slight recurrence four months later.

Robert Jones, in 1905, gave a brief history of 15 cases of the third variety personally observed, and a résumé of most of the cases collected by Cahier and Binnie. Most of Jones's cases occurred in the vicinity of joints. In only two of Jones's cases was there a microscopical examination made and the pathologist's report (Dr. Dimond, hospital pathologist) reads as follows: "In the first case the bone generally is of

the cancellous type and at the edge of the bone the muscle seems to have been sprinkled with numerous small foci, around which the bony matter has been deposited; generally the centre of these foci contains a small branched cell (osteoblast). The bony matter is deposited along the muscle-fibres and at parts of the specimen the striation of the muscle is still visible. The condition is a true ossification, not calcification."

In the second case he reports: "The general shape of the bone was that of a V. There were no signs of any periosteum whatsoever. There were numerous foramina over the whole bone, into many of which passed small tendinous extensions from the surrounding muscle, and into others passed small blood-vessels which communicated directly with the cancellous spaces throughout the mass of bone. The general structure was that of soft or cancellous bone, the spaces being fairly large and occupied by blood-corpuscles and a few giant-cells, etc."

These two cases show a structure strikingly similar, both macroscopically and microscopically, to that observed in my own two cases. The clinical history in Jones's and the collected cases was much the same. We have the history of an antecedent blow or injury and the subsequent development of a hard tumor a few weeks or months, or in some cases years, thereafter.

In none of the cases thus far reported has there been a history of transformation or degeneration of the bony tumor into a sarcoma or malignant growth. Yet it would be impossible to state that such a result never occurred in these cases, inasmuch as they are nearly all lacking in the very important detail of after-history. Makins' two cases published in the *Transactions of the Royal Soc. of Med.*, Surg. Section, 1911, are an important exception. In both cases an X-ray was shown of the original condition and the condition six years later.

Etiology.—The question of the etiology of traumatic myositis ossificans has already been fully discussed by Binnie

and Robert Jones, and therefore I will not go into it at length, but will merely mention the various theories propounded.

The first theory was, that the blood which extravasated at the time of the injury later became transformed into bone. Our increased knowledge of pathology has made such a theory untenable.

Another theory is that advanced by Cahn, and based upon the assumed correctness of Conheim's theory of tumor development. It presupposes aberrant embryonic cells in various parts of the body and has little to support it.

The third theory is that at the time of the injury, a portion of periosteum becomes detached and from these fragments of periosteum result the bone formations in the muscles and fascia. In other words, that they are in the nature of bone grafts.

Ziegler and other pathologists of more recent times believe that the process is one closely related to tumor formation.

Binnie states: "It will be noticed that in my case ossification is as far advanced in the distal as in the proximal portions, that around and throughout the tumor there is great proliferation of the intramuscular connective tissue, that ossification is both of the fibrous and cartilaginous type, and that muscle-fibres in every stage of degeneration are scattered here, there, and everywhere, lying in the connective tissue, in among the islands of cartilage, and hugged by the trabeculæ of bone. There is no microscopical evidence of any inflammatory changes. If this case is one of purely periosteal origin, then the scattering of the periosteal cells or grafts must have been through a territory extraordinary in length and in latitude wonderfully limited. Its origin from a separated periosteal flap is simply inconceivable in view of its relations to the innumerable discrete and degenerating muscular fibres. From careful examination of even this one case, one is forced to admit the possibility and probability of the bone tumor being the result of proliferation and metamorphosis of the intramuscular connective tissue."

Robert Jones believes that in the majority of cases the

growth springs from the periosteum. He bases his conclusions "largely upon the frequency with which these growths are associated with dislocation; their frequent attachment to bone; their frequent growth between the bone and muscle, and sometimes their attachment below the muscle origin, which has been subjected to a violent strain; that in fractures shreds of periosteum may give rise to the development of bone apart from the callus and reparative processes." Jones states that in nine-tenths of the cases the tumor formation is marked in the first two months, the majority by the end of the first month. The recent researches of Macewen upon the growth of bone give rise to some doubt as to the periosteum's being the sole cause of the new bone.

After a very full discussion of the various theories as to the etiology of myositis ossificans, Lapointe states that in his opinion "the theory of an ossifying myosteoma is tenable both for the adhering myosteomas and for the free ones. It can be seen that the insertion into the skeleton is the only point which distinguishes them. All of their other characteristics, both microscopical and macroscopical, are the same. No difference in the method of their development or in their structure has ever been found. The cartilaginous ossificans that has been considered as a type of periosteal osteogenesis is found also in the medullary osteogenesis, so, why should we maintain that the tendinous insertion of a muscle, which is an incontestable factor in the formation of free myosteomas, has not to do with the formation of adherent myosteomas? Is the implantation or non-implantation enough to justify two different pathogenic theories?"

Gillet, in his Thesis of Paris (1910), discusses at some length the difference between myosteomas (myositis ossificans) and true neoplasms. He states the fact that the former not infrequently recur does not constitute them neoplasms, although some writers take the opposite view. A true neoplasm is capable of not only local return but of general metastases, a quality which the tumor in myositis ossificans

does not possess, there being no case on record so far of other than a local return.

He believes that whatever the anatomical considerations, clinically osteomas should never be classed as tumors, and states that, in the first place, we are able to reassure the patient and his family as regards any fears of a tumor. Whatever the variety of osteoma, it is always benign without tendency to increase indefinitely or to generalize, and never is transformed into a malignant process.

This statement of Gillet's was probably true at the time it was written, though the evidence here presented may lead to some qualification in the future.

Diagnosis.—Various conditions may simulate myositis ossificans, particularly in the early stages, *e.g.,* contusion, hæmatoma, myositis, periostitis, periarthritis, syphilitic tumors; but all of these conditions can be differentiated by means of a careful examination aided with a good radiograph.

In periostitis and osteomyelitis, we usually have elevation of temperature, local tenderness, severe pain which is worse at night. Myositis is prone to develop in certain muscles which are seldom the site of syphilitic disease, and the Wassermann test will furnish an additional aid in differentiating the conditions.

On the other hand, the age of the patients (usually young adults) and the fact that the tumor developed shortly after an injury furnish a history almost identical to that observed in sarcoma. In many cases, too, there is a striking similarity in the X-ray picture between the two diseases. In my first case, the X-ray plates had been examined by at least half a dozen X-ray experts and all pronounced the lesion sarcoma. Careful examination, however, of the radiographs which I have been able to observe personally shows this important difference:

In myositis ossificans the sharp outline, corresponding to the junction of the tumor with the bone, is always present, while in sarcoma it is less distinct except in the very early stages of the disease. It was this feature which influenced me

chiefly in making the diagnosis of myositis ossificans in the first case. In the second case the same clear line of differentiation is observed in the earlier picture, although it is not so distinct in the later. I have seen but one case of periosteal sarcoma in which this was not true, and this happened to be a case of extremely rapid growth, apparently sarcoma, in a young adult, a woman of nineteen. The X-ray photograph taken about a month after the beginning of the tumor showed a clear line without any roughness or indentations, which could easily be mistaken for myositis ossificans. In this case, however, there was the absence of a severe injury which is almost always the exciting cause in myositis ossificans, which furnished an important aid in making the diagnosis.

A further and very important point which I have not seen noted in other articles is the marked difference in the consistence of the tumors as determined by palpation. In myositis ossificans the consistence is much harder than in sarcoma; furthermore, it is almost always uniform in character, whereas in sarcoma it is very apt to be soft in some places and harder in others, but there is never the bony hardness that is typical of myositis ossificans.

The pain is another important differential symptom. In sarcoma there is rarely pain in the early stages, unless the tumor is situated near some important nerve, whereas in myositis ossificans pain is much more apt to be a feature in the early development of the disease. Furthermore, the early disability of the neighboring joint, as usually observed in myositis ossificans, has been seldom noted in sarcoma in the early stages. Flexion of the knee is almost lost or greatly limited, and this may occur very soon, a few days after the injury, in myositis ossificans.

The clinical history together with the characteristic features already enumerated will, in most cases, enable one to render a correct diagnosis of myositis ossificans; yet the great importance of making an early and absolutely certain differentiation from sarcoma, in my own opinion, justifies an early exploratory operation and removal of sufficient ma-

terial for a microscopical examination. This is especially true if the tumor is located along the shaft of the bone and not in the neighborhood of a joint. In case the patient is unwilling to submit to an exploratory operation, very careful and frequent observations will soon determine the true character of the disease. If it is sarcoma, there will be steady and fairly rapid increase in size, if myositis ossificans, but very slow increase in size, if any, is noted.

Treatment.—The question of treatment is an extremely important one. Yet the data at the present time would seem hardly sufficient to warrant the laying down of any absolute rule. Jones states that "if we operate early, we risk leaving histological elements behind. If we operate late, apart from the greater destruction of tissue, the proceeding is sometimes very difficult. With our limited experience we would suggest early operation, feeling it would be wiser to risk the performance of a second operation in an endeavor to prevent the spread of trouble, than to delay operative interference, which might result in exuberant development of bone."

Jones, however, in a letter to Mr. Godlee (*Trans. Royal Soc. of Med.*, Surg. Section, 1911), admits that further experience led him to considerably modify his original opinion as regards treatment. In this letter he states: "Since writing the article I have come upon cases where the deposits, instead of increasing, have decreased, and I am not now at all convinced of the value of operation. The simplest looking mass in the bend of the elbow is a very difficult problem to negotiate operatively, and I have on more than one occasion wished I had left the whole thing alone."

A careful review of the cases thus far recorded would lead one to conclude that no single method of treatment is applicable to all cases. The two very interesting and most typical cases, carefully reported by Makins (*Trans. Royal Soc. of Med.*, 1911, p. 132) furnish further strong ground for first trying conservative treatment. These two cases, as shown by the history and radiographs, are almost identical with my first case. Makins's cases were both young adults;

in both the disease occurred in the quadriceps muscle, one followed a football injury, the other the kick of a horse. In both cases he was able to show radiographs taken six years after the original injury, demonstrating almost complete resorption of the bony tumor.

With regard to treatment, Makins states: "As to the general line of treatment to be adopted, a period of some weeks' complete rest should be maintained during the continuance of the active progress of ossification. When it is judged by clinical observation and X-ray examination that progress has ceased, or the process is retrogressive, massage and exercise should follow. Operative treatment should only be considered when the process has manifestly come to a definite standstill, and the patient suffers from functional disability which there is a chance of relieving."

Godlee's case (*l.c.*) still further shows the advantages of conservative treatment. Godlee stated that Mr. Clutton operated upon two similar cases in which the operation had done harm, and he strongly urges "the advisability of leaving these swellings alone until ample time has been allowed, at least a year for the absorption of what may be called provisional callus. Even after this time, I think that removal would only be justified if the mass were causing mechanical inconvenience and pain. It must be remembered that the operation is inflicting another traumatism upon a part, which for some reason has shown a special tendency to the development of bone, and it cannot therefore be surprising if renewed activity of the process should follow."

Some advise early incision and evacuation of the extravasated blood, but this is of doubtful expediency and not to be recommended. Massage is, likewise, inadvisable.

Finney has this to say as regards treatment: "There is an unfavorable as well as a favorable time for operation. It should never be recommended early in the development of the bony tumor, even for diagnostic purposes, since, if we have to deal with a subperiosteal sarcoma, it is of doubtful efficacy, and in this condition the tendency to recur at this stage is very great. If the operation is performed when increase in the size

of the tumor is no longer present and its consistency has become harder, the chances of a recurrence are very materially lessened. The operation should consist in a thorough excision with ample margin of all the osteoid tissue, including some healthy muscle. The underlying periosteum should be thoroughly excised and the shaft of the bone cleaned off until a smooth surface remains. Cauterization with the actual cautery of the denuded bone surface has been recommended. Operation is not recommended in every case; many of them recover under rest and later massage and active and passive motion."

I cannot agree with Finney in advising against exploratory operation for diagnostic purposes. He states that, if we have to deal with a subperiosteal sarcoma, it is of doubtful efficacy. This advice is evidently based on the generally accepted belief that subperiosteal sarcoma is an entirely hopeless condition. Yet we now have a rapidly increasing number of cases of subperiosteal sarcoma which have been cured (and are well over three years) either by the mixed toxins of erysipelas and *Bacillus prodigiosus,* alone, or by the toxins combined with operative treatment. One such case I have the pleasure of showing this evening. This case, a round-celled subperiosteal sarcoma of the femur with extensive multiple metastases, recovered under the toxins and remained well over ten years. A full report of this case will appear in a later number of the ANNALS OF SURGERY. Another important case in point is the case of Williamson (*Transactions of N. Dakota Med. Soc.,* 1910), periosteal round-celled sarcoma, confirmed by microscopical examination by the pathologist of the State Laboratory, and pronounced too far advanced for hip-joint amputation by Dr. W. J. Mayo, who advised the mixed toxins. The patient entirely recovered, with a normally useful leg, and is now well 3½ years later. I do not believe that the small exploratory incision with removal of sufficient material for diagnosis, does any harm in either condition in ordinary cases, and may be of the greatest value in enabling the surgeon to at once advise the proper method of treatment.

In laying down any general rules for the treatment of myositis ossificans, I believe with Lapointe, that sharp distinction should be drawn between the two classes of myositis ossificans, *i.e.*, the cases occurring along the diaphysis of the bone and those situated in the neighborhood of a joint. The latter cases are often complicated with ossifying periarthritis which greatly affects the operative prognosis. While in a number of the cases recorded in the literature there has been a true recurrence after operation, in no case has the size of the recurrence reached that of the original tumor. Lapointe was able to find only 2 cases that had been re-operated upon after recurrence, the cases of Hoffmann (*D. Militärärztl. Zeitschr.*, 1902, vol. xxxi) and Patry (*Soc. méd. de Genève*, 28 janvier, 1909). In the case of Patry there were three successive operations at intervals of a few weeks. The third recurrence was not operated upon, but finally disappeared and the patient fully recovered the function of the extremity.

The thesis of Chabrol (Contribution a l'etude des ostéomes musculaires, etc., *Thèse de Paris*, juillet, 1912) gives the latest facts bearing upon the end results of operation. In 95 cases which he collected there was complete restoration of function in 77; improvement was noted in 15, and no improvement in 3 cases.

In the cases in which the lesion occurred in the neighborhood of a joint, in which there was more or less coexistent ossifying periarthritis, the results were not as good. Chabrol found 25 cases of extirpation of the anterior brachial muscle after dislocation, with complete restoration of function in 8, improvement in 8, and no improvement in 9.

Lapointe's conclusions as regards treatment are that prophylactic measures are uncertain; the value of conservative treatment is more apparent than real and explains the spontaneous regression of the ossifying process which, in time, often results in complete restoration of function. He believes that extirpation six or eight weeks after the trauma is the method of choice in cases not complicated with ossifying

periarthritis. In some of these, the more severe cases, resection may be advisable.

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BIBLIOGRAPHY.

Boudin: Bull. et Mém. Soc. Chirurg. m février, 1907.
Broco: Soc. Chir., 1907.
Delorme: Soc. de Chirurgie, 1 février, 1907.
Herrenschmidt: Soc. Anat., juillet, 1906.
Koenig: Soc. Allem. Chir., XXXV Congrès, 1906.
Lecène: Soc. Anat., juin, 1906.
Loison: Soc. Chir., février, 1907.
Mauclaire: Soc. Chir., 1 février, 1907.
Picqué: Rapport sur un cas d'Osteome du droit anterieur, 21 juillet, 1909.
Sieur: Soc. Chir., 1 février, 1907.
Battle and Shattock: Proc. Roy. Soc. Med., 1908 (Path. Sect.).
Ewald: Deutsch. Zeitschrift f. Chir., Leipz., 1910, cvii.
Schultz: Deutsch. militararztl. Zeitschr., 1910, Heft 4.
Strauss: Archiv. f. klin. Chir., 1906, Bd. lxxiii, p. 111.
Aizner: Münch. med. Wochenschr., 1909, vol. lvi, No. 15, p. 757.
Bloodgood: Progressive Medicine, December, 1902–1908.
Bunting: Journ. Exp. Med., 1906, vol. viii, p. 365.
Whitelocke: Sprains and Allied Injuries of Joints (Henry Frowde, London, 1909).
Nichols and Richardson: Boston Med. and Surg. Jour., 1909, vol. clx, p. 33.
Bergerhout, H.: Nederl. Tydschr. v. Geneesk. Amst., 1906, 1, 1363.
Berndt, F.: Arch. f. klin. Chir., Berl., 1906, xxix, 617.
Ferrator: Rev. d'orthop, Par., 1906, vii, 427.
Frangenheim, P.: Arch. f. klin. Chir., Berl., 1906, xxx, 445.
Binnie: ANNALS OF SURGERY, Sept., 1903.
Jones, Robert: Arch. of the Röntgen Ray and Allied Phenomena, 1905–1906.
Cahier: Rev. de Chir., 1904.
Finney: Transactions of the Southern Surgical Society, 1909.
Lapointe: Review de Chir., Nov., 1912.
Makins: Transactions Royal Society of Medicine, Surgical Section, 1911.
Godlee: Transactions Royal Soc. of Med., Surgical Section, 1911.
Gillet: Thesis of Paris, 1910.
Chabrol: Thèse de Paris, July, 1912.