tion and perhaps will permit a less extensive removal of the stomach without fear of the consequences of an anastomotic ulcer.

Possibly the greatest value of vagotomy lies in the treatment of an ulcer which is uncomplicated by penetration, bleeding or stenosis and which has failed to respond or be controlled by medical therapy as opposed to the complicated ulcer for which a sub-total gastrectomy continues to be the best method of management or as an adjunct to a partial gastrectomy of gastrojejunostomy. Finally, vagotomy has been shown to be useful in relieving epigastric pain due to such pathological conditions as pancreatitis and pancreatic calculi. It is suggested here that its further use may be in the relief of pain that is sometimes associated with inoperable malignant ulcers* of the stomach.

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* One patient, Mrs. N., aged 39, who was found at operation to have an inoperable carcinoma of the stomach and who had been suffering considerably from epigastric pain, was relieved completely insofar as the pain was concerned following subdiaphragmatic vagotomy. The operation was done on November 8, 1947 and relief of the epigastric pain has continued until the present time (January 20, 1948).

INSECTICIDAL SOLUTIONS.—Various insecticidal dusts and sprays have proved highly effective in the householder's war against insects and other pests but such agents include potentially dangerous chemicals including lead arsenate, basic copper arsenate, paris green, cyanide and fluoride compounds, sulphur and nicotine. The poisonous effect of each of these insecticides varies according to the nature of its chemical composition but prolonged contact with most of them may have harmful effects. Care should therefore be taken when handling all such toxic materials.

OSTEOID OSTEOMA*

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THE osteoid osteoma is a small but usually painful, tender and troublesome benign lesion of the bones. It has often been mistaken for other conditions such as chronic osteomyelitis, cortical abscess, bone abscess with sequestrum, Brodie's abscess, sclerosing osteitis, osteochondritis dissecans, tuberculosis, bone cyst and even sarcoma, with the result that it sometimes has been improperly treated even to the extent of unnecessarily extensive resections or amputations. It is important therefore that it be recognized for the benign tumour that it is, and to know that it can be cured promptly and easily by complete local removal.

This tumour was first presented as an entity and named osteoid osteoma by Jaffe, pathologist to the Hospital for Joint Diseases, New York, in a report of 5 cases published in 1935.[1] In two subsequent reports by Jaffe and Licktenstein[2] and by Jaffe[3] from that same source, published in 1940 and 1945 respectively, 57 more cases were recorded. These three very excellent papers give a thorough analysis of all aspects of the disease.

That this lesion is a distinct entity and a tumour we must agree with Jaffe. We feel that there is no longer any point in discussing why it is not an inflammatory one. The differential diagnosis between osteoid osteoma and certain other lesions of bones, especially abscess, we must admit is not always easy without the aid of histologic sections. However, as one becomes familiar with the clinical behaviour and the radiographic appearances of this disease, a correct diagnosis can nearly always be made before operation. Even in doubtful cases, exposure of the lesion should enable the surgeon to recognize its true nature.

Prior to Jaffe's original article there were published under other titles a number of case reports[4, 5, 6, 7] examination of which leaves no doubt that the lesions described are the same as Jaffe's osteoid osteoma. Since then several papers by other authors have been published under the title of osteoid osteoma.[8 to 20] All these reports indicate that the osteoid osteoma is by no means infrequent. From the single source, the Hospital for Joint Diseases mentioned above, 62 cases were reported between the years 1935

* From the Departments of Pathology and Radiology, McGill University and the Montreal General Hospital.

and 1945. In a general hospital no such large numbers are likely to be found.

In our own experience in the past 18 years, 19 of these tumours have been encountered, 8 are recorded in the files of the Montreal General Hospital, 6 were shown to us by our pathologist colleagues in Montreal, and sections of 2 and radiographs of 3 were sent from outside sources for an opinion. Of these 19 cases, 15 are selected for this report.

CASE 1

A young woman of 26 first noticed pain and swelling in the proximal phalanx of the middle finger of the right hand in 1936. This gradually increased and in February, 1939, she consulted her doctor because of the very troublesome pain which disturbed her sleep. Joint movements were good. There was no history of trauma. A radiograph made at that time outside the hospital was reported as osteitis and bone abscess containing a sequestrum. The swelling and pain increased and on May 15, 1939, she was admitted to the Montreal General Hospital. The x-ray film accompanying the patient was interpreted as osteoid osteoma (Fig. 12).

Operation revealed a very hard, rounded, pea-sized nodule in the cancellous bone near the distal end of the diaphysis. This was removed easily with the curette and the cavity was thoroughly curetted. The specimen received in the laboratory consisted of a 5 mm. pearl-gray, finely jagged, rounded body of the consistency of hard bone. Histologically it was typical of osteoid osteoma with atypical lamellar bone formation. The pathological diagnosis was osteoid osteoma.

Following the operation there was immediate relief of the troublesome pain. A month later, examination showed a good functioning finger and no symptoms. On May 26, 1947, 8 years after operation, the patient was again examined. There were no symptoms and the finger functioned perfectly. A radiograph showed restitution of the bone with the exception of a slight notch at the site of operation. The other bones of the hand which

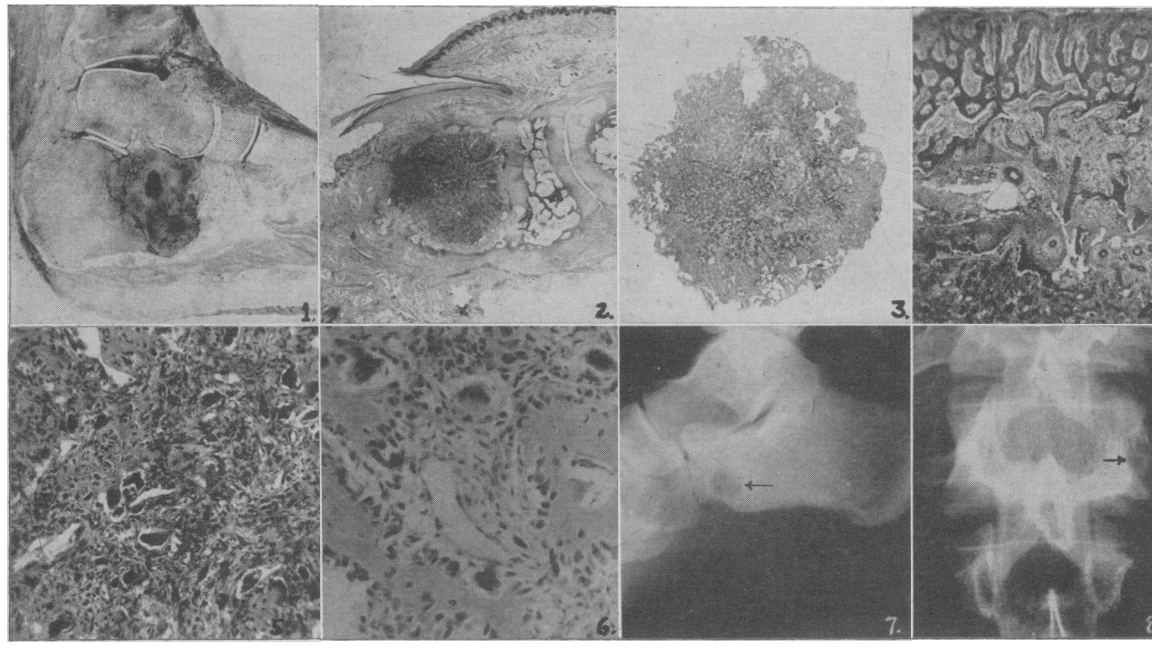

Fig. 1. (Case 4).—Longitudinal section through the foot showing the 4.5 x 4 cm. circumscribed tumour in the anterior end of the os calcis. In it are areas of hæmorrhage. **Fig. 2.** (Case 3).—Photomicrograph x 3 of a longitudinal section of the toe showing the sharply demarcated rounded and finely trabeculated body occupying the whole of the medulla of the diaphysis of the distal phalanx. The epiphysis is intact. Note the thin cortex above and below and its complete absence distally. Between the tumour and the cortex there is a pale zone of connective tissue. **Fig. 3.** (Case 2).—Photomicrograph x 10 of the tumour removed by the curette. It is composed of finely meshed trabeculæ of calcified osteoid in a substrate of osteoblastic connective tissue. **Fig. 4.**—The periphery of the tumour shown in Fig. 2. The margin of the osteoid osteoma is seen along the lower border and the cortex along the upper border. The area between the tumour and the cortex is occupied by a well vascularized connective tissue in which are a few osteoid trabeculæ. The cortex shows marked lacunar absorption and replacement by connective tissue. The periosteum is very cellular and there is new periosteal bone formation. **Fig. 5.**—A small area of the tumour shown in Fig. 2. It shows the basic osteoblastic type of tissue, well vascularized and containing many multinucleated giant cells. There are many small irregular deposits of osteoid but no formed trabeculæ. Elsewhere in this tumour osteoid trabeculæ, as in Fig. 6, are abundant. **Fig. 6.**—The tumour illustrated in Fig. 1. It shows well the non-calcified osteoid trabecular with intervening well vascularized osteoblastic type of connective tissue containing numerous giant cells. This is the non-calcified stage. **Fig. 7.** (Case 10).—The head of the os calcis shows a roughly rounded area of radiotranslucency, the non-calcified stage of the tumour. **Fig. 8.** (Case 9).—Marked rarefaction of the transverse process of the vertebra; at its base there is a small rounded radiotranslucent area surrounded by a rim of condensed bone, the non-calcified stage of the tumour with reactive bone formation surrounding it.

previously showed marked general rarefaction had returned to normal.

CASE 2

A young woman of 24 years, was admitted to the Service of Dr. S. E. Goldman at the Jewish General Hospital, Montreal, on October 16, 1935, complaining of pain of 15 months' duration in the right ankle on walking and on everting the foot. At times the ankle swelled and was tender. A radiograph (Fig. 11) was diagnosed as Brodie's abscess. At operation, a pea-sized dense bony nodule was easily removed. There was no pus. The specimen received in the laboratory consisted of a rounded, brown, 5 mm. nodule of bony consistency. Microscopically (Figs. 3 and 9) it was a typical osteoid osteoma.

This patient was in the Massachusetts General Hospital, Boston, in March, 1935, 7 months prior to operation and 7 months after the onset of symptoms. An x-ray examination at that time was reported as showing general rarefaction of the bones of the foot and no localized lesion. Following operation there was prompt relief of symptoms and the patient is still free of symptoms 12 years after operation.

CASE 3

A boy of 13 was admitted to the Montreal General Hospital on March 10, 1939, complaining of a sore,

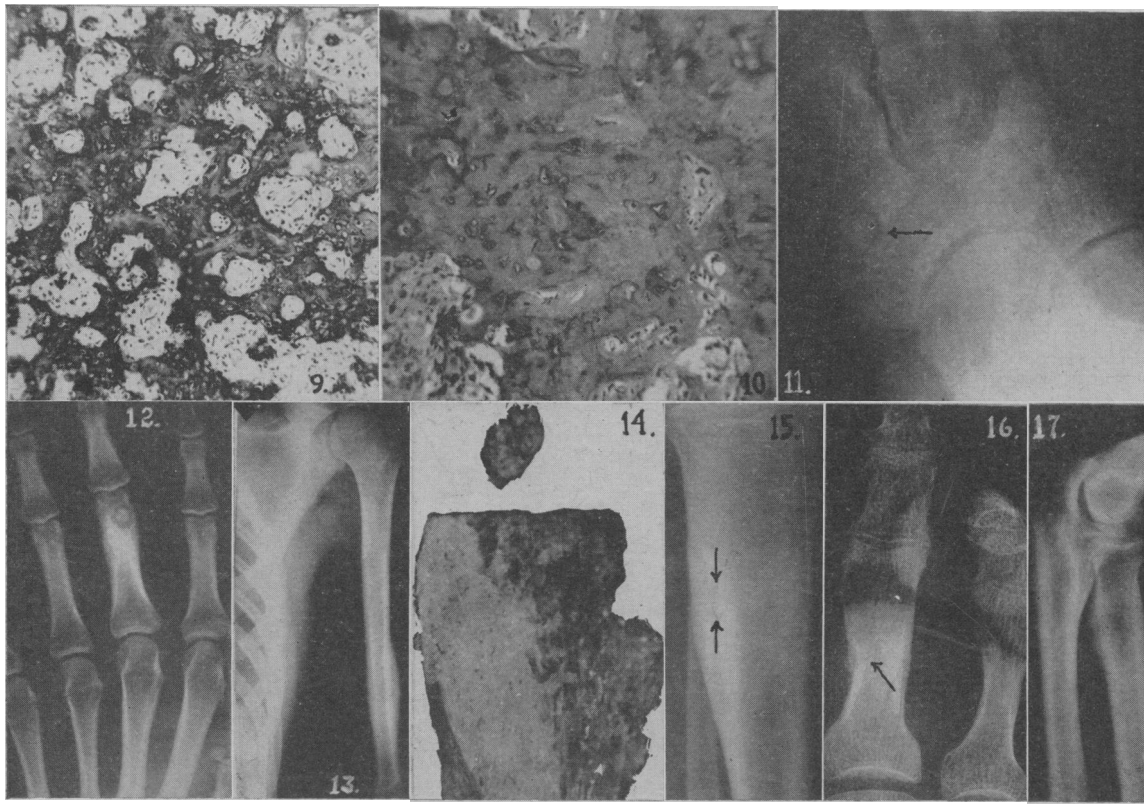

Fig. 9.—Higher power photomicrograph from the centre of the tumour shown in Fig. 3. There is a meshwork of calcified osteoid trabeculæ in the interstices of which there is a moderately cellular and moderately vascularized connective tissue and only a few giant cells. This is the calcified stage later than in Fig. 6. See Fig. 11. **Fig. 10.** (Case 1).—Photomicrograph of the tumour showing massive calcified osteoid and some lamellar bone formation. The interstices are narrow and filled with poorly vascularized connective tissue. Giant cells are very scanty. This is the still later calcified and ossified stage. See Fig. 12. **Fig. 11.** (Case 2).—Radiograph showing in the navicular bone a rounded area of radio-translucency with a large central rounded moderately opaque body. The bones generally are rarefied. The opaque nodule after removal is shown in Figs. 3 and 9. **Fig. 12.** (Case 1).—Radiograph showing in the distal end of the first phalanx, a very dense rounded body surrounded by a zone of radio-translucency. About the tumour and extending proximally the bone is condensed and thickened. There is general rarefaction of the other bones. **Fig. 13.**—Preoperative radiograph showing periosteal bone formation and in the cortex the small rounded radio-translucent zone. A small central opaque core overlaid by the dense cortex can be identified with difficulty. **Fig. 14.** (Case 14).—Photograph x 3. The larger mass represents the thickened condensed cortex. The smaller one is the osteoid osteoma which separated easily when the bone was being chiselled away. See Fig. 15. **Fig. 15.** (Case 14).—Lateral view showing the marked cortical condensation and thickening posteriorly in the tibia. In the thickened cortex can be seen very faintly, the oval dense body surrounded by a narrow zone of radio-translucency. **Fig. 16.** (Case 10).—Radiograph showing marked cortical thickening and condensation of the shaft of the proximal phalanx of the toe. Along the medial margin where condensation is greatest, there is rough periosteal bone formation. Beneath this area in the deep margin of the cortex the little tumour is scarcely visible. Note the rarefaction of the rest of the bone. **Fig. 17.** (Case 12).—Radiograph showing the radio-translucency in the tubercle of the radius and the translucent tract extending through the cortex. There is overlying periosteal bone formation with faint condensed streaks at right angles to the surface.

swollen toe for two months. Examination showed a bulbous, tender swelling of the distal phalanx of the second toe of the right foot. There was no history of injury. The temperature was normal and there were no other symptoms but he was considered to have a rheumatic heart. The Mantoux test was 4 plus. The clinical impression was tuberculous osteomyelitis. An x-ray examination was reported as showing marked swelling of the soft tissues and decalcification of the bone of the distal phalanx without any breakdown of bone. The chest x-rays were negative. On a diagnosis of tuberculosis, the toe was amputated through the middle joint on March 16, 1939. A longitudinal section through the specimen (Fig. 2) shows swelling of the soft tissues and in the diaphysis of the distal phalanx, a rounded, reddish, tough body. The epiphyseal cartilage is intact. The cortex is thinned by absorption from within. The gross appearance is typical of osteoid osteoma. Histologically it was also typical osteoid osteoma. The boy was alive and well 8½ years after operation.

CASE 4

A boy of 14 years was admitted to the Montreal Hospital on September 22, 1928, complaining of sharp pain and swelling of one month's duration in the region of the external malleolus. Four months previously he had twisted his ankle with no ill-effects other than slight soreness for a few days. Examination revealed a tender swelling on the lateral aspect of the ankle. X-ray examination on September 28, 1928, was reported as showing swelling of soft parts, decalcification of the bones of the foot and leg, indistinctness and slight loss of joint spacing and no evidence of fracture or of localized destructive or productive bone changes suggestive of tuberculosis. The tuberculin and blood Wassermann tests were negative. His temperature ranged up to 99.2°. There were no other significant signs or symptoms. A cantilever cast was applied with some relief of pain and he was discharged on October 8, 1929. Two months later on December 16, 1928, and four months after the onset of symptoms, he was re-admitted with increased pain and swelling. Movements at the ankle were limited. X-ray examination on December 29, 1928, was reported as follows: "There is evidence of productive and destructive bone change involving the anterior end of the os calcis and extending into the joint which is suggestive of new growth. There is marked rarefaction of all bones in this film". Blood leucocytes numbered 8,200 to 9,000. Hgb. 80%; blood Wassermann negative. Enlarged inguinal glands appeared on December 29, 1928. One of these was removed and reported pathologically as catarrhal lymphadenitis and no tumour. His temperature during the second admission was normal with the exception of a rise to 100° on January 14, 1929. The condition in the foot was considered a malignant tumour so an amputation was done through the lower third of the leg on January 17, 1929.

The specimen (Fig. 1) cut longitudinally in the antero-posterior plane shows in the anterior end of the os calcis a 4 x 4.5 cm. roughly rounded, firm, pink mass replacing the cancellous bone and cortex and bulging into the joint. It was sharply circumscribed but not encapsulated and in it there are small hæmorrhagic areas. The pathological diagnosis originally was osteogenic sarcoma but on review of the sections 6 years later, the diagnosis was altered to osteoid osteoma of which it is a good example. This patient was alive and well 18 years after operation.

CASE 5

A woman of 36 years had had a painful swelling of the anterior end of the mandible for 2 years. Because of the pain she consulted her doctor in September, 1936. No x-ray examination was made. The condition was thought to be a bone cyst or an unerupted tooth. On cutting down on the lesion the surgeon encountered tough, gritty tissue, "like spongy bone", in the cancellous part of the mandible. The whole was excised along with a margin of cortical bone. The material sent to the Montreal General Hospital consisted of a 2 x 1.3 cm. triangular piece of tough gritty, grayish pink tissue and a small fragment of attached hard bone. The pathological diagnosis was osteoid osteoma.

A letter from this woman in June, 1945, 11 years after operation reported no symptoms and no recurrence of the swelling.

CASE 6

The only information available is that this man of 24 years had had a painful patella for several months. A radiograph was submitted to the x-ray department of the Montreal General Hospital for diagnosis. It showed in the patella a small rounded area of rarefaction with its densely calcified core characteristic of osteoid osteoma. The radiologic diagnosis was osteoid osteoma. No further information has been obtained.

CASE 7

Male, aged 44, injured the right knee in a fall on March 20, 1947. He visited the Out-patient Department the next day complaining of pain in the knee on flexing the leg, only since the accident. There was tenderness over the lateral aspect of the knee. A radiograph showed in the patella near the articular surface a 7 x 5 cm. rounded area of rarefaction in the centre of which there was a densely calcified rounded body. The radiologic diagnosis was osteoid osteoma. The tumour development must have preceded the injury and symptoms, and therefore must have reached this advanced stage without symptoms. This man ignored advice to return to the hospital for further examination.

CASE 8

A girl of 20 years complaining of swelling, slight stiffness and limitation of movement of the right knee of two years' duration, consulted Dr. W. O. Rothwell of Temiskaming, about November 1, 1947. There was no point of tenderness and no complaint of pain and no history of injury. The quadriceps muscles showed considerable atrophy. A radiograph sent to the Montreal General Hospital for an opinion revealed in the patella near the anterior surface a small area of radio-translucency with a dense central core typical of osteoid osteoma.

Because of the minor degree of symptoms the orthopædic surgeon consulted advised no surgical interference. After about one month's treatment with active exercises, her doctor reports that there is now full movement at the knee and the swelling is diminishing.

CASE 9

A boy of 19 years was admitted to the service of Dr. R. C. Laird at the Toronto Western Hospital in June, 1946, complaining of pain of unstated duration, radiating from the right costo-vertebral angle into the right flank. The pain seemed to be of root neuritis type. The radiograph (Fig. 8) shows rarefaction of the right transverse process of the first lumbar vertebra. At the base of the process is a small round radio-translucent spot about which there is a narrow rim of condensed bone. There is no calcified core.

The transverse process was removed. The histological sections sent to us by Dr. George Shanks, then pathologist to that hospital, are typical of osteoid osteoma without calcification of the osteoid. Following the operation relief of pain was prompt and has remained so up to the latest report one year after operation.

CASE 10

A man of 25 years consulted his doctor about November 1, 1947, because of soreness in the foot toward the end of the day. Inversion of the foot caused pain over the lateral aspect and there was tenderness on pressure over the head of the os calcis. There was no swelling. His general health was good. A radiograph (Fig. 7) shows a 1.5 cm. ovoid, sharply demarcated area of radio-

translucency in the head of the os calcis. There is no central condensation although there is a little irregularity in the density of the lesion. The radiologic diagnosis was osteoid osteoma. It represents the non-calcified stage of the tumour. Removal of the tumour has been recommended, but has not yet been done.

CASE 11

A 36-year old man was admitted to the service of Dr. L. T. Barclay at the Toronto Western Hospital in 1939, complaining of increasing pain commencing two months previously in the proximal phalanx of the second toe. Later the toe became swollen. A radiograph (Fig. 16) shows marked bone condensation in the middle part of the diaphysis. Along the medial margin where condensation is greatest, there is slight periosteal, right angle new bone formation. Beneath this area in the deep margin of the cortex and bulging into the medulla there is the very faint outline of a dense rounded body partially surrounded by a very narrow radio-translucent ring. The neighbouring bones show considerable decalcification. The lesion was curetted in 1939 and microscopic sections of the tissue were sent to us by Dr. George Shanks. They show fragments of typical osteoid osteoma. Operation gave prompt relief from pain and on April 28, 1947, 8 years after operation, this man was reported well and free from symptoms.

CASE 12

A man of 30 years of age was admitted to another local hospital in March, 1933, complaining of severe pain in the arm and tenderness at a point corresponding to the tubercle of the radius. In 1930 he received a blow on the wrist following which he had intermittent pain from the hand to the elbow. At first mild, the pain gradually became worse and more frequent and finally constant and severe disturbing his sleep. External rotation of the forearm aggravated the pain. There was a mild tingling sensation in the hand and tenderness over the tubercle of the radius. In November, 1932, a radiograph was reported as negative. Five months later, March, 1933, a repeat radiograph (Fig. 17) revealed a radio-translucency of the tubercle of the radius extending up to the periosteum. There was no calcified core but in the lesion were fine linear radio-opaque streaks running at right angles to the surface. Osteogenic sarcoma was suspected. A hard, rounded body removed surgically was reported pathologically as osteogenic sarcoma. Disarticulation at the shoulder was advised but the patient refused this operation. A little later the upper one-third of the radius was resected. On review of the sections a few years later, the diagnosis was corrected to osteoid osteoma. This man is alive and well and has a good functioning arm 15 years after operation.

CASE 13

A boy of 18 years admitted to the Jewish General Hospital, Montreal, service of Dr. R. Breitman, on August 20, 1946, gave a history of pain in the left arm for about 1 year. For 1 month prior to admission the pain had been of a severe, stabbing character lasting about one minute and radiated down the arm and up into the neck and scapular region. Examination revealed a tender, hard mass about 2 inches long on the anterior surface of the humerus about its middle. There were no other significant signs or symptoms. Blood Wassermann was negative. A radiograph (Fig. 13) shows a circular translucent area in the cortex of the humerus. Close examination reveals a small central condensation largely obscured by the cortex. Overlying this defect and extending up and down the shaft for some distance, there is marked periosteal bone formation producing a thickening of the humerus cortex.

At operation on August 24, 1946, hard bone was chiselled away exposing what the surgeon thought was the medullary cavity obliterated by a mass of tissue the consistency of spongy bone. The surgical diagnosis was sclerosing osteomyelitis. It was obvious by a postoperative x-ray examination that the lesion was entirely within the cortex and that what the surgeon thought was medullary cavity was actually the osteoid nodule in the thickened cortex. The pathological diagnosis was osteoid osteoma. Following the operation relief of symptoms was prompt and the patient was free from symptoms 15 months later.

CASE 14

This young man of 21 years of age injured his left leg below the knee in 1945. There was pain and swelling of short duration. In August, 1946, he again sustained an injury to the same part, followed by a persistent, tender swelling and increasing pain in the upper leg, particularly severe on weight-bearing. On admission to the Montreal General Hospital on October 18, 1946, there were no other significant clinical findings. Radiographs showed marked cortical bone condensation and thickening posteriorly in the upper end of the tibia. Although no central rarefaction could be seen, an osteoid osteoma was suspected and the patient was brought back for further radiological examination. The second radiograph (Fig. 15) made with the Buckey diaphragm and more penetrating rays revealed in the centre of the condensed cortex very faintly, an oval, dense body surrounded by a narrow radio-translucent zone. This confirmed the suspicion of osteoid osteoma.

At operation on October 21, 1946, the thickened cortical bone was chiselled away. During this procedure a pea-sized brown firm nodule separated from the bone. The specimen received in the laboratory consisted of fragments of dense cortical bone measuring up to 2 cm. in thickness and a 5 mm. rounded, reddish brown nodule of bony consistency. The pathological diagnosis was osteoid osteoma and hyperplastic compact cortical bone. Relief of symptoms was prompt and a year later this man was free of symptoms.

CASE 15

An 11-year old girl entered the Jewish General Hospital, Montreal, service of Dr. Mark Kaufmann, on September 24, 1946, complaining of pain and swelling over the middle of the left tibia for three weeks. Her mother stated that the child had complained of pain in this location at intervals for the past year. Physical examination revealed over the middle third of the left tibia, a hard fusiform tender swelling. A radiograph showed cortical thickening of the antero-medial aspect of the middle third of the bone. In the centre of the condensed thickened cortex there was a faintly visible ring of rarefaction about a dense rounded body. The radiological diagnosis was sclerosing osteitis, osteoid osteoma or Ewing's tumour and a biopsy was advised. At operation on September 28, 1946, hard bone was chiselled away and underlying soft tissue was removed with a curette. No pus was encountered. The pathological diagnosis was osteoid osteoma. The patient was discharged, symptom-free and was still free of symptoms a year later.

THE PATHOLOGIC NATURE OF THE LESION AND ITS RADIOLOGIC APPEARANCES

It may be profitable to combine the discussion of the pathologic and radiologic findings in order that the interpretation of the latter may be based upon the former through the various phases of the development of this tumour. Early in the course of the disease, even though pain and tenderness and sometimes swelling of the soft tissues are marked, there may be no noticeable radiologic change whatever, as in case 12, or there may be general rarefaction of the bones

of the region without any localized demonstrable lesion as in cases 2 and 4. At this stage no one has had the opportunity of examining pathologically any of the bone tissue; therefore, the genesis of the lesion is not known. However, a very fair idea of it may be gained from a study of its later stages.

At a demonstrable stage the osteoid osteoma occurs as a more or less rounded nodule commonly 0.5 cm. and usually not exceeding 1 cm. in diameter. Occasionally it attains considerably larger dimensions as in case 4 in which the tumour measured 4.5 cm. in its longest axis. In location it may be entirely within cancellous bone, entirely within the cortex, subperiosteal, or in the deep margin of the cortex bulging into the medulla. Originating in the cancellous bone it may later involve the cortex. The consistency of the nodule varies from that of soft, spongy to hard bone. In colour it may be brownish red, pink or pearly gray.

In situ, demarcation of the nodule is sharp (Figs. 1 and 2). The cut surface on slight magnification is seen to be finely trabeculated (Fig. 3). Between the tumour nodule and the surrounding bone, a zone of loosely arranged cellular and vascularized connective tissue can be defined (Fig. 2). Higher magnification of this zone (Fig. 4) reveals that lacunar absorption and replacement of the pre-formed bone by this vascular actively growing connective tissue in which new bone may form, extends considerably beyond the actual tumour nodule. When the process reaches the periosteum that membrane is stimulated into active cellular proliferation followed by a new periosteal bone formation.

The little nodule can be easily separated from its bed through the zone of loosely arranged connective tissue immediately surrounding it. Hence, very commonly the specimen received in the laboratory consists of a small ball of tissue. The fundamental nature of this small ball, the osteoid osteoma, is that of a very cellular osteoblastic type of connective tissue, well vascularized and containing numbers of multinucleated giant cells (Fig. 5). It reminds one of the type of tissue seen in the metaphysis of the growing bone. It resembles somewhat the substance of the giant cell tumour and the intertrabecular tissue in active Paget's disease of bone. But in none of the specimens that we have examined has the content been entirely of this nature. If Fig. 5 is carefully examined, small, irregular, scattered deposits of osteoid can be detected. This illustration represents only a very small area of the tumour in Fig. 2. Elsewhere in that specimen well developed trabeculæ of osteoid are abundant. Fig. 6 taken from the tumour shown in Fig. 1 shows well developed, non-calcified osteoid trabeculæ. It is these trabeculæ that impart to the tumour its finely trabeculated appearance.

At this stage the radiograph will reveal a small more or less rounded radio-translucent area as in case 10, of three months' duration. The radio-translucent zone is comprised of the non-calcified tumour and the immediately surrounding zone of reactive connective tissue. Often at the periphery of the surrounding reactive connective tissue zone new bone formation may be stimulated and then a rim of bone condensation appears about the rarefied nodule (Fig. 8).

The next phase in the development of the tumour is calcification of the osteoid (Fig. 9). The time of its appearance is variable. It may take place almost as soon as the osteoid forms, yet it may be delayed for several months. Beyond the margin of the tumour nodule the vascular connective tissue zone described above persists. As time goes on, the cellular activity in the tumour diminishes, giant cells become fewer and vascularity lessens and layers of calcifying osteoid may be deposited upon the original calcified trabeculæ forming atypical irregularly lamellated bone (Fig. 10). The radiographic appearance now will be that of the previous stage described above but, in addition, there will be in the radio-translucent zone a central opaque body which will vary in size and density according to the extent and degree of calcification of the osteoid. The non-opaque rim about the dense nodule can be accounted for by the reactive connective tissue about the tumour and by non-calcified tissue at the periphery of the tumour. When the lesion is located in cancellous bone it stands out distinctly in the radiograph as a small dense body surrounded by a zone of radio-translucency (Figs. 11 and 12). This is a very common and characteristic radiologic appearance of the osteoid osteoma and is often seen on first examination of the patient.

When the tumour is located in the cortex, or involves it from the medulla, the proliferative cellular reaction about the tumour may be at-

tended by an increased bone formation in the cortex and in the overlying activated periosteum resulting in a more or less marked cortical thickening and condensation. This reaction may extend a considerable distance beyond the tumour, as illustrated in Figs. 12 to 16. So dense may be this bone reaction that, by the ordinary radiologic technique, the embedded tumour is scarcely visible (Figs. 13 and 16) or it may be entirely obscured and the use of the Buckey diaphragm and more penetrating rays will be required to visualize it as in case 11 (Fig. 15). It is to be noted that the calcification of the tumour does not bear any direct relation to the degree of surrounding proliferative bone reaction. The radiographic appearance of the condensed central core in the tumour may or may not exist in the presence of a marked surrounding bone reaction.

As previously mentioned the osteoid osteoma may be located subperiosteally. Jaffe in one of his papers presents a very good example. In our own material case 12 showed a rather unusual appearance. The lesion was located in the tubercle of the radius. The radiograph (Fig. 17) shows an oval radio-translucent area from which a similar translucent tract extends through the cortex to the surface. In this tract faint condensed streaks can be seen at right angles to the surface. It was probably this appearance that raised the suspicion of sarcoma which was at first mistakenly confirmed on biopsy, but later corrected to osteoid osteoma.

In this lesion of osteoid osteoma there appears to be two distinct features. One is the circumscribed nodule forming the tumour; the other is the surrounding zone of proliferating connective tissue. This connective tissue may do one of two things, or both. It may and probably always does cause lacunar absorption of preformed bone and then later provides the connective tissue bed for additional bone formation in membrane, thus accounting for the condensation and thickening of the bone about the tumour. Just what the relationship is between the tumour and the surrounding reactive process is difficult to explain. That the reactive process is dependent upon the tumour is borne out by the fact that removal of the tumour brings about a cessation of the reactive process and eventual restitution of bone architecture, as illustrated by case 1. Furthermore if, in the course of operation, the tumour is not removed symptoms and the progress of the lesion continue.

The evolution of the osteoid osteoma is, like other benign tumours of bone, a relatively slow process. The initiation of the tumour we may presume to be a proliferation of the intertrabecular bone-forming mesenchyme which by its pressure effects, causes bone pain. It is attended by a vascular disturbance manifested by swelling of the soft tissues. This phase may continue for some time without showing any focal bone replacement noticeable in the radiographs. There may however be some general rarefaction of the bone of the region due to the local vascular disturbance and disuse because of pain. This phase may persist for at least seven months as in case 2, but usually is of much shorter duration. It is followed by local bone absorption due to the lytic action of the tumour and the lesion then becomes demonstrable radiologically as an area of radio-translucency. Later a central condensed core appears when the osteoid becomes calcified. The surrounding proliferative cellular reaction, particularly when the cortex and periosteum become involved, provokes new bone formation which may extend far beyond the tumour and may be so dense, as seen in the radiograph, as to entirely mask the appearance of the little tumour.

Knowing the behaviour of this peculiar lesion, two important procedures can be recommended in those cases in which the characteristic appearance of the tumour is not noticed radiologically.

1. In those cases in which the symptoms of troublesome pain, tenderness, soreness or stiffness, and often swelling suggestive of osteoid osteoma are present and the first radiologic examination reveals no lesion or only general rarefaction of the bones of the area, further exposures should be made at various angles and should be very carefully examined because the focal radio-translucency may be very faint or masked by the accompanying surrounding bone rarefaction. If by this means demonstration of the lesion fails, repeated radiographs should be made at short intervals until a diagnosis can be made.

2. In the presence of suggestive symptoms when only marked eccentric cortical condensation and thickening can be demonstrated by the usual radiologic technique, further examination by the use of the Buckey diaphragm and more penetrating rays should be carried out in an effort to demonstrate the embedded little tumour.

CLINICAL CONSIDERATIONS

The osteoid osteoma is a disease affecting chiefly young adults and adolescents and occurs about twice as often in the male as in the female. In this series of cases, the ages ranged between 11 and 36, with one at 44 years. It has been reported as early as 1½ years and as late as 49 years. Ten cases were males and five, females.

The skeletal location is predominantly in the bones of the lower limbs which were involved in 10 of the cases. Three were in the upper limbs, 1 in the mandible and 1 in the transverse process of a vertebra. As yet this tumour has not been reported in the ribs, clavicles, scapulæ or skull bones other than the mandible. There is no good reason to believe that it should not appear in these bones.

Pain is the outstanding symptom. It was because of this that all but one of the cases sought medical attention. At first intermittent and mild, it increases in severity and persistence and may be troublesome enough to interfere with sleep. Active movements and weight-bearing may aggravate it. Usually it is localized to the area involved, but it may radiate for some distance as in cases 9, 12 and 13. However, pain is not always complained of, nor is it always severe. In case 8 there was none. In cases 3 and 10 the complaint was of soreness rather than definite pain. In case 7 symptoms followed a fall on the knee 24 hours previous to the finding of a well developed osteoid osteoma in the patella and could not therefore be attributed to the tumour. Tenderness over the location of the tumour is a pretty constant sign. In several cases it was not mentioned, but in only one was it said definitely that there was none.

Swelling of the regional soft tissues is often found and in those cases where the cortex is involved, the underlying hard cortical swelling can be palpated. Limitation of joint movements seems to be due to the pain evoked and stiffness is probably due to the soft tissue swelling. Local heat and redness is persistently absent.

Trauma cannot be considered an etiologic factor. In only 4 cases was trauma referred to by the patients as a cause of their trouble. In one it antedated symptoms by 4 months. In another, a blow on the wrist appeared to initiate symptoms which were promptly relieved three years later by removal of an osteoid osteoma in the upper end of the radius. In the third case symptoms followed immediately after trauma to the part and two months later a well developed osteoid osteoma accompanied by a marked and wide area of cortical thickening was demonstrated, a lesion much larger than would be expected at two months. In the fourth case pain and tenderness followed a fall on the knee 24 hours prior to the finding of a well developed osteoid osteoma in the patella. It appears that trauma may initiate symptoms in the presence of an already developing tumour.

There is usually no significant rise in temperature, pulse rate or leucocytes and regional lymph nodes rarely enlarge. In case 4 in which there was an unusually large and active tumour in the os calcis and into which there was hæmorrhage, there was slight elevation of temperature and a palpable catarrhal inguinal lymphadenopathy.

TREATMENT

Surgical removal of the tumour gave prompt relief from symptoms and a lasting cure in 11 cases. In 8 of these the tumour was removed by the chisel and curette. Two amputations and one resection, done under mistaken diagnoses, also gave prompt and lasting cures. Two were not operated on and have been lost track of. One recent case, advised to have the tumour removed, has not yet been operated on. Another one in which symptoms were slight has been advised against operation and has improved under treatment by active exercises. The outcome of this last case will be watched with interest. Judging by the behaviour of the other cases and those reported by other authors, we would not be surprised if the return and increase of symptoms necessitated the removal of the tumour.

It is interesting to speculate as to what might be the fate of this tumour if left untreated. Cases with troublesome symptoms come to operation. But what happens in those cases in which symptoms are mild or absent? It is not inconceivable that the ossified tumour might fuse with the surrounding condensed bone, accounting for some of those foci of osteopetrosis accidentally found in the bones on radiologic examination.

SUMMARY

Fifteen cases of osteoid osteoma are reported. The pathology of the lesion in its various phases is discussed in correlation with the radiologic

findings. The clinical features and results of treatment are also discussed.

We are indebted to our pathologist colleagues, Dr. Morris Simon of the Jewish General Hospital, Montreal, and Dr. N. Sharp of the Toronto Western Hospital and to the radiologists of those two hospitals for permission to use their materials. We appreciate very much the kindness of the surgeons mentioned for allowing us to make use of their cases.

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B.C.G. VACCINE IN THE PREVENTION OF TUBERCULOSIS

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B.C.G. (bacillus of Calmette and Guerin) vaccine consists of a one time virulent strain of bovine tubercle bacilli. After years of subculturing and experimenting with animals, Calmette and Guerin discovered that the organism gradually became innocuous for all laboratory animals. Since its first trial on humans in 1921 (by Weill-Hallé, Paris) considerable controversial articles and papers appeared in the literature. (By 1934, 1,600 papers had been written on the subject[3]). Finally, after 25 years the use of the vaccine is becoming increasingly more popular throughout the world.

Reaction of host to B.C.G. vaccine.—Rosenthal[1] demonstrated by animal inoculation (guinea pigs) that the organisms could be given intradermally, intravenously, intracardially, intraperitoneally and intratesticularly in large quantities without producing progressive tuberculosis. In another experiment he describes the development of tubercles, and finally their complete resolution, following guinea pig inoculation with 10 to 15 mgm. of the organisms intracardially.[2] All cells (due to tissue response) disappeared by the end of the third month. Fibrosis or caseation rarely occurred and restitution was complete. Kayne[3] mentions the work of K. A. Jensen (Holland) in which the protective mechanism in vaccinated guinea pigs is a delaying of the effect of virulent bacilli on this highly susceptible animal.

Harmlessness of B.C.G. for humans.—Kayne[3] again, quotes Irvine (1934),

> "If we review the whole of this chapter we see a great tragedy in Germany, (Luebeck disaster) due to a contaminated vaccine, a suspicious but inadequately investigated minor disaster in Hungary, a doubtful incident in Chile, and several suggestive but quite unproved individual cases (of tuberculosis developing following B.C.G. but not proved due to B.C.G.). When we consider that 1,343,000 infants have been given the vaccine and there is not yet one sure case of death from the B.C.G., we should indeed be cautious if we still doubted the safety of the vaccine for normal infants. Even if every case (of tuberculosis) mentioned in this chapter had been proved to be due to the B.C.G., the ratio to the total number inoculated would only have been just under 1 in every 15,000."

From 1934 and to this day, to the best of my knowledge there are no reports of any ill effects following vaccination with B.C.G. vaccine. Heimbeck of Norway, Wallgren of Sweden, Baudouin of Montreal, Ferguson of Saskatchewan, Aronson and Danenberg of Philadelphia, Kereszturi and Park, New York City, Rosenthal of Chicago make no mention of ill effects in over 30,000 infants, children and adults vaccinated since 1934.

Birkhaug of Norway stated at the N.T.A. meeting, Buffalo, N.Y., June, 1946, that tuberculin negative student nurses and applicants for medical schools are accepted for training only if rendered positive following B.C.G. vaccination. Ferguson, Saskatchewan, at the same meeting stated that tuberculin negative reactors working in a sanatorium environment, provided they are rendered positive to old tuberculin following vaccination, are now granted insurance as arranged by the Saskatchewan Tuberculosis League.

Results of vaccination in humans.—Heimbeck[4] (Norway) in a study among student nurses from 1927 to 1938 at the Ullevaal Hospital. Oslo, presented the following results. Among previously positive reacting student nurses, without history or evidence of disease on commencing training, 3.29% developed tuberculosis but there were no deaths. Among those negative reactors not receiving the vaccine 34.15% developed tuberculosis and 4.23% of the total