TREATMENT OF OSTEOCLASTOMA BY RADIATION

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Osteoclastomata arise in the metaphyses of long bones, but when there is fusion of epiphyses the tumours may extend as far as the articular cartilage. They occur also in the bones of the face, skull and spine. In the skull, the tumour follows the distribution of cartilaginous centres of ossification and this has been held to support the view that it is attributable to "persisting developmental processes occurring in pre-cartilaginous and pre-ossaceous connective tissues" (Geschickter and Copeland 1931). Willis (1948) considered that osteoclasts, osteoblasts, fibroblasts and chondroblasts were intermutable and that enzyme changes probably determined the function, and therefore the histological appearances, of the cells. Geschickter and Copeland said that "in osteoclastoma and osteitis fibrosa giant cells can be seen on the outside of new blood vessels and vascular spaces, showing that the giant cells in these lesions retain the same histological function as the osteoclasts seen in human and other mammalian embryos." They suggested that there was a growth of blood vessels with osteoclasts from the marrow towards part of the cortex, the blood supply of which had suffered in some cases from trauma; and that an osteoclastoma might result from persistence of the excess of of osteoclasts. They considered that osteoclastomata arose only in regions where bone was developed in pre-existing cartilage, and this view accords with experience. Osteoclastomata are quite distinct from solitary bone cysts, and from the cystic lesions associated with hyperparathyroidism, but they are probably related to the giant-cell epulis and possibly to giant-cell tumours of tendons.

Diagnosis—Before treatment is undertaken the diagnosis of osteoclastoma should be established beyond reasonable doubt. Difficulties may arise in distinguishing the tumour from bone sarcoma, malignant myeloma and metastatic carcinoma; and from such benign lesions as simple bone cysts, hyperparathyroid fibrocystic disease, chondromata and chronic bone abscesses. Investigations that may be helpful in the differential diagnosis include the blood count, Wassermann reaction, radiography of lung fields, urine analysis and blood chemistry. The serum alkaline phosphatase is raised in osteogenic sarcoma, osteoplastic metastases, hyperparathyroidism and osteitis deformans; it may be raised slightly in osteoclastoma, endothelio-ma of bone and plasma cell tumour. The serum inorganic phosphate is low in hyperparathyroidism and may be high with osteolytic metastases and plasma cell myeloma; it is normal in other neoplastic conditions including osteoclastoma. The serum calcium is high in hyperparathyroidism and may be high with osteolytic metastases and plasma cell myeloma, being normal in other neoplastic conditions including osteoclastoma (Greenstein 1947).

Biopsy—Biopsy is so valuable a method of diagnosis that it should always be used when the nature of a bone tumour is doubtful. The arguments advanced against biopsy appear to have little validity. It was said by Bloodgood (1931) that, of sixty-five patients with bone tumour surviving five years, no less than half had been submitted to biopsy before operation, which suggests that the chances of survival were not prejudiced thereby. Moreover, there is evidence that radiation before or after biopsy has protective value. This author has made much use of drill biopsy, which often provides unequivocal results, and has certain advantages over open biopsy in that complications are less frequent and admission to hospital is unnecessary.

Differentiation of osteoclastoma from bone cysts—This differentiation has often given rise to confusion, and yet it is important because bone cysts represent healed osteoclastic lesions and do not require treatment. Age incidence—The age incidence of bone cysts is earlier than that of osteoclastomata although of course there is much overlap; a bone
cyst has been reported in a patient of sixty years and an osteoclastoma in a child of seven years. Site—Osteoclastomata usually occur at the metaphyseal ends of the diaphyses, most commonly in the tibia, femur or humerus. The cyst which results from healing of the osteoclastic process tends to lie behind the shaft as epiphyseal growth proceeds. Histology—The histological appearances are distinctive. A bone cyst is lined with fibrous tissue which may contain areas of old haemorrhage and spicules of newly formed bone, surrounded by osteoblasts, probably formed from fibroblasts which are laying down intercellular substance; the giant cells that are typical of osteoclastoma may be present around the new vessels in small numbers. On the other hand the histology of an osteoclastoma is characterised by uniform distribution of large giant cells containing from twenty to two hundred nuclei embedded in a mass of small round or spindle cells which may show mitotic figures. Geschickter and Copeland stated that in true osteoclastomata “round cells outnumber the spindle cells in every instance,” and that spindle-cell formation was indicative of a healing form of giant-cell tumour. Willis on the other hand did not mention round cells. Radiographic appearances—A bone cyst is seen typically as a central area of translucency in the shaft of the bone near the metaphysis, situated progressively further from the end of the bone as epiphyseal growth continues. This is an important differential point. The appearances in osteoclastoma are those of a destructive lesion, asymmetrically or centrally placed, with an expanded bone shell, usually in the end of a long bone. There is seldom aseptic reaction and the epiphysis is usually united. The cortex may be perforated. Successful treatment of an osteoclastoma by surgery or radiation may result in normal growth with a residual cyst left behind in the shaft of the bone.

PRINCIPLES OF TREATMENT

The aims of treatment, whether by curettage, resection, amputation or radiation, are to relieve symptoms and restore normal structure and function of the bone. Curettage may be unsatisfactory by reason of persisting mechanical weakness and the danger of local recurrence necessitating further operation. Resection is justified only when the site of the lesion permits complete removal without impairment of function, as for example in the upper end of the radius, the lower end of the ulna, and the fibula. Amputation is seldom justified because the lesion is essentially local and satisfactory results can be obtained by conservative treatment. Radiation is capable of achieving results no less satisfactory than those of surgical operation and without the danger of weakening the bone by removal of intact cortex in order to expose the tumour.

RADIATION TREATMENT OF OSTEOCLASTOMA

The radiation used in most cases in the series now reported was by X-rays, a total of 3000 roentgens being given on alternate days over a period of three weeks. The object was to treat only the lesion itself; the tumour is so circumscribed that there is no need to treat a large area of adjacent bone as in the case of malignant tumours. Greater doses have sometimes been used but they were probably unnecessary. Indeed, many successful results have been reported with even shorter exposures, and it is proposed to treat a series of cases with a dosage of no more than 1500r. In four patients it was thought advisable to repeat the course of treatment because there was persistence of symptoms or because there was no radiographic evidence of consolidation and, from the rapid effect of such a second course, it appears that this is justified in occasional cases. A few patients have been treated by the implantation of radium needles into the tumour, and in one early case by the insertion of radium into the cavity after curettage. It should be recognised, however, that radium needles produce no better results than X-ray treatment and they cause much more trouble, not only to the surgeon and radiotherapist but also to the patient. The use of radium after curettage may cause bone necrosis and increases the risk of other complications.
The mode of action of irradiation on osteoclastomata is unknown, but from our knowledge of the effects of irradiation on enzymes, the sensitivity of osteoclastomata to small doses, and the relationship of osteoclasts and their precursors to osteogenic tissue, it is reasonable to suppose that irradiation gives rise to enzyme modifications which alter the form of activity of the cells so that a predominantly osteolytic process is replaced by a process of new bone formation.

**Results of radiation treatment of patients reported in this series**—The results of treatment in this series of twenty-six cases are summarised in Table 1. In every case the response to irradiation was good. Brief summaries of individual case histories are appended. In the Table, under the heading of "final diagnosis" which is based upon all evidence including that of response to treatment, the possibility has been considered that tumours with giant cells may have been healing lesions. Thus, four of the twenty-six cases were classified finally as healing lesions at the time of treatment, though in each of them the history was short. Five of the twenty-six cases have been excluded from the report because there was some doubt as to the diagnosis. All others were true osteoclastomata, except Case II which was a malignant osteoclastoma.

**Results of treatment by radiation alone reported in the literature**—Lacharité (1927) reported fourteen cases, traced for periods of three to ten years after treatment; seven were cured; in seven there was recurrence. Herenden (1931) followed up five patients for five to ten years after treatment and all were cured. Soeur (1931) traced six patients for three to ten years and all were cured. Hummel (1932) reported twelve cases; ten were cured by radiation treatment and two became malignant. Peirce (1932) treated five patients and all were cured.
TREATMENT OF OSTEOCLASTOMA BY RADIATION

Pfahler and Parry (1932) reported twenty-six patients of which twenty-four were cured by radiation alone. Gunsett et al. (1934) treated two patients (4000r. and 5000r.) and both are well. Stevens (1935) treated one patient with a dosage of 1500r. in two months and he is well. Freund and Meffert (1937) reported that two of five patients were cured by radiation and one was "improved"; of twelve patients treated surgically only two were "improved." Doub et al. (1938) reported four cases, two of which were cured by radiation and two proved to be malignant. Leucutia et al. (1941) reported "good results" in eighteen patients treated with 700–1000r. repeated two monthly. Edelken (1940) reported one patient cured with 1500r. and a further 2000r. after two months.

CASE REPORTS

Case 1. E. B., female, aged 16 years—Osteoclastoma of the mandible. (Figs. 1 and 2.) November 1944, tumour of left side of lower jaw, eight months' duration. December 1944, referred with swelling 5 x 3 cm. in the region of the lower left first molar. Cortex intact over external surface but eroded at the inner surface of the mandible. Drill biopsy—osteoclastoma. X-ray treatment 3500r.; fourteen treatments in twenty-one days; no change; no pain. April 1946, X-ray treatment 3000r.; ten treatments in twenty-one days. December 1947, tumour 3-5 x 3 cm. May 1948, no further change. Comment—An osteoclastoma developing in cartilaginous bone.

Case 2. C. W., female, aged 19 years—Recurrent osteoclastoma of the humerus. Referred December 1944 having had curettage of a tumour in the head and neck of the left humerus in December 1942. Histology—osteoclastoma. No change in size of the lesion as shown by radiographs until June 1944 when there was much increase in size. On examination—tender swelling of the upper end of the left humerus with loss of power. December 1945, X-ray treatment 3000r.; ten treatments in twenty-two days; tenderness relieved after seven weeks; gradual recalcification; well after three years. Comment—Successful treatment by radiation of recurrence after curettage.

Case 3. S. L., female, aged 11 years—Fibro-osteoclastoma of the calcaneus. (Figs. 3 and 4.) July 1945, referred for pain in the left heel of three weeks' duration. On examination—left os calcis thickened; not tender; radiographs showed destructive lesion of the os calcis with expansion. Clinical diagnosis—osteoclastoma. Drill biopsy—osteoclastoma with few osteoclasts, composed mostly of spindle cells and collagen fibres. July 1945, radiation treatment 3000r.; ten treatments in twenty-three days; symptoms relieved only after three months. Remains well but with some wasting of the left calf. Radiographs show complete consolidation. Comment—The histology suggests a lesion healing at the time of the biopsy, before treatment.

Case 4. M. E., female, aged 14 years—October 1945, referred with pain in the left shoulder after a fall one year before. On examination—upper end of the left humerus swollen, tender, and slightly hot; abduction of the limb impossible; radiographs showed osteolytic lesion of the epiphysis of the great tuberosity. Drill biopsy—yellow material; osteoclastoma; giant cells not numerous. November 1945, radiation treatment 3000r.; ten treatments in twenty-one days; pain and disability persisted. February 1946, treatment repeated 3000r.; ten treatments in twenty-one days; pain relieved after six weeks. May 1948, well; no pain; telangiectasia of treated skin; still marked limitation of movement; radiographs show consolidation, but still an area of translucency. Comment—In spite of the possible cystic nature of the tumour the patient did not lose her pain until after the second course of radiation.

Case 5. D. C., male, aged 13 years—November 1945, swelling of the mandible of three weeks' duration. On examination—fleshy ulcerated tumour near the premolar teeth. Drill biopsy—osteoclastoma. December 1945, radiation treatment 3000r.; thirteen treatments in twenty-eight days; rapidly improved; well since. Comment—A giant-cell epulis.

Case 6. K. St P., male, aged 14 years—Osteoclastoma of the head and neck of the fibula. November 1945, pain in the upper end of the right fibula of five weeks' duration after injury. Radiographs showed pathological fracture. November 1945, excision of the whole tumour and upper shaft of the fibula. December 1945, radiation treatment 2800r.; ten treatments in twenty-four days. July 1947, well. August 1948, normal except for slight weakness of leg and aching after exercise. Comment—Would he have been better without excision? *

Case 7. M. F., male, aged 11 years—Osteoclastoma of the maxilla. February 1947, six months' increasing painless swelling right side of face. On examination—thickening of the maxilla with bone expansion of antral wall and destruction of the right half of the hard palate which showed a soft cystic

* Editor's note—On the other hand would he have been better without radiation? But perhaps I am prejudiced. It happens that I excised it.

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swelling. March 1947, right antrostomy; friable tissue. Histology—osteoclastoma. April 1947, radon insertion, 4500r. in nine days, six differentially loaded needles. Drill biopsy of fluctuant swelling—osteoclastoma. March 1948, swelling smaller; no symptoms. Comment—Radium used in this case to localise the dose and thus minimise damage to unerupted teeth.

**Case 8. J. T., female, aged 22 years—Osteoclastoma of the femur.** (Figs. 5 and 6.) June 1944, pain in the right knee with loss of function. Radiographs showed osteoclastoma, lower end of femur. Radiation treatment 2000r.; eight treatments in twenty-four days. June 1945, recurrence of pain after dancing. July 1945, radiation treatment 3000r.; ten treatments in twenty-three days; symptoms relieved after six weeks. Remains well; slight limitation of extension of knee. Comment—Typical osteoclastoma.

**Case 9. S. E., female, aged 22 years—Osteoclastoma of the radius.** (Figs. 15 and 16.) January 1944, pain and swelling left wrist; pathological fracture. Open biopsy and curettage—osteoclastoma confirmed. February 1944, radiation treatment; ten treatments in twenty-two days; plaster immobilisation. May 1945, telangiectasia; ulnar deviation and dorsal displacement of wrist. July 1948, no change. Comment—Marked deformity in spite of attempts to maintain position by plaster.

**Case 10. E. L., female, aged 28 years—Osteoclastoma of the maxilla.** January 1946, swelling left maxilla; increasing in size; operation one year previously; cavity opened and lining removed. Histological examination—osteoclastoma. On examination—swelling of the left maxilla 4.5 × 2 cm. “cracking” on pressure. Antrostomy opening in the swelling. February 1946, radiation treatment 3000r.; ten treatments in twenty-two days; marked erythema occurred. August 1946, swelling reduced to 3 × 2 cm. November 1947, no swelling; free from symptoms.

**Case 11. S. K., female, aged 29 years—Malignant osteoclastoma of the tibia.** (Figs. 7-10.) May 1943, increasing intermittent pain left knee; sprain two years previously. On examination—swelling of the upper end of the tibia; slight “cracking.” Drill biopsy, 1945—osteoclastoma. May 1945, radiation treatment 3000r.; ten treatments in twenty-three days; symptoms relieved until January 1946 when radiographs showed further destruction outside the previous sclerotic zone. Drill biopsy, 1946—malignant osteoclastoma. February 1946, radiation treatment 3300r.; twelve treatments in twenty-six days. March 1946, slight improvement. May 1946, radiographs showed deterioration and metastases in the chest. July 1946, amputation for the relief of pain. November 1946, died. Metastases in the spine and lungs. Comment—Probably a malignant case from the start. Rapidly fatal and very painful. At first behaved like an osteoclastoma in its response to radiation. (See “Malignant Osteoclastoma” by Prof. D. Russell, this number of the Journal.)
Case 11. Female, aged 29 years. Malignant osteoclastoma of the tibia (see article, this number of the Journal, by Professor D. Russell). The radiograph in May 1945 is shown in Fig. 7. At that time drill biopsy suggested that the tumour was a typical osteoclastoma; but is the radiographic evidence of calcification of the tumour a sign of its atypical character? Two months later, after irradiation, there is increased porosis (Fig. 8). Five months after treatment the lesion appears to be healing (Fig. 9). Twelve months after treatment there was extensive bone destruction (Fig. 10) and drill biopsy at that time showed evidence of a malignant osteoclastoma. The patient died two months later with metastases in the lungs and spine.
Case 14. Male, aged 42 years. Osteoclastoma of the tibia, confirmed by biopsy (Fig. 11). After irradiation there was initial increase in the size of the tumour (Fig. 12). Immobilisation in traction in a Thomas’ splint, and later in plaster, was necessary. Six months later there was radiographic evidence of recalcification (Fig. 13). After two years there was marked increase in the calcification; the lesion is healing and the patient is well and walking unaided (Fig. 14).
Case 12. G. C., female, aged 34 years—Osteoclastoma of the mandible. Swelling of the right lower jaw of five months’ duration. October 1945, operation—excision of central osteoclastoma from lower jaw. Histology—osteoclastoma with moderate number of giant cells, much delicate fibrous tissue and new formation of woven bone. No evidence of malignancy. October 1945, radiation treatment 4000r.; ten treatments in twenty-one days; erythema of skin and gradual closing of cavity. Well two and a half years later.


Case 14. A. R., male, aged 42 years—Osteoclastoma of the tibia. (Figs. 11–14.) May 1945, increasingly severe pain in the right knee for ten weeks. On examination—hot, tender swelling of upper end of the right tibia; possibility of osteogenic sarcoma or malignant synovioma considered. Drill biopsy—osteoclastoma. May 1945, radiation treatment 3070r.; eleven treatments in twenty-eight days. October 1947, well; walking. Comment—The pain and loss of function were so marked that the only alternative to X-ray treatment was amputation. Radiographs suggested initial increase in size of the tumour.

Case 15. R. B., male, aged 23 years—Osteoclastoma of the ilium. Operated upon in 1923 for "sarcoma of left ilium"; histology, revised in January 1944, proved that it was an osteoclastoma. Radiographic appearances—constant for many years. Forty-two exposures to irradiation between 1932 and 1938; total dose about 16,000r. to skin; three or four fields. Well until April 1946 when he developed pain down the right leg. June 1946, ulceration at the centre of the scar; ulcer did not heal; deep sinus. January 1948, cavity in bone. Biopsy—1) pieces of bone invaded by vascular and cellular growth; the cells are of the small round type with dark nuclei and uniform arrangement similar to those of Ewing’s sarcoma; 2) piece of skin shows marked fibrotic changes and infiltration with plasma cells and lymphocytes; no evidence of malignancy. (Dr. T. Jockes.) February 1948, ulcer healing. Comment—Repeated radiation over a long period, together with scarring due to operation, caused radio-necrosis. Subsequent healing suggests that the biopsy report really indicates an inflammatory lesion.

Case 16. B. R., female, aged 11 years—Osteoclastoma of the maxilla. January 1934, tumour at the side of the nose displacing the eye outwards, 3.5 cm. × 2 cm. Open biopsy with insertion of radium needles into tumour mass, 7000r. given to the periphery; other parts received larger doses. Histology—osteoclastoma. No trouble; well fourteen years later.

Case 17. M. B., female, aged 18 years—Osteoclastoma of the maxilla. December 1934, swelling of the upper jaw involving most of the left side and crossing the midline. On examination—tumour of left upper alveolus and hard palate. Curettage (Mr. Wilkinson) and insertion of radium, 7000r. to walls of cavity. Histology—osteoclastoma. Developed osteomyelitis. Sequestrum removed after seven months, leaving a cavity in the upper jaw involving the alveolus from the right incisor region to the third molar, opening into the right antrum. Obturator fitted. Well ten years later. Comment—Infection and delayed healing due to radium.

Case 18. M. R., female, aged 27 years—Osteoclastoma of the radius (Fig. 17). December 1938, pain in the left wrist for some months; gradual onset. Radiographic examination—osteoclastoma, thought possibly to be malignant; no histological examination. January 1939, radiation treatment 3500r. in three weeks. Well after ten years. Comment—By a chance discussion this patient was saved from amputation of the hand. The tumour is not considered ever to have been malignant.

Case 19. E. W., female, aged 39 years—Osteoclastoma of the mandible. October 1928, tumour removed from right mandibular ramus; 55 mg. radium for two days. Well for five years; then pain in the right upper jaw and cheek, radiating into the cranium. Histology—osteoclastoma. February 1936, slight swelling of right supra-orbital region; radiographic examination showed destructive lesion of the skull. March 1936, radiation treatment 5000r.; symptoms relieved but recurrence of pain after one year. February 1940, died from "brain abscess." Comment—Without autopsy the possibility of connection between the osteoclastoma and death is unsettled.

Case 20. J. S., male, aged 67 years—Osteoclastoma of the tibia. July 1939, pain and swelling of knee for eight months. On examination—thickening of upper end of tibia; radiographs show well-defined cystic area with trabeculation; some expansion; appearances consistent with osteoclastoma. July 1939, radiation treatment 3000r. in three weeks. June 1940, died from meningococcal meningitis.
### Table I

**Summary of Cases of Osteoclastoma Treated by Irradiation**

(London Hospital, Cases 1 to 15; Sheffield, before 1939, Cases 16 to 21)

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age</th>
<th>Symptoms</th>
<th>Duration</th>
<th>Site</th>
<th>Histology (D=Drill biopsy)</th>
<th>Diagnosis</th>
<th>Treatment</th>
<th>Dose</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>16</td>
<td>Swelling, $5 \times 3$ cm.</td>
<td>8 months</td>
<td>Mandible</td>
<td>Osteoclastoma (D)</td>
<td>Osteoclastoma</td>
<td>X-rays</td>
<td>3000r—15 months 3000r</td>
<td>Still swelling, $3.5 \times 3$ cm. Consolidating 4 years</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>19</td>
<td>Tender recurrence after curettage</td>
<td>2 years</td>
<td>Head of humerus</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>X-rays</td>
<td>3000r</td>
<td>Pain disappeared 7 weeks. Well 3 years</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>11</td>
<td>Pain on putting foot to ground</td>
<td>3 weeks</td>
<td>Calcaneus</td>
<td>Fibro-osseous tissue (D)</td>
<td>Osteoclastoma (7 healing osteothesis)</td>
<td>X-rays</td>
<td>3000r</td>
<td>Symptom free after 3 months Consolidated 3 years</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>14</td>
<td>Pain left shoulder after fall from bicycle</td>
<td>9 months</td>
<td>Left humerus</td>
<td>Fibro-osseous tissue (D)</td>
<td>Osteoclastoma</td>
<td>X-rays</td>
<td>3000r Two courses</td>
<td>No relief of pain until after second course</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>13</td>
<td>Swelling of mandible occasional bleeding</td>
<td>3 weeks</td>
<td>Mandible</td>
<td>Osteoclastoma (D)</td>
<td>Giant-cell epulis</td>
<td>X-rays</td>
<td>3000r</td>
<td>Rapid improvement. Well $2\frac{1}{2}$ years</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>14</td>
<td>Football injury. Pain right fibula</td>
<td>5 weeks</td>
<td>Right fibula</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Excision X-rays</td>
<td>2800r</td>
<td>Normal except for some weakness and aching of leg. $2\frac{1}{2}$ years</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>11</td>
<td>Painless swelling right side of face</td>
<td>6 months</td>
<td>Maxilla</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Antrotomy radon</td>
<td>4500r in 9 days</td>
<td>Normal. No swelling. 1 year</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>22</td>
<td>Pain in right knee after fall</td>
<td>6 weeks</td>
<td>Right femur</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>X-rays</td>
<td>1) 2000r. 2) 3000r</td>
<td>Pain relieved in six weeks after second course</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>22</td>
<td>Sudden pain left wrist after sudden grab at bannister</td>
<td>5 months</td>
<td>Left wrist</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>X-rays</td>
<td></td>
<td>Moist desquamation. Permanent deformity</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>28</td>
<td>Tender swelling over left upper jaw</td>
<td>$2\frac{1}{2}$ years</td>
<td>Left maxilla</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Excision X-rays</td>
<td>3000r</td>
<td>Became symptom free. Well $1\frac{1}{2}$ years</td>
</tr>
<tr>
<td>No.</td>
<td>Sex</td>
<td>Age</td>
<td>Duration</td>
<td>Location</td>
<td>Lesion</td>
<td>Diagnosis</td>
<td>Treatment</td>
<td>X-rays</td>
<td>Outcome</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>34</td>
<td>5 months</td>
<td>Mandible</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Excision D.X.R.</td>
<td>4000r.</td>
<td>Gradual closing of cavity. Well 2 1/2 years</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>61</td>
<td>2 months</td>
<td>Mandible</td>
<td>Fibro-osteoclastoma (D)</td>
<td>Osteoclastoma</td>
<td>Pre-op. D.X.R. Removal</td>
<td>500r.</td>
<td>Well 1 year</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>42</td>
<td>10 weeks</td>
<td>Right tibia</td>
<td>Osteoclastoma (D)</td>
<td>Osteoclastoma</td>
<td>D.X.R.</td>
<td>3070r.</td>
<td>Well 2 1/2 years</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>23</td>
<td>21 years</td>
<td>Left ilium</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Surgery D.X.R.</td>
<td>16,000r. (skin)</td>
<td>Radio-necrosis, 3 years</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>F</td>
<td>11</td>
<td>?</td>
<td>Maxilla</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Surgery radium</td>
<td>7000r.</td>
<td>Well 14 years</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>18</td>
<td>?</td>
<td>Maxilla</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Surgery radium</td>
<td>7000r.</td>
<td>Osteomyelitis and sequestrum. Well 10 years</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>F</td>
<td>27</td>
<td>Several months</td>
<td>Left radius</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>D.X.R.</td>
<td>3500r.</td>
<td>Well 10 years</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>F</td>
<td>39</td>
<td>?</td>
<td>Mandible</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>Surgery 1) Radium 2) D.X.R.</td>
<td>55 mg. for 2 days 5000r.</td>
<td>Well for 5 years. Died 11 1/2 years from cerebral abscess</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>M</td>
<td>67</td>
<td>8 months</td>
<td>Tibia</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>D.X.R.</td>
<td>3000r.</td>
<td>Died 1 year from meningococcal meningitis</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>68</td>
<td>7 months</td>
<td>Maxilla</td>
<td>Osteoclastoma</td>
<td>Osteoclastoma</td>
<td>D.X.R.</td>
<td>5000r.</td>
<td>Residual bone expansion 5 months. Died: Uraemia and retention of urine</td>
<td></td>
</tr>
</tbody>
</table>

During this period five other cases, believed to be osteoclastomas of bone, were treated successfully but they have been excluded because the diagnosis was not definitely confirmed.
Case 9. Female, aged 22 years. Osteoclastoma of the radius confirmed by open biopsy (Fig. 15). The tumour was curetted and then treated by radiation. It healed, but radiographs four years later show that it proved impossible to prevent deformity (Fig. 16).

Case 18. Female, aged 27 years. Osteoclastoma of radius treated by irradiation alone (3500r. in three weeks). Radiographs ten years later show complete healing without deformity.
Case 21. F. P., male, aged 68 years—Osteoclastoma of the maxilla. March 1938, swelling right maxillary region of seven months' duration; occasional bleeding from nostril; no other symptoms; no loss of weight; history of injury to nose forty-eight years previously. On examination—tumour of maxilla with spread to soft tissue between cheek and alveolus; bone expanded. Biopsy—osteoclastoma. March 1938, radiation treatment 5000r. August 1938, well; some residual bone expansion. Died from uraemia due to retention of urine from urethral stricture.

DISCUSSION

The advantages claimed for treatment by irradiation are that it is curative, painless, free from unfortunate complications, and capable of being used without necessarily admitting the patient to hospital. An obvious disadvantage lies in the fact that complete histological study of the tumour tissue is not available. This, however, may be overcome by using drill biopsy before treatment is begun. Other possible disadvantages such as extension of the lesion after treatment, malignant transformation, and disturbance of epiphysial growth, call for further discussion.

Apparent extension after radiation—Several authors have drawn attention to apparent deterioration, which may be shown in radiographs during the first eight or twelve weeks after treatment, and which is then followed by recalcification during the next two or three years. In only two cases in the series now reported was this seen (Fig. 12). It is evident, therefore, that apparent extension of growth does not always occur after radiation and that, if it does, it should not be the signal for ill-advised surgery.

Malignant transformation—It has been suggested that radiation may cause malignant transformation of an osteoclastoma. It appears more probable, however, that when this is suspected the tumour has been malignant from the start. Whether or not malignant osteoclastoma occurs as a primary tumour is still a matter of discussion among pathologists; the possibility is accepted by some, whereas others take the view that it represents a form of osteogenic sarcoma.

If intermutability of the cells taking part in osteogenesis is accepted, there seems every possibility that a malignant process, starting as an osteoclast, may give rise not only to other malignant osteoclasts but also to other malignant cells such as fibroblasts and osteocytes which are characteristic of osteogenic sarcoma. More definite evidence is available from the reported cases of malignant osteoclastoma in which metastases consisted of deposits indistinguishable from the primary osteoclastoma and of almost benign appearance (Finch and Gleave 1920). Case 11 of this series is of special interest. It was thought at first to be a benign osteoclastoma, but it soon proved to be malignant and metastasized. (Figs. 7–10.) The case is discussed in this number of the Journal by Professor Dorothy Russell. The question remains whether the malignancy was in any way the consequence of radiation. It is well known that radiation can give rise to genetic changes in cells and, presumably, a genetic change could result in malignancy. But malignant changes due to radiation in skin and connective tissue are reported as occurring only after long intervals and in the presence of profound tissue changes. Moreover, malignant change is unknown after radiation of essentially benign lesions such as infections, and degenerative conditions such as arthritis. For these reasons it seems unlikely that radiation could be responsible for rapid malignant change in a benign osteoclastoma. If, as a result of radiation, osteoclastomata were more prone to become malignant than other lesions one would expect it to have been reported with greater frequency. Moreover, of the cases in which malignant transformation after radiation has been reported, none can be accepted if there has been no preliminary biopsy because clinical and radiographic appearances alone cannot be relied upon in establishing the diagnosis of benign osteoclastoma.
Effect of radiation on epiphyseal growth—It has been shown in animals that radiation may cause arrest or delay of epiphyseal growth (Wilkins and Regen 1934, Brooks and Hilstrom 1933) and the possibility of similar growth disturbance in young children must be borne in mind. This author's view is that the possibility of such a complication makes it unwise to treat a simple bone cyst by radiation in a child less than ten years of age but that, in true osteoclastoma, radiation is justified even in early childhood. At present there is no clear evidence that radiation, in the dosage commonly employed, gives rise to significant growth change in the human being, and in a wide personal experience of treatment by radiation there has been no case in which such an effect was observed.

Summary of the management of a suspected case of osteoclastoma—After clinical and radiographic examination, and the completion of blood chemistry tests, the diagnosis is confirmed by drill biopsy, this being preceded by irradiation with a dose of approximately 300r, if it is suspected that the tumour might be malignant. If histological examination of the biopsy specimen shows few osteoclasts, and a relatively large proportion of spindle cells, treatment may be unnecessary and it is safe to wait; but if the diagnosis of true osteoclastoma is confirmed, treatment by radiation is begun at once. The standard dose, including the pre-biopsy dose, in most cases reported in this series has been 3000r; but it is quite possible that 1500–2000r. may usually be sufficient. These are the doses received by the tumour, the necessary skin dose varying according to the number and arrangement of fields and the physical dimensions of the region. As a rule no other treatment is required. If there is serious structural weakness, or a pathological fracture, suitable orthopaedic measures are of course needed. Recalcification usually occurs gradually and progressively over a period of from one to two years. If this is not so, a second course of treatment may be given.

SUMMARY

The problems of diagnosis and treatment of osteoclastoma are considered. The importance of full investigation, and the advantages of drill biopsy in confirming the diagnosis, are discussed. Treatment by radiation is believed to be better than treatment by surgical measures. Curettage and excision are unnecessary. Amputation for benign osteoclastoma is unjustifiable.

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