JUXTA-ARTICULAR BONE CYSTS (INTRA-OSSEOUS GANGLIA)

A CLINICOPATHOLOGICAL STUDY OF EIGHTY-EIGHT CASES

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The clinical, radiographic and pathological features of eighty-eight cases of histologically verified intra-osseous ganglia in eighty-three patients are described. All were located in the subchondral bone adjacent to a joint and most frequently involved the hip, the ankle (medial malleolus), the knee and the carpal bones. Forty-seven of the eighty-three patients were male and all the patients were between fourteen and seventy-three years of age, with an average age of forty-one years.

There are two fundamental types of intra-osseous ganglia, one apparently arising by penetration of a juxta-osseous ganglion into the underlying bone, a mechanism proved in fourteen of our eighty-eight cases (16 per cent); in the remaining seventy-four cases, the ganglion cyst was primarily intra-osseous ("idiopathic"). The initial cause of the intramedullary mucoid degeneration is discussed. We believe that mechanical stress and repeated minor trauma near the surface of the bone may lead to intramedullary vascular disturbance with consequent foci of aseptic bone necrosis. The revitalisation of these areas causes fibroblastic proliferation, followed by mucoid degeneration of the connective tissue, possibly due to some unknown local factor. Curettage or excision is usually effective, and recurrence (only four cases) is exceptional.

Ganglia are common and usually occur in close relationship to joints, tendon sheaths or tendons. However, in spite of their frequency, involvement of bone has been considered as very rare until a few years ago. But, since the report by Fisk (1949) of the intra-osseous penetration of a periosteal ganglion-like structure, with formation of a cystic defect in the subjacent bone, this concept has changed. A similar origin of defects in the upper end of the tibia, resulting from pressure erosion of a cyst in the lateral meniscus, had been previously reported by Fairbank and Lloyd (1934) and Ghormley and Dockerty (1943).

Cystic juxta-articular lesions in the subchondral bone with similar macroscopic and microscopic features may, however, occur without soft-tissue ganglia and in the absence of any inflammatory or degenerative joint lesion. The fate of subchondral cysts in osteoarthritis of the hip has been discussed in detail by Harrison, Schajowicz and Trueta (1953), Landells (1953), Lloyd-Roberts (1955), Rhaney and Lamb (1955) and by Ondrouch (1963).

Cystic defects of bone not related to joint lesions have been reported under different names, according to

the interpretation of their pathogenesis. Thus we find "bone cavity caused by a ganglion" (Fisk 1949); "necrobiotic pseudocysts or cysts caused by capsular herniation of the carpal bones" (Bugnion 1951); "synovial cysts in bone" (Hicks 1956; Crane and Scarano 1967); "subchondral bone cysts" (Woods 1961); "intra-osseous ganglia" (Crabbe 1966; Seymour 1968; Mainzer and Minagi 1970; Feldman and Johnston 1973; Menges *et al.* 1977); "capsulo-synovial intra-osseous inclusions" (Nezelof and Laurent 1966); "ganglia affecting bone" (Salzer and Salzer-Kuntschik 1968); "ganglion cysts of bone" (Sim and Dahlin 1971; Willems *et al.* 1973); "intra-osseous mucous cysts" (Campanacci and Cervellati 1971); "ganglionic cystic defects of bone" (Kambolis, Bullough and Jaffe 1973); "geodi isolati sottocondrali" (Scaglietti and Stringa 1960); and "geodi subcondrali non atrosici" (Catalano 1969).

Such a great variety of different names for a lesion with the same macroscopic and microscopic characteristics is confusing enough; but to make matters worse some authors, like Spjut *et al.* (1971) in the fascicle of "Tumors of Bone and Cartilage" of the Armed Forces

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Fig. 1

Fig. 2

Fig. 3

Figure 1—Man aged thirty-four years. Anteroposterior and lateral radiographs of the right knee showing a well-defined radiolucent lesion of the upper tibia with a slightly sclerotic inner border. Figure 2—Photograph of the soft-tissue ganglion adjacent to the radiolucent lesion. Figure 3—Fragments of the intra-osseous multiloculated mucoid cystic lesion obtained by curettage.

Fig. 4

Anteroposterior and lateral radiographs of the left knee of the same patient, showing similar radiographic findings. The pathological findings also were similar.

Institute of Pathology, separate as distinct entities a "subchondral bone cyst" (page 353) and a "synovial cyst of bone" (page 355).

Following the W.H.O. classification of bone tumours and tumour-like lesions (Schajowicz, Ackerman and Sissons 1972) we have used the term "juxta-articular bone cyst (intra-osseous ganglion)", which is defined as "a benign cystic and often multiloculated lesion made up of fibrous tissue, with extensive mucoid changes, located in the subchondral bone adjacent to a joint. Radiologically it appears as a well-defined osteolytic lesion with a surrounding area of sclerosis. It has been described as a synovial cyst, but it lacks a synovial lining." The definition excludes the not infrequent cystic juxta-articular bone lesions observed

in "pigmented villonodular synovitis", included by some authors (Hicks, Case 3; Nezelof and Laurent, Case 1) in the group of lesions under discussion.

In view of the relative frequency, the disputed pathogenesis and the confused nomenclature of juxta-articular cystic lesions of bone, we reviewed our cases over the last seventeen years (until August 1976); there were eighty-eight histologically verified lesions. In the literature there are only a few recent reports of more than ten cases (Feldman and Johnston 1973; Kambolis *et al.* 1973; Menges *et al.* 1977).

MATERIALS AND METHODS

The eighty-eight lesions of our series were found in eighty-three patients. Only those with sufficient clinical and radiological information were included. Cysts in the diaphyses of long bones (subperiosteal ganglia with bone penetration) were excluded, as were cystic lesions occurring in inflammatory (rheumatoid) arthritis and in degenerative joint disease (osteoarthritis). A few cases with degenerative articular lesions were, however, included; in these the great size of the cystic bone defect, together with the limited area and mild grade of the degenerative process suggested that degeneration was probably the consequence and not the cause of the cystic lesion.

All cases were followed for periods of from one to twelve years. Where possible the entire surgically excised intra-osseous cyst, together with any adjacent para-osseous ganglionic cyst, was studied. In the remaining cases the fragmented pieces obtained by curettage of the bone defect were examined. For the histological study, in addition to routine stains with haematoxylin and eosin, PAS and mucin-staining techniques were used.

CLINICAL FEATURES

Incidence. Although intra-osseous ganglia are not common, there is no doubt that they are much more frequent than reported in earlier publications. This is shown by the large number of recent reports. Most of these publications describe only small numbers of cases, but Bugnion, as early as 1951, reported a significant number of cystic lesions of carpal bones; he suggested

that they were much more frequent than previously supposed but that many were asymptomatic and were incidental findings during radiography. Only in the last few years have a few reports appeared describing more than ten cases (Kambolis *et al.* with fifteen cases; Feldman and Johnston with thirty-eight cases; and Menges *et al.* with nineteen cases).

Table I. Age and sex incidence of eighty-three patients with eighty-eight intra-osseous ganglia.

Age (years)	Male	Female	Total
10-19	1	3	4
20-29	7	4	11
30-39	18	9	27
40-49	8	9	17
50-59	8	3	11
60-69	2	5	7
70-79	3	3	6
	47	36	83

Age and sex. Seventy-nine per cent of the lesions were in adults between twenty and fifty-nine years of age. The youngest patient in our series was fourteen years of age and the oldest seventy-three, with an average age of forty-one years (Table I). Lesions in the hip, the malleoli, the carpal and the tarsal bones were mostly in patients aged less than forty.

Although some authors (Nezelof and Laurent 1966) reported a higher incidence in females, most authors record a male predominance (Hicks 1956;

Woods 1961; Campanacci and Cervellati 1971; Feldman and Johnston 1973). In our series there were forty-seven in males and thirty-six in females.

Site. A characteristic feature is the juxta-articular, subchondral location, more commonly in long tubular bones. Multiple lesions, often bilateral and symmetrical, reported by Hicks (1956), Crabbe (1966), Dominok and Crasselt (1967), Feldman and Johnston (1973), Campanacci and Gulino (1974), and Menges *et al.* (1977), were also observed by us in four patients: a thirty-four-year-old man with lesions in both medial tibial condyles (Figs. 1 to 4); a forty-three-year-old woman with cystic lesions in the radius, olecranon and medial malleolus (Figs. 5 to 7); a thirty-five-year-old man with cysts in both lunate bones; and another thirty-five-year-old man with cysts in both carpal scaphoid bones. The location of the eighty-eight cysts in eighty-three patients is shown in Table II.

Symptoms. The lesions may remain asymptomatic for several years. Sometimes soft-tissue swelling causes pain from pressure of the ganglion on the underlying bone. The intrusion of such a ganglion-like process of the extra-osseous connective tissue appeared to be the origin of the bone cyst in fourteen of our eighty-eight cases (16 per cent). A similar origin was suggested in seven of the fifteen cases reported by Kambolis *et al.* (1973), although only four of their cases had a direct communication between the soft-tissue ganglion and the bone cysts. Feldman and Johnston reported that in two of their thirty-eight cases a soft-tissue mass had been observed clinically, two others being detected only radiologically.

In many cases the bone lesion is clinically silent and is discovered only when a radiograph is taken for some other reason. However, even in the absence of an extra-osseous ganglion, the most constant symptom is

Fig. 5

Fig. 6

Fig. 7

Figures 5 and 6—This woman aged forty-three complained of pain and swelling in the elbow region for six months. The large cysts in the upper end of the ulna and radius were excised. Figure 7—Six months later another cyst appeared in the medial malleolus. One year after curettage of this cyst, no other lesions had appeared.

Fig. 8

Fig. 9

Man aged forty-three years with a previous history of rheumatoid arthritis of several years duration. A partial synovectomy and excision of the patella was performed. Figure 8—Large, in part multiloculated, lytic lesions in the tibia, medial femoral condyle and patellae. Figure 9—Radiograph of the excised patella.

pain (in approximately 60 per cent of our cases) in close relationship to a joint, sometimes increasing with exercise. The duration of the pain varies from months to years.

Table II. Site and pathogenesis

Site	Idiopathic	Penetrating	Total
Acetabulum	11	1	Hip 21
Upper end of femur	7	2	
Upper end of tibia	10	3	Knee 16
Upper end of fibula	3	—	
Medial malleolus	12	1	Ankle 16
Lateral malleolus	1	2	
Carpal bones	14	2	16
Scapula	1	—	Shoulder 6
Acromioclavicular joint	2	—	
Humeral head	3	—	
Olecranon	3	2	5
Tarsal bones	3	1	4
Distal end of ulna	2	—	2
Talus	2	—	2
Total	74	14	88

RADIOGRAPHIC FEATURES

The radiographs show a well-defined oval or circular osteolytic area usually situated eccentrically at the end of a long bone, close to the thinned and sometimes expanded cortex. The defect are usually close to the subchondral layer of the affected bone and is outlined by a thin rim of sclerotic bone. Small cysts may be unilocular, but large ones are often multiloculated.

Fig. 10

Photomicrograph from the same patient as the radiographs in Figures 8 and 9 showing two adjacent cystic cavities with an obvious joint communication. The articular cartilage shows advanced degenerative and destructive changes with fissure formation.

Although plain radiographs may show a communication between the bone cyst and the adjacent joint, this is more easily seen (as a translucent line) in tomograms (Menges *et al.* 1977). Most cysts are 1 or 2 centimetres in diameter but a few are as large as 5 centimetres. The radiographic appearance and size of the bone defect are not related to the clinical findings.

DIFFERENTIAL DIAGNOSIS

Intra-osseous ganglion must be always included in the differential diagnosis of cystic bone lesions in the vicinity of a joint. Only a few other tumours and tumour-like lesions, such as chondroma, aneurysmal bone cyst and particularly chondroblastoma, occur in this area, and they mostly show more conspicuous thinning and expansion of the cortex, together with stippled calcification in chondroid tumours. Other osteolytic lesions, such as solitary bone cyst, non-ossifying fibroma and chondromyxoid fibroma, typically occur in the metaphysial region. It is important to differentiate cystic

Fig. 11

Woman aged fifty-eight years with advanced osteoarthritis of the hip showing several large subchondral cysts in the "pressure" (weight-bearing) zone; the cysts communicate with the joint.

lesions in inflammatory arthritis (Figs. 8 to 10), and in osteoarthritis (Fig. 11), including cysts secondary to aseptic necrosis. In a relatively high percentage of cases of pigmented villonodular synovitis intra-osseous penetration occurs (Schajowicz and Blumenfeld 1968), the hip, the ankle and the knee joints being most commonly affected; but, unlike ganglion cysts, the bone lesions in

pigmented villonodular synovitis are frequently found on both sides of the affected joint (Figs. 12 and 13).

PATHOLOGICAL FINDINGS

Macroscopically there were no major differences between intra-osseous cysts and ganglia found in juxta-articular connective tissue. The size of the cysts,

Fig. 12

Fig. 13

Figure 12—Two cases of pigmented villonodular synovitis showing osteolytic multiloculated lesions of different size on both sides of the hip joint (acetabulum and femoral head) with secondary osteoarthritic changes. Figure 13—Another case of pigmented villonodular synovitis showing a soft-tissue mass and an osteolytic, well-defined lesion in the lower radius. This was clinically interpreted as an intra-osseous ganglion penetrating into bone, but at operation the villonodular synovitis was found penetrating into the radius and also into the scaphoid. The radiographic changes in the scaphoid were originally missed.

Fig. 14

Fig. 15

Fig. 16

Fig. 17

Fig. 18

Radiographs of cystic lesions in different carpal bones. Figure 14—Man aged thirty-seven (scaphoid). Figure 15—Woman aged forty-four (scaphoid). Figure 16—Man aged thirty-five (lunate). Figure 17—Man aged thirty-eight (capitate). Figure 18—Woman aged twenty-six (triquetrum).

Fig. 19

Man aged fifty-three years, complaining of mild pain in the left knee for five years, increasing for the past month. The cyst is large but there is no evidence of osteoarthritis.

whether in bone or soft tissue, ranged from less than 1 centimetre in the carpal bones (Figs. 14 to 18) to a maximum of 4 centimetres (Figs. 5, 6 and 19). Some were unilocular but more were multilocular (Figs. 3 and 30) and they were surrounded by a fibrous membrane of variable thickness, always easily separable from the adjacent spongiosa. The cysts were filled with a viscous whitish or yellowish mucoid jelly-like material. In fourteen cases we found additional soft-tissue cysts close to the underlying intra-osseous cyst; they had the same macroscopic features as the bone cysts, and appeared to have penetrated through the thinned or interrupted cortex. In the remaining cases we did not find juxta-osseous ganglia and only exceptionally any communication with the articular cavity.

Histologically the structure of the bone cysts is identical to that of soft-tissue ganglia. The major cystic or "mature" cavity is surrounded by a connective tissue

membrane, formed by parallel fascicles of collagen fibres with relatively few fibroblasts. These cells cover the inner surface of the cavity discontinuously and are often flattened, acquiring an aspect similar to synovium; but a continuous synovial layer was lacking in our cases (Fig. 21). Besides the larger "mature" cysts, there are always more or less numerous and extensive foci of myxoid transformation of the connective tissue, with stellate cells, separated by abundant mucoid ground-substance. These foci evidently represent new cysts in formation. Several cells in these areas are round with abundant vacuolar cytoplasm, filled with PAS-positive material and apparently secreting mucoid material. Similar elements are found floating free in the cystic cavities. Sometimes, adjacent to the newly formed cysts, an increased number of fibroblasts is observed which seems to suggest that the proliferation of fibroblasts ("fibroplasia") may precede or accompany the mucoid degeneration. The cancellous bone which surrounds the cyst contains some areas of osteoclastic resorption, probably where cysts are still growing, but new bone formation predominates, giving rise to a rim of slight bone sclerosis.

TREATMENT AND PROGNOSIS

Excision of the extra-osseous ganglion, and curettage or excision of the bone cyst (bone grafting the cavity if large), was the treatment in most cases. Segmental resection was used for large lesions located at the end of a non-weight-bearing bone (Figs. 22 to 25). Healing was usually uneventful. Recurrences have been reported (Crabbe 1966; Feldman and Johnston 1973), and Sim and Dahlin (1971) described a case with six recurrences. We had one case with five recurrences, but apart from this we have observed recurrence only once.

Radiographs of fourteen of our cases (16 per cent) showed degenerative joint lesions, but of only moderate severity and always restricted to the side of the bone

Fig. 20

Photomicrographs ($\times 40$) of the cyst wall in two different cases showing the multiloculated aspect, formed by folded membranes of dense fibrous tissue; *a* shows an area of evident congestion close to the surrounding bone which shows signs of new formation.

Fig. 21

Photomicrographs at higher magnification ($\times 100$) showing several focal areas of myxoid degeneration. In addition to areas of dense connective tissue, other looser myxoid zones are observed. There is no continuous cell lining at the inner surface of the cyst, as in synovial membrane; *a* shows newly formed bone.

Fig. 22

Fig. 23

Figure 22—Radiograph of a man aged thirty-three who complained of pain and swelling for two months. Figure 23—Photomicrograph ($\times 50$) of the fibrous wall consisting of fibrous tissue which was surrounded by newly-formed bone.

defect; these changes were commonest around the elbow (75 per cent) and the knee. The cysts were always large and in five cases the degenerative joint lesion occurred below forty years of age. We have never seen articular changes with bone cysts involving the malleoli, nor in the carpal or tarsal bones. Of the twenty-one cysts around the hip only three showed degenerative lesions, one being in an adolescent. In none of these patients was there evidence of previous articular abnormality such as subluxation or aseptic necrosis (Figs. 26 to 30). Eggers *et al.* (1963) and Golding (1966) have suggested that the intra-osseous cyst may be a precursor of osteoarthritis, but in those of our cases in which segmental resection was performed (upper end of the fibula or lower end of the ulna) osteoarthritis had not developed up to twelve years after operation and healing was satisfactory.

Fig. 24

Fig. 25

Fig. 24

Fig. 25

Photomicrographs of a cyst in the lower ulna in a man aged fifty-four. Figure 24 ($\times 4$) and Figure 25 ($\times 80$) show the multiloculated nature of the cyst, in part "mature", that is lined by a membrane of fibrous tissue, and in part showing focal areas of myxoid degeneration with smaller cysts surrounded by slightly sclerotic bone.

Fig. 26

Fig. 27

Fig. 28

Fig. 29

Fig. 30

Four different acetabular cysts, all in young people with no evidence of joint disease. Figure 26—Girl aged seventeen years. Figure 27—Girl aged fifteen years. Figure 28—Man aged twenty-seven. Figure 29—Woman aged twenty-nine. Figure 30—The specimen removed from the patient shown in Figure 29.

DISCUSSION

Juxta-articular (subchondral) bone cysts with the features of ganglia, without previous inflammatory or degenerative joint lesions, are becoming better recognised by radiologists and orthopaedic surgeons. This is clearly shown by the increasing number of publications in the last few years, some reporting a considerable number of cases. Most cases occur in middle age, ranging from fourteen to seventy-three years of age in our series. Multiple lesions, mostly bilateral and symmetrical, have been reported and also observed by us in four patients.

Although well recognised as a clinical entity, the pathogenesis of juxta-articular bone cysts is still obscure. It is clear and is widely accepted that the macroscopic and microscopic appearances are identical (or at least very similar) to those of juxta-articular soft-tissue ganglia, and it is likely that both share a common pathogenesis, that is mucoid degeneration of connective tissue.

There seem to be two fundamental types of intra-osseous ganglia: one originating by penetration of an extra-osseous ganglion into the underlying bone, the other being "idiopathic". The most striking examples of the penetrating type were those reported by Fairbank and Lloyd (1934), Ghormley and Dockerty (1943) and by Fisk (1949). Kambolis *et al.* (1973) thought that penetration was the most important cause, although in only seven of their fourteen cases was this mechanism proved. In our series (see Table II) we found this possible pathogenesis in only fourteen out of eighty-eight cases (16 per cent), one being due to the penetration of a cyst of the medial meniscus into the tibial plateau (Figs. 31 and 32).

In most cases, however, the ganglion cyst was primarily intra-osseous, located in the juxta-articular (subchondral) region, and until the exact pathogenesis is established, we suggest calling this type "idiopathic". Communication of the bone cyst with the articular cavity (Scaglietti and Stringa 1960; Crane and Scarano 1967; Catalano 1969; Nigrisoli and Beltrami 1971) has suggested a possible traumatic origin and Menges *et al.* (1977), using tomography, found such a channel in 57 per cent of their cases. Most authors, however, have failed to find any such communication. We also found no communication between bone cyst and joint in most of our cases, though we recognise the possibility that such a channel might have become obliterated. Whether these communications exist or not the term "synovial cyst of bone" is incorrect because the cyst lining lacks a characteristic synovial cell surface.

It is generally accepted that the histogenesis of the "idiopathic" juxta-articular cyst is a mucoid transformation of connective tissue, possibly preceded by intramedullary metaplasia and proliferation of fibroblastic elements ("fibroplasia"), followed by a degenerative stage with mucoid secretion and accumula-

Fig. 31

Fig. 32

Figure 31—Man aged fifty-nine years, who complained of swelling and pain on the medial side of the knee for one year. The radiograph shows a well-defined radiolucent lesion of the upper tibia and slight narrowing of the medial joint space. Figure 32—The upper photograph shows the intra-osseous cyst, and the lower two show the mucoid cyst of the medial meniscus which has penetrated into the adjacent bone.

tion which enlarges the ganglionic cyst (Goldman and Friedman 1969; Feldman and Johnston 1973). However, the cause of this intramedullary "fibroplasia" and myxoid degeneration is still disputed. In view of the close relationship of many bone cysts to periarticular capsular and ligamentous insertions Bugnion, who studied cysts in carpal bones, maintained that some developed as a result of herniation of capsular and ligamentous structures into bone, while others followed cystic degeneration of a focal area of aseptic bone necrosis. We also favour a localised vascular disturbance as the primary cause of the cyst formation, whether there is communication with the joint or not. Although we have not found signs of aseptic bone necrosis in our cases, we believe that this is due to the fact that, as a rule, only fully developed cysts are excised; small foci of bone necrosis may have been present at an earlier stage, but have become eliminated later through a process of bone resorption and remodelling. Mechanical factors and repeated minor trauma at the superficial bone areas might have caused such intramedullary vascular disturbances.

Intra-osseous ganglia are very similar to the subchondral cysts of osteoarthritis and it is sometimes difficult to establish whether a juxta-articular cyst is secondary to articular degeneration or whether the articular lesions are the consequence of the cyst. In

several cases reported as ganglion cysts, advanced osteoarthritic lesions were present, especially around the hip (Feldman and Johnston 1973); these cysts may well have been secondary to the osteoarthritis; this applies also to those rare cases of rheumatoid arthritis with bone cysts. However, in other cases the bone cysts, most frequently located around the knee or hip and generally of great size, were evidently precursors of the degenerative joint disease. A few of our cases we accepted as true primary, juxta-articular cysts, in spite of some articular changes; these all occurred in younger

patients (less than thirty years), who had joint lesions of only moderate severity confined to the site of the cyst. Moreover, there was no progress of the osteoarthritis after excision of the cyst. Precise pathological differentiation may be impossible, but features which strongly suggest an osteoarthritic cyst are as follows: the presence in the "pressure" zone of several small cysts in addition to the large one; more or less numerous joint communications due to defects in the articular cartilage; and the presence of necrotic bone and cartilage debris, or of cartilaginous metaplasia inside the cysts.

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