BENIGN CHONDROBLASTOMA*

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Benign chondroblastoma is a rare primary neoplasm of bone, probably of cartilaginous origin. The relative rarity of a neoplasm should not lull one into a complacent disregard for it, because anyone dealing with bone tumours must be prepared to interpret and manage any lesion he encounters. Its recognition is of some practical importance also, because it is not infrequently "overdiagnosed" as chondrosarcoma (Phemister 1930) or even as osteosarcoma (King 1931) with consequent recommendation of ablation. In this paper stress is laid on the pitfalls in the diagnosis of this tumour.

FIG. 1

FIG. 2

Case 1—Radiological appearances. Figure 1—Initial radiograph showing the transradiant lesion arising from the upper humeral epiphysis. Note the line of sclerosis at the lateral margin of the tumour. Figure 2—Two years after excision and bone grafting. The fibular graft has hypertrophied and its epiphysis has retained its growth potential.

NOMENCLATURE

Ewing in 1923 (quoted by Codman 1931) was probably the first to recognise this type of tumour: he called it a calcifying giant-cell tumour. He made a plea that this peculiar tumour should receive special recognition and a distinguishing designation.

Kolodny (1927) distinguished it as a variant of giant-cell tumour and used the term cartilage-containing giant-cell tumour. Codman (1931) collected nine tumours of the upper end of the humerus from the Registry of Bone Sarcoma and called them epiphysial chondromatous giant-cell tumours. He was not satisfied with the long cumbersome name. He wrote: "We must find a name which will not tie the tongue but it should associate adolescence with this puzzling type of lesion."

Jaffe and Lichtenstein (1942) held the view that the lesion should be completely dissociated from giant-cell tumour and regarded as an independent clinico-pathological entity. They suggested the descriptive term benign chondroblastoma, which has gained general acceptance.

* The material for this paper formed part of a thesis submitted for the M.Ch.Orth. Examination of the University of Liverpool in 1963.

MATERIAL

The present series includes six cases, of which four were from the Liverpool area and two from Madras. The discussion includes a survey of the literature with special reference to histogenesis, pathology, diagnosis and treatment.

CASE REPORTS

Case 1 (Mr E. N. Wardle's case)—A boy aged fourteen had had pain in the right shoulder for about eight months when he was seen at the Northern Hospital in April 1960. The right shoulder was slightly swollen but movements were full.

Radiographs showed an area of rarefaction in the upper humeral epiphysis extending to the subchondral region with a line of reactive sclerosis at the margin (Fig. 1). The lesion was diagnosed as tuberculous and was treated with a short course of anti-tuberculous drugs without any response. The lesion was therefore curetted and packed with bone chips. A histological diagnosis of benign chondroblastoma was made (Dr Winston Evans).

In August 1960 there was recurrence of pain with slight restriction of movements. Radiographs showed that the bone grafts had disappeared. In September 1960 the patient was given a course of radiotherapy (dosage not known). Though painless, the swelling had increased in size. In March 1961 the upper end of the humerus, including four inches of the shaft, was excised and replaced by the upper end of the right fibula. By January 1963 the bone graft had hypertrophied and the epiphysis of the fibula had increased in size, indicating retention of its growth potential (Heikel 1959) (Fig. 2). Abduction to 90 degrees and rotation of 20 degrees were present at the shoulder. The patient was working as a welder when last seen.

Case 2 (Mr G. L. Shatwell's case)—A boy aged sixteen reported in September 1954 with pain in the right shoulder of two months' duration. There was tenderness over the greater tuberosity of the right humerus. Abduction was restricted to 100 degrees but other movements were full.

Radiographs showed an osteolytic lesion in the region of the greater tuberosity with periosteal reaction of the adjoining metaphysis (Fig. 3). Tissue removed from the large cavity was greyish in colour with a few yellow nodules. The patient was given a short course of anti-tuberculous drugs.

FIG. 3

FIG. 4

Case 2—Radiological appearances. Figure 3—The tumour is seen in its "classical" site in the greater tuberosity extending across the epiphysal plate. Note the areas of fuzzy calcification within the tumour and periosteal reaction of the upper shaft. Figure 4—Three years after curettage and irradiation. The lesion has healed with dense calcification and the periosteal reaction has been incorporated into the lateral cortex.

Though doubts were raised regarding the benignity of the lesion a diagnosis of benign chondroblastoma was made on the basis of histological examination. In November 1954 the lesion was irradiated (dosage: 7,000 röntgen). Radiographs taken in March 1958 showed patchy areas of dense calcification without any evidence of recurrence of the lesion (Fig. 4). The patient was last seen

in October 1962. He was in good health and had regained almost full range of movement at the shoulder.

Case 3 (Mr N. W. Roberts' case)—A man aged twenty complained of swelling over the dorsum of the right hand in February 1962. He had injured the hand while gardening six months earlier.

There was painless thickening of the shaft of the right third metacarpal bone. Movements of the fingers were full. Radiographs showed a multiloculated cystic swelling in the shaft of the third

FIG. 5

FIG. 6

FIG. 7

Case 3—Radiological appearances. Figure 5—The multiloculated transradiant lesion has expanded the shaft of the third metacarpal bone. Figure 6—The tumour has recurred after curettage. Note the expansion in the volar aspect of the metacarpal and absorption of bone grafts. Figure 7—The lesion has consolidated satisfactorily after second curettage and bone grafting.

metacarpal bone (Fig. 5). The lesion was diagnosed as an enchondroma and was explored through a dorsal incision. The contents were soft, reddish and semi-fluid, quite unlike an enchondroma. After curettage the cavity was packed with deproteinised bone. The sections were seen by Dr Jane I. Gibson and Professor H. L. Sheehan, who diagnosed respectively benign chondromatous giant-cell tumour and benign chondroblastoma.

Within six months the tumour recurred (Fig. 6). In September 1962 the lesion was explored through a palmar incision. A tense haematoma was evacuated and the cavity was filled with deproteinised bone. The histological appearances resembled those of the first specimen and there was no evidence of malignancy. When the patient was last seen in January 1963 the metacarpal was thickened, but was causing no pain. Radiographs showed good incorporation of the bone grafts (Fig. 7).

Case 4 (Mr H. G. Almond's case)—A boy aged fourteen complained in October 1952 of pain and swelling of the right knee of three months' duration. The right knee was swollen and was kept flexed. Radiographs showed a well defined area of decalcification in the lateral femoral condyle (Fig. 8). An evening rise of temperature was noted. The Mantoux test was positive at 1 in 100 and the erythrocyte sedimentation rate was 37 millimetres in the first hour. Aspirate was negative. Synovial biopsy showed evidence of non-specific synovitis. The condition was treated as tuberculous without any response.

Further radiographs showed increase in the size of the lesion with periosteal reaction of the adjoining shaft of femur. Some calcification was seen in the region of the intercondylar notch. The knee was now greatly swollen, tense and oedematous, with distended veins (Fig. 9).

FIG. 8

FIG. 9

Case 4—Radiological and clinical appearances. Figure 8—An area of rarefaction with erosion of the articular cartilage is seen in lateral femoral condyle. Figure 9—Gross swelling of knee with distended veins coursing up the thigh.

Histological examination of further specimens taken from the lateral femoral condyle and the intra-articular tumour tissue showed the appearances of benign chondroblastoma. This diagnosis was later confirmed by Dr H. L. Jaffe. In spite of the histological diagnosis, the rapid progress and certain features of the tumour raised doubts as to its benign nature. It was also clear that there was no hope of recovery of function of the knee. Accordingly, above-knee amputation was done. The patient did not report for review.

Case 5—A boy of fifteen was seen in May 1960 with a swelling over upper end of left tibia. He had injured his left knee five months earlier. There was a globular swelling measuring three inches by three inches over the medial aspect of the upper end of left tibia. There was a 20 degree flexion deformity of the knee with a range of movement of 40 degrees. Radiographs showed an eccentric tumour, with fuzzy calcification, arising from the medial tibial condyle (Fig. 10).

Biopsy was done: the appearances were said to be those of a giant-cell tumour. The tumour was irradiated; and a dose of 2,000 röntgen had been given when the possibility of an error in diagnosis was recognised. The sections were reviewed and another opinion was sought. At that stage the appearances were reported as being typical of benign chondroblastoma.

The tumour had by now increased in size and had burst through the articular cartilage of the tibia (Fig. 11). In August 1960 the medial condyle of the tibia was excised. The knee joint was later fused by excision of articular cartilage and fixation with a central graft. When last seen in August 1961 the patient had no complaints and knee fusion was progressing satisfactorily (Fig. 12).

FIG. 10

FIG. 11

FIG. 12

FIGS. 10 TO 12

Case 5—Radiological appearances. Figure 10—The tumour arising from the medial condyle of tibia demonstrates the "typical" features: eccentric situation; the lesion astride the "open" epiphyseal plate, and "mottled" calcification. Figure 11—The tumour has burst through the articular cartilage after a short course of radiotherapy. Figure 12—Six months after excision of medial condyle of tibia and knee fusion by central-graft operation.

Case 6—A girl of ten came in November 1960 with pain in the left hip of two months' duration. She walked with a limp. All movements of the left hip were limited at the extremes. Radiographs showed a circular area of rarefaction in the superior aspect of the neck of femur extending across the epiphyseal line into the capital epiphysis (Fig. 13). Skeletal survey and biochemical investigations were negative. The lesion was thought to be an endosteal focus of tuberculosis and treatment by skin traction and chemotherapy was begun. Although the pain in the hip was relieved, serial radiographs showed that the lesion was getting bigger (Figs. 14 and 15). The lesion was therefore explored and maroon-coloured material was curetted out. The cavity was filled with cancellous bone taken from the left ilium. The histological diagnosis of benign chondroblastoma was later confirmed by Dr P. D. Byers of the Institute of Orthopaedics, London. In spite of the healing reaction inside the lesion the supero-lateral part of the head of the femur collapsed and produced degenerative arthritis (Fig. 16).

HISTOGENESIS

The name "benign chondroblastoma" implies that the lesion develops from cartilage germ cells and certainly the cytological appearance of the unmodified tumour cells suggests that they might be chondroblasts. However, Jaffe warns that this idea should not be taken too rigidly.

FIG. 13

FIG. 14

FIG. 15

FIG. 16

Case 6—Radiological appearances. Figure 13—A transradiant lesion in the lateral part of the capital epiphysis and supero-lateral aspect of neck of femur. Note that the joint space is normal. Figure 14—After curettage and bone grafting. The head of femur is flattened and the neck of the femur is widened. Figure 15—One year after curettage and bone grafting the lesion is consolidating slowly. Figure 16—Two years after curettage the lesion has consolidated to a greater extent. Note the onset of degenerative arthritis in the hip.

Two types of cells in these tumours have specially attracted the attention of pathologists—basic polyhedral cells and giant cells. These are the cause of disagreement on histogenesis. Ewing (1928) and Codman (1931) regarded them as atypical giant-cell tumours. Codman described the microscopic appearance as being "chiefly distinguished by the presence of peculiar epithelioid cells which merge into a low grade type of cartilage on the one hand and into cells of the tumour on the other. Sometimes the newly formed cartilage forms the bulk

of the tumour and sometimes a tissue indistinguishable from giant-cell tumour occupies most of the space. Sometimes there is a deposit of calcium in the cartilage and new bone formation."

Jaffe and Lichtenstein (1942) strongly refuted the idea that the tumour was a giant-cell variant, stating that the giant cells were usually sprinkled in areas of necrosis, haemorrhage or chondroid organisation and that they were rather larger than tumour giant cells. The readily discernible clue to the diagnosis of benign chondroblastoma is the presence of focal areas of calcification throughout the cellular tumour tissue. Whenever this calcification is particularly heavy the tumour cells swell and undergo degeneration and necrosis (like cartilage cells undergoing calcification preparatory to osseous transformation). Coley and Santoro

TABLE I
SITES OF OCCURRENCE OF BENIGN CHONDROBLASTOMA

Bones involved		Number of cases reported	Number of cases in present series
Femur	Proximal portion	11	1
	Distal portion .	21	1
	Not stated .	3 (35)	— (2)
Humerus	Proximal portion	27	2
	Not stated .	2 (29)	— (2)
Tibia	Proximal portion	13	1
	Distal portion .	2 (15)	— (1)
Innominate bone . .		4	—
Talus		3	—
Scapula		3	—
Fibula		2	—
Calcaneus		2	—
Temporal		1	—
Radius		1	—
Metacarpal		1	1
Rib		1	—
Thoracic vertebra . .		1	—
Sacrum		1	—
Metatarsal		1	—
Patella		1	—
Total		101	6

(1947) and Copeland and Geschickter (1949) agreed with Jaffe and Lichtenstein on the histogenesis. Willis (1948), on the other hand, favoured Codman's original view that these tumours were cartilaginous variants of osteoclastoma. He believed that the proliferating chondroblasts and osteoclasts were related and naturally interconvertible.

Geschickter and Copeland (1949) recognised both benign and malignant chondroblastic tumours and suggested that the lesions developed as a consequence of disorderly and distorted proliferation of cartilage cells which took place on the metaphysial side of the epiphysial plate. The benign variant could be considered related to enchondroma and the malignant

chondroblastoma to chondrosarcoma. The existence of a malignant form of chondroblastoma has not been corroborated, however, and is denied by Lichtenstein.

Stout (quoted by Coley 1960), while conceding that the lesion should be considered as a distinct entity, doubted whether the mononuclear cells of such a chondroblastoma were comparable with embryological chondroblasts and suggested that the tumour was probably caused by an upset during development which caused a malposition of tissues.

Valls, Ottolenghi and Schajowicz (1951) suggested that this tumour had a reticulo-histiocytic origin. Their evidence for this hypothesis was derived from the use of a silver staining technique which demonstrated the reticulin fibres surrounding individual cells and groups of cells. Dahlin (1956) suggested the possibility of a morphological relationship between benign chondroblastoma and chondromyxoid fibroma and it appears that tumours may occasionally be encountered where distinction between these two entities may be rather difficult or even impossible.

Schajowicz (1962), using histochemical methods, demonstrated intense enzymatic activity of acid phosphatase, beta-glucuronidase and succinic dehydrogenase with no evidence of alkaline phosphatase activity in the normal chondroclastic and osteoclastic cells. However, the multinucleated giant cells of giant-cell tumour of bone and of the so-called variants exhibited identical histochemical behaviour. Hence histochemical study is of no diagnostic value in differentiating giant-cell tumour from its so-called variants.

CLINICAL CONSIDERATIONS

Incidence—Benign chondroblastoma is a rare tumour. It comprised less than 1 per cent of 2,000 or more tumours of bone studied at the Mayo Clinic (Dahlin 1957). So far about 101 cases have been reported. There is a striking preponderance among males: five out of six in our series were males. Most tumours are seen in patients in the second decade of life but a few are seen in the first or after the sixth decade.

Localisation—Though Codman originally described the lesion in the upper end of humerus, it can arise at the ends of long bones, in flat bones (Kunkel, Dahlin and Young 1956) and rarely in the bones of the hands and feet (Table I).

According to Jaffe (1958) the lesion starts in the epiphysis and involvement of the metaphysis is secondary. However, Geschickter and Copeland (1949) believed that the epiphysial side of the metaphysis was the site of origin and that metaphysis was always involved. I am inclined to concur with Jaffe's view though one of our cases presented with an atypical lesion in the metacarpal. Dahlin has reported a primary metaphysial chondroblastoma in the lower part of femur in a boy of eight.

The occurrence of benign chondroblastoma in the flat bones is not inconsistent with the hypothesis that this tumour is of epiphysial origin, for the innominate bones and the scapula both have multiple primary centres of ossification.

Buraczewski, Lysakowska and Rudowski (1957) reported the case of an hour-glass tumour involving the neural arches of the third and fourth thoracic vertebrae and causing compression of the spinal cord. This tumour showed the histological appearance typical of a benign chondroblastoma.

Clinical features—The symptoms start in an insidious manner, and are often referred to the adjoining joint. Usually the patients seek advice after a lapse of a few months. Two of the patients in this series (Cases 3 and 5) had a history of previous injury.

The early clinical features are those related to the joints and are likely to be mistaken for those of an infective lesion. The joint may be swollen and warm and there may be some effusion. Movements may be restricted and painful, and in the case of the lower limb there may be a painful limp. A bony tumour is not noticeable until late in the disease, at which stage muscle wasting and fixed deformities may be present.

Radiological features—The lesion is oval or round, rarely exceeding six centimetres in diameter. It is eccentrically situated involving part of an epiphysis or an epiphysis and adjoining metaphysis. Rarely, the cortex is distended with some periosteal reaction in the metaphysis. “The lesional area appears as a fuzzily rarefied and even mottled focus which tends to be delimited by a well defined, narrow, encircling line of sclerotized bone” (Jaffe 1958). The fuzzy mottling of its shadow indicates spotty calcification within the focus. Indeed, it is a characteristic radiological feature of benign chondroblastoma. The lesions in the upper end of the humerus can be correctly diagnosed on the clinical and radiological evidence alone.

PATHOLOGICAL FEATURES

Gross pathology—It is rather exceptional to see a lesion intact in its setting, because the standard treatment is curettage. There is one such specimen in this series (Fig. 17). The tumour is five centimetres in diameter with a pale necrotic, calcified central portion and an outer pink, gelatinous edge which is sharply demarcated from the surrounding cancellous epiphysal bone. The tumour tissue can be seen to have eroded the articular cartilage and to have encroached upon the joint space which is filled with necrotic calcified tumour. It is rather unusual for the tumour to transgress the articular cartilage.

“The curetted tumour tissue is likely to appear in part reddish grey, rather cellular and quite vascular or even haemorrhagic, and in part more greyish and gritty and flecked with yellowish calcific material” (Jaffe 1958).

Microscopical appearances—The basic cells are polyhedral with roundish or oval nuclei which are often indented. The cytoplasm is slightly acidophilic. The cell borders are clear cut with little interstitial ground substance (Fig. 18). When a chondroid substance is present in cellular areas it forms the stroma (Fig. 19). Foci of possible transition from cellular areas into cartilage are present. An outstanding histological feature is the presence of focal areas of calcification (Fig. 20). Calcific deposits are noted within and between the cells, giving a “honeycombed” appearance. Jaffe and Lichtenstein (1942) suggested that this calcification was primary and that accompanying necrosis of the tumour was secondary to it.

The multinucleated giant cells are seen “either singly or in small collections, here and there in the lesions and especially about the areas of haemorrhage and necrosis.” They are not part of the primary cytological pattern of the tumour but are secondary to haemorrhage and necrosis.

DIFFERENTIAL DIAGNOSIS

Quite a few cases of benign chondroblastoma are still being misdiagnosed as giant-cell tumour, chondromyxoid fibroma or chondrosarcoma.

Giant-cell tumour—In most cases the patient is between twenty and forty years of age. The lesion usually affects the end of a long tubular bone. Radiographs show a large more or less circumscribed area of striking transradiancy. The so-called trabeculation is rarely seen. The cytological pattern is that of a vascularised network of plumpish, spindle-shaped or ovoid stromal cells, heavily intermingled with multinuclear giant cells.

Apart from the site of predilection, the only feature common to a giant-cell tumour and benign chondroblastoma is the presence of multinucleated giant cells; and even these are few and far between in the latter tumour. In all other respects the two conditions are quite distinctive. *Chondromyxoid fibroma*—This presents like most bone tumours with pain, tenderness or swelling. There is no difference in sex incidence between it and chondroblastoma, but 80 per cent of these tumours have occurred in patients less than thirty years old. In a long bone the tumour develops in or near the metaphysis and sometimes crosses the epiphysal line. The proximal end of the tibia is by far the most common site. Radiologically it appears as a well defined, transradiant, eccentrically situated lesion without any periosteal reaction. Histologically, the abnormal tissue consists of a mixture of fibrous, myxoid and chondroid

areas of varying maturity with increased cellularity at the periphery. There are occasional foci of calcification, giant cells and cells with irregular nuclei which may look deceptively malignant and may lead to a mistaken diagnosis of chondrosarcoma.

Chondrosarcoma—It may be difficult sometimes to distinguish between benign chondroblastoma and central chondrosarcoma either radiologically or histologically. However, chondrosarcoma is rare in young people and when it does occur in the second decade of life its histological appearances are unequivocally those of a malignant tumour. The constituent cells are surrounded by lacunae set in a well defined intercellular matrix. There are numerous binucleated cartilage cells with hyperchromatism and several mitotic figures. If the chondroid areas of benign chondroblastoma are seen in their proper setting, the distinction from chondrosarcoma can readily be made.

Treatment—The lesion is benign, so curettage, or local excision when indicated, is adequate. Radiotherapy combined with curettage has also proved successful. A few cases treated

FIG. 17

Case 4—Serial sagittal sections through the lower end of femur to show the tumour in its natural setting.

successfully by radiotherapy after biopsy have been reported (Valls *et al.* 1951, Kunkel *et al.* 1956). Hatcher and Campbell (1951), however, reported the development of chondrosarcoma in the upper end of the humerus three and a half years after irradiation of a benign chondroblastoma.

In the present series two tumours were treated by curettage (Cases 3 and 6), one by curettage followed by irradiation and later excision of the lesion (Case 1), one by curettage followed by irradiation (Case 2), one by irradiation (2,000 röntgen) followed by excision (Case 5), and one by amputation (Case 4).

DISCUSSION

In this series the average age (fourteen years and nine months) and range of ages (ten to twenty years) are like those previously reported. The five to one preponderance in males was slightly greater than the four to one ratio previously reported.

FIG. 18

Case 4—Photomicrograph showing the polyhedral cells with well defined cell borders. Note the scanty intercellular matrix and focus of calcification at the lower right corner. Giant cells are fewer in number and contain fewer nuclei. (Haematoxylin and eosin, $\times 150$.)

FIG. 19

Case 4—Photomicrograph showing an area of chondroid differentiation with few outlying multinucleated giant cells. (Haematoxylin and eosin, $\times 150$.)

FIG. 20

Case 4—Photomicrograph showing foci of calcification and areas of chondroid differentiation. (Haematoxylin and eosin, $\times 150$.)

But for the atypical lesion in the shaft of a metacarpal (Case 3) the location of the tumours was similar to that previously reported (Table I). The lesion in Case 3 is unique in several respects: it had probably started in the metaphysis and later involved the diaphysis of the metacarpal; only one other case of affection of a metacarpal has so far been reported.

In none of our cases was the diagnosis of benign chondroblastoma made in the first instance. In fact, four lesions (Cases 1, 2, 4 and 6) were thought to be tuberculous and were treated as such for varying periods. Two lesions (Cases 3 and 5) were recognised as neoplastic but were thought to be respectively an enchondroma and an osteoclastoma. It seems a great pity that even a typical case (Case 5) with all the clinical, radiological and pathological features should have been missed. Goethe's axiom "Man sees that which he knows" was never more true. "The 'suspicion index' should be high, when pain is associated with a tumour in the epiphysis of long bone in a young male whose general health is good and in whom symptoms have been present for a long time" (Kunkel *et al.* 1965). As with other bone tumours, biopsy is imperative.

Copeland and Geschickter have recognised both benign and malignant chondroblastic tumours. However, others do not agree with them. The clinical features, rapid progression and ominous parts of the microscopic fields in Case 4 were very suggestive of malignant transformation. It is very unfortunate that this patient could not be traced. Ackerman and Spjut (1962) reported a case of metastasising chondroblastoma. In the light of these, I am inclined to agree with Copeland and Geschickter's classification.

The treatment should be essentially conservative. The tumour recurred in three cases (Cases 1 to 3), but was suppressed either by a second curettage and bone grafting (Case 3) or excision (Case 1) or irradiation (Case 2). Thorough removal of the tumour is clearly desirable. Bone grafts may be necessary after curettage, resection or excision. Though benign chondroblastoma may respond to irradiation alone, it seems advisable to avoid such treatment unless the site of the tumour makes removal impossible.

All other patients except one (Case 4) are alive and free from recurrence after an average period of three years and seven months from operation, the range of the observation period being from one year to eight years and ten months.

SUMMARY

1. Benign chondroblastoma is a rare primary neoplasm of bone with excellent prognosis. It is believed that instances of it are still being missed.
2. Six cases are described with special emphasis on diagnostic pitfalls.
3. A critical survey of the literature and a discussion on nomenclature and histogenesis are included.

I am most grateful to Mr E. N. Wardle, Mr N. W. Roberts, Mr G. L. Shatwell and Mr H. G. Almond for permission to report their cases. I am grateful to the Dean, Government Stanley Hospital, for permission to report my cases. I am particularly grateful to Dr P. D. Byers of the Department of Morbid Anatomy, Institute of Orthopaedics, London, and to Dr E. Tapp for their advice in the preparation of this paper.

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