XXI. Tumours of bones and joints

W. MISDORP [1] & R. O. VAN DER HEUL [2]

Tumours of bones and joints are not infrequent in dogs but are rare in other domestic animals. In the dog, most bone tumours are malignant; osteosarcomas are by far the most frequently encountered tumours, especially in giant breeds and boxers. The following main categories of bone tumour are described: bone-forming, cartilage-forming, giant cell, marrow, vascular, miscellaneous, metastatic, unclassified, and tumour-like lesions. The tumours of joints and related structures are classified as synovial sarcomas, fibroxanthomas, and malignant giant cell tumour of soft tissues.

This classification of the bone tumours of animals is very similar to the WHO classification of the bone tumours of man [a] and is likewise based on histological criteria, particularly the type of differentiation shown by the tumour cells and the type of intercellular material they produce.

This classification includes malignant and benign tumours of bones and joints, and a few related tumours that were not discussed in the classification of the soft tissue tumours of domestic animals.[b] The descriptions of the latter are similar to those for the counterparts in man in the WHO classification of soft tissue tumours.[c] A number of tumour-like lesions are also included for comparison and because of their importance in differential diagnosis. For the same reason, metastatic tumours are also briefly discussed. Tumours such as squamous cell carcinoma and malignant melanoma that are known to infiltrate bone are not discussed here.

During the last few years, reports on hitherto unknown tumours in domestic animals have appeared and it can be expected that more types of bone and joint tumours will be detected, owing to increasing interest in oncology and improved clinical–radiological procedures. This classification, which reflects more or less the present state of knowledge, has to be considered as a first step and modifications are almost certain to be needed as experience accumulates.

Our study is based on 322 tumours from the files of the Netherlands Cancer Institute and 43 cases acquired from several institutes in Europe, the USA, and Australia. These latter cases were selected to represent rare types of tumour recently reported in the veterinary literature. The material consisted of 283 tumours in the dog, 40 in the cat, 15 in the horse, 13 in the sheep, 11 in the cow, and 3 in the pig. In some instances we failed to acquire material of types of tumour reported in the literature. The majority were post-mortem cases and a few were amputation specimens. Since most of the animals were killed relatively early in the course of the disease because of their primary bone tumour, it was difficult to correlate the histological picture with the biological behaviour. It will therefore be necessary to continue collecting well-documented cases.

Although the present knowledge on animal bone tumours is still limited, some tentative conclusions can be drawn:

1. In the dog primary bone tumours outnumber metastatic tumours (by 5 to 1 in our material); this contrasts with the situation in man.

2. Malignant bone tumours seem to be, especially in the dog and cat, far more frequent than benign ones, whereas in man benign tumours are relatively more common. It may be that, by more intensive

[1] Veterinary Pathologist, Department of Pathology, Netherlands Cancer Institute, Amsterdam, Netherlands.

[2] Professor of Pathology, Department of Pathology, Medical Faculty, University of Rotterdam, Netherlands.

[a] SCHAJOWICZ, F. ET AL. Histological typing of bone tumours. Geneva, World Health Organization, 1972 (International Histological Classification of Tumours, No. 6).

[b] WEISS, E. Tumours of the soft (mesenchymal) tissues. *Bulletin of the World Health Organization*, 50: 101-110 (1974).

[c] ENZINGER, F. M. ET AL. Histological typing of soft tissue tumours. Geneva, World Health Organization, 1969 (International Histological Classification of Tumours, No. 3).

radiographical examination, more benign lesions will be detected in the animal skeleton.

3. Osteosarcoma in the dog, especially in the giant breeds and boxers, is numerically the most important. This tumour can be considered a good model for the human situation and is therefore the subject of clinicopathological, immunological, therapeutic, and etiological (bone-seeking isotope) studies.

4. Chondrosarcomas in the dog and sheep are the second most common type of tumour after osteosarcomas in the dog and the cat. Chondrosarcomas are also fairly common in man. Haemangiosarcomas (in the dog and horse), osteochondromas (in the dog, horse, and cat), and myelomas (in the dog) are less frequently found, all three types occurring mostly in multiple forms. The latter two types of tumour are more common in man than in animals. We have seen no convincing cases of Ewing's sarcoma, chondroblastoma, chondromyxoid fibroma, desmoplastic fibroma, mesenchymal chondrosarcoma, chordoma, haemangioendothelioma, or eosinophilic granuloma in animals. Apart from the osteosarcomas and possibly the chondrosarcomas and malignant synoviomas, too few cases were available for a study of variability in the histology of certain types of lesion.

5. Some reports on the familial occurrence of osteochondroma in dogs and horses and of fibrous dysplasia in dogs indicate that genetic factors are involved.

6. The reported coincidence of multiple bone infarcts in dogs and of " osteodystrophia " lesions in cats with hypervitaminosis A and osteosarcoma is most interesting from the etiological and histogenetical points of view.

The diagnosis of bone tumours

The diagnosis of a bone lesion can be greatly aided by a combination of clinical, radiological, and pathological investigations. Some important aspects of these three approaches are as follows:

Clinical history. This includes the duration and type of the clinical signs and the localization of the lesion.

Radiography. Taken from two or more directions, radiographs help to establish the size, shape, and precise site of origin of the lesion. In doubtful cases comparison with the contralateral bone and repeated radiographs (3-week intervals) can be helpful.

Biopsy techniques. A surgical biopsy must be of sufficient size to include portions both of the growing margin and of deeper parts of the tumour. This holds especially true for osteosarcoma, of which the histological structure may vary widely in different parts and at the growing margin of which intercellular substances such as osteoid material may be absent. The choice of site is aided by radiography.

Amputation and post-mortem specimens. These provide the opportunity for detailed examination of the whole tumour. The use of giant sections, although difficult and time-consuming to prepare, gives the maximum amount of information on the composition and structure of the tumour and its relation to pre-existing and reactive tissues. After fixation the specimen is photographed and examined radiographically in two directions. A thick (6-mm) section through the middle of the tumour is prepared by sawing and is photographed and radiographed. It is decalcified in a buffered sodium formate–formic acid solution until it can be cut with a knife, and is then dehydrated and vacuum embedded in paraplast. Sections for histological examination are cut at 7–10 μm on a special sledge microtome.

In addition to haematoxylin and eosin, alcian blue may be helpful for differentiation between osteosarcomas with a cartilage component and chondrosarcomas with secondary ossification. Reticulin-fibre stains and birefraction methods are useful in distinguishing tumour bone from reactive and preexistent bone and from undulating dense collagen.

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HISTOLOGICAL CLASSIFICATION AND NOMENCLATURE OF TUMOURS OF BONES AND JOINTS

Tumours of bone

I. BONE-FORMING TUMOURS

A. Osteoma

B. Osteoid osteoma and osteoblastoma (benign osteoblastoma)

C. Osteosarcoma

D. Juxtacortical osteosarcoma (parosteal osteosarcoma)

II. CARTILAGE-FORMING TUMOURS

A. Chondroma

B. Osteochondroma (osteocartilaginous exostosis)

C. " Chondroma rodens "

D. Chondrosarcoma

III. GIANT CELL TUMOUR (OSTEOCLASTOMA)

IV. MARROW TUMOURS

A. Myeloma

B. Others

V. VASCULAR TUMOURS

A. Haemangioma

B. Haemangiosarcoma (malignant haemangioendothelioma)

VI. MISCELLANEOUS TUMOURS

A. Fibrosarcoma

B. Liposarcoma

C. Osteoliposarcoma (malignant mesenchymoma)

D. " Adamantinoma " of long bones

E. Undifferentiated sarcoma

VII. METASTATIC TUMOURS

VIII. UNCLASSIFIED TUMOURS

IX. TUMOUR-LIKE LESIONS

A. Solitary bone cyst (simple or unicameral bone cyst)

B. Aneurysmal bone cyst

C. Juxtacortical bone cyst (subchondral bone cyst)

D. Fibrous dysplasia

E. " Myositis ossificans "

F. Brown tumour of hyperparathyroidism

G. Epidermoid cyst of the phalanx

H. Others

Tumours of joints and related structures

I. SYNOVIAL SARCOMA (MALIGNANT SYNOVIOMA)

II. FIBROXANTHOMA (FIBROUS HISTIOCYTOMA)

III. MALIGNANT GIANT CELL TUMOUR OF SOFT TISSUES

DESCRIPTION OF TUMOURS

Tumours of bone

I. BONE-FORMING TUMOURS

A. *Osteoma*

This is a benign, very hard lesion consisting of well-differentiated mature bone tissue with a predominantly lamellar structure. This slowly growing tumour is very rare in animals as it is in man, and is restricted to the skull and mandibula. A number of lesions reported in the veterinary literature as fibro-osteoma, when examined by us proved to be structurally more similar to fibrous dysplasia and are therefore placed in that category.

B. *Osteoid osteoma and osteoblastoma (benign osteoblastoma)*

Both lesions are benign and show great resemblance histologically. They consist of cellular, highly vascularized tissue made up of immature bone and osteoid tissue. The osteoid osteoma is a very small lesion, usually surrounded by a zone of reactive bone. In cats we examined two osteoblastic, apparently benign lesions in the vertebrae, which showed some resemblance to osteoblastoma in man.

C. *Osteosarcoma*

This is a malignant tumour characterized by the direct formation of bone or osteoid tissue by the tumour cells. Tumour bone formation must be distinguished from reactive bone formation and from bone formed by chondral ossification. Osteosarcomas show considerable variation in histological pattern. The tumour seems to arise centrally and expands and invades the surrounding connective tissue, muscles, and blood vessels. In about 50% of the canine osteosarcomas in our series only neoplastic bone and osteoid was present (" pure osteosarcomas "). In other osteosarcomas, in addition to bone and osteoid, neoplastic cartilage, fibrous tissue, or myxoid tissue was also produced (" combined sarcomas "). There are strong indications that the latter group has a more favourable prognosis than the former. In man, osteosarcomas with a basically fibrosarcomatous pattern are associated with a relatively favourable prognosis.

Osteosarcoma is the most common of the primary malignant tumours of bone in the dog (about 80% of all bone tumours) and the cat. Osteosarcoma is mostly found in middle-aged and older dogs and cats, several years after bone growth has ceased, whereas most osteosarcomas in man occur in adolescents. In some feline osteosarcomas multinucleate giant cells are very numerous.

Paget's disease, which is associated with osteosarcoma in man and occurs after middle age, is not yet known to exist in animals.

The metaphyses of the long bones of large and giant dogs and of cats are common sites; the lower end of the radius and the upper end of the humerus (especially in boxers) are the main sites in dogs. In the horse, ox, and sheep few osteosarcomas, mostly situated in the head, have been reported. Osteosarcomas in the dog, especially of the combined type, are sometimes difficult to distinguish from chondrosarcomas and fibrosarcomas.

D. *Juxtacortical osteosarcoma (parosteal osteosarcoma)*

This is a distinct type of osteosarcoma, characterized by its origin in the external surface (periosteal sarcoma) of a bone and a high degree of structural differentiation. The tumour tissue consists of a mass of bone trabeculae, often mature and lamellar, merging with fibrous tissue and sometimes cartilage. The cells generally show little pleomorphism and mitotic activity. The few cases seen in animals were situated in the head, whereas in man these tumours usually involve the metaphyses of the long bones. These tumours are rather circumscribed lesions, adhering to or tending to surround the underlying shaft.

II. CARTILAGE-FORMING TUMOURS

A. *Chondroma*

This is a benign tumour, characterized by the formation of mature cartilage but lacking the histological characteristics of chondrosarcoma (high cellularity, pleomorphism, and the presence of large cells with double or plump nuclei or mitoses). Chondromas have been reported in the dog, cat, and sheep; in the dog they occur as solitary and multicentric lesions (enchondromatosis). Chondromas are rare in animals but rather common lesions in man.

B. *Osteochondroma (osteocartilaginous exostosis)*

This benign tumour is a cartilage-capped bony projection on the external surface of a bone. These lesions in animals are mostly multicentric, involving the ribs, vertebrae, scapulae, and metaphyses of the long bones. Malignant change has been observed in dogs with the multicentric form. This tumour, although not rare in animals, seems to occur more frequently in man. Multiple familial cases in dogs and horses indicate a hereditary basis, which is established in man.

C. " *Chondroma rodens* "

A special type of tumour with fibrocartilaginous differentiation was first named " chondroma rodens " (Jacobson) and later the " cartilaginous counterpart of fibromatosis " (Liu & Dorfman). This tumour is characterized by an aggressive growth. It has a lobulated structure, with islands of partly calcified and ossified neoplastic cartilage surrounded by cellular strands of spindle cells. This tumour, which is nearly always found in the cranium, could be primarily a soft tissue tumour arising, for exam-

ple, in aponeuroses secondarily invading the underlying bone. More cases of this interesting tumour should be studied in order to learn more about its biological behaviour and structural variations.

D. *Chondrosarcoma*

A malignant tumour characterized by the formation of cartilage, but not of bone, by the tumour cells. It is distinguished by the presence of cellular and pleomorphic tumour tissue and by appreciable numbers of cells with plump, large, or double nuclei. The cells are often surrounded by a cartilaginous or mucinous intercellular substance, but undifferentiated areas can also be present. Chondrosarcomas may contain variable amounts of intercellular tissue, which may be mineralized; enchondral ossification is very common and should be distinguished from direct bone formation as found in osteosarcomas.

According to the differentiation of the tumour tissue, the chondrosarcomas can be classified into three grades. Low grade tumours (grade I) are composed of well differentiated cartilage with rather uniform cells, some of which have double nuclei and lack mitotic figures; high grade tumours (grade III) consist partly of undifferentiated sarcomatous tissue or of pleomorphic cells with a high mitotic rate. The grade II tumours are of intermediate type. The prognostic value of grading chondrosarcomas in animals has still to be evaluated.

Chondrosarcomas are not infrequent in dogs (about 10% of all bone tumours in our series) and sheep; but are rare in cats and horses. In dog, sheep, and man flat bones (ribs, sternum, nose, and pelvis), as well as the metaphyseal parts of the long bones, may be involved. In dogs, as in man, no significant preference for any age group was found. Boxers and German shepherd dogs appear to be the breeds most likely to develop chondrosarcomas. In animals, these tumours are sometimes difficult to distinguish from chondromas and from osteosarcomas with cartilaginous differentiation.

III. GIANT CELL TUMOUR (OSTEOCLASTOMA)

This is an aggressive tumour, characterized by cellular tissue consisting of plump mesenchymal cells and numerous multinucleate giant cells of the osteoclast type, which are uniformly distributed throughout the tumour tissue. Relatively little collagen is present; osteoid tissue or bone can occasionally be seen. These rare tumours, some of which produced metastases, have been reported in the dog and the cat. In one feline case there was an associated mast cell response. The animal tumours were located either in the epiphyseal part of the long bones, in the ribs, or in the vertebrae.

IV. MARROW TUMOURS

A. *Myeloma*

A malignant tumour, usually showing multiple or diffuse bone involvement. It is characterized by round cells resembling plasma cells but showing various degrees of immaturity, including atypical multinucleate forms. The lesions appear either as focal osteolytic areas or as areas of diffuse marrow replacement without alteration in bone structure. The lesions in animals, as in man, may sometimes be associated with the presence of abnormal proteins in the blood and urine. Myeloma is not very rare in the dog; as in man, the vertebrae, pelvis, ribs, and long bones are the most common sites. In the dog no significant age preference was found (range 1–10 years), whereas in man mostly older people are affected. Myeloma is a rare tumour in the pig and the horse. In two pigs of our series the cut surface of all bones was green. In animals and man with multiple myeloma, tumorous deposits are usually also found in other organs as nodular or diffuse growths.

B. *Others*

We were not able to study any primary reticulosarcomas of bone in animals, although tumours of this type have been reported in the dog.[a] Primary lymphosarcoma of bone in animals has not been recorded. In lymphosarcoma of the multicentric type and in the thymic type in maturing cattle, however, ribs and vertebrae are sometimes partially destroyed by tumour tissue. Destructive bone lesions have rarely been found in lymphosarcoma of the dog and cat.

V. VASCULAR TUMOURS

A. *Haemangioma*

This is a benign lesion, consisting of newly-formed blood vessels either of the capillary or cavernous type. Only one case in animals (in a dog) has been reported; this was in a vertebra, the most common site in man, where multiple haemangiomas of bone are also encountered.

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[a] DRIEUX, H. & VERETENNIKOFF, S. *Recueil de médecine vétérinaire*, **139**: 523-547 (1963).

B. *Haemangiosarcoma (malignant haemangioendothelioma)*

This is a malignant tumour characterized by the formation of irregular anastomosing vascular channels, which are lined by one or more layers of atypical endothelial cells; these cells often appear immature and are accompanied by solid masses of poorly differentiated or anaplastic tissue. Multiple haemangiosarcomas of bone, or of bone and soft tissue, can occur in dog, horse, and man. This type of tumour is not rare in the dog, involving both long bones (proximal humerus) and flat bones (ribs). This destructive tumour is very malignant and metastasizes rapidly to the lungs. It may sometimes be difficult to decide whether haemangiosarcomas in bone and other tissues are multifocal or metastatic.

Special care is necessary to distinguish this tumour from the highly vascular type of telangiectatic osteosarcomas, from aneurysmal bone cysts, and from atypical malignant synoviomas.

VI. MISCELLANEOUS TUMOURS

A. *Fibrosarcoma*

A malignant tumour, characterized by the formation by the tumour cells of interlacing bundles of collagen fibres and by the absence of other types of histological differentiation. Fibrosarcomas occur as osteolytic lesions in the long bones of dogs, and in the mandibles of sheep and horses. In advanced cases, especially in the dog and cat, it can be difficult to decide whether the tumour is primarily a bone tumour or a soft tissue tumour involving bone. This tumour has to be distinguished from osteosarcomas of the fibrosarcomatous type, which contain only a small amount of tumour bone.

B. *Liposarcoma*

A malignant tumour, characterized by lipoblastic differentiation as shown by the presence of atypical lipoblasts in various stages of differentiation. This tumour, which is exceedingly rare in man, has been reported to occur in the metaphyses of young dogs. In one dog, multiple liposarcomas were present in the long bones and also in other organs.

C. *Osteoliposarcoma (malignant mesenchymoma)*

This is a malignant tumour consisting of both osteosarcomatous and liposarcomatous tissue. This tumour is rare in the dog, as it is in man.

D. " *Adamantinoma* " *of long bones*

A malignant tumour characterized by the presence of circumscribed masses of apparently epithelial cells surrounded by spindle cell tissue. The structure of the epithelium shows similarity to that of the ameloblastoma (" adamantinoma ") in the jaw. This type, which is rare in man, has been reported to have occurred in a dog.[a]

E. *Undifferentiated sarcoma*

This is a malignant tumour with a pleomorphic structure, devoid of any specific pattern of histological differentiation. Insufficient sampling, especially from the peripheral zone of a malignant tumour, may result in a diagnosis of undifferentiated sarcoma. Extensive examination by means of giant sections resulted in a lower number of undifferentiated sarcomas in our later series than in the earlier one but sometimes, even after careful study, some cases remained in which no specific pattern of differentiation could be detected.

VII. METASTATIC TUMOURS

Metastatic tumours in the skeleton of the dog and cat are of diagnostic importance since their clinical and radiological appearance may simulate osteosarcoma or other malignant bone tumours (myeloma). The ribs, vertebrae, and long bones are the favourite sites of these often multiple metastases. The primary tumours are usually situated in the mammary gland, lungs, or prostate.

VIII. UNCLASSIFIED TUMOURS

This group consists either of tumours showing features that apparently belong to more than one of the groups mentioned in this classification, or of tumours showing features that have hitherto been unrecognized. Some feline tumours were particularly difficult to classify.

IX. TUMOUR-LIKE LESIONS

A. *Solitary bone cyst (simple or unicameral bone cyst)*

This is a unicameral cavity filled with clear or sanguineous fluid, and lined by a membrane of

[a] NIELSEN, S. W. & SCHNELLER, G. B. *Journal of the American Veterinary Medical Association*, **121**: 84-89 (1952).

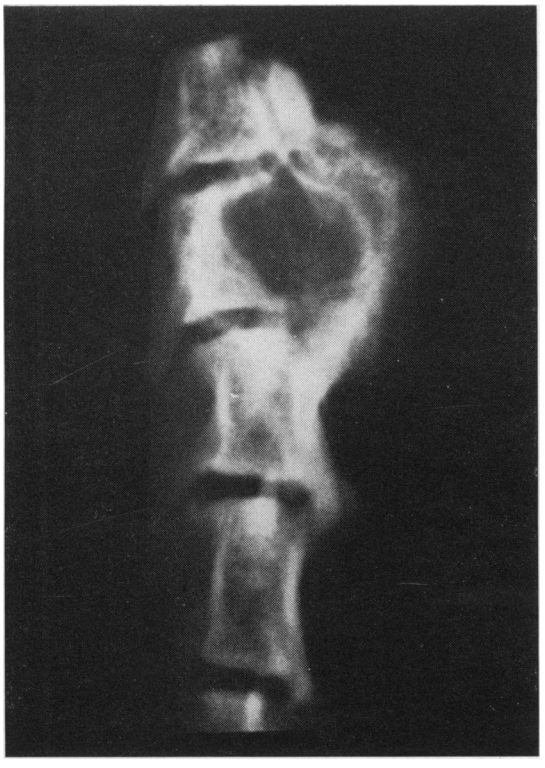

Fig. 1. Osteoblastoma, vertebra (cat).

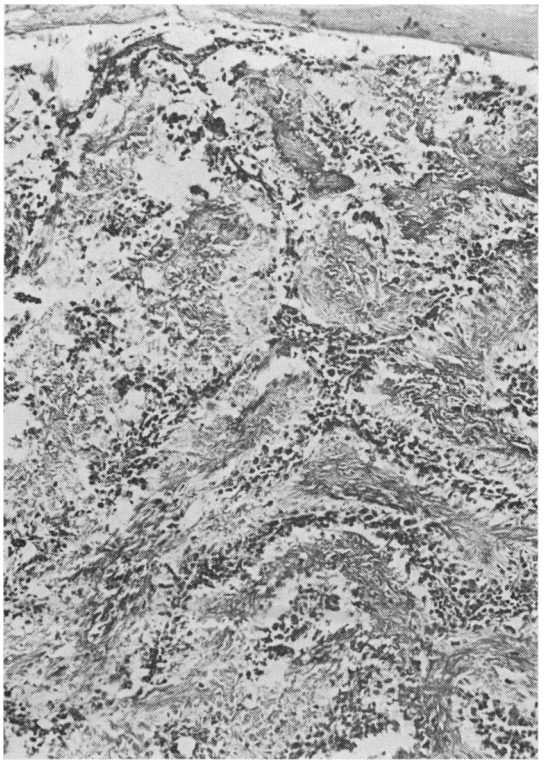

Fig. 2. Osteoblastoma, vertebra (cat).

Fig. 3. Osteosarcoma, distal radius (dog). Osteosclerotic–osteolytic type. Clinical radiograph.

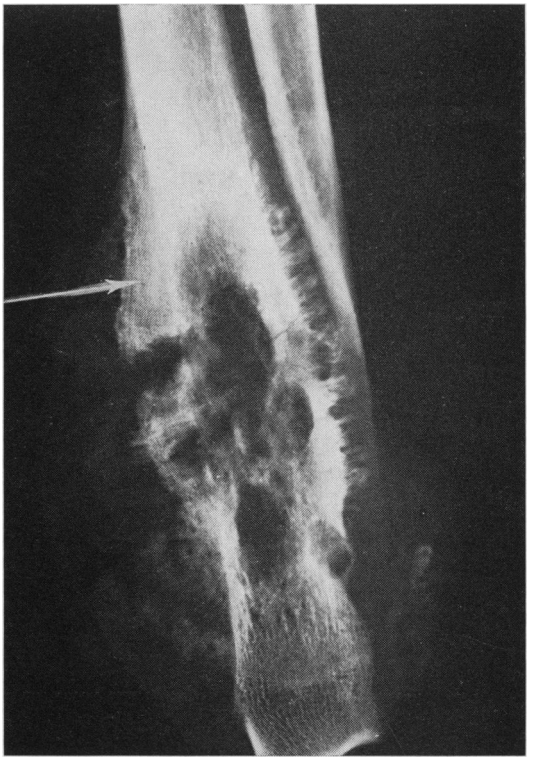

Fig. 4. Osteosarcoma, distal radius (dog). Same case as Fig. 3. Radiograph of median slice (Codman's triangle arrowed).

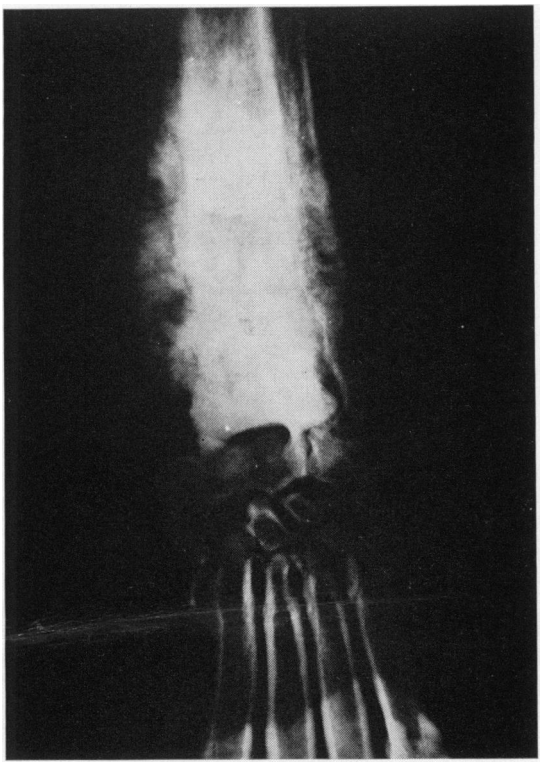

Fig. 5. Osteosarcoma, distal radius (dog). Osteosclerotic type. Radiograph of post-mortem specimen.

Fig. 6. Osteosarcoma, distal femur (dog). Osteolytic type. Clinical radiograph.

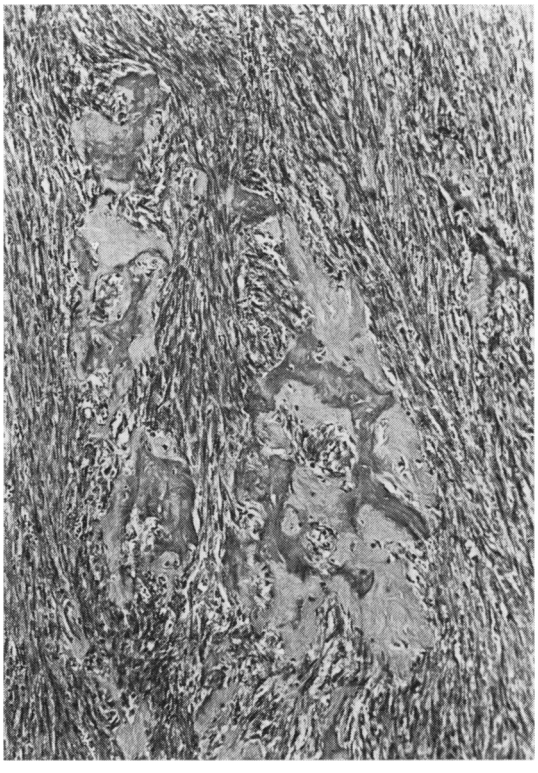

Fig. 7. Osteosarcoma, combined (osteo–fibro) pattern (dog).

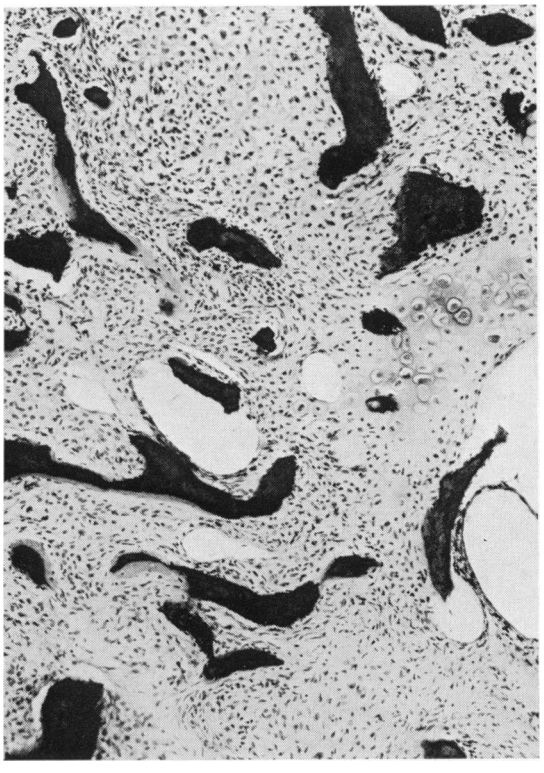

Fig. 8. Osteosarcoma, combined (osteo–chondro) pattern (dog).

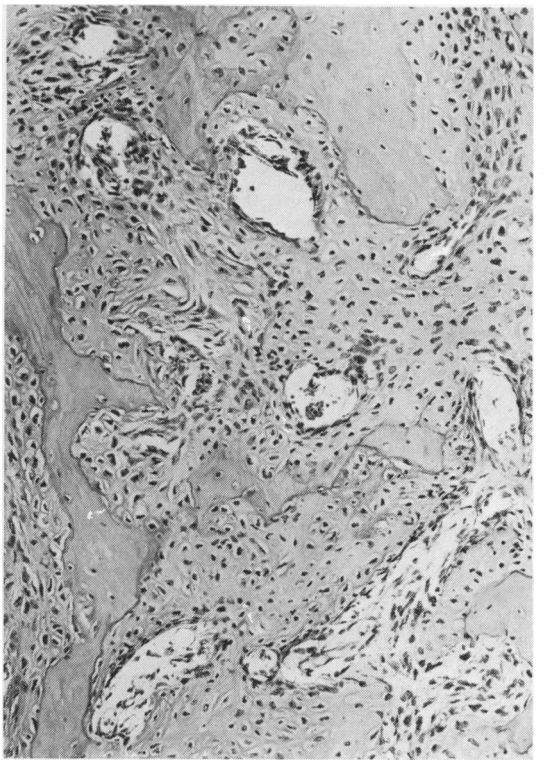

Fig. 9. Osteosarcoma, simple osteoblastic pattern (dog). Deposition of tumorous osteoid on pre-existing trabeculae.

Fig. 10. Osteosarcoma, tibia (dog). Multiple bone infarcts are arrowed.

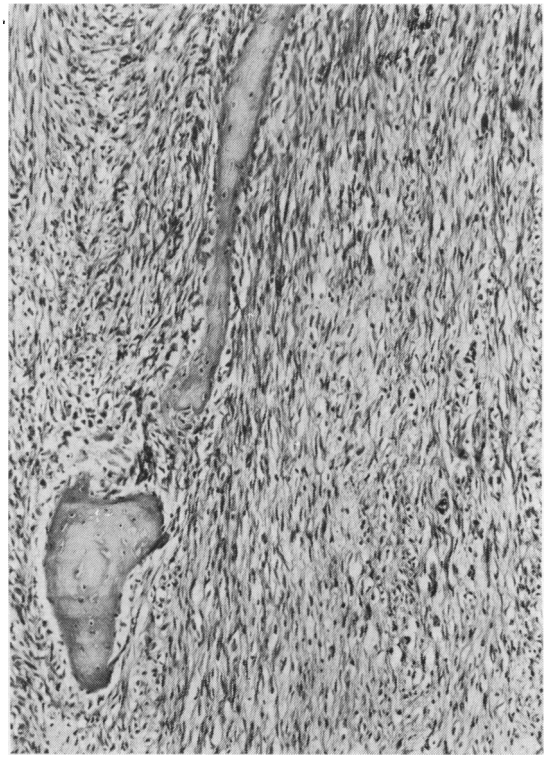

Fig. 11. Juxtacortical osteosarcoma, skull (sheep). Cellular fibrous tissue and highly differentiated tumour bone.

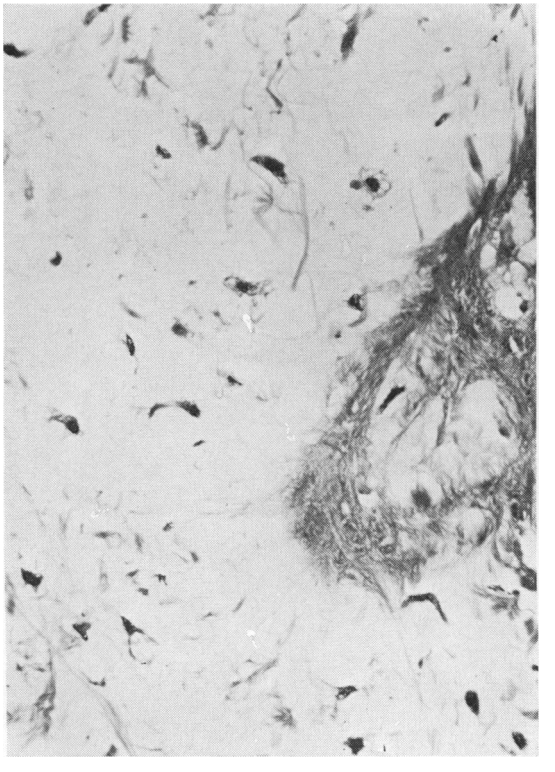

Fig. 12. Chondroma, orbital crest (dog).

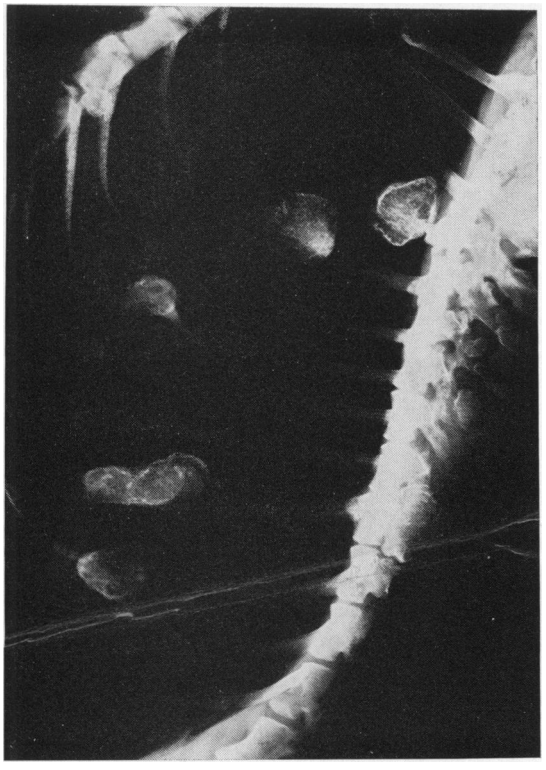

Fig. 13. Multiple osteochondromas, ribs and spine (dog). Radiograph of post-mortem specimen.

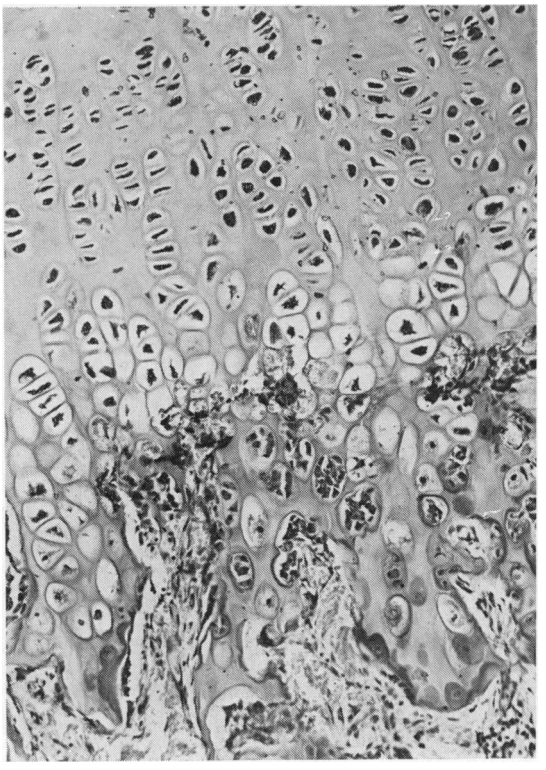

Fig. 14. Osteochondroma, rib (dog). Enchondrial ossification similar to that in epiphyseal lines.

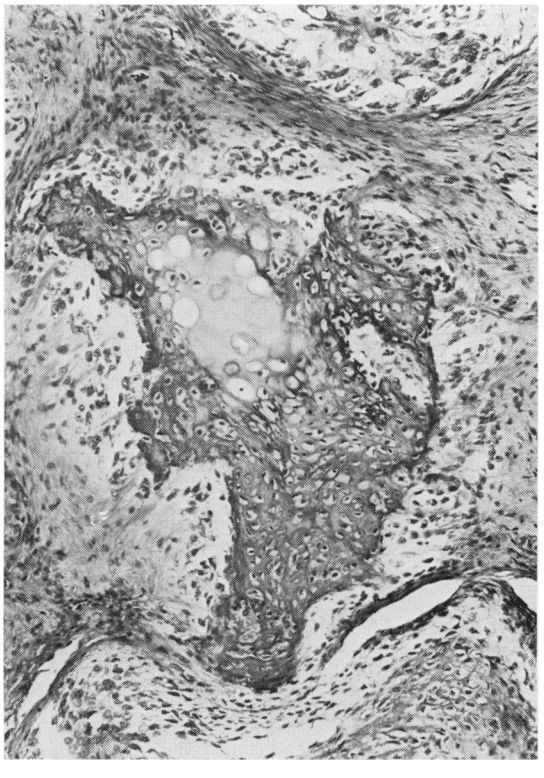

Fig. 15. " Chondroma rodens ", cranium (dog). Island of calcified cartilage surrounded by spindle cells.

Fig. 16. Chondrosarcoma, scapula (sheep). Extensive calcification. Radiograph of a slice from a post-mortem specimen.

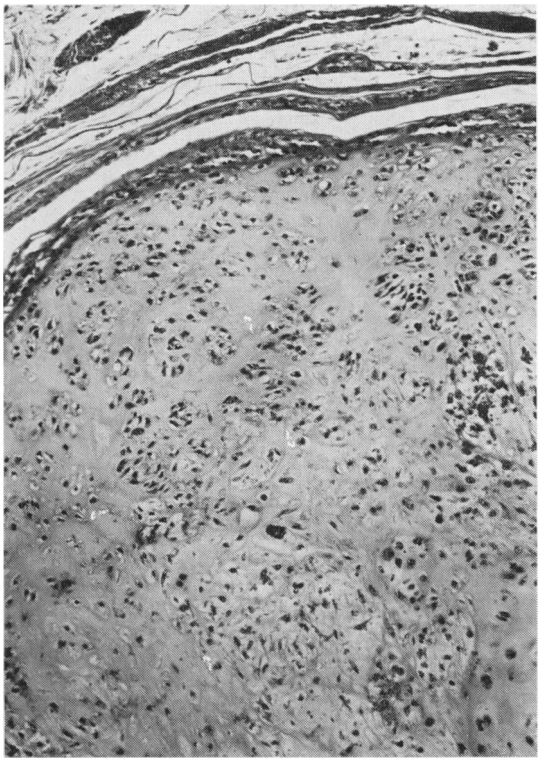

Fig. 17. Chondrosarcoma, rib (dog). Highly differentiated (Grade I).

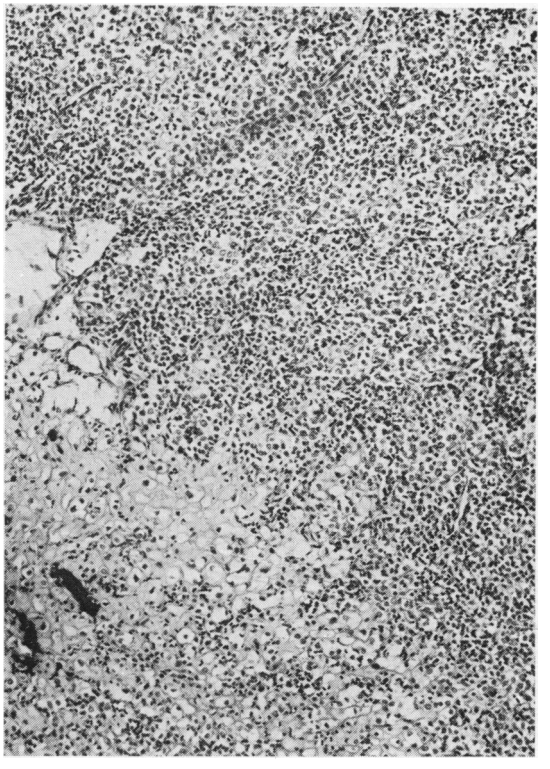

Fig. 18. Chondrosarcoma, nasal turbinate (dog). Poorly differentiated (Grade III).

Fig. 19. Giant cell tumour, lumbar vertebra (dog).

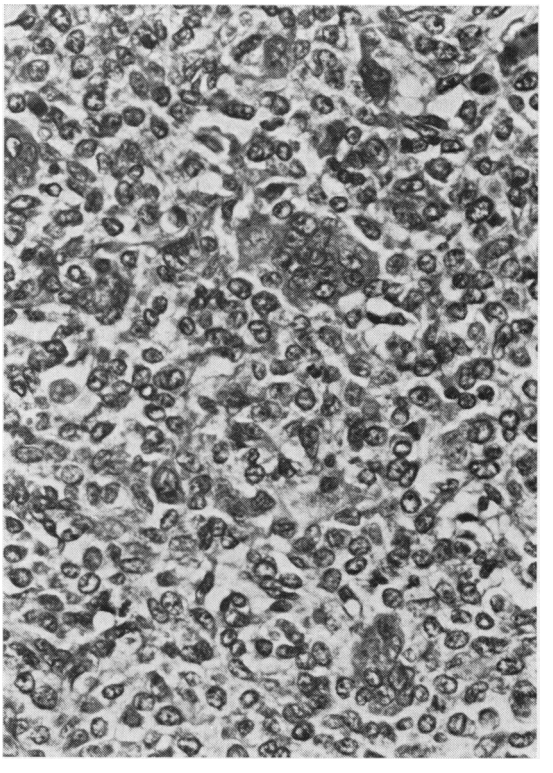

Fig. 20. Giant cell tumour, proximal humerus (dog).

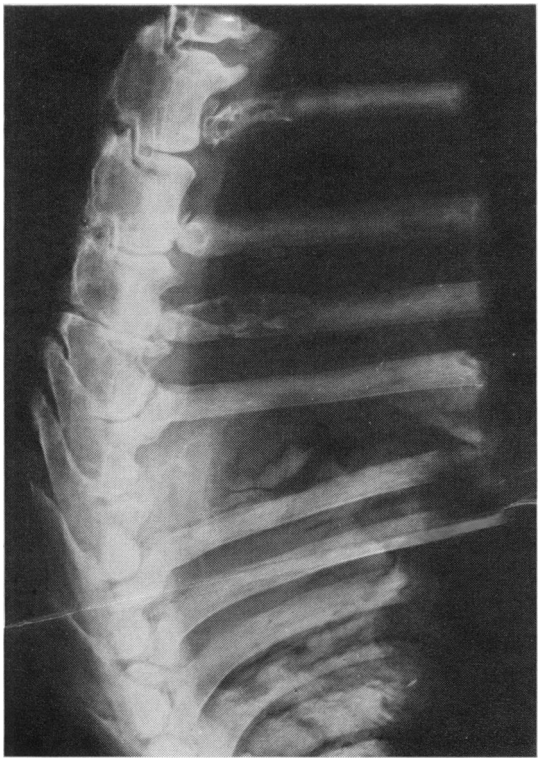

Fig. 21. Myeloma, multiple osteolytic lesions in ribs and vertebrae (dog). Radiograph of post-mortem specimen.

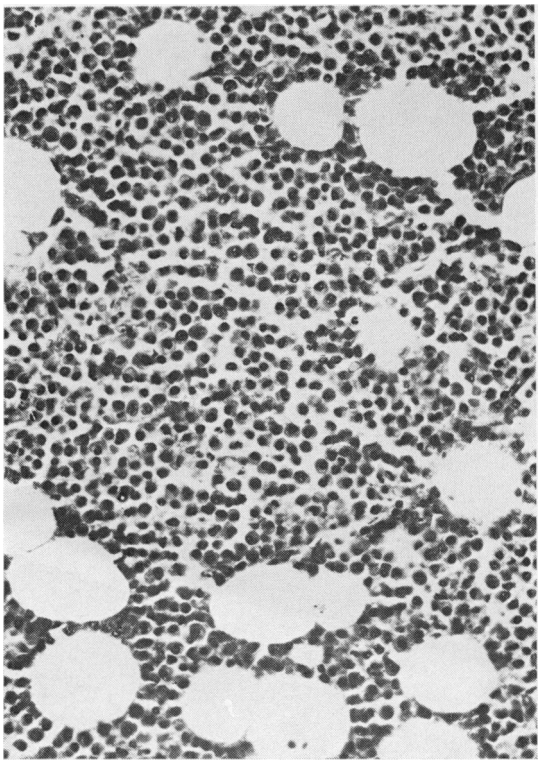

Fig. 22. Myeloma, tibia (dog). Cells resembling plasma cells.

Fig. 23. Cavernous haemangioma, vertebra (dog). Clinical radiograph.

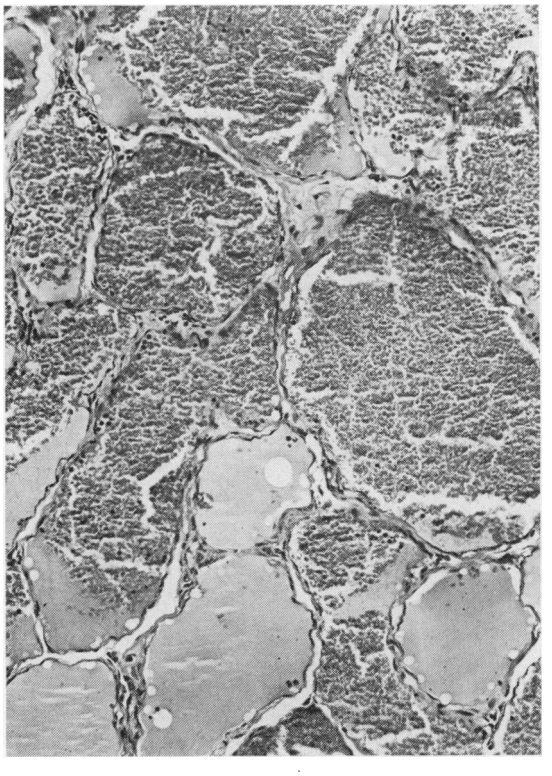

Fig. 24. Cavernous haemangioma, vertebra (dog).

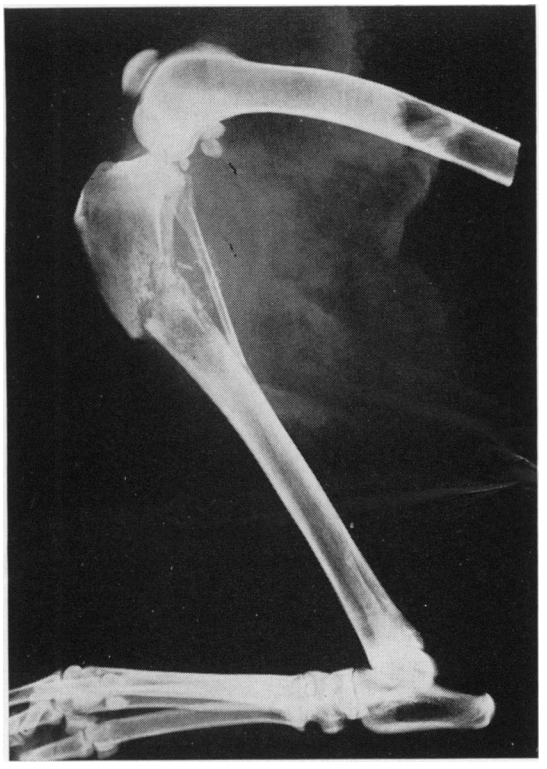

Fig. 25. Haemangiosarcoma, upper tibia (dog). Pathological fracture. Radiograph of post-mortem specimen.

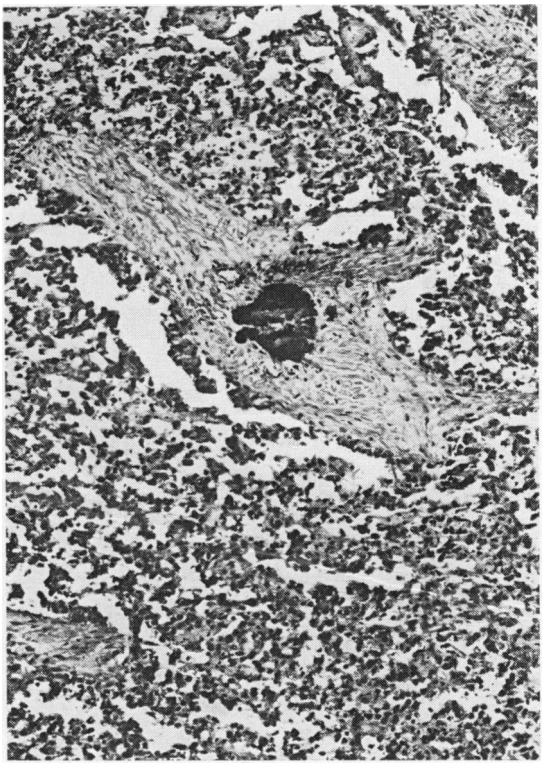

Fig. 26. Haemangiosarcoma, frontal bone (dog).

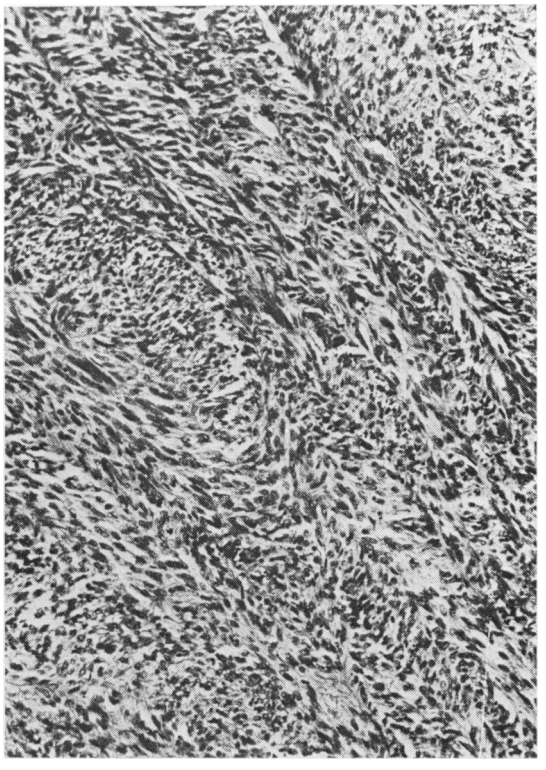

Fig. 27. Fibrosarcoma, mandible (horse).

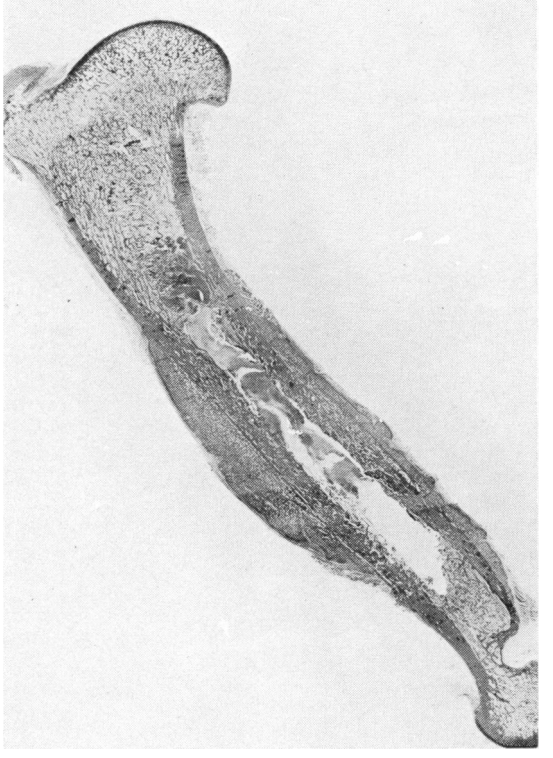

Fig. 28. Liposarcoma, diaphysis humerus (dog) Extensive necrosis and periosteal reactive bone.

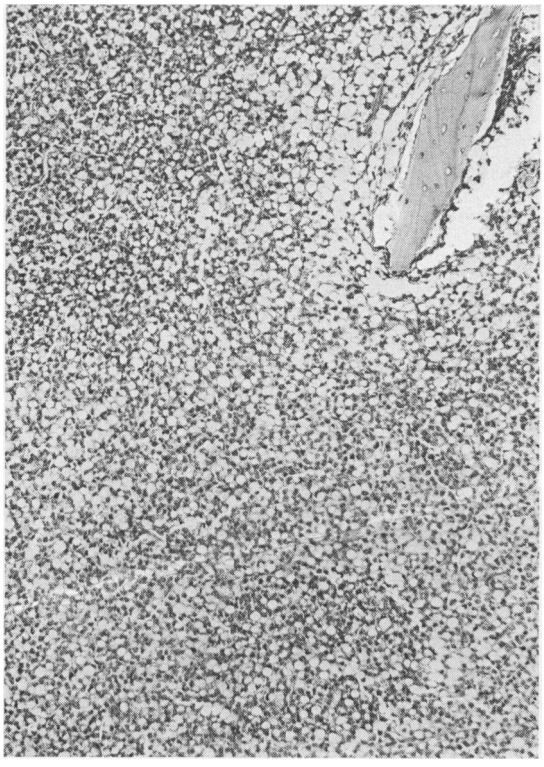

Fig. 29. Liposarcoma, diaphysis humerus (dog).

Fig. 30. Malignant mesenchymoma (osteosarcoma + liposarcoma), proximal humerus (dog). Radiograph of post-mortem specimen.

Fig. 31. Solitary bone cyst, distal ulna (young dog). The radiographic picture is also compatible with that of an aneurysmal bone cyst. Clinical radiograph.

Fig. 32. Solitary bone cyst, ulna (dog).

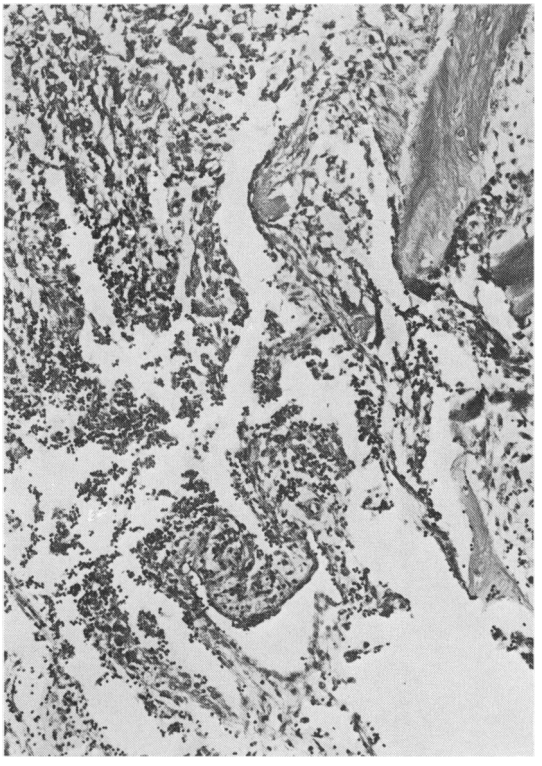

Fig. 33. Aneurysmal bone cyst, os ileum (cat).

Fig. 34. Fibrous dysplasia, maxilla (cat).

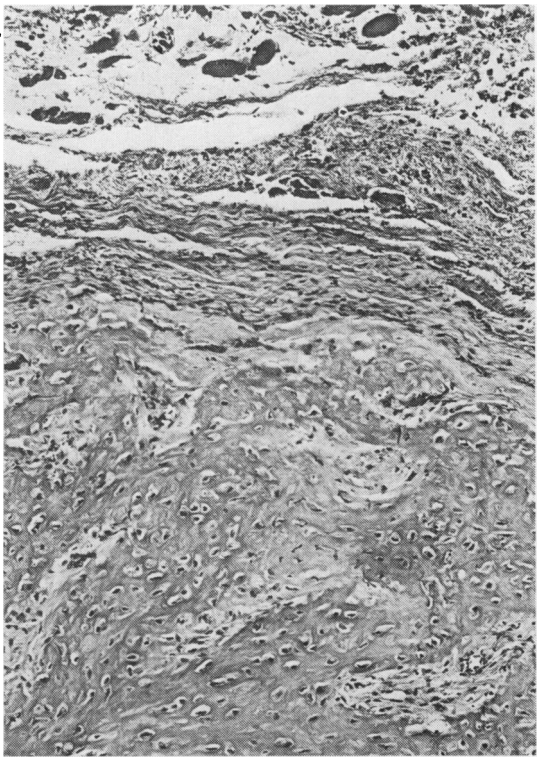

Fig. 35. " Myositis ossificans ", near the right olecranon (cat).

Fig. 36. Malignant synovioma, tarsal joint (dog). Extensive involvement of many bones. Clinical radiograph.

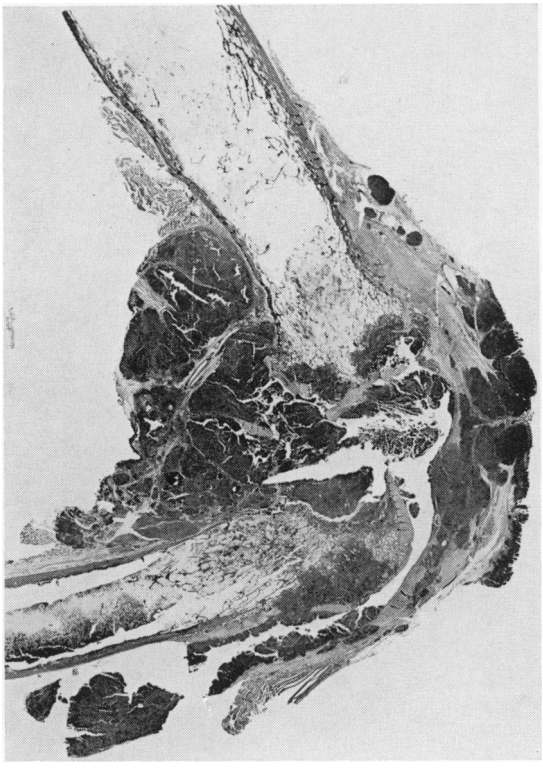

Fig. 37. Malignant synovioma, femorotibial joint (dog).

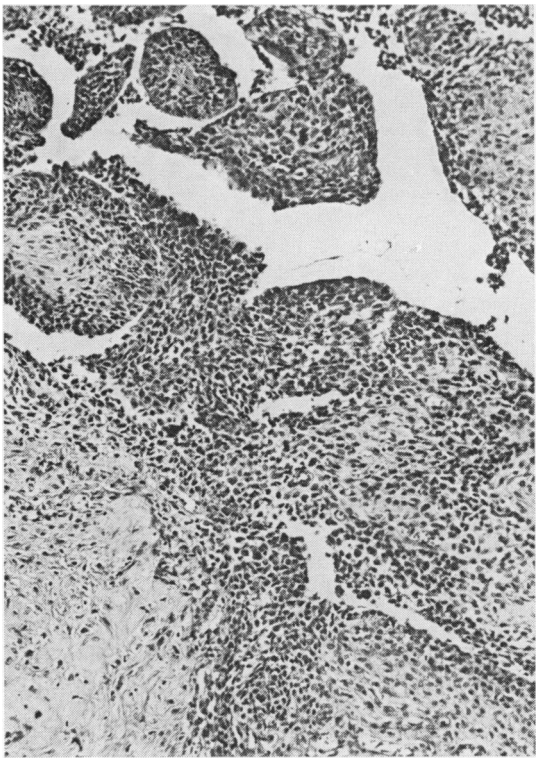

Fig. 38. Malignant synovioma, humero-radial joint (dog).

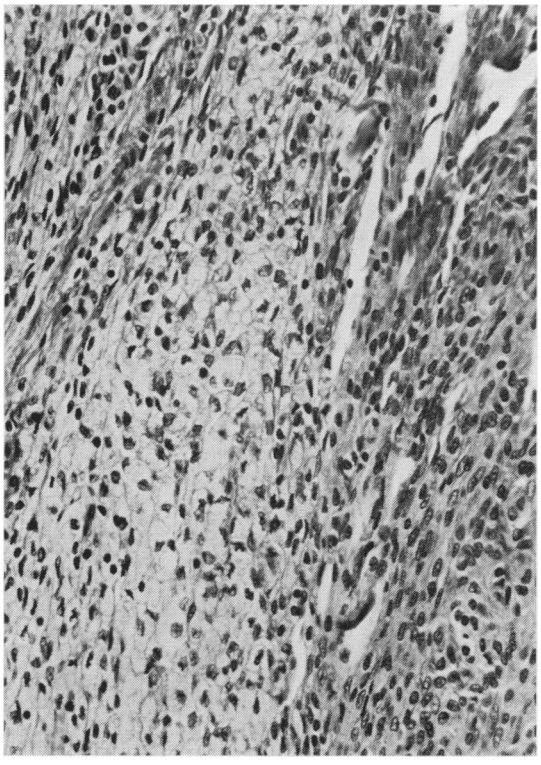

Fig. 39. Benign fibroxanthoma, digit (dog).

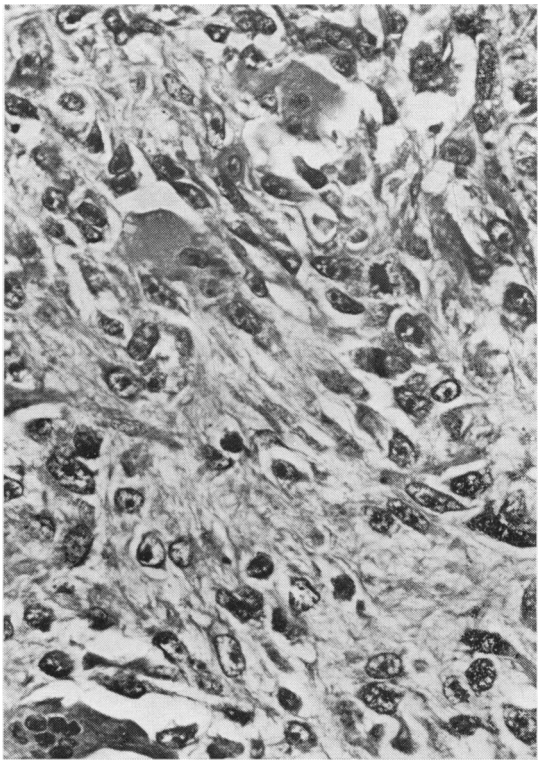

Fig. 40. Malignant giant cell tumour of soft tissues hind leg (cat).

variable thickness consisting of loose connective tissue with scattered osteoclast giant cells. Bands of fibrin-like material, or of hyalinized or calcified connective tissue, are commonly present in the tissue of the wall and occasional bone trabeculae may also be present. These cysts occur, rarely, in the long bones of young dogs. A few cases of multiple cysts have been reported.

B. *Aneurysmal bone cyst*

This is an expanding osteolytic lesion consisting of blood-filled spaces of variable size, and separated by connective tissue septa containing trabeculae of bone or osteoid tissue and osteoclast giant cells. This type of lesion has recently been reported in the vertebral column of the cat.

C. *Juxtacortical bone cyst (subchondral bone cyst)*

This is a benign cystic and often multilocular lesion, made up of fibrous tissue with extensive myxoid change, situated in the subchondral bone adjacent to a joint. These lesions have been reported to occur particularly in the phalanx of young horses.[a] They are not uncommon in man and usually involve the lower end of the tibia or humerus.

D. *Fibrous dysplasia*

This is a benign condition, probably developmental in nature, characterized by the presence of fibrous connective tissue with a characteristic whorled pattern and containing trabeculae of immature non-lamellar bone. In the mandible and maxilla of young horses, solitary lesions resembling fibrous dysplasia in man are not unusual and have been termed fibro-osteoma in the veterinary literature. Fibrous dysplasia is a rare condition in the dog, cat, and pig. In the dog, a familial form of polyostotic fibrous dysplasia with subperiosteal cortical defects has been described.

E. " *Myositis ossificans* "

A non-neoplastic condition, occurring on the external surface of a bone (periostitis ossificans) and extending into the soft tissues, or occurring in soft tissue distant from the periosteum. This lesion is characterized by proliferation of bone-forming fibrous tissue; cartilage may also be present. This lesion appears to be rare in animals, but is known to occur in the cat and the pig.

[a] PETTERSON, H. & SEVELIN, F. *Equine veterinary journal*, 1: 75 (1968).

F. *Brown tumour of hyperparathyroidism*

This is a circumscribed lesion consisting of large numbers of osteoclast giant cells, usually arranged in groups and separated by richly vascularized fibrous tissue with areas of bone formation. Areas of haemorrhage are common. In the surrounding bone there can be evidence of increased osteoclastic resorption and osteoblastic bone formation. This type of lesion is rare in animals.

G. *Epidermoid cyst of the phalanx*

This is an expanding cyst, lined by keratinizing squamous epithelium. It is a very rare lesion in the dog and may resemble bone cysts and other benign lesions.

H. *Others*

The bone lesions of the infectious granulomatous diseases are normally readily distinguished from tumours but certain diseases, especially tuberculosis in the horse and coccidioidomycosis in the dog, may produce lesions that are confusing radiologically or histologically.

Tumours of joints and related structures

I. SYNOVIAL SARCOMA (MALIGNANT SYNOVIOMA)

A malignant neoplasm showing a biphasic cellular pattern composed of clefts or acinar structures, lined by epithelium-like cells with or without formation of mucoid material, and separated by reticulin and collagen-forming, fibrosarcoma-like spindle cell areas of varying cellular density and hyalinization. Calcification is less commonly found in synovial sarcomas of animals than in those of man. Mucin can sometimes be demonstrated in the epithelial cells as well as in the intercellular substances in the spindle cell areas. The proportion in which the two components are represented varies greatly from tumour to tumour. In some tumours the gland-like spaces, and in others the spindle cell areas, are exceedingly rare (" monophasic form ").

Synovial sarcomas occur in dogs of different ages and rarely in the cat and ox. These tumours are usually found in the vicinity of the joints of the extremities. They tend to grow in an aggressive way, often invading joints and adjacent bones. Metastasis is common, especially to the lungs and lymph nodes. Whether true benign synoviomas exist in animals is, as it is in man, doubtful.

II. FIBROXANTHOMA (FIBROUS HISTIOCYTOMA)

The benign variant is a localized or diffuse process, composed chiefly of collagen-producing fibroblasts arranged in a whorled or cartwheel pattern, xanthoma cells, multinucleate giant cells, and deposits of haemosiderin. Calcified, osteoid-like material may be present. The lesions we found in the toe and shoulder regions of dogs showed some resemblance to those known as nodular tenosynovitis in man. In horses, lesions of joints have been recorded, the structure of which resembled that of pigmented villonodular synovitis in man. A few tumours were, because of local destructive growth and in one case also because of distant metastases, considered to be malignant. These tumours were found near and in joints of dogs and cats.

III. MALIGNANT GIANT CELL TUMOUR OF SOFT TISSUE

An ill-defined neoplasm consisting of pleomorphous spindle cells, with collagen fibres and abundant multinucleate giant cells present throughout the tumour. Areas with hyalinization and cartilage-like material can be found. This tumour, which may sometimes be associated with fasciae, occurs sporadically in the cat.