ACTA ORTHOPAEDICA SCANDINAVICA
SUPPLEMENTUM NO. 182

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Primary Malignant Bone Tumours

A retrospective study of 869 cases reported to the Finnish Cancer Registry between 1962 and 1968

BY

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MUNKSGAARD · COPENHAGEN 1980

Vammala 1980, Vammalan Kirjapaino Oy

ISBN 87-16-08628-7
ISSN 0300-8827

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1. INTRODUCTION

Primary malignant bone tumours have been known for thousands of years. Archaeological research shows that the Egyptians were familiar with them already at the time of the building of the pyramids (see Christensen, 1925; Ott et al. 1977). The study and diagnosis of bone tumours has continued right up to our own time. As far as one can tell from the literature on the subject, the first person to describe a primary malignant bone tumour was Dalrymple, who, in 1846, diagnosed myeloma nodules or *mollities ossium* (see Carson et al. 1955). Bence-Jones discovered that the urine of myeloma patients secreted thermolabile albumin. The clinical details of myeloma were described by McIntyre in 1850 (see Lumb et al. 1948). Virchof diagnosed chordoma in 1857 (see Spjut et al. 1964) and in 1922 Beck observed the carcinogenic effect on bone of ionising radiation. In the same year, James Ewing published a study of diffuse endothelioma of the bone, a disease that differed from both osteosarcoma and myeloma and which is now known as Ewing's sarcoma. In 1928 and 1930 respectively, Oberling discovered reticulum-cell sarcoma and Phemister, chondro-sarcoma, diseases that now bear their names. In 1943, Budd and MacDonald diagnosed fibro-sarcoma. Parosteal osteosarcoma was discovered in 1951 (Gesichicter and Copeland) and lipo-sarcoma in 1955 (Dawson). Primary malignant fibrous histio-cytoma of the bone was first mentioned in 1975 (Spanier et al.).

Primary malignant bone tumours have been a constant object of scientific study. As a result of developments in surgery, new techniques like extensive bone transplants and bio-mechanical prostheses have made it possible to treat patients without disabling them to the same extent as heretofore. Developing radiation treatment and in recent years particularly cytostat treatment, as well as immunological treatment which is still at the experimental stage have provided new possibilities for helping patients with bone tumours.

Table 1. Studies dealing with primary malignant bone tumours, 1925—1972.

Christensen (1925)	1,000	cases
Cambell (1934)	250	»
Poppe (1949)	20	»
Prevo (1950)	205	»
Hoppe et al. (1952)	31	»
Coventry et al. (1957)	430	»
Platt (1962)	256	»
Aakhus et al. (1963)	71	»
Hendersson et al. (1963)	288	»
Phillips (1965)	827	»
Copeland (1967)	700	»
Dahlin et al. (1967)	600	»
Falk et al. (1967)	940	»
Dahlin (1972)	2,962	»

In Finland, primary malignant bone tumours have been studied by the follow-

ing investigators among others: F. Langenskiöld (1929), Mustakallio (1937, 1947), Roukkula (1959), Tala and Koikkalainen mio (1969), Koskinen (1967, 1968, 1972, 1973, 1978, 1979) and Paavolainen and Teppo (1976).

2. SURVEY OF LITERATURE

2.1. INCIDENCE

According to the information provided by cancer registries in different countries primary malignant bone tumours are rare. They account for approximately two per cent of all malignant tumours in man. Since the weight of the human skeleton is about 20 % of the whole body (Rauber-Kopsch 1958) it might be expected that there would be a higher frequency of bone tumours. The 10^5 incidence rate per inhabitant varies in different countries from 0.7 to 4.0 (Hoppe et al. 1952, The Swedish Cancer Registry 1960, The Cancer Registry of Norway 1964, Copeland 1967, Robertsson et al. 1967, Boyd et al. 1969, Bristol Bone Tumour Registry 1971, Teppo et al. 1972, Ott et al. 1977). The lack of national registries outside Scandinavia makes it difficult to get precise information.

The occurrence of malignant bone tumours may vary geographically within the same country. Thus in South Africa, bone tumours and connective-tissue tumours are less common in the Johannesburg region than elsewhere (Robertson et al. 1967). Paget's disease and the bone sarcoma that results from it are common in Great Britain, but rare in Norway, Greece, Japan and the United States (Price et al. 1962, Lochkin et al. 1963). Paget's disease is most widespread in Great Britain (Price et al. 1962).

2.2. HISTO-PATHOLOGICAL CLASSIFICATION

The present histo-pathological classification of bone tumours is the outcome of prolonged research. The classification published by the World Health Organization (Schajowicz et al.) in 1972 is based on clinical, radiological and histo-pathological research. Table 2.

Table 2. Histological classification of primary malignant bone tumours (Schajowicz et al. WHO, 1972).

Bone-forming tumours
Osteo-sarcoma
Parosteal osteo-sarcoma
Cartilage-forming tumours
Chondro-sarcoma
Juxta-cortical chondro-sarcoma
Mesenchymal chondro-sarcoma
Giant-cell tumours
Malignant giant-cell tumour
Bone-marrow tumours
Ewing's sarcoma
Reticulum-cell sarcoma
Lympho-sarcoma
Myeloma
Vascular tumours
Angio-sarcoma
Other connective-tissue tumours
Fibro-sarcoma
Lipo-sarcoma
Malignant mesenchymoma
Undifferentiated sarcoma
Other tumours
Chordoma
Adamantinoma of long bones
Neuro-sarcoma

In Finland, it is planned to add the following categories in the clinical classification of tumours: secondary chondrosarcoma, the sub-groups of myeloma — solitary myeloma and multiple myeloma, extra-medullary plasma-cytoma and the sub-groups IgA, IgG and IgM; also haemangio-endothelioma-sarcoma haemangio-pericytoma-sarcoma, radiation sarcoma, primary malignant fibrous histiocytoma, NUD sarcoma, fibrolipo-myxoma malignum, chondro-myxoma malignum and fibro-myxoma malignum (Sorvari, 1976).

2.3. ETIOLOGY

It has been shown that genetic factors are involved in primary malignant tumours occurring in Ollier's disease and in hereditary multiple chondromatosis (Mainzer et al. 1971, Lichtenstein 1972). Among patients suffering from the last-mentioned disease, chondro-sarcoma occurs in 25 % (Solomon 1974) (Marcove 1977).

In osteo-genesis imperfecta, spontaneous fractures are common and it might be supposed that there would be a high frequency of sarcoma, resulting from abundant callus formation. This, however, is not the case and sarcoma of the bone is in fact rare, though individual cases have been reported (Koskinen 1958, Klenerman et al. 1967).

Malignant giant-cell tumours are preceded by benign giant-cell tumours (Sabanas et al. 1956, Copeland et al. 1967).

In Gardner's syndrome, where the patient has carcinoma of the colon and sarcoma of the bone, the malignancy develops in a polyp in the colon, and in the bone by way of a fibrous dysplasia (Johnson et al. 1972).

In Paget's disease the probability that malignancy will develop is 0.7 % — 3.0 % per year (Esposito et al. 1960, MacKenzie et al. 1961, Dahlin et al. 1967, Fölsch 1968, Price et al. 1969).

The development of malignancy in fibrous dysplasia was described by Coley and Stewart in 1945. Their study revealed that those patients in whom malignant fibrous dysplasia developed had undergone radiation treatment for the bone lesion in question. Radiation treatment has also often been given for Paget's disease (Tanner et al. 1961, Dahlin et al. 1967).

Chronic osteitis has been considered an etiological factor in the development of malignant bone tumours. Streptococcus cavitae found in a fistula has been considered an irritant that causes malignancy (Lacassagne et al. 1928). The incidence of malignancy in fistulating osteitis is 0.23 % per year (Poprikov 1968).

It has been shown that radiation, particularly in connection with tubercular inflammation, causes malignant bone tumours (Marie et al. 1910, Cahan et al. 1948). It has been found that patients who have had radiation treatment and people exposed to radiation in industrial work are more liable than others to get malignant bone tumours (Cade 1955, Mindell et al. 1977). In females treated for breast cancer with a dose of 4,000 rad, there is a probability of 0.07 % — 0.22 % that malignant bone tumours will develop (Schwartz 1968, Hatfield 1970).

It has been found in experiments with animals that osteo-sarcoma can just as well be caused by a single dose of radiation as by repeated doses (Sabanas et al. 1956, Steiner 1965, Arlen et al. 1971, Yamanato 1971, Mindell et al. 1977, Ott et al. 1977). The latency time is long and it is typical that during this time the organ

in question is symptom-free. The younger the patient and the larger the dose the greater is the risk of radiation sarcoma (Mindell et al. 1977). Radiation sarcoma is often caused by radiation treatment given for a benign bone lesion (Arlen et al. 1971). Radiation affecting the whole body has seldom been shown to cause bone tumours; the radiation dose necessary to induce sarcoma must be large and in the cases studied the doses were usually fatal (Yamamoto 1971).

It has not been possible to demonstrate to what extent trauma may be an etiological factor in the development of primary malignant bone tumours, although some investigators are of the opinion that trauma may partly explain the greater frequency in males of such tumours (Ewing 1935, Phemister 1948, Cade 1955, Krebs et al. 1963, Hellner 1966, Voutilainen et al. 1967, Fisher 1971). It has been observed that sarcoma in the metaphysis sometimes penetrates all tissues but stops short at the epiphyseal line: a suggested explanation is that the greater amount of growth hormone in the epiphyseal part prevents the development of osteo-sarcoma (Krebs 1962).

2.4. AGE DISTRIBUTION

There are two periods in the course of life when the risk of primary malignant bone tumour is great. Ewing's sarcoma tends to occur especially between the ages of 11 and 13 and osteo-sarcoma between 16 and 18 (Price et al. 1975). Chondro-sarcoma and myeloma occur most frequently between the ages of 55 and 60 (Coley et al. 1938, Prevo 1950, Hoppe et al. 1952, Cade 1955, Compere 1964, Lodwick 1964, Ranke 1968, Dahlin 1972). Children account for approximately 20 % of all patients suffering from primary malignant bone tumours (Dedo 1971, Grover et al. 1972, Welte et al. 1974). Children and young adults are more likely than people of middle age or old people to suffer from primary malignant bone tumours (Coley et al. 1938). Welte (1974) described a series of 109 children suffering from malignant tumours, and of these 13 % had primary bone tumours.

2.5. RACE

Except for Ewing's sarcoma, which occurs more among white people (see Bethge, 1953), race does not appear to be a factor in the incidence of bone tumours.

2.6. SEX

Primary malignant bone tumours are on the whole found more frequently in males than in females (Christensen 1925, Phemister 1948, Glenchur et al. 1959, Price 1962, Foster et al. 1964, Phillips 1965, Dahlin et al. 1967).

2.7. LOCATION

Location is presented in Table 3.

Bone sarcomas are most often located in the metaphysis of long bones. Chondrosarcoma is often also found in the pelvis and ribs. Malignant giant-cell tumours are most frequently situated in the region of the knee, in the humerus and in the distal metaphysis and epiphysis of the radius, tibia and fibula (Dahlin 1972). Parosteal osteo-sarcoma and parosteal chondro-sarcoma are located juxta-cortically. Individ-

Table 3. Location of primary malignant bone tumours (Coley et al. 1950, Wang et al. 1953, Bethge 1953, Sherman et al. 1956, Coventry et al. 1957, Henderson et al. 1963, Dahlin 1972, Spanier et al. 1975).

	Long bones	Pelvis Rib	Skull	Spine
Bone-forming tumours				
Osteo-sarcoma	++++	++	++	++
Parosteal osteo-sarcoma	++++	+	+	+
Cartilage-forming tumours				
Primary chondro-sarcoma	++++	++++	+	++
Secondary chondro-sarcoma	++++	++++	+	+
Parosteal chondro-sarcoma	++++	++++	+	+
Mesenchymal chondro-sarcoma	++++	++++	+	+
Giant-cell tumours				
Malignant giant-cell tumour	++++	+	+	+
Bone-marrow tumours				
Ewing's sarcoma	++++	++	++	+
Reticulum cell sarcoma	+++	++	++	+++
Lympho-sarcoma	+++	+	+	++
Myeloma	++++	++++	++++	++++
Vascular tumours				
Angio-sarcoma	++++	++	+	+
Haemangio-endotelioma-sarcoma	++++	++	+	+
Haemangio-pericytoma-sarcoma	++++	++	+	+
Other connective-tissue tumours				
Fibro-sarcoma	++++	+++	+	+
Lipo-sarcoma	++++	++	+	+
Malignant mesenchymoma	++++	++	+	+
Primary malignant fibrous histio-cytoma	++++	+	+	+
Undifferentiated sarcoma	++++	++	++	++
Radiation sarcoma	++++	+++	++	++
Other tumours				
Chordoma	—	—	—	++++
Adamantinoma of long bones	++++	—	—	—
Neuro-sarcoma	++++	+	+	+

ual cases of osteo-sarcoma in the soft tissues have been reported (Fine et al. 1956, Dahlin 1972).

Myelomas are typical in the diaphysis of the long bones, in the spine, the skull, the pelvis and the ribs (Dahlin 1972). 75 % of extra-medullary plasma-cytomas are situated in the region of the upper respiratory passages (Wiltshaw 1976), most frequently in the hypo-pharynx, the nose, the clavicular recess or neck glands and occasionally in the orbit, thyroid gland or abdominal cavity (Rodman et al. 1968, Oberkircher et al. 1972, Sasse et al. 1973).

Chordomas are always located in the region of the spine, generally in the fora-

men magnum or in the sacrum (Dahlin 1972). Adamantinomas of long bones are always found in the diaphysis.

90 % of all primary malignant bone tumours in the thorax are situated in the ribs (Teilbaum 1972).

2.8. SYMPTOMS AND DIAGNOSIS

2.8.1. Pain

Local pain is often the first symptom of a primary malignant bone tumour (Coley et al. 1938, Aakhus et al. 1963, Dahlin 1972). Severe pain, felt especially in a joint, means that the tumour is continuously growing (Dahlin 1972). The tumour is situated where the pain is felt, except when the tumour causes radicular pains (Copeland 1967). Different tumours cause different kinds of pain. It is typical of malignant giant-cell tumours that they cause slight, intermittent pain (Murphy et al. 1956). If a benign giant-cell tumour begins to cause pain, this is always a pathognomonic symptom (Dahlin 1972). 80 % of myeloma patients have pains in the bone (Glenchur et al. 1959). These pains are often radicular and accompanied by paresthesias.

2.8.2. Resistance to palpation

Resistance to palpation, combined with a flushing and reddening of the skin are typical features of an advanced tumour (Dahlin 1972). If the tumour is not attached to the cortex of the bone, tenderness is the only observable feature (Dahlin 1972). It is typical of parosteal tumours that they are palpable, are attached to the surrounding tissue and feel diffuse (Dwinnel et al. 1954). It has been ascertained that in 80 % of patients suffering from malignant giant-cell tumours, there is a hard, crepitating resistance to palpation (Williams et al. 1964). In myeloma patients it has been found that 20 % showed resistance to palpation in the ribs, clavicle or skull (Glenchur et al. 1959).

It is usually possible to confirm chordoma of the sacrum and also tumours of the pelvis by palpation per rectum. An extra-medullary plasma-cytoma can be felt in situ (Dahlin 1972).

2.8.3. Decreased activity

Limitation of movement and a tendency to become easily fatigued are signs of a rapidly advancing tumour (Dahlin 1972). In chordoma of the sacrum, common symptoms, connected with the paresis caused by compression of the sacral roots of the spinal cord, are constipation, sciatic pain and numbness of the buttocks (Dahlin 1972).

2.8.4. Pathological fracture

50 % of myeloma patients have a pathological fracture at some stage of the disease (Carson et al. 1955, Glenchur et al. 1959) and 10 % have paraplegia, resulting from the pathological fracture of a vertebra, when they first present themselves for treatment (Lumb et al. 1948, Ulrich et al. 1958). Pathological fracture has been certified in 5 % of sarcoma patients (Banshali et al. 1963) and in 6 % of chondrosarcoma patients (Copeland 1967) when they first presented themselves for treatment.

2.8.5. Decline in general health

A typical symptom of a far advanced malignant bone tumour is a decline in

general health. 50 % of myeloma patients have symptoms of this kind when they come for treatment (Glenchur et al. 1959).

2.8.6. Trauma

In earlier literature a trauma reported by the patient has been considered an etiological factor contributing to the development of a primary malignant bone tumour (Krebs et al. 1963). It has not, however, been possible to define either the mechanism of injury or the severity of the trauma with sufficient exactitude to decide whether or not it was really an etiological factor. 75 % of bone sarcoma patients report trauma and symptoms resulting from it (Derian et al. 1968). Present-day investigators consider trauma to be an unlikely etiological factor (Hellner 1966, Copeland 1967, van der Heul et al. 1967, Fisher 1971). An attempt has been made by means of tissue cultures to determine the part played by trauma, but this was not successful (Krebs et al. 1963). Trauma may cause secondary spreading of the disease by releasing malignant cells into the blood stream and lymphatic ducts, and also haematoma by means of resorption. Tissue pressure increases the development of metastases and extravasion (Krebs et al. 1963). A developing tumour may cause symptoms similar to those in trauma. (Phemister 1948).

2.8.7. Lack of symptoms

About one per cent of patients suffering from primary malignant bone tumours are symptom-free at the moment of diagnosis. Extramedullary plasma-cytoma is sometimes discovered by chance when the nose and throat are being examined (Dahlin 1972).

2.8.8. Duration of symptoms

The symptoms of primary malignant bone tumours usually last about 1—3 months before they are diagnosed. Exceptions are chondro-sarcoma, for which symptoms may last 11—12 months before diagnosis and parosteal osteo-sarcoma, the symptoms of which may go on for years (O'Neal et al. 1952).

2.9. X-RAY EXAMINATIONS

2.9.1. Plain radiography

Radiological diagnosis of primary malignant bone tumours is difficult (Gold 1975). The most important method of examination is plain radiography, by means of which 90 % of bone tumours can be revealed (Lodwick 1964, Ranke 1968).

In diagnosing bone tumours by X-ray the following factors are taken into account: the radiological location of the tumour, its structure and its relationship to the surrounding tissue (Ranke 1968, Dedo 1971).

With the help of a computer it is usually possible by analysing the X-rays to make a histo-pathological diagnosis of the bone tumour before starting treatment (Lodwick 1964, Lodwick et al. 1965, 1970, Virtama et al. 1979). It is possible in this way to provide the patient with the best possible treatment.

2.9.2. Angiography

Angiography is an important X-ray technique for diagnosing bone tumours; it gives a good idea of the size and location of the tumour, its relationship to the surrounding tissue, its haemodynamics and its rapidity of growth (Kittredge et al.

1970, Honcomp et al. 1973, Gold 1975, Jacobs 1976). Angiography is no substitute for biopsy in making a histo-pathological diagnosis (Gold 1975) but is often a great help in deciding where to take the biopsy sample from (Jacobs 1976). The significance of angiography does not lie in its diagnostic value, but rather in the planning of treatment (Virtama 1979). About 25 % of angiographies have diagnostic value (Voegeli et al. 1976). Angiography provides valuable additional information about the degree of malignancy of the tumour, the development of secondary malignancy, the probability of recurrence, possibility of treatment and checking the progress of the disease (Koskinen et al. 1968, Yagmai et al. 1971, Honkomp et al. 1973).

2.9.3. Lymphography

Lymphography is a method that has not been much used for determining the degree of spreading of primary malignant bone tumours. In a dissertation published in 1976, Tallroth found that the spreading of a tumour into the lymphatic ducts could be determined by means of lymphography in 100 % of reticulum-cell sarcomas, in 57 % of osteo-sarcomas and in 50 % of Ewing's sarcomas. In cases where the tumour has spread into the lymphatic ducts, it is especially important to think carefully before embarking on any far-reaching treatment of the primary tumour (Herzog 1972, Rao et al. 1977). Bone tumour metastases in the lymphatic ducts are more common than was earlier thought (Macintosh et al. 1975).

2.9.4. Other examinations

The advantage of scintigraphy over many other radiological methods for studying bone tumours is that it is less exhausting for the patient. It is also cheap. Nowadays pyrophosphates, polyphosphates and diphosphonates labelled Tecnetium 99 m are much used in bone scintigraphy. The scan is compatible with X-ray findings in 75 % of cases (Holsti et al. 1967, Tong et al. 1968, Nordman et al. 1977). Scintigraphy does sometimes give incorrect positive findings, but generally the strong tracer uptake correlates with the high degree of bone destruction (Aho et al. 1973). The following are some of the advantages of scintigraphy (McCormack 1975, Nordman et al. 1977):

- it is indicated in all examinations for the degree of spreading of bone tumours
- identification of primary focus is earlier than with other X-ray examinations
- it makes possible determination of polyostotic changes
- it makes possible determination of early and late as well as skip metastases in the medulla
- it provides the possibility of following the effects of treatment
- it provides the possibility of using radiopharmaceutical drugs, especially for myeloma
- it determines what other X-ray examinations are necessary

In cases where the tumour is known to be polyostotic, scintigraphy of the whole body is indicated. For example, 30 % of chordomas and Ewing's sarcomas are polyostotic (McCormack 1975).

Tomography is significant for the differential diagnosis of inflammation and can reveal possible sequesters. Computer tomography gives a good idea of the spread of the tumour into the bone mar-

row and the metastases therein (de Santos et al. 1978, Virtama 1979).

Some investigators have made use of thermography for studying primary bone tumours, but its precise significance is not yet clear (Farrell et al. 1971).

2.10. LABORATORY STUDIES

2.10.1. General

Laboratory studies are important in the diagnosis of primary malignant bone tumours and also for determining the degree of spreading of the tumour. In sarcoma patients with a far advanced tumour there is usually an elevated erythrocyte sedimentation rate, reduced Hb and pathological alkaline phosphatase. It is possible by studying the large enzymes to distinguish between alkaline phosphatase originating in the bones and that which stems from the liver. The elevated level of alkaline phosphatase originating in the bones which occurs in sarcomas arising from Paget's disease returns to normal when the tumour is removed (McKenna et al. 1964). It is also possible by means of laboratory tests to follow the results of treatment (O'Hara et al. 1968, Fölsch 1968, Derian et al. 1972).

2.10.2. Laboratory diagnosis of myeloma

The earliest laboratory findings concerning myeloma were made in the last century. Bence-Jones discovered in 1845 that myeloma patients had albumin in their urine and he later isolated what is known as Bence-Jones proteinuria. If electrophoresis and a precipitation reaction are used it is possible to confirm Bence-Jones proteinuria in 85 % of myeloma patients (Carson et al. 1955, Martinez-Maldonado et al. 1971). At the moment of diagnosis 60 % of myeloma patients have an erythrocyte sedimentation rate of more than 50 mm/t and Hb less than 120 g/l (Carson et al. 1955, Leawell et al. 1966). Leukopenia occurs in 60 % and leukocytosis in 20 % of myeloma patients (Lumb 1948). More than half of these patients suffer from pathological lympho-cytosis. One third of myeloma patients have a pathological number of plasma cells in the peripheral blood (Glenchur et al. 1959, Drivsholm 1965).

In 80 % of myeloma patients plasma albumin is as high as 80 g/l and more (Lumb et al. 1948, Drivsholm 1965). 20 % —40 % of myeloma patients have hypercalcemia (Carson et al. 1955). Alkaline phosphatase is elevated in 30 % of myeloma patients (Esposito et al. 1960) whereas in Paget's disease it is elevated in over 95 % of patients (Leawell et al. 1966, Drivsholm 1965).

Electrophoresis and immuno-electrophoresis are important methods for studying serum immunoglobulins. By electrophoretic means it is possible to make pathological and diagnostic findings in the serum of 90 % of myeloma patients (Drivsholm 1965, Leawell et al. 1966). Immunoglobulins are usually of the IgG type. IgA cases are less than half as numerous as IgG. The IgM type accounts for less than one per cent of cases (Leawell et al. 1966). Only three cases of the IgE type have been reported in literature (Wasastjärna 1974). Biclonal myeloma, containing two M-components, is rare (Wasastjärna 1974).

Bence-Jones proteinuria is found in the urine of 18 % of myeloma patients with normal electrophoresis. In studying the electrophoresis of serum and urine, a diagnostic result is achieved in 93 % of cases

(Leawell et al. 1966). A similar finding has been made by Azar (1972) among others.

Ten per cent of myeloma patients suffer from amyloidosis when they come for treatment (Carson et al. 1955). The cause of amyloidosis is the sensitivity of tissue to paraproteins (Carson et al. 1955, Martinez-Maldonado et al. 1971). In myeloma patients it is amyloidosis that is the principal cause of renal insufficiency. Renal function is impaired in 40 % of myeloma patients (Drivsholm 1965).

Bone marrow tests give positive diagnostic results in 80 % of myeloma cases (Drivsholm 1965, Leawell et al. 1966).

2.11. HISTO-PATHOLOGICAL EXAMINATIONS

Because of the quality of the tissue to be studied, histo-pathological examination of bones may be difficult. Moreover, bone tumours are rare and the result is that very few pathologists are experts in the histo-pathology of bones. It is nevertheless necessary to have histo-pathological confirmation before bone tumours can be treated clinically. If a benign bone lesion is diagnosed as a malignant tumour the treatment given may involve irreversible loss and on the other hand, to diagnose a malignant tumour as benign will be fatal for the patient (Copeland 1967).

In order to be reliable, pre-operative biopsy must be performed as open biopsy (Hajdu et al. 1971). Some investigators think there is a risk that open biopsy may cause metastases to develop.

Some people favour the use of needle biopsy (Schajowicz et al. 1968, Hajdu et al. 1971, 1975). For giant-cell tumours it is an untrustworthy method (Williams et al. 1964). Biopsy means a less favourable prognosis (Lindbom et al. 1961) and needle biopsy does not generally lead to a clear diagnosis (Aakhus et al. 1963). Study of frozen sections is difficult for the pathologist. Some investigators consider that the accuracy of such a study is not greater than 30 %—75 % (Derian et al. 1968). Copeland (1967) expressed the following thought about the study of frozen sections and this we may consider realistic: »... it is valuable for an experienced pathologist, but measures like amputation should never be undertaken without first doing a paraffin examination.»

2.12. DIAGNOSIS

2.12.1. General

The possibility of primary malignant bone tumour is not always taken into account and this is one reason why diagnosis is sometimes difficult (Dissing et al. 1977, Salenius 1978). The patient is treated on the basis of an incorrect diagnosis, for example dislocation of a joint, bruising, anaemia, kidney disease, or fever (Dissing et al. 1977). Diagnosis of bone tumours must be based on the results of clinical tests — radiography, laboratory and histo-pathological study — and a synthesis of the findings (Cade 1955, Compere 1964, Hellner 1966, Copeland 1967, Koskinen 1976, Sissons 1977, Compere 1978).

2.12.2. Differential diagnosis

In osteogenesis imperfecta, hyperplastic callus simulates osteo-sarcoma (Baker 1967). In connection with trauma, myositis ossificans resembles a bone tumour and is sometimes difficult to distinguish from osteo-sarcoma. Furthermore, if there is a

slight trauma, the bruises may make diagnosis more difficult (Banshali et al. 1963). Stress fracture and low-grade osteo-myelitis in which there is slight periostitis resembles inflammatory osteo-sarcoma (Hellner 1966, Orava et al. 1978). In differential diagnosis, the progress of the disease and the failure of anti-biotics to take effect are important factors (Hellner 1966). Bouts of slight fever, elevated erythrocyte sedimentation rate, leucocytosis and serological findings are not conclusive (Hladik et al. 1967). Even in biopsy, it is difficult to distinguish between Ewing's sarcoma and osteo-myelitis (Banshali et al. 1963, Hellner 1966). Benign bone lesions are frequently misdiagnosed as malignant, especially in children. A misdiagnosis, either in children or adults, may have tragic consequences (Copeland 1964).

2.13 TREATMENT

2.13.1. General

There are many different ideas about how to treat primary malignant bone tumours (Ranke 1962). Because treatment of bone tumours often severely disables the patient or leads to death, the great problem is how to plan the treatment (Compere 1964). It is the histological diagnosis of bone tumours that finally decides the treatment to be given (Reichmann 1976, Aho 1979). Recent improvements have made it possible to make a correct histological diagnosis pre-operatively and this has made it easier to choose the correct treatment.

2.13.2. Radical ablative surgery

Until recently the treatment for primary malignant bone tumour has been radical ablative surgery (Copeland 1967, Dahlin 1972). The general belief has been that other forms of treatment are ineffective (Coventry et al. 1957, Nilsonne 1965, Copeland 1967, Wagner et al. 1967). According to Compere (1964)) only 10 % of patients treated with ablative surgery have been cured. The traumatic effect of ablative surgery can only be minimized by maximizing medical, surgical, pathological and psychological knowledge (Enelow 1975). In individual cases a permanent cure has been effected by super-radical ablative surgery — hemipelvectomy and hemicorporectomy (Higinsbotham et al. 1956, Pack 1956, Koskinen 1967, Franklin et al. 1977, Miller 1977, Sneppen et al. 1978), but there is no difference in the five-year survival rates (Foster et al. 1964). Although radical ablative surgery is by no means always curative it has been reported that it definitely slows down the development of metastases and thus prolongs the patient's life (Nilsonne 1965). If the tumour recurs in the stump of an amputated limb, this means that the surgery was not radical (Dahlin et al. 1967).

2.13.3. Radical resection

In the treatment of malignant bone tumours the method of radical resection has developed considerably in recent years. The resected bone is replaced by an autogenic bone, an allograft or a prosthesis. A vascular bone transplant is possible in special cases (Weiland et al. 1978). A precondition for the success of radical resection is that the tumour can be removed in its entirety. The method is best suited for parosteal osteo-sarcoma of the long bones, chondro-sarcoma, giant-cell tumours and, in special cases, fibro-sarcoma (Volkov 1970, Parrish 1972, Ottolenghi 1973, Wil-

son 1975, Burrows et al. 1975, Meyers 1977, Smith et al. 1977, Koskinen 1978, Koskinen et al. 1979).

2.13.4. Local resection

In local resection, the distance between the tumour and the resection line is less than five centimetres. The smaller the distance, the greater is the possibility that tumour cells will remain behind. Local resection has proved to be a successful method especially in treating chondrosarcoma in small bones and also giant-cell tumours. Local resection has also been used rather often in the past in the treatment of sarcoma of long bones. Early results for patients treated in this way were often good, but recurrence of the tumour or metastases developed rapidly. In the series reported by Lindbom (1961) recurrence of tumour or development of metastases was very rapid.

2.13.5. Local evacuation

Neither local evacuation, abrasion, nor electro-coagulation are acceptable methods of treatment for any kind of malignant bone tumour. When giant-cell tumours have been treated in this way it has led to the »paradoxical response» described by Herenden (see Murphy et al. 1956) in which the malignancy of the tumour is increased.

2.13.6. Palliative surgery

Palliative surgery, in which some tumour tissue is knowingly left in place, is sometimes necessary in treating a bone tumour patient in order to dispel severe pain or relieve the necrotization of the tumour (Cade 1955).

Palliative surgical treatment of metastases has in individual cases led to good results, even with a ten-year follow-up and longer (Francis et al. 1962, Dahlin et al. 1967, Tala et al. 1967, Sellors 1970, Scanlon 1972, Holmes et al. 1977). In the treatment of all malignancies it has been found that the patient's own resistance is longer if the greater part of the tumour is removed or destroyed (Reichmann 1976).

2.13.7. Radiation treatment

Primary malignant bone tumours can be classified as sensitive to radiation, moderately sensitive to radiation and resistant to radiation (Table 4). Radiation treatment has a clear effect on tumours that are sensitive to it and the significance of radiation treatment has increased in recent years (Cade 1955, Aakhus et al. 1963, Heilmann 1971, Holsti et al. 1977).

Radiation treatment is of very little use in the treatment of bone and cartilage-forming tumours, neither is it of much value for malignant giant-cell tumours. Bone marrow tumours react well to radiation treatment. Radiation treatment is an important part of therapy for Ewing's sarcoma and is the main form of treatment for reticulum-cell sarcoma and lympho-sarcoma. Reticulum-cell sarcoma and lympho-sarcoma are curable by radiation and mutilating ablative surgery is contra-indicated in the treatment of these tumours (von Ronnen et al. 1974, Nordman 1979).

Vascular tumours, connective-tissue tumours and other malignant bone tumours are generally somewhat sensitive to radiation (Table 4).

In recent years the significance of preoperative radiation treatment has declined considerably owing to the increase in bone

Table 4. Sensitivity to radiation of primary malignant bone tumours (Sherman 1956, Cade 1955, Millburn et al. 1968, van der Heul et al. 1967, Wang 1968, Phillips et al. 1969, Dahlin 1964, 1972).

	Sensitive to radiation	Moderately sensitive to radiation	Radiation resistant
Bone-forming tumours			
Osteo-sarcoma			+
Parosteal osteo-sarcoma			+
Cartilage-forming tumours			
Primary chondro-sarcoma			+
Secondary chondro-sarcoma			+
Parosteal chondro-sarcoma			+
Mesenchymal chondro-sarcoma			+
Giant-cell tumours			
Malignant giant-cell tumour			+
Bone-marrow tumours			
Ewing's sarcoma	+		
Reticulum-cell sarcoma	+		
Lympho-sarcoma	+		
Myeloma	+		
Vascular tumours			
Angio-sarcoma		+	
Haemangio-endothelioma-sarcoma		+	
Haemangio-pericytoma-sarcoma		+	
Other connective-tissue tumours			
Fibro-sarcoma			+
Lipo-sarcoma		+	
Malignant mesencymoma		+	
Primary malignant fibrous histio-cytoma			+
Undifferentiated sarcoma		+	
Radiation sarcoma			+
Other tumours			
Chordoma		+	
Adamantinoma of long bones			+
Neuro-sarcoma		+	

resections. Radiation treatment de-vitalizes the surrounding tissue and reduces the likelihood of success of bone transplant (Koskinen et al. 1968, McCormack 1978). The schema for treatment proposed by Ferguson (1940), in which preoperative necrotizing radiation and late amputation are used, still has its supporters (Cederlöf et al. 1961, Aakhus et al. 1963, Lissner 1969, Heilman 1971). There is still today uncertainty about the value of preoperative radiation treatment. Preoperative radiation in osteo-sarcoma is without value (von Ronnen et al. 1974, Nordman 1979).

The relationship between the curative possibilities of radiation treatment and the size of the tumour is clear. If the area of the malignancy is small, it responds better to radiation and it is thus important to remove the tumour as far as possible by means of palliative surgery, before giving radiation treatment. Sub-clinical micro-metastases can be destroyed with a dose of 5,000—6,000 rad, but a primary tumour cannot be cured with such a dose. Radiation treatment is thus indicated for metastases in the lungs or regional lymph nodes. Two successive doses of 200 rad. are indicated for preoperative radiation before biopsy (von Ronnen et al. 1974).

Palliative radiation treatment is important for slowing down temporarily the growth of a tumour in cases where surgical measures are impossible on account of the anatomical location or because of vital function. Such tumours are often situated in the base of the skull, the spine or the pelvis (Beck et al. 1976).

Solitary myeloma and extra-medullary plasma-cytoma can be cured by radiation.

The clinically effective radiation dose for osteo-sarcoma is between 4,000 and 9,000 rad. given 1,000 rad per week (Woodard et al. 1947).

According to present ideas radiation treatment alone, without up-to-date cytostat treatment is not indicated (Beck et al. 1976).

2.13.8. Treatment with cytostatic agents

Treatment with cytostatic agents has developed considerably in recent years. Earlier it was mostly used palliatively and as an adjunct to radiation treatment. Nowadays cytostat treatment is used actively and as an integral part of overall treatment (Sack 1976). There have been big changes in the doses of drugs given. The intra-arterial administration of cytostatic agents is at the experimental stage (Oka 1970). Different drug combinations and mammoth doses have given encouraging results (Lochshin et al. 1963, Price et al. 1975, Rosen 1975, Akahoshi et al. 1977, Copeland 1977, Huvos et al. 1977, Jaffe 1977, Kotz et al. 1977, Gröhn et al. 1978, Nikkanen 1978). Cytostat treatment carries with it the risk of a carcinogenic effect. Renner (1971) found that a primary benign tumour became malignant owing to the effect of cytostat treatment. The sensiti-

Table 5. Sensitivity of primary malignant bone tumours to cytostatic agents (Sach 1976).

Degree of sensitivity	Effect %	Tumour
I	= 10	Chondro-sarcoma
II	= 30	Ewing's sarcoma
III	= 40	Osteo-sarcoma, lipo-sarcoma, malignant giant-cell tumour, neuro-sarcoma.
IV	= 50	Bone-marrow tumours, fibro-sarcoma, angio-sarcomas. Undifferetiated sarcomas.

vity of primary malignant bone tumours to cytostat treatment is different from their sensitivity to radiation.

Cytostatic agents have long been the basic treatment for myeloma. With cytostats it has often been found that metastases either disappear or become smaller (Sack 1976). There is no information available as yet about the effect on prognosis in a long-term follow-up. Before the introduction of massive cytostat treatment, 80 % of osteo-sarcoma and Ewing's sarcoma patients died within two years after the making of the diagnosis. With the present treatment 80 % are still alive after two years (Ivins et al. 1976, Jenkin et al. 1976, Dissing et al. 1977, Jaffe 1977).

In treating recurrence of tumour and metastases the most important method is combined surgical and cytostat treatment (Oldhoff 1970).

2.13.9. Immunological treatment

The immunological treatment of primary malignant bone tumours is at the experimental stage. Encouraging results have been achieved in individual cases (Koskinen 1976, Tallberg 1976, Salenius 1977). In connection with immunological resistance, the spontaneous disappearance of tumours has been observed (Copeland 1975).

2.13.10. Interferon

For the treatment of osteo-sarcoma and multiple myeloma, interferon is at the experimental stage and preliminary results are encouraging (Cantell 1978, Idenström et al., Mellstedt et al. 1979).

2.13.11. Treatment of pathological fractures

Pathological fractures are common among bone tumour patients. Surgical treatment of fractures is very important for relieving pain. One useful method is intra-medullary nailing of long bones, combined with radiation treatment (Marcove et al. 1967, Phelan 1968, Cech 1970, Koskinen et al. 1973). Prophylactic osteosynthesis is necessary, for example, if there is a large myeloma nodule in the diaphysis of the femur. There is no evidence that nailing leads to the spread of a tumour (Phelan 1968, Harrington 1977).

Marcove's report (1967) on patients who underwent surgery after pathological fracture showed that 40 % lived for over six months postoperatively and 34 % for over a year. If the patients had multiple fractures, 39 % lived 1—6 months and 26 % more than one year. Complications after surgery were common.

2.13.12. General treatment

Care of patients suffering from primary malignant bone tumours is very important in order to improve their general condition and their immunity. Many patients are seriously disabled by the disease and its treatment, their resistance and mental stability being shaken. The patient must be treated as a totality.

2.14. PROGNOSIS

2.14.1. General

The prognosis for primary malignant bone tumours is considered to be serious (Platt 1962), though it is very different for

Table 6. Five-year and ten-year survival rates for osteo-sarcoma in different reports.

Investigator(s)	Patients No.	5-year No.	survival %	10-year No.	survival %
MacDonald et al. (1943)	118	14	11.8		
Poppe (1949)	20	2	10.0	1	5.0
Cade (1955)	133	16	12.0		
Coventry et al. (1957)	430	83	19.3	45	15.3
Cederlöf et al. (1961)	27	3	11.1		
Lindbom et al. (1961)	96	18	18.8		
Platt (1962)	121	30	24.8	15	12.4
Aakhus et al. (1963)	71	6	8.5		
Price (1966)	130	20	15.4		
Copeland et al. (1967)	121	19	15.7		
Dahlin (1972)	408	83	20.3	10	2.5
Price et al. (1975)	125				
	1 800	294	16.3	71	7.3

different types of tumour. As far as prognosis is concerned no difference between the sexes has been discovered (Dahlin et al. 1969). Prognosis has improved as treatment has developed (Lochshin et al. 1963, Dahlin et al. 1969).

2.14.2. Bone-forming tumours

2.14.2.1. Osteo-sarcoma

The 5-year survival rate for osteo-sarcoma varies between 10 % and 30 % in different studies. The results of surgery are better than those of radiation.

There is no certain evidence that pre-operative radiation treatment improves the prognosis for sarcoma (Beck et al. 1976).

The location of the tumour is important for prognosis (Holsti et al. 1973). The prognosis for tumours in the elbow and knee joints is better if they are located distally than if they are proximally situated (Coventry et al. 1957, Dahlin et al. 1967). There is a good prognosis for tumours of the

Table 7. Five-year survival rate for osteo-sarcoma when treated surgically, with radiation only and with pre-operative radiation, according to Lochshin et al. 1963.

Investigator(s)	Surgical treatment		Radiation only		Pre-operative rad.	
	No. of patients	5-y.s. %	No. of patients	5-y.s. %	No. of patients	5-y.s. %
Farrel	17	5.9	9	0	16	43.8
Francis	25	12.0			33	26.2
Hayles	101	20.8	15	6.7		
McKenna	101	21.8	22	0.0	93	12.9
Phelan	35	17.1	12	8.3	5	0.0
	279	19.0	58	3.4	147	17.0

Table 8. Effect of location of osteo-sarcoma on 5-year and 10-year survival rates.

Location and investigator(s)	No. of patients	5-y.s. %	No. of patients	10-y.s. %
Antebrachium (Dahlin et al. 1967)		35.5		
Tibia (Dahlin 1972)		36.6		
Tibia (Coventry et al. 1957)		34.6		
Femur (Dahlin 1972)		17.6		
Humerus and femur (distal) (Dahlin 1972)	71	25.4		
Knee & elbow joints (distal)	38	35.8		
Scapula-clavicula		13.0		
Mandibula (Kragh et al. 1958)	19	17.6		
Mandibula (Garrington et al. 1967)	22	41.0	13	38.0

lower jaw (Kragh et al. 1958, Garrington et al. 1967, Finkelstein 1967).

The prognosis for osteogenic sarcoma in soft tissue is the same as for tumours originating in bone (Fine et al. 1956).

The prognosis for osteo-sarcoma is better for females than for males (Lindbom et al. 1961, Platt 1962). This may be because of the location of tumours. Tumours in females are more often situated in the limbs (Foster et al. 1964).

It is generally thought that the age at which tumours develop has no effect on prognosis (Dahlin 1967). In many studies, however, the prognosis has been better for patients between 20 and 40 years old (Coley et al. 1940, Cederlöf et al. 1961, Price 1966). The prognosis for osteo-sarcoma is better when symptoms are of long duration than when there is a tumour that has produced symptoms only for a short time (Cederlöf et al. 1961).

Prognosis is poor for osteo-sarcoma that results from Paget's disease (Lockshin et al. 1963, Ross 1964, McKenna et al. 1964, Price et al. 1969). For osteo-sarcomas that developed from Paget's disease Platt (1962) reported a 5-year survival rate of 2 % and Price (1969) a 5-year survival rate of 5 %. On the other hand, the prognosis for tumours of the lower jaw is rather good (Finkelstein 1967).

The prognosis for osteo-sarcoma is better if the tumour can be removed radically by surgical means as soon as the diagnosis is certain. In osteo-sarcoma conservative ablative treatment is often sufficient (Sneppen et al. 1978). Osteo-sarcoma also produces metastases very rapidly in the lungs, liver and bones; it also recurs locally. Ten per cent of osteo-sarcoma patients have metastases in the regional lymph nodes when they come for treatment (Caceres et al. 1969). If the patient has metastases in the regional lymph nodes the prognosis is worse than otherwise (Baumann 1970, Rao et al. 1977). In cases of osteo-sarcoma it has been found that radiation treatment either makes them disappear, or at least reduces them in size (Francis et al. 1962). Removal of the regional lymph nodes worsens the prognosis in cases of osteo-sarcoma (Rao et al. 1977). In osteo-sarcoma patients who survived for more than ten years there was no clear explanation as to why these had survived and not the others (O'Hara et al. 1968).

2.14.2.2. Parosteal osteo-sarcoma

It is typical of parosteal osteo-sarcoma that the prognosis is better than for osteo-sarcoma in general and also that late metastases may develop as long as sixteen years after primary treatment (Shaglietti et al. 1962, van der Heul et al. 1967, Wolfel et al. 1969). After local excision the tumour always recurs (Dwinnel et al. 1954, Stevens et al. 1957).

The recommended treatment for parosteal osteo-sarcoma is resection combined with bone transplant, or amputation (Shaglietti et al. 1962, van der Heul et al. 1967). A small tumour which has histopathologically low-grade malignancy is treated by »en bloc» resection; large tumours by amputation, Pre-operative radiation is not recommended (Wolfel et al. 1969). The plan for treatment must be made on the basis of clinical examination and X-ray examination (Wolfel et al. 1969).

The five-year survival rate for parosteal osteo-sarcoma is more than 50 % (Copeland 1967). If adequate treatment is given early enough the majority of patients recover (Dahlin 1972). The five-year survival rate for parosteal osteo-sarcoma does not correspond exactly to the progress of the disease, because late metastases are common. There are no figures available for long-term follow-ups of ten years or more. For individual cases of osteo-sarcoma, the prognosis is better than for other primary malignant bone tumours.

Recurrence of the tumour is common in parosteal osteo-sarcoma (van der Heul et al. 1967) and the tumour forms metastases in the same organs as osteo-sarcoma in general.

2.14.3. Cartilage-forming tumours

2.14.3.1. Chondro-sarcoma

The best treatment for all chondro-sarcomas is radical surgery (Lindbom et

Table 9. Principles for treating parosteal osteo-sarcoma (van der Heul et al. 1967).

— local excision leads to recurrence
— after resection, recurrence is less common
— amputation as primary treatment does not always prevent metastases from forming
— radiation treatment has no effect
— excision of new tumour does not prevent further recurrence;
on the contrary, a further tumour will develop even more rapidly.

Table 10. Five-year survival rate for parosteal osteo-sarcoma when treated surgically.

Investigator(s)	Patients No.	5-year survival No.	5-year survival %
Dwinnel et al. (1954)	15	10	66.7
Copeland et al. (1964)	18	11	61.1
van der Heul et al. (1967)	16	11	68.8
Dahlin (1972)	25	19	76.0
	74	51	68.9

al. 1961, Foster et al. 1964). Chondro-sarcoma is localized in 50 % of patients when they present themselves for treatment (Foster et al. 1964) A biopsy should be carried out before any treatment is given (Dahlin 1972). The results of local excision in chondro-sarcoma seem to be good, but this procedure fails to prevent metastases from forming (Lindbom et al. 1961, Dahlin 1972). If chondro-sarcoma is treated radically, either the tumour recurs or metastases follow quickly and the prognosis is poor (Copeland 1967). Radiation treatment has no effect on chondro-sarcoma, but in tumours located in the pelvis and in the spine it has a clear palliative effect and suppresses patients' symptoms for a long time. If chondro-sarcoma is treated in the same way as osteo-sarcoma, the results age good (Marcove 1977). As far as prognosis is concerned there is no difference between the sexes.

The histo-pathological distribution of chondro-sarcoma is important for prognosis. The best prognosis is that for juxta-cortical chondro-sarcoma and the worst is for menenchymal, which forms early metastases (Dahlin 1972, Wu et al. 1977).

The prognosis for chondro-sarcoma is better when it is peripheral than when it is centrally situated. It is seldom possible to perform radical treatment when the tumour is in the spinal or pelvic region and therefore the results of treatment are usually poor (Dahlin et al. 1956).

The 5-year survival rates for chondro-sarcoma patients undergoing radical surgery are between 30 % and 70 %. The results of palliative surgery are exceptionally unfavourable. In Lindbom's series (1961) metastases developed in 75 % of the patients. Phelan (1964), reported that metastases developed in all patients treated with local surgery. There are few reports dealing with chondro-sarcoma patients who have received radiation treatment only and such reports as there are show extremely poor results. Spontaneous recovery has occasionally been reported (McLaughlin et al. 1979).

Table 11. Five-year survival rate for chondro-sarcoma according to method of treatment.

Investigator(s) and treatment	Patients No.	5-year survival No.	5-year survival %
Copeland et al. (1949) radical surgery	36	38	44.2
Lindbom et al. (1961) radical surgery	23	14	60.9
Lindbom et al. (1961) radiation	16	1	6.3
Henderson et al. (1963) radical surgery	92	68	73.9
Henderson et al. (1963) various methods	132	49	37.1
Copeland (1967) radical resection or radical amputation	118	45	38.1
	467	215	46.0

2.14.4. Giant-cell tumours

2.14.4.1. Malignant giant-cell tumour

The treatment for giant-cell tumours is the same as for osteo-sarcoma (Jaffe 1953, Hutter et al. 1962). The present treatment, radical resection and bone transplant (auto-transplant or allotransplant) has given encouraging results in individual cases (Jaffe 1955, Koskinen 1978). Palliative resection or evacuation leads to recurrence of the tumour in 85 % of cases (Goldenberg 1970, Koskinen 1978). Radiation treatment usually has no effect on giant-cell tumours but it has been found to give some relief in the case of tumours situated in the pelvic region (Cade 1955, Murphy et al. 1956, Dahlin 1972). Herenden (1924) described the »paradoxical responce», in which radiation treatment activates giant-cell tumours in a more malignant direction.

The prognosis for malignant giant-cell tumours is good if primary treatment is radical, and there is no recurrence of tumour nor do metastases develop (Koskinen et al. 1978). Prognosis is usually poor if the tumour recurs (Dahlin 1972, Koskinen 1978). Radiation treatment has no effect on a recurrent tumour (Williams et al. 1964).

2.14.5. Bone-marrow tumours

2.14.5.1. Ewing's sarcoma

Ewing's sarcoma is a tumour that is sensitive to radiation and produces early metastases (Copeland 1967). For this reason the tumour has more frequently been treated with radiation than by surgery (Banshali et al. 1963, Jenkin et al. 1975). Patients suffering from Ewing's sarcoma are young and thus treatment must meet special demands. No cases of spontaneous recovery have been recorded (Bethge 1953).

Results of treatment vary. Some have considered the disease to be hopeless and as recently as 1964 Dahlin reported that only one per cent of Ewing's sarcoma patients recovered as a result of treatment. Prognosis is considered to be slightly better for women than men, because tumours are usually nearer the periphery in women (Foster et al. 1964).

The results of radiation treatment and radical surgery are similar. The 5-year survival rate is approximately 10 %. Results of treatment have improved somewhat in the last few years, because patients have come sooner for treatment. Diagnostic improvement has also had a positive effect (Foster et al. 1964).

25 % of patients suffering from Ewing's sarcoma are found to have metastases when they present themselves for treatment (Banshali et al. 1963). Because of the early formation of metastases, pre-operative radiation combined with amputation after 4—6 months is still practised as a method of treatment. The significance of surgical treatment for Ewing's sarcoma has not lessened (Banshali et al. 1963). Palliative radiation treatment is useful in cases where the tumour is far advanced (Dahlin et al. 1961). 75 % of those suffering from Ewing's sarcoma have either died or are in the terminal phase of the disease within two years of its being diagnosed (Copeland 1967, Baird et al. 1963).

Surgical treatment of distant metastases has in certain cases proved successful (Macintosh et al. 1975). Encouraging results have been achieved in recent years when micro-metastases have been treated

Table 12. Five-year and ten-year survival rates for Ewing's sarcoma.

Investigator(s) and treatment	Patients No.	5-year survival No.	5-year survival %	10-year survival No.	10-year survival %
McCormack et al. (1952)					
whole material	63	8	12.7	6	9.5
radiation treatment	37	4	10.8	3	8.1
surgery	26	4	15.4	3	11.5
Wang et al. (1953)	50	7	14.0		
Platt (1962)	30	8	26.7	5	16.7
Baird et al. (1963)	107	3	2.8		
Banshali et al. (1963)	14	2	14.3	0	0.0
Phelan et al. (1964)	940	102	10.9		
Falk et al. (1967)	54	13	24.1		
Phillips et al. (1967)	33	3	9.1		
Dahlin (1972)	210	32	15.2		
	1564	186	11.9	17	10.0

with massive cytostat combinations. There are no follow-up studies as yet.

2.14.5.2. Reticulum-cell sarcoma

Reticulum-cell sarcoma is sensitive to radiation and it forms metastases rather late. For this reason, many investigators recommend radiation as primary treatment for this type of tumour (Ulrich et al. 1958, Wang et al. 1968, Jack et al. 1975). If radiation has no effect locally, surgical treatment is indicated (Wang et al. 1968, Shoji et al. 1971). A further drawback of radiation treatment is that it inactivates the resistance of the reticulum-endoteliate system and thus weakens the patient's immunity to the tumour (Miller et al. 1971).

The results of surgery and radiation in the treatment of reticulum-cell sarcoma are similar, some hospitals favouring the one and some the other. Surgeons are in favour of radical surgery, because the necrosis that follows radiation treatment causes difficulties (Boyes 1974). In any case, radiation seldom succeeds in preventing the growth of a primary tumour (Dahlin 1972). High amputation has proved a successful method for treating tumours in the distal part of the femur (Boyes 1974). Post-operative radiation treatment is recommended for reticulum-cell sarcoma (Francis et al. 1955).

Primary treatment of the lymph nodes is important in dealing with reticulum-cell sarcoma, because the tumour easily spreads along the lymphatic ducts (Tikka et al. 1969, Shoji et al. 1971, Tallroth 1976). Surgery and radiation are considered to be equally effective for this (Dahlin 1972). In cases where reticulum-cell sarcoma is far advanced cytostat treatment is useful (Shoji et al. 1971, Dahlin 1972).

The five-year survival rate for reticulum-cell sarcoma is approximately 50 %. If the tumour is situated in the pelvic region the prognosis is worse (Shoji et al. 1971).

2.14.5.3. Lympho-sarcoma

Primary lympho-sarcomas of the bone account for about 10 % of all lympho-

Table 13. Five-year and ten-year survival rates for reticulum-cell sarcoma.

Investigator(s) and treatment	Patients No.	5-year survival No.	5-year survival %	10-year survival No.	10-year survival %
Coley et al. (1950)					
radiation	21	10	47.6	6	28.6
Francis et al. (1955)					
radiation	31	15	48.4		
Ivins (1963)					
treatment not specified	46	16	34.8		
Wang et al. (1968)					
radiation or surgery	10	5	50.0		
Shoji et al. (1971)					
treatment not specified	46	19	41.3		
Miller et al. (1971)					
radiation & surgery	35	15	42.1		
Coley toxin	47	30	63.8		
	236	110	46.6	6	28.6

sarcomas (Craver et al. 1934). Treatment and prognosis are about the same as for reticulum-cell sarcoma (Mincey et al. 1974).

2.14.5.4. Myeloma

The basic treatment for myeloma is cytostats, radiation and surgery, combined with good general treatment (Biro 1971, Palva 1979). Surgery alone should be the treatment for solitary nodules in the limbs and extra-medullary plasma-cytoma.

50 % of myeloma patients react well to cytostat treatment (Copeland 1967). The most effective cytostats are cyclophosphamide and melphalan. Nitrogen mustard, which was used earlier, had a good primary effect, but its duration was limited. Urethane (ethyl carbamate) has a beneficial effect on 20 % of patients and its power to prevent the growth of osteolytic tumours has been emphasized (Copeland 1967). Urethane combined with cytostats is of no avail (Copeland 1967). Cortisone reinforces the effect of urethane.

Cortisone has a beneficial effect especially on older myeloma patients (Biro 1971). On the other hand, cortisone adds to the complications of myeloma, provoking especially renal insufficiency and amyloidosis (Biro 1971). 80 % of myeloma patients have neuropathy (Davis et al. 1972, Dahlin 1972). Cortisone is most valuable for myeloma patients with the hyper-calcemic syndrome, in which psychopathy, wasting of the muscles, polyuria and constipation occur (Copeland 1967).

Anabolic hormones improve the patient's general condition. Gammaglobulin, administered 3—4 times a month, prevents infections and helps the patient to recover from them (Biro 1971).

Radio-active phosphorus and fluoride are used sometimes in treating myeloma. It has been discovered by means of X-rays that when treating myeloma with radioactive drugs, trabeculation is strengthened and the damage is repaired (Cook et al. 1968).

The proportion of solitary myelomas is approximately 10 % (Dahlin 1964). The

treatment for solitary myeloma is pre-operative radiation and radical resection (Benedict 1970, Dahlin 1972). Prognosis for solitary myeloma is good, provided there is no dissemination in the bone marrow (Cohen et al. 1964). The treatment for extra-medullary plasma-cytoma is a combination of radiation and surgery (Gosepath et al. 1969, Wiltshaw 1976).

In cases of myeloma, palliative surgery and radiation are very significant in the treatment of paralysis caused by pathological fractures of the spine (Martin et al. 1970). Radiation should be preceded by a decompressing operation (Dahlin 1972). When a limb is fractured, intra-medullary osteo-syntheses are best used in combination with post-operative radiation treatment. Prophylactic intra-medullary nailing is sometimes necessary to prevent a fracture (Koskinen 1976).

Prognosis for myeloma has been considered to be hopeless. Copeland (1967) reported that in his material not a single patient had recovered from myeloma and only a few patients lived for more than five years. A similar picture is given by Baldwin, et al. (1967). In Dahlin's material (1972) the majority of the patients died less than two years after the appearance of the first symptoms, the average period of survival being 13 months. Five-year survival rates are usually under 10 %. The prognosis is generally better if the disease is local. It has been observed that solitary myeloma spreads after several years (Richards 1972). The prognosis for myeloma correlates poorly with radiological changes at the time of diagnosis (Gompels et al. 1972).

It has been reported that myeloma develops in various different ways. In young people, the disease sometimes begins gradually; the M-component is small, bone changes are peripheral, marrow smear normal — and the tumour develops slowly (Waldenström 1970).

Prognosis for solitary myeloma in the spine is rather good. In a study comprising 55 patients (Cohen et al. 1964) 33 % were still alive five years after the moment of diagnosis. There have been individual cases where patients with solitary myeloma, treated with radiation, have lived as much as 30 years. (Pankovich et al. 1972).

The immunological distribution of myeloma is important for the prognosis. In Baldwin's material (1967) the average period of survival for IgG myeloma patients was 25.3 months and for IgA myeloma patients, 26.6 months. In Glenchur's material (1958) prognosis was worst if electrophoresis was normal. It has been reported that radiation gives best results in the treatment of IgG myeloma (Maryana 1970).

The prognosis for extra-medullary plasma-cytoma is not known exactly. It is generally considered to be much better than for multiple myeloma (Gosepath et al. 1969, Poole et al. 1968). The location of the tumour and the degree of spreading affect the prognosis (Boyd et al. 1969). After treatment late recurrence of tumours has been observed as much as 20—36 years subsequently (Gosepath et al. 1969).

The immediate cause of death in myeloma patients is usually infection, renal insufficiency, cardiac insufficiency, paralysis or haemorrhage (Martinez-Maldonado et al. 1971). In myeloma patients, hypertony is not associated with nephropathy (Biro 1971). Especially in the case of geriatric patients the use of contrast infusions

in X-ray studies of the kidneys of myeloma patients is contraindicated on account of irreversible changes in the kidneys (Biro 1971). In Glenchur's study of 51 terminal myeloma patients, the immediate cause of death in 17 cases was pneumonia. Other infections were present in a further 29 patients.

2.14.6. Vascular tumours

2.14.6.1. Angio-sarcoma

Individual cases of angio-sarcoma have been treated in the same way as osteo-sarcoma (Dahlin 1972). Angio-sarcoma often causes extensive osteolytic damage and surgical treatment is often necessary on account of pathological fracture. Prognosis is similar to that for osteo-sarcoma (Dahlin 1964).

2.14.6.2. Haemangio-endothelioma-sarcoma

Treatment and prognosis for haemangio-endothelioma-sarcoma are the same as for osteo-sarcoma.

2.14.6.3. Haemangio-pericytoma-sarcoma

Treatment and prognosis for haemangio-pericytoma-sarcoma are the same as for osteo-sarcoma.

2.14.7. Connective-tissue tumours

2.14.7.1. Fibro-sarcoma

Fibro-sarcoma is a tumour that is resistant to radiation and treatment is the same as for osteo-sarcoma (Dahlin 1972). There are two types of fibro-sarcoma, secondary and medullary. It is difficult to distinguish between the fibro-plastic type of osteo-sarcoma and fibrotic dysplasia (McLeod et al. 1957). About 20 % of cases are secondary fibro-sarcoma, the etiology being fibrous dysplasia, Paget's disease or giant-cell tumour (Eyre-Brook et al. 1969). The prognoses for medullary and secondary fibro-sarcomas are similar to that for primary fibro-sarcoma (Gilmer et al. 1958, Dahlin 1972). Some investigators consider the prognosis for fibro-sarcoma to be just as poor as that for osteo-sarcoma (Coventry et al. 1957).

2.14.7.2. Lipo-sarcoma

Lipo-sarcoma is a malignant tumour, which produces early metastases in the lungs and liver. Treatment and prognosis are the same as for osteo-sarcoma (Dawson 1955, Catto et al. 1963, Goldman 1964).

2.14.7.3. Malignant mesenchymoma

Malignant mesenchymoma is very rare and the tumour has features in common

Table 14. Five-year and ten-year survival rates for fibro-sarcoma.

Investigator(s)	Patients No.	5-year survival No.	5-year survival %	10-year survival No.	10-year survival %
Gilmer et al. (1958)	227	59	26.0		
Eyre-Brook et al. (1969)	50	14	28.0	6	12.0
Dahlin et al. (1969)	92	25	27.2	20	21.6
Pritchard et al. (1977)	158	45	28.7	34	21.8
	527	143	27.1	60	20.0

with osteo-sarcoma and lipo-sarcoma (WHO, Schajowicz et al. 1972).

2.14.7.4. Primary malignant fibrous histio-cytoma

Primary malignant fibrous histiocytoma is the latest malignant bone tumour to be discovered. Typical of it are extensive osteolytic damage and pathological fracture (Spanier 1977). The tumour forms early metastases like osteosarcoma (Spanier et al. 1975).

There is as yet no clear idea about how to treat primary malignant fibrous histiocytoma. Radical surgery combined with radiation treatment has been used (Spanier et al. 1975, Feldmann et al. 1977). This has been justified on the basis of a possible connection between this type of tumour and lympho-sarcoma or reticulum-cell sarcoma (Spanier et al. 1975). Prognosis is poor. In Spanier's material, the average period of survival after treatment was 21 months. Slootweg et al. (1977) and Webber et al. (1977) report similar results. Prognosis is better for a malignant fibrous histiocytoma located in soft tissue (Rantakokko 1978).

2.14.7.5. Undifferentiated sarcoma

Undifferentiated sarcoma is a little known tumour with features of osteosarcoma, reticulum-cell sarcoma, fibrosarcoma and metastatic carcinoma (Schajowicz 1972).

2.14.7.6. Radiation sarcoma

Radiation sarcoma is a very malignant tumour (Schwartz et al. 1958). The prognosis for a tumour that has developed in the place of a benign bone lesion is generally better than for osteo-sarcoma (Arlen et al. 1971). Treatment and prognosis for radiation sarcoma are the same as for osteo-sarcoma (Steiner 1965, Mindell et al. 1977).

2.14.8. Other tumours

2.14.8.1. Chordoma

Chordoma is a rare tumour. It accounts for 1.5 % of all malignant bone tumours (Paavolainen et al. 1976). Chordoma originates from the notochord, the remains of the notochord, or from the nuclei pulposi. 10 % of chordomas produce metastases by the haematogenous route. Deposits may develop in unusual locations, including the skin. Recurrence may take place after many years (Dahlin 1972).

There is not complete agreement about how to treat chordoma. Because the tumour grows slowly, partial resection gives years of remission and the patient is symptom-free. Some chordomas are sensitive to radiation. Radical surgery is seldom possible for spheno-occipital chordoma and partial resection and post-operative radiation are generally indicated (Greenwald et al. 1957, Dahlin et al. 1952, Paavolainen et al. 1976). Surgical treatment is necessary for sacrococcygeal chordoma. The prognosis for chordoma is directly related to how the tumour is treated surgically. Radical excision of a spheno-occipital tumour is seldom possible. Tumours in this area easily cause lethal pressure in the region of the medulla oblongata. It is quite often possible to remove a sacrococcygeal chordoma by radical surgery and then the prognosis is good (Kamrin et al. 1964, Rissanen et al. 1967, Paavolainen et al. 1976).

2.14.8.2. Adamantinoma of long bones

Adamantinoma of long bones is a rare tumour, the treatment for which is like that for osteo-sarcoma (Dockerty et al. 1942). Metastases are common after resection (Dahlin 1972).

2.14.8.3. Neuro-sarcoma

Treatment for neuro-sarcoma is the same as that for osteo-sarcoma. Prognosis is only known from a few individual cases and is usually very unfavourable (Güthert 1972).

3. PURPOSE OF THE STUDY

The purpose of the study is to clarify the clinical picture, methods of treatment and follow-up results, of primary malignant bone tumour and to attempt an answer to the following questions:

- How common are primary malignant bone tumours in Finland?
- What symptoms do bone tumour patients have and what are the findings?
- Where are the tumours located?
- What is the treatment to be given?
- What is the prognosis?

4. MATERIAL AND METHODS

The material for this study has been supplied by the Finnish Cancer Registry and consists of all primary malignant bone tumours reported between 1962 and 1968. During that period 985 cases were reported. The incidence was 3.16 cases per year for 100,000 inhabitants. During the same time an average of 10,958 tumours of all types were reported annually (Teppo et al. 1975). Primary malignant bone tumours accounted for 1.25 % of all malignant tumours. Included in the clinical follow-up study were patients whose diagnoses had been confirmed by histo-pathological tests, accompanied by a statement from a specialist. Giant-cell tumours were considered malignant if they were found to be malignant either clinically or histo-pathologically, or both. Diagnosis of myeloma was considered certain if it was based on the results of histo-pathological examination or if it was supported by clinical examination, X-ray examination and laboratory findings. Tumours originating in the teeth are not included in this study.

The series finally comprised 869 patients, whose case histories, X-rays and histo-pathological samples were collected for further study.

There were 86 patients (8.7 % of the original 985 cases) for whom no case history could be found and 20 (2.0 %) for whom the case histories were defective. These patients were excluded from the study.

Histo-pathological samples from 273 (86.4 %) sarcoma patients and 45 (8.1 %) myeloma patients were available for further study. In 10 cases it was certified in the further study that a primary malignant bone tumour was not involved. In 36 cases (13.2 %) the diagnosis was modified in the light of histo-pathological, clinical and X-ray examinations.

Further study of the histo-pathological samples was made by Docent Tapani Sorvari at the university of Kuopio and in problematic cases assistance was also given by Professors Osmo Järvi, Erkki Saxen, L. V. Ackerman and H. A. Sissons. The author has familiarized himself with the histological study of bone tumours under the guidance of Dr. Sorvari.

Re-analysis of the X-rays was carried out by Professor Pekka Virtama and Dr. Kalevi Katevuo, using the computer-assisted diagnosis developed by Lodwick.

Information about survival was checked personally in hospitals, church registers and in documents provided by the Finnish Central Office for Statistics. The follow-up period varied from six years to eleven years, eleven months (average 6 1/2 years). The follow-up ended on 31. 12. 1974.

Surgical intervention was considered to be radical if amputation or resection allowed a distance of 5 cm. from the di-

seased tissue. It was considered to be local if the distance was less than 5 cm. Biopsy was not considered to be part of treatment.

The histological classification of tumours according to their degree of malignancy was made on the basis of the recommendations published by the World Health Organization in 1972, together with a complementary classification of additional tumours, drawn up by Docent Tapani Sorvari.

Crude survival of patients was calculated by means of the so-called actuary technique (Cutler et al. 1958). This procedure makes it possible to include all the information available, regardless of the length of the follow-up time. In order to eliminate the part played by the normal mortality rate, the figure obtained for crude survival was compared with the normal mortality rate for a population of the same age. The latter was calculated from tables supplied by the Central Office for Statistics. The relationship between the two figures is called age-corrected or relative survival (Ederer et al. 1961).

The normal laboratory values were based on Laboratoriotutkimusten vertailuarvoja by Leskinen et al. 1972.

Statistical significance was calculated by the Mantel-Haenszel method.

5. RESULTS

5.1. INCIDENCE, AGE AND SEX DISTRIBUTION

The clinical study comprised 869 patients suffering from primary malignant bone tumour. Incidence was 2.7 new cases per 10^5 inhabitants annually. The average age of the patients was 54.7 years, the youngest being two years old and the oldest 93. 82.5 % of the patients were over 40 and there were 442 men (50.9 %) and 427 women (49.1 %).

5.2. HISTOLOGICAL DISTRIBUTION

There were 21 different histological types of tumour. It was possible by means of electrophoresis to classify 494 (89.3 %) of the 553 myeloma patients into immunological sub-groups (Table 15). Of the myeloma patients 262 (47.4 %) were male and 291 (52.6 %) were female. Of the remaining patients, i.e. those with sarcoma, 180 (57.0 %) were male and 136 (43.0 %) were female. In the case of 18 sarcoma patients, the sample was too small or too badly preserved for it to be possible to classify it in further study, but it was nevertheless possible to confirm that sarcoma was involved. Histological age distribution is shown in Figs. 21—35.

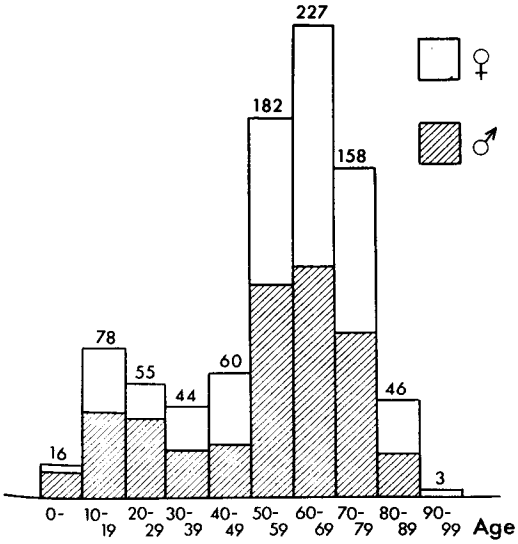

Figure 1. Age distribution of 869 patients with primary malignant bone tumour.

5.3. SYMPTOMS AND DIAGNOSIS

5.3.1. Pain

Pain is the most common symptom of malignant bone tumours. 280 (88.6 %) of the sarcoma patients and 511 (92.4 %) of the myeloma patients experienced pain at the place of the tumour. In 566 cases (71.6 %) it was considered to be referred pain or neurological pain.

5.3.2. Size of tumours and resistance to palpation

In sarcoma patients tumours were on the average 6.0 cm. in diameter.

There was a palpable tumour in 260 patients (29.9 %), 209 (66.1 %) of whom were

Table 15. Histological distribution, sex distribution and average age of 869 patients suffering from primary malignant bone tumours.

Type of tumour	Patients		Male		Female		Average age
	No.	%	No.	%	No.	%	years
Bone-forming tumours							
Osteo-sarcoma	123	14.2	73	59.3	50	40.7	31.7
Parosteal osteo-sarcoma	4	0.5	1	25.0	3	75.0	22.0
Cartilage-forming tumours							
Primary chondro-sarcoma	53	6.1	31	58.5	22	41.5	42.6
Secondary chondro-sarcoma	15	1.7	7	46.7	8	53.3	45.8
Giant-cell tumours							
Malignant giant-cell tumour	25	2.9	10	40.0	15	60.0	36.0
Bone-marrow tumours							
Ewing's sarcoma	18	2.1	8	44.4	10	55.6	19.1
Reticulum-cell sarcoma	14	1.6	6	42.9	8	57.1	46.1
Lympho-sarcoma	6	0.7	6	100.0			47.9
Solitary myeloma	10	1.1	5	50.0	5	50.0	54.1
Type NUD	8	0.9	4	50.0	4	50.0	50.2
Type IgG	2	0.2	1	50.0	1	50.0	69.5
Multiple myeloma	533	61.3	250	46.9	283	53.1	64.5
Type NUD	42	4.8	17	40.5	25	59.5	63.9
Type IgA	129	14.8	60	46.5	69	53.5	63.9
Type IgG	359	41.3	171	47.6	188	52.4	65.1
Type IgM	3	0.3	2	66.7	1	33.3	66.2
Extra-medullary plasma-cytoma	10	1.1	7	70.0	3	30.0	58.1
Type NUD	9	1.0	7	77.8	2	22.2	56.9
Type IgA	1	0.1			1	100.0	68.8
Vascular tumours							
Angio-sarcoma	4	0.5	3	75.0	1	25.0	44.5
Haemangiopericytoma-sarcoma	2	0.2	2	100.0			36.1
Other connective-tissue tumours							
Fibro-sarcoma	14	1.6	10	71.4	4	28.6	47.1
Primary malignant fibrous-histio-cytoma	9	1.0	5	55.6	4	44.4	42.5
NUD sarcoma	18	2.1	12	66.7	6	33.3	56.4
Radiation sarcoma	2	0.2			2	100.0	53.8
Fibrolipo-myxoma malignum	1	0.1	1	100.0			58.6
Condro-myxoma malignum	1	0.1	1	100.0			66.2
Fibro-myxoma malignum	1	0.1			1	100.0	60.7
Other tumours							
Chordoma	5	0.6	3	60.0	2	40.0	60.1
Neuro-sarcoma	1	0.1	1	100.0			34.0
Total	869	99.8	442	50.9	427	49.2	54.7

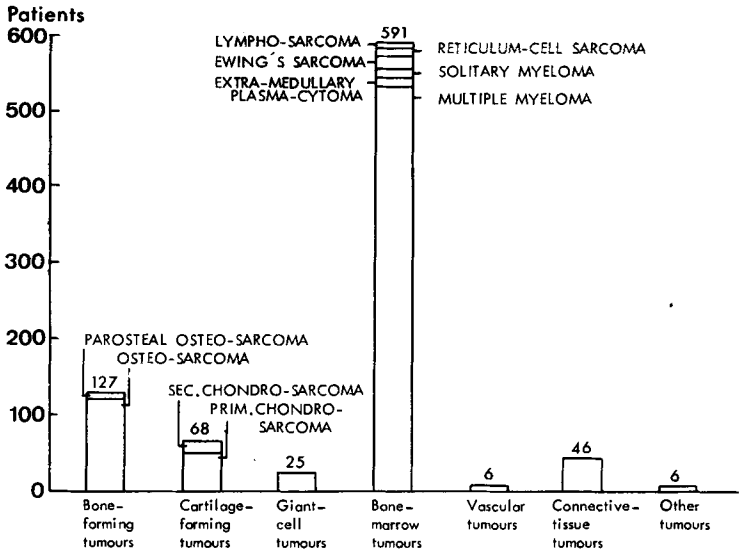

Figure 2. Histological distribution of 869 primary malignant bone tumours.

sarcoma patients and 51 (9.2 %) myeloma patients.

5.3.3. Pathological fracture

There was pathological fracture in 310 patients (35.7 %). Of these, 58 (18.4 %) were sarcoma patients and 252 (79.5 %) were myeloma patients.

5.3.4. Deterioration of general health

Deterioration of general health was a symptom in 491 patients (56.4 %), of whom 41 (13.0 %) were sarcoma patients and 450 (81.4 %) were myeloma patients. 28 (8.9 %) of the sarcoma patients and 380 (43.7 %) of the myeloma patients reported that they had lost weight.

5.3.5. Trauma in anamnesis

Only 7 patients (0.8 %) reported certain trauma in the region of the tumour. Of these, there was one sarcoma patient who had chondro-sarcoma.

5.3.6. General symptoms

Slight fever was a symptom in 9 (2.8 %) of the sarcoma patients and 90 (16.3 %) of the myeloma patients. Local inflammation occurred in 12 (3.8 %) of the sarcoma patients and in 130 (23 %) of the myeloma patients. Oedema at the site of the tumour was a symptom in 234 patients (26.9 %), of whom 106 (33.5 %) were sarcoma patients and 128 (23.1 %) myeloma patients. Haemorrhage was a symptom in 87 patients (10.0 %), 2 of whom (0.6 %) were sarcoma patients and 85 (15.4 %) myeloma patients.

5.3.7. Lack of symptoms

There were 12 patients (1.4 %) who had no symptoms. Two of these had primary chondro-sarcoma, one had secondary chondro-sarcoma and one had chordoma. Four multiple myeloma patients and two extra-medullary plasma-cytoma patients had no symptoms.

Table 16. Skeletal distribution of 869 primary malignant bone tumours.

Type of tumour	Total	Skull	Mandibula	C 1—C7	Th 1—Th 12	L 2—L 5	S 1—S 4	Sternum	Clavicula	Costa 1—12
Bone-forming tumours										
Osteo-sarcoma	123	6	4	1	1	2	2	1	1	4
Parosteal osteo-sarcoma	4		1		1					
Cartilage-forming tumours										
Primary chondro-sarcoma	53	2			1	1	3	2	1	5
Secondary chondro-sarcoma	15				1				1	2
Giant-cell tumours										
Malignant giant-cell tumour	25		1		2		1			
Bone-marrow tumours										
Ewing's sarcoma	18					4				2
Reticulum-cell sarcoma	14				1	3		1		
Lympho-sarcoma	6				1					
Solitary myeloma										
Type NUD	8				3		1	1		2
Type IgG	2					2				
Multiple myeloma										
Type NUD	42	22	4	3	14	13	1	4	7	13
Type IgA	129	91	16	12	48	44	10	9	23	31
Type IgG	359	249	61	43	143	137	24	21	64	105
Type IgM	3	2	1	2	1	2	1	1	1	2
Extra-medullary plasma-cytoma										
Type NUD	9									
Type IgA	1									
Vascular tumours										
Angio-sarcoma	4	1			1					
Haemangio-pericytoma-sarcoma	2									
Other connective-tissue tumours										
Fibro-sarcoma	14		1				1		1	1
Primary malignant fibroushistio-cytoma	9		1							
NUD sarcoma	18		1		2			1	1	
Radiation sarcoma	2									
Fibrolipo-myxoma malignum	1									
Condro-myxoma malignum	1									
Fibro-myxoma malignum	1	1								
Other tumours										
Chordoma	5	1				1	3			
Neuro-sarcoma	1					1				

5.3.8. Duration of symptoms

The average duration of symptoms before diagnosis was 7.2 months. Symptoms had lasted for less than six months in patients with osteo-sarcoma, reticulum-cell sarcoma, lympho-sarcoma, fibro-sarcoma, primary fibrous histio-cytoma; also in cases of myeloma (with the exception of solitary myeloma) and extra-medullary plasma-cytoma. Symptoms had lasted longer in patients with parosteal osteo-sarcoma (15.3

Pubis	Ischii	Femur	Tibia	Fibula	Ossa-tarsii	Ossa-metatars.	Phal-ped	Humerus	Radius	Ulna	Ossa-carpii	Ossa-metacarp.	Phal-man	Patella
1	4	44	20	9				13	1					
		1	1											
2		14	7					1	2			1	1	
1		3	1					3				1	1	
	1	11	3	1	1		1		2			1		
		2	5					2						
1	1	4				1								
		1	1					1						
		1												
13	11	19	2					10	1	1				
33	38	52	9	3				33	8	7			1	3
135	133	153	25	17	2	2	3	105	25	19	5	4	3	1
2	2	2												
								1						
		1												
			1											
									1					
		7	2					2				1		
		2	2	1				1						
	1	4	1					1						
		1												
		1												
		1												

months), primary chondro-sarcoma (13.0 months), secondary chondro-sarcoma (16.7 months), malignant giant-cell tumours (17.9 months), chordoma (11 months) and extra-medullary plasma-cytoma (11—24 months).

No information was available for the duration of symptoms in 19 patients.

5.4. ETIOLOGY

It was not possible in this study to demonstrate any hereditary factor in the de-

velopment of primary malignant bone tumours, neither could it be proved that trauma had anything to do with the growth of the tumour. Radiation sarcoma was confirmed in two female patients. One of these had been given radiation treatment for tuberculosis of the knee and the other had had radiation treatment in the humerus: radiation sarcoma subsequently developed at these sites. There was one case where fibro-sarcoma had developed as a result of Paget's disease.

5.5. LOCATION

The location of tumours is shown in Table 16 and Figures 21—35. Extra-medullary plasma-cytoma was in five patients located in the nose, in two patients in the hypo-pharynx, in one in the sinus maxillaris; there was also one case where the tumour was in the orbit and another in which it was situated in the inguinal nodule.

5.6. DISCUSSION

The 10^5 incidence of primary malignant bone tumours was 2.84 new tumours annually and bone tumours accounted for 1.28 % of all malignant tumours. These figures correspond roughly to those published elsewhere (Swedish Cancer Registry 1960, The Cancer Registry of Norway 1964, Copeland 1967, Bristol Registry 1971).

Histological distribution was similar to that in earlier studies. There were no cases of the following rare tumours: juxta-cortical chondro-sarcoma, mesenchymal chondro-sarcoma, lipo-sarcoma, malignant mesenchymoma, undifferentiated sarcoma and adamantinoma of long bones. The Finnish classification included also secondary chondro-sarcoma, solitary myeloma, extra-medullary plasma-cytoma, haemangio-pericytoma-sarcoma, radiation sarcoma, primary malignant fibrous histio-cytoma, NUD sarcoma, fibrolipo-myxoma malignum, chondro-myxoma malignum and fibro-myxoma malignum.

Pain was the most common symptom and it occurred in 88.6 % of the patients. It was at first considered to be neurological or referred pain in 71.6 % of the patients. It was not possible in the present study to show that trauma played any part in the etiology of primary malignant bone tumours. Symptoms, on the whole, had lasted rather a short time when the diagnosis was made, 7.2 months on the average. Diagnosis was delayed in only three cases.

5.7. X-RAY FINDINGS

5.7.1. Plain radiography

Plain radiography was carried out before treatment on 816 patients (93.9 %) in order to discover whether there were changes in the bone. In 746 cases (91.4 %) the result of this examination was concordant with the presence of malignant tumour. The X-ray was interpreted as normal in 70 cases (8.6 %). Of the sarcoma patients 290 (97.6 %) were found in the X-ray examination to have symptoms concordant with malignant bone tumour. The corresponding figures for myeloma patients were 456 (87.9 %).

5.7.2. Angiography

Angiography was performed on 60 patients (6.9 %). The result of the examina-

Table 17. X-ray findings for 869 primary malignant bone tumours.

Type of tumour	Plain radiography		Angiography		Tomography	
	Diagn.	Norm.	Diagn.	Norm.	Diagn.	Norm.
Bone-forming tumours						
Osteo-sarcoma	112	2	24	3	21	1
Parosteal osteo-sarcoma	4		1		1	
Cartilage-forming tumours						
Primary chondro-sarcoma	47	1	11		11	
Secondary chondro-sarcoma	17	1		1	5	
Giant-cell tumours						
Malignant giant-cell tumour	21		2	2	6	
Bone-marrow tumours						
Ewing's sarcoma	16	1			2	
Reticulum-cell sarcoma	11		2		4	
Lympho-sarcoma	6				2	
Solitary myeloma	10				6	
Multiple myeloma	445	62	1	4	42	5
Extra-medullary plasma-cytoma	1	1	1			
Vascular tumours						
Angio-sarcoma	4				1	
Haemangio-pericytoma-sarcoma	2				1	
Other connective-tissue tumours						
Fibro-sarcoma	12	2	1		3	
Primary malignant fibrous histio-cytoma	9		1		6	
NUD sarcoma	18		2	1		
Radiation sarcoma	2		1		2	
Fibrolipo-myxoma malignum	1				1	
Chondro-myxoma malignum	1				1	
Fibro-myxoma malignum	1		1		1	
Other tumours						
Chordoma	5		1			
Neuro-sarcoma	1					
Total	746	70	49	11	116	6

tion was concordant with the presence of malignant bone tumour in 47 of the sarcoma patients (87.0 %). For myeloma patients the figure was 33.3 %.

5.7.3. Lymphography

Lymphography was performed on 5 patients (0.6 %). The examination showed that the tumour had spread into the lymphatic ducts in one (25 %) of the sarcoma patients. Lymphography was performed on one myeloma patient who was suffering from extra-medullary plasma-cytoma and it was found that the tumour had reached the lymph nodes.

5.7.4. Other examinations

Scintigraphy was performed on 26 patients (3.0 %). It was found in 13 (76.5 %) of the patients with sarcoma that isotope had collected in the bone at the place revealed in the X-ray examination. In all the nine myeloma patients examined it was found that isotope had collected.

Tomography was performed on 122 patients (14.3 %) and the result was concordant with the presence of primary malignant bone tumour in 68 of the 69 sarcoma patients (98.6 %). For myeloma patients 48 of 53 examinations (90.6 %) were positive.

Neither computer tomography, nor thermography were performed for the present study.

5.7.5. Discussion

The final radiological diagnosis was possible when using ordinary radiographs in 91.4 % of cases, which is in accord with findings reported elsewhere (Lodwick 1967, Ranke 1968).

Angiography was usually helpful for determining the extent of the tumour outside the bone involved. Angiography may also be helpful for differentiating chondrosarcoma from benign osteo-chondroma, but in general it does not seen to help when trying to distinguish between benign and malignant bone lesions (Yaghmai 1979). It is valuable in preoperative planning, particularly in the case of malignant tumours of the pelvis.

Scintigraphy is an important method for revealing primary malignant bone tumours. Because the series studied consists of cases in the nineteen-sixties, scintigraphy was used in only 26 cases. No conclusions concerning its value can therefore be drawn. It does, however, seem to be of great value for detecting local bone marrow and distant metastases. It is very useful in postoperative follow-up.

The significance of lymphography is widely recognized and it is used increasingly in planning treatment for primary malignant bone tumours.

5.8 HISTO-PATHOLOGICAL EXAMINATION AND CONFIRMATION OF DIAGNOSIS

5.8.1. Sarcoma patients

A histological diagnosis of every sarcoma patient in the present study was supplied by an expert pathologist. Samples from 261 patients (82.3 %) were available for this study.

5.8.2. Myeloma patients

A diagnosis by a specialist, either histopathological or on the basis of a marrow smear, was supplied for 486 of the mye-

loma patients (87.9 %). 56 of these patients (11.5 %) came for a further examination.

5.8.3. Study of frozen sections

Study of frozen sections was carried out on 41 sarcoma patients in connection with surgery. In six cases (14.6 %) the tumour was considered to be benign in the light of this study. In the remaining 35 cases (85.4 %) the study of frozen sections revealed the presence of malignant tissue.

5.8.4. Confirmation of diagnosis

Diagnosis was considered to be confirmed if the result of the histo-pathological examination was certain. In cases of myeloma, the diagnosis was considered to be confirmed if there was either a clear histo-pathological diagnosis or if X-ray findings and laboratory findings, together with the clinical picture, were concordant with such a diagnosis. Only a few marrow smears were available for the present study, because haematological laboratories do not keep such samples for long.

5.8.5. Discussion

A frozen section taken during surgery may sometimes be helpful, but generally the diagnosis should be made before surgery is embarked upon, radiologically and with the aid of histological examination of adequate biopsy specimens. In the present series, a frozen section was examined in 41 cases and malignancy was confirmed in 85.4 % of these cases.

5.9. LABORATORY TESTS

Laboratory findings are shown in Figure 3.

Table 18. S.R. values for 850 sarcoma and myeloma patients.

S.R. mm/h	Sarcoma patients %	Myeloma patients %
1—19	49·4	5.5
20—49	30.2	13.8
50—99	15.6	26.4
≧ 100	4.9	54.3

5.9.1. Discussion

Laboratory findings are important in diagnosing primary malignant bone tumours and especially when studying the degree of spreading. The laboratory tests required in the diagnosis of bone sarcomas are very simple and are easy to carry out in any hospital. In the present study, the blood group distribution was approximately the same as in the study by Nevanlinna (1973).

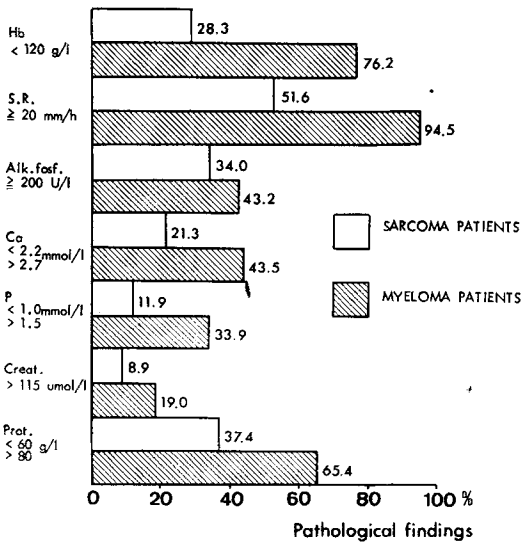

Figure 3. Pathological laboratory findings (%) for sarcoma and myeloma patients.

Table 19. Treatment of 336 patients suffering from primary malignant bone tumour (multiple myeloma patients excluded).

Type of tumour	Radical ablative surgery			Radical resection			Local resection		
	No rad.	Rad.	Other	No rad.	Rad.	Other	No rad.	Rad.	Other
Bone-forming tumours									
Osteo-sarcoma	24	32	8	1	8	1		6	
Parosteal osteo-sarcoma	1			1	1			1	
Cartilage-forming tumours									
Primary chondro-sarcoma	10	5	5	4		1	3	1	2
Secondary chondro-sarcoma		2			1	2	1	1	1
Giant-cell tumours									
Malignant giant-cell tumour	3	1	2	3	1			3	
Bone-marrow tumours									
Ewing's sarcoma	1	2	3					2	1
Reticulum-cell sarcoma		1					1		
Lympho-sarcoma	1			1				1	
Solitary myeloma							1	2	
Multiple myeloma									
Extra-medullary plasma-cytoma							2	3	
Vascular tumours									
Angio-sarcoma							1		
Haemangio-pericytoma-sarcoma							1		
Other connective-tissue tumours									
Fibro-sarcoma	1		2		1			2	
Primary malignant fibrous histio-cytoma	2				2			1	
NUD sarcoma		1		1	1		1		
Radiation sarcoma	1		1						
Fibrolipo-myxoma malignum								1	
Chondro-myxoma malignum							1		
Fibro-myxoma malignum								1	
Other tumours									
Chordoma									
Neuro-sarcoma							3		
Total	44	44	21	11	15	4	15	25	4

5.10. TREATMENT

Treatment of patients is shown in Tables 19 and 20 and also in appendix 9.2. Of the osteo-sarcoma patients, 74 (60.2 %) were treated by means of radical surgery. It proved possible to treat 30 (44.1 %) of the chondro-sarcoma patients by means of radical surgery. The corresponding figure for giant-cell tumours was 10 (40.0 %). Of the Ewing's-sarcoma patients it was possible to treat six (33.3 %) by means of radical surgery. In the case of other tumours, radical surgery was less frequent.

Evacuation			Radiation treatment		Cytostat treatment	No specific treatment	Total
No rad.	Rad.	Other		Cytostat			
	5	1	22	4	3	8	123
							4
			16	3		3	53
4			3				15
4	2		4			2	25
			5	2	1	1	18
			7	2		3	14
			1	2			6
			3	2		2	10
			4			1	10
			2			1	4
			1				2
	2		4		1	1	14
			1	1	1	1	9
			7	2		5	18
							2
							1
							1
							1
						2	5
				1			1
8	9	1	80	19	6	30	336

If we consider the whole series (with the exception of patients suffering from multiple myeloma) the figures for different types of treatment are the following: 139 patients out of 336 (41.4 %) were treated with radical surgery; 62 patients (18.5 %) were treated with non-radical surgery; 80 (23.8 %) were given radiation treatment; 19 (5.7 %) were given radiation treatment and cytostat treatment; 6 (1.8 %) received cytostat treatment; and for 30 patients (8.9 %) no specific treatment was possible.

Of the myeloma patients, 334 (62.7 %)

Table 20. Treatment of 533 patients suffering multiple myeloma.

Type of treatment	Subgroups of myeloma				Total No.
	NUD	IgA	IgG	IgM	
Cytostat treatment	7	29	93	2	131
Survival rate more than 5 years	0	1	9	0	
Average age, years	65.2	61.5	63.8	65.5	
Survival rate, years	0.6	0.6	1.0	2.2	
Cytostat + radiation	7	23	59	1	90
Survival rate more than 5 years	0	0	4	0	
Average age, years	60.2	61.3	61.6	68.1	
Survival rate, years	1.6	1.6	1.5	0.6	
Cytostat + cortisone	2	17	59		78
Survival rate more than 5 years	0	0	3		
Average age, years	47.6	66.8	64.0		
Survival rate, years	1.0	1.0	1.0		
Urethane	1	10	24		35
Survival rate more than 5 years	0	0	0		
Average age, years	66.3	64.6	64.1		
Survival rate, years	0.1	0.3	1.1		
Radiation treatment	7	8	17		32
Survival rate more than 5 years	0	0	0		
Average age, years	67.3	60.6	65.2		
Survival rate, years	0.5	1.1	0.9		
Radiation + cortisone			9		9
Survival rate more than 5 years			0		
Average age, years			56.2		
Survival rate, years			1.9		
Cortisone	3	12	9		24
Survival rate more than 5 years	0	0	0		
Average age, years	65.8	66.3	69.7		
Survival rate, years	0.3	0.3	0.5		
Testosterone		2			2
Survival rate more than 5 years		0			
Average age, years		66.1			
Survival rate, years		0.3			
Fluoride		2			2
Survival rate more than 5 years		0			
Average age, years		71.4			
Survival rate, years		1.3			
General treatment	15	26	89		130
Survival rate more than 5 years	0	0	2		
Average age, years	64.7	68.5	75.9		
Survival rate, years	0.7	0.6	0.5		
					533

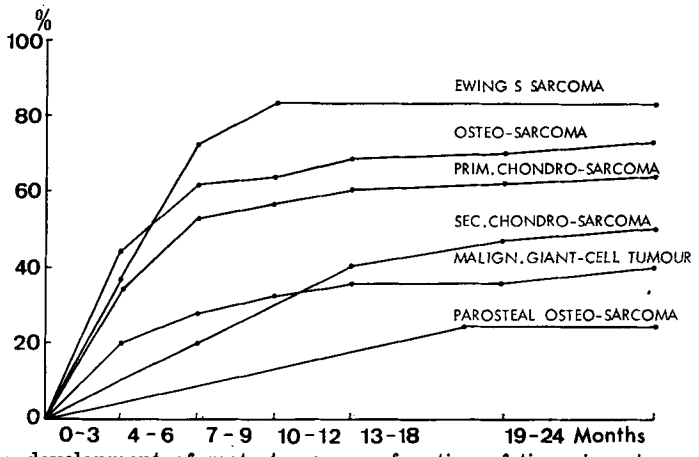

Figure 4. The development of metastases as a function of time, in osteo-sarcoma, parosteal osteo-sarcoma, primary and secondary chondro-sarcoma, malignant giant-cell tumour and Ewing's sarcoma.

were given cytostat treatment, 131 (24.6 %) received radiation treatment and 28 (5.3 %) other treatment. 130 (24.4 %) of these patients received basic treatment.

In the present study the radiation referred to is roentgen therapy; only very few patients received megavolt therapy. The radiation dose was 200 rad. per day. For Ewing's sarcoma the dose was 5,500—8,200 rad., for reticulum-cell sarcoma 2,400—6,800 rad. and for lympho-sarcoma 4,000—6,000 rad.

The cytostatic agents used were cyclophosphamide, methotrexate, melphalan and ethyl carbamate. Treatment with massive doses of three or four different cytostatic agents was not used.

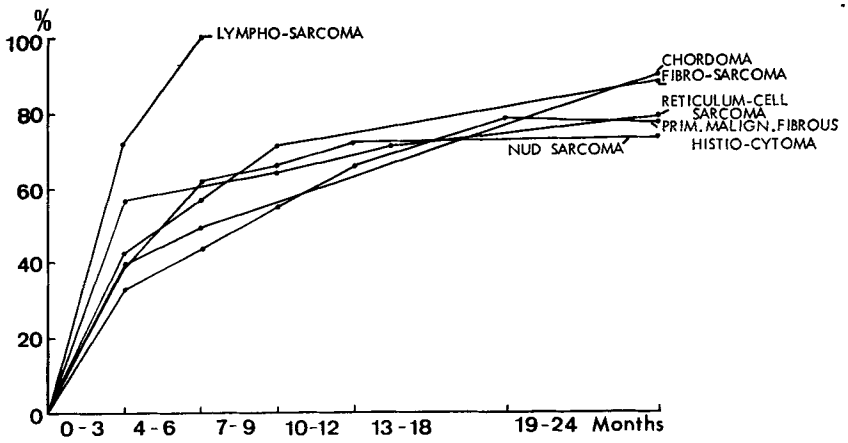

Figure 5. Development of metastases, in reticulum-cell sarcoma, fibro-sarcoma, chordoma, malignant fibrous histio-cytoma and NUD sarcoma.

5.11. PROGNOSIS

5.11.1. Metastases

More than 50 % of sarcoma patients had metastases within six months of presenting themselves for treatment, with the exception of those suffering from secondary chondro-sarcoma, for whom the figure was 40 % and those suffering from malignant giant-cell tumours, for whom the figure was 32 %. Metastases were rather rare after one year (Figures 4 and 5).

5.11.1.1. Discussion

Metastases of primary malignant bone tumours develop rapidly by the haemathogeneous route, most frequently in the lungs, liver, organs of the abdominal cavity and more rarely in the lymphatic ducts (Sellors 1970, Beck et al. 1976, Tallroth 1976). The realization that metastases form quickly has led to the use of modern combined cytostat treatment for many primary malignant bone tumours.

5.11.2. Survival

5.11.2.1. Bone-forming tumours

5.11.2.1.1. Osteo-sarcoma

The 5-year survival rate for osteo-sarcoma was 28.4 % and the 10-year survival rate was 24.8 %.

The 5-year survival rate for patients with osteo-sarcoma in the humerus was 7.7 %. Only one patient lived more than five years; this patient had a tumour in the diaphysis of the humerus, which was treated by extirpation and post-operative radiation.

For osteo-sarcoma patients whose tumour was in the femur, the 5-year survival rate was 27.3 %. The location of the tumour has considerable significance. Prognosis is better if a tumour is situated in the distal part of the bone. Of those patients who had tumours in the collum or trocanter region of the femur, not one lived for five years. All those patients with osteo-sarcoma in the femur who lived more than five years, were treated by means of radical amputation.

The prognosis for osteo-sarcoma in the tibia is better than for osteo-sarcoma in the other long bones. The 5-year survival rate was 45.0 % and the 10-year survival rate was 40.0 %. With one exception, all those patients who lived for more than five years were treated by means of radical ablative surgery.

The results of treatment when the tumour was in the fibula or radius correspond approximately to the above.

Prognosis was poor for osteo-sarcoma patients if the tumour was located elsewhere than in the long bones. No patient with a tumour in the scapula lived as long as five years and the average period of survival from the moment of diagnosis was 1.1 years. For patients with osteo-sarcoma in the ribs the prognosis was even worse, none surviving longer than 0.4 years.

The prognosis for osteo-sarcoma if the tumour is in the pelvis or the spine is poor, because radical excision of the tumour is seldom possible.

Prognosis was good for the four patients who had osteo-sarcoma in the maxilla. All these tumours were treated by means of radical resection and radiation; all the patients have survived for more than five years and are still symptom-free.

Table 21. Survival rate for 869 patients suffering from primary malignant bone tumours (crude survival).

Type of tumour	Survival					
	0—1 years %	1—2 years %	2—3 years %	3—4 years %	4—5 years %	≧10 years %
Bone-forming tumours						
Osteo-sarcoma	55.3	38.2	33.3	30.9	28.4	24.8
Parosteal osteo-sarcoma	100.0	100.0	100.0	100.0	75.0	75.0
Cartilage-forming tumours						
Primary chondro-sarcoma	66.0	49.0	41.5	37.7	35.8	27.3
Secondary chondro-sarcoma	93.3	93.3	86.7	73.3	66.7	58.8
Giant-cell tumours						
Malignant giant-cell tumour	80.0	68.0	68.0	68.0	64.0	64.0
Bone-marrow tumours						
Ewing's sarcoma	55.6	27.8	16.6	16.6	16.6	16.6
Reticulum-cell sarcoma	42.9	35.7	28.9	21.5	21.5	12.9
Lympho-sarcoma	66.7	0.0	0.0	0.0	0.0	0.0
Solitary myeloma	50.0	50.0	50.0	50.0	50.0	25.0
Type NUD						
Type IgG						
Multiple myeloma	38.1	19.1	8.9	6.0	4.8	3.0
Type NUD	26.2	11.9	2.3	2.3	0.0	0.0
Type IgA	36.4	12.3	4.7	3.9	2.3	2.3
Type IgG	40.4	22.6	11.2	7.8	6.4	4.3
Type IgM	33.3	0.0	0.0	0.0	0.0	0.0
Extra-medullary plasma-cytoma	80.0	80.0	70.0	60.0	50.0	30.0
Type NUD	89.9	89.9	78.7	67.4	56.1	33.3
Type IgA	100.0	0.0	0.0	0.0	0·0	0.0
Vascular tumours						
Angio-sarcoma	25.0	25.0	25.0	25.0	25.0	25.0
Haemangio-pericytoma-sarcoma	50.0	50.0	50.0	50.0	0.0	0.0
Other connective-tissue tumours						
Fibro-sarcoma	50.0	35.7	28.7	21.5	21.5	10.8
Primary malignant fibrous histio-cytoma	66.7	56.0	45.0	33.0	22.2	11.1
NUD sarcoma	33.3	22.0	16.5	11.0	11.0	11.0
Radiation sarcoma	0.0	0.0	0.0	0.0	0.0	0.0
Fibrolipo-myxoma malignum	100.0	100.0	100.0	100.0	100.0	100.0
Chondro-myxoma malignum	100.0	100.0	0.0	0.0	0.0	0.0
Fibro-myxoma malignum	100.0	100.0	100.0	100.0	100.0	100.0
Other tumours						
Chordoma	60.0	40.0	40.0	40.0	40.0	0.0
Neuro-sarcoma	100.0	0.0	0.0	0.0	0.0	0.0

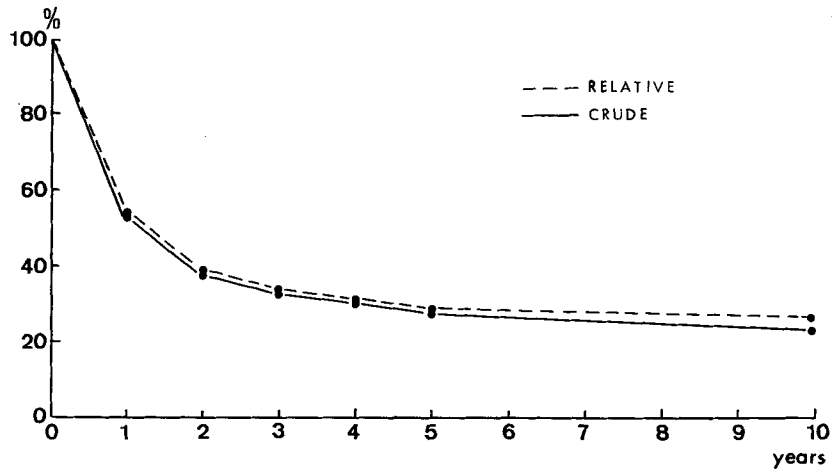

Figure 6. Survival curves for those suffering from osteo-sarcoma; 123 patients (relative and crude survival).

The longest period of survival for a patient with osteo-sarcoma in the mandibula was 1.2 years.

5.11.2.1.2. Parosteal osteo-sarcoma

The 5-year and 10-year survival rates for parosteal osteo-sarcoma were 75 %.

5.11.2.1.3. Discussion

The common treatment for osteo-sarcoma in long bones is radical ablative surgery. 64 patients (73.6 %) with osteo-sarcoma in long bones were treated by means of radical amputation or ex-articulation. Massive cytostat treatment had not yet

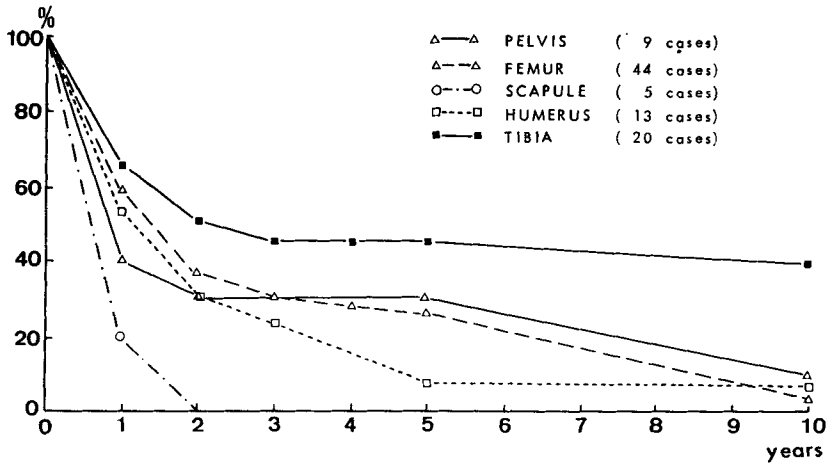

Figure 7. Survival curves for osteo-sarcoma patients with tumours in the scapula, pelvis and femur (crude survival).

been developed when the patients in this study were being treated. With three exception all those patients with osteosarcoma in long bones who survived for more than five years were treated by means of ablative surgery.

The five-year survival rate was particularly bad for patients who had a tumour elsewhere than in long bones. The prognosis in this study for patients with tumours in the scapula, ribs, spine or skull is worse than in the report by Dahlin (1972). The results of treatment for tumours in the mandibula were equally bad and deviated from the results generally reported elsewhere (Garrington et al. 1967).

According to the findings of the present study it is possible by means of radiation to slow down the growth of a tumour and prolong the period of survival. It was impossible to determine the exact dose of radiation that had been given to each patient.

The prognosis for parosteal osteo-sarcoma is better than for any other primary malignant bone tumour. The three patients in this study with parosteal osteosarcoma, lived for more than ten years. This result compares favourably with those in other reports. All these patients were treated surgically.

5.11.2.2. Cartilage-forming tumours

5.11.2.2.1. Primary chondro-sarcoma

The five-year survival rate for primary chondro-sarcoma was 35.8 % and the 10-year survival rate 27.3 %.

The five-year survival rate for patients who had tumours in the femur was 14.3 %. The prognosis for those with tumours in the tibia was the same. Those patients with chondro-sarcoma in long bones who lived more than five years were treated with radical surgery. One patient with chondro-sarcoma in the pelvis, who lived more than ten years, underwent hemipelvectomy. Four of the 11 patients with chondro-sarcoma in the pelvis were treated with radiation and they lived for more than five years.

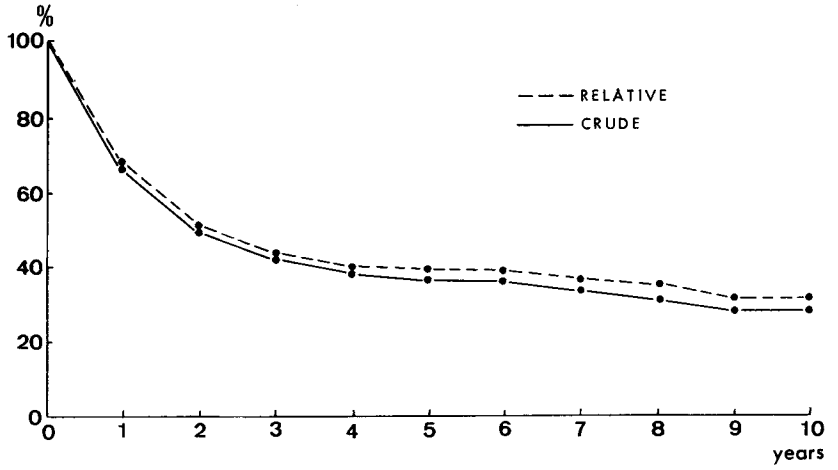

Figure 8. Survival curves for those suffering from primary chondro-sarcoma; 53 patients (relative and crude survival).

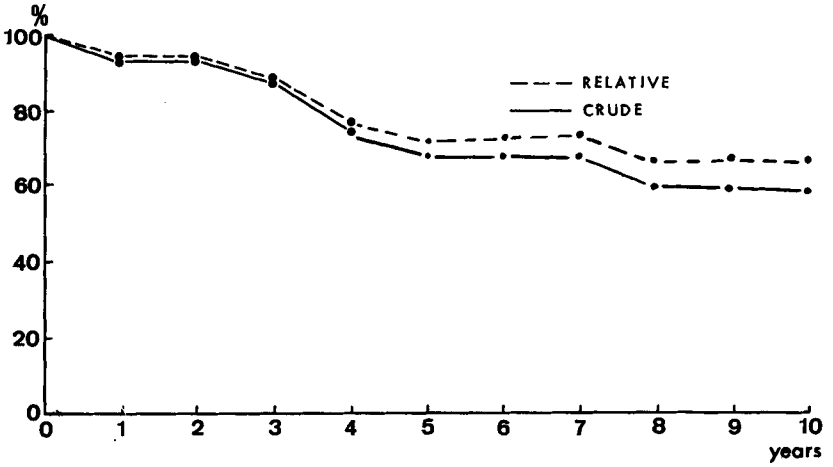

Figure 9. Survival curves for those suffering from secondary chondro-sarcoma; 15 patients (relative and crude survival)).

5.11.2.2.2. Secondary chondro-sarcoma

The five-year survival rate for secondary chondro-sarcoma was 66.7 % and the ten-year survival rate was 58.8 %.

Ten patients survived for more than five years. All of these had undergone surgery, four of them radical surgery.

5.11.2.2.3. Discussion

In the present study the prognosis for primary chondro-sarcoma was the same as for osteo-sarcoma, although it has generally been considered better (Dahlin 1972). The prognosis for secondary chondro-sarcoma is twice as good as that for primary chondro-sarcoma. The general idea seems to be that the results of treatment for secondary chondro-sarcoma are good in a short term follow-up, but bad in a long term follow-up (Lindbom et al. 1961, Dahlin 1972). This concept is not borne out by the results of the present study. Our findings suggest that in certain cases it may be worth considering whether, instead of radical ablative surgery one may not use a less disabling surgical intervention.

5.11.2.3. Giant-cell tumours

5.11.2.3.1. Malignant giant-cell tumour

The five-year survival rate for malignant giant-cell tumours was 64.0 % and the ten-year survival rate was the same.

5.11.2.3.2. Discussion

The prognosis for malignant giant-cell tumours is good, if the primary treatment is radical (Dahlin 1972, Koskinen 1978). The present study showed that in some cases conservative surgical treatment was possible. Late metastases, even after ten years, sometimes occur.

5.11.2.4. Bone-marrow tumours

5.11.2.4.1. Ewing's sarcoma

Both the five-year and ten-year survival rates for Ewing's sarcoma were 16.6 %.

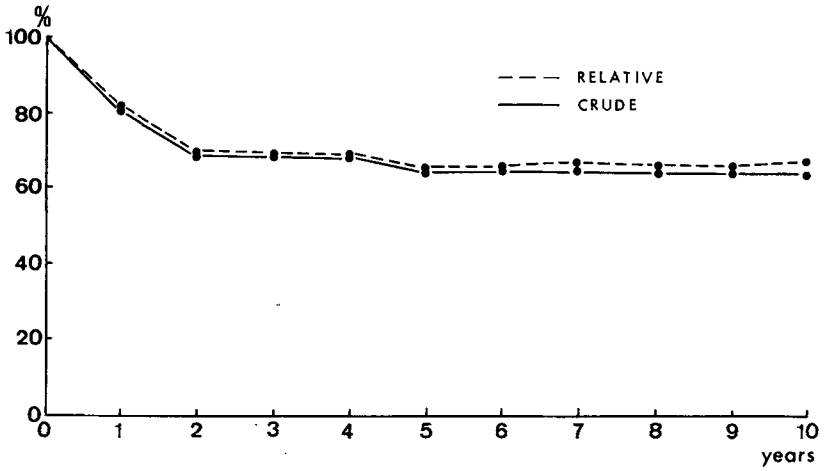

Figure 10. Survival curves for those suffering from malignant giant-cell tumours; 25 patients (relative and crude survival).

It is typical of Ewing's sarcoma that it develops early metastases and the prognosis is poor. In the present series, distant metastases developed within nine months in all certified cases. Prognosis was best if the tumour was in the tibia, the average survival period for such cases being 1.7 years. Three patients lived for over five years. One with a tumour in the caput humeri, was treated with radical radiation. The other two had tumours in the femur: in one case the tumour was in the distal metaphysis and that patient underwent hemipelvectomy; the other patient had a tumour in the diaphysis and the treatment was amputation. These results are comparable with what has been reported earlier (McCormack et al. 1952,

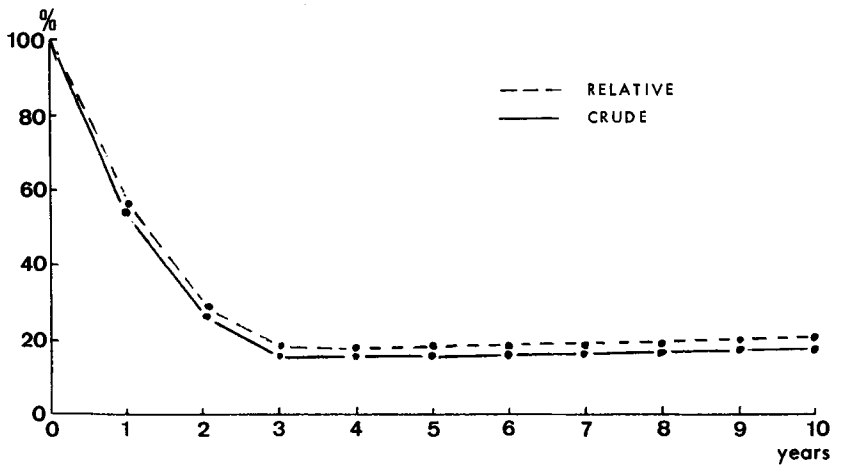

Figure 11. Survival curves for those suffering from Ewing's sarcoma; 18 patients (relative and crude survival).

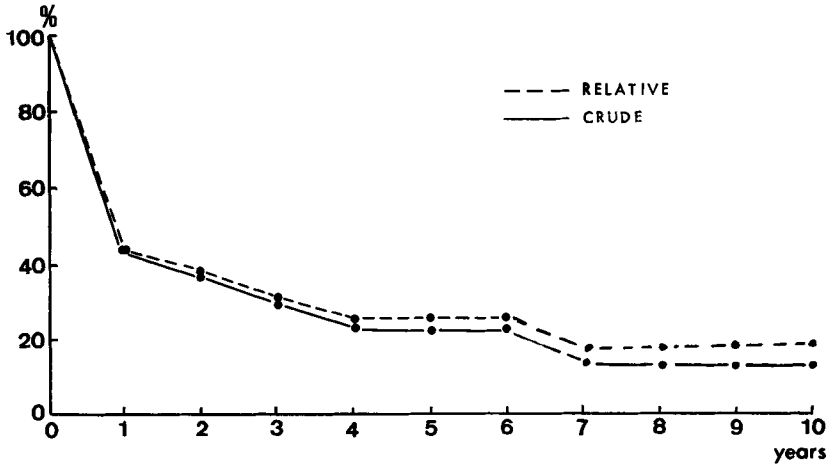

Figure 12. Survival curves for those suffering from reticulum-cell sarcoma; 14 patients (relative and crude survival).

Wang 1953, Phelan et al. 1964, Phillips et al. 1967, Dahlin 1972).

5.11.2.4.2. Reticulum-cell sarcoma

The 5-year survival rate for reticulum-cell sarcoma was 21.5 % and the 10-year survival rate was 12.9 %.

Three patients who lived more than five years were treated with radiation and with a combination of radiation and cytostats. In two cases the tumour was located in the femur and in one in the spine.

5.11.2.4.3. Lympho-sarcoma

The five-year and ten-year survival rates for lympho-sarcoma were 0 %. Not a single patient lived as long as two years from the moment of diagnosis.

The treatment of patients suffering from

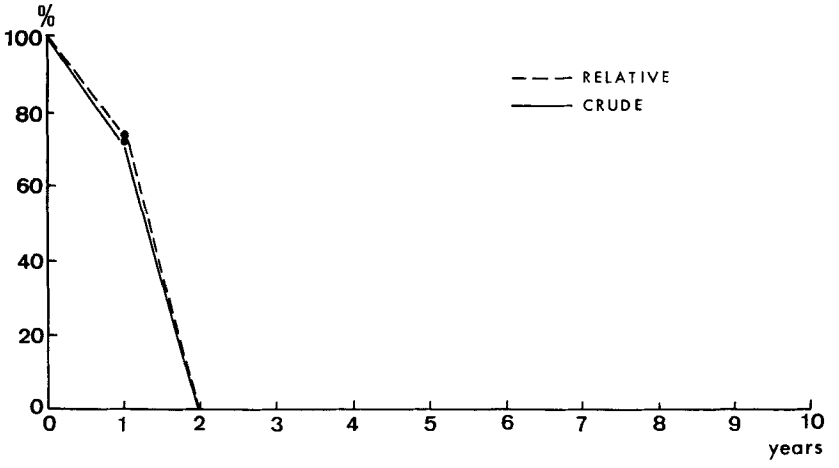

Figure 13. Survival curves for those suffering from lympho-sarcoma; 6 patients (relative and crude survival).

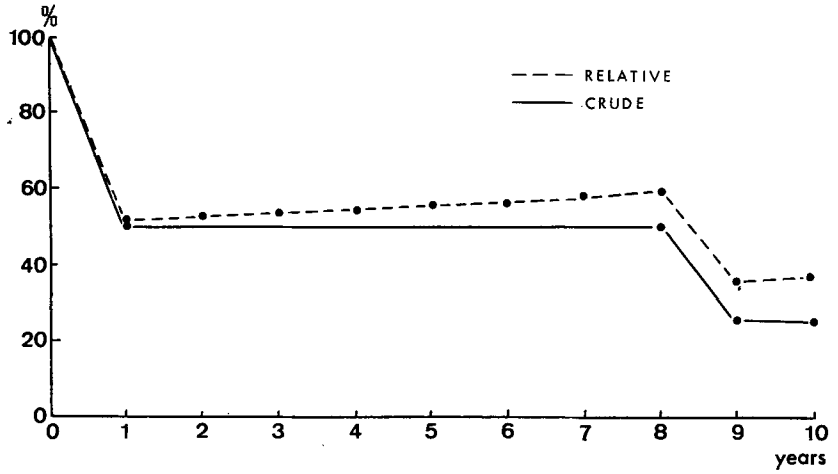

Figure 14. Survival curves for those suffering from solitary myeloma; 10 patients (relative and crude survival).

lympho-sarcoma did not differ from that for patients with reticulum-cell sarcoma, but the prognosis was worse.

5.11.2.4.4. Solitary myeloma

The five-year survival rate for solitary myeloma were 50.0 %, and the ten-year survival rate was 25.0 %.

Four of the five solitary myeloma patients who lived for more than five years were given radiation treatment. Two of them underwent palliative surgery. One patient was given anabolic hormones.

5.11.2.4.5. Multiple myeloma

The five-year survival rate for patients suffering from multiple myeloma was 4.8 % and the ten-year survival rate was 3.0 %.

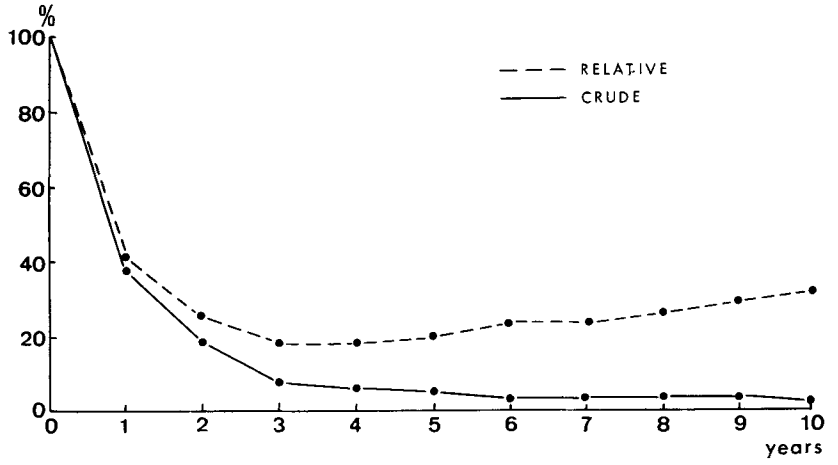

Figure 15. Survival curves for those suffering from multiple myeloma; 533 patients (relative and crude survival).

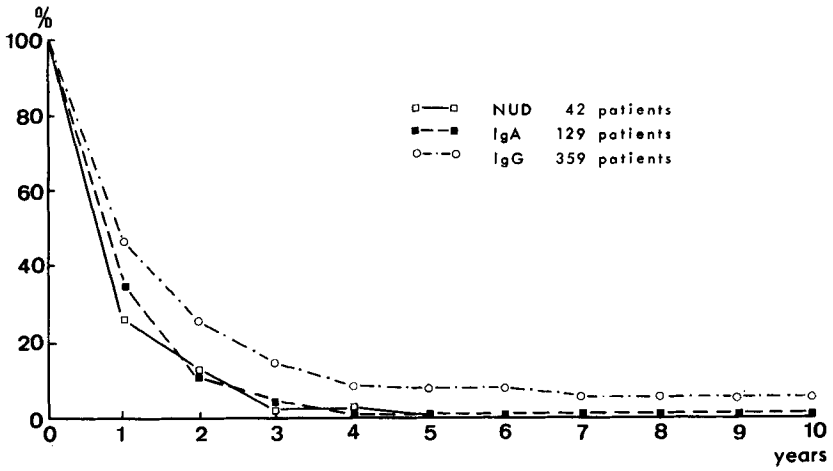

Figure 16. Survival curves for patients suffering from multiple myeloma types NUD, IgA and IgG (crude survival).

Of those patients suffering from multiple myeloma, 131 (24.6 %) were given cytostat treatment and the five-year survival rate was 7.6 %. 90 patients (16.9 %) received cytostat and radiation treatment, the five-year survival rate being 4.4 %. 78 patients (14.6 %) received cytostat and cortisone treatment, the five-year survival rate being 3.8 %. Of those patients who received radiation, cortisone, urethane, anabolic hormone and radio-active fluoride treatment or a combination of these, not one lived for five years. Of the 130 patients (24.4 %) who received basic treatment two patients lived more than five years.

The average survival periods were 0.7 years for the NUD type, 0.8 years for the IgA type, 1.1 years for the IgG type and 0.9 years for the IgM type. If we compare different methods of treatment, the average period of survival when a combination of cytostat and radiation treatment was used was 1.6 years; for cases of IgG myeloma the average period of survival when radiation and cortisone treatment were combined was 1.9 years. However, these figures are not statistically significant owing to the small number of patients involved (9). With all other methods of treatment, the average period of survival was less than one year.

5.11.2.4.6. Extra-medullary plasmacytoma

The five-year survival rate for patients suffering from extra-medullary plasmacytoma was 60 % and the ten-year survival rate was 30.0 %.

Two of the six extra-medullary plasma-cytoma patients who lived for over five years had been treated surgically and with radiation. Two patients were given radiation treatment and one was treated by means of surgical extirpation.

5.11.2.4.7. Discussion

In the present study the five-year survival rate for Ewing's sarcoma corresponded approximately to that reported by other investigators. The basis of present experimental treatment is massive cytostat treatment, a combination of three or four

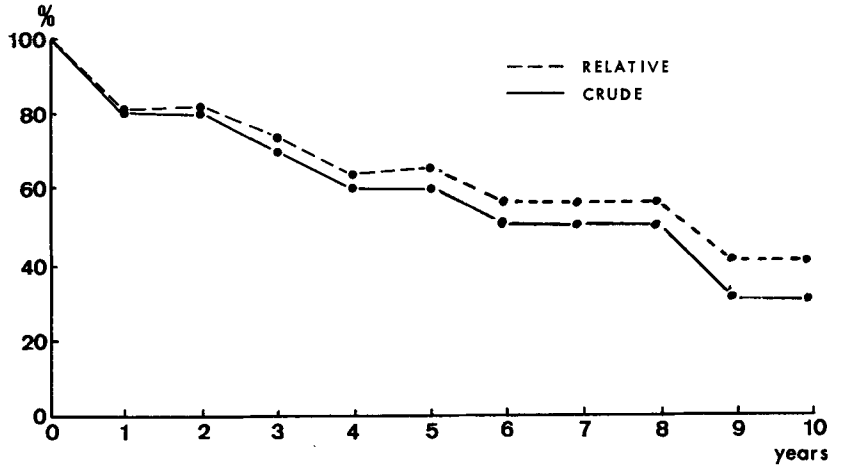

Figure 17. Survival curves for those suffering from extra-medullary plasma-cytoma; 10 patients (relative and crude survival).

drugs, plus surgical and radiation treatment (Jenkin et al. 1976). No other form of treatment is possible, because in this disease micro-metastases develop early. There are as yet no published reports of a long term follow-up of patients treated in this way.

The results of treatment for reticulum-cell sarcoma were clearly worse in this study than in most other reports. The average period of survival was 1.5 years. Only three of the 14 reticulum-cell sarcoma patients lived more than five years. Two patients had a tumour in the femur and were treated with radiation; one of them was also given cytostat treatment, which has been found effective by other investigators (Shoji et al. 1971, Dahlin 1972).

In the present study the prognosis for lympho-sarcoma, unlike that in other reports (Mincey et al. 1974), was exceptionally bad.

For myeloma, both the treatment given and the prognosis corresponded exactly with what has been reported elsewhere. In treating solitary myeloma, a combination of surgery and radiation gave good results, which corresponds with the picture given by other investigators (Gosepath et al. 1969). The results of treatment for multiple myeloma are very poor and the average period of survival as from the moment of diagnosis was less than one year. This is about the same as reported elsewhere (Carson et al. 1955, Baldwin, et al. 1967, Dahlin 1972).

The prognosis for extra-medullary plasma-cytoma is good if the location and spread of the tumour allow radical treatment to be undertaken (Poole et al. 1968). In the present study, the five-year survival rate was 60.0 %. The ten-year survival rate was only 30.0 % however, which is in keeping with the finding that late metastases are common with extra-medullary plasma-cytoma (Gosepath et al. 1969).

5.11.2.5. Vascular tumours

5.11.2.5.1. Angio-sarcoma

Of the four patients suffering from angio-sarcoma, one lived for over five years.

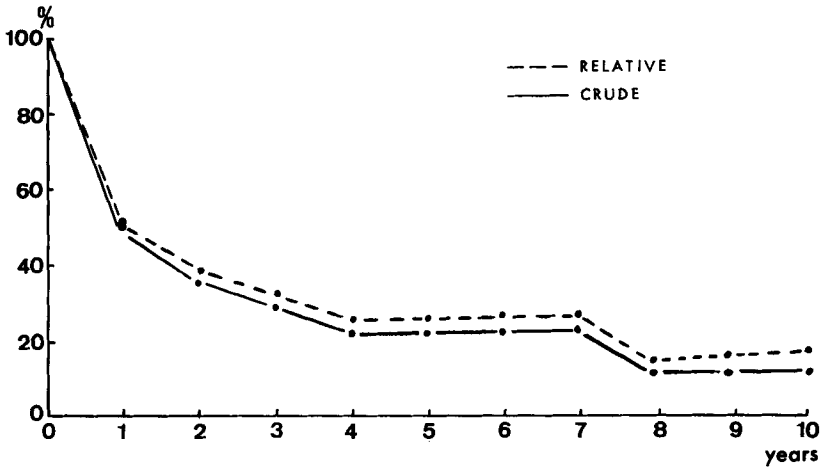

Figure 18. Survival curves for those suffering from fibro-sarcoma; 14 patients (relative and crude survival).

5.11.2.5.2. Haemangio-pericytoma-sarcoma

Neither of the two patients suffering from haemangio-pericytoma-sarcoma lived as much as five years.

5.11.2.5.3. Discussion

The prognosis for angio-sarcoma and haemangio-pericytoma-sarcoma cannot be established with any certainty on account of the rarity of these tumours. The treatment recommended follows the same principles as that for osteo-sarcoma (Dahlin 1972). In the light of the individual cases in the present study it may be said that the tumours are rather malignant. Prognosis is very poor.

5.11.2.6. Other connective-tissue tumours

5.11.2.6.1. Fibro-sarcoma

The 5-year survival rate for patients suffering from fibro-sarcoma was 21.5 % and the ten-year survival rate was 10.8 %.

All the fibro-sarcoma patients who lived for more than five years were treated by means of radical surgery and radiation. One tumour located in the mandibula was treated by means of local evacuation and radiation.

5.11.2.6.2. Primary malignant fibrous histio-cytoma

The five-year survival rate for patients suffering from primary malignant fibrous histio-cytoma was 22.2 % and the ten-year survival rate was 11.1 %.

Of the nine patients suffering from primary malignant fibrous histio-cytoma, two lived for more than five years. Both were treated by means of radical ablative surgery.

5.11.2.6.3. NUD sarcoma

For NUD sarcoma, both the five-year and ten-year survival rates were 11.1 %.

5.11.2.6.4. Radiation sarcoma

The average period of survival for the two patients in the study was 0.3 years.

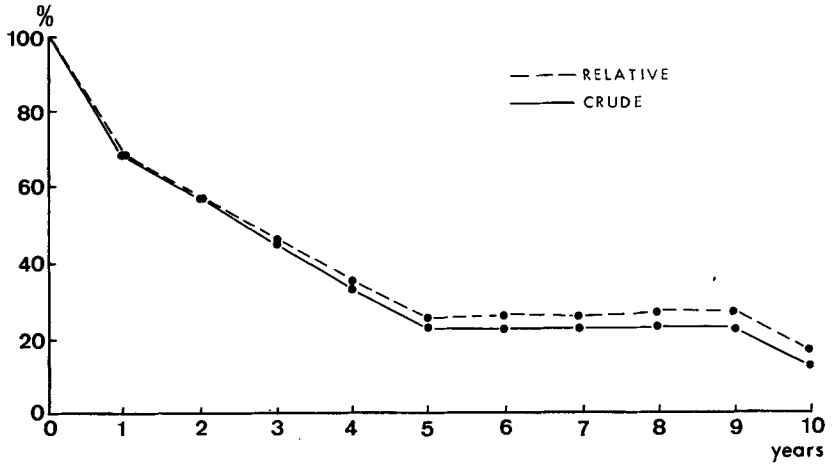

Figure 19. Survival curves for those suffering from primary malignant fibrous histiocytoma; 9 patients (relative and crude survival).

5.11.2.6.5. Fibrolipo-myxoma malignum

The one patient in this study who had fibrolipo-myxoma malignum has lived, without symptoms, for eight years.

5.11.2.6.6. Chondro-myxoma malignum

The only patient in this study who had chondro-myxoma malignum lived for 1.5 years after evacuation of a tumour in the trocanter of the femur.

5.11.2.6.7. Fibro-myxoma malignum

The only patient in this study who had a fibro-myxoma malignum in the skull lived for 7.4 years after local extirpation and post-operative radiation treatment.

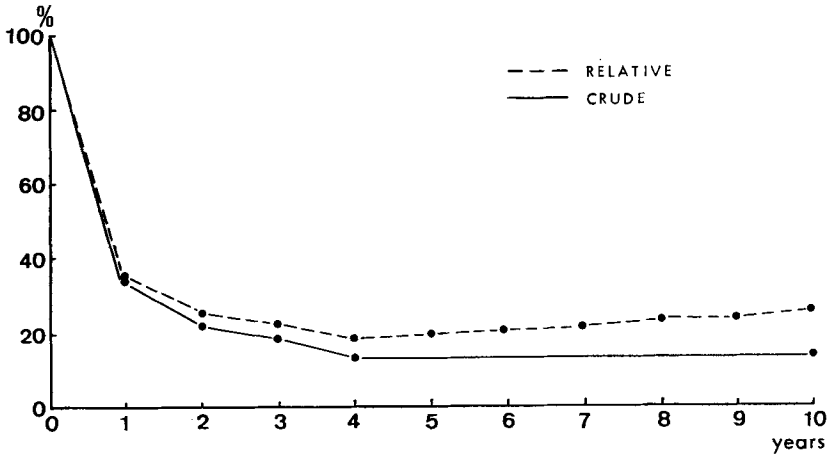

Figure 20. Survival curves for those suffering from NUD sarcoma; 18 patients (relative and crude survival).

5.11.2.6.8. Discussion

25 % of fibro-sarcomas are of the secondary type (Dahlin 1972); in the present study there was one fibro-sarcoma which stemmed from Paget's disease. The survival rates published here correspond well with those reported elsewhere (Eyre-Brook et al. 1969, Dahlin 1972). All the three patients who lived for more than five years were treated surgically and with radiation. The treatment for fibro-sarcoma is the same as that for osteo-sarcoma.

It is only a few years ago that primary malignant fibrous histio-cytoma was discovered and there is no information about prognosis. In the present study it was found to be very malignant and prognosis was worse than for osteo-sarcoma. The average period of survival was 1.8 years and the results of treatment were similar to those reported elsewhere (Spanier et al. 1975, Slootweg et al. 1975, Webber et al. 1977).

In the present study, NUD sarcoma was considered as a separate disease, because the most precise diagnosis possible in further histo-pathological study was that it was a primary bone tumour of the sarcoma type. Prognosis was worse than for osteo-sarcoma and treatment must be as radical as for osteo-sarcoma.

Radiation sarcoma, fibrolipo-myxoma malignum, chondro-myxoma malignum and fibro-myxoma malignum are all rare tumours and there is no precise information about prognosis or treatment. Surgical treatment similar to that for osteo-sarcoma is necessary.

5.11.2.7. Other tumours

5.11.2.7.1. Chordoma

There were five patients with chordoma in the present study. One had a tumour in the spine and lived for 0.6 years and another had a tumour in the skull and lived for 1.3 years. Three patients had a tumour in the sacrum; two of these were removed surgically and both the patients in question lived for 8.9 years. The third, who only received basic treatment lived for 0.4 years.

5.11.2.7.2. Neuro-sarcoma

Only one patient in the present study had neuro-sarcoma. The tumour was located in the 4th lumbar vertebra. After extirpation of the tumour and post-operative radiation treatment, this patient lived for 0.2 years.

5.11.2.7.3. Discussion

Because of the anatomical location of the tumour, it is seldom possible with chordoma to undertake radical surgery. However, the tumour grows slowly and thus palliative surgery often gives satisfactory results. A similar picture is given by Greenwald (1957) and Dahlin (1972). In the present study, there was no case in which radical surgery was possible.

Neuro-sarcoma is an extremely rare tumour and there are no reports about treatment or prognosis. In the light of individual cases it has been considered that treatment should follow the same lines as that for osteo-sarcoma (Güthert 1972).

6. GENERAL DISCUSSION

Between 1962 and 1968 a total of 985 new primary malignant bone tumours were recorded in the Finnish Cancer Registry. The clinical follow-up comprised 869 patients (88.2 %); there were 316 cases of sarcoma and 553 cases of myeloma. In Finland, hospitals and departments of pathology are obliged to inform the authorities if they treat or diagnose malignant tumours and therefore the figures supplied by the Finnish Cancer Registry may be considered representative of the whole country.

The age and sex distribution of the 869 patients with primary malignant bone tumour included in the clinical study corresponds to that in earlier reports (Dahlin 1972). There were no examples of the very rarest tumours in the present series. Primary malignant fibrous histio-cytoma was diagnosed in Finland for the first time in this study and there were nine cases. The basis for the histo-pathological classification was the schema published by the World Health Organization (Schajowicz et al. 1972) supplemented by some additional categories for Finnish conditions (Sorvari 1976).

In bone sarcomas symptoms lasted 4.6 months and in myelomas 6.6 months. There were three cases where the correct diagnosis was not made and the patient received inadequate treatment. In many cases the diagnosis was delayed after the primary lesion was detected.

A correct radiological diagnosis was made, using ordinary radiographs, in 91.4 % of cases. This corresponds approximately to results reported elsewhere (Lodwick 1967, Ranke 1968).

Angiography was usually helful for determining the extent of the tumour outside the bone involved. Angiography may also be helpful for differentiating chondrosarcoma from benign osteo-chondroma, but in general it does not help when trying to distinguish between benign and malignant bone lesions (Yaghmai 1979). It is valuable in preoperative planning, particularly in the case of malignant tumours of the pelvis.

Scintigraphy is an important method for revealing primary malignant bone tumours. Because the series studied consists of cases in the nineteen-sixties, scintigraphy was used in only 26 cases. No conclusions concerning its value can therefore be drawn. It does, however, seem to be of great value for detecting local bone marrow and distant metastases. It is also useful in planning radiographical examinations and in post-operative follow-up.

A frozen section taken during surgery may sometimes be helpful, but generally the diagnosis should be made before surgery is embarked upon, radiologically and

with the aid of histological examination of adequate biopsy specimens. In the present series a frozen section was examined in 41 cases and malignancy was confirmed in 85.4 % of these cases.

There were two cases in this series where the malignancy was certainly caused by earlier radiation treatment. There was one case where Paget's disease had developed into osteo-sarcoma; this is very rare in Finland. The effect of radiation in Paget's disease is well documented (Marie et al. 1910, Cohen et al. 1948, Esposito et al. 1960, MacKenzie et al. 1967). Because of the risk involved, radiation treatment is no longer used for treating benign bone lesions. In the present study, there was no case in which trauma could ascertained as an etiological factor, although it is often mentioned in literature on the subject (Phemister 1948, Hellner 1966, Fisher 1971).

Laboratory studies for bone sarcomas are simple routine tests and in the present study the results of these tests corresponded to those reported elsewhere (O'Hara 1968, Derian et al. 1972). Laboratory diagnosis of myeloma has developed rapidly and it was possible to classify 95.2 % of myelomas into immunological sub-groups. Laboratory tests are of especial significance in following the progress of primary malignant tumours.

In recent years, since the practice of extensive bone resections became widespread, ablative surgery has been less favoured as a means of treating bone tumours. In the present study 64 osteo-sarcoma patients (52.0 %) were treated by means of ablative surgery. Radical bone resection was performed in 10 cases. Since the period when the patients in this study were undergoing treatment allograft bone transplants and bio-mechanical prostheses have been developed, which make possible even more extensive bone resections (Volkov 1970, Parrish 1972, Ottolenghi 1973, Koskinen 1978). Local resection or evacuation proved to be a poor method of treatment, because of recurrence of tumours. Evacuation was performed on six patients, many of whom later had to undergo amputation on account of recurrence. This experience was similar to that reported by Koskinen (1978).

With the development of surgical and cytostat treatment, the importance of radiation for treating solid bone tumours has diminished in recent years (Koskinen 1976). However, even for osteogenic and chondrogenic tumours which cannot be radically removed, radiation treatment increases the survival time and it is justified as palliative treatment especially among older patients (Nordman 1979). In our study 99 sarcoma patients were treated with radiation only and it was commonly used as a supplement to surgery.

Treatment with cytostatic agents has developed rapidly since the introduction of combined treatment. Most patients in this study were given cytostat treatment which consisted of a small dose of a single drug. 62.7 per cent of myeloma patients received cytostat treatment in some form.

Immunological treatment and interferon are still at the experimental stage (Koskinen 1975, Tallberg 1976, Salenius 1977, Cantell 1978).

The therapy for primary bone sarcomas and multiple myelomas is very different. Bone-forming tumours have long been treated by means of ablative surgery when this is anatomically possible. The value of ablative surgery is reflected in the higher survival rates for patients with peripheral osteo-sarcomas. Thus, the five-year survival rate where there were tumours in the tibia was 45.0 % and where

there were tumours in the femur, 27.5 %. The five-year survival rate with humeral osteo-sarcomas was only 7.7 %, which is lower than that reported by Dahlin (1972). Because this group consisted of five cases only and because the therapy was probably not quite adequate in all of these cases, the difference is not significant.

The five-year survival rate does not give a dependable picture of parosteal osteo-sarcoma, because of the slow progression of the tumours and late development of metastases (Wolfel et al. 1969). There were only four parosteal osteo-sarcomas in the present series and it is thus impossible to draw any conclusion.

The prognosis for patients with cartilage-forming tumours is considered better that for those with osteo-sarcomas. In the present series, the five-year survival rate for primary chondro-sarcoma was 35.8 % and the ten-year survival rate was 27.3 %. Henderson and Dahlin (1963) reported a survival rate of 69.2 % in cases treated with adequate surgery. No useful conclusions can be drawn from comparing these results with those of the present study because our patients received different, and sometimes also inadequate treatment.

The prognosis for malignant giant-cell tumours is good when the primary treatment is radical (Dahlin 1972). Both the five-year and ten-year survival rates were treated by means of radical surgery and 64.0 %. In the present study, eight patients were treated by means of radical surgery and seven by means of local surgery. All these patients lived for more than five years. The patients who underwent local surgery were all given radiation treatment.

Bone-marrow tumours are usually very malignant primary bone tumours. Theoretically, massive combined treatment with cytostatic agents is especially indicated in order to destroy micro-metastases. Particularly in the case of Ewing's sarcoma the results after a short follow-up have shown improvement. The results of radical ablative surgery are not good. In the present study, the prognosis for reticulum-cell sarcoma was worse than that reported in literature generally. The five-year survival rate was 21.5 %; only three patients treated with radiation lived for five years, although it is generally considered that radiation gives good results in the treatment of reticulum-cell sarcoma (Coley et al. 1950, Shoji et al. 1971, Miller et al. 1971). The prognosis for lympho-sarcoma was even worse, not a single patient surviving for as much as two years. This is not as good as results reported elsewhere (Mincey et al. 1974).

According to most investigators the best way of treating solitary myeloma is with a combination of surgery and radiation (Dahlin 1972). In individual cases, a period of survival as long as 30 years has been reported (Pancovich et al. 1972). In the present study, the five-year survival rate was 50.0 % and the ten-year survival rate 25.0 %. It is known that as the years pass the disease develops into multiple myeloma and for that reason prognosis becomes worse as the follow-up time increases.

The prognosis for patients suffering from multiple myeloma is known to be poor, few patients surviving more than five years (Copeland 1967, Baldwin et al. 1967). In the present study the five-year survival rate was 4.8 %. There was no statistically significant difference in these rates when the treatment was a combination of different cytostatic agents and cortisone. Of the patients who received only basic treatment, not one lived for five

years. The immunological category to which the tumour belonged had no effect on the prognosis. The average period of survival for patients in the present study was as follows: IgA myeloma 0.8 years; IgG myeloma 1.1 years; IgM myeloma 0.9 years and NUD myeloma 0.7 years. A comparison of the results reveals that after combined cytostat and radiation treatment the period of survival was 1.6 years, whereas a combination of radiation and cortisone when dealing with the IgG type of myeloma gave a survival period of 1.9 years. However, on account of the small number of patients involved, these figures are not significant statistically.

The five-year survival rate for patients suffering from extra-medullary plasmacytoma was 60.0 % and the ten year survival rate was 30.0 %. These figures are in accord with what has been stated elsewhere about the development of late metastases (Gosepath et al. 1969).

On the basis of individual cases reported in literature on the subject the treatment of and prognosis for primary malignant vascular tumours is the same as for osteosarcoma (Dahlin 1972).

In the case of other connective-tissue tumours it is typical that there is osteolytic damage, pathological fracture and the development of rather early metastases, all of which mean a poor prognosis. The five-year survival rate for fibro-sarcoma was 21.5 %, which is about the same as that reported in other studies (Gilmer et al. 1958, Eyre-Brook et al. 1969, Dahlin et al. 1969). In the present study, those fibro-sarcoma patients who lived for more than five years had been treated surgically and had also had radiation treatment. Because of the similar prognosis, the principles of treatment for osteo-sarcoma are completely applicable to fibro-sarcoma (Dahlin 1972). On account of its rarity and the small numbers involved, there is very little information about the prognosis and treatment for primary malignant fibrous histio-cytoma. In the light of the present study it may be said that it is at least as malignant a tumour as osteo-sarcoma, develops metastases just as early and requires similar principles of treatment (Spanier et al. 1975, Slootweg et al. 1975). The cases reported here are the first primary malignant fibrous histio-cytomas to be diagnosed in Finland. Because the prognosis is so bad, the NUD-sarcoma cases show convincingly that if it is not possible to achieve a clear histo-pathological diagnosis of malignancy, the tumour should be treated in the same way as osteo-sarcoma. Radiation-sarcoma, fibrolipo-myxoma malignum, chondro-myxoma malignum and fibro-myxoma malignum must also be treated in the same way as osteo-sarcoma.

Of those in the final group, »other tumours», chordoma is a tumour that grows slowly and can often only be treated palliatively. Of the five chordoma patients in this study it was possible to treat only two by means of radical surgery. For these, the period of survival was 8.9 years, whereas the longest period for those who were not operated on radically was 1.3 years. Treatment and prognosis for neuro-sarcoma are not well known. The general principle of treatment is the same as for osteo-sarcoma (Gilbert 1972).

7. SUMMARY AND CONCLUSIONS

Between the years 1962 and 1968, 985 new cases of primary malignant bone tumour were reported by the Finnish Cancer Registry. Because hospitals and departments of pathology are obliged to report all new cases to the central authority these figures may be considered representative for the country as a whole. Incidence was 3.16 primary malignant bone tumours per 10^5 inhabitants annually. Primary malignant bone tumours accounted for 1.25 % of all malignant tumours. These figures are comparable to those reported elsewhere (Swedish Cancer Registry 1960, The Cancer Registry of Norway 1964, Bristol Bone Tumour Registry 1971, Ott. et al. 1977).

The final study comprised 869 patients suffering from primary malignant bone tumour. Age and sex distribution was similar to that in earlier studies.

Pain at the site of the tumour was the first symptom in 88.6 % of sarcoma patients and 92.4 % of myeloma patients. In the case of three patients, correct treatment was significantly delayed because of a wrong diagnosis.

Plain radiography is the most important form of X-ray examination for primary malignant bone tumour. Angiography gives additional information that can be used in planning treatment. As it develops, X-ray examination aided by computer will be useful. Providing as it does a reasonably sure pre-operative diagnosis, this will facilitate the making of decisions about the method of treatment to be adopted.

Diagnosis of primary malignant bone tumour should be based on a histological examination. In the present series, it was shown that study of frozen sections led in 85.4 % of cases to a diagnosis of certain malignancy and was thus valuable for making decisions about treatment.

Tumours were classified as 21 different histological types. There were 553 cases of myeloma (63.6 %), 123 cases of osteo-sarcoma (14.2 %) and 68 cases of chondro-sarcoma (7.7 %). These were the most common types.

For osteo-sarcoma, radical ablative surgery was carried out on 64 patients, 32 of whom also had radiation treatment. Radical resection was performed on 10 patients, eight of whom received radiation treatment. Local resection was the treatment for six patients, all of whom were also treated with radiation. Evacuation was the treatment for six patients, five of these also being given radiation treatment. Radiation treatment was given to 26 patients, four of whom were also treated with cytostatic agents. There were eight patients who received no specific treatment, either because of their poor general condition or because they refused.

For chondro-sarcoma the number of pa-

tients who underwent radical ablative surgery was 22, seven of whom had radiation treatment. Radical resection was performed on eight patients, only one of these receiving radiation treatment. Nine patients had local resection, two of them also receiving radiation treatment. Evacuation was the treatment for four patients. In all, 22 patients received radiation treatment and of these, three also had cytostat treatment. Three patients received no specific treatment.

Metastases developed in more than 50 % of the sarcoma patients within six months. Patients suffering from secondary chondro-sarcoma or malignant giant-cell tumours had fewer metastases. It was unusual for metastases to develop later than 12 months after patients presented themselves for treatment.

The five-year survival rate for osteo-sarcoma was 28.4 % and the ten-year survival rate was 24.8 %. For primary chondro-sarcoma, the corresponding figures were 35.8 % and 27.3 %; for secondary chondro-sarcoma, 66.7 % and 58.8 %. The five-year and ten-year survival rates for malignant giant-cell tumours were 64.0 %. The corresponding figure for Ewing's sarcoma was 16.6 %. For reticulum-cell sarcoma the five-year survival rate was 21.5 % and the ten-year survival rate was 12.9 %. No patient suffering from lympho-sarcoma lived as long as two years.

The average period of survival for patients with multiple myeloma was 0.9 years. For those with the IgG type of myeloma the five-year survival rate was 6.4 % and ten-year survival rate was 4.3 %. The corresponding figures for other types were worse.

The prognosis for fibro-sarcoma was worse than that for osteo-sarcoma. The five-year survival rate was 21.5 % and the ten-year survival rate was 10.8 %. Malignant fibrous histio-cytoma of the bone is a very malignant tumour. The five-year survival rate was 22.2 % and the ten-year survival rate was 11.1 %. The prognosis for NUD sarcoma is very poor. The five-year survival rate is 11.1 % and the ten-year survival rate is the same.

In the light of the present study it may be asserted that because primary malignant bone tumours are rare and because the symptoms are rather slight, diagnosis may be delayed. Diagnosis should be based on histological examination and active treatment must be begun at once. The use of a combination of cytostatic agents has become an important method of treatment, particularly for bone-marrow tumours. Malignant fibrous histio-cytoma of the bone, now diagnosed in Finland for the first time, is a very malignant tumour which must be treated according to the same principles as osteo-sarcoma. If it is impossible to achieve an absolutely certain diagnosis for a primary bone tumour, but malignancy has been confirmed, the procedure for treatment should be as for osteo-sarcoma.

Generally speaking these has been a somewhat pessimistic view of the results of treatment in cases of primary malignant bone tumour. The present study shows, however, that prompt diagnosis and adequate treatment may considerably improve the prognosis and help patients, many of whom are younger than in other malignant diseases. If treatment were concentrated in important centres it seems seasnably certain that results would be even better.

8. ACKNOWLEDGEMENTS

I began the present study when I was working at the surgical clinic of the University Hospital in Turku, under the supervision of Professor Sauli Viikari, whose support and expert advice I here acknowledge with deepest gratitude. I owe a particular debt also to Professor Erkki Saxen, director of the Finnish Cancer Registry, who kindly made important records available to me. The further study of original histological material carried out by Dr. Tapani Sorvari was indispensable and for that work as well as much wise counsel received in the course of numerous discussions with him I am profoundly grateful. Dr. Sorvari's wide knowledge of the field has moreover enabled me to gain many valuable insights concerning bone pathology and the intricacies of clinical examination. In this context I wish to thank also Dr. Timo Romppainen for his assistance with the study of the histological material. I am profoundly appreciative of the help accorded me by Professor Pekka Virtama: he generously included me in his bone tumour study group and I have benefited greatly from the wisdom of his advice in matters radiological. Professor Virtama's further contribution, in analysing the X-rays used in this study, in checking the first draft of the radiological section of my work and in suggesting improvements to the text in the course of writing, is hereby gratefully acknowledged. I wish likewise to convey my thanks to Dr. Kalevi Katevuo for helping with the analysis of X-rays. I have been greatly helped, especially in the final stages of composition, by the sympathetic interest of Dr. Pär Slätis, head of the Division of Orthopaedic Surgery and Traumatology, Surgical Hospital, University Central Hospital, Helsinki, where I am at present working. The assistance I have received from Dr. Allan Aho, Assistant Professor of Surgery in Turku, has been spread over many years: he has followed the vicissitudes of the study from the very beginning and he has been unstinting in his advice and encouragement. He has also served as one of the official examiners and I have benefited in numerous ways from his wide clinical experience in the field of bone tumours. My obligation to Dr. Aho is thus considerable and I extend him my heartfelt thanks. I acknowledge, with respect, the contribution made to this study by Professor Erkki V. S. Koskinen. I have had the inestimable advantage of his friendship over many years and have been privileged to draw upon his wide experience in innumerable discussions. I remain especially indebted to him for what he has taught me about clinical investigations but I have also been able, under his guidance, to follow the progress of bone tumour patients undergoing treatment. Professor Koskinen was also an offi-

cial examiner for the thesis and his advice has helped me in many ways.

Among the many others who have rendered assistance I cannot omit to thank the following: Mr. Kari Helander, for familiarizing me with the statistical treatment of the material and looking after the automatic data processing; Mr. & Mrs. Antony Landon for translating the Finnish manuscript; Mrs. Kirsti Lundstedt for drawing the pictures; Miss Pirjo Rasivaara and Mrs. Terttu Kaisti for helping me to assemble material in the early stages; the heads of various hospitals and departments for supplying material; the staff of the Turku University medical library for their courtesy and co-operation.

Finally a word of praise for my long-suffering family. Without the patience and fortitude shown by my wife and children during the long years of waiting it is doubtful whether this book would ever have been completed. They have been to me a constant source of inspiration.

I am obliged to the Finnish Cancer Society for financial assistance.

Helsinki, November 1979

Pekka Jussila

9. APPENDIX

9.1. SKELETAL, AGE AND SEX DISTRIBUTION OF PRIMARY MALIGNANT BONE TUMOURS, ACCORDING TO HISTOLOGICAL DIAGNOSIS, 869 CASES. FIGS. 21—35

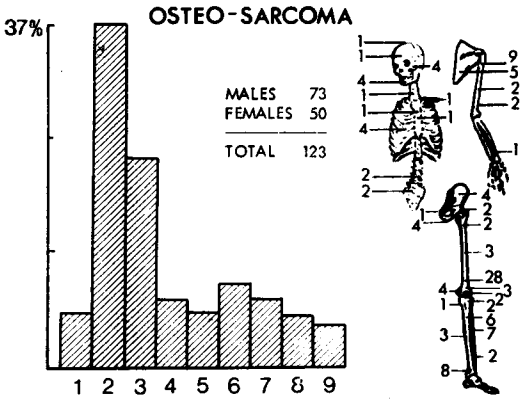

Fig. 21. Skeletal, age and sex distribution of 123 cases.

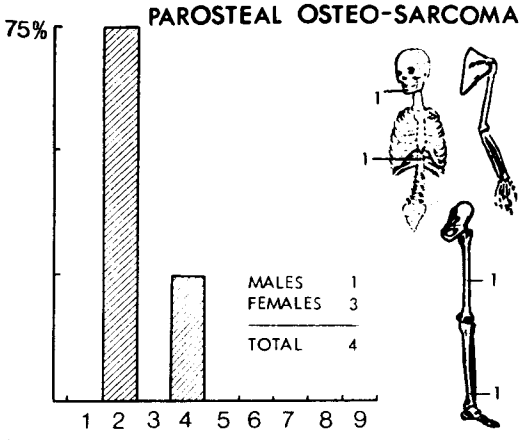

Fig. 22. Skeletal, age and sex distribution of 4 cases.

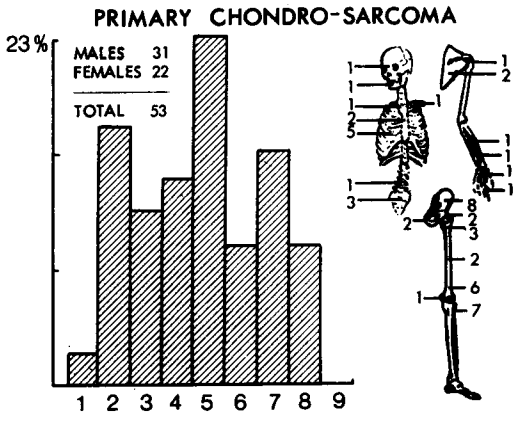

Fig. 23. Skeletal, age and sex distribution of 53 cases.

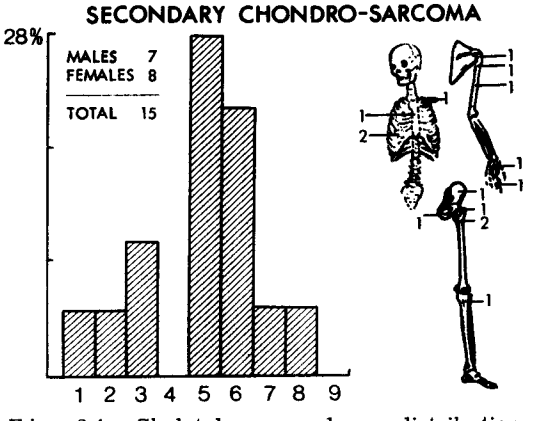

Fig. 24. Skeletal, age and sex distribution of 15 cases.

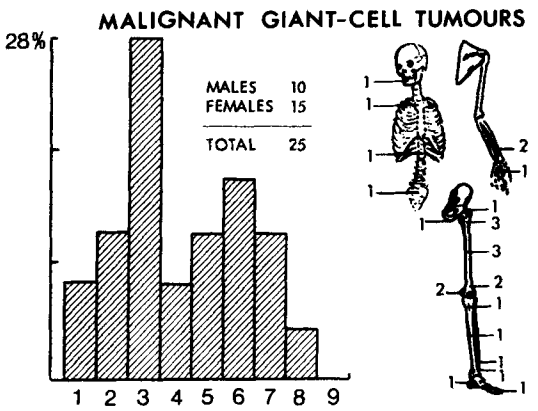

Fig. 25. Skeletal, age and sex distribution of 25 cases.

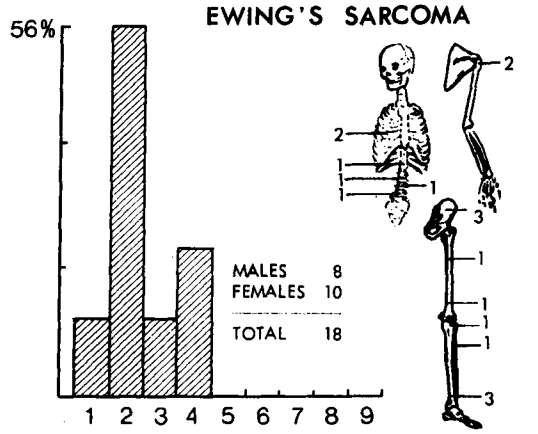

Fig. 26. Skeletal, age and sex distribution of 18 cases.

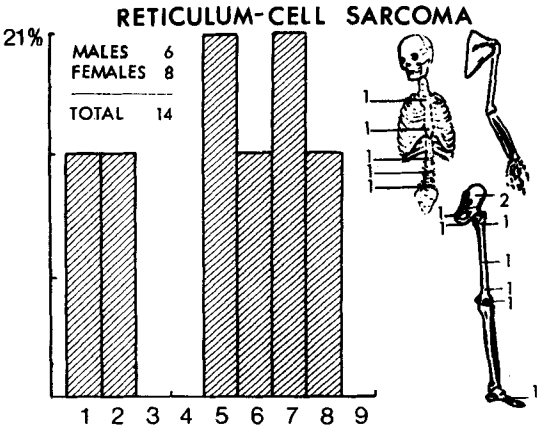

Fig. 27. Skeletal, age and sex distribution of 14 cases.

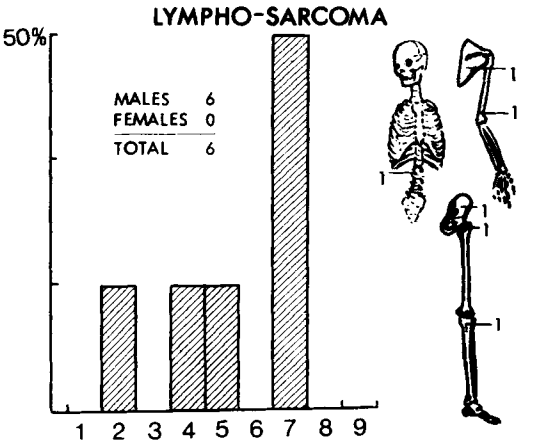

Fig. 28. Skeletal, age and sex distribution of 6 cases.

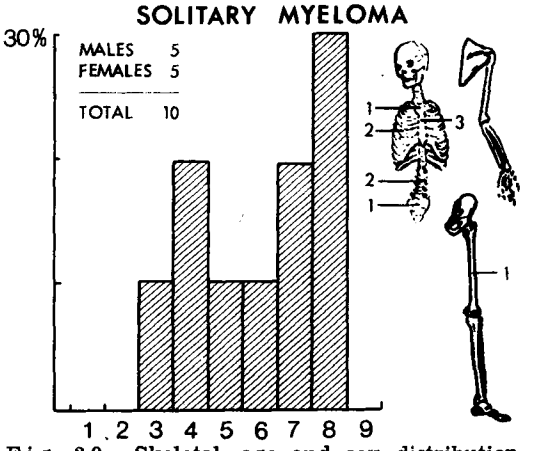

Fig. 29. Skeletal, age and sex distribution of 10 cases.

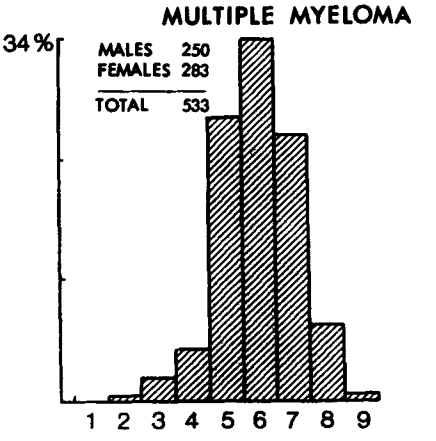

Fig. 30. Age and sex distribution of 533 cases.

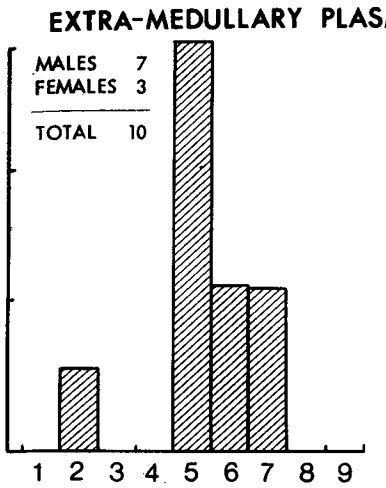

Fig. 31. Age and sex distribution of 10 cases.

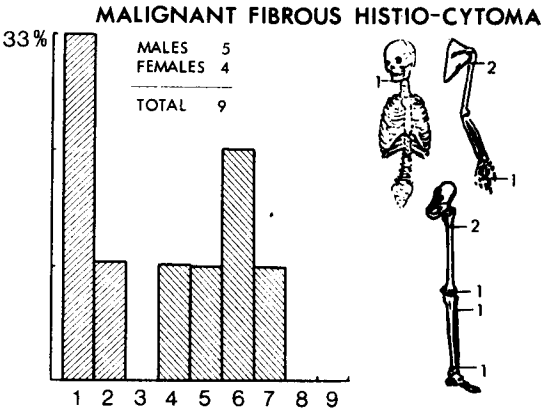

Fig. 34. Skeletal, age and sex distribution of 9 cases.

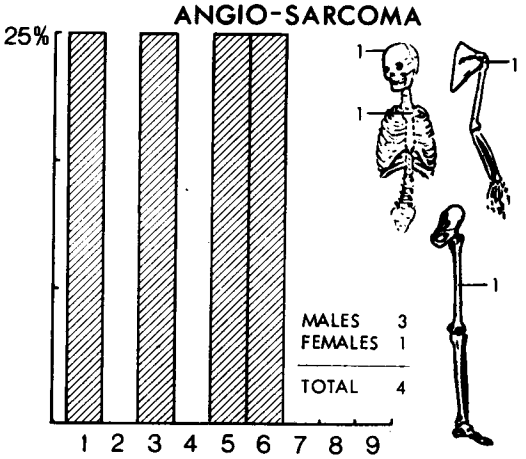

Fig. 32. Skeletal, age and sex distribution of 4 cases.

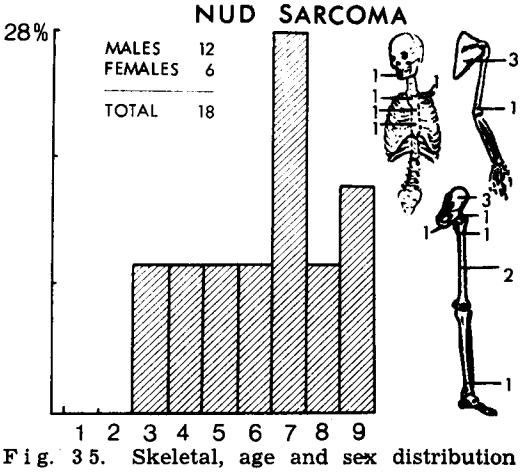

Fig. 35. Skeletal, age and sex distribution of 18 cases.

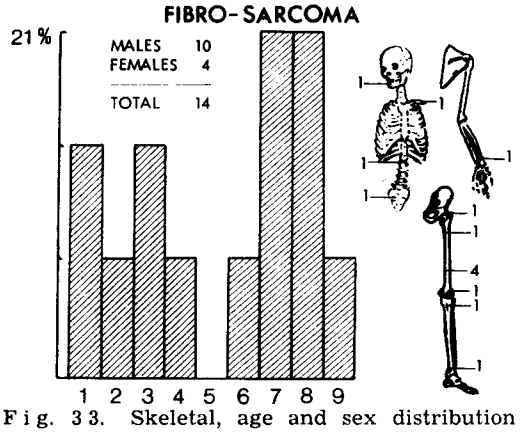

Fig. 33. Skeletal, age and sex distribution of 14 cases.

9.2. CLASSIFICATION OF PATIENTS ACCORDING TO LOCATION OF TUMOUR: TREATMENT, AVERAGE PERIOD OF SURVIVAL AND AVERAGE AGE, 336 CASES

9.2.1. Bone-forming tumours

Table 22. Osteo-sarcoma: location of tumour, treatment, average period of survival and average age. (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Rad.treatm.	4.8	65.6
	1	Basic treatm.	0.5	62.7
	2		2.7	64.1
Trochanter	1	Evac. + amp.	0.3	20.7
	1	Rad.treatm.	0.5	65.1
	2		0.4	42.9
Diaphysis	1	Preop.rad. + exartic.	0.3	41.7
	1	Amp.	L	23.0
	1	Part.res. + amput.	1.1	12.9
	3		0.7	25.9
Metaphysis dist.	6	Amp.	0.8	17.3
	2	Amp.	L	20.2
	1	Exartic.	1.7	11.1
	5	Preop.rad. + amp.	1.3	18.5
	1	Preop.rad. + amp.	L	8.8
	1	Amp. + evac.lymp nodes	0.7	16.9
	1	Amp. + postop.rad.	1.2	19.3
	1	Preop.cyt. + amp.	1.4	16.2
	1	Evac + amp.	L	11.4
	1	Preop.cyt. + amp.	L	17.5
	1	Evac. + rad.	6.2	57.0
	5	Rad.treatm.	1.0	23.7
	1	Amp. + postop.rad.	L	23.9
	1	Basic treatm.	0.8	23.1
	28		1.2	20.3
Epiphysis dist.	1	Preop.rad. + amp.	L	17.3
	1	Preop.rad. + amp.	2.0	17.8
	2		2.0	17.6

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Condylus lat.	1	Amp.	0.9	21.2
	1	Preop.rad. + amp.	L	20.5
	1	Rad.treatm.	0.9	16.3
	3		0.9	19.3
Condylus. med.	2	Amp.	2.0	21.2
	1	Amp.	L	27.3
	1	Preop.rad. + amp.	L	22.3
	4		1.5	23.0
Tibia				
Condylus lat.	1	Preop.rad. + amp.	L	17.2
	1	Preop.rad. + amp.	0.7	14.7
	2		0.7	15.9
Condylus med.	1	Amp.	1.3	18.3
Metaphysis prox.	3	Preop.rad. + amp.	L	13.5
	1	Evac. + part.res. + evac. lymph nodes	L	27.9
	1	Evac. + postop.rad.	1.9	13.0
	1	Rad.treatm.	0.3	8.0
	6		1.1	15.1
Diaphysis	1	Amp.	6.2	68.8
	1	Amp.	L	56.8
	1	Rad. + cyt.treatm.	0.9	16.3
	3		3.7	47.3
Metaphysis dist.	1	Amp.	L	14.3
	2	Amp.	1.4	16.2
	1	Preop.rad. + amp.	L	12.9
	3	Preop.rad. + amp.	1.2	14.5
	1	Evac. + rad.	0.9	25.4
	8		1.2	16.0
Fibula				
Metaphysis prox.	2	Amp.	L	16.0
	2	Preop.rad. + amp.	0.6	36.8
	1	Preop.rad. + loc.res. + amp.	2.3	18.6
	1	Amp. + postop.rad.	2.4	18.8
	1	Basic treatm.	0.4	81.0
	7		1.2	32.0
Metaphysis dist.	1	Amp.	L	21.0
	1	Evac. + amp.	1.8	30.2
	2		1.8	25.6

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Humerus				
Metaphysis prox.	1	Exartic.	2.5	27.8
	3	Preop.rad. + amp.	2.3	13.8
	1	Preop.rad. + exartic.	0.7	64.1
	1	Evac. + amp. + postop.rad.	2.0	24.0
	2	Rad.treatm.	1.1	18.3
	1	Cyt.treatm.	0.6	5.3
	9		1.4	22.2
Diaphysis	1	Extirp. + postop.rad.	L	40.5
	1	Cyt.treatm.	0.9	83.3
	2		0.9	61.9
Metaphysis dist.	1	Exartic. + postop.rad.	0.3	53.1
	1	Rad.treatm.	4.9	36.5
	2		2.6	44.8
Radius				
Metaphysis dist.	1	Preop.rad. + amp.	L	21.1
Skull				
Maxilla	1	Radic.res. + postop.rad.	L	27.6
	1	Radic.extirp. + postop.rad.	L	62.1
	1	Preop.rad. + radic.extirp.	L	29.8
	1	Preop.rad. + radic.res.	L	49.8
	4			42.3
Os parietable	1	Extirp. + postop.rad.	3.8	25.8
Os temporale	1	Evac. + radic.extirp. + postop.rad.	0.7	52.8
Mandibula	1	Radic.res. + postop.rad.	0.6	28.2
	1	Preop.rad. + exartic.	1.2	37.0
	1	Rad.treatm.	0.4	7.8
	1	Basic treatm.	0.1	67.8
	4		0.6	35.2
Columnae vertebralis				
C VI	1	Extirp. + postop.rad.	L	17.2
Th II	1	Rad.treatm.	1.3	34.0
L V	1	Extirp. + postop.rad.	0.5	37.2
	4		0.8	31.4
Pelvis				
S II	2	Rad.treatm.	0.6	58.8
Ileum	1	Rad.treatm.	L	59.7
	1	Rad.treatm.	0.7	50.8

Location of tumour	Patients No	Treatment	Survival period years	Average age years
	1	Rad.cyt.treatm.	0.9	21.7
	1	Basic treatm.	0.1	21.5
	4		0.6	38.4
Pubis	1	Radic.extirp.	L	33.8
Ischii	2	Rad.treatm.	0.8	65.5
	1	Rad. + cyt.treatm.	0.8	77.2
	1	Basic treatm.	9.0	52.7
	4		2.8	65.2
Clavicula	1	Preop.rad. + radic.extirp.	L	17.6
Sternum	1	Basic treatm.	0.3	17.6
Scapula	1	Preop.rad. + res.part.	0.5	31.8
	1	Evac. + postop.rad.	0.8	37.1
	1	Rad.treatm.	3.6	58.5
	1	Cyt.treatm.	0.8	80.7
	1	Basic treatm.	0.1	70.1
	5		1.1	55.6
Costa				
VII	1	Radic.extirp. + postop.rad.	0.3	53.4
IX	1	Preop.rad. + radic.extirp. + postop.rad.	0.4	55.4
VI	1	Rad.treatm.	0.3	69.8
XII	1	Cyt.treatm.	0.1	80.0
	4		0.3	64.7

Table 23. Parosteal osteo-sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still alive; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Diaphysis	1	Amp.	L	38.7
Tibia				
Metaphysis dist	1	Radic.res. + bone transpl.	L	23.0
Columnae vertebralis				
Th XI	1	Laminect + postop.rad.	L	21.3
Mandibula	1	Preop.rad. + extirp. + res.part.	3.7	25.1

9.2.2. Cartilage-forming tumours

Table 24. Primary chondro-sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still alive, survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Clavifix.	0.1	70.4
	1	Hemipelvect.	L	24.3
	2		0.1	47.6
Trochanter	1	Amp.	1.2	61.5
	1	Amp. + cyt.treatm.	0.9	10.8
	1	Rad.treatm.	0.8	43.0
	3		1.1	46.2
Diaphysis	1	Rad.treatm.	1.8	76.3
	1	Rad. + cyt.treatm.	0.6	15.3
	2		1.2	45.8
Metaphysis dist.	1	Exartic.	1.1	25.8
	1	Amp.	0.5	36.8
	1	Amp. + lymph nodes rad.	0.3	6.5
	1	Amp. + postop.rad.	1.0	15.4
	2	Amp. + postop.rad.	4.4	16.8
	6		1.8	19.7
Condyli med.	1	Preop.rad. + amp.	L	45.8
Tibia				
Metaphysis prox	2	Amp.	L	21.8
	2	Preop.rad. + amp.	1.6	17.3
	1	Amp.	2.0	18.1
	1	Amp. + postop.rad.	2.0	63.6
	1	Rad. + cyt.treatm.	0.5	10.0
	7		1.5	24.3
Humerus				
Collum	1	Rad.treatm.	1.9	49.0
Radius				
Diaphysis	1	Radic.res. + bone transpl.	L	25.4
Metaphysis dist.	1	Amp.	L	51.8
Manus				
Metacarpus	1	Evac. + exartic. + postop.rad.	L	49.8
Phalanx	1	Amp.	L	58.3

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Skull				
Basis	1	Basic treatm.	0.1	58.5
Os ethmoideum	1	Extirp. + postop.rad.	L	70.6
Columnae vertebralis				
Th IV	1	Extirp. + postop.rad. + cyt.	L	40.2
L IV	1	Extirp. + postop.rad.	0.7	26.1
	2		0.7	38.2
Pelvis				
Ileum	1	Hemipelvect.	L	20.6
	1	Rad.treatm.	L	45.0
	4	Rad.treatm.	1.3	55.2
	1	Rad. + cyt.treatm.	0.2	67.4
	1	Basic treatm.	0.3	64.4
	8		1.0	52.3
Pubis	1	Rad.treatm.	L	55.0
	1	Rad.treatm.	0.7	60.8
	2		0.7	57.9
S I	2	Rad.treatm.	L	48.9
	1	Rad.treatm.	0.4	24.0
	3		0.4	40.6
Sternum	1	Radic.extirp.	0.1	32.1
	1	Evac. + extirp.	L	33.1
	2		0.1	32.6
Scapula	1	Part.res.	1.3	47.9
	1	Rad.treatm.	1.0	61.5
	2		1.2	54.7
Clavicula	1	Radic.extirp.	2.8	44.9
Costa				
IV	1	Radic.extirp.	L	25.3
II	1	Radic.res. + Lobect.pulm. + postop.rad.	L	56.4
III	1	Part.res.	1.9	40.2
VIII—IX	2	Rad.treatm.	4.2	50.4
	5		3.4	44.4

Table 25. Secondary chondro-sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Preop.rad. + clavifix.	L	42.4
Trochanter	1	Evac. + bone transpl.	L	7.5
	1	Part.res. + Postop.rad. + cyt.	2.9	17.3
	2		2.9	22.4
Tibia				
Metaphysis prox.	1	Evac. + bone transpl.	L	56.8
Humerus				
Caput	1	Preop.rad. + exartic.	L	41.3
Metaphysis prox.	1	Part.res.exostosis	L	11.4
Diaphysis	1	Evac.	4.3	51.0
Manus				
Metacarpus	1	Evac. + bone transpl.	L	41.9
Phalanx	1	Amp.	L	46.1
Columnae vertebralis				
Th VIII	1	Part.res. + postop.rad.	L	41.4
Clavicula	1	Radic.res. + postop.rad.	L	23.8
Pelvis				
Ileum	1	Rad.treatm.	0.9	71.5
Pubis	1	Rad.treatm.	3.3	60.7
Costa				
II	1	Radic.extirp. + postop.rad. + cyt.	3.5	59.1
VI	1	Radic.extirp. + postop.rad.	L	58.1
	2		3.5	58.6

9.2.3. Giant-cell tumours

Table 26. Malignant giant-cell tumours: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Preop.rad. + radic.res. (endoproth.)	L	43.6
Trochanter	1	Radic.res. + bone transpl.	L	23.3
	1	Rad.treatm.	0.3	5.3
	1	Clavifix.	1.6	53.4
	3		1.0	27.3
Diaphysis	1	Amp.	1.8	63.3
	1	Evac. + clavifix.	0.7	72.2
	1	Clavifix. + amp.	4.8	66.3
	3		2.4	67.3
Condylus lat.	1	Evac. + bone transpl.	L	24.8
	1	Evac. + postop.rad.	L	50.3
	2		L	37.6
Condylus med.	1	Preop.rad. + amp.	0.6	15.8
	1	Evac. + postop.rad.	L	28.8
	2		0.6	22.3
Tibia				
Metaphysis prox.	1	Amp.	L	56.1
Diaphysis	1	Rad.treatm.	1.8	22.1
Metaphysis dist.	1	Preop.rad. + evac.	L	46.6
Fibula				
Metaphysis dist.	1	Radic.extirp.	L	64.0
Radius				
Metaphysis dist.	1	Res. + amp.	10.3	34.8
	1	Evac. + bone transpl.	L	30.2
	2		10.3	32.5
Columnae vertebralis				
Th V	1	Extirp. + postop.rad.	L	35.5
Th XII	1	Extirp. + postop.rad.	L	24.7
	2		L	30.1
Pelvis				
S II	1	Radic.extirp.	L	23.8
Ischii	1	Rad.treatm.	0.3	54.7
Manus				
Metacarpus	1	Preop.rad. + evac. + amp.	L	14.4
Pedis				
Calcaneus	1	Extirp. + postop.rad.	0.6	56.9
Phalanx	1	Amp.	L	54.0
Mandibula	1	Rad.treatm.	L	12.5

9.2.4. Bone-marrow tumours

Table 27. Ewing's sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Diaphysis	1	Preop.rad. + amp.	L	24.7
Metaphysis dist.	1	Hemipelvect.	L	37.2
Tibia				
Metaphysis prox.	1	Amp. + postop.rad.	2.4	14.3
Condylus lat.	1	Preop.rad. + amp. + cyt.	1.1	11.7
Metaphysis dist.	1	Amp. + lymph nodes rad.	1.3	36.1
	2	Rad. + cyt.treatm.	1.8	12.4
	3		1.6	16.9
Humerus				
Caput	1	Amp. + postop.rad. + lymph nodes oper.	0.6	13.2
	1	Rad. treatm.	L	34.9
	2		0.6	24.1
Columnae vertebralis				
L I	1	Rad.treatm.	1.1	17.9
L III	1	Basic treatm.	0.1	16.2
L IV	1	Cyt.treatm.	0.2	2.2
L V	1	Rad.treatm.	0.3	1.5
	4		0.4	9.5
Pelvis				
Ileum	1	Extirp. + postop.rad.	1.8	15.2
	1	Excisio + postop.rad. + cyt.	0.5	15.2
	1	Rad.treatm.	0.9	10.5
	3		1.1	13.6
Costa				
V	1	Rad.treatm.	0.3	39.0
VII	1	Extirp. + postop.rad.	0.8	28.5
	2		0.6	33.8

Table 28. Reticulum-cell sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Trochanter	1	Rad. + cyt.treatm.	L	59.2
Diaphysis	1	Basic treatm.	0.3	14.4
Metaphysis dist.	1	Preop.rad. + amp.	3.9	4.8
Condyli lat.	1	Rad. treatm.	L	49.3
Columnae vertebralis				
Th IV	1	Laminect.	1.1	69.3
L II	1	Basic treatm.	0.4	67.0
L IV	1	Rad. treatm.	2.2	72.2
L V	1	Rad. treatm.	6.9	70.9
	4		2.7	69.9
Pelvis				
Ileum	1	Rad. treatm.	0.8	49.2
	1	Basic treatm.	0.1	38.0
	2		0.5	43.2
Pubis	1	Rad.treatm.	0.5	16.8
Ischii	1	Rad.treatm.	0.8	56.3
Sternum	1	Rad. + cyt.treatm.	0.4	71.1
Pedis				
Metatarsus	1	Rad.treatm.	0.5	17.9

Table 29. Lympho-sarcoma: Location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Clavifix. + radic.res. + applic.endoproth.	0.7	68.1
Humerus				
Metaphysis dist.	1	Rad. + cyt.treatm.	1.5	42.8
Tibia				
Metaphysis prox.	1	Amp.	0.3	67.0
Columnae vertebralis				
Th XII	1	Laminect. + postop.rad.	1.3	62.4
Pelvis				
Ileum	1	Rad.treatm.	0.3	10.1
Scapula	1	Rad. + cyt.treatm.	0.3	31.1

Table 30. Solitary myeloma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Columnae vertebralis				
Th IX	1	Rad.treatm.	L	33.4
Th X	1	Laminect. + postop.rad.	L	69.1
Th XII	1	Extirp. + postop.rad.	L	35.5
L IV (IgG)	1	Rad. + cyt.treatm.	0.4	64.4
L V (IgG)	1	Rad. + cyt.treatm.	0.8	74.5
	5		0.6	55.6
Femur				
Diaphysis	1	Hormone treatment	L	22.1
Sternum	1	Rad. treatment	0.2	79.1
Pelvis				
S II	1	Basic treatment	0.4	70.3
Costa				
IV	1	Rad.treatment	L	32.6
VII	1	Extirp.	0.1	50.7
	2		0.1	41.7

Table 31. Extra-medullary plasma-cytoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Nose and hypo-pharynx	2	Rad.treatm.	L	62.7
	2	Rad.treatm.	2.8	37.2
	1	Extirp.	0.6	62.3
	1	Extirp. + postop.rad.	3.4	77.2
	1	Preop.rad. + extirp.	L	54.1
	7		2.3	41.9
Maxilla (IgA)	1	Basic treatment	0.2	68.8
Orbit	1	Extirp. + postop.rad.	L	52.6
Reg. inquinalis	1	Extirp.	L	59.4

9.2.5. Vascular tumours

Table 32. Angio-sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Diaphysis	1	Rad.treatm.	0.4	68.8
Humerus				
Metaphysis prox.	1	Extirp.	L	55.8
Skull				
Os parietale	1	Rad.treatm.	0.2	32.3
Columnae vertebralis				
Th II	1	Basic treatment	0.1	19.2

Table 33. Haemangio-pericytoma-sarcoma: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Tibia				
Metaphysis prox.	1	Extirp.	3.6	20.1
Scapula	1	Rad.treatm.	0.3	52.2

9.2.6. Connective-tissue tumours

Table 34. Fibro-sarcoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Rad.treatm.	0.8	84.9
Diaphysis (Paget))	1	Preop.rad. + clavifix.	0.3	66.4
Condylus med.	1	Evac. + postop.rad.	7.7	75.2
Metaphysis dist.	1	Extirp. + postop.rad.	0.5	41.9
	1	Rad.treatm.	0.3	2.5
	1	Extirp. + postop.rad.	2.2	71.0
	1	Cyt.treatm.	0.3	29.5
	4		0.8	36.2
Tibia				
Metaphysis prox.	1	Preop.rad. + amp.	1.3	18.3
Metaphysis dist.	1	Amp. + postop.rad.	3.0	37.0
Radius	1	Amp.	0.4	77.8
Clavicula	1	Basic treatment	0.1	62.0
Pelvis				
SI	1	Rad.treatm.	1.4	29.1
Costa				
XII	1	Extirp. + postop.rad.	L	2.5
Mandibula	1	Evac. + postop.rad.	L	61.2

Table 35. Primary malignant fibrous histio-cytoma: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Diaphysis	1	Extirp. + postop.rad.	4.3	25.5
	1	Basic treatment	1.9	75.3
	2		3.1	50.4
Tibia				
Metaphysis prox.	1	Amp.	1.3	12.3
Metaphysis dist.	1	Preop.rad. + radic.extirp.	3.0	68.3
Humerus				
Metaphysis prox.	1	Rad.treatm.	L	15.7
	1	Rad. + cyt.treatm.	0.4	16.0
	2		0.4	15.9
Fibula				
Metaphysis prox.	1	Cyt.treatm.	0.3	55.2
Manus				
Metacarpus	1	Amp.	0.7	65.1
Mandibula	1	Preop.rad. + extirp.	L	44.7

Table 36. NUD sarcoma: location of tumour, treatment, average period of survival and average age (patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Collum	1	Clavifix.	1.5	15.5
Trochanter	1	Extirp. + postop.rad.	2.3	27.4
Diaphysis	2	Basic treatment	0.1	67.9
Tibia				
Metaphysis dist.	1	Amp. + postop.rad.	L	27.4
Humerus				
Metaphysis dist.	1	Rad.treatm.	L	81.2
Columnae vertebralis				
Th I	1	Laminect.	0.1	60.2
Th II	1	Rad.treatm.	1.7	40.3
	2		0.9	50.3
Pelvis				
Ileum	3	Rad.treatm.	0.8	71.9
Ischii	1	Basic treatm.	0.1	67.2
Mandibula	1	Rad. + cyt.treatm.	1.3	25.5
Sternum	1	Basic treatm.	2.1	83.0
Clavicula	1	Rad. treatm.	1.0	62.3
Scapula	1	Radic.extirp.	1.2	52.1
	1	Rad.treatm.	0.9	48.6
	1	Rad. + cyt.treatm.	0.5	33.8
	3		0.9	44.8

Table 37. Radiation sarcoma: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Condylus med.	1	Amp.	0.4	55.0
Humerus				
Metaphysis dist.	1	Amp. + postop.rad.	0.1	52.6

Table 38. Fibrolipo-myxoma malignum: location of tumour, treatment, average period of survival and average age (L = patient still living; survival over 6.5 years).

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Diaphysis	1	Extirp. + postop.rad.	L	58.6

Table 39. Chondro-myxoma malignum: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Femur				
Trochanter	1	Evac. + transpl.oss.	1.5	66.3

Table 40. Fibro-myxoma malignum: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Skull				
Os perietale	1	Extirp. + postop.rad.	7.4	60.5

9.2.7. Other tumours

Table 41. Chordoma: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Skull				
Basis	1	Basic treatment	1.3	64.0
Columnae vertebralis				
L V	1	Laminect.	0.6	59.3
Pelvis				
S I	2	Extirp.	8.9	54.2
	1	Basic treatment	0.4	54.5
	3		6.1	54.3

Table 42. Neuro-sarcoma: location of tumour, treatment, average period of survival and average age.

Location of tumour	Patients No	Treatment	Survival period years	Average age years
Columnae vertebralis L. IV	1	Rad. + cyt.treatm.	0.2	24.0

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