Virchows Arch [Pathol Anat] (1982) 396:197–211

Virchows Archiv A

Ultrastructural Study of Conventional Chondrosarcomas and Myxoid- and Mesenchymal-Chondrosarcomas

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Summary. Five cases of conventional chondrosarcomas (CS.) of graded malignancy, 3 cases of myxoid CS. and 2 cases of mesenchymal CS. were studied by electron-microscopy. The chondrocyte like tumor cells of conventional CS. were characterized by: an ovoid shape, eccentric nucleus, abundant endoplasmic reticulum with dilated cisternae of RER; cytoplasmic glycogen, lipid droplets, and filaments plus numerous thin cytoplasmic projections. The histologically high grade tumors showed fewer cytoplasmic organelles, bizarre nuclei and more prominent nucleoli than the better differentiated ones. The tumor cells of myxoid CS. were chiefly fusiform. The cells frequently presented a pattern of rows with good cellular cohesion, and scanty cytoplasmic projections. The most prominent cytoplasmic feature was a conspicuous RER. Abundant cytoplasmic filaments and cytoplasmic glycogen were also observed. The undifferentiated areas of the mesenchymal CS. showed primitive mesenchymal cells with rounded nuclei, and scanty cytoplasm which was poor in organelles and glycogen. The cytoplasmic membranes were very cohesive and cytoplasmic projections were not present. Scanty cytoplasmic filaments and conspicuous desmosome like junctions were observed. The intercellular matrix of conventional and myxoid CS. consisted of fibrils, glycosaminoglycan granules and collagen fibers. In the undifferentiated zones of the mesenchymal CS. the intercellular matrix was very scanty and did not contain collagen fibrils. The more immature cells correspond to the small undifferentiated cells of mesenchymal chondrosarcoma.

Key words: Chondrosarcoma – Mesenchymal – Myxoid – Ultrastructure

Several histological types of chondrosarcomas are recognized: 1. The common or conventional chondrosarcoma; 2. The mesenchymal chondrosarcoma; 3. The myxoid chondrosarcoma and 4. The clear cell chondrosarcoma. There exists an

This study has been presented at the VIIIth. European Congress of Pathology (Martinez-Tello and Navas-Palacios 1981)

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0340-1227/82/0396/0197/$02.80

ample bibliography on their clinicopathological features, including their histological appearance. However, only a few papers deal with the electron microscopy of those tumors. Most publications are concerned with the ultrastructure of conventional chondrosarcomas (Anderson et al. 1963; Welsh and Meyer 1964; Taniguchi 1964; Spjut et al. 1971; Hirohata and Morimoto 1971; Levine and Bensch 1972; Schajowicz et al. 1974; Erlandson and Huvos 1974; Kahn 1975; Schulz 1980). In the literature there are only 7 reports, concerning the ultrastructure of 7 cases of mesenchymal chondrosarcomas (Steiner et al. 1973; Fu and Kay 1974; Mandelanakis 1974; Mikata and Inumaya 1977; Scheitenhauer and Rubinstein 1978; Zucker and Horoupian 1978; Rollo et al. 1979) and 4 publications on the electron microscopy of 5 cases of myxoid chondrosarcoma (Fu and Kay 1974; Enzinger and Shiraki 1972; Smith et al. 1976; Mehio and Ferenczy 1978). Finally, there is a unique report of the ultrastructure of clear-cell chondrosarcoma (Le Charpentier et al. 1979).

The aim of this study is to compare the ultrastructural features of conventional chondrosarcomas of different histological grades of malignancy with those of myxoid and mesenchymal chondrosarcomas.

Material and Methods

In this study, we examined by light and electron microscopy; 5 cases of conventional chondrosarcoma of bone (from poorly to well differentiated tumors), 3 cases of myxoid chondrosarcomas (2 extraosseous), and 2 cases of mesenchymal chondrosarcoma (1 extraosseous).

In all cases the medical history, X-Ray pictures, surgical protocols and clinical follow-up of the patients were studied and documented. The clinicopathological characteristics of the ten patients with chondrosarcoma are given in Table 1.

Multiple paraffin blocks of each case were available. Histological stains employed included H&E, trichrome, reticulin and alcian blue.

Conventional Chondrosarcomas. The minimal criteria for diagnosing the conventional chondrosarcomas were: increased number of cartilage cells with plump nuclei, more than occasional binucleated

Table 1.

No	Sex	Age	Site	Histologic type
1	M	59	Lt. iliac bone	Grade I
2	M	27	Lt. mandible	Grade II
3	M	66	1st. Phalan 2nd. finger, lt hand	Grade II
4	M	58	Rt. femur	Grade III
5	M	31	Rt. humerus	Grade III
6	M	59	Soft tissues, lt. arm	Myxoid, extraskeletal
7	M	77	Soft tissues, rt. thoraco-abdominal wall	Myxoid, extraskeletal
8	M	9	Rt. femur	Myxoid
9	M	42	Retroperitoneum	Mesenchymal, extraskeletal
10	F	24	Rt. humerus	Mesenchymal

tumor cells, and the presence of multinucleated giant cartilage cells. For the histological grading, the cytological criteria described by Evans et al. (1977) were used. Those criteria are: Grade I 1) the presence of a marked preponderance of small densely stained nuclei, 2) two or more nuclei within one lacuna, easily found in most cases 3) a small number of larger, somewhat pleomorphic nuclei present in isolated areas. Grade II: tumors that contain areas with increased cellularity in which a significant proportion of the nuclei are at least of moderate size but the mitotic rate is less than two mitosis per 10× high power fields. Grade III: the presence of two or more mitosis per ten high power fields in the most active areas of the tumor and/or areas with the appearance of a spindle cell sarcoma.

Tissue for electron microscopy was obtained at surgery. The tissue was minced into 1 mm. cubes, fixed in paraformaldehyde (1%) glutaraldehyde (2.5%) in 0.1 M. sodium cacodylate buffer and postfixed in cacodylate buffered 1% osmium tetroxide. Following Epon embedding, one micron sections stained with toluidine blue were screened. The thin sections were obtained with a LKB Ultratome, mounted on uncoated copper grids and stained with uranyl acetate and lead citrate. The sections were examined and photographed with a Hitachi HU-12-A electron microscope.

Results

The clinicopathological characteristics of the ten patients are given in Table 1.

Histology

Conventional Chondrosarcomas: Five cases were conventional chondrosarcomas of bone (Table 1). One case was classified as Grade I (No. 1), two cases as Grade II (No. 2, 3) and 2 cases as Grade III (No. 4, 5).

Myxoid Chondrosarcomas. The tumor in case number 6 (Fig. 1a) showed a nodular pattern and was composed of small, uniform, rounded or elongated cells. They were arranged in strands, clusters or whorls and were always surrounded by a myxoid ground substance with an inconspicuous vascular network. The cells had a narrow, eosinophilic and sometimes vacuolated cytoplasm; the nuclei presented atypia but mitotic figures were rare. Cartilaginous or bony structures were not found.

In case number 7 areas showing lacunae around the chondroblasts were present. The tumor in case number 8 (Fig. 1b) showed a similar histological appearance to case No. 6 and 7. The neoplasm exhibited a lobular pattern separated by septae of dense fibrous connective tissue. In this case mitotic figures were frequently observed. Some tumor areas presented lacunae around the chondroblasts.

Mesenchymal Chondrosarcomas. Both cases showed the typical features of mesenchymal chondrosarcoma with islands of well differentiated cartilage, surrounded by small undifferentiated rounded cells (Fig. 1c). A pericytomatous pattern was observed in some areas. Islands of well differentiated cartilage were very scarce in case No. 10.

Electron Microscopy

Conventional Chondrosarcomas. The chondrocyte-like tumor cells were characterized by a rounded or ovoid shape, an eccentric nucleus, abundant endoplasmic

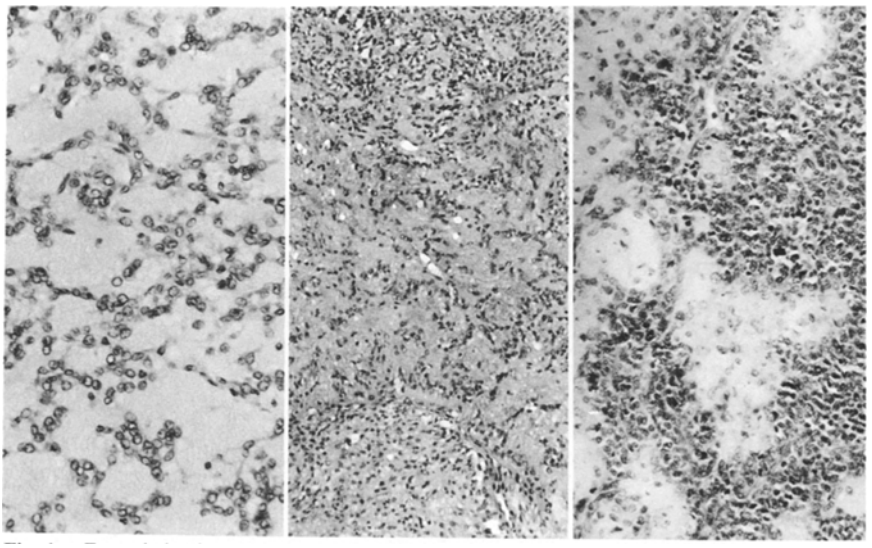

Fig. 1. a Extraskeletal myxoid chondrosarcoma (case No. 6). Tumor area showing the characteristic cord-like cellular arrangement and lack of a plexiform capillary pattern. The tumor cells are separated by large amounts of myxoid material (HE ×200). **b** Myxoid chondrosarcoma in the femur of a nine year old boy (case No. 8). Typical myxoid areas (*m*) are associated with chondroblastic zones showing lacunae around the chondroblasts (*c*) (HE ×80). **c** Mesenchymal chondrosarcoma (case No. 9). The typical features of this tumor are shown in the picture; islands of well differentiated cartilage surrounded by small undifferentiated rounded cells (HE ×200)

reticulum with frequent dilated cisternae of RER, cytoplasmic glycogen, lipid droplets, intracellular filaments and numerous thin cytoplasmic projections (Figs. 2 and 3). The cells were surrounded by a fibrillo-granular matrix of low electron density. Frequently condensation of this material was present at the lacunar margin. The histologically high grade tumors (Grade II and III) were made up by tumor cells which showed fewer cytoplasmic organelles, less cytoplasmic glycogen, more lipid droplets and more abundant cytoplasmic filaments than the low grade tumors (G-1). Furthermore Grade II and III chondrosarcomas presented bizarre nuclei with prominent nucleoli and multinucleated tumor cells with highly indented nuclei (Fig. 6); as well as spindle cells with elongated nuclei that resembled fibroblast-like tumor cells, especially in Grade III chondrosarcomas.

Myxoid-Chondrosarcomas. The extraskeletal myxoid chondrosarcomas (Fig. 4) presented a pattern of cells arranged in nests. The cells were of two types: 1. round-polygonal or 2. spindle-stellate shaped (Fig. 4), although transitional forms were also present. They were set in a myxoid matrix. The nuclei were oval or fusiform, with frequent indentations of the nuclear envelope, abundant euchromatin and large nucleoli (50% of the nuclear sections). The cytoplasm was conspicuous, containing abundant large mitochondriae, and multiple dilated cisternae of RER which contained abundant granular material. The Golgi complex and the lysosomes were not prominent. The cytoplasm displayed a high electron density because of abundant free ribosomes, smooth vesicles, and cytoplasmic filaments which formed a dense network (Fig. 5). Cytoplasmic glycogen

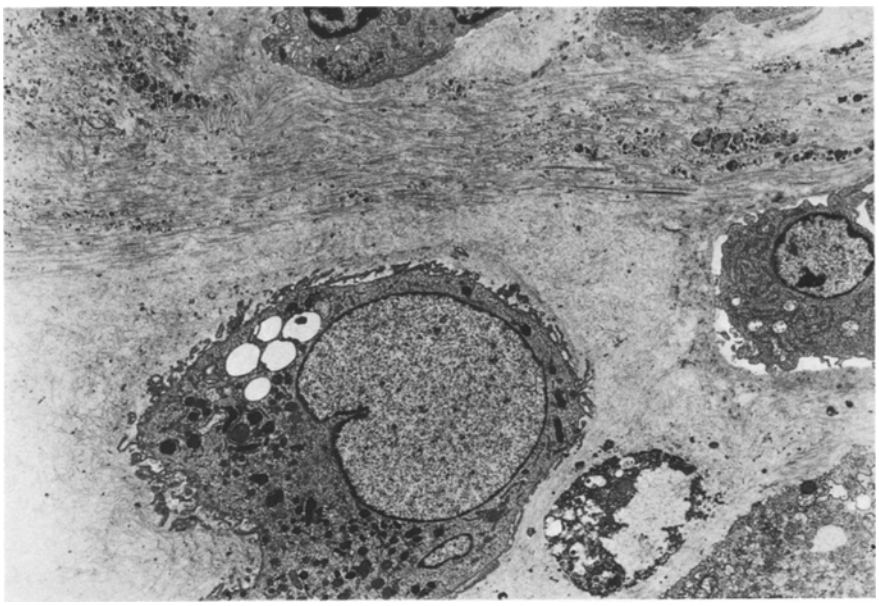

Fig. 2. Electron micrograph of conventional chondrosarcoma of low-grade malignancy. The chondrocyte-like tumor cells show rounded shape, eccentric nucleus, abundant RER, and numerous thin cytoplasmic projections. The cells are surrounded by a fibrilo-granular matrix of low electron density. Collagen fibers are also present (HE ×3,200)

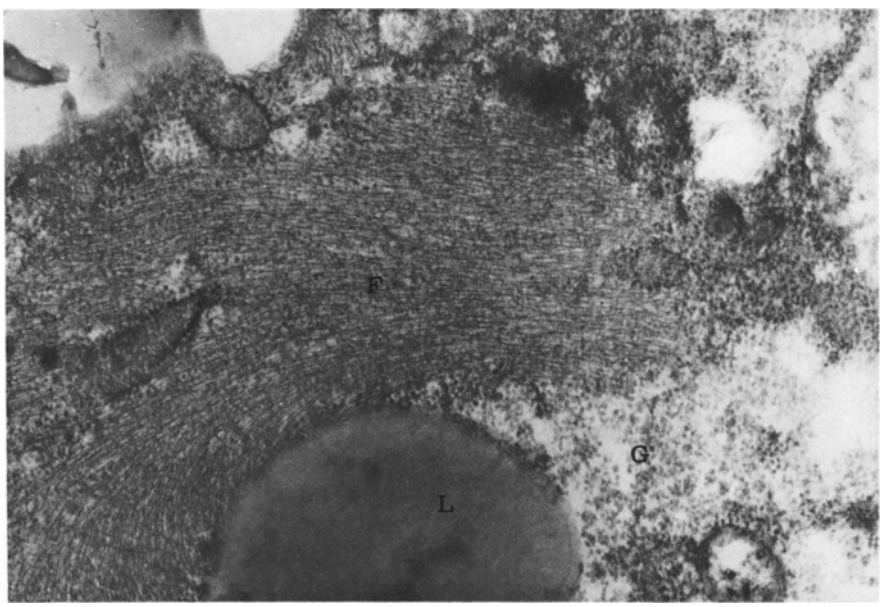

Fig. 3. Electron micrograph of a chondrocyte-like cell of a low grade conventional chondrosarcoma. The picture shows a lipid vacuole (*L*), cytoplasmic glycogen (*G*) and numerous cytoplasmic filaments (*F*) (HE ×16,000)

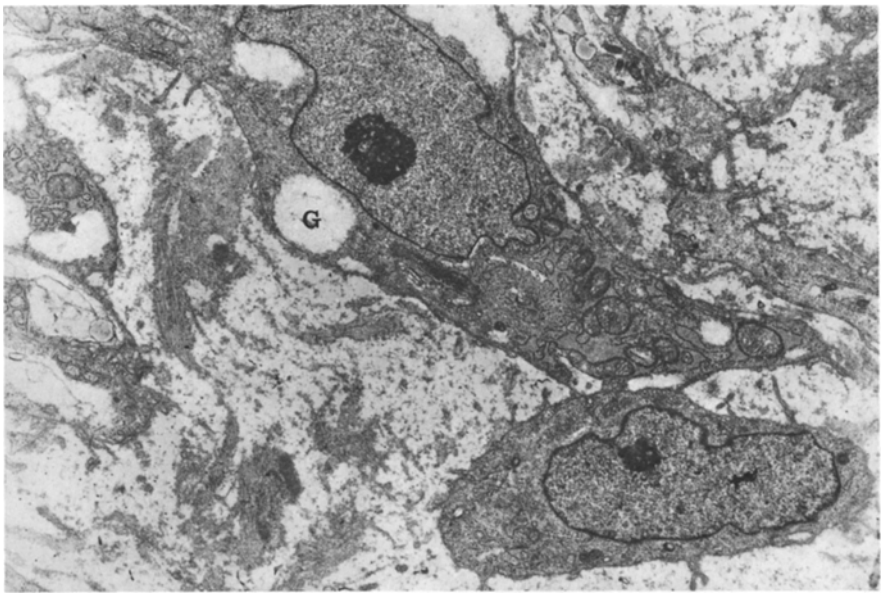

Fig. 4. Electron micrograph of an extraskeletal myxoid chondrosarcoma (case No. 6) showing two spindle-shaped cells set in a myxoid matrix. The nuclei are elongated and present a prominent nucleus. The cytoplasm is conspicuous with large mitochondria and prominent RER. Also note the cytoplasmic glycogen (*G*) (× 4,800)

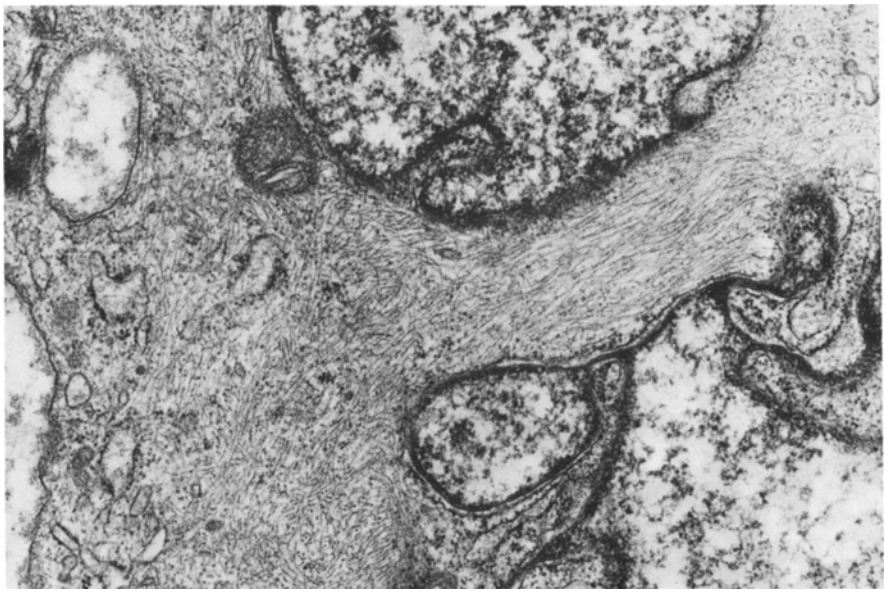

Fig. 5. Electron micrograph of an extraskeletal myxoid chondrosarcoma showing cytoplasmic filaments which form a dense network (× 24,000)

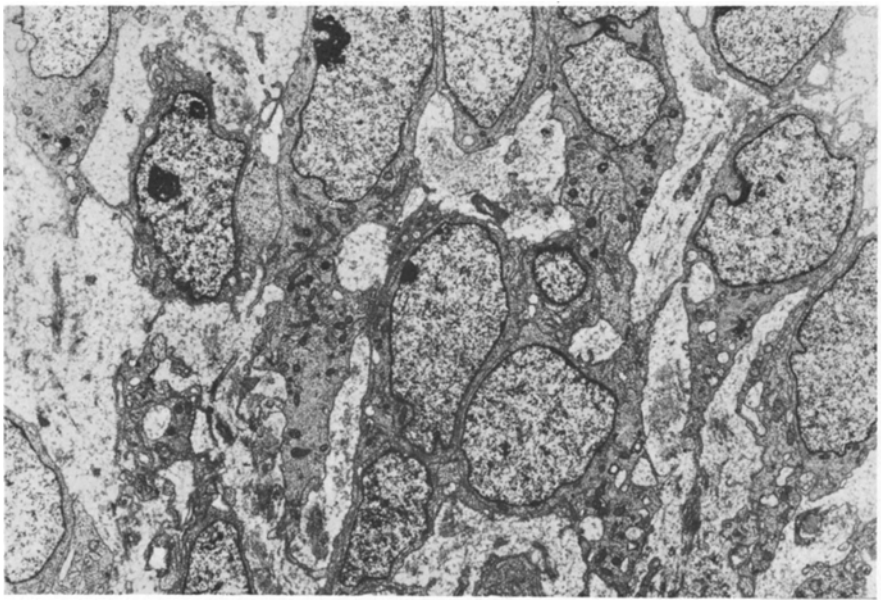

Fig. 6. Electron micrograph of myxoid chondrosarcoma of bone showing elongated cells that present a pattern in rows. There is good cellular cohesion and cytoplasmic projections are rare (×3,000)

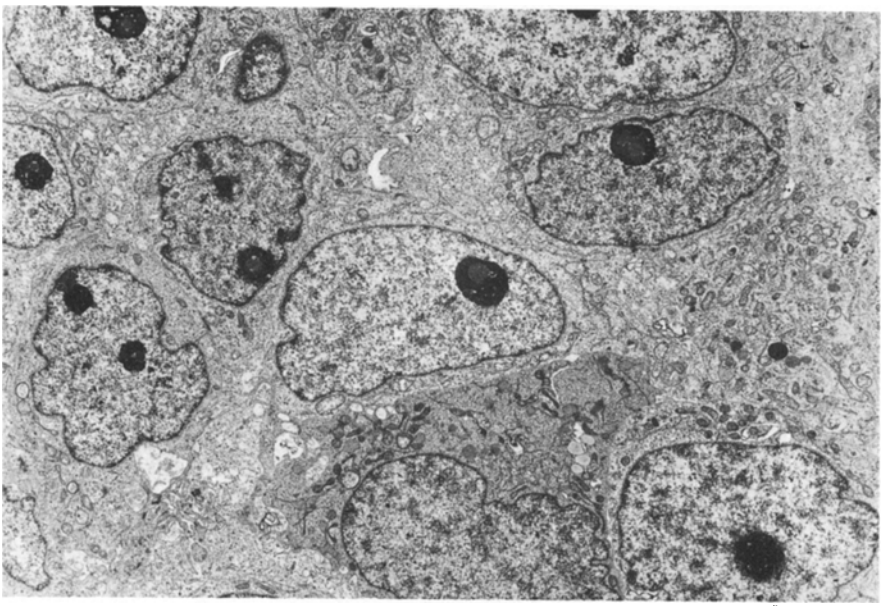

Fig. 7. Electron micrograph of mesenchymal chondrosarcoma showing polygonal and ovoid shaped tumor cells with ovoid nuclei that present smooth nuclear envelopes. There are one or two prominent nucleoli in each cell. Most of the cells have sparsity of organelles. The cell membranes are straight and very cohesive (×4,000)

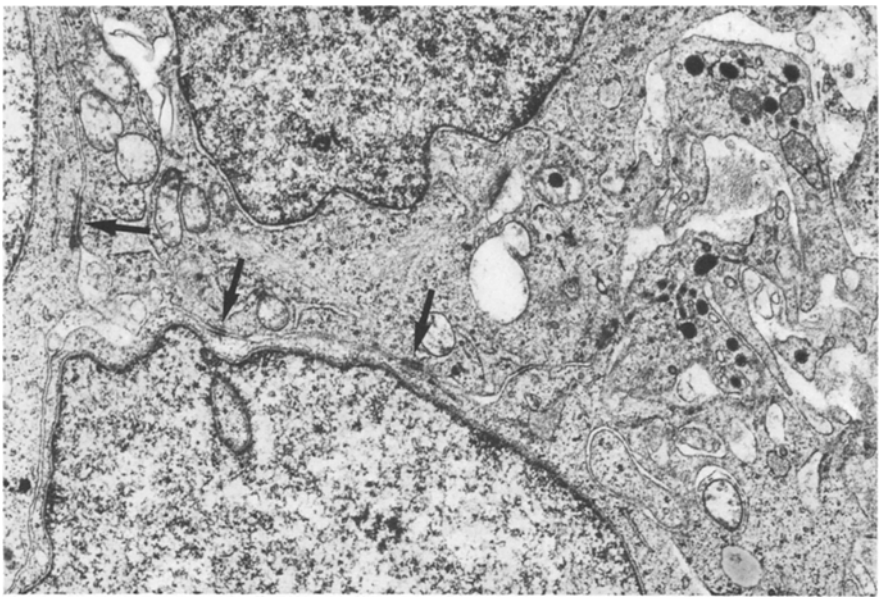

Fig. 8. Electron micrograph of mesenchymal chondrosarcoma showing cohesive cell membranes and desmosome like junctions (*arrows*) (× 19,200)

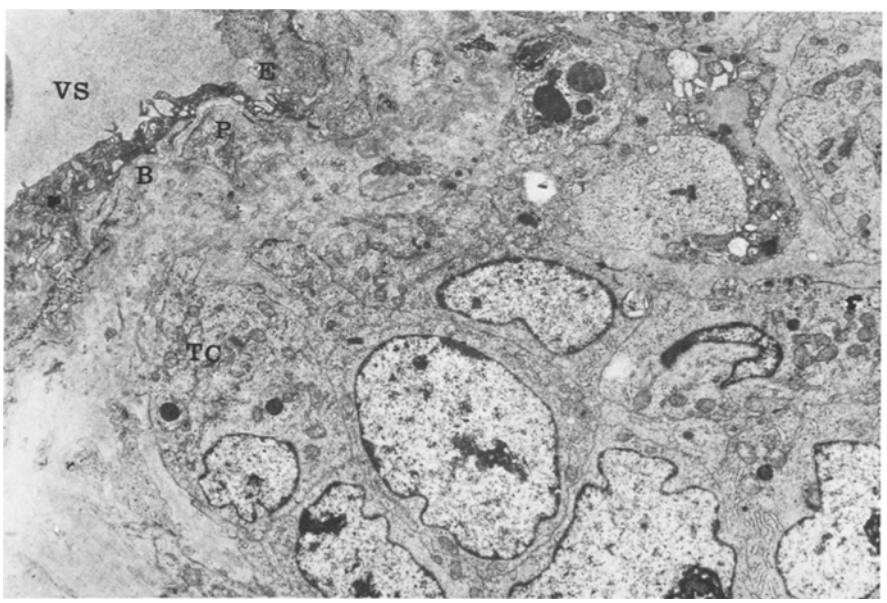

Fig. 9. Electron micrograph of mesenchymal chondrosarcoma showing an area of the tumor with a vascular pattern resembling hemangiopericytoma. A vascular space (*VS*), endothelial cells (*E*), basement membrane (*B*) and pericytes (*P*) are seen in a corner of the picture. Poorly differentiated tumor cells (*TC*) are seen surrounding the vascular structure (× 4,000)

Table 2. Ultrastructural findings in conventional, myxoid and mesenchymal chondrosarcomas

		Conventional	Myxoid	Mesenchymal
Cell shape		Round-ovoid	Spindle-stellate	Round-ovoid
Cell membrane		Numerous projections	Straight	Straight
Nucleus		Round-ovoid	Ovoid-spindle	Round-ovoid
Nucleolus		Large	Large	Large
Golgi		Prominent	Prominent	Inconspicuous
RER		Abundant	Moderately abundant	Scant
Cytoplasmic filaments		Numerous	Numerous	Scant
Glycogen		Abundant	Moderately abundant	Scant-abundant
Extracellular space:	Amount	Large	Large	Scant
	Content	Fibril-granules	Fibril-granules	Reduced to intercellular gaps

accumulation and lipid vacuoles were also frequent. There was a wide intercellular space. Occasionally intercellular contacts were observed, but we could not find desmosome-like junctions. In case No. 8 both these types of cells were also seen, but the cells frequently presented a pattern of rows and showed good cellular cohesion and very scanty cytoplasmic projections (Fig. 6). As in cases 6 and 7, desmosome-like junctions were not found. The intercellular matrix in both tumors consisted of amorphous material, electron dense granules and collagen fibers.

Mesenchymal Chondrosarcoma. Both tumors (9 and 10) presented very similar features. The well differentiated cartilaginous cells of mesenchymal chondrosarcomas showed many features common to the chondrocyte-like cells of conventional chondrosarcomas. The undifferentiated areas showed a uniform pattern that were made up of sheets of cells that presented a uniform size and morphology (Fig. 7). They were either polygonal or oval shaped; the diameter of the tumor cells of the bone tumor measured between 10 and 16 microns ($\bar{x}$14 microns), and the cells of the soft tissue tumor measured in average 11 microns. The nuclei were rounded or oval shaped. The nuclear envelopes were generally smooth, with occasional indentations in the tumor of the soft tissues. The nuclei were rich in euchromatin. The nucleoli were of medium or large size and were found in 40–75% of the nuclear sections. They were spherical, frequently showing segregation of the nucleolar components while having a concentric pattern with a granular component in the centre and a fibrous component at the periphery. The nuclear-cytoplasmic ratio was high. The cytoplasm was scarce, reduced to a narrow perinuclear rim, and poor in organelles. The mitochondria and the cisternae of RER were inconspicuous. The lysosomes and Golgi complex were not prominent. The abundance of free ribosomes was notable. Occasionally small lipid vacuoles and small amounts of glycogen were detected. Scanty cytoplasmic filaments were constantly observed (70–100 Å)

without any special distribution. The cell membranes were straight and very cohesive, and desmosome-like structures were frequently found (Fig. 8). The intercellular matrix was very scarce and did not contain collagen fibers. The areas with a hemangiopericytoid pattern showed a moderate number of blood vessels (Fig. 9). There were capillaries of continuous endothelium. A basement membrane was present outside the endothelium, and a small number of pericytes were seen. Some vascular spaces were partially surrounded by bundles of collagen fibrils. The ultrastructural findings are summarized in Table 2.

Discussion

There are few reports concerning the ultrastructural features of human chondrosarcoma and most of the literature deals with the electron microscopy of conventional chondrosarcoma. Anderson et al. (1963) were the first to describe the ultrastructure of a chondrosarcoma. Welsh and Mayer (1964), and Levine and Bensh (1972) studied 3 and 1 cases of chondrosarcoma respectively in their histogenetic study of chondroblastoma; but the descriptions were short and incomplete. Taniguchi (1968) studied 6 cases and described 3 basic cell types: 1. chondroblastic 2. fibroblastic and 3. mesenchymal. The electron microscopic characteristics of his chondroblastic type corresponds to those of the chondrocyte-like tumor cells we have observed in our conventional chondrosarcomas. The fibroblastic type is similar to the cells of the poorer differentiated tumor areas of Grade III chondrosarcomas. The mesenchymal cell type, described as small round cells which contained very irregularly shaped nuclei, probably correspond to very anaplastic tumor cells. They differ from the tumor cells we have observed in the undifferentiated areas of mesenchymal chondrosarcoma, since those cells had round or oval nuclei with generally smooth nuclear envelops. Spjut et al. (1971) illustrated three electron-micrographs. They observed a similarity between the tumor cells and inmature cartilage cells. Hirohata and Marimoto (1971) illustrated in their atlas a case of chondrosarcoma and mentioned that the tumor cells contained an abundance of glycogen and microtubules, and that the cell surface was scalloped.

Schajowicz et al. (1974) studied seven cases of graded conventional chondrosarcomas. They observed high organelle density in the low-grade tumors whereas they saw few organelles and more bizarre nuclei with prominent nucleoli in the poorly differentiated tumors. Furthermore, these authors observed an inverse relationship between glycogen amount and the histological grade of malignancy. Finally, they emphasized that the most typical feature of the tumor cells was the abundant RER which usually encircled other organelles, specially mitochondria.

Erlandson and Huvos (1974) studied 8 cases of conventional chondrosarcomas ranging from low grade to high grade tumors. They noted that Grade II and Grade III chondrosarcoma cells were characterized by more pronounced nuclear atypia, a coarse chromatin pattern and one or more prominent nucleoli. They also observed that lipid droplets and cytoplasmic filaments were considerably increased in number in the higher grade chondrosarcomas but found that gross dilatations of RER cisternae and glycogen particles were much less conspicuous than in the well differentiated tumors. Furthermore, they noted in Grade III chondrosarcomas rare giant and spindle-shaped cells with highly convoluted nuclei.– Remagen et al. (1976) have also observed a higher amount of cytoplasmic glycogen in the well differentiated chondrosarcomas. – Schulz (1980) reported the ultrastructure of nine conventional chondrosarcomas. He distinguished four types of tumor cells; proliferating, mature, hypertrophying and degenerating. This author considered these cell types

showed the different morphological aspects that the tumor cells of the chondrosarcomas may present in their development from proliferation to degeneration. In undifferentiated tumor areas he observed fusiform anaplastic cells. These cells were considered to be the morphological expression of a failure in cell differentiation with increased collagen production and simultaneous decrease of the synthesis of mucopolysaccharides.

Our findings are in agreement with the above mentioned reports. The Grade II and III chondrosarcomas were made up of tumor cells which showed fewer cytoplasmic organelles, less cytoplasmic glycogen, more abundant lipid droplets and more numerous cytoplasmic filaments than Grade I tumors. The poorly differentiated chondrosarcomas presented bizarre nuclei with prominent nucleoli, multinucleated tumor cells with highly indented nuclei, and spindle cells with elongated nuclei that resembled fibroblast-like tumor cells.

Kahn (1976) published the ultrastructural findings of a chondrosarcoma of bone with dedifferentiated foci. The cells of those areas were also of a fibroblast-like type, similar to those we have observed in some zones of Grade III tumors.

Extraskeletal chondrosarcoma was first described as an entity in 1953 by Stout and Verner as a tumor of the soft tissues. Enzinger and Shiraki (1972) described the extraskeletal myxoid chondrosarcoma for the first time, as a tumor composed largely of loosely arranged, small acidophilic cells suspended in large amounts of mucoid matrix rich in sulphated mucopolysaccharides. Characteristically, these neoplasms exhibited a less agressive behaviour than chondrosarcomas of bone. Enzinger and Shiraki (1972) noted the close resemblance of those tumors of the soft tissues to the slowly growing and locally invasive form of chondrosarcoma of bone described by Lichtenstein and Bernstein (1959) as chondroblastic sarcoma. Subsequently, Fu and Kay (1974) described a myxoid chondrosarcoma located in the greater trochanter of the left femur in a 25 year old man.

The main ultrastructural findings of myxoid and mesenchymal chondrosarcomas of reported cases are summarized in Table 3. Our findings are in general in agreement with the previous reports: the cells of myxoid chondrosarcomas varied in shape ranging from rounded to more spindle shaped forms and were arranged loosely spaced, with the exception of one case (No. 8) in which the cells showed good cellular cohesion.

The chordoid sarcoma is an unusual soft tissue tumor. Few papers have been published on this lesion and it has at times been termed: "chordoma peripheric um" by Laskowsky (1955 and 1962); "chordoid sarcoma" by Martin et al. (1973) and "parachordoma" by Dabska (1977). Although the clinical, morphological and histochemical characteristics of this tumor have been established, the histogenesis has remained obscure. It has been suggested that the chordoid sarcoma shows chordoid differentiation in electron-microscopy, rather than chordoid features (Martin et al. 1973; Pardo-Mindan et al. 1975; Weiss 1976). This is an agreement with the work of Mehio et al. (1978). Never the less Robertson and Hogg (1980) have indicated a synovial origin for this uncommon neoplasm based on their ultrastructural study of one case.

Of our three myxoid chondrosarcomas, case No. 8, also exhibited chordoid features histologically. Myxoid chondrosarcomas and chordoid sarcomas have

Table 3. Ultrastructural Features of myxoid and mesenchymal chondrosarcomas reported in previous previous publications

	Authors	Number of cases	Tumor cells			Nucleolus	Golgi	RER	Cytoplasmic filaments	Glycogen	Extracellular Space	
			Shape	Membrane	Nucleus						Cell pattern	Content
Myxoid	Enzinger and Shiraki (1972)	2	stellate	scalloped	ovoid	incp.	w.d.	incp.	varying amounts	scattered	loosely spaced	collagen scanty
	Fu and Kay (1974)	1	ovoid	scalloped Desm. l. junct.	ovoid	incp.	w.d.	abundant	–	abundant	loosely spaced	collagen scanty
	Smith et al. (1976)	1	ovoid	–	ovoid	incp.	w.d.	abundant	–	clusters	loosely spaced	collagen scanty
	Mehio and Ferenczy (1977)	1	1. round 2. spindle 3. spindle	scalloped Desm. l. junct.	1. ovoid 2. elong. 3. elong.	–	w.d.	1. abundant 2. abundant 3. incp.	present	abundant No No	wide extracel. spaces	collagen scanty
Mesenchymal	Steiner et al. (1973)	1	1. rounded 2. spindle	1. smooth 2. ondulated	1. rounded 2. elong.	f.s.	incp.	incp.	rare	very scant	–	collagen scanty
	Fu and Kay (1974)	1	1. rounded 2. elong.	1. straight 2. cytopl. proc. Desm. l. junct.	1. rounded 2. elong.	–	1. incp. 2. w.d.	1. incp. 2. profiles	–	–	very close	immature collagen scanty
	Mandelanakis (1974)	1	elongated	–	elongated	–	prominent	conspicuous	bundels	–	loosely spaced	bundels of collagen
	Mikata and Inuyama (1977)	1	rounded to elongated	–	rounded to elongated	–	–	incp.	–	–	–	–
	Scheitenhauer and Rubinstein (1978)	1	round to stellate	–	–	–	–	w.d.	–	–	wide extracel. spaces	groups of cells surrounded by collagen
	Zucker and Horoupian (1978)	1	rounded	straight macula densa	rounded	f.s.	–	slightly dilated	–	–	close direct contact	collagen scanty
	Rollo et al. (1979)	1	–	irregular macula adherens	–	f.s.	–	conspicuous dilated cisternae	no	scanty foci	close	–

Desm. l. junct.: Desmosome like junctions; incp.: inconspicuous; –: not reported; w.d.: well developed; f.s.: frequently seen

mainly been described in the soft tissues. However, examples of both entities have been later reported in bones (Fu and Kay 1974; Pardo-Mindan 1975).

Mesenchymal chondrosarcoma is a well-defined tumor entity (Lichtenstein and Bernstein 1959; Salvador et al. 1971). Although it was initially thought to be a neoplasm of bone, it is now apparent that nearly one-half of the cases occur in extraosseous sites (Guccion et al. 1973). Fourteen meningeal mesenchymal chondrosarcomas have been reported (Raskind and Grand 1966; Wu and Lapi 1970; Salvador et al. 1971; Guccion et al. 1973; Scheitenhauer and Rubinstein 1978; Zucker and Houroupian 1978; Rollo et al. 1979). However, we could only find 7 reports on the ultrastructure of those tumors (Table 3). Our 2 cases of mesenchymal chondrosarcomas were made up of rounded or polygonal cells, with rounded nuclei and mostly straight cell membranes, as has been observed in the previous publications (Table 3).

In the areas with an hemangiopericytoid pattern we observed thin capillaries with endothelial cells that were on a basement membrane; in some areas few pericytes surrounded the blood vessels. But we think that the hemangiopericytoid pattern is the result of proliferation of undifferentiated cells around vascular spaces rather than pericytes (Rhodin 1968; Murad et al. 1968; Hahn et al. 1973; Battifora 1973).

If we consider the ultrastructure of chondrosarcomas in a comprehensive way, we think that there is a spectrum from immature to mature cells. The more immature cells correspond to the small undifferentiated mesenchymal cells of mesenchymal chondrosarcomas. These cells resembled the cells of Ewing's sarcoma ultrastructurally and by light microscopy, a factor already mentioned by Steiner et al. (1973). However Ewing's sarcoma cells are usually rich in cytoplasmic glycogen, although in rare cases the glycogen can be inconspicuous or absent. Mikata et al. (1977) and Rollo et al. (1979) demonstrated that ultrastructural examination of non cartilaginous areas in mesenchymal chondrosarcomas showed mesenchymal cells with features suggestive of cartilaginous differentiation of prechondroblasts. At the other end of the histological spectrum, the more mature conventional chondrosarcomas are made up by cells indistinguishable from normal chondrocytes (Godman and Porter 1960; Welsh and Meyer 1964; Anderson 1967; Silberberg 1968; Weiss et al. 1968) or chondrocyte-like cells of benign tumors (Erlandson and Huvos 1974). In between, there is a range of tumors that consists of cells of different degrees of maturation in the line of chondral differentiation. Finally, the tumor cells of chondrosarcoma may undergo a process of dedifferentiation whose morphological counterparts would be the cells observed in fibrosarcomatous dedifferentiated areas of conventional chondrosarcomas.

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Accepted March 1, 1982