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Osteochondroma of the Posterior Clinoid Process
Report of a Case with Special Reference to Its Histogenesis

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Summary. There have been some controversial opinions as to the nature and origin of cartilaginous tumors arising from the base of the skull. An autopsy case of a giant osteochondroma arising from the posterior clinoid process is presented. The tumor connected to the posterior clinoid process in an exostotic fashion resulted, clinically, in left abducens paralysis. The tumor was encapsulated by thin fibrous tissue which was connected to the inner layer of the dura mater adjacent to the posterior clinoid process. Histologically, the tumor consisted of multiple osteocartilaginous nodules which were connected by osteo-fibrous connective tissue of high vascularity. Each nodule represented a pattern similar to enchondral ossification. Precise gross and histological examinations of the tumor confirmed that it was not enchondromatous but was osteochondromatous in nature.

Key words: Osteochondroma — Skull Base — Posterior Clinoid Process — Histogenesis.

Introduction

The skull is an unusual site for chondroma (or osteochondroma), and most cases reported originate from the vault rather than the base (Russel and Rubinstein, 1971). Thus, cartilaginous tumors from the skull base are interpreted as a rare disorder. Less than seventy cases have been reported in literature (Bakadash *et al.*, 1969; Kano *et al.*, 1968; Minagi and Newton, 1969; Takahashi *et al.*,1971). These tumors are generally considered as osteochondroma, chondroma or chondrosarcoma, according to their histological characteristics. The chondromatous remnant tissue along the basilar synchrondrosis, particularly the foramen lacerum, has generally been speculated as the site of origin. However, cases which have clarified their histogenesis are rather limited (Kleinsasser and Griedmann, 1958; Klingler, 1951; List, 1969).

This paper presents an autopsy case of so-called osteochondroma of the skull base which arose from the posterior clinoid process in a form of osteocartilaginous projection. Although reports on three similar cases appeared in the literature (List, 1969; Richards and Thompson, 1961; Stigliani, 1951), only clinical and operative findings were described and nothing on the histopathology of the tumor as a whole was reported. The present report is the first one providing full histopathological findings of this interesting tumor and may, as such, contribute to a further understanding of the debatable origin of the tumor.

Case Report

1. Clinical Course

A 24 year-old male was admitted to Tokyo Medical and Dental University Hospital on May 21, 1970 with the complaint of double vision. He had been completely asymptomatic until a month prior to admission. On admission, left abducens paralysis and slight depression of adreno-hypophyseal function were observed. By X-ray examination, osteochondroma was suspected because of the cauliflower-like, irregularly stippled, trabeculated calcification of the tumor (Berkman and Blatt, 1968). On June 15, 1970 partial resection of the tumor was performed. Two days after the operation, the patient died of bleeding in the residual tumor.

2. Patho-Anatomical Analysis

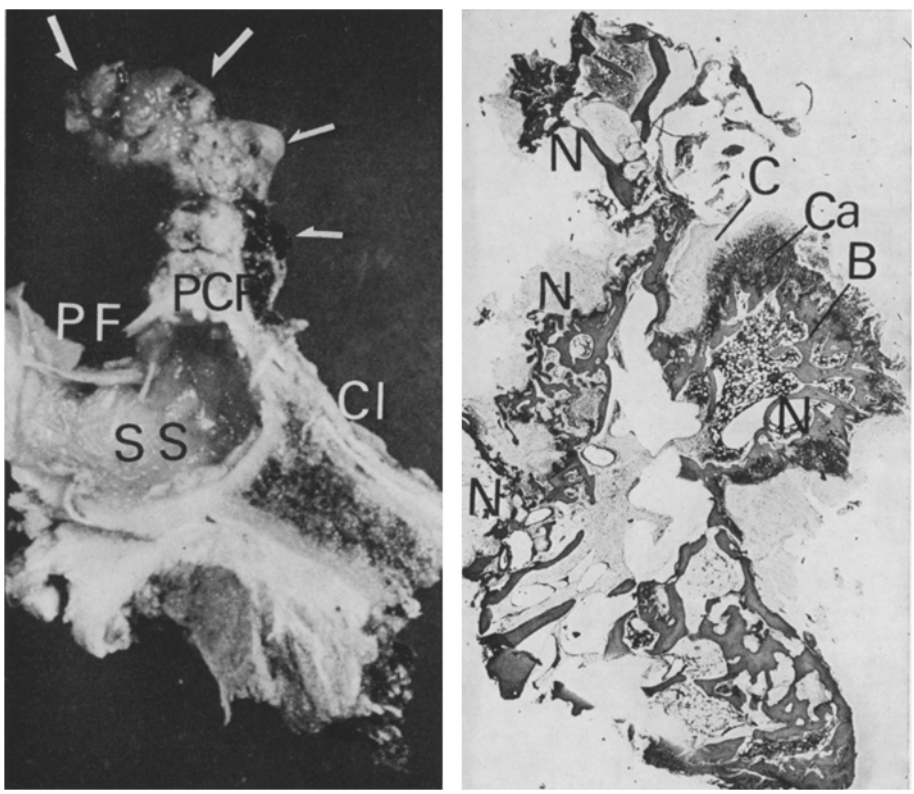
a) Gross Findings. A dumbbell-shaped tumor ($6.0 \times 3.5 \times 3.5$ cm) was found on the middle fossa, expanding to the posterior fossa and clivus beyond the medial pyramidal ridge. The narrowest part of the tumor was situated on the tip of the pyramis, as illustrated in Fig. 1. The left half of the tumor extended laterally to the temporal wall almost occupying the middle fossa, and the medial half grew on the supra-sellar region reaching the clivus posteriorly. A small tumor mass protruded herniating from the ruptured thin capsule of the medial mass of the tumor (Fig. 1). As a whole, the mass was covered by a thin fibrous capsule which was connected to the inner layer of the dura mater adjacent to the posterior clinoid process. Macroscopically, the tumor extended between outer and inner layer of the dura mater. Careful dissection demonstrated the distinct connection of the tumor tissue with the posterior clinoid process. After removal of the main mass, this particular portion remained attached to the clinoid process as a finger-tip-sized osteochondromatous projection (Fig. 2). These findings indicated that the tumor grew from bone tissue. The main tumor mass consisted of a coral-like calcified mass invested with cartilage and semitranslucent, gelatinous tissue. Cerebral base and brain stem were also markedly deformed and molded by the tumor. Structure of this tumor is schematically described in Fig. 3.

Fig. 1. Cranial base of the skull at autopsy. A dumbbell-shaped giant tumor (*T*) extending from left para-sellar, supra-sellar to retro-clival portion. A bony tumor mass herniates at the tumor dome (arrow)

b) Histology. Histologically, a bony projection from the clinoid process (Fig. 2) consisted of granulated osteochondromatous tissues which contained marrow space. Bone trabeculae extended irregularly with complicated branching. Chondromatous tissues covered the entire surface of the osteoid tissue with variation in thickness at locations (Fig. 2 B). Multiple, localized, prominent proliferation of the chondromatous tissue with osteoid gave a granular appearance to the surface of the tumor. Morphology of the proliferating cells will be described in the following section.

Histology of the main tumor mass differed little from those of the osteochondromatous projection described above. Chondromatous tissues formed multiple nodules surrounding partially calcified vasculated connective tissue.

Four layers were clearly distinguished: immature or proliferating cartilaginous cell zone, provisional calcification zone and osteoid zone (Fig. 4). Cells of the immature or proliferating cartilaginous cell zone were from large and round to asteroid in shape containing round nuclei rich in chromatin. They were embedded diffusely in a basophilic substance, but the territorial matrix was not clearly discernible around the cells. Cells in the hypertrophic cartilaginous cell zone were vacuolated, showing an irregular cytoplasmic border. In this zone, the basophilic



A B

Fig. 2. A Sagittal cut plane of osteocartilaginous projection (arrows) of the posterior clinoid process (PCP). Pituitary fossa (*PF*), sphenoid sinus (*SS*) and clivus (*Cl*). The projection is connected to the branched bony mass of the main tumor. B A low power view of the histological specimen from the material shown in Fig. 2 A (arrows). The projection consists of confluent small osteocartilaginous nodules (*N*). Each nodule consists of a cartilaginous cap (*C*), underlying calcified layer (*Ca*) and central bone trabeculae (*B*) which contain fatty and cellular marrow

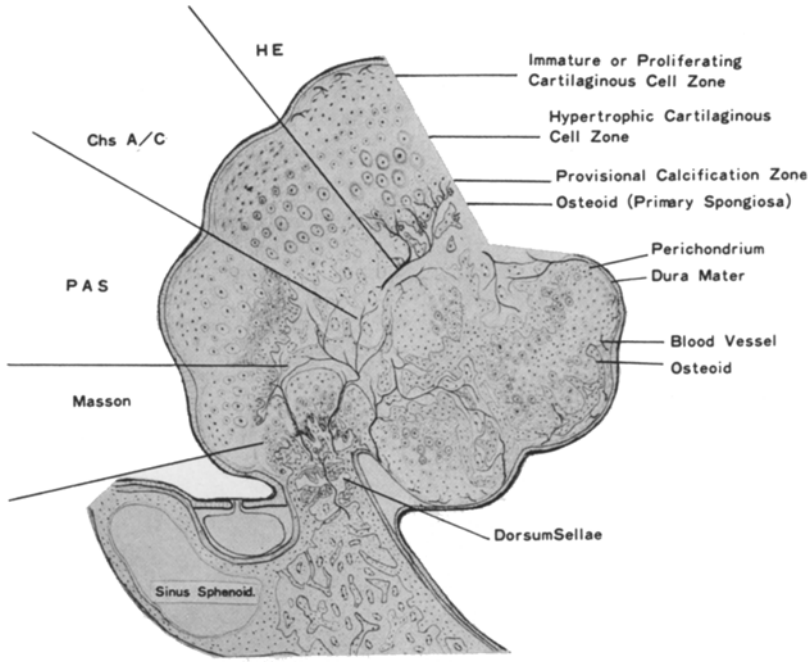


Fig. 3. Schematically summarized structure and histochemical characteristics of the tumor *HE* Hematoxylin-Eosin stain; *Chs A/C* Chondroitin Sulfate A and C; *PAS* Periodic Acid Schiff stain; *Masson* Trichrome stain. Findings in individual specific staining can be referred to in the text

substance was significantly diminished, leaving the basophilic area only around the cells (territorial matrix). Increased amounts of collagen were evident in this area. In the provisional calcification zone, the ground substance became neutrophilic associated with deposition of calcium salt in or around the territorial matrix. The cells of this zone were extremely atrophic. Penetration of the small blood vessels could be identified in this zone. In the osteoid zone, bone trabeculae extended irregularly and fatty marrow, rich in blood vessels, was frequently noted at the center. The differentiation pattern of the proliferating cells was similar to that described in physiological enchondral ossification.

Histochemical analyses on the ground substance of this tumor showed the presence of chondroitin sulfate A and C, and hyaluronic acid in the matrix of both proliferating and hypertrophic cartilaginous cell zones. The degree of hyaluronic acid in the proliferating cell layer exceeded that observed in the physiological epiphyseal cartilage (Bona *et al.*, 1967; Conklin, 1963; Hirschman *et al.*, 1966). A PAS positive substance appeared in the ground material of the hypertrophic cartilaginous cell zone particularly in the zone of provisional calcification (Conklin, 1963). This phenomenon might be related to increase of electron-dense materials around the fine fibrils identified by electron microscopy in this area (Godman and Porter, 1960). A detailed report of both electron microscopy and histochemistry of the tumor will be published in a separate note.

Both histological and histochemical characteristics of this tumor are schematically summarized in Fig. 3.

Discussion

In this present case, the tumor apparently originated from the posterior clinoid process in an exostotic form without the concentric expansion characteristic in

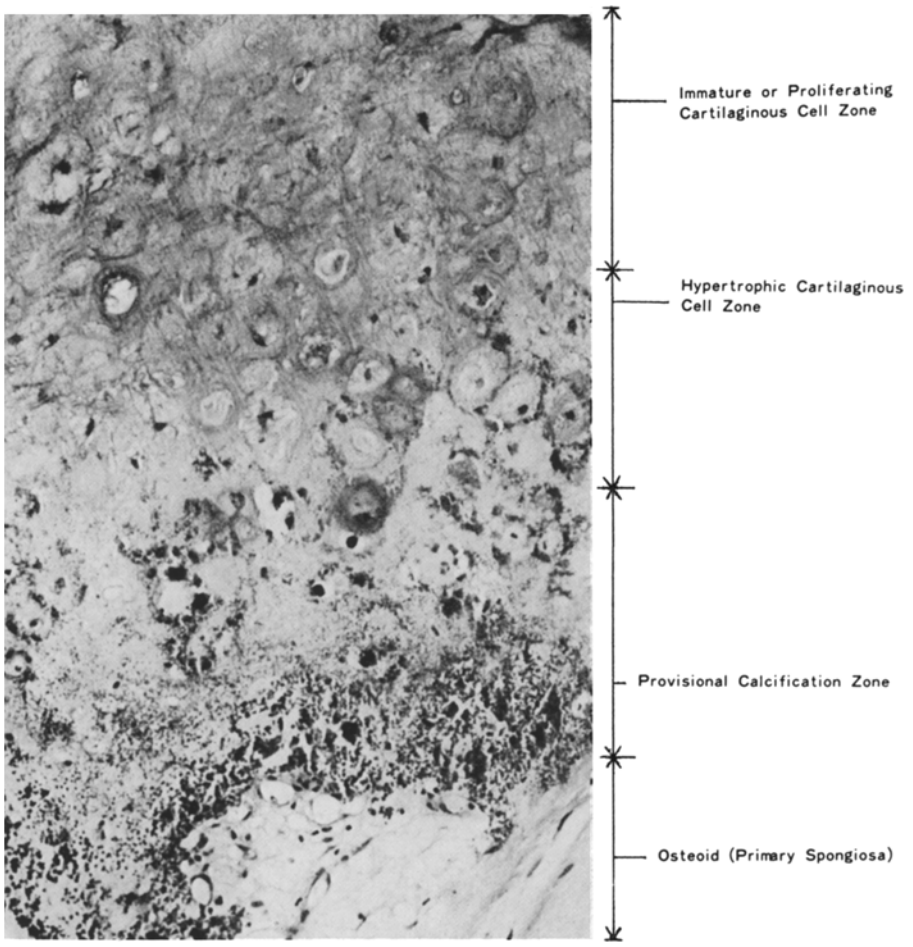


Fig. 4. A high power view of a cartilaginous nodule. Four layers can be distinguished clearly. Immature or proliferating cartilaginous cell zone: Spherical or stellate cells with chromatin rich round nuclei are scattered in the basophilic matrix. Lacuna or territorial matrix is obscure. Hypertrophic cartilaginous cell zone: Lacune or territorial matrix around the cell gradually enlarges. The presence of many vacuoles in the cytoplasm results in irregularity or swelling of the cell structure. Basophility of the matrix gradually decreases except for the territorial matrix. Provisional calcification zone: Spotted calcification appears in the neutrophilic matrix especially in the territorial matrix. The cells are shrunken and degenerated. Osteoid zone: Osteoid is arranged irregularly with thick trabeculae which surround fatty marrow with vessels

enchondroma. Histologically, the tumor showed a clear pattern of cell differentiation from immature chondrocytes to the mature bone, suggesting a osteogenetic potential (Jaffé, 1958). Thus we concluded that this tumor might be an osteochondroma which originated from the posterior clinoid process in an exostotic form.

The intracranial tumor reported here apparently falls in the category of a cartilage-containing tumor of the skull base designated as chondroma, osteochondroma or chondrosarcoma according to their histological characteristics. The

enchondromatous nature of the tumor is much favored (Gabrielsen and Kingman, 1964) particularly in the German literature in which the histogenetic relation of the tumor to embryonal cartilagenous remnants along the basilar synchondrosis has been emphasized (Kleinsasser and Griedmann, 1958; Klingler, 1957; List, 1969). According to this school, ossification has been regarded as a reactive bone formation in the tumor. Because of the definite histological characteristics discussed above, this theory is hardly applicable to the present case. King and Butcher (1944) and Gabrielsen and Kingman (1964) have stated that osteochondroma of the skull base may be analogous to osteocartilaginous exostosis of the systemic skeleton. This hypothesis may well be applicable to histogenesis of the tumor of our present case. Our study, however, did not give any definitive answer as to whether the tumor was a real neoplastic growth or simple exostosis.

Myxomatous stroma is frequently associated with a tumor of this type. These histological characteristics lead frequently to a misdiagnosis of the lesion as chordoma (Poppen and King, 1952). Histologically, our case showed neither physaliferous cells in the myxomatous area nor syncytial formation of the proliferating cells. These findings tend to indicate that the present tumor is not a chordoma (Falconer *et al.*, 1968). Moreover, chondromatous growth observed in this case should not be seen in the chordoma (Jaffe, 1958).

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