210

ODONTOMA IN AN AFRICAN ELEPHANT *(Loxodonta africana)*

E J RAUBENHEIMER*, W F P VAN HEERDEN*, M L TURNER* and L K MARÉ**

ABSTRACT
The first known case of an odontoma in an African elephant *(Loxodonta africana)* is described. The tumour was fused with the coronal cementum of the sixth right mandibular molar tooth, thus preventing its eruption.

Key words: African elephant, *Loxodonta africana*, **odontoma**

Raubenheimer E.J.; van Heerden W.F.P., Turner M.L., Maré L.K. Odontoma in an African elephant *(Loxodonta africana). Journal of the South African Veterinary Association* **(1989) 60 No. 3, 149-150 (En.) Department of Oral Pathology and Biology, Medical University of Southern Africa, 0204 Medunsa, Republic of South Africa.**

INTRODUCTION

The term "odontoma" by definition alone, refers to any tumour of the dental tissues[4]. Through usage, however, it has come to be employed in a much more restricted sense and refers to a tumour in which induction has resulted in the development of both enamel and dentine[1].

Odontomas represent a hamartomatous malformation rather than a neoplasm[9]. Thus, they are frequently formed in the place of a missing tooth, or if all the teeth are present, an odontoma may represent a malformation of a supernumerary tooth germ[6]. Odontomas are subdivided according to morphological features into complex and compound odontomas. The complex odontoma consists of a mass of irregularly-arranged enamel, dentine, cementum and connective tissue, bearing no morphologic similarity to teeth. In the compound odontoma the enamel, dentine and cementum are laid down in an orderly fashion so that toothlike structures can be identified. In humans the complex type of odontoma is less common than the compound type, although some lesions are a combination of both types[6].

Odontomas have been reported in various animals, including dogs[11], horses[2 3 8] and nonhuman primates[10 12]. This report describes the first known case of an odontoma occurring in an African elephant *(Loxodonta africana)*.

CASE REPORT

A dried mandible of an African elephant, containing a 350 x 250 x 200 mm calcified tumour in the right corpus was submitted to the Department of Oral Pathology for examination and diagnosis. The tumour caused buccal and lingual expansion (Fig. 1) and was partially erupted and functional: the abraded occlusal surface showed haphazardly-arranged cementum, enamel and dentine. The tumour had an irregular surface and was not attached to the surrounding bone which showed features of osteomyelitis. A portion of a molar tooth protruded from the anterior (rostral) surface of the lesion which had a total mass of 7,8 kg (Fig. 2). The associated molar tooth was clearly visible on the sectioned surface and the cementum of the tooth was fused to the tumour, the latter of which was composed of cementum-like tissue surrounding well-formed enamel and dentinal structures (Fig. 3).

Radiographic examination of the distal corpus and ramus of the right mandible failed to exhibit additional developing teeth. The 6th molar tooth on the left was fully developed, erupted and partially abraded.

Microscopic examination of the tumour revealed cellular cementum, dental enamel and regular dentine arranged in an orderly fashion (Fig. 4).

DISCUSSION

Odontomas develop in place of a tooth or, if the normal complement of teeth are present, from a supernumerary tooth germ. They follow the normal growth pattern of a developing tooth and even though quite large dimensions may be attained, the cellular activity of odontomas cease after completion of hard tissue formation.

Unlike humans, elephant have a total of 6 successive developing molar teeth in each quadrant which are abraded and shed throughout the life of the animal. Examination of the left mandible of our specimen showed the 6th molar to be fully developed and erupted and the age of the animal was estimated to be in excess of 35 years. As the chronology of tooth development in the specimen is unknown, the origin of the odontoma suggests two possibilities. The lesion may have originated from the germ of the 5th molar which develops and erupts between the ages of 16 and 43 years[5]. Alternatively, in the presence of a normal complement of teeth, the odontoma could have developed from a supernumerary tooth germ. The occurrence of supernumerary molar teeth in elephant however, has not been described.

The macroscopic and microscopic appearance of the lesion were consistent with a mature compound type odontoma. Enamel, dentine and cementum were arranged in an orderly fashion and the interface between these tissue types resembles that found in a normal tooth. Fusion between the cementum of the odontoma and the associated molar tooth was the result of cementum formation on the enamel surfaces in both structures. The formation of cementum on enamel is a normal phenomenon in many animals[7]. The forces of eruption of the fused molar tooth probably forced the odontoma into occlusion with the opposing maxillary molar tooth, hence the smooth abraded area on the ventral surface thereof. Partial exposure of the odontoma to the oral environment resulted in the development of an osteomyelitis in the bone surrounding the lesion.

ACKNOWLEDGEMENT

We wish to express our appreciation to Mrs C S Begemann for secretarial services.

REFERENCES

1. Batsakis J G 1979 Tumours of the Head and Neck 2nd edn Williams & Wilkins, Baltimore
2. Dillehay D L, Schoeb T R 1986 Complex odontoma in a horse. Veterinary Pathology 23: 341-342
3. Dubielzig R R, Beck K A, Levine S, Wilson J W 1986 Complex odontoma in a stallion. Veterinary Pathology 23: 633-635
4. Gabell D P, James W W, Payne J L 1914 The Report on Odontomes 1st edn British Dental Association, London
5. Grzimek B 1975 Grzimek's Animal Life Encyclopedia Volume 12 1st edn Van Nostrand Reinhold Company, New York
6. Lucas R B 1976 Pathology of Tumours of the Oral Tissues 3rd edn Churchill Livingstone, Edinburgh
7. Osborn J W 1981 Dental Anatomy and Embryology Volume 1 Book 2 1st edn Blackwell Scientific Pulbications
8. Peter C P, Myers V S, Ramsey F K 1968 Ameloblastic odontoma in a pony. American Journal of Veterinary Research 29: 1495-1498
9. Shafer W G, Hine M K, Levy B M 1983 A Textbook of Oral Pathology 4th edn W B Saunders Company, Philadelphia
10. Splitter G A, Pryor W H, Casey H W 1972

* Department of Oral Pathology and Biology, Medical University of Southern Africa, 0204 Medunsa, Republic of South Africa

** P.O. Box 553, 1240 White River

Received: February 1989 Accepted: March 1989

Ameloblastic odontoma in a Rhesus Monkey. Journal of the American Veterinary Medical Association 161: 710-713
11. Valentine B A, Lynch M J, May J C 1985 Compound odontoma in a dog. Journal of the American Veterinary Medical Association 186: 177-79
12. Ziemer E L, Turrel J M, Duhamel G, George L W 1986 Surgery and radiotherapy for management of compound odontoma in a heifer. Journal of the American Veterinary Medical Association 189: 794-796

Fig. 1: Right corpus of mandible with partially erupted odontoma. (arrow) and buccal and lingual bone expansion (bar = 10 cm) Note abraded surface

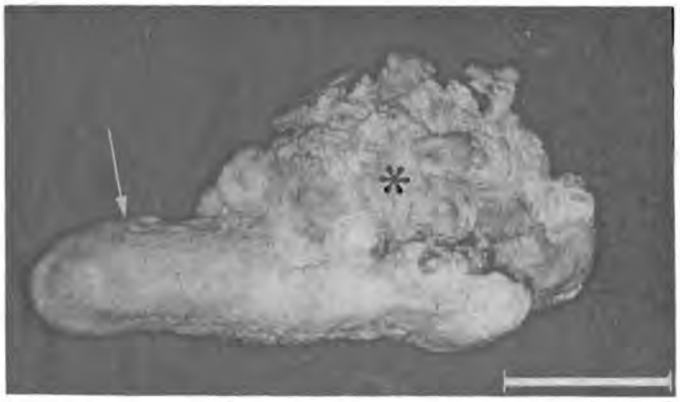

Fig. 2: Molar tooth (arrow) with attached odontoma (asterisk) (bar = 10 cm)

Fig. 3: Length section through odontoma (asterisk) and molar tooth (arrows), showing the enamel (e), dentine (d) and cementum (c) of both structures (bar = 2 cm)

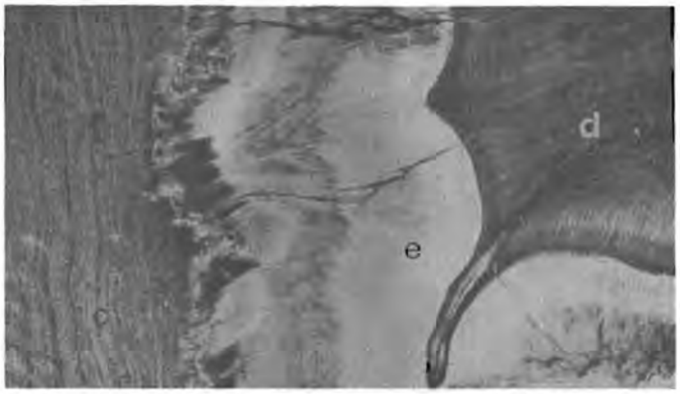

Fig. 4: Micrograph of the orderly-arranged cementum (c), enamel (e) and dentine (d) of the odontoma (Ground section, x 20)

Giant ossifying fibroma: a clinicopathologic study of 8 tumors

W. F. P. van Heerden[1], E. J. Raubenheimer[1], R. G. Weir[2] and J. Kreidler[1]

Departments of [1]Oral Pathology and Oral Biology, [2]Maxillofacial and Oral Surgery, Medical University of Southern Africa, Medunsa, Republic of South Africa

van Heerden WFP, Raubenheimer EJ, Weir RG, Kreidler J: Giant ossifying fibroma: a clinicopathologic study of 8 tumors. J. Oral Pathol Med 1989; 18: 506–509.

Clinical, radiographic and microscopic features of 8 ossifying fibromas diagnosed in 7 patients and measuring more than 8 cm in greatest diameter, were reviewed. The tumors occured in both juvenile and middle aged patients and all lesions in women involved the maxilla. The abundance of fibrous connective tissue and resorption of mineralized deposits are indicative of altered cellular differentiation and proliferative activities in large ossifying fibromas. Focal areas of aneurysmal bone cyst formation were identified in the majority of lesions.

Key words: fibro-osseous lesion; giant ossifying fibroma; juvenile aggressive ossifying fibroma.

W. F. P. van Heerden, Department of Oral Pathology, Medical University of Southern Africa, P. O. Medunsa, 0204, Republic of South Africa.

Accepted for publication August 9, 1989.

Ossifying fibromas are generally regarded as slow growing and well circumscribed jaw tumors which contain foci of trabecular and spherical calcifications resembling bone and cementum respectively (1). They are reported to be more common in blacks, occur frequently in women and the majority of lesions involve the mandible (1, 2).

Although no convincing definition of giant ossifying fibromas are to be found in the literature, these neoplasms were reported by various authors as large tumorous fibro-cemento-osseous proliferations (3–7). Unfortunately, many of the reported cases are not documented satisfactorily. HAMNER *et al.* (1968) however, arbitrarly defined giant lesions as those exceeding 2 × 2 cm in size or involving the space occupied by two or more teeth.

There is no published series of giant ossifying fibromas in the literature. Therefore, this study was undertaken to determine the clinical and radiographic appearances and the microscopic features of the large ossifying fibromas diagnosed by the Department of Oral Pathology at the Medical University of Southern Africa (Medunsa) over a 6-yr period.

Material and methods

All the cases diagnosed as ossifying fibroma over the last 6 yr were retrieved from the files of the Department of Oral Pathology, Medunsa, Most patients seen at the hospitals served by the department are black and of rural origin. The pathology reports were reviewed and all lesions with a longitudinal diameter of 8 cm or more as measured on the excision specimen, were included in this study. Radiographs were available in all the selected cases. Histologic evaluation was done by means of light microscopy. Three specimens (Cases 1, 3, 4) were bivalved in the longitudinal diameter, and a 5 mm slice of the entire cut surface was obtained by means of a band-saw. The slice was then radiographed and blocked into multiple squares, each of which was numbered on a scheme corresponding to the radiograph and processed for routine light microscopy. Representative histologic sections were avialable in the remaining cases.

Results

Seven patients from a total of 30 cases of ossifying fibroma were found to have tumors larger than 8 cm in greatest diameter (Fig. 1). The age, sex, site and size of the tumors are indicated in Table 1. Case 5 presented with a mandibular and a maxillary tumor, both exceeding 8 cm. Signs and symptoms varied, the most common of which was swelling. At the age of 2 yr, Case 1 presented with a mandibular tumor 4 cm in diameter. Biopsy showed a benign fibro-osseous proliferation and due to parenteral refusal the lesion was followed over a period of 7 yr during which it became less radiopaque and tripled in diameter. The duration of the other lesions could not be determined reliably. Although the post-operative follow-up is in some cases as short as one year, none of the lesions have recurred.

All tumors involved the tooth-bearing areas of the jaws and were well demarcated with scattered foci of radiopacities (Fig. 2). Root resorption were present in three cases.

Case 1 was treated with hemimandibulectomy. Enucleation of the tumor was done in the other cases. No cortical perforation was present, only expansion in all directions. On cut surface, the tumors had a gray-white color with a gritty consistency. Cystic spaces representing aneurysmal bone cyst changes and measuring up to 1 cm in diameter could be seen focally in six tumors.

The histologic features correlated with the radiographic appearance of the corresponding area. The inconspicuous radiodense areas consisted of woven trabecular bone, although a few lamellar bony trabeculae and psammomatous calcifications were also found. Active resorption of the trabeculae with accumulation of osteoclast type giant cells were evident in all tumors (Fig. 3). Vascularity was more prominent in the areas of resorption and the fibrous component adjacent to these areas were cellular.

The radiolucent zones consisted

Fig. 1. A, clinical appearance of Case 3. B, clinical appearance of Case 4.

mainly of fibrous tissue. The stroma varied from mature collagen to tissue with a cellular storiform pattern (Fig. 4). Small amounts of mineralized tissue, mainly of a psammomatous cementum-like nature were present in the fibrous tissue. The aneurysmal bone cyst changes were found in areas where the fibrous tissue had a loose, edematous structure.

Discussion

The sizes of the eight tumors described surpass that of all giant ossifying fibromas reported in the literature. HAMNER *et al.* (3), defining 'giant' lesions as those exceeding 2 × 2 cm in diameter, found 17% of their cases of cemento-ossifying fibromas to have reached these dimensions. Seven (or 23%) of our collection of ossifying fibromas had a diameter of more than 8 cm. If the criteria of *Hamner et al.* (3) had to be applied to our collection of ossifying fibromas, almost all of the 30 cases diagnosed in our department over the last 6 yr will be regarded as 'giant'. The large dimensions of our tumors is related to the rural character of the populations served where proper diagnosis and treatment is often delayed through tribal customs.

Table 1. Clinical data of the seven patients.

Case No	Age	Gender	Site	Size
1	9	M	Mandible	12 cm
2	7	W	Maxilla	8 cm
3	13	W	Maxilla	13 cm
4	46	W	Maxilla	15 cm
5	40	M	Mandible	8 cm
			Maxilla	10 cm
6	49	M	Mandible	10 cm
7	57	W	Maxilla	10 cm

The age range of our patients was 7–57 yr with an age peak in the first and fifth decades, a distribution corresponding to that generally reported for ossifying fibromas (1). The occurrence of large ossifying fibromas in young children is of particular interest as it is believed that these tumors require many years of growth to attain large dimensions (2). One of our cases, diagnosed at 2 yr of age, showed an increase of 8 cm in diameter over a follow-up period of 7 yr. As far as we can ascertain, this represents the youngest age at which an ossifying fibroma had been diagnosed. Five of the eight tumors and all lesions in women involved the maxilla. This is in contrast to the generally held view that ossifying fibromas occur more frequently in the mandible (2).

Radiographically, the large ossifying fibromas in our study contain relatively less mineralized tissue than smaller lesions. This finding is substantiated by the microscopic appearance of the giant lesions where the balance of cellular activity favor fibrous tissue formation and bone resorption at the expense of new bone formation. Although the majority of our lesions showed foci of aneurysmal bone cyst formation, STRUTHERS & SHEAR (8) found this change to occur in only 4% of their ossifying fibromas and *Eversole et al.* (9) noted aneurysmal bone cyst features in three of their 64 cases. The high prevalence of aneurysmal bone cyst formation in our lesions is probably due to the prominent fibrous component which contains more loose edematous areas than is found in smaller ossifying fibromas. This feature is not responsible for the giant dimensions, as the foci of aneurysmal bone cyst change are limited and the cystic spaces are of relative small size.

HAMNER *et al.* (3) stated that ossifying fibromas containing cementum are larger and more aggressive than pure ossifying or cementifying lesions. HALL *et al.* (10) consider mixed cementifying and ossifying fibromas as a potentially aggresive variant of ossifying fibroma. WALDRON & GIANSANTI (11) however stated that a separation into cementifying and ossifying types is artificial as they could find no difference in the behaviour of tumors with these histologic designations. Cementum-like as well as osseous deposits were present in all tumors in our series and we believe that if representative tissues of ossifying fibromas are taken for microscopic examination, most tumors will be found to be of a mixed nature.

Our study furthermore suggests that ossifying fibromas with a gigantiform growth potential are characterized by the appearance of large fibrous areas which are represented radiographically by less radiodense areas. This is in contrast to the normal progression of these lesions where the islands of mineralizations are reported to increase in size and coalesce resulting in a more radiopaque lesion (2).

The microscopic appearance of the giant lesions does not resemble that of juvenile aggressive ossifying fibromas. The criteria defined by WALDRON (12) for the diagnosis of juvenile aggressive ossifying fibroma include a cellular vascular stroma with varying amounts of giant cells and little collagen production. Osteoid lined by osteoblasts are usually present. These lesions furthermore appear most often in young patients – predominantly younger than 20 yr and almost always below 40 yr of age (13). None of the lesions in the three young patients in our series can be classified as the aggressive variant because of the prominent fibrous tissue and collagen component and the scarcity of osteoid formation. This however does not exclude the possibility that at some earlier stage our lesions may have had the microscopic features of juvenile aggressive ossifying fibromas.

This study suggests that the shift in cellular activity from osteoblastic in small ossifying fibromas to fibroblastic in the giant lesions represents a phenomenon associated with gigantiform tumor enlargement.

Fig. 2. A, radiograph of Case 3 shows a well demarcated lesion with smokescreen appearance and irregular radiolucent areas. B, Prominent lytic areas are present in Case 1 (arrows).

Acknowledgments – We wish to thank Mrs. C. S. BEGEMANN for secretarial services and Miss L. I. HOPE, Audio Visual Department of the Medical University of Southern Africa for photographic services.

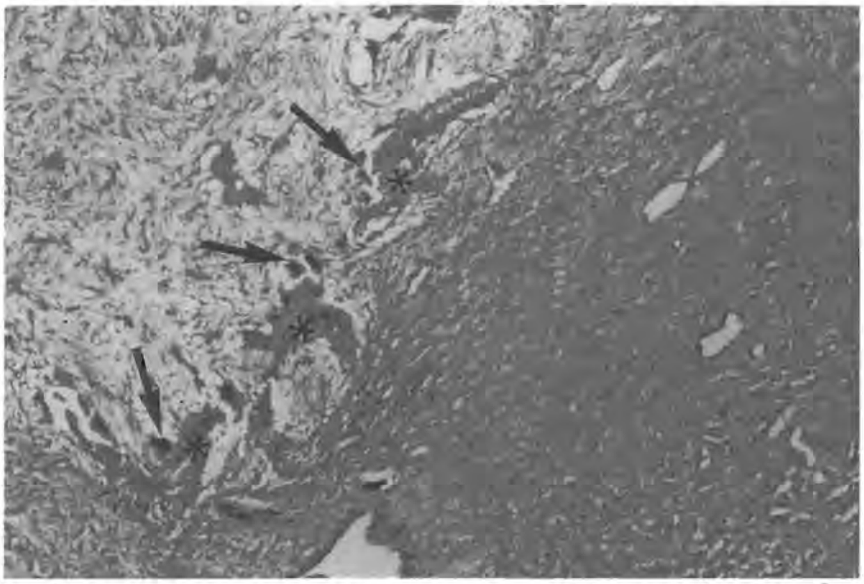

Fig. 3. Interface between dense fibrous zone and area of bone resorption. Note bony trabeculae (asterisks) and osteoclasts (arrows) in loose fibrous tissue. H&E, × 40.

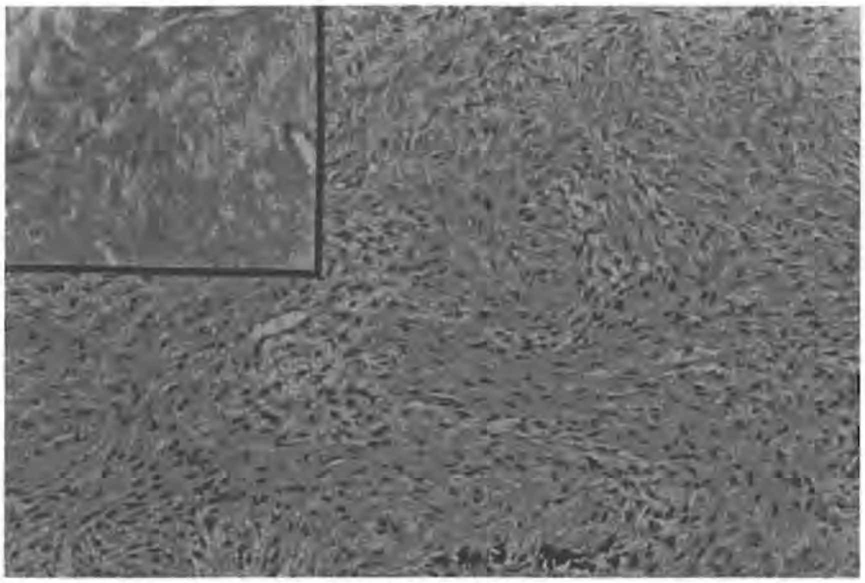

Fig. 4. Cellular storiform growth pattern. H&E, × 100. Inset: mature collagen. H&E, × 150.

References

1. Lucas RB. *Pathology of tumours of the oral tissues.* 4th ed. Edinburgh: Livingstone, 1984, 402–5.
2. Shafer WG, Hine MK, Levy BM. *A textbook of oral pathology.* 4th ed. Philadelphia: W. B. Saunders Co, 1983; 142–4.
3. Hamner JE, Scofield HH, Cornyn J. Benign fibro-osseous jaw lesions of periodontal membrane origin: an analysis of 249 cases. *Cancer* 1968; **22**: 861–8.
4. Carlisle JE, Hamner WB. Giant central ossifying fibroma of the mandible: report of case. *J Oral Surg* 1979; **37**: 206–11.
5. Vuolo SJ, Berg H, Pierri LK, Jandinski J, Yamane GM, Chaudry AP. Giant ossifying fibroma of the maxillary sinus. *J Oral Med* 1986; **41**: 152–5.
6. Anand SV, Davey WW, Cohen B. Tumours of the jaw in West Africa: a review of 256 patients. *Br J Surg* 1967; **54**: 901–17.
7. Kennet S, Curran JB. Giant cemento-ossifying fibroma: report of a case. *J. Oral Surg* 1972; **30**: 513–6.
8. Struthers PJ, Shear M. Aneurismal bone cyst of the jaws (II). Pathogenesis. *Int J Oral Surg* 1984; **13**: 92–100.
9. Eversole LR, Leider AS, Nelson K. Ossifying fibroma: a clinicopathologic study of sixty-four cases. *Oral Surg* 1985; **60**: 505–11.
10. Hall EH, Naylor GD, Mohr RW, Warnock GR. Early aggressive cemento-ossifying fibroma: a diagnostic and treatment dilemma. *Oral Surg* 1987; **63**: 132–6.
11. Waldron CA, Giansant JS. Benign fibro-osseous lesions of the jaws: a clinical-radiologic-histologic review of sixty-five cases. *Oral Surg* 1973; **35**: 340–50.
12. Waldron CA. Fibro-osseous lesions of the jaws. *J Oral Maxillofac Surg* 1985; **43**: 249–62.
13. Walter JM, Terry BC, Small EW, Matteson SR, Howell RM. Aggressive ossifying fibroma of the maxilla. *J Oral Surg* 1979; **37**: 276–86.

Adenomatoid odontogenic tumour: a report of two large lesions

E.J. Raubenheimer, J.E. Seeliger*, W.F.P. van Heerden and A.F. Dreyer*

Medical University of Southern Africa, Faculty of Dentistry, Medunsa and *University of Pretoria, Faculty of Dentistry, Pretoria, Republic of South Africa

Received 30 January 1990 and in final form 30 May 1990

Adenomatoid odontogenic tumours with a diameter of more than 4 cm are uncommon. Two cases, both measuring in excess of 7 cm, are described and the differential diagnosis discussed. The progressive growth and cortical perforation in these two cases support the view that it is a benign neoplasm rather than a hamartoma.

Keywords: Odontogenic tumours; maxilla

The adenomatoid odontogenic tumour (AOT) is a rare, benign odontogenic tumour of which approximately 170 verifiable cases have been reported in the English literature. It occurs most often in young females and commonly involves the anterior maxilla. Although many AOTs are detected during routine radiographic examination, patients may present with a gradually enlarging, painless swelling which can lead to facial asymmetry. Radiographs generally show a clearly demarcated, radiolucent lesion surrounding an unerupted tooth, usually a maxillary canine[1,2]. Radiopaque foci frequently occur in the tumour. The size of an AOT varies between 1.5 and 3.0 cm but some as large as 9.0 cm have been reported[3]. It is usually diagnosed radiographically as a follicular, lateral periodontal[1], residual[4] or 'globulo-maxillary' cyst[2,5]. If calcification is present, the differential diagnosis should also include calcifying odontogenic cyst, central ossifying fibroma, calcifying epithelial odontogenic tumour and ameloblastic fibro-odontome. Microscopically, AOTs are characterized by a well-defined fibrous capsule surrounding sheets, strands and nodular masses of epithelial cells which form tube-like structures and rosettes[1]. The purpose of this paper is to report two large AOTs with diameters of more than 7 cm.

Case reports

Case 1

A 12-year-old black female presented complaining of a maxillary swelling obstructing her nose; the duration of the swelling was unknown. On examination, a maxillary tumour, extending from the lower border of the right eye and crossing the midline of the face, was present. The size of the lesion interfered with lip closure. The nose was deviated, the nasal passage obstructed and on palpation the bony cortex was perforated, resulting in fluctuation. The skin overlying the lesion had three parallel scars (each 4 cm long). Intra-oral examination showed mobile and displaced maxillary permanent incisors and a primary canine, and bulging of the right palatal shelf and buccal plate (Figure 1). Radiographs revealed a well-circumscribed unilocular radiolucency containing the crown of the unerupted permanent canine (Figures 2, 3). A clinical diagnosis of follicular cyst was made and the lesion was enucleated through an intra-oral approach. The specimen submitted for pathological examination consisted of a cystic lesion measuring 12 × 10 × 10 cm which contained a normal maxillary canine. The lining of the cyst contained multiple nodules measuring up to 5 mm in diameter. Microscopic examination showed an epithelial lining containing nodular masses of odontogenic epithelial cells forming rosettes and pseudoglandular spaces. A diagnoses of AOT was made.

Case 2

A 9-year-old black female presented with a complaint of swelling in the right maxilla obstructing her nose. The lesion was painless and had been present for 3 years. On examination, there was a 9 × 8 cm swelling in the right maxilla, which had elevated the right ala (Figure 4). The maxillary permanent central incisors,

Figure 1 Case 1. Intraoral view of the tumour

0250–832×91/010043–03

Figure 2 Case 1. Lateral cephalometric radiograph. Note the displacement of the permanent maxillary canine (arrow)

primary canines and molars were erupted and the palatal shelf and buccal plate were expanded by a firm swelling. Radiographically, there was a well-circumscribed radiolucent lesion, surrounding the crown and neck of an unerupted maxillary canine; the developing maxillary premolars were dilacerated and the second incisor displaced and impacted (Figure 5). In the absence of calcification in the wall of the lesion, a clinical diagnosis of a follicular cyst was made. The lesion was enucleated and an opened cyst, 8 cm in diameter, surrounding the crown and neck of an unerupted maxillary canine and containing mural granules, was submitted for pathological examination. Microscopically, the cyst wall consisted of abundant connective tissue lined by thin and inactive odontogenic epithelium which surrounded nodular masses of epithelial cells exhibiting rosettes and pseudoglandular structures. A diagnosis of AOT was made.

Discussion

As far as can be ascertained, Case 1 represents the largest AOT reported in the English literature.

Figure 3 Case 1. Panoramic radiograph. Note the well circumscribed, expansile lesion in the right maxilla with displacement of the roots of involved teeth as well as the canine

Figure 4 Case 2. Frontal photograph

Another large tumour had a diameter of 9 cm and formed part of a series of 13 cases occurring in Nigerian patients[3]. The large size of our two cases could be related to their more rapid growth in younger patients, certainly, the average age is higher in previous reports. However, the size may also result from a delay in seeking proper dental treatment. This view is supported by the presence of linear scars on the skin overlying the tumour in Case 1, an indication of regular visits to tribal medicine men before seeking hospital treatment.

The histogenesis of the AOT is unknown but the possibilities range from the dental lamina to reduced enamel epithelium[6–8]. One investigator[9] suggested that the epithelial rests of Malassez at the apex of deciduous teeth is the progenitor tissue. His argument is based, in

Figure 5 Case 2. Panoramic radiograph. Note the dilacerated first and second permanent maxillary premolars (arrows)

part, on the fact that AOTs have never occurred in association with impacted deciduous teeth nor in areas not preceded by deciduous teeth. The existence of those lesions not associated with an unerupted tooth and therefore not arising from the reduced enamel epithelium, may be explained on this basis.

Courtney and Kerr[10] from a study of 20 AOTs, as well as others[11-13], believe the lesion to be an hamartoma rather than a benign neoplasm. However, hamartomas have a limited growth potential and progressively differentiate into more mature tissue with ageing[14]. Our cases do not support a limited growth potential as postulated by Saito *et al.*[4] nor did they exhibit maturation into more differentiated dental tissues. We therefore believe the lesion to be a benign neoplasm. The growth potential of AOTs is supported by Ajagbe *et al.* and others[15,16] and earlier detection is likely to be the reason for the small size of most cases reported in the literature.

Radiographically both of our cases resembled a follicular cyst, the most common lesion to consider in the differential diagnosis of AOT. The well demarcated radiolucency associated with an AOT is reported to extend more apically on the root of the associated unerupted tooth than in the case of a follicular cyst[17]. Another feature that could be helpful in distinguishing between these two lesions is the virtual absence of root resorption in AOTs[18]. The dilaceration of the permanent premolars in Case 2 is most likely the result of pressure exerted by the enlarging tumour on the roots of the developing teeth.

Nasal obstruction is a common complaint in patients with maxillary AOTs measuring 5 cm or more in diameter[3,19]. Furthermore, erosion of bone has been reported in a large AOT and actual perforation has led to it being described as a 'fluctuant mass'[19]. Our Case 1 also exhibited this feature but we do not agree with Poulson and Greer[20] that its presence warrants the exclusion of an AOT and the consideration of a more aggressive tumour in the differential diagnosis.

Acknowledgement

We would like to express our gratitude to Mrs C.S. Begemann for typing the manuscript.

References

1. Lucas RB. *Pathology of Tumours of the Oral Tissues*. 4th edn. London: Churchill Livingstone. 1984: 61–6.
2. Kuntz AA, Reichart PA. Adenomatoid odontogenic tumor mimicking a gobulo-maxillary cyst. *Int J Oral Maxillofac Surg* 1986. **15:** 632–6.
3. Ajagbe HA, Daramola JO, Junaid TA, Ajagbe OA. Adenomatoid odontogenic tumor in a black African population. *J Oral Maxillofac Surg* 1985; **43:** 683–7.
4. Saito I, Ide F, Umemura S. An unusual adenomatoid odontogenic tumor presenting as a residual cyst. *J Oral Maxillofac Surg* 1983; **41:** 534–5.
5. Glickman R, Super S, Sunderaj M, Jain R, Chaudhry A. An adenomatoid odontogenic tumour simulating globulo-maxillary cyst. *J Oral Med* 1983; **38:** 26–9.
6. Shear M. The histogenesis of the 'Tumour of enamel organ epithelium'. *Br Dent J* 1962; **112:** 494–8.
7. Bhaskar SN. Adenoameloblastoma: its histogenesis and a report of 15 new cases. *J Oral Surg* 1964; **22:** 218–26.
8. Spouge JD. The adenoameloblastoma. *Oral Surg Oral Med Oral Pathol* 1967; **23:** 472–82.
9. Chambers KS. The adenoameloblastoma. *Br J Oral Surg* 1973; **10:** 310–20.
10. Courtney RM, Kerr DA. The odontogenic adenomatoid tumor. A comprehensive study of twenty new cases. *Oral Surg Oral Med Oral Pathol* 1975; **39:** 424–35.
11. Abrams AM, Melrose RJ, Howell FV. Adenoameloblastoma. A clinical pathologic study of ten new cases. *Cancer* 1968; **22:** 175–85.
12. Milobsky L, Miller GM. Adenomatoid odontogenic tumor (adenoameloblastoma). Report of a case. *Oral Surg Oral Med Oral Pathol* 1975; **40:** 681–5.
13. Khan MY, Kwee H, Schneider LC, Saber I. Adenomatoid odontogenic tumor resembling a globulo maxillary cyst: light and electron microscopic studies. *J Oral Surg* 1977; **35:** 739–42.
14. Anderson WAD, Scotti TM. *Synopsis of Pathology*, 10th edn. St Louis: CV Mosby, 1980; 241.
15. Hacihanefio-glu U. The adenomatoid odontogenic tumor. *Oral Surg Oral Med Oral Pathol* 1974; **38:** 65–73.
16. Tsaknis PJ, Carpenter WM, Shade NI. Odontogenic adenomatoid tumor. Report of a case and review of the literature. *J Oral Surg* 1977; **35:** 146–9.
17. Giansanti JS, Someren A, Waldron CA. Odontogenic adenomatoid tumor (adenoameloblastoma). Survey of 3 cases. *Oral Surg Oral Med Oral Pathol* 1970; **30:** 69–86.
18. Shear M. *Cysts of the Oral Regions*. Bristol: John Wright and Sons 1976; 63.
19. Webb DJ, Colman MF, Moore L, Correll RW. Expansile radiolucent mass in the maxilla. *J Am Dent Assoc* 1985; **111:** 474–6.
20. Poulson TC, Greer RO. Adenomatoid odontogenic tumor: clinicopathologic and ultrastructural concepts. *J Oral Maxillofac Surg* 1983; **41:** 818–24.

Address: Professor E.J. Raubenheimer, Department of Oral Pathology, Medical University of Southern Africa, PO Medunsa, 0204, Republic of South Africa.

Journal of the Dental Association of South Africa **45**, 467-471

Amelogenesis imperfecta: multiple impactions associated with odontogenic fibromas (WHO) type

WFP van Heerden*, EJ Raubenheimer*, AF Dreyer† and AML Benn‡

*Department of Oral Pathology and Oral Biology, †Department of Maxillofacial and Oral Surgery, ‡Department of Conservative Dentistry, Medical University of Southern Africa, PO Medunsa, 0204, South Africa.

Keywords: Amelogenesis imperfecta; fibroma; odontogenic fibroma

SUMMARY

Three types of amelogenesis imperfecta (AI) are recognised, namely hypoplastic, hypomature and hypocalcified varieties. We report on two cases of hypoplastic AI, the type which occurs most frequently. Both patients presented with multiple impacted permanent teeth. Odontogenic fibromas of the WHO type were found to be associated with the crowns of all the impacted teeth and are considered to have prevented normal eruption. Dentinal dysplasia found only in the furcation area of the multirooted impacted teeth was evident. The macroscopic, microscopic and radiological appearance of the affected teeth, pericoronal lesions and interradicular dentinal dysplasia are described, and the most likely origins of the odontogenic fibromas and calcifications observed, are discussed.

OPSOMMING

Drie tipes amelogenese imperfekta (AI) word aangetref namlik hipoplasties, hipovolwasse en hipogekalsifiseerde tipes. Hierdie artikel beskryf twee gevalle van hipoplastiese AI, die mees algemene tipe. Altwee pasiënte het veelvuldige geïmpakteerde tande gehad. Odontogene fibrome, WGO tipe, is aangrensend tot die geïmpakteerde tandkrone gevind en het moontlik erupsie vertraag. Dentinale displasie is slegs in die furkasiegebied van die geïmpakteerde molaartande gevind. Die makroskopiese, mikroskopiese en radiologiese beelde van die betrokke tande, perikoronale letsels en dentinale displasie word beskryf en die moontlike oorsprong van die odontogene fibrome en kalsifikasies wat waargeneem is, word bespreek.

INTRODUCTION

Amelogenesis imperfecta (AI) is an inherited, congenital defect that primarily affects enamel formation and which is not accompanied by morphologic or metabolic defects in other body systems except abnormal tooth form or eruption (Witkop, 1989). The recent classification of Witkop (1989) describes different types of AI according to the predominant clinical and histological characteristics as well as the mode of Mendelian inheritance. The enamel abnormality can be either hypoplastic, hypomature, hypocalcified or a combination of these with autosomal dominant, autosomal recessive, sex-linked dominant or sex-linked recessive modes of inheritance (Table I). The hypoplastic type is characterised by thin, hard enamel of normal radiographic translucency. This type is the result of insufficient matrix formation with normal mineralisation. Hypomature enamel is a result of a defect in the formation of crystalline apatite in various parts of the enamel rods and sheaths. The enamel is of normal thickness with a mottled appearance, is slightly softer than normal and chips off the dentine. Radiographically it has approximately the same density as dentine. Hypocalcified enamel develops to a normal thickness but is lost soon after eruption. It is the result of defective mineralisation of the formed matrix and radiographically the enamel is less radiodense than dentine (Witkop and Sauk, 1976).

The combined prevalence of all types of AI has been reported to be 1:14 000 in the United States (Witkop and Sauk, 1976); 1:8 000 in Israel (Chosack *et al*, 1979) and 1:4 000 in Sweden (Sundell and Valentin, 1986). The most common type of AI is the hypoplastic variety with a reported prevalence that varies from 1:8 800 (Chosack *et al*, 1979) to 1:6 700 (Sundell and Valentin, 1986). Impacted teeth are often associated with the smooth hypoplastic type and, less frequently, with the rough hypoplastic type (Witkop and Sauk, 1976).

The purpose of this paper is to report two cases of rough hypoplastic amelogenesis imperfecta associated with impacted teeth and pericoronal odontogenic fibromas of the WHO type.

CASE 1

A 14-year-old girl presented for treatment with the main complaint of delayed eruption of her teeth. The child had no systemic abnormalities. Intraoral examination revealed thin, hard enamel on all the erupted teeth. The enamel surface varied from smooth to rough and had a yellow-white colour. The teeth failed to meet at the interproximal contact points. The patient had 5 sisters of whom 3 had AI with the same enamel appearance. The mother had normal teeth but the father was edentulous. His teeth had been extracted at a young age. This mode of inheritance was suggestive of an autosomal dominant inheritance pattern.

Radiographic examination revealed the normal number of teeth, of which 13 were unerupted, including the 4 developing third molars. Dilated follicles or cyst-like lesions were apparent as well demarcated radiolucencies with sclerotic margins associated with the crowns of the unerupted teeth (Fig 1). No well developed enamel could be seen. The roots of the molar teeth showed gross disfigurement with structures suggestive of pulpal calcifications.

Table 1: **Classification of amelogenesis imperfecta according to Witkop (1989)**

Type I	– Hypoplastic
IA	– hypoplastic, pitted autosomal dominant
IB	– hypoplastic, local autosomal dominant
IC	– hypoplastic, local autosomal recessive
ID	– hypoplastic, smooth autosomal dominant
IE	– hypoplastic, smooth X-linked dominant
IF	– hypoplastic, rough autosomal dominant
IG	– enamel agenesis, autosomal recessive
Type II	– Hypomaturation
IIA	– hypomaturation, pigmented autosomal recessive
IIB	– hypomaturation, X-linked recessive
IID	– snow capped teeth, autosomal dominant
Type III	– Hypocalcified
IIIA	– autosomal dominant
IIIB	– autosomal recessive
Type IV	– Hypomaturation-hypoplastic with taurodontism
IVA	– Hypomaturation-hypoplastic with taurodontism, autosomal dominant
IVB	– Hypoplastic-hypomaturation with taurodontism, autosomal dominant

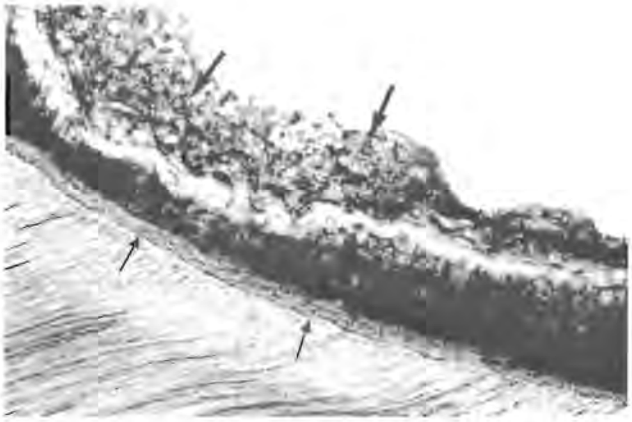

Fig. 2: **Ground section of an unerupted molar tooth with irregular enamel and globular calcifications (bold arrows). Note the straight dentinoenamel junction (fine arrows) × 100.**

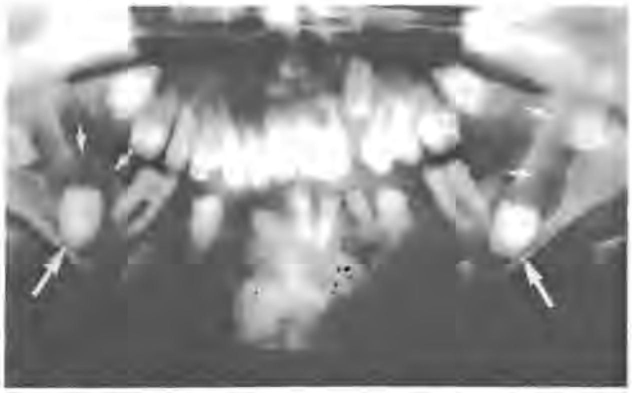

Fig. 1: **Case 1. Pantomograph showing unerupted teeth with pericoronal radiolucencies (small arrows). No evidence of enamel is present and the unerupted molar teeth show gross root disfigurement (large arrows).**

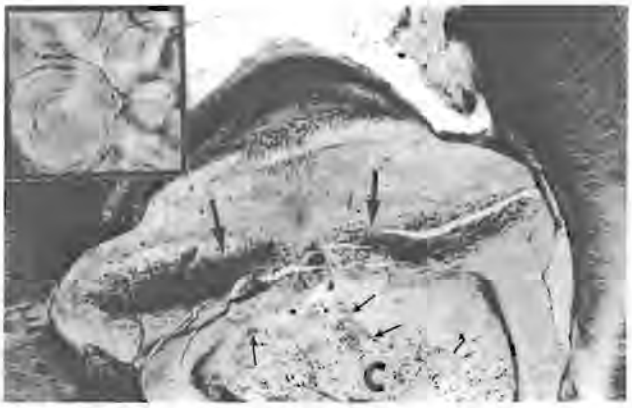

Fig. 3: **Interradicular dentine dysplasia (bold arrows) associated with hypercementosis (c) and globular calcifications (fine arrows). Ground section, unstained × 10. Inset: Calcified globules with an onion-like appearance. Ground section, unstained × 200.**

All the unerupted teeth with the associated pericoronal tissue were removed surgically under general anaesthesia. The bone was found to be normal in texture and no excessive haemorrhage was encountered. Post-operative healing was uneventful.

Light microscopy of ground sections of the molar teeth showed irregular hypoplastic enamel with globular calcifications. The dentinoenamel junction lacked the normal scalloping (Fig 2). The dentine of the crowns and roots showed no abnormalities. An irregular mass of dentine was present in the interradicular area at the level of root bifurcation in all the molar teeth. Hypercementosis, consisting of cellular cementum extending into the interradicular space of the roots, was present.

Calcified globules with an onion-like appearance were present in the cementum in close association with the irregular dentine (Fig 3). False pulpal stones, not associated with the dentinal wall, were observed.

Scanning electron microscopy (SEM) of the outer enamel surface showed irregular globular and linear masses in association with depressions (Fig 4). SEM of the fractured surface confirmed the straight dentinoenamel junction and showed normal dentine. The enamel had voids and loss of structure with a resulting honeycomb appearance throughout its full thickness (Fig 5).

The pericoronal tissue consisted of fibrous tissue that varied in cellularity. No evidence of a cystic lining was found. Odontogenic epithelial cell rests were scattered in the connective tissue. These epithelial cells appeared to be inactive with no peripheral pallisading of ameloblast like cells. Some of the epithelial cells had a vacuolated appearance. Two types of calcifications were present in the fibrous tissue. The most common type consisted of psammomatous lamellar bodies with an eosinophilic centre and a more basophilic peripheral zone. The second type consisted of eosinophilic material with a fibrillar matrix and peripheral tufts resembling Sharpey's fibres. Both types were closely associated with the odontogenic epithelial cell rests (Fig 6). The lesions were considered to be odontogenic fibromas, WHO type.

CASE 2

A 26-year-old black female reported to the hospital, requesting that she be fitted with full upper and lower dentures. The patient was clinically edentulous and had marked vertical enlargement of the entire alveolar ridge in all four quadrants. No abnormalities were found on systemic examination.

Radiological examination confirmed the enlargement of all four quadrants with both maxillary tuberosities markedly overdeveloped. There was evidence of recent tooth extractions in the mandible in the form of healing sockets and 13

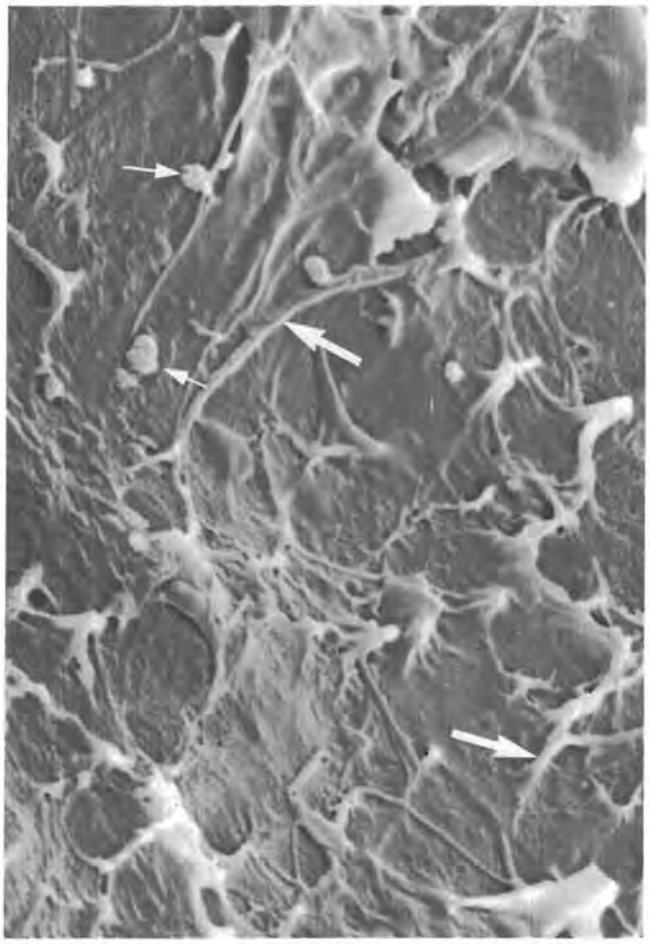

Fig. 4: **The outer enamel surface showing globular (fine arrows) and linear (bold arrows) masses associated with depressions ×2 000.**

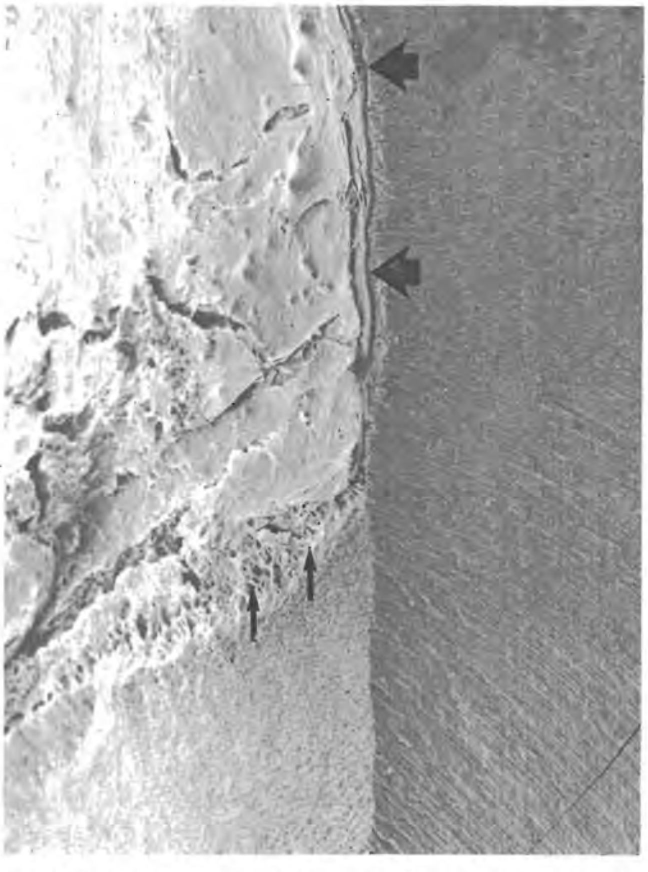

Fig. 5: **SEM of the fractured surface confirmed the straight dentinoenamel junction (bold arrows) and a honeycomb appearance in the enamel (fine arrows) ×72.**

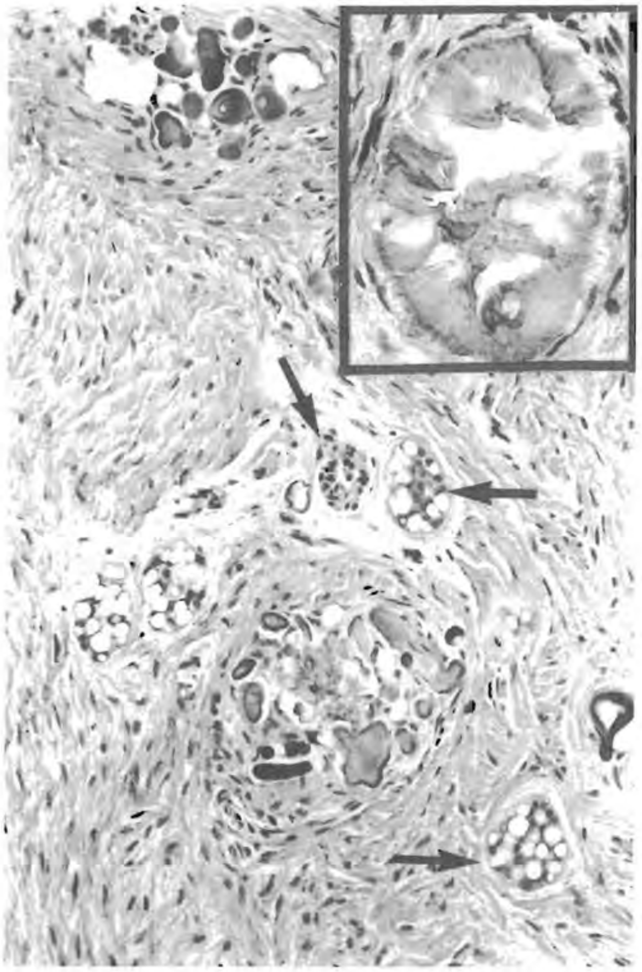

Fig. 6: **Odontogenic epithelium (arrows) associated with psammomatous calcifications in a fibrous stroma. H and E ×100. Inset: Fibrillar calcification with peripheral tufts. H and E ×200.**

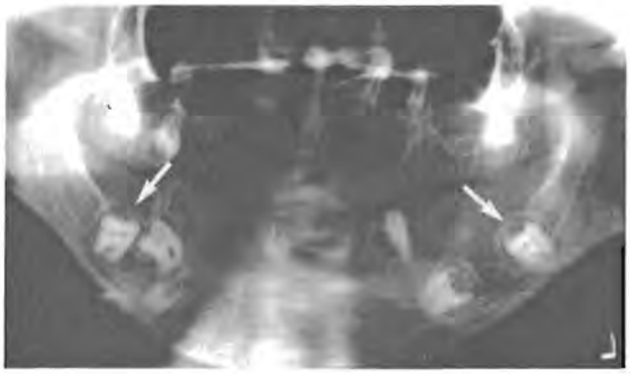

Fig. 7: **Case 2. Pantomograph showing impacted teeth with pericoronal radiolucencies (arrows).**

impacted teeth could be observed within the four quadrants. The enamel of the crowns of all teeth appeared markedly hypoplastic, with abnormally shaped pulp chambers which were smaller than normal. The roots of the teeth were malformed, shorter than normal, with occasional dilaceration. The crowns of the impacted teeth were surrounded by what looked like hyperplastic follicles. The follicular spaces were less radiolucent than normal (Fig 7). Radiological examination of the skeleton showed no abnormalities.

Macroscopic examination of an impacted molar tooth revealed thin, hard enamel with a granular appearance. The enamel could easily be chipped off. Microscopic examination of a 50 μm ground section showed normal dentine with an almost flat dentinoenamel junction. The enamel was thinner than normal and short curling enamel rods were seen. These were covered by irregular globular calcified masses (Fig 8). These features were consistent with rough hypoplastic amelogenesis imperfecta. The mode of inheritance could not be established. The pericoronal lesions had the same microscopic appearance as in case 1 (Fig 9).

DISCUSSION

Calcifications associated with odontogenic epithelial remnants have been reported in odontodysplasia, impacted dens in dente, congenitally absent teeth in which there is an attempt at tooth formation and several types of AI (Witkop and Sauk, 1976). Odontogenic epithelium was present in 60 cases and calcifications in 54 cases of the 130 cases of opercula of impacted third molars (Cutright, 1976). Gardner and Sapp (1973) described two types of calcifications designated types A and B associated with the soft tissue and a periapical area of an involved tooth of a patient with regional odontodysplasia. The type A and B calcifications are similar in appearance to the two types that were found in our cases. Calcifications are also frequently found in the excised gingivae covering unerupted teeth in patients with AI (Nakata, Kimura and Bixler, 1985; Bab *et al* 1985, Ooya, Nalbandian and Noikura, 1988).

Our radiological differential diagnosis of pericoronal radiolucent lesions was dilated dental follicles, hyperplastic dental follicles, follicular cysts or odontogenic fibromas. Normally some teeth have dilated follicles in the preeruptive phase but according to Shear (1983) it does not signify a cyst unless the pericoronal width is at least 3-4 mm as measured on a radiograph. The hyperplastic follicle presents macroscopically as a solid rather than cystic lesion and no signs of a cyst can be seen microscopically. The histological appearance of hyperplastic follicles and odontogenic fibromas are similar. According to Gardner (1980) the distinction is based on the size and location of the lesion. The follicles are invariably associated with the crowns of unerupted teeth whereas it is not necessarily true for odontogenic fibromas. Sandler *et al* (1988) reported a case of a 16-year-old boy with 13 unerupted teeth, each one associated with hyperplastic pericoronal tissue that had histological features suggestive of the WHO type of odontogenic fibroma. The erupted as well as removed impacted teeth in their case were macroscopically normal. Gardner (1980) considers the WHO type of odontogenic fibroma to be a fibroblastic neoplasm. The pericoronal location of the tumours in our two patients suggested a follicular origin. The association of this fibroma-like tissue with impacted and unerupted teeth in AI suggested a hamartomatous lesion rather than a neoplasm. It is possible that the WHO type of odontogenic fibromas associated with impacted teeth, as in our cases, have a different histogenesis than the tumours described by Doyle, Lamster and Baden (1985), as none of their 6 cases was in a pericoronal location. Dunlap and Barker (1984) consider the central odontogenic fibroma of the WHO type to be the morphologic and histogenetic counterpart of the peripheral odontogenic fibroma. The authors postulated an ectomesenchymal-epithelial interaction in the histogenesis of this tumour. The close association of calcifications with odontogenic epithelium in both our cases supported their theory.

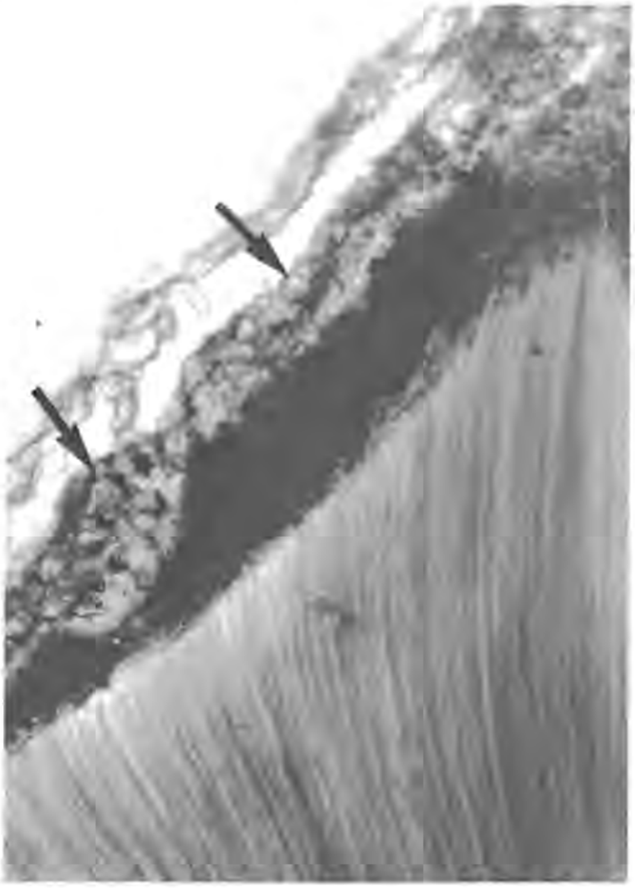

Fig. 8: **Thin abnormal enamel covered by irregular globular calcifications (bold arrows). Unstained × 100.**

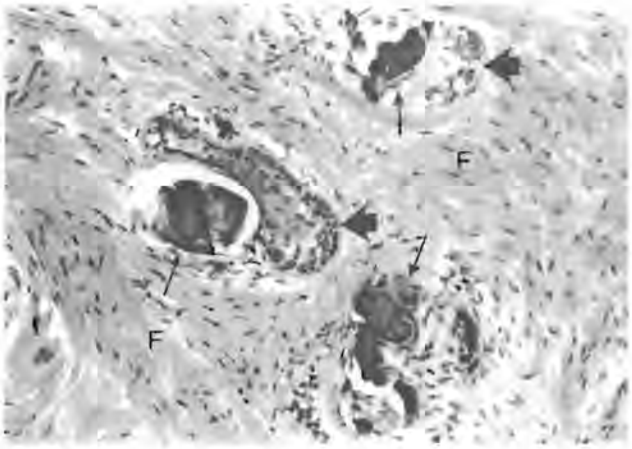

Fig. 9: **Odontogenic epithelium (bold arrows) closely associated with psammomatous calcifications (fine arrows) in a cellular fibrous tissue (F). H and E × 150.**

AI associated with interradicular dentinal dysplasia has been reported by Nakata *et al* (1985). They suggested 3 possible mechanisms for the presence of dysplastic dentine: resorption of the interradicular area followed by secondary calcification; gene influence on matrix formation in this area; and secondary calcification for some unknown reason. No sign of resorption of roots or crowns of the impacted teeth in our cases was found. No abnormalities in the roots of single rooted teeth were seen on radiological and microscopic examination. This is an indication that the underlying cause is likely to be associated with the process of root branching. A genetic influence responsible for the abnormal interradicular dentine is unlikely since the abnormal dentine present in our first patient did not occur in her 3 sisters who had AI. They had no other dental abnormalities or impacted teeth. The erupted molar teeth of the first patient showed no radiological evidence of root abnormalities. The association between the interradicular abnormalities and impactions was unclear. No abnormalities apart from AI could be seen on the impacted single rooted teeth. It is unlikely that a disturbance affecting the eruption occurred first and then caused a secondary abnormality of the interradicular area of the impacted teeth as suggested by Nakata *et al* (1985). It has been shown that eruption proceeds normally in the absence of root formation (Cahill and Marks, 1980). Both erupted and impacted molars in the AI patient reported by Nakata *et al* had interradicular dentinal dysplasia. The odontogenic fibromas WHO type associated with the pericoronal areas were probably the main reason for the impaction of teeth in both our cases. The suggested follicular origin of the odontogenic fibromas as a hamartomatous growth under the influence of the follicular epithelium supported this statement as Cahill and Marks (1980) have shown that a dental follicle is required for the eruption of a tooth.

ACKNOWLEDGEMENTS

Our gratitude to Mrs CS Begemann for secretarial services, Mr M Turner for the electron microscopy and Miss L Hope for photographic services.

REFERENCES

Bab, I., Lustmann, J., Azaz, B., Gazit, D. & Garfunkel, A. (1985) Calcification of non-collagenous matrix in human gingiva; a light and electron microscopic study. *Journal of Oral Pathology*, **14**, 573-580.

Cahill, DR. & Marks, SC. Jr. (1980) Tooth eruption: evidence for the central role of the dental follicle. *Journal of Oral Pathology*, **9**, 189-200.

Chosack, A., Eidelman, E., Wisotski, I. & Cohen, T. (1979) Amelogenesis imperfecta among Israeli Jews and the description of a new type of local hypoplastic autosomal recessive amelogenesis imperfecta. *Oral Surgery*, **47**, 148-156.

Cutright, DE. (1976) Histopathologic findings in third molar opercula. *Oral Surgery*, **41**, 215-224.

Doyle, JL., Lamster, IB. & Baden, E. (1985) Odontogenic fibroma of the complex (WHO) type: Report of six cases. *Journal of Oral and Maxillo-facial Surgery*, **43**, 666-674.

Dunlap, DL. & Barker, BF. (1984) Central odontogenic fibroma of the WHO type. *Oral Surgery*, **57**, 390-394.

Gardner, DG. (1980) The central odontogenic fibroma: An attempt at clarification. *Oral Surgery*, **50**, 425-432.

Gardner, DG. & Sapp, JP. (1973) Regional odontodysplasia. *Oral Surgery*, **35**, 351-365.

Nakata, M., Kimura, O. & Bixler, D. (1985) Interradicular dentin dysplasia associated with amelogenesis imperfecta. *Oral Surgery, Oral Medicine, Oral Pathology*, **60**, 182-187.

Ooya, K., Nalbandian, J. & Noikura, T. (1988) Autosomal recessive rough hypoplastic amelogenesis imperfecta. *Oral Surgery, Oral Medicine, Oral Pathology*, **65**, 449-458.

Sandler, HJ., Nersasian, RR., Cataldo, E., Pochebit, S. & Dayal, Y. (1988) Multiple dental follicles with odontogenic fibroma-like changes (WHO) type. *Oral Surgery, Oral Medicine, Oral Pathology*, **66**, 78-84.

Shear, M. (1983) *Cysts of the Oral Regions*, 2nd ed. Ch. 5, pp. 62-63. Bristol: Wright.

Sundell, S. & Valentin, J. (1986) Hereditary aspects and classification of hereditary amelogenesis imperfecta. *Community Dentistry and Oral Epidemiology*, **14**, 211-216.

Witkop, CJ. Jr. (1989) Amelogenesis imperfecta, dentinogenesis imperfecta and dentin dysplasia revisited: problems in classification. *Journal of Oral Pathology*, **17**, 547-553.

Witkop, CJ. Jr. & Sauk, JJ. Jr. (1976) Heritable defects of enamel. *In Oral Facial Genetics*, ed. Stewart, RE. & Prescott, GH., Ch. 7. Saint Louis: Mosby.

Diffuse peripheral odontogenic fibroma: report of 3 cases

A. Weber[1], W. F. P. van Heerden[2], A. J. Ligthelm[1] and E. J. Raubenheimer[2]

Departments of Oral Pathology and Oral Biology, [1]University of Pretoria, [2]Medical University of Southern Africa, South Africa

Weber A, van Heerden WFP, Ligthelm AJ, Raubenheimer EJ: Diffuse peripheral odontogenic fibroma: report of 3 cases. J Oral Pathol Med 1992; 21: 82–4.

Since peripheral odontogenic fibroma (POF) is characteristically described as a solitary lesion and no diffuse POF had been reported in the literature, our cases should be considered as extremely unusual. Three diffuse cases of POF are described of which one case was seen in association with ocular and skin lesions. The question arises whether POF should be considered as a true odontogenic tumor rather than a diffuse hamartomatous lesion caused by uncontrolled induction of the gingiva. It is also possible that such lesions could be part of a yet undescribed syndrome.

Key words: hamartoma; mouth, neoplasms; odontogenic fibroma; peripheral odontogenic lesions.

A Weber, Department of Oral Pathology and Oral Biology, University of Pretoria, P.O.Box 1266, Pretoria, 0001, South Africa

Accepted for publication July 16, 1991

The odontogenic fibroma is defined by the World Health Organization as a benign odontogenic neoplasm of fibroblastic origin characterized by relatively mature collagenous fibrous tissue and varying amounts of odontogenic epithelium, with the potential to occur in either a central or extraosseous location. The extraosseous counterpart is designated peripheral odontogenic fibroma (POF) (1).

All the POF's described in the literature presented as single, exophytic tumors which frequently prompted a clinical diagnosis of localized gingival hyperplasia. Diffuse involvement of the gingiva has not yet been reported. Three cases with the histologic appearance of POF with diffuse involvement of the gingiva, of which one case was associated with dermatological and ocular abnormalities, are presented.

Material and methods

Case 1

An 8-yr-old Black girl presented with diffusely enlarged gingiva in both jaws, causing delayed eruption of the perma-

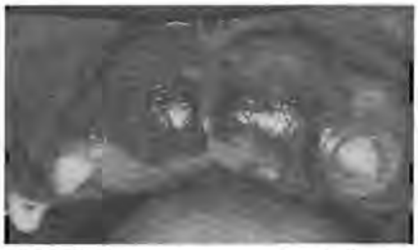

Fig. 1. Clinical photograph of Case 1 showing diffusely enlarged gingivae in both jaws.

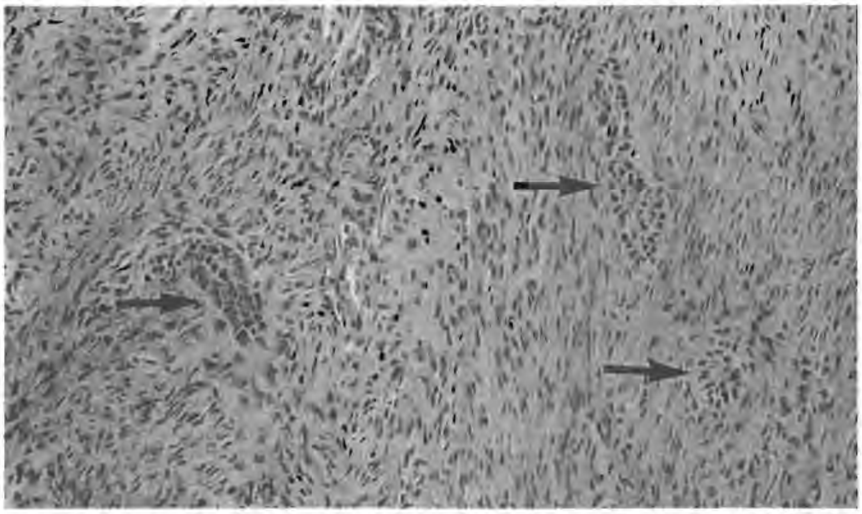

Fig. 2. Histologic appearance of lesion in Case 1 showing cellular fibrous tissue with inactive odontogenic epithelium arranged in nests and strands (arrows).100.

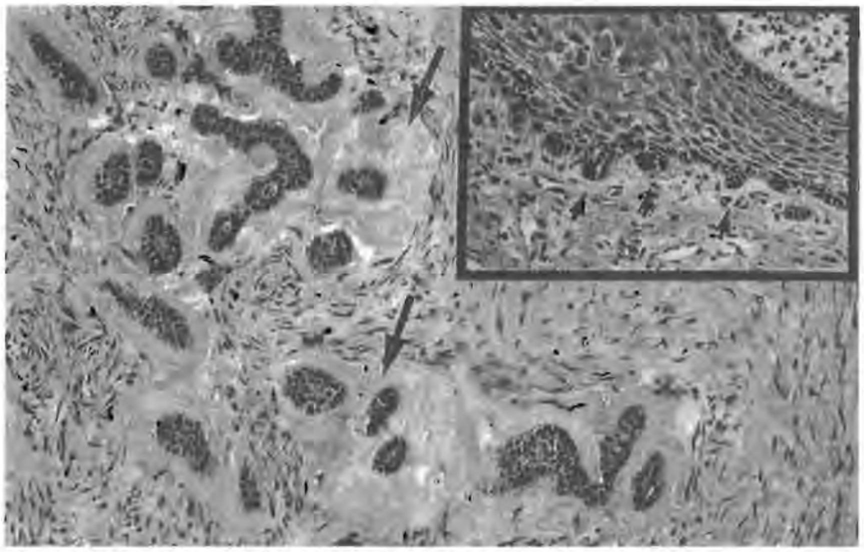

Fig. 3. Microscopic examination of lesion in Case 2 showing strands of odontogenic epithelium with prominent hyalinization (arrows).100. Inset: budding of overlying epithelium (arrows).100.

Fig. 4. Diffuse nodular gingival hyperplasia (arrows) in Case 3.

nent incisors. Nodules were present in the gingival masses which were firm in consistency (Fig. 1). The duration of the lesions could not be determined and no evidence of a family history was found. Radiographic examination showed no bone involvement or disturbance in tooth development. Gingivectomy of the hyperplastic tissue was done and the tissue sent for histologic examination.

Microscopically, the lesion consisted of cellular fibrous tissue with myxomatous areas. The odontogenic epithelium appeared inactive and was arranged in cell nests and strands (Fig. 2). No hard tissue formation was seen. The overlying epithelium was hyperplastic without evidence of downward proliferation of the rete ridges.

Case 2

A 56-yr-old black woman presented with diffuse gingival hyperplasia of both jaws resulting in enlarged alveolar ridges. The duration of the lesions was not known. The mandibular canines were displaced. All teeth were severely afflicted by plaque and calculus deposits. A biopsy of the lesion was performed and oral hygiene procedures implemented.

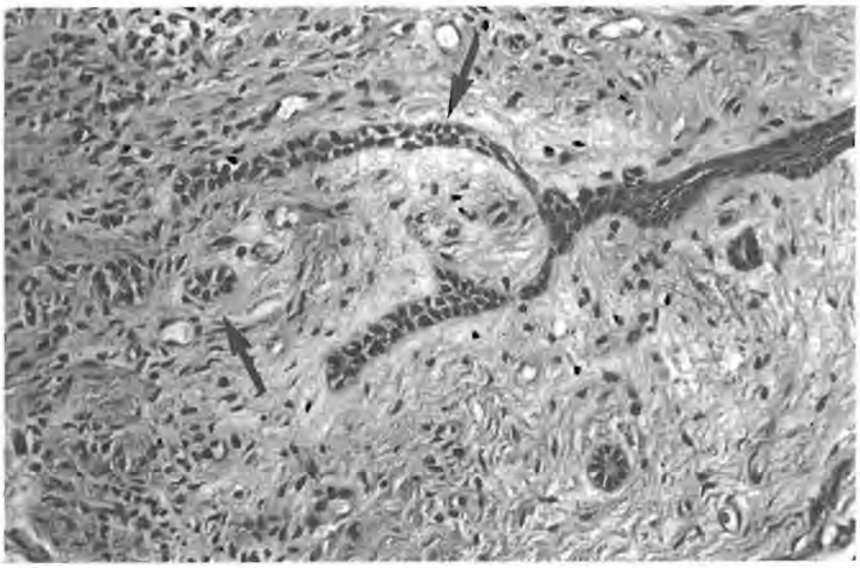

Fig. 6. Histologic appearance of tumor in Case 3 showing islands and strands of odontogenic epithelium (arrows) scattered in connective tissue.100.

Microscopically the gingival enlargement resulted from a proliferation of loose cellular connective tissue with scattered islands of inactive odontogenic epithelium. Hyalinization and calcifications were present in relation to the odontogenic epithelial rests. Budding of the overlying oral epithelium (Fig. 3) and focal areas of chronic inflammation were seen.

Case 3

A 3-yr-old white boy presented with diffuse nodular maxillary and mandibular gingival hyperplasia which became evident soon after birth (Fig. 4). The normal eruption pattern was disturbed but no other abnormalities were found radiographically. The patient also had small nodular skin lesions diagnosed as xanthogranulomas (Fig. 5), as well as corneal opacities. Corneal transplants were done in the eye lesions which could not be diagnosed as any specific pathological entity as yet. The oral lesions were clinically diagnosed as gingival hyperplasia and a biopsy performed.

Microscopically the lesion was composed of cellular fibrous tissue with islands and strands of odontogenic epithelium scattered in the connective

Fig. 5. Clinical photograph of Case 3 showing xanthogranuloma on skin (arrows).

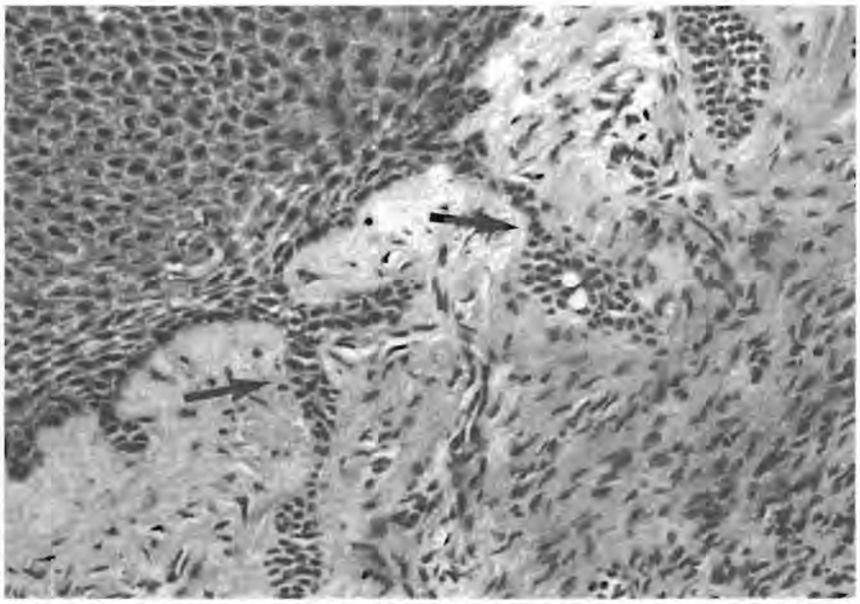

Fig. 7. Overlying epithelium in Case 3 showing downward proliferation into the connective tissue (arrows).200.

tissue (Fig. 6). No mineralized matrix formation was evident and the surface epithelium exhibited mild hyperplasia with downward proliferation (Fig. 7). A diagnosis of POF was suggested and gingivectomy of the hyperplastic tissue was performed. All the tissue submitted exhibited similar microscopic features.

Discussion

Not one of the accepted cases of POF in the literature were described as a diffuse gingival lesion. Furthermore, POF was never before described in relation to any other lesions as was seen in Case 3.

The question arises as to whether POF is a true neoplasm or whether it should be regarded as an hamartomatous developmental anomaly. The diffuse involvement of the gingiva in our three cases supports the possibility that POF does have an hamartomatous origin rather than being a true benign neoplastic lesion. We agree however, that the distinction between an hamartoma and a benign neoplasm is at best difficult and is differently interpreted.

The authors are of the opinion that POF should be considered as solitary or diffuse hamartomatous lesions which are caused by uncontrolled induction in the gingiva in a local or diffuse manner. Furthermore, the possibility that POF is an hamartomatous growth, which could be part of a yet undescribed syndrome, cannot be excluded, and should be investigated.

Acknowledgments – The authors thank C. S. BEGEMANN for secretarial services.

References

1. PINDBORG JJ, KRAMER IRH, TORLONI H. *Histoligical typing of odontogenic tumours, jaw cysts and allied lesions.* International histological classification of tumours No. 5, Geneva, World Health Organization, 1971; 30–1.

Central odontogenic fibroma-like tumors, hypodontia, and enamel dysplasia: Review of the literature and report of a case

Erich J. Raubenheimer, MChD, PhD,[a] and Claudia E. Noffke, MSc(Odont),[b] Medunsa, South Africa
MEDICAL UNIVERSITY OF SOUTHERN AFRICA

A patient with multiple odontogenic fibroma-like tumors in the mandible and enamel dysplasia is presented, bringing the total number of cases reported in the literature to 3. In addition to these manifestations, this case had hypodontia. The absence of associated teeth, the size of the lesions, the lingual expansion, and the green-yellow polarization of collagen with Picrosirius stains supported the neoplastic nature of the central odontogenic fibroma-like tumors in the case presented. Laminated psammomatous deposits distinguished the tumors from the World Health Organization–type central odontogenic fibroma. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:74-7)**

Odontogenic fibromas are defined by the World Health Organization (WHO) as benign fibroblastic odontogenic neoplasms containing varying amounts of apparently inactive odontogenic epithelium.[1] These neoplasms occur either within jaw bones (central) or in an extra osseous location (peripheral). Central odontogenic fibromas (COFs) present over a wide age range with a marked predilection for females. Most cases occur in the maxilla anterior to the first permanent molar tooth. In the mandible, half of the cases are located posterior to the first permanent molar tooth. Most COFs present as unilocular radiolucencies with well-defined borders, but they may also show multilocular appearances and in rare instances exhibit mixed radiolucent-radiopaque features with poorly defined borders.[2]

Microscopically, the spectrum of differentiation is diverse. The simple type odontogenic fibroma is composed of stellate fibroblasts, fine collagen fibrils, and considerable ground substance. Small groups of odontogenic epithelium and foci of dystrophic calcifications may be present. The so-called WHO type is more complex, with, in addition to the simple type, long strands of odontogenic epithelium and calcifications composed of cementum-like material and dentinoid.[3] Other histologic variants include the granular cell type and a hybrid odontogenic fibroma giant cell-like tumor.[4-6] COFs have been linked to intracranial aneurysm and tuberous sclerosis.[7] Normal dental follicles associated with unerupted teeth are frequently misinterpreted histologically as COF.[8] Unerupted teeth occur commonly in patients with amelogenesis imperfecta.[9] Two cases with amelogenesis imperfecta and multiple unerupted teeth, the crowns of which were surrounded by large pericoronal radiolucencies that had been described as WHO–type COF–like lesions, were reported from our laboratory more than a decade ago.[10] Hyperplastic dental follicles with COF–like features and associated with amelogenesis imperfecta were reported by Peters, Cohen, and Altini[11] shortly thereafter. The Picrosirius red staining technique has subsequently been shown to be helpful in distinguishing hyperplastic dental follicles from COFs, the latter exhibiting green to greenish-yellow fluorescence of collagen bundles with polarization microscopy.[12] This article documents an association between enamel dysplasia, hypodontia, and multiple large well-demarcated multilocular tumors resembling WHO–type COFs.

CASE REPORT

A 19-year-old black man was seen with pain during mastication from unerupted molar teeth. Medical history and general physical condition were unremarkable. Intraoral examination revealed hypodontia, with only the mandibular incisors, right mandibular canine, 2 mandibular first premolars, maxillary incisors, left maxillary canine, and 2 maxillary first premolars being fully erupted. Except for the recent removal of maxillary canine, mandibular molar, and mandibular canine teeth, the patient reported that he had had no previous extractions. The crowns of the erupted teeth showed diasthemas and thin enamel coverage of normal hardness. The corpus of the mandible showed bilateral expansion of the lingual cortices. An anterior open bite was evident, and a clinical diagnosis of enamel dysplasia and hypodontia was established. Radiographic examination confirmed a diagnosis of hypodontia, and no unerupted teeth were present. The

[a]Professor and Head, Oral Pathology, Medical University of Southern Africa, Medunsa, South Africa.
[b]Senior Lecturer and Section Head, Oral and Maxillofacial Radiology, Medical University of Southern Africa, Medunsa, South Africa.
Received for publication Dec 11, 2001; returned for revision Dec 31, 2001; accepted for publication Feb 11, 2002.

1079-2104/2002/$35.00 + 0 **7/14/124862**
doi:10.1067/moe.2002.124862

Fig 1. Bilateral multilocular mixed radiolucent-radiopaque lesions in mandible with well-defined corticated borders.

extraction sockets of the maxillary canine, mandibular canine, and mandibular molar teeth were evident, and the enamel of the remaining teeth appeared thin and of normal radiodensity. Multiple mixed radiolucent-radiopaque lesions with partially sclerotic margins were seen in the left and right corpus of the mandible (Fig 1). The patient was referred for biopsy.

An incision biopsy of a lesion in the left corpus of the mandible was performed. On macroscopic examination, the tissue appeared solid and contained calcifications. Microscopic examination showed fibrous connective tissue exhibiting strands of inactive odontogenic epithelium with calcifications resembling dentine and globular laminated psammomatous deposits, some of which were calcified (Figs 2 and 3). Thioflavin T staining of the deposits showed fluorescence. The fibrous connective tissue was mature and dense in areas and exhibited foci of myxomatous change. Examination of Picrosirius red stains showed thick collagen fibers exhibiting green and greenish-yellow change with polarizing microscopy. The other mandibular tumors were removed and showed similar microscopic features. The lesions were diagnosed as WHO-type COF-like tumors.

DISCUSSION

This case is the third case of multiple COF-like lesions associated with enamel dysplasia reported in the literature. The first 2 cases of COF-like proliferations and enamel dysplasia, the latter diagnosed as amelogenesis imperfecta, were reported from our laboratory.[10] The COF-like tumors in these cases differed from the present case by being smaller and associated with the crowns of unerupted teeth. One of the patients reported initially had a normal number of permanent teeth, whereas the second had hypodontia. The remaining teeth of the latter patient were all unerupted and showed abnormal development with short dilacerated roots. The multiple COF-like tumors in the present case developed in place of teeth and were larger than those previously reported. Calcified psammomatous laminar deposits, frequently associated with inactive odontogenic epithelium, were present in all 3 cases. The morphology and staining characteristics of these deposits were similar to those in calcifying epithelial odontogenic tumors.[1] The deposits exhibited the staining characteristics of amyloid and may have, as in calcifying epithelial odontogenic tumors, represented degradation of lamina densa material produced by the associated epithelium.[3] It is interesting to note that these deposits have not yet been reported in COFs and could be regarded as an important microscopic feature in distinguishing the COF-like tumors in the case reported from true WHO-type COFs.

In addition to the 3 cases, the case reported by Peters, Cohen, Altini[11] in 1992 with amelogenesis imperfecta and hyperplastic dental follicles with COF-like features may have in fact represented lesions, which had the capacity, if untreated, to become as large as the COF-like tumors in our patient. This case also showed laminar psammomatous deposits microscopically.

It is interesting to note that all COF-like proliferations associated with enamel dysplasia reported in the literature occurred in South Africa (2 black females aged 14 and 26 years and a black male aged 26 years). Hamartomatous versus neoplastic nature of the lesions is, however, speculative. Gardner[13] separates hyperplastic dental follicles from odontogenic fibromas but acknowledges the difficulty in distinguishing them.

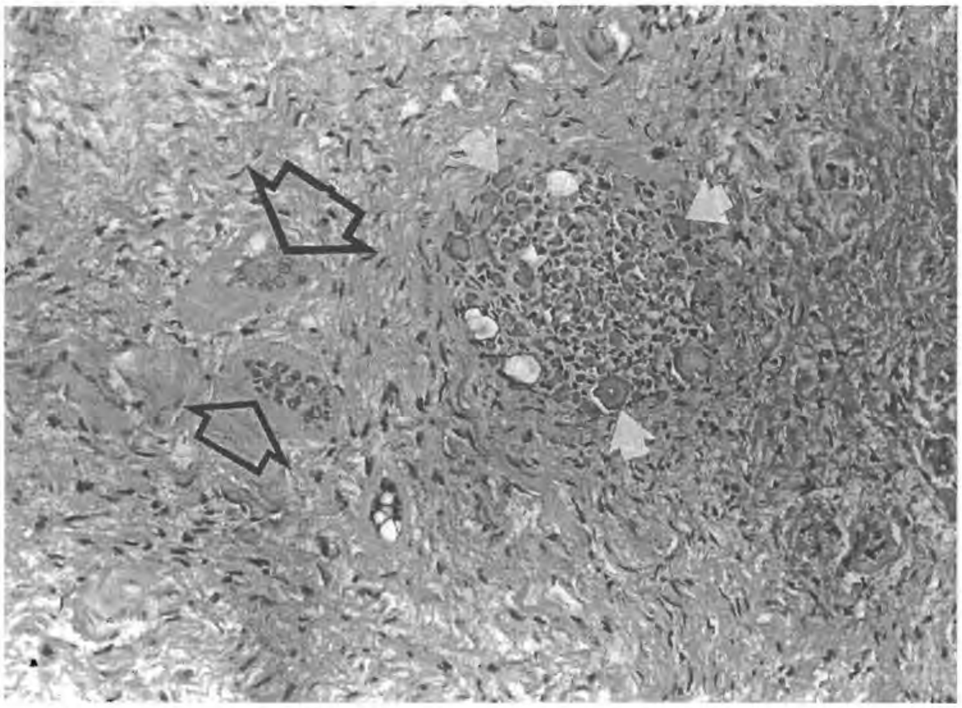

Fig 2. Fibrous connective tissue containing psammomatous calcifications (*white arrows*) and inactive islands of odontogenic epithelium (*black arrows*; hematoxylin-eosin stain; original magnification, ×200).

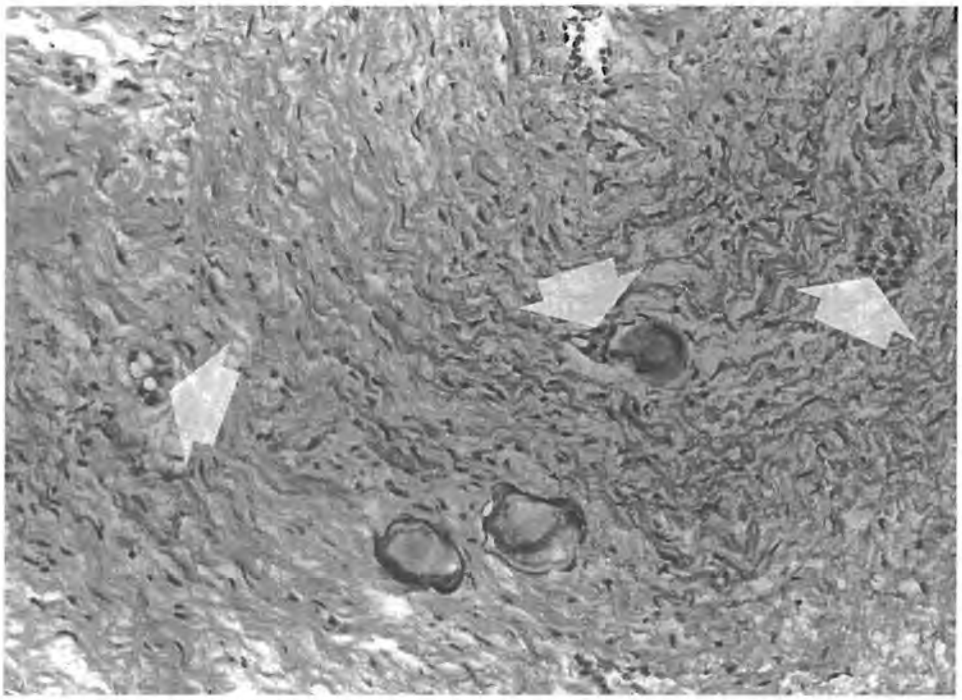

Fig 3. Inactive odontogenic epithelial islands (*arrows*), one of which is associated with ovoid calcified body with concentric lamination (hematoxylin-eosin stain; original magnification, ×300).

Hirschberg, Buchner, and Dayan[12] used Picrosirius red stains examined with polarized light to differentiate between COF and hyperplastic dental follicles. The greenish to yellow polarizing fibers of COFs suggest that the collagen in COFs is loosely packed and might be composed of procollagens, intermediates, or other pathologic collagens rather than the tightly packed fibers seen in hyperplastic dental follicles. The COF-like tumors in this case cannot be regarded as hyperplastic follicles as the associated teeth failed to develop. Furthermore, the size of the lesions, lingual expansion, and Picrosirius stains showing green-yellow polarizing collagen support a diagnosis of a neoplastic and yet unclassified variant of COF.

We thank Mrs C. S. Begemann for secretarial assistance.

REFERENCES

1. Kramer IRH, Pindborg JJ, Shear M, editors. Histological typing of odontogenic tumours. Berlin: Springer-Verlag; 1992. p. 22.
2. Kaffe I, Buchner A. Radiological features of central odontogenic fibroma. Oral Surg Oral Med Oral Pathol 1994;78:811-8.
3. Waldron CA. Odontogenic cysts and tumors. In: Neville BW, Damm DD, Allen CM, Bouquot JE, editors. Oral and maxillofacial pathology. Philadelphia: WB Saunders Company; 1995. p. 522-35.
4. Dunlap CL. Odontogenic fibroma. Semin Diagn Pathol 1999;16:293-6.
5. Allen CM, Hammond HL, Stimson PG. Central odontogenic fibroma, WHO type. A report of three cases with an unusual associated giant cell reaction. Oral Surg Oral Med Oral Pathol 1992;73:62-6.
6. Odell EW, Lombardi T, Barrett AW, Morgan PR, Speight PM. Hybrid giant cell granuloma and central odontogenic fibroma-like lesions of the jaws. Histopathology 1997;30:165-71.
7. Swarnkar A, Jungreis CA, Peel PL. Central odontogenic fibroma and intracranial aneurysm associated with tuberous sclerosis. Am J Otolaryngol 1998;19:66-9.
8. Kim J, Ellis GL. Dental follicular tissue: misinterpretation as odontogenic tumors. J Oral Maxillofac Surg 1993;51:762-7.
9. Neville BW, Damm DD, Allen CM, Bouquot JE, editors. Oral and maxillofacial pathology. Philadelphia: WB Saunders Company; 1995. p. 79-84.
10. Van Heerden WFP, Raubenheimer EJ, Dreyer AF, Benn AML. Amelogenesis imperfecta: multiple impactions associated with odontogenic fibromas (WHO) type. J Dent Assoc S Afr 1990; 45:467-71.
11. Peters E, Cohen M, Altini M. Rough hypoplastic amelogenesis imperfecta with follicular hyperplasia. Oral Surg Oral Med Oral Pathol 1992;74:87-92.
12. Hirschberg A, Buchner A, Dayan D. The central odontogenic fibroma and the hyperplastic dental follicle: study with Picrosirius red and polarizing microscopy. J Oral Pathol Med 1996; 25:125-7.
13. Gardner DG. The central odontogenic fibroma: an attempt at clarification. Oral Surg Oral Med Oral Pathol 1980;50:425-30.

Reprint requests:

Professor Erich J. Raubenheimer
Department of Oral Pathology
Medical University of Southern Africa
Box D24
Medunsa 0204
Republic of South Africa
ejraub@medunsa.ac.za

Peripheral dentinogenic ghost cell tumor

E. J. Raubenheimer[1], W. F. P. van Heerden[1], F. Sitzmann[2] and B. Heymer[3]

Departments of [1]Oral Pathology and Biology, Medical University of Southern Africa, Medunsa, South Africa, [2]Dental Surgery and Radiology, and [3]Pathology, University of Ulm, Ulm, Germany.

Raubenheimer EJ, van Heerden WFP, Sitzman F, Heymer B: Peripheral dentinogenic ghost cell tumor. J Oral Pathol Med 1992; 21: 93–5.

A case of dentinogenic ghost cell tumor, that has originated peripherally in the jaw, is presented and the literature reviewed with particular reference to the origin of the tumor. The total number of central and peripheral cases reported in the English literature is 10 and although mucosal infiltration is common, peripheral origin of the neoplasm could be verified in only 3 cases.

Key words: dentinogenic ghost cell tumors; jaws, neoplasms; odontogenic tumors

E. J. Raubenheimer, Department of Oral Pathology, Medical University of Southern Africa, P.O. Medunsa, Republic of South Africa.

Accepted for publication August 4, 1991

The calcifying odontogenic cyst is a unique jaw lesion described as a distinct entity in 1962 by GORLIN *et al.* (1). In a study of 16 cases by PRAETORIUS *et al.* (2), it became evident that this group of lesions contains two entities, a cyst (Type I) and a neoplasm (Type II), and for the latter the term 'dentinogenic ghost cell tumour' was proposed. The neoplasm occurs predominantly in later life and consists microscopically of ameloblastoma-like odontogenic epithelial proliferations infiltrating the bone and connective tissue. Ghost-cells are present as well as varying amounts of dentinoid the latter being closely associated with odontogenic epithelium.

The purpose of this paper is to present an unique case of a dentinogenic ghost cell tumour originating in an extraosseous location.

Case report

An 82-yr-old man presented in the Department of Dental Surgery and Radiology, University of Ulm, complaining of a slow growing nodule on the mandibular right alveolar ridge. The lesion started 6 yr ago after extraction of the mandibular right canine. On examination the patient was found to be edentulous. A 6 mm broad based polypoid lesion was located on the mandibular right alveolar ridge. Radiographic examination revealed no underlying bone involvement (Fig. 1) and a clinical diagnosis of a peripheral giant cell granuloma was made. During surgical removal, the lesion was found to be located within the alveolar mucosa and the alveolar bone was not involved.

The surgical specimen measured 6 × 6 × 4 mm and had a firm consistency with foci of calcifications. Microscopic examination revealed hyperplasia of overlying epithelium and a solid tumor, composed of odontogenic epithelium associated with calcifications in the subepithelial connective tissue (Fig. 2). The neoplastic epithelium showed a well defined cuboidal to cylindrical basal cell layer closely associated eosinophilic cells with abrupt keratinization, resembling ghost cells (Fig. 3). Although the epithelial cells displayed nuclear pleomorphism, no mitotic figures were present. In focal areas, stellate reticulum-like differentiation as well as the formation of dental lamina-like structures were observed. Masses of acellular calcified material, resembling dentinoid, were evident in close association with the epithelium (Fig. 3). The surrounding connective tissue contained strands of inactive epithelium associated with small globular dentinoid deposits. Slight inflammation with vasodilatation and edema was present and a diagnosis of peripheral dentinogenic ghost cell tumor was made. Six year follow-up after removal failed to reveal a recurrence.

Discussion

Peripheral occurence of the cystic types of calcifying odontogenic cysts (Type I) is well documented in the English literature (1, 3). This may result from cortical bone perforation by a central lesion or more rarely, true peripheral origin from gingival epithelial remnants (4).

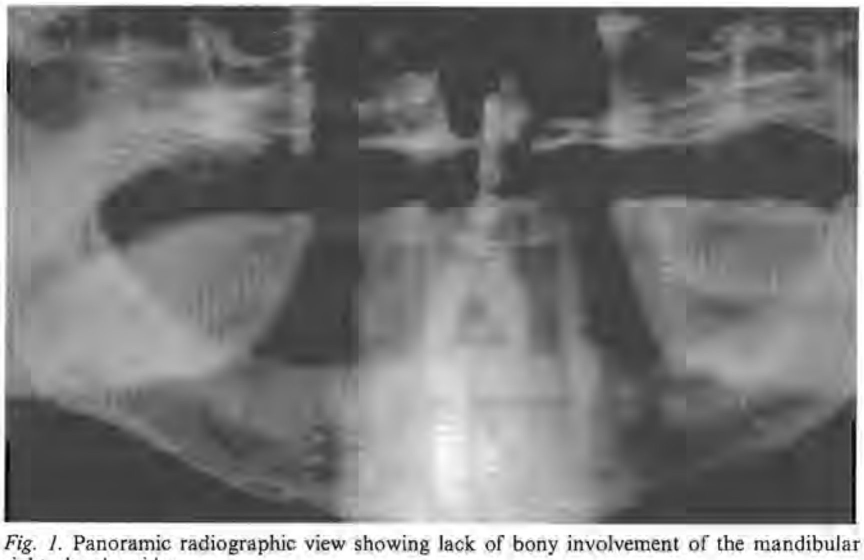

Fig. 1. Panoramic radiographic view showing lack of bony involvement of the mandibular right alveolar ridge.

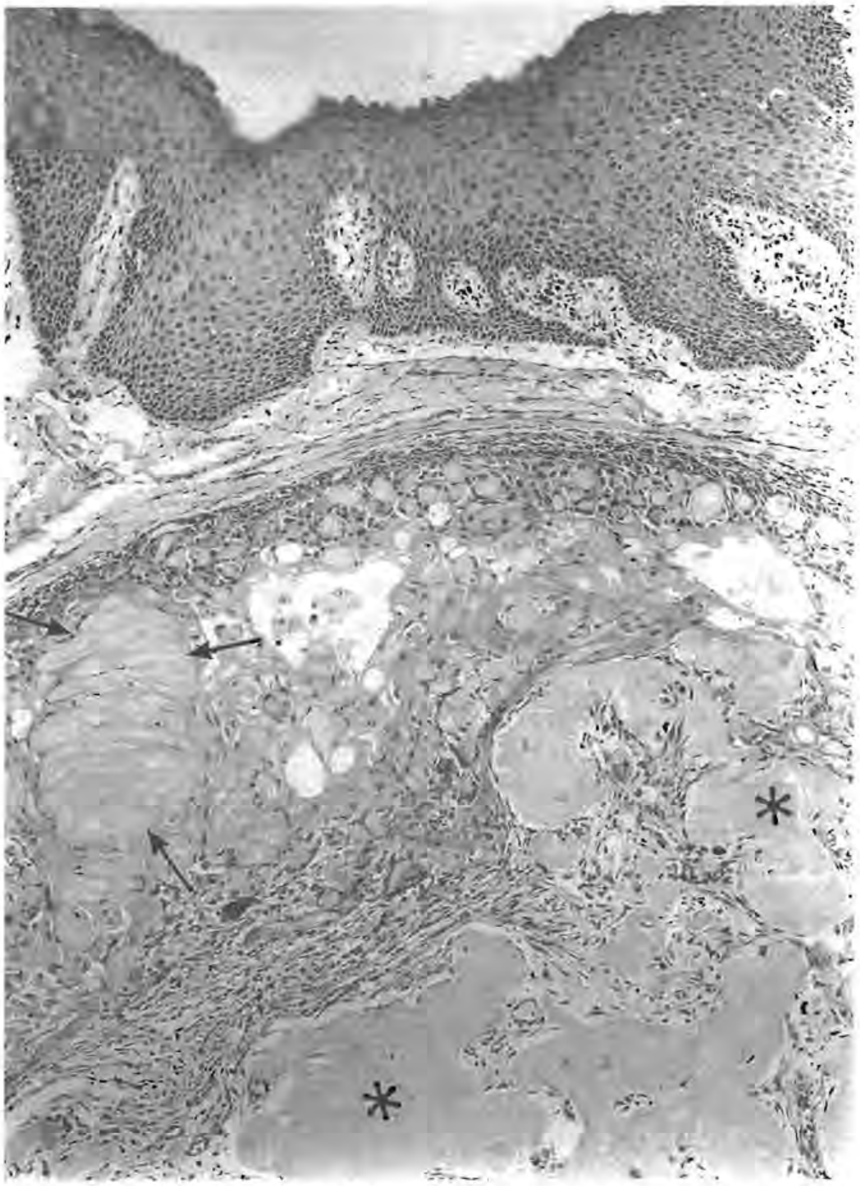

Fig. 2. Well encapsulated tumor with ghost cell formation (arrows) and dentinoid deposits (asterisks). H&E stain, ×30.

Conflicting data on the origin of the solid type calcifying odontogenic cyst (Type II) or dentinogenic ghost cell tumor are present in the literature. A recent review article summarizes the clinico-pathological features of 10 cases published in the English literature. In this article gingival swelling is considered to be the most frequent clinical feature. Radiographically all cases presented as lucencies with poorly defined margins (5). An earlier paper, reviewing 5 cases, proposed that dentinogenic ghost cell tumors usually occur peripherally and on the gingiva (6). Analysis of the original publications, mostly case reports, proves the discrepancy to lie in the interpretation of the clinical descriptions. Both cases reported by PRAETORIUS (2) are described as being 'extraosseous', despite radiographic signs of bony and dental involvement. Although peripheral involvement is probably implied by the authors, true peripheral origin of these lesions need to be questioned. The first of two cases reported by FEJERSKOV & KROGH (7) is described as an exophytic palatal mass. Unfortunately roentgenograms were not available and central origin of this case can therefore not be excluded. Central dentinogenic ghost cell tumors were also reported by GÜNHAN & SENGÜN (8) – 1 case, – TAJIMA (9) – 1 case – and COLMENERO *et al.* (5) – 1 case –, bringing the total number of central dentinogenic ghost cell tumors in the literature to 7. The 'peripheral odontogenic tumor with ghost-cell keratinization' reported by VULETIN *et al.* (10) contained no dentinoid deposits and exhibited odontogenic epithelium surrounded by cellular fibroblastic tissue, resembling and primitive dental pulp. On microscopical grounds, this lesion can not be classified as a dentinogenic ghost cell tumor since ghost cells are found in many other odontogenic neoplasms (2).

Peripheral presentation of dentinogenic ghost cell tumors is related to their infiltrative behaviour and although this feature appears to be common, true peripheral origin is not as frequently reported. ABRAHAMS & HOWELL (11) describe a dentinogenic ghost cell tumor located entirely extraosseous and palatal to a maxillary cuspid. Peripheral dentinogenic ghost cell tumors involving only the gingiva or alveolar mucosa, with radiographic support, were also reported in the lingual mandibular left premolar region (6) and the anterior part of the maxilla (12). This brings the number of true peripheral tumors to four, including our case.

The average age reported in the literature is 50, the oldest being 72 and the youngest 17 (5). Our patient, with an age of 82 yr, represents the most advanced age at which a dentinogenic ghost cell tumour has been diagnosed. Although the central tumors have a high rate of recurrence after removal (5), long term follow-up of our case and lack of proof of recurrence of any of the other peripheral dentinogenic ghost cell tumors suggests a favourable course for the peripheral type.

Acknowledgments – We are indebted to Ms C. S. BEGEMANN for secretarial assistance.

References

1. GORLIN RJ, PINDBORG JJ, CLAUSEN FP, VICKERS RA. The calcifying odontogenic cyst - a possible analogue of the cutaneous calcifying epithelioma of Malherbe. *Oral Surg Oral Med Oral Pathol* 1962: **15**: 1235–43.
2. PRAETORIUS F, HJÖRTING-HANSEN E, GORLIN RJ, VICKERS RA. Calcifying odontogenic cyst. Range, variations and neoplastic potential. *Acta Odontol Scand* 1981: **39**: 227–40.
3. ALTINI M, FARMANN AG. The calcifying odontogenic cyst. Eight new cases and a review of the literature. *Oral Surg Oral Med Oral Pathol* 1975: **40**: 751–9.
4. BHASHAR CS. The gingival cyst and the keratinizing ameloblastoma. *Oral Surg Oral Med Oral Pathol* 1965: **19**: 796–8.

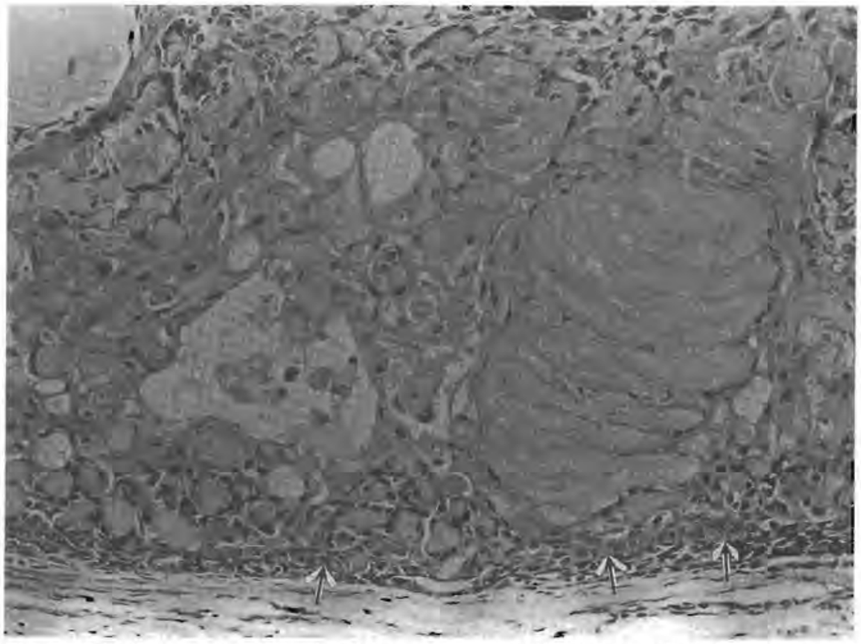

Fig. 3. Cuboidal peripheral basal cell layer (arrows) and adjacent cells exhibiting abrupt keratinization with ghost-cell formation. H&E stain, × 150.

5. Colmenero C, Patron M, Colmenero B. Odontogenic ghost cell tumours. The neoplastic form of calcifying odontogenic cyst. *J Cranio-Max Fac Surg* 1990: **18**: 215–8.
6. Hirshberg A, Dayan D, Horowitz I. Dentinogenic ghost cell tumor. *Int J Oral Maxillofac Surg* 1987: **16**: 620–5.
7. Fejerskov O, Krogh J. The calcifying ghost cell odontogenic tumor – or the calcifying odontogenic cyst. *J Oral Pathol* 1972: **1**: 273–7.
8. Günhan O, Sengün O, Celasun B. Epithelial odontogenic ghost cell tumor: report of a case. *J Oral Maxillofac Surg* 1989: **47**: 864–7.
9. Tajima Y, Utsumi N. The dentinogenic ghost cell tumor. *J Oral Pathol* 1986: **15**: 359–62.
10. Vuletin JC, Solomon MP, Pertschuk LP. Peripheral odontogenic tumor with ghost-cell keratinization. *Oral Surg Oral Med Oral Pathol* 1978: **45**: 407–15.
11. Abrams AM, Howell FV. The calcifying odontogenic cyst. *Oral Surg Oral Med Oral Pathol* 1968: **25**: 594–606.
12. Sauk JJ. Calcifying and keratinizing odontogenic cyst. *J Oral Surg* 1972: **30**: 893–7.

234

GLANDULAR ODONTOGENIC CYST

Willem F.P. van Heerden, MChD, Erich J. Raubenheimer, MChD, and Martin L. Turner, DipTech(Med)

Two cases of glandular odontogenic cysts are reported. The unique histological features, eg, the intraepithelial glandular structure, papillary processes, and eosinophilic cuboidal and larger granular superficial cells are sufficient to warrant glandular odontogenic cyst as a distinct entity. Electron microscopic examination of the superficial eosinophilic cuboidal cells are suggestive of a process similar to apoptosis. Eroded cortical plates suggest an aggressive behavior.
HEAD & NECK 14:316–320

The glandular odontogenic cyst (GOC) is a rare cystic lesion that is not incorporated in classifications of jaw cysts. Only a few examples of this lesion have been described in the literature. Gardner et al[1] collected eight cases of GOC. Padayachee and van Wyk[2] reported two cases, which they described as "sialo-odontogenic cysts."

The GOC has an equal sex distribution and occurs in both the mandible and maxilla of adults.[1,2] These lesions, which can attain a large size, appear on radiographs as uni- or multilocular lytic lesions. The histologic features described by Gardner et al[1] include a cyst lining consisting of stratified squamous epithelium of varying thickness that contains pools of mucicarmine-positive material. The superficial layer consists of eosinophilic cubiodal and occasionally mucous- and ciliated cells. Spherical structures produced by swirling epithelium and lack of cell polarization are focally present in the epithelium lining. Irregular-shaped calcifications are occasionally found in the subepithelial connective tissue.

This report describes the clinical, histopathologic, and ultrastructural features of two cysts.

From the Department of Oral Pathology and Oral Biology, Medical University of Southern Africa, Medunsa, South Africa.

Acknowlegment: The authors thank Mrs. Colleen Begemann for secretarial services and Miss Laura Hope for photographic services.

Address reprint requests to Dr. W. F. P. van Heerden at the Department of Oral Pathology and Oral Biology, P.O. Medunsa 0204, Republic of South Africa.

Accepted for publication August 8, 1991

CCC 0148-6403/92/040316-05 $04.00

CASE 1

A 27-year-old woman reported to the clinic complaining of a painless swelling in the anterior mandible of three years' duration. Intraoral examination revealed a 6 × 3 cm sized swelling extending from the left first mandibular molar to the right second premolar with buccal as well as lingual bone expansion. The mucosa was intact, but the bone was eroded in areas causing the swelling to fluctuate on palpation (Figure 1). No sensory nerve fallout was found. Radiography revealed a well-defined unilocular radiolucent lesion with a scalloped border. Displacement of the anterior teeth was present (Figure 2). During biopsy, a unicystic cavity containing yellow serous fluid was found. Differential diagnoses included a unicystic ameloblastoma and odontogenic keratocyst.

Histologic examination of the incisional biopsy revealed a cyst lining consisting of a nonkeratinized epithelium. The epithelium varied in thickness from double-layer cuboidal to

FIGURE 1. Mandibular lesion showing buccal and lingual expansion associated with tooth displacement.

FIGURE 2. Pantomograph exhibiting an unilocular radiolucency (arrows) of the anterior mandible.

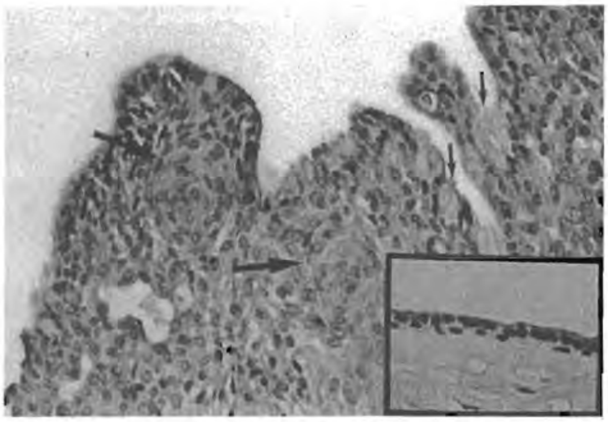

FIGURE 3. Papillary processes associated with epithelial spheres (bold arrows) and superficial mucous cells (fine arrows). Hematoxylin & eosin; original magnification, ×200. Inset: The cyst lining is partly composed of a double layer cuboidal epithelium. Hematoxylin & eosin; original magnification ×200.

FIGURE 4. Superficial cell layer consisting of small cuboidal cells with hyperchromatic nucleii and eosinophilic cytoplasms (arrows). Note the papillary processes. Hematoxylin & eosin; original magnification, ×200.

FIGURE 5. Glandular structure lined partly with granular cells (bold arrow). Note the granular superficial cells (fine arrows). Hematoxylin & eosin; original magnification, ×200.

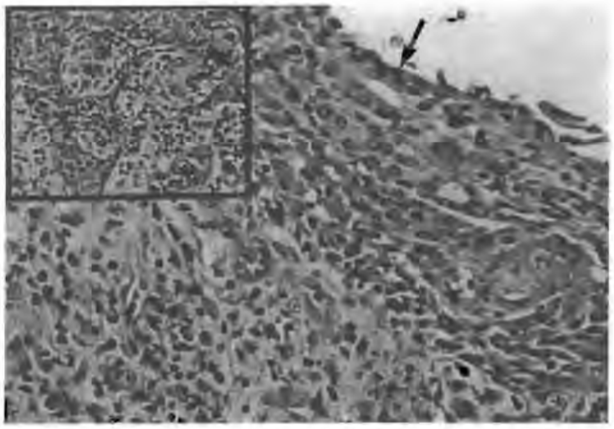

FIGURE 6. Inflammatory induced changes in lining of case 1. A glandular structure is visible (arrow). Hematoxylin & eosin; original magnification, ×200. Inset: Epithelial arcading associated with lymphocytes. Hematoxylin & eosin; original magnification ×100.

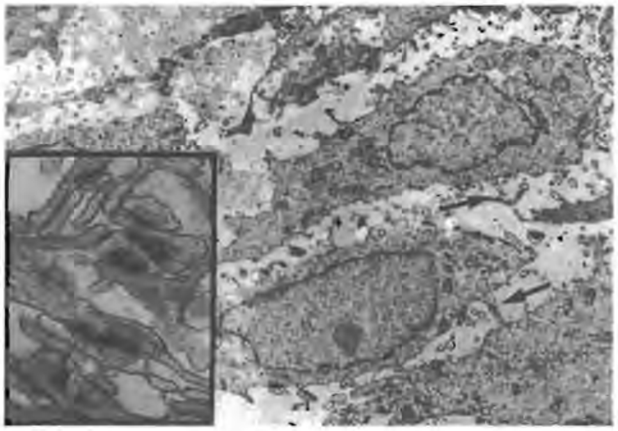

FIGURE 7. Transmission electron micrograph of the inflammed lining revealed widened intercellular spaces containing finger-like protrusions (arrows). Original magnification, ×2600. Inset: Well-formed desmosomes were present between the protrusions. Original magnification, ×8300.

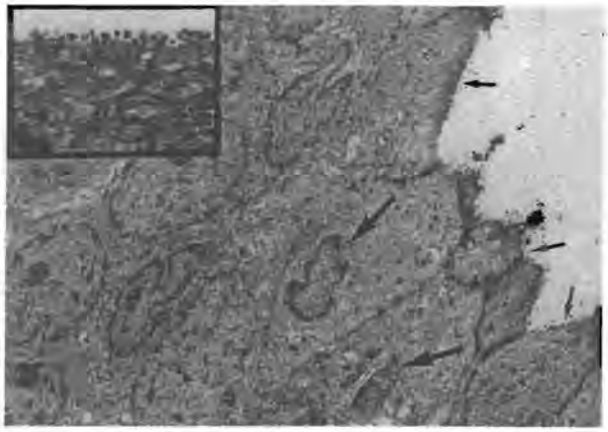

FIGURE 8. Electron micrograph of the lining of case 1 representing the superficial eosinophilic cuboidal cells. Note the smaller, denser nucleoli in the more superficial cells (bold arrows) and the absence of nuclear material in the remainder of the superficial cells (fine arrows). Original magnification, ×3300. Inset: Microvilli on the luminal aspect of the superficial cells. Original magnification, ×10,000.

FIGURE 9. Occlusal radiograph revealed a well-circumscribed radiolucency causing root divergence of the lateral and incisor teeth.

stratified squamous. Papillary epithelial processes into the lumen were noted, especially where epithelial thickenings were present. Epithelial spheres consisting of swirled epithelial cells were found occasionally (Figure 3). The superficial cell layer consisted mainly of small cuboidal cells with scanty eosinophilic cytoplasm and hyperchromatic nuclei (Figure 4). Larger cells with an eosinophilic granular cytoplasm and a round nucleus, which was oriented away from the surface, as well as scattered mucous cells were also present in the superficial layer. Ciliated cells were focally seen.

Intra-epithelial glandular structures, filled with an eosinophilic, mucicarmine-positive material were present, the majority located in the superficial half of the epithelium (Figure 5). These glandular spaces were lined mainly by granular cells, although mucous cells were focally present. No mitotic figures were noted. Palisading of the basal cells were focally seen, and no maturation changes of the epithelial cells were noted. Cleaving between the epithelium and connective tissue was focally observed. The underlying connective tissue consisted of dense fibrous tissue with a few vascular spaces. No epithelial islands nor calcifications were noted.

A diagnosis of a glandular odontogenic cyst was made, and the cyst lining was enucleated under general anesthesia. The wound was closed primarily and healing was uneventful. Small fragments of the lining were fixed separately in 3% gluteraldehyde for electron microscopic examination. Light microscopic examination of the enucleated material revealed a dense, chronic inflammatory cell infiltrate consisting mainly of lymphocytes in the subepithelial connective tissue and neutrophils in the epithelium. The epithelial lining had lost most of the features described in the incisional biopsy material. Epithelial hyperplasia and proliferation into the underlying connective tissue with an arcading effect were present. The eosinophilic cuboidal superficial cell layer as well as glandular structures in the epithelium were focally present (Figure 6).

Electron microscopic examination revealed widened intercellular spaces with numerous fingerlike protrusions that attached adjoining epithelial cells by well-formed desmosomes (Figure 7). As the biopsies taken for electron microscopy were not representative of all epithelial types as seen in the sections of the incision biopsy, a small fragment was then removed from the wax block of the noninflammed biopsy specimen and processed for electron microscopy. This epithelial lining consisted of tightly aggregated cells with well-formed desmosomes. Microvilli-like projections were present on the luminal aspect of the superficial cells, the majority of which contained no nucleii. Their cell volume seemed to be decreased, resulting in a closer association of the desmosomes (Figure 8). The cells immediately underneath the superficial cells contained a denser nucleus, and signs of nuclear fragmentation were present.

CASE 2

A 14-year-old boy presented with swelling of the right upper lip. Oral examination revealed a firm buccal and palatal swelling involving the right maxillary canine area. Radiographs showed a well circumscribed, unilocular lytic lesion in the globulo-maxillary area causing root divergence of the lateral and incisor teeth (Figure 9). A biopsy was taken, and microscopic examination showed a cyst lining with similar features as described in case 1 (Figure 10). A diagnosis of a glandular odontogenic cyst was made. The patient did not return for treatment.

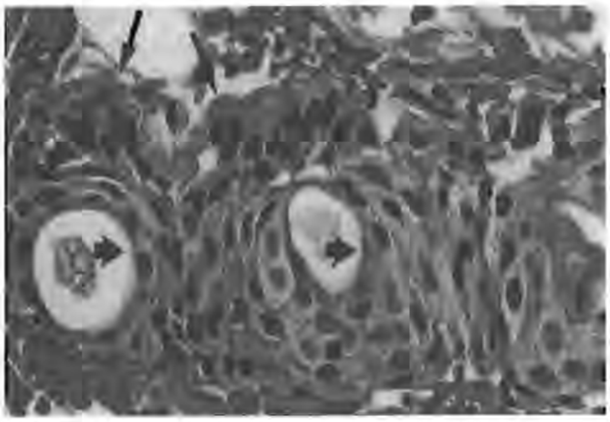

FIGURE 10. Glandular structures were present in the lining epithelium (short arrows). The superficial cells had a granular appearance (long arrows). Hematoxylin & eosin; original magnifications, ×400.

DISCUSSION

There are sufficient criteria to regard GOC as a distinct entity and not a variant of any other cyst. The unique features include the presence of eosinophilic cuboidal and larger granular superficial cells, intraepithelial glandular structures lined by granular and mucous cells, and papillary processes protruding into the lumen. Epithelial spheres are also found in both lateral periodontal cysts and dentigerous cysts.[3] The presence of numerous mucous cells alone does not warrant the diagnosis of GOC. Browne has shown that mucous metaplasia is fairly common in dentigerous cysts, and can be found in the majority of jaw cysts.[4]

The widened interepithelial cell spaces and the finger-like protrusions found in inflammed GOC tissue on electron microscopic examination are also present in inflammed as well as noninflammed radicular and follicular cysts.[5] The spinous cells of odontogenic keratocysts, however, show a close intercellular relationship with desmosomes rarely detected.[5] The tissue fragment removed from the wax block for electron microscopy study contained superficial eosinophilic cuboidal cells. It is tempting to speculate that the superficial cells undergo a process similar to apoptosis. This will explain the eosinophilic light microscopic appearance of the superficial cells with hyperchromatic nucleii, although the microvilli-like projections seen on electron microscopy are too small to represent apoptotic bodies.[6]

The prevalence of GOC is low. The two cases reported in this study are the only GOCs in our collection of 152 jaw cysts that were diagnosed during an 8-year period. A contributory factor to this low prevalence may be the difficulty in identifying the characteristic features of a GOC in inflammed tissue, especially if only material from an incisional biopsy is available. The changes brought about by an inflammatory process were evident in the excised tissue in case 1.

Glandular odontogenic cysts are considered to be aggressive. One of the cases reported by Padayachee and van Wyk[2] recurred, and recurrences were present in two of the eight cases described by Gardner et al.[1] Although no recurrence was present in case 1, after 2 years, the eroded cortical plates suggested aggressive behavior.

REFERENCES

1. Gardner DG, Kessler HP, Morency R, Schaffner DL. The glandular odontogenic cyst: an apparent entity. *J Oral Pathol* 1988;17:359–366.
2. Padayachee A, van Wyk CW. Two cystic lesions with features of both the botryoid odontogenic cyst and the central mucoepidermoid tumor: sialo-odontogenic cyst? *J Oral Pathol* 1987;16:499–504.
3. Shear M. Cysts of the oral regions. 2nd ed. Bristol: Wright PSG, 1983:52–72.
4. Brown RM. Metaplasia and degeneration in odontogenic cysts in man. *J Oral Pathol* 1972 11:145–158.
5. Meurman JH, Ylipaavalniemi P. Ultrastructure of odontogenic jaw cysts. *Scand J Dent Res* 1984;92:577–586.
6. Wyllie AH, Morris RG, Smith AL, Dunlop D. Chromatin cleavage in apoptosis: association with condensed chromatin morphology and dependence on macromolecular synthesis. *J Pathol* 1984;142:67–77.

Dentomaxillofacial Radiology (2002) 31, 333–338

www.nature.com/dmfr

REVIEW

The glandular odontogenic cyst: Clinical and radiological features; review of the literature and report of nine cases

C Noffke*[,1] and EJ Raubenheimer[2]

[1]*Departments of Oral and Maxillofacial Radiology, Faculty of Dentistry, Medical University of Southern Africa, South Africa;* [2]*Department of Oral Pathology, Faculty of Dentistry, Medical University of Southern Africa, South Africa*

Nine cases with glandular odontogenic cysts (GOC's) are presented bringing the total number reported in the literature to 54. Our study confirmed that most GOC's occur in the mandible, whereas maxillary lesions present only in the globulo-maxillary region. The radiological features were found to be non-distinctive and presented as well-defined radiolucencies with uni- and multilocular appearances. Most of the mandibular GOC's were unilocular, involved the symphysis region and only one extended into the ramus. All GOC's larger than 6 cm in diameter showed perforated margins radiologically. Our two multilocular GOC's demonstrated microscopic features supporting their infiltrative radiological appearance. The invasive clinical and radiological features of GOC support the notion of a possible histo-pathologic overlap between GOC and low-grade central mucoepidermoid carcinoma of the jaw.
Dentomaxillofacial Radiology (2002) **31**, 333–338. doi:10.1038/sj.dmfr.4600730

Keywords: odontogenic cysts; radiography, dental; jaw cysts; review literature

Introduction

Two multilocular mandibular cysts were originally described by Padayachee and Van Wyk[1] who speculated on the possibility of salivary gland origin and proposed the term sialo-odontogenic cyst. Histological characteristics, which supported their choice of terminology, were mucinous material within the cystic spaces and epithelial thickening or plaques in the epithelial lining. One of their cysts recurred. The histological characteristics led to the association of the cysts with the central mucoepidermoid tumour. Gardner[2] reported eight cases in 1988 involving both the maxilla and mandible, which occurred over a wide age range in both genders and recurred if not excised adequately. One of their cases was associated with an ameloblastoma. Radiologically the lesions were reported to be either unilocular or multilocular with smooth or scalloped margins. Based on their histopathological features they assumed the cysts to be of odontogenic origin and a histologic variant of the botryoid odontogenic cyst. The term glandular odontogenic cyst (GOC) was suggested. Shear[3] favoured the term muco-epidermoid cyst, which was advocated by Sadeghi and co-workers.[4] However, the latter term had already been used by Hodson[5] to describe simple radicular, residual and dentigerous cysts showing mucous metaplasia of the epithelial linings. In 1992 the World Health Organisation accepted GOC as a distinct pathological entity and classified it as a developmental odontogenic cyst.[3] Patron, Colmeri and Larrauri[6] reported three cases in 1991, which did not recur after surgical removal. One case was associated with a squamous odontogenic tumour-like proliferation in its wall. They included thirteen previously reported cases in their study and found predilections for males (9/13) and the mandible (10/13) and an age range of 19 to 85 years with a mean age of 50 years. Radiologically they described the lesions as well defined, uni- or multilocular without specific diagnostic characteristics. The occurrence during the fifth to seventh decade, location in the mandibular premolar region, multilocularity, tendency to recur and histological similarity of the epithelial lining led them to support the suggestion that GOC's are histologic variants of the botryoid odontogenic cyst. In 1994 Takeda[7] reported a GOC in the mandibular third molar region that presented as a

*Correspondence to: C Noffke, Department of Oral Radiology, Box D16, P.O. Medunsa, 0204, South Africa; E-mail: ejraub@medunsa.ac.za
Received 14 November 2001; revised 13 April 2002; accepted 19 August 2002

lateral periodontal cyst with a unilocular appearance. He supported the unsubstantiated hypothesis that a lateral periodontal cyst may develop in a GOC. Hussain, Edmondson and Browne[8] described four new cases of GOC in the mandible, with a predilection for females and a mean age of 44 years. The clinical and the radiological features were described as non-specific. Semba *et al*[9] added one new case in 1994, reviewed the clinical features of GOC and compared it with botryoid odontogenic cysts. He suggested that the GOC and the latter are histological variants in a separate group of non-keratizing odontogenic cysts, but share the same epithelial origin, namely the dental lamina, its remnants or reduced enamel epithelium. There was no sign of recurrence 2 years after surgical removal of their case.

Agreement has been reached on the aggressive, somewhat neoplastic nature of GOC's and their tendency to recur.[2,6,10,11] Toida and co-workers (1994)[12] in their review of the literature found a predilection for the mandible (14/18), notably the anterior region (13/18) and an equal gender distribution. The age range was reported to be 14 to 85 years (mean age of 49 years) and the majority of patients were older than 40 years. Radiologically the lesion lacked specific features making distinction from ameloblastoma and odontogenic keratocyst difficult. A more aggressive surgical removal rather than simple curettage was suggested and cases should be carefully followed up. Economopoulou and Patrikiou[13] added one case to the literature in 1995 and reviewed 19 cases in total. They found that GOC's occurred over a wide age range, with a predilection for men and the anterior mandible. The cysts may reach large dimensions, are often associated with expansion and radiological findings were reported to be non-specific.[14] The most recent literature research revealed a total of 47 reported cases, a male to female ratio of 19 : 28 and mean age 46.7 years (range 14–75 years) in males and 50.0 years (range 21–72 years) in females, resulting in a mean age of 48.3 years for both genders.[15]

Our study was aimed at analysing the clinical, radiological and histopathological features of seven new cases of GOC's in a rural African population and to compare our findings with those reported in the literature. The aggressive nature of GOC's makes distinction from other cystic lesions of the jawbones important. Diagnosis prior to surgical intervention is essential in this regard.

Report of new cases

Nine cases of GOC were diagnosed over the past 10 years in the Department of Oral Pathology at Medunsa, which serves mainly a rural Black population. Two of these were previously published as case reports.[11] None of our cases recurred, however follow-up is poor due to the remoteness of the region. Clinical and radiological data are reflected in Table 1. Radiographic examination was performed with panoramic, occlusal, Waters and peri-apical radiographs and measurements were made in horizontal and vertical dimensions on standardized panoramic films.

All GOC's showed cortical expansion (Figure 1) and those with a diameter of more than 6 cm, perforation. Maxillary GOC's had a well-circumscribed unilocular radiological appearance without exception (Figure 2). Both multilocular GOC's in our sample occurred in the

Table 1 Clinical and radiological features of eight cases

Case no.	*Gender*	*Age* (years)	*Site*	*Size* (cm)	*Radiological features*	*Clinical*
1*	M	14	R Max 12–13	3.2 × 2	Unilocular, well circumscribed, smooth contour, tooth displacement	Expansion
2*	F	27	L & R Mand 36–45	6 × 3	Unilocular, well circumscribed, irregular borders, tooth displacement	Expansion Perforation
3	M	50	L & R Mand 34–43	7 × 2.5	Unilocular, well circumscribed, smooth borders, tooth displacement	Expansion Perforation
4	M	15	R Max 22–23	3 × 3	Unilocular, well circumscribed, smooth borders, tooth displacement	Expansion
5	M	17	L Max 12–17	4.5 × 4	Unilocular, well circumscribed, smooth borders, tooth displacement	Expansion
6	F	58	L & R Mand 37–48	16.5 × 4	Multilocular, variable circumscription, irregular borders, partially sclerotic with perforations, tooth displacement	Expansion Perforation
7	F	11	L & R Mand 33–46	5.7 × 3	Unilocular, well circumscribed, irregular borders, tooth displacement	Expansion
8	F	59	RMand 47-ramus	4 × 2.7	Unilocular, well circumscribed, smooth sclerotic borders	Expansion
9	F	59	Lmand 36–42	9 × 4.5	Multilocular, scalloped borders with perforation and tooth displacement	Expansion Perforation

*Appeared as case reports[11]

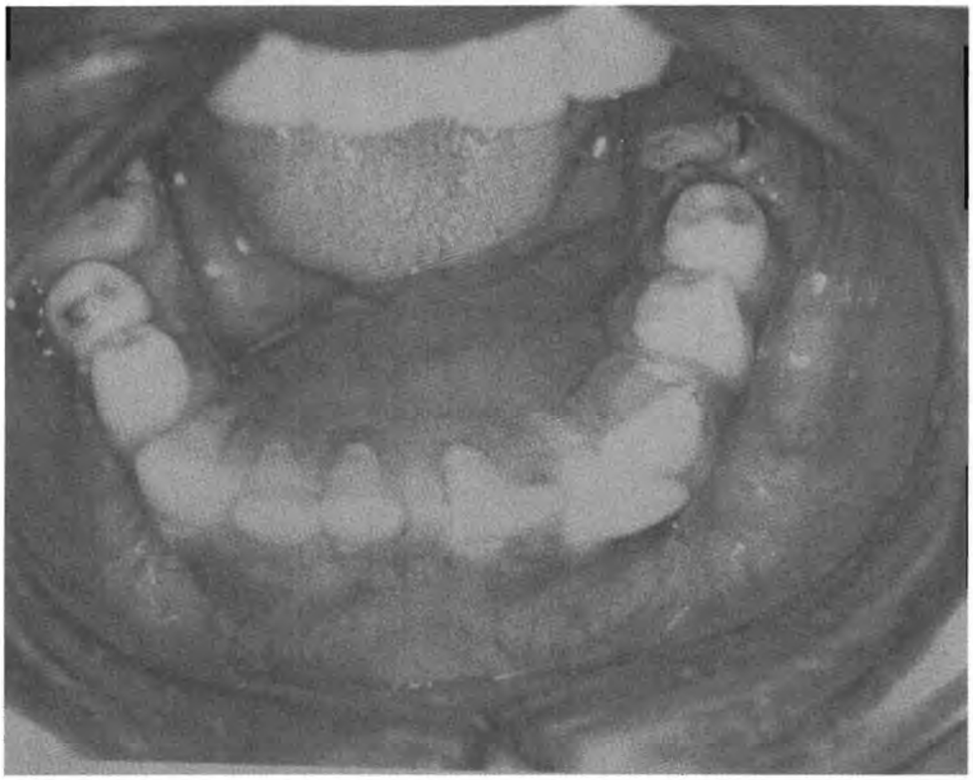

Figure 1 Case 3: buccal and lingual expansion with tooth displacement

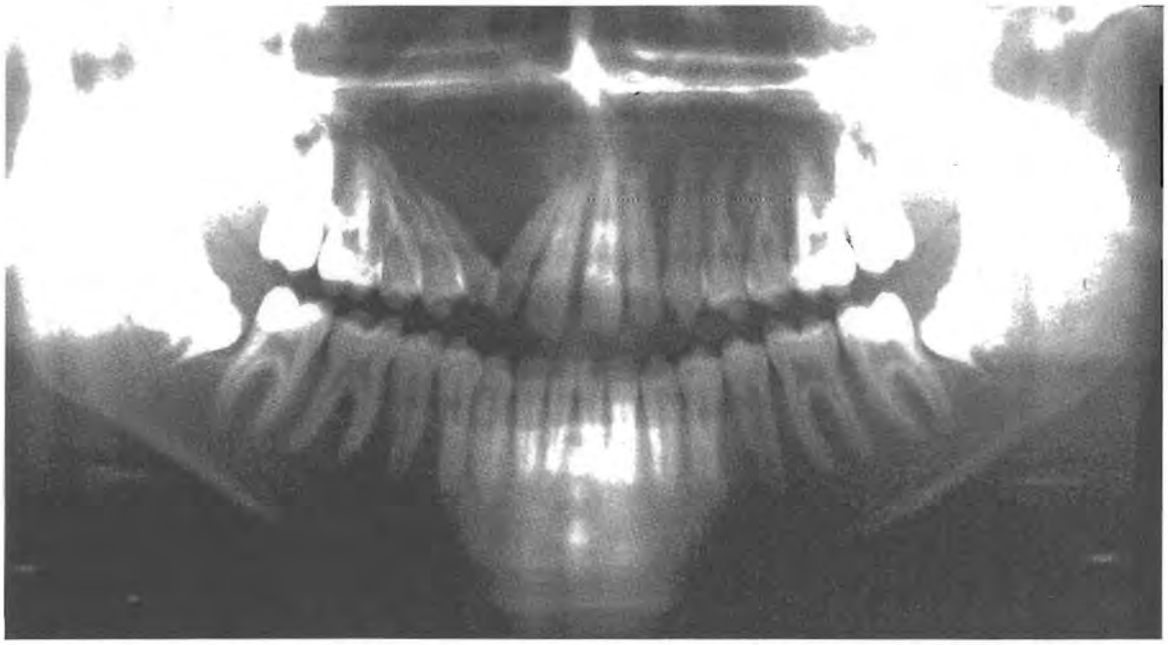

Figure 2 Case 4: unilocular well-circumscribed cyst in the maxilla between teeth 12 and 13, with smooth borders and tooth displacement

mandible and perforated through the cortex and into the alveolar mucosa (Figures 3 and 4). All mandibular cases were limited to the body and symphysis except one case that extended into the ramus (Figure 5).

All cases fulfilled the histopathological criteria for a diagnosis of GOC advocated by Gardner and co-workers in 1988.[2] The multilocular cases exhibited daughter cyst formation. Early invasion was character-

Figure 3 Case 6: multilocular mandibular lesion with partially sclerotic margins showing foci of perforation (arrows)

Figure 4 Case 9: multilocular mandibular lesion showing mild tooth displacement and perforation into the alveolar mucosa (arrow)

ized by the formation of adenoid structures which penetrated the connective tissue wall. These features were not seen in the unilocular types.

Discussion

Our series of nine cases of GOC, of which two had previously been reported[11] was diagnosed over a period of 10 years, confirming its low prevalence. The male to female ratio in our sample was found to be equal. Our mean age (35 years) was a decade younger than generally reported[14,15] mainly due to the significantly younger average age of 24 years at presentation of our male patients. The younger age may represent a racial difference in the manifestation of GOC. This tendency is, however, in agreement with the literature where males are generally reported to be affected at a younger age. Twice as many cases occurred in the mandible than maxilla, corresponding with the findings of other studies.[6,12,14,16] In our sample five of the six mandibular cases involved the symphysis area, the site of prevalence reported in other series. One of our cases occurred in the molar area of the mandible and extended into the ramus. All our maxillary GOC's were present in the globulomaxillary area. Two of these were pear shaped and associated with divergence of the roots of the lateral incisor and canine teeth and one

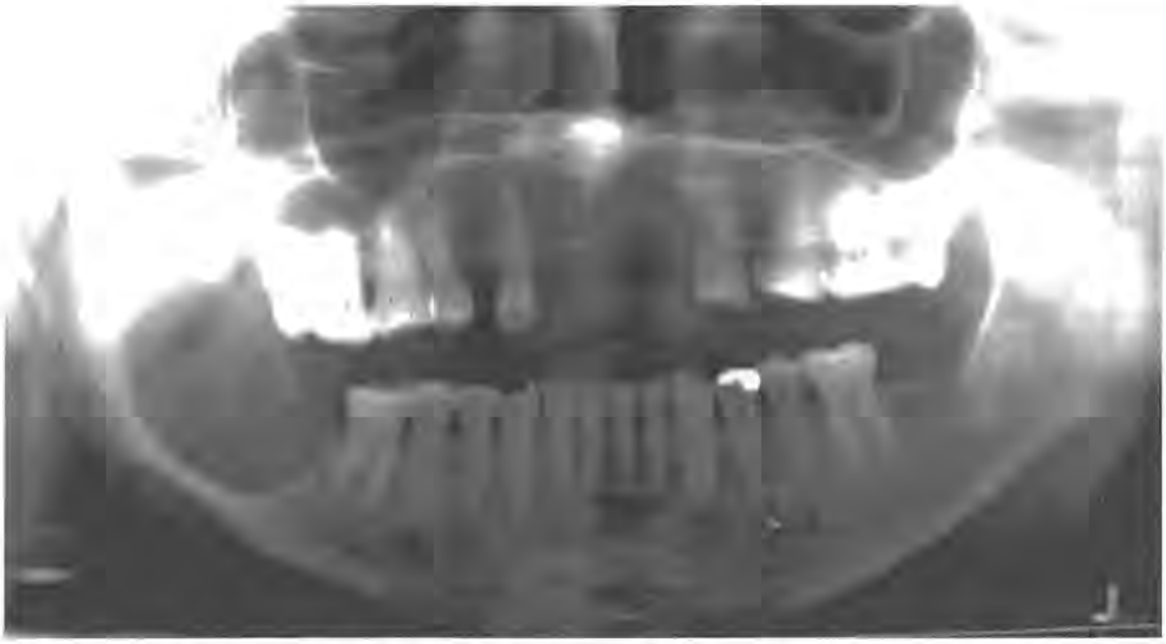

Figure 5 Case 8: unilocular well-circumscribed lesion with smooth sclerotic borders involving the mandibular ramus

extended distally to the second molar tooth. No maxillary GOC has been reported to occur in another location. The sizes of our lesions ranged between 2 and 16.5 cm in horizontal dimensions, the latter being the largest GOC reported thus far. The two multilocular GOC's were the largest lesions in our series, measuring 16.5 and 9 cm in horizontal dimension respectively. This may indicate that multilocularity is a size dependant phenomenon, developing only in the larger lesions. All our GOC's which measured in excess of 6 cm showed bone expansion with perforation, a feature supporting their aggressive expansile behaviour.[3]

Most authors conclude that there is no radiological feature distinctive for GOC.[14–16] All maxillary GOC's in our series were well circumscribed unilocular with regular borders, findings that correspond with those of a previous paper.[15] In our sample unilocular GOC's with irregular borders were common in the mandible (two out of four lesions). Two of our mandibular lesions showed sclerotic borders and one case scalloped between the roots of mandibular canine and premolar teeth. The two largest GOC were multilocular and resembled ameloblastoma radiologically. Radiological features which may be helpful in distinguishing multilocular GOC's from ameloblastomas include irregular loculations and a partially sclerotic border with foci of perforation. One GOC was, however, reported to be associated with an ameloblastoma[2] and representative histological sampling of large multicystic lesions is required to exclude the possibility of this manifestation. The question whether a GOC in association with an ameloblastoma represents a collision growth of two initially distinct lesions or a metaplastic phenomenon within an ameloblastoma (or GOC) remains speculative. The epithelial lining of a GOC may possess the ability to induce an ameloblastomatous proliferation in the connective tissue wall, similar to the phenomenon described in calcifying odontogenic cysts.[17] The proliferative capacity of the lining of GOC's could explain the histogenesis of the squamous odontogenic tumour-like proliferation reported in the wall of a GOC.[6] The presence of the epithelial plaques in a small number of GOC's is in our opinion not sufficient to confirm an association between this aggressive cyst type and the more innocuous lateral periodontal–and botryoid odontogenic cysts. Both our multilocular GOC's showed proliferations that infiltrated the connective tissue wall. This should not be confused with the plaques in the latter two cyst types, which are in fact localized thickenings consisting of mitotically inactive clear cells.[18] The GOC's in our sample were not associated with impacted teeth but rather tended to displace erupted teeth. This finding is indicative that GOC's generally develop after all permanent teeth have erupted. No significant resorption of the roots of involved teeth were observed in our study.

Taking the above mentioned radiological appearances into account, the provisional diagnoses for GOC on a radiograph would include odontogenic keratocyst, unicystic and multicystic ameloblastoma, lateral periodontal cyst, botryoid odontogenic cyst, simple bone cyst and central mucoepidermoid tumour. Features which may increase a suspicion of GOC include a sclerotic border with fine perforations or a pear shaped unilocular cyst with smooth margins in the globulo-maxillary region of the maxilla. Histologically the central muco-epidermoid carcinoma is considered the most important differential diagnosis.[18] Care should furthermore be taken not to interpret mucous cell metaplasia, which occurs commonly in a variety of odontogenic cysts and even ameloblastomas[19] as foci of GOC transformation. In order to prevent this from occurring, microscopic criteria for the diagnosis of GOC should stringently be applied. These include a superficial layer of cuboidal or columnar epithelial cells occasionally with cilia and a glandular or pseudo-glandular structures and intraepithelial crypts frequently containing mucin. The remaining of the cyst may be lined by thin non keratinised stratified squamous epithelium.[3] Our study showed that the multicystic type exhibits neoplastic features with infiltration of the surrounding tissue and daughter cyst formation. The distinction between low-grade central mucoepidermoid carcinoma and GOC is difficult, if not impossible. Both are reported to be unilocular or multilocular and may infiltrate and destroy bone. Microscopically, the lining of the cystic spaces of both exhibit squamous-, cylindrical- and cuboidal epithelium and mucus producing cells arranged in papillary folds. Within the epithelial lining of both mucus containing crypts (or gland-like structures) are found.[20,21] The only feature which has not been reported in low-grade central mucoepidermoid carcinoma and which may justify the existence of GOC as a separate entity is occasional presence of epithelial plaques, similar to those seen in lateral periodontal cysts.

In conclusion, in view of the histogenetic relationship that had been proposed between GOC and central mucoepidermoid carcinoma of the jaw,[1,10,22] the possibility that both entities represent a spectrum of one disease, should be investigated.

References

1. Padayachee A, Van Wyk CW. Two cystic lesions with features of both the botryoid odontogenic cyst and the central mucoepidermoid tumor: sialo-odontogenic cyst? *J Oral Pathol* 1987; **16:** 499–504.
2. Gardner DG, Kessler HP, Morency R, Schaffner DL. The glandular odontogenic cyst: an apparent entity. *J Oral Pathol* 1988; **17:** 359–366.
3. Shear M. *Cysts of the oral regions.* 3rd edn, Cambridge: University Press, 1992: pp.72–74.
4. Sadeghi EM, Weldon LL, Kwon PH, Sampson E. Mucoepidermoid odontogenic cyst. *Int J Oral Maxillofac Surg* 1991; **20:** 142–143.
5. Hodson JJ. Muco-epidermoid odontogenic cysts of the jaws with special reference to those in the mandible. *Proc R Soc Med* 1956; **49:** 637–641.
6. Patron M, Colmero C, Larrauri J. Glandular odontogenic cyst: Clinicopathologic analysis of three cases. *Oral Surg Oral Med Oral Pathol* 1991; **72:** 71–74.
7. Takeda Y. Glandular odontogenic cyst mimicking a lateral periodontal cyst: a case report. *Int J Oral Maxillofac Surg* 1994; **23:** 96–97.
8. Hussain K, Edmondson HD, Browne RM. Glandular odontogenic cysts. Diagnosis and treatment. *Oral Surg Oral Med Oral Pathol* 1995; **79:** 593–602.
9. Semba I, Kitano M, Mimura T, Miyawaki A. Case Report. Glandular odontogenic cyst: analysis of cytokeratin expression and clinicopathological features. *J Oral Pathol Med* 1994; **23:** 377–382.
10. Ficarra G, Chou L, Panzoni E. Glandular odontogenic cyst (sialo-odontogenic cyst). *Int J Oral Maxillofac Surg* 1990; **19:** 331–333.
11. Van Heerden WFP, Raubenheimer EJ, Turner MJ. Glandular odontogenic cyst. *Head and Neck* 1992; **14:** 316–320.
12. Toida M, Nakashima E, Okumura Y, Tatematsu N. Glandular odontogenic cyst: A case report and literature review. *J Oral Maxillofac Surg* 1994; **52:** 1312–1316.
13. Economopoulou P, Patrikiou A. Glandular odontogenic cyst of the maxilla: a report of a case. *J Oral Maxillofac Surg* 1995; **53:** 834–837.
14. Magnusson B, Göransson L, Ödesjö B, Gröndahl K, Hirsch JM. Glandular odontogenic cyst. Report of seven cases. *Dentomaxillofac Radiol* 1971; **26:** 26–31.
15. Koppang HS, Johannessen S, Haugen LIC, Haanaes HR, Solheim T, Donath K. Glandular odontogenic cyst (sialo-odontogenic cyst): a report of two cases and literature review of 45 previously reported cases. *J Oral Pathol Med* 1998; **27:** 455–462.
16. Ramer M, Montazem A, Lane SL, Lumerman H. Glandular odontogenic cyst. Report of a case and review of the literature. *Oral Surg Oral Med Oral Pathol* 1997; **84:** 54–57.
17. Praetorius F. Calcifying odontogenic cyst. Range, variations and neoplastic potential. *Acta Odontol Scand* 1981; **39:** 237–240.
18. Waldron CA. Odontogenic cysts and tumors. In: Neville BW, Damm DD, Allen CM, Bouquot JE (eds). *Oral and Maxillofacial Pathology*. Philadelphia: WB Saunders 1995: pp. 493–530.
19. Raubenheimer EJ, van Heerden WFP, Noffke CEE. Infrequent clinicopathological findings in 108 ameloblastomas. *J Oral Pathol Med* 1995; **24:** 227–232.
20. Auclair PL, Ellis GL. Mucoepidermoid carcinoma. In: *Surgical Pathology of the Salivary Glands*. Philadelphia: WB Saunders 1991: pp. 291–295.
21. Kramer IRH, Pindborg JJ, Shear M. *Histological typing of odontogenic tumours.* 2nd edn. Berlin: Springer-Verlag, 1992; p. 28.
22. Waldron CA, Koh ML. Central mucoepidermoid carcinoma of the jaws: a report of four cases with analysis of the literature and discussion of the relationship to mucoepidermoid, sialodontogenic, and glandular odontogenic cysts. *J Oral Maxillofac Surg* 1990; **48:** 871–877.

SPECIAL ARTICLE

Classification of Odontogenic Cysts of the Jaws

E.J. Raubenheimer, J. Kreidler, W.F.P. van Heerden

Recent developments in the classification and diagnosis of cysts of the jaws necessitate a revision of the topic. This paper discusses the revised World Health Organisation classification of odontogenic cysts and illustrates short descriptions of cyst types with appropriate examples.

INTRODUCTION

Cysts are pathological, fluid filled cavities lined by epithelium. They are more common in the jaws than in any other bone because of the epithelial rests remaining in the tissue after dental development. Cysts of odontogenic origin are the most common cause of chronic swelling of the jaws and have been recognised as diagnostic problems for a long time. During the past few years, numerous articles have appeared regarding the pathogenesis, behaviour, diagnosis and treatment of the different types of jaw cysts and various new concepts have since emerged. In order to standardize the diagnoses of jaw cysts, utilization of uniform diagnostic criteria is essential. The purpose of this article is to present the revised World Health Organisation's classification of odontogenic cysts of the jaws and to illustrate the typical features with appropriate examples obtained from the files of the Department of Oral Pathology, Medical University of Southern Africa.

Erich J Raubenheimer, MChD (Oral Path); Joachin Kreidler, PhD; Willie FP van Heerden, MChD (Oral Path), Department of Oral Pathology and Oral Biology, MEDUNSA, and *Department of Maxillofacial and Oral Surgery, Ulm, Germany.*

CLASSIFICATION

The classification of the odontogenic cysts of the jaws is based on that recommended in the World Health Organization's (WHO) publication *Histological Typing of Odontogenic Tumours*[1] and a recently published textbook on oral cysts[2] (Table 1). The histogenetic division into 'Developmental' and 'Inflammatory' groups remain unchanged.

Table 1.

1. Developmental
1.1 Gingival cyst of infants
1.2 Odontogenic keratocysts
1.3 Dentigerous (follicular) cyst
1.4 Eruption cyst
1.5 Lateral periodontal cyst
1.6 Gingival cyst of adults
1.7 Botryoid odontogenic cyst
1.8 Glandular odontogenic cyst
2. Inflammatory
2.1 Radicular cyst (apical and lateral)
2.2 Residual cyst
2.3 Paradental cyst
2.4 Inflammatory collateral cyst

This classification excludes the calcifying odontogenic cyst (which is now categorized as an odontogenic tumour) as well as other cystic tumours like the unicystic ameloblastoma. It is furthermore noteworthy that the concept of cysts developing in the closure lines of embryologic processes (such as median palatine cyst, median mandibular cyst and globulo-maxillary cyst) which were previously classified as of non odontogenic origin, has been rejected after detailed clinical[3,4] and embryological[5,6] studies.

DEVELOPMENTAL

Gingival cysts of infants

Gingival cysts of infants, also referred to as Bohn's nodules, occur commonly on the alveolar processes of newborn infants (Figure 1). They soon disappear through involution and are seldom seen after three months of age. These cysts arise from the dental lamina and although rarely biopsied, are lined by keratinizing squamous epithelium.[2]

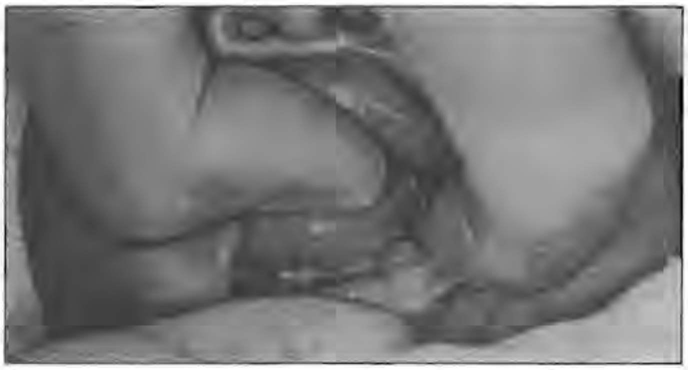

Figure 1. *Gingival cyst of the infant on the left mandibular alveolus.*

Odontogenic keratocysts

The term 'primordial cyst', which was often used synonomously with odontogenic keratocyst, has fallen in disuse because no convincing evidence for development from a tooth primordium has yet been forwarded. There is however, evidence supporting origin from primordial odontogenic epithelium, that is, dental lamina or its remnants[7,8]. Although other odontogenic cysts may exhibit foci of squamous metaplasia, odontogenic keratocysts are primarily recognised by their stretched and keratinized epithelial lining with a well defined, often palisaded basal cell layer. Basal cell budding, as well as daughter cyst formation are found in odontogenic keratocysts and are especially pronounced in patients with the naevoid basal cell carcinoma syndrome in which multiple keratocysts occur. These phenomena as well as the fragility of the cyst wall are the primary causes for incomplete surgical removal and the high recurrance rate. Odontogenic keratocysts may occur in the place of a tooth (replacement variety), around the crown of an impacted tooth (envelopmental variety) in the ramus of the mandible (extraneous variety) or between the roots of adjacent teeth (collateral variety)[9]. Although the majority present as unilocular radiolucencies (Figure 2), scalloped margins may be misinterpreted as multilocularity leading to an erroneous diagnosis of ameloblastoma[2]. The envelopmental variety is often indistinguishable radiologically from a dentigerous cyst and the collateral variety from a lateral periodontal or lateral placed radicular cyst.

Dentigerous (follicular) cysts

A dentigerous cyst is one which encloses the crown of an unerupted tooth by expansion of its follicle, and is attached to its neck[2] (Figure 3). It probably developes by accumulation of fluid between the reduced enamel epithelium and the enamel after formaton of the crown has been completed. The diagnosis of dentigerous cyst should not be made on radiographic evidence only, otherwise keratocysts of the envelopmental variety and unilocular ameloblastomas involving adjacent unerupted teeth, are liable to be misdiagnosed. The wall of a dentigerous cyst is lined by thin epithelium of two to three layers of undifferentiated cells derived from reduced enamel epithelium.

Figure 2. *Odontogenic keratocyst in the anterior mandible. Note the sclerotic margin surrounding the cyst.*

Figure 3. *Panoramic view of a dentigerous cyst surrounding the crown of an impacted maxillary central canine. Note the displacement of the permanent lateral incisor and canine.*

Eruption cyst

An eruption cyst is in effect a dentigerous cyst which occurs in the soft tissues. There is usually no radiographic evidence of bone involvement. The cyst is exposed to masticatory trauma and many eruption cysts burst spontaneously with only few requiring surgical exposure of the involved tooth.

Lateral periodontal cyst

The designation 'lateral periodontal cyst' is confined to those cysts which occur in the lateral periodontal position and in which an inflammatory aetiology and a diagnosis of collateral keratocyst have been excluded on clinical and histological grounds.[10] Radiographs show a round or oval, well circumscribed, radiolucent area somewhere between the apex and cervical margin of a vital tooth (Figure 4). Various theories on the histogenesis of this cyst type were forwarded, of which the proposal that it arises initially as a dentigerous cyst developing by expansion of the follicle along the lateral surface of the erupting tooth is an attractive one[11]. Most commonly, the lateral periodontal cyst is lined by a thin, non keratinized layer of squamous or cuboidal epithelium with small inconspicuous nucleii and convoluted epithelial plaques, which develop as a result of localized proliferation of cells[2].

The botryoid odontogenic cyst is a multilocular variant of the lateral periodontal cyst. This rare cyst has a

Figure 4. *Periapical radiograph showing a lateral periodontal cyst in the alveolus between teeth 35 and 36.*

Figure 5. *Multicystic appearance of a botryoid odontogenic cyst (H&E stain X40).*

lining similar to the lateral periodontal cyst with thin connective tissue septae separating distinct cystic cavities (Figure 5).

Gingival cyst of adults

The gingival cysts of adults is located in the gingival soft tissue and presents as a gingival swelling without any radiographic signs of bone destruction. Although many theories have been proposed on its histogenesis, the most favoured is derivation from gingival odontogenic epithelial cell nests[2] or reduced enamel epithelium after the eruption of a tooth.[12,13] If the latter theory is accepted, gingival cysts in adults may represent the soft tissue counterpart of lateral periodontal cysts. This is supported by the numerous similarities both clinically and histologically between these two cyst types.

Glandular odontogenic cyst

A cyst with fairly typical histological features and which has some characteristics in common with lateral periodontal cyst has recently been reported[14,15]. Radiographically, some cases exhibit a unilocular radiolucency with either smooth or scalloped margins (Figure 6), while others are distinctly multilocular. The cyst may be lined in parts by a non-keratinized stratified squamous epithelium. The superficial layer of the epithelial lining consists of columnar or cubiodal cells with occasional cilia and the epithelium has a glandular or pseudo glandular structure, with intra-epithelial crypts lined by cells similar to those on the surface.

INFLAMMATORY

Radicular cyst

A radicular cyst is one which arises from epithelial residues in the periodontal ligament as a result of inflammation[2]. The inflammation usually follows necrosis of the dental pulp and the identification of a non vital tooth associated with the cyst is an important diagnostic parameter. Although these cysts are usually located around the apex of a tooth (Figure 7), they may also be found on the lateral surfaces of a root in association with the opening of an accessory pulpal canal. Radiographically these cysts are characterized by round or ovoid radiolucencies surrounded by a narrow radio-opaque margin which extends from the lamina dura of the involved tooth. The size of the lesion is not reliable in distinguishing it from a periapical granuloma, unless it is larger than 2 cm in diameter in which case the lesion is most likely a radicular cyst.[16] Almost all radicular cysts are lined

Figure 6. *Glandular odontogenic cyst presenting as an unilocular cyst in the maxilla. Note the displacement of the adjacent teeth.*

Figure 7. *Radiograph of a radicular cyst surrounding the apex of a maxillary incisor.*

wholly or in part by stratified squamous epithelium. The epithelial lining may proliferate and exhibits arcading and a considerable degree of spongiosis with an intense inflammatory infiltrate.

Residual cyst

A residual cyst can be described as a radicular cyst of which the associated tooth has been extracted. All the radiographic and histological features of radicular cysts except for the association with a non-vital tooth therefore apply to residual cysts.

Paradental cyst

Craig (1976) wrote the first detailed account of a cyst of inflammatory origin which occured on the lateral aspect of the roots of partially erupted mandibular third molars where there was an associated history of pericoronitis. In these cases the teeth are vital and radiographic examination shows a well demarcated radiolucency distally to a partially erupted tooth: Ackerman, Cohen and Altini[17] like Craig[18] favour origin from reduced enamel epithelium but suggested that cyst formation occurs as a result of unilateral expansion of the dental follicle secondary to inflammatory destruction of the periodontium and alveolar bone. This is different from the histogenesis of dentigerous cysts where expansion occurs primarily with consequent bone destruction.

Paradental cysts are microscopically indistinguishable from radicular cysts and a proper clinical history and radiograph must accompany the biopsy in order to facilitate a correct diagnosis.

Inflammatory collateral cyst

This rare cyst type occurs as a result of inflammatory process in the periodontal pocket[2]. The associated tooth is vital and the cyst is microscopically indistinguishable from radicular cysts. Microscopic diagnosis relies heavily on adequate clinical information. This cyst appears to favour developing buccally to the lower first or second molars.

CONCLUSION

Accurate diagnosis of cysts of odontogenic origin is important as various cyst types like odontogenic keratocysts and glandular odontogenic cysts are aggressive lesions and tend to recurr after incomplete removal. It is important that clinicians are aware of the unreliability of radiographic interpretations. On the other hand, a microscopic diagnosis of biopsies taken from densely inflamed cyst walls is often difficult, if not impossible, to interpret without clinical information and radiographs. A high degree of diagnostic accuracy, when dealing with jaw cysts, can only be achieved through communication between the clinician and resident pathologist.

REFERENCES

1. Kramer IRH, Pindborg JJ and Shear M. *Histological Typing of Odontogenic Tumours* 1992. Berlin, Springer Verlag.
2. Shear M. *Cysts of the Oral Regions.* Third Edition. Oxford, Wright 1992.
3. Christ TF, The globulo-maxillary cyst - an embryological misconception. *Oral Surg* 1970; **30**, 515-26.
4. Kitimura H. Origin of non-odontogenic cysts: an embryological consideration of fissural cysts. *Bull Kanagawa Dent Coll* 1976; **4**, 1-18.
5. Sicher H. Anatomy and Oral Pathology. *Oral Surgery, Oral Medicine, Oral Pathology* 1962; **15**, 1264-69.
6. Arey LB. *Developmental Anatomy,* 7th edn. Philadelphia and London, Saunders 1965; p 205.
7. Soskolne WA and Shear M. Observations on the pathogenesis of primordial cysts. *Br Dent J* 1967; **123**, 321-26.
8. Toller PA. Origin and growth of cysts of the jaws. *Ann Royal Coll Surg.* 1967; **40**, 306-336.
9. Main DMG. Epithelial jaw cysts - a clinicopathological reappraisal. *Br J Oral Surg* 1970; **8**, 114-125.
10. Shear M and Pindborg JJ. Microscopic features of the lateral periodontal cyst. *Scan J Dent Res* 1975; **83**, 103-110.
11. Shafer WG, Hine MK and Levy BM. A textbook of Oral Pathology, 4th edn, Philadelphia and London, Saunders 1983.
12. Wysocki GP, Brannon RB, Gardner DG and Sapp P. Histogenesis of the lateral periodontal cyst and the gingival cyst of the adult. *Oral Surg* 1980; **50**, 327-334.
13. Buchner A, Hansen LS. The histomorphologic spectrum of the gingival cyst in the adult. *Oral Surg* 1979; **48**, 532-539.
14. Padayachee A and van Wyk CW. Two cystic lesions with the features of both the botryoid odontogenic cyst and the central mucoepidermoid tumor: sialo-odontogenic cyst. *J Oral Path* 1987; **16**, 449-504.
15. Gardner DG, Kessler HP, Morency R and Schaffner DL. The glandular odontogenic cyst: an apparent entity. *J Oral Path* 1988; **17**, 359-366.
16. Natkin E, Oswald RJ and Carnes LI. The relationship of lesion size to diagnosis, incidence and treatment of periapical cysts and grandulomas. *Oral Surg* 1984; **57**, 82-94.
17. Ackerman G, Cohen M and Altini M. The paradental cyst: a clinicopathological study of 50 cases. *Oral Surg* 1987; **64**, 308-12.
18. Craig GT. The paradental cyst. A specific inflammatory odontogenic cyst. *Br Dent J* 1976; **141**, 9-14.