

Investigative Pathology of the Odontogenic Cysts

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CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Reissued 2019 by CRC Press

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ISBN 13: 978-0-367-22294-9 (hbk)

ISBN 13: 978-0-429-27432-9 (ebk)

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CRC Press Web site at <http://www.crcpress.com>

PREFACE

The existence of cysts as clinical entities has been recognized from the early days of medical and dental practice. Descriptions feature in some of the early writings of the literature. Today a cyst may be defined as a pathological fluid-filled cavity, usually lined by epithelium, in which the fluid is not composed of pus. Such a definition is broad and encompasses a wide range of pathologically derived lesions. The odontogenic cysts form a group of lesions which have in common an origin from the tissues of tooth formation. Not surprisingly, therefore, they are found only in the tissues of the jaws, the majority of them occurring within bone. Indeed they comprise a group of lesions which are relatively common within the mandible and maxilla, making these bones the most commonly affected by cystic lesions in the entire skeleton.

A cyst may form either as a primary disease process or secondarily as a change in some other condition, for instance, a neoplasm. Such a change is quite common in some forms of neoplasms affecting the jaws, for example, the ameloblastoma. Although the cystic change may become the outstanding clinical feature in such neoplasms, it is the neoplastic character of the lesion which determines its clinical behavior and prognosis and sets it apart from other forms of cyst. Cysts arising in this way are therefore not part of the subject matter of this monograph.

In addition to the odontogenic cysts, other forms of cystic lesions may occur in the jaws. These other types of cysts are, in general, much less common and apart from their clinical identity and behavior, there is comparatively little known about them. The primary objective of this monograph is to review the investigative pathology of the odontogenic cysts. Over recent years there has been an increasing number of studies of these lesions in which the modern investigative tools of pathology have been employed. It is therefore, an opportune time to review the progress that has been made and to attempt to interpret the findings in the light of the current understanding of disease processes. As is often the case, such studies tend to raise more questions than provide answers and their application to the field of odontogenic cysts is no exception. However, we have attempted to highlight the areas of progress and give indications as to the direction in which future work might proceed.

The clinical and radiological features of the odontogenic cysts have been comprehensively described and discussed by previous authors. No attempt is made therefore to present these aspects in any detail in the present work; such would lead only to duplication of contributions already so ably presented elsewhere.¹ It is, however, assumed that the reader has such knowledge as a background before reading this text. Much of the previous work into the classification of the odontogenic cysts was based upon the clinical and radiological features of the different types of cyst, although it has only been in the last 20 years or so, that the importance of other features, such as their histological structure, has been emphasized. This change is exemplified by the recognition in 1956 by Philipsen² of a group of odontogenic cysts which showed a characteristic histological appearance and which lead to the recognition of a hitherto unidentified form of cyst, the odontogenic keratocyst. A brief resume of the classification of odontogenic cysts is presented in the following chapter.

A specimen of an odontogenic cyst, when it arrives in the laboratory, consists of a central cavity, the limits of which are demarcated by a layer of soft tissue which forms its wall. The central cavity or lumen is, of course, *in vivo* full of a fluid which is usually liquid in nature, but may be in the form of a coagulum. The wall of the cyst is usually composed of two distinct layers. There is always a fibrous tissue capsule which forms the peripheral limit of the lesion, but also in the majority of cases an epithelial lining forming a layer of varying thickness between the capsule and lumen. A detailed account of the light and electron microscopical features of the different types of odontogenic cyst is presented in Chapter 3. The simple basic structure of cysts provides the medium within which a series of relatively complex cellular and molecular interactions occur. The variety of these interactions con-

tributes to the diversity of behavior of the different forms of odontogenic cyst. Although knowledge is presently far from complete, the remaining chapters attempt to analyze these interactions in the light of current understanding of the biological processes involved.

It is inevitable that there is a certain amount of overlap in the subject matter of different chapters. However, in a book of this type, it is felt that each chapter to a large extent should be independent, so that the reader does not need necessarily to digest the book in its entirety, but only those chapters in which there is particular interest. In general, the advances over the last two decades have been referred to and no attempt is made to trace the historical background to the subject.

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ACKNOWLEDGMENTS

We would like to acknowledge the secretarial assistance of Mrs. Helen Richmond and the photographic assistance of Miss Marina Tipton, both from the Department of Oral Pathology, University of Birmingham, England.

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Chapter 1

THE CLASSIFICATION OF ODONTOGENIC CYSTS**R. M. Browne****TABLE OF CONTENTS**

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I. INTRODUCTION

There have been many different classifications of the odontogenic cysts over the years and most of them have formed a practical basis for the understanding and treatment of these lesions, based upon the knowledge existing at the time. The earliest classifications were based primarily upon the varied clinical and radiological presentations of the different forms of cyst, and relatively little note was paid to their histological features. This was hardly surprising, since such classifications were promoted mostly by clinicians and the discipline of oral pathology was only in its infancy. Attempts to classify these lesions have also been plagued by the use of a variety of different terms by different authors to describe the same pathological entity, particularly where classifications have been proposed by authors from different countries.

The emergence of oral pathology as a properly recognized specialty in dentistry has led to a rationalization of these differences and the presentation of more generally acceptable classifications. It is now widely recognized that some different types of cysts have histologically distinguishable cyst walls, but by no means all of them; that cysts with a particular histological type of wall behave differently clinically from other cysts; and that the histological features are at least as important as the clinical and radiological parameters in the classification of odontogenic cysts.

There is little to be gained from a detailed historical review of the many classifications of odontogenic cysts that have been proposed over the years. Such an exercise would be time consuming and not particularly productive. What is required, however, is a classification upon which the discussion of this group of lesions elsewhere in this book can be based. It is necessary also to present a brief description of each entity included in the classification, together with an evaluation of any variants of each type of cyst that have been described in the literature.

Classification of odontogenic cysts is complicated further by the fact that other epithelial-lined and non-epithelial lined cysts occur in the jaws. Such lesions arise because epithelia other than odontogenic residues are present in the jaws, particularly in the maxilla. Further, cystic breakdown can occur in essentially neoplastic lesions of odontogenic epithelium or in hyperplastic lesions of bone or their contained tissues. However, although the presence of such lesions is widely recognized and has been fully discussed in other texts,^{1,2} this monograph is restricted to the odontogenic cysts.

II. CLASSIFICATION

The classifications of odontogenic cysts, almost without exception, recognize two main groups, developmental and inflammatory. It is well documented that the process of odontogenesis involves a series of complicated and extensive epithelial proliferations and that once each stage of tooth formation is complete, the epithelium undergoes involution, but only partially, and always leaves behind residues either within the oral mucosa, the periodontal ligament, or the adjacent bone. Many cysts arise without any obvious etiological stimulus and there is much evidence, albeit circumstantial, that such residues may undergo proliferation and lead to cyst formation: such cysts are generally described as being developmental in origin. On the other hand, foci of inflammation are common in and around the teeth as a consequence of the two major dental diseases, dental caries and periodontal disease. Epithelial hyperplasia arises if residues are affected by such inflammation and as a consequence cyst formation may occur. Such cysts are usually designated as being inflammatory in origin. However, many developmental cysts contain infiltrates of inflammatory cells within their walls to a greater or lesser degree, thus perhaps making the distinction between the two categories of cyst less definite. Nevertheless, it is widely believed that the stimulus to

TABLE 1
Odontogenic Cysts

Developmental
 Primordial cyst (keratocyst)
 Gingival cyst
 Eruption cyst
 Dentigerous (follicular) cyst
 Inflammatory
 Radicular cyst

Adapted from Pindborg, J. J. and Kramer, I. R. H., in *Histological Typing of Odontogenic Tumors, Jaw Cysts and Allied Lesions*, World Health Organization, Geneva, 1971.

TABLE 2
Odontogenic Cysts

Developmental
 Primordial cyst (odontogenic keratocyst)
 Gingival cyst of infants
 Gingival cyst of adults
 Lateral periodontal cyst
 Dentigerous (follicular) cyst
 Eruption cyst
 Calcifying odontogenic cyst
 Inflammatory
 Radicular cyst
 Residual cyst
 Inflammatory collateral cyst
 Paradental cyst

Adapted from Shear, M., *Cysts of the Oral Regions*, 2nd ed., Wright PSG, Bristol, 1983.

the initial epithelial hyperplasia is different in the two groups and that the distinction is therefore valid. Perhaps the greatest difficulty in this respect lies in the pathogenesis of the dentigerous cyst and this is discussed further in Chapter 4.

The most widely quoted classification of odontogenic cysts is that proposed in the WHO booklet, *Histological Typing of Odontogenic Tumors, Jaw Cysts and Allied Lesions*, published in 1971.³ This classification is presented in Table 1. Since the publication of this classification, several other carefully documented types of cyst have been reported, many of which were included in a modification of the above classification as presented by Shear² (Table 2). This classification is the one adopted in this monograph with the one modification that "odontogenic keratocyst" is used rather than "keratocyst". The inclusion of the term odontogenic is regarded as necessary as other forms of keratinizing cyst are now believed to occur rarely in the jaws, including nonodontogenic lesions such as epidermoid cysts. The modified classification is presented in Table 2. All the lesions included in this classification are discussed in the pages that follow with the exception of the calcifying odontogenic cyst. There is still a considerable difference of opinion as to whether this lesion should be regarded as a cyst or a cystic form of neoplasm, or indeed as to whether there are two distinct forms, a cystic and neoplastic variant.⁴ There have, in any event, been virtually no investigative studies of the cystic form of this lesion and so it has been excluded.

The basic characteristics of each cyst are briefly described below.



FIGURE 1. A lateral oblique radiograph of the mandible, demonstrating an odontogenic keratocyst in the premolar region, appearing as a primordial cyst in place of the first premolar.

III. DEVELOPMENTAL CYSTS

A. PRIMORDIAL CYST (ODONTOGENIC KERATOCYST)

The primordial cyst is a developmental cyst. In its original usage, the term primordial cyst was reserved for cysts which arose from odontogenic epithelial primordia in place of a tooth of the normal dentition. They thus had a characteristic radiological presentation where a cyst-like radiolucency is present in the bone at a site where no tooth has developed (Figure 1).

The term, odontogenic keratocyst, is much more recent, having been introduced by Philipsen in 1956.⁵ This term was based upon the characteristic histological appearance of a group of odontogenic cysts which clearly distinguished them from the others.⁵⁻⁷ Such cysts have, however, a wide variety of radiological appearances such that they simulate most other types of odontogenic cyst.⁸⁻¹¹ Indeed, the presentation as a primordial cyst as originally described is one of the least common radiological appearances. This variety of presentations has led to confusion in their classification in the past. However, careful analysis has indicated clearly that odontogenic keratocysts have a statistically significant different age and site distribution from other forms of odontogenic cyst^{12,13} and should therefore be classified separately. The confusion has been added to as it is now recognized that keratin metaplasia can occur in other types of odontogenic cyst.^{13,14} However, when such metaplasia occurs, its histological appearance is quite different from that of an odontogenic keratocyst, although there is a small number of instances when the distinction between the two is difficult. Keratin metaplasia in other types of odontogenic cyst is however relatively rare,¹³ occurring in only approximately 2.0%.

Most authors now believe that odontogenic keratocysts arise from epithelium of the tooth primordium (dental lamina, tooth germ) or its residues and the terms primordial cyst



FIGURE 2. A lateral oblique radiograph of the mandible, demonstrating an odontogenic keratocyst in the ascending ramus and molar region, appearing as a dentigerous cyst associated with an unerupted and displaced third molar. Note the cystic radiolucency does not extend to the level of the amelocemental junction of the associated tooth.

and odontogenic keratocyst are used synonymously. Hence a primordial cyst is now recognized as a developmental cyst arising from the epithelium of a tooth primordium or its residues, but not only arising in place of a tooth of the normal dentition. Indeed such a presentation is relatively uncommon, occurring in only approximately 10%.^{10,11} However, such a diagnosis can be made only when the teeth of the normal dentition are present and it should be noted that a substantial number of these cysts are diagnosed in edentulous regions of the jaw when the exact pathogenesis is unclear in the absence of fully documented patient records. On the other hand, their histological appearance is quite characteristic and because it is on the basis of their histological appearance alone that the diagnosis can be made, in my view the term odontogenic keratocyst is preferable.

The most common radiological appearance is that of an apparent dentigerous cyst,⁹⁻¹¹ being present in 40 to 50% of lesions. However, careful examination of the radiographs suggests that the crown of the associated unerupted tooth does not project into the cyst cavity, but rather has been displaced by it (Figure 2). This relationship is confirmed when the appropriate histological material can be examined.^{7,15} However, in a small proportion of cysts, the odontogenic keratocyst is in true dentigerous relationship to the associated unerupted tooth.^{7,16} This has given rise to the term follicular primordial cyst.¹⁷ There is evidence that such lesions arise originally in an extrafollicular position, discrete from the associated tooth, and subsequently either their epithelial linings fuse with the reduced enamel epithelium, so enclosing the entire anatomical crown of the tooth,⁷ or the tooth actually erupts into the cyst lumen.¹⁷ In whatever way the relationship arises, such cysts should be regarded as a variant of the odontogenic keratocyst and classified with them. In addition to its radiological appearance as a dentigerous cyst, the odontogenic keratocyst can assume a variety of other presentations, including that of a lateral periodontal cyst (Figure 3), a

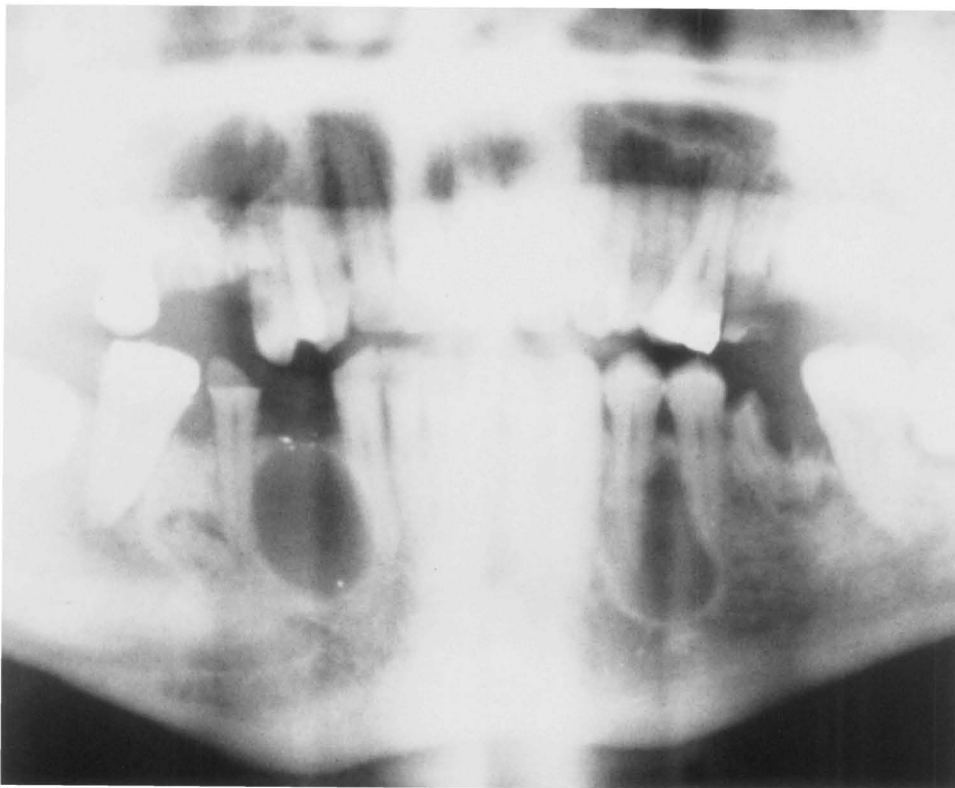


FIGURE 3. Part of a panoral radiograph, demonstrating an odontogenic keratocyst appearing as a lateral periodontal cyst on the left side of the mandible and as a residual cyst on the right, in a patient with multiple cysts.

radicular cyst (Figure 4), a primordial cyst (Figure 1) and a residual cyst (Figure 5). It is this variety of clinical and radiological appearances that has contributed to the delay in the recognition of the odontogenic keratocyst as a distinct entity. A single case report of a primary odontogenic keratocyst arising solely in the alveolar mucosa has been published.¹⁸ The use of the term peripheral odontogenic keratocyst was suggested by the authors to describe this rare occurrence.

Odontogenic keratocysts not uncommonly are multiple in the same patient: when this occurs, such patients usually display other clinical or radiological features of the basal cell nevus syndrome, although in some reports this has not always been the case. The relationship of odontogenic keratocysts to this syndrome is fully discussed in Chapters 11 and 12.

B. GINGIVAL CYST OF INFANTS

These developmental cysts occur in newborn infants up to 3 months of age² and are found on the edentulous ridges. Their exact incidence is unknown, although they occur more commonly in the maxilla than the mandible¹⁹ and appear as small whitish, nodular elevations of the mucosa, some 2 to 3 mm in diameter (Figure 6). Indeed, they are commonly referred to eponymously as Bohn's nodules, despite Fromm's¹⁹ observation that Bohn was describing remnants of mucous glands.

There is good histological evidence that these cysts arise from the remnants of the dental lamina. In the normal process of tooth development, the dental lamina, from which the individual tooth germs are derived, undergoes fragmentation into a number of apparently discrete rests of stratified squamous epithelium. A number of these demonstrate differentiation



FIGURE 4. A lateral oblique radiograph of the mandible, demonstrating an odontogenic keratocyst in the premolar and molar region, appearing as a radicular cyst.



FIGURE 5. A lateral oblique radiograph of the mandible, demonstrating an odontogenic keratocyst in the molar region, appearing as a residual cyst.



FIGURE 6. Gingival cyst of the newborn. The edentulous dental ridges of a 2-month-old child showing numerous cystic, nodular elevations (Bohn's nodules). (Courtesy of Dr. M. C. Grundy.)

of keratinizing squames towards the center of the rests, which process may progress to the formation of discrete keratin-filled cysts. The number of these cysts increases up to the 22nd week of fetal life.²⁰ These small cysts usually involute, in one of two ways, before reaching clinically detectable size. Most commonly, there may be fusion between the epithelium of the cyst lining and the overlying mucosa so that the keratin contents of the microcysts is discharged and the cyst involutes. Less frequently, the epithelial cells lining the microcyst break down, thus exposing the keratin contents of the cyst to the surrounding connective tissue. As a consequence, macrophages are attracted to the area where they digest the keratin, often in the process forming multinucleate giant cells, so that the residue involutes completely. Occasional cysts persist however, and enlarge to produce the gingival cysts of the newborn evident clinically, but eventually themselves involute as above. This process of epithelial atrophy is apparently complete by the third month postpartum.

C. GINGIVAL CYSTS OF ADULTS

These cysts occur only infrequently and there has therefore, not surprisingly, been some confusion as to their precise classification. Several recent surveys^{2,21,22} have helped to clarify the nature of these lesions. It seems sensible to classify them separately from the lateral periodontal cyst, for although the two lesions may have a similar pathogenesis, they have a quite distinct clinical presentation. The gingival cyst of adults lies only within soft tissue although there may occasionally be some surface pressure resorption of the underlying alveolar bone, whereas the lateral periodontal cyst always arises within the bone.

However, there is difficulty in determining the classification of the latter type of cyst if it has eroded the bone to involve the overlying soft tissue at the time of clinical presentation. Gingival cysts occur predominantly on the buccal and labial aspects of the jaw, mostly in the canine and premolar region. They are more common in the mandible than maxilla. Occasionally, such soft tissue cysts may have the histological features of an odontogenic



FIGURE 7. A panoramic radiograph, illustrating a lateral periodontal cyst lying between the mandibular right canine and lateral incisor.

keratocyst²¹ and these lesions should not be classified as gingival cysts of adults but rather as odontogenic keratocysts.

Because of an absence of other known etiological factors, such as inflammatory stimuli, these cysts are regarded as being developmental in nature, despite the fact that they become increasingly common with age, up to the sixth decade.² However, a number of such cysts can be found as incidental findings in routine gingival biopsies in the absence of clinical signs²³ and so it is possible that they can be present for many years, even perhaps from infancy, before a swelling appears clinically. Occasionally, they are polycystic.²²

D. LATERAL PERIODONTAL CYST

In the past, the term lateral periodontal cyst has been used in a variety of ways and to include a number of cysts of clearly differing pathogenesis.^{24,25} Such lesions have included laterally placed cysts arising in an inflammatory focus of either pulpal (laterally placed radicular cyst) or periodontal (inflammatory collateral cyst, paradental cyst) origin, gingival cysts of adults and odontogenic keratocysts. If these other types of cyst are excluded, however, there remains a small group of cysts of presumed developmental origin which arise laterally to a tooth within the bone of the alveolus;²⁶ these are lateral periodontal cysts.

Several recent surveys^{22,27,28} have indicated that lateral periodontal cysts are diagnosed in a wide range of age groups from the second to ninth decades, with a mean of approximately 50 years of age. Approximately 70% arise in the mandible, predominantly in the canine/premolar region. They are frequently incidental findings observed on radiological examination, when they appear as well circumscribed radiolucent areas laterally placed in relation to the root of a vital tooth (Figure 7). Occasionally they are multilocular in form when the term botryoid has been applied to them.²⁹ Such lesions may recur following enucleation.³⁰⁻³² Recently a further histological type of cyst has been reported as a sialo-odontogenic cyst³³ or glandular odontogenic cyst.³⁴ As there are so few reports of this lesion at present,

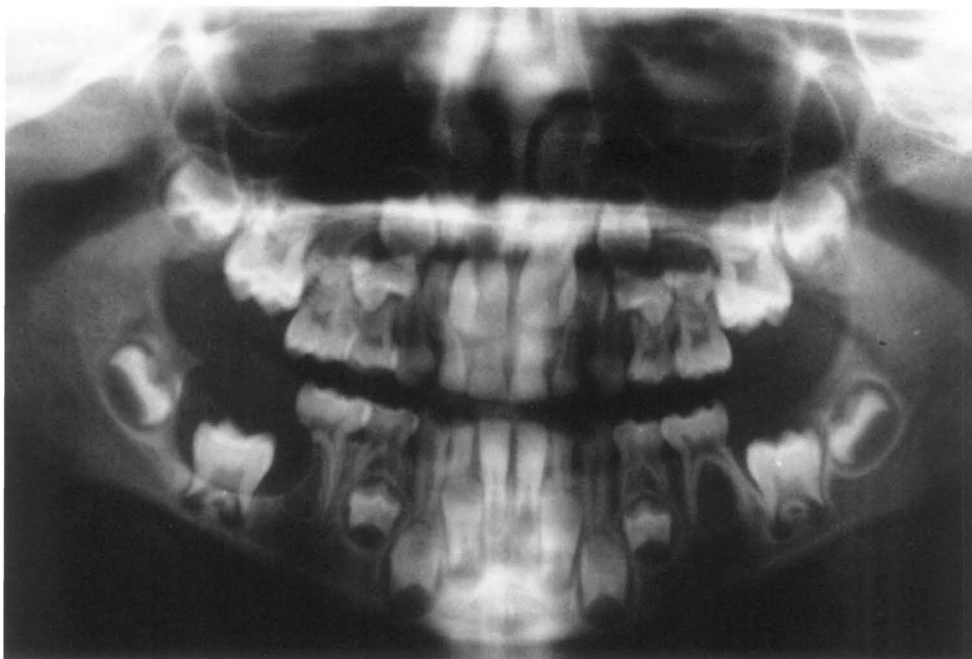


FIGURE 8. A panoramic radiograph illustrating a dentigerous cyst on the right mandibular second molar. There has been marked resorption of the distal aspect of the right mandibular first molar.

it remains to be determined whether it is a further variant of the lateral periodontal cyst or a distinct entity in its own right.

E. DENTIGEROUS (FOLLICULAR) CYST

Dentigerous literally interpreted means “tooth-bearing” and is a good descriptive term for this cyst which by definition is one which encloses the crown of an unerupted tooth lying within bone, and cannot be assigned to any other classification. Rarely the crowns of two or more teeth may be enclosed within the one cyst cavity. Less rarely one patient may have more than one dentigerous cyst at the same time.

This relationship between cyst and tooth crown is quite precise so that the wall of the cyst is attached to the cervical region of the tooth and encloses the entire crown. As a consequence, the radiological appearance of the lesion is characteristic (Figure 8). However, it is not pathognomonic and a variety of other odontogenic cysts and tumors can produce a similar radiological image. Over the years the term dentigerous cyst has been loosely applied to any lesion producing an appropriate radiographical appearance. This usage is quite wrong and, indeed, misleading as lesions with a variety of different pathogeneses (such as adenomatoid odontogenic tumor, odontogenic keratocyst, unicystic ameloblastoma), may thus be included. The term should be reserved only for any cyst fulfilling the definition in the above paragraph. If a cyst enclosing the crown of an associated unerupted tooth fulfills the histological criteria for the diagnosis of an odontogenic keratocyst (follicular primordial cyst,) ¹⁷ that lesion should be classified as an odontogenic keratocyst and not a dentigerous cyst.

The term dentigerous cyst is preferred to that of follicular cyst. The latter term implies a derivation from the tooth follicle which is a mesodermal structure. Whatever the pathogenesis of dentigerous cysts, a consistent feature is the presence of an epithelial-lined cavity attached to the neck of the tooth. Such a finding indicates that the cystic change must have



FIGURE 9. A plexiform unicystic ameloblastoma associated with the crown of an unerupted molar tooth. The cystic part of the lesion is in dentigerous relation to the crown of the associated tooth.

arisen either within the reduced enamel epithelium itself or between it and the tooth surface, but not within the connective tissue of the tooth follicle. The term follicular cyst is, therefore, misleading. The suggestion that some dentigerous cysts may be extrafollicular in origin is even more misleading. This pathogenesis, which has been referred to following the case reports of Gillette and Weinmann,¹⁵ implied that the source of the epithelial lining of dentigerous cysts may have its origin in residues outside the tooth follicle. However, the cases reported by the above authors were clearly examples of odontogenic keratocysts and should be classified as such. There is, therefore, no evidence for such an origin.

Because dentigerous cysts arise in association with teeth, the eruptive pathway of which is presumed to have been compromised, they are generally regarded to be of developmental origin. Although it is widely stated that they are most common in the second and third decades, when most of the permanent teeth are erupting and thus supporting their developmental origin, some data suggest that their incidence may increase up to the fifth decade.¹³ The physical disturbance to eruption may itself be a cause of tissue damage and it is not therefore surprising that some degree of inflammation is commonly present in the cyst wall. However, inflammation is mostly regarded as a consequence of the cyst formation and not as its cause. The recognition that inflammation may sometimes be an important etiological factor in dentigerous cysts arises from the description of the inflammatory follicular cyst.³⁵ This study reported 13 cases of dentigerous cysts associated with unerupted premolars, all but one in the mandible, in which periapical or inter-radicular inflammation, in association with a nonvital primary molar, was regarded as the etiological factor. This type of pathogenesis does, however, appear to be very much the exception.

A number of lesions which on first sight appear to fulfill the requirements for the diagnosis of a dentigerous cyst, on further detailed examination, particularly if serial sections are employed, demonstrate features of ameloblastoma. Such variants of ameloblastoma have been variously described as unicystic ameloblastoma,³⁶ mural ameloblastoma³⁷ (Figure 9),



FIGURE 10. A lateral oblique radiograph of the mandible, demonstrating a unicystic plexiform ameloblastoma occupying most of its body and ramus.

plexiform unicystic ameloblastoma,^{38,39} and cystic ameloblastoma.⁴⁰ The mural nodule of ameloblastoma may be only relatively small, thus emphasizing the need to exclude such lesions before making a diagnosis of dentigerous cyst. This form of ameloblastoma is associated with the crown of an unerupted tooth in 50 to 80% of cases^{39,40} and as they are most common in the second and third decades, the confusion between these lesions and dentigerous cysts is understandable (Figure 10). It is widely stated that such ameloblastomas arise by neoplastic transformation of the epithelial lining of a dentigerous cyst. There is, however, no convincing evidence for this origin and it can be argued equally strongly that this form of ameloblastoma is a variant of the neoplasm in which early cyst formation is a characteristic feature, without needing to postulate the previous existence of a dentigerous cyst.



FIGURE 11. An eruption cyst overlying the crown of an unerupted permanent canine. (Courtesy of Dr. L. Shaw.)

F. ERUPTION CYST

An eruption cyst forms in the mucosal soft tissues (Figure 11) overlying the crown of an erupting tooth. As intact histological specimens of the cyst and its associated tooth are only occasionally available for examination, the exact relationship between the crown of the unerupted tooth and the cyst lining is uncertain, but it is widely believed to be the same as that in a dentigerous cyst. It occurs most frequently in the first and second decades, but occasionally arises in patients of greater age. The cyst is generally believed to be developmental in origin arising in association with some interruption in the eruptive pathway of the tooth, but during the soft tissue phase.

IV. INFLAMMATORY ODONTOGENIC CYSTS

A. RADICULAR CYST

A radicular cyst arises within a focus of inflammation in the periodontium derived from the root of a nonvital tooth. It is not surprising, therefore, that it is diagnosed with similar frequency in the third, fourth, fifth, and sixth decades,^{2,13} when pulpal necrosis as a consequence of dental caries is most likely. These cysts usually occur in association with the apical foramen of the root or roots of the nonvital tooth (Figure 12). Consequently, the terms periapical cyst or apical periodontal cyst have been widely used. However, rarely the cyst occurs in association with the foramen of a laterally placed root canal in which case it lies laterally to the root of the nonvital tooth (Figure 13). For this reason, the term radicular cyst is preferable as it includes all cysts with a common pathogenesis irrespective of their anatomical relationship to the causative tooth.

Approximately 60% of radicular cysts occur in the maxilla^{2,13} and 40% in the mandible; although they may arise on any tooth, the maxillary incisors and canine are most frequently involved, approximately 37% of the cysts being associated with these teeth.

The inclusion of laterally placed cysts in this classification indicates that the development

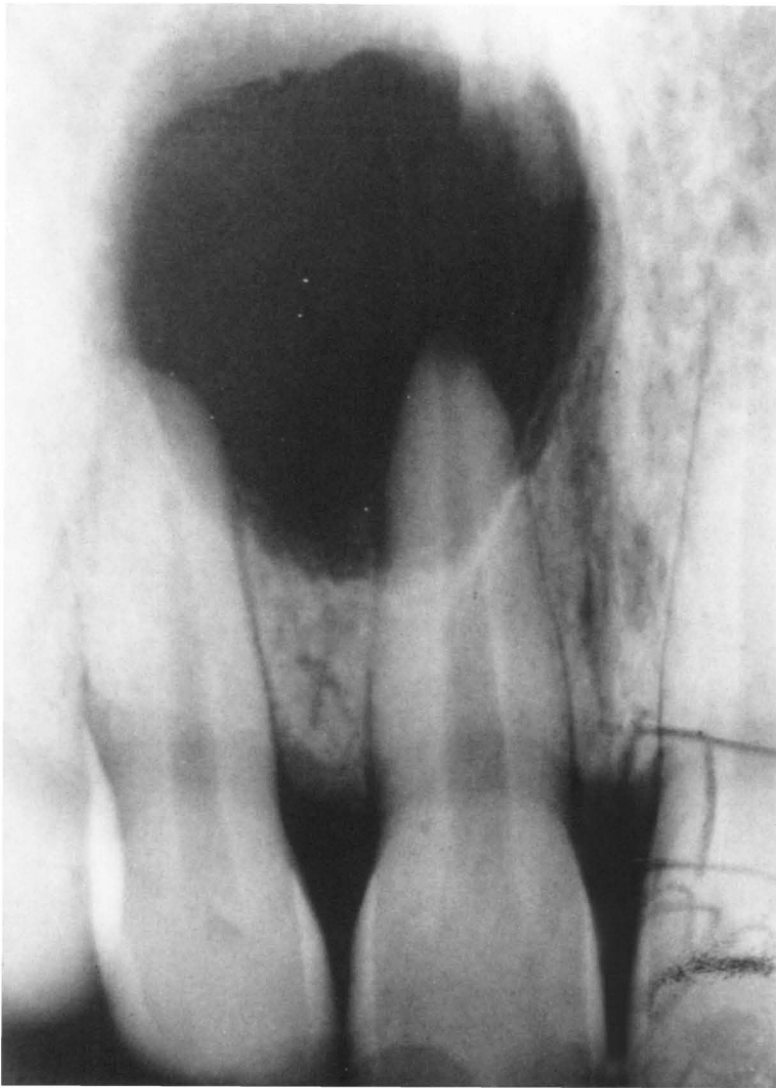


FIGURE 12. A periapical radiograph of a periapically positioned radicular cyst associated with a maxillary central incisor with necrotic pulp.

of a cystic lesion in this position may arise by a variety of different pathogenetic mechanisms. In addition to the laterally placed radicular cyst, odontogenic keratocysts, lateral periodontal cysts and inflammatory collateral cysts may all give a similar radiographical appearance. Further, a variety of odontogenic tumors may also arise in this position.

Although it is usual for only one tooth to be associated with a radicular cyst at any one time, there is a small number of patients in whom more than one radicular cyst may be present or who develop more than one cyst over a period of time.^{41,42} Such patients may have some genetic predisposition to epithelial hyperplasia and cyst formation, although there is no firm evidence for such a hypothesis.

B. RESIDUAL CYST

A residual cyst is a cyst left behind within the bone of the jaws after the associated tooth has been removed (Figure 14). Although it is theoretically possible for this to occur



FIGURE 13. A periapical radiograph of a laterally placed radicular cyst between the maxillary central and lateral incisors associated with a lateral perforation of the mesial aspect of the root of the lateral incisor. Some endodontic material is extruded into the adjacent tissues.

with a variety of different types of odontogenic cyst, in reality the only occurrence for which there is firm evidence is the persistence of a radicular cyst following the extraction of the causative tooth. Once the tooth has been removed, the persisting cyst is classified as a residual cyst.

Most previous studies have combined the data for radicular and residual cysts and so there is relatively little information on the age and site distribution of these lesions. This is surprising because in a recent study residual cysts were found to comprise some 10% of odontogenic cysts.⁴³ This study found a predominance in the mandibular premolar region,



FIGURE 14. An occlusal radiograph of the anterior maxilla, demonstrating a residual cyst in the central incisor region.

although they can occur in any part of the jaws. Although radicular cysts are more common in the anterior maxilla, the demand to retain teeth in this part of the jaw for aesthetic reasons probably explains the relatively low incidence of residual cysts. There is evidence too that most residual cysts become progressively smaller in size with age⁴³ and even resolve completely.⁴⁴

C. INFLAMMATORY COLLATERAL CYST

This term was introduced by Main^{45,46} to distinguish cysts arising laterally to a tooth within an inflammatory focus associated with a periodontal pocket, from lesions in a similar position but of developmental origin. They are extremely rare, notwithstanding the widespread incidence of chronic periodontal disease in most populations. Because of their rarity and their confusion with other similarly situated lesions such as lateral periodontal cysts, laterally placed radicular cysts and odontogenic keratocysts, there is little data on them. However, it seems that they can occur in either jaw and at any age.²⁵



FIGURE 15. A panoramic radiograph illustrating a paradental cyst associated with the impacted and partially erupted right mandibular third molar.

D. PARADENTAL CYST

The paradental cyst was first described only recently⁴⁷ and is probably a specific form of inflammatory collateral cyst. It is found only in association with partially erupted mandibular third molars (Figure 15), when it lies either buccally or distobuccally in the majority of cases.⁴⁷⁻⁴⁹ It is perhaps surprising that, although it has only recently been characterized, in Craig's series it accounted for 3 to 5% of all odontogenic cysts. Two thirds of them are diagnosed in the third decade and approximately three quarters in males. They are believed to be of inflammatory origin, all the patients giving a history of past recurrent pericoronitis. Occasionally, they are bilateral.

It is probable that the mandibular infected buccal cyst, first described by Stoneman and Worth in 1983,⁵⁰ is a variant of the paradental cyst. These lesions, however, have been reported predominantly in association with recently erupted mandibular first and second molars: they occur therefore in a younger age group.⁵⁰⁻⁵² When further data are available, it is probable that inflammatory collateral cysts and paradental cysts will be categorized together, possibly as inflammatory paradental cysts.⁵³

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