



REVIEW ARTICLE

RADICULAR CYSTS AND TREATMENT CONCEPTS

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ABSTRACT

The maxillofacial region is affected by a greater number of cysts than any other part of the body. Periapical radiolucencies are commonly associated with non vital teeth. Radicular cysts are the most common odontogenic cystic lesions of inflammatory origin. It is a true cyst as the lesion consists of a pathologic cavity lined by epithelium and is often fluid filled. This condition is usually asymptomatic but can result in slow growth tumefaction in the affected region. Cysts can be managed surgically or non-surgically depending on the site and size of the cyst. The aim of this review is to highlight the epidemiology, pathogenesis, radiology, clinical and histopathologic features of radicular cyst and laying emphasis on the treatment options of the cyst.

INTRODUCTION

In 1974, Kramer defined a cyst as a pathological cavity containing a fluid, semi-fluid or gaseous content that is not created by the accumulation of pus and is frequently but not always lined by an epithelium. A radicular cyst is defined as a cyst arising from the epithelial residues in the periodontal ligament known as the cell rests of Malassez, as a consequence of an inflammatory reaction, usually following the death of the dental pulp (1). A chronic periapical granuloma generally precedes a radicular cyst. Radicular cysts are the most common of all odontogenic cystic lesions of inflammatory origin affecting the jaws. They are found most commonly at the apices of the involved teeth. However they may also be found on the lateral aspect of the roots of the involved teeth in relation to the lateral accessory root canals. Most of the radicular cysts are asymptomatic and are discovered only when intraoral periapical radiographs of teeth with non-vital pulps are taken. Patients often complain of slowly enlarging swellings. Radiographically most radicular cysts appear as round or pear shaped unilocular radiolucent lesions in the periapical region of the affected tooth. The cyst may have the tendency to displace adjacent teeth or cause mild root resorption. When a radicular cyst remains behind in the jaw after the removal of the offending tooth, it is referred to as a residual cyst. They are most commonly associated with the permanent dentition and are rare in the primary teeth. Radicular cysts are otherwise also called as periapical cyst, apical periodontal cyst, dental cyst or root end cyst.

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Epidemiology

Radicular cyst is the most common cystic lesion of the jaw comprising approximately 52 to 68% of all jaw cystic lesions. The prevalence of radicular cysts is only about 15% of all apical periodontal lesions. Large number of cases are found in the 3rd to 5th decades of life after which there is a gradual decline. It is more common in males comprising about 58% & in females comprising about 42%. White patients are involved with a frequency of about twice that of Black patients. Hence it has a male predilection and more common in the white race. It occurs with a frequency of 60% in Maxilla (Kahn and Michael, 2001). Though it may occur in all tooth bearing areas of both the jaws, preferably it occurs in the anterior region of maxilla. Upper lateral Incisors and dens in dente are usually the affected teeth (Del Balso, 1995). It occurs most commonly at the apices of offending teeth. They may however also be found in relation to the lateral accessory root canals of the involved teeth.

Classification

Radicular cysts are classified as (1):

- **Periapical Cyst:** These are the radicular cysts which are seen at root apex of the offending teeth.
- **Lateral Radicular Cyst:-** These are the radicular cysts which are seen at the opening of lateral accessory root canals of offending teeth.
- **Residual Cyst:-** These are the radicular cysts which remain behind in the bone even after the extraction of offending tooth.

Pathogenesis

In 1972, Valdehaug described in detail that radicular cysts develop in response to an inflammatory stimulus. This inflammatory response occurs in three stages (Del Balso, 1995) (Harris, 1974).

Initial stage: Inflammation in the periapical region of a non-vital tooth leads to the proliferation of epithelial cells, which originate from the epithelial cell rests of Malassez (Harris and Toller 1975). However in some cases, epithelial lining may be derived from,

- Respiratory epithelium of the Maxillary sinus when the periapical lesion communicates with sinus wall.
- Oral epithelium from Fistulous tract.
- Oral epithelium proliferating apically from Periodontal pocket.

The mechanism of stimulation of epithelial cells to proliferate is not clear. It is assumed to be due to an inflammation in periapical granuloma or some products of dead pulp may initiate the process and at the same time it evokes an inflammatory reaction. There is also evidence of local changes in the supporting connective tissue which may be responsible for activating the cell rests of Malassez. One theory states that inflammations in the apical region of non-vital teeth or in periapical granulomas are caused by bacterial endotoxins. Endotoxins are known to have various biological functions. They serve as mitogens for epithelial cells and as a stimuli for cytokine production. Cytokines are produced by activated cells of the immune system and have a specific range of functions. Some of the most important cytokines include interleukin-1 (IL-1), interleukin-6 (IL-6), transforming growth factor-beta (TGF-beta), platelet-derived growth factor (PDGF), and tumor necrosis factor (TNF).

Cyst development stage: The proliferative epithelial strands serve as a scaffold for cyst wall development. This generally occurs due to simultaneous decomposition of epithelial and granulation tissue and convergence of multiple cavities, with subsequent epithelialisation (simultaneous intra- and extra-epithelial cavity formation).

There are two theories regarding it which are as follows:- (Del Balso, 1995)(4)(Harris, 1974)

- Most widely accepted theory suggests that initial reaction leading to cyst formation is a proliferation of epithelial rests of Malassez in the periapical region involved by the granuloma. This proliferation continues with the epithelial mass increasing in size by rapid division of the cells in the periphery corresponding to the basal layer of surface epithelium. The cells of the central portion of the epithelial mass fail to obtain sufficient nutrition in comparison with basal layer due to which they become separated further and further, and eventually degenerate, become necrotic and liquify. This creates an epithelium lined cavity filled with fluid.
- The other theory suggests that a cyst may form through proliferation of epithelium in order to line a pre-existing cavity formed by focal necrosis and degeneration of connective tissue in periapical granuloma. However, the

presence of epithelium or epithelial proliferation near an area of necrosis is not common. This theory is not widely accepted.

Cyst growth stage: Previous studies provided evidence that osmosis makes contribution to increase in size of cyst (Harris, 1974). Investigators found that fluids of Radicular cysts have Gamma Globulin level high by almost more than half of patient's own serum. Due to the decomposition of epithelial cells and leukocytes and the accumulation of plasma exudates, the osmolality of the cyst fluid increases and becomes higher than that of the serum. As a result, hydrostatic internal pressure becomes greater than capillary pressure. Tissue fluid therefore diffuses into the cyst, making it increase in size. Thus plasma protein exudate & hyaluronic acid as well as products of epithelial cell breakdown contribute to high osmotic pressure of cystic fluid on cyst walls which causes resorption of bone by osteolysis and enlargement of cyst.

Clinical presentation

Most of the radicular cysts are asymptomatic and are discovered when periapical radiographs are taken of teeth with non-vital pulp. Patient often complains of slowly enlarging swellings. At first the enlargement is bony hard but as the cyst increases in size, the covering bone becomes very thin despite subperiosteal bone deposition and the swelling then exhibits a characteristic 'springiness'. Only when the cyst has completely eroded the bone by osteolysis, there will be fluctuation. In the maxilla there may be buccal or palatal enlargement whereas in the mandible it is usually labial or buccal and only rarely lingual. Pain and infection are other clinical features of some radicular cysts. It is often said that radicular cysts are painless unless they get infected. Some patients with these lesions, however, complain of pain although no evidence of infection is found clinically and no evidence of acute inflammation is seen histologically after the cyst has been removed. Likewise, some patients have clinically infected and histologically inflamed cysts which are not painful. A sine qua non for the diagnosis of a radicular cyst is the related presence of a tooth with a non-vital pulp. Occasionally, a sinus may lead from the cyst cavity to the oral mucosa. Quite often, more than one radicular cysts may be found in one patient. Radicular cysts arising from deciduous tooth are very rare. Deciduous tooth which had been treated endodontically with materials containing Formecresol, which in combination with tissue protein is antigenic and may elicit a humoral or cell-mediated response like rapid buccal expansion of the cyst. Rarely, parasthesia or pathologic jaw bone fracture may occur (Narula *et al.*, 2011) (Latoo *et al.*, 2009).

Radiological features

It is virtually impossible to differentiate a granuloma from a cyst radiographically. If the lesion is large it is more likely to be a cyst. Radiographically both granuloma and cyst appear radiolucent, associated with the apex of non vital tooth. Intra Oral Peri Apical Radiographs (IOPA) are common radiographs which are used as a diagnostic aid. Radiographically, radicular cysts are round or ovoid radiolucent areas surrounded by a thin radio-opaque margin, which extends from the lamina dura of the involved tooth. In infected or rapidly enlarging cysts, radio-opaque margins may not be seen. Root resorption is rare but may sometimes occur. The periphery of the cyst usually has a

well defined cortical border. If the cyst is secondarily infected, the inflammatory reaction of the surrounding bone may result in loss of cortex or alteration of cortex into a more sclerotic border. The outline of the radicular cyst is curved or circular usually unless it is influenced by surrounding structures such as cortical boundaries. In most cases, internal structure of radicular cyst is radiolucent. Occasionally, dystrophic calcification may develop in long standing cysts which appear as sparsely distributed, small particulate radio-opacities. If a radicular cyst is large, displacement and resorption of roots of adjacent teeth may occur. The resorption pattern may have a curved outline. In rare cases, the cyst may resorb the roots of related non-vital teeth. The cyst may invaginate the maxillary antrum, but there should be evidence of a cortical boundary between the contents of cyst and internal structure of antrum. The outer cortical plates of maxilla and mandible may expand in a curved or circular shape. Cyst may sometimes displace the inferior alveolar nerve canal in the mandible in an inferior direction (Harshitha *et al.*, 2015).

Pathological features

Gross features: The gross specimen may be a spherical or an ovoid intact cystic mass, but often it is irregular and collapsed. The walls of the cyst vary from extremely thin to a thickness of about 5 mm. The inner surface may be smooth or corrugated. Yellow mural nodules of cholesterol may project in to the cavity. The fluid contents are usually brown resulting from the breakdown of blood and when cholesterol crystals are present they impart a shimmering gold or straw colour. The length of the cholesterol crystals vary from 0.2-1.3 mm. They appear shimmery in transmitted light and microscopically appear as rhomboidal crystals. They are needle shaped in H&E staining and express foreign body giant cell reaction. Histopathological features (Latoo *et al.*, 2009) (Harshitha *et al.*, 2015): Histopathological studies show an epithelial lining, Rushton's hyaline bodies, cholesterol clefts, fibrous capsule, inflammatory cells, mast cells, remnants of odontogenic epithelium and occasionally satellite microcysts. Almost all radicular cysts are histopathologically lined entirely or in part by non-keratinized stratified squamous epithelium and the thickness ranges from 1 to 50 cell layers.

The only exception to this is in those rare cases of periapical lesions of Maxillary Sinus. In such cases, cyst is then lined with a pseudo stratified ciliated columnar epithelium or respiratory type of epithelium. Ortho or para keratinised linings are very rarely seen in radicular cysts. Secretory cells or ciliated cells are frequently found in the epithelial lining, generally in the maxilla. In approximately 10% of cases of radicular cysts, Rushton's Hyaline bodies are found in the epithelial linings. Very rarely they are found in the fibrous capsule. The hyaline bodies are tiny linear or arc shaped bodies which are amorphous in structure, eosinophilic in reaction and brittle in nature. Deposition of cholesterol crystals are found in many radicular cysts, slow but considerable amount of cholesterol accumulation could occur through degeneration and disintegration of lymphocytes, plasma cells and foamy macrophages taking part in the inflammatory process, with consequent release of cholesterol from their walls. Fibrous capsule of radicular cyst is composed of mainly condensed parallel bundles of collagen fibres peripherally and a loose connective tissue adjacent to epithelial lining. Acute

inflammatory cells are present when epithelium is proliferating. Chronic inflammatory cells are present in connective tissue immediately adjacent to epithelium. Mast cells, remnants of odontogenic epithelium & occasionally satellite micro cysts are also present. Some cysts are markedly vascularised. Various kinds of calcifications, mainly diffuse, are also present.

Differential diagnosis

- Dense bone Island
- Condensing Osteitis
- Periapical Granuloma
- Traumatic Bone Cyst
- Periapical Scar
- Periapical Cemental Dysplasia
- Periapical Surgical Defect
- Globulomaxillary Cyst
- Pumice Cyst
- Aneurysmal Bone Cyst
- Mandibular Infected Buccal Cyst
- Periapical Cemento-osseous dysplasia

Treatment prerequisite

The following complications may arise if radicular cysts are not treated properly and at the right time (Shear and Speight, 2007).

- **Carcinomatous/Neoplastic Changes:-**
Squamous Cell Carcinoma or Epidermoid Carcinoma may occasionally arise from epithelial lining of Radicular Cyst.
- **Pathologic Jaw Fracture:-**
If a Cyst has completely eroded the bone, especially if it is present in the posterior region which is very rare in the case of Radicular Cyst, it may cause pathologic jaw bone fracture.
- **Secondary Infection:-**
Cyst may get secondarily infected and create further complications.

Treatment

The choice of treatment may be determined by various factors such as extent of the lesion, its relation with noble structures, evolution, origin, clinical characteristics of the lesion, co-operation and systemic condition of the patient. Treatment options for radicular cysts can be conventional nonsurgical root canal treatment when the lesion is localized or surgical treatment like enucleation, marsupialization or decompression when the lesion is large (Sakkas and Shoen, 2007) (Shear, 1992) (Shear and Speigh, 2007).

Endodontic Treatment

Peripheral lesions including radicular cysts are eliminated once the causative agents are removed. Majority of radicular cysts can undergo resolutions following Root Canal Treatment and do not require surgical intervention. It is suggested that insertion of a dental file or other root canal instrument beyond the apical foramen for about 1-2mm produces a transitory acute inflammation which may destroy epithelial lining of radicular

cyst and convert it into a granuloma thus leading to its resolutions.

Surgical Treatment

Enucleation

By enucleation, removal of a cystic lesion is successfully achieved. It basically involves the shelling-out of the entire cystic lesion without the chance of rupture. Enucleation of cysts should be performed with utmost care, in an attempt to remove the cyst in one piece avoiding the chance of fragmentation, which reduces the possibility of recurrence by increasing the likelihood of total removal.

Indications

The treatment of choice for removal of cyst of the jaws by enucleation should be used for those cysts that can be safely removed without unduly sacrificing adjacent structures.

Advantages

- The main advantage of enucleation is that pathologic examination of the entire cyst can be undertaken.
- Another advantage is that the initial excisional biopsy (i.e., enucleation) has also appropriately treated the lesion.
- The patient does not have to care for a marsupial cavity with constant irrigations.
- Once the mucoperiosteal access flap has healed, the patient is no longer bothered by the cystic cavity.

Disadvantages

If any of the conditions outlined under the section on indications for marsupialization exist, enucleation may be disadvantageous. For example, normal tissue may be jeopardised, fracture of the jaw could occur, devitalization of teeth could result, or associated impacted teeth that the clinician may wish to save could be removed.

Technique

- **Special considerations:** The use of antibiotics is unnecessary unless the cyst is large or the patient's health condition warrants it.
- Because it is impossible to determine whether a periapical radiolucency is a cyst or a granuloma, removal at the time of the tooth extraction is recommended.
- When extracting teeth with periapical radiolucencies, enucleation via the tooth socket can be readily accomplished using curettes when the cyst is small.
- Caution is used in teeth whose apices are close to important anatomic structures, such as the inferior alveolar neurovascular bundle or the maxillary sinus, because the bone apical to the lesion may be very thin or nonexistent.
- With large cysts, a mucoperiosteal flap may be reflected and access to the cyst is obtained through the labial plate of the bone, which leaves the alveolar crest intact to ensure adequate bone height after healing.

- Once access to a cyst has been achieved through the use of an osseous window, the dentist should begin to enucleate the cyst.
- Care must be taken to avoid tearing the cyst and allowing the cystic contents to escape, because margins' of the cyst are easier to define if the cystic wall is intact.
- Furthermore the cyst separates more readily from the bony cavity when the intracystic pressure is maintained.
- In large cysts or cysts proximal to neurovascular structures, nerves and vessels are usually found pushed to one side of the cavity by the slowly expanding cyst and should be avoided or handled as atraumatically and as little as possible.
- Once the cyst has been removed, the bony cavity should be inspected for remnants of tissue.
- Irrigating and drying the cavity with gauze will aid in visualizing the entire bony cavity.
- Residual tissue is removed with curettes.
- The bony edges of the defect should be smoothed with a file before closure.
- After enucleation, watertight primary closure should be obtained with appropriately positioned sutures.
- The bony cavity fills with a blood clot, which then organises over time.
- Radiographic evidence of bone fill will take 6 to 12 months.
- Jaws that have been expanded by cysts slowly remodel to a more normal contour.

Marsupialization

Marsupialization, decompression, and the Partsch operation all refer to creating a surgical window in the wall of the cyst, evacuating the contents of the cyst, and maintaining continuity between the cyst and the oral cavity, maxillary sinus, or nasal cavity. The only portion of the cyst that is removed is the piece removed to produce the window. The remaining cystic lining is left in situ. This process decreases intracystic pressure and promotes shrinkage of the cyst and bone fill.

Indications

- Amount of tissue injury.
- Assistance in eruption of teeth
- Surgical access.
- Extent of surgery.
- Size of cyst

Advantages

- The main advantage of marsupialization is that it is a simple procedure to perform.
- It may after spare vital structures from damage should immediate enucleation be attempted.

Disadvantages

- The major disadvantage of marsupialization is that pathologic tissue is left in situ, without thorough histologic examination.
- Another disadvantage is that the patient is inconvenienced in several respects.

- The cystic cavity must be kept clean to prevent infection, because the cavity frequently traps food debris.
- In most instances this means that the patient must irrigate the cavity several times every day with a syringe.

Technique

- Prophylactic systemic antibiotics are not usually indicated in marsupialization.
- After anaesthetisation of the area, the cyst is aspirated.
- If the aspirate confirms the presumptive diagnosis of a cyst, the marsupialization procedure may proceed.
- The initial incision is usually circular or elliptic and creates a large (1 cm or larger) window into the cystic cavity.
- If the bone has been expanded and thinned by the cyst, the initial incision may extend through the bone into the cystic cavity.
- If the overlying bone is thick, an osseous window is removed carefully with burs and rongeurs.
- The cyst is then incised to remove a window of the lining, which is submitted for pathologic examination.
- The contents of the cyst are evacuated, and, if possible, visual examination of the residual lining of the cyst is undertaken.
- Irrigation of the cyst removes any residual fragments of debris.
- Areas of ulceration or thickening of the cystic wall should alert the clinician to the possibility of dysplastic or neoplastic changes in the wall of the cyst.
- In this instance enucleation of the entire cyst or incisional biopsy of the suspicious area or areas should be undertaken.
- If the cystic lining is thick enough and if access permits, the perimeter of the cystic wall around the window can be sutured to the oral mucosa.
- Otherwise the cavity should be packed with strip gauze impregnated with tincture of benzoin or an antibiotic ointment and left in place for 10 to 14 days to prevent the oral mucosa from healing over the cystic window.

Conclusion

Marsupialization is rarely used as the sole form of treatment for cysts. In most instances enucleation is done after marsupialization.

The possibility of complete healing and conservation of vital structures using either aggressive or minimal invasive approach is the best treatment option. Despite the disadvantages of the marsupialization technique, and considering this together with the unnecessary loss of bone and vital teeth obtained with the enucleation, the marsupialization revealed to be more advantageous in many respects according to recent studies and is therefore considered a worthwhile procedure for cases in which the large radiolucent area involves the ant rum and tooth germ buds.

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