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# RADIOGRAPHIC CHARACTERISTICS OF PERIAPICAL LESIONS SUGGESTIVE OF APICAL GRANULOMAS AND THEIR ASSOCIATION WITH ENDODONTIC TREATMENT STATUS

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**Abstract**

Apical granulomas represent common chronic inflammatory periapical lesions of endodontic origin, typically developing as a host immune response to persistent intraradicular infection. The present retrospective observational study aimed to describe the radiographic characteristics of apical granulomas in a series of 30 retroalveolar periapical radiographs. Lesions were evaluated according to patient sex distribution, dominant radiographic appearance, lesion size, and periapical extension, as well as their association with endodontic treatment status. Female patients accounted for 60% of the cases, indicating a moderate predominance. The majority of lesions presented as well-defined periapical radiolucencies (80%), significantly exceeding diffuse radiographic patterns ($p < 0.001$). Lesion dimensions varied, with moderate lesions (3-5 mm) representing the most frequent category (40%), while 26.7% exceeded 5 mm, suggesting advanced osteolytic extension. A substantial proportion of cases were associated with incomplete root canal therapy or inadequate obturation, supporting the role of insufficient apical sealing in sustaining chronic periapical inflammation. These findings emphasize the importance of high-quality endodontic treatment and careful radiographic monitoring in the management of apical inflammatory pathology.

**Keywords**: apical granuloma, periapical radiolucency, chronic apical periodontitis, endodontic treatment quality, retroalveolar radiography.

## Introduction

Apical granulomas represent one of the most frequent chronic inflammatory periapical lesions of endodontic origin, developing as a localized immune response to persistent microbial infection within the root canal system. Clinically, these lesions are often asymptomatic and are



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commonly detected incidentally during routine radiographic examinations. Their relevance lies not only in the prevalence within dental practice but also in their potential to progress toward more extensive periapical destruction when the underlying endodontic pathology remains untreated or inadequately managed [1].

The diagnostic approach to apical lesions is primarily based on intraoral periapical radiography, which remains a widely accessible tool for identifying apical radiotransparencies. However, conventional radiographs provide limited information regarding the true extent and biological nature of periapical pathology, prompting the increasing use of complementary modalities such as ultrasonography and cone-beam computed tomography for improved differential diagnosis [2]. In addition, clinicians must consider that a variety of non-endodontic and nonmalignant entities may mimic inflammatory periapical lesions radiographically, reinforcing the importance of careful diagnostic interpretation [3].

Population-based clinical and radiological investigations have shown that apical granulomas and periapical cysts constitute the majority of inflammatory jaw lesions diagnosed in the periapical region. Large series analyses confirm the predominance of these lesions among radiolucent findings associated with root apices [4]. Histopathological surveys further support that most periapical radiotransparencies correspond to granulomatous inflammatory tissue rather than true cystic lesions, although the distinction cannot be reliably achieved through imaging alone [5]. Persistent periapical radiotransparencies following root canal therapy are frequently linked to unresolved intraradicular infection or inadequate treatment outcomes [6].

Long-term retrospective studies have emphasized the chronic inflammatory character of radiolucent periapical lesions, demonstrating stable prevalence patterns across decades and highlighting their continued clinical relevance [7]. Importantly, discrepancies between clinical or radiographic impressions and histopathological diagnoses have been documented, suggesting that radiographic diagnosis should be regarded as presumptive in the absence of tissue confirmation [8].

From a pathobiological perspective, chronic apical inflammation involves complex immunological interactions that may stimulate epithelial proliferation and contribute to cyst formation in selected cases [9]. Molecular investigations have identified the expression of matrix metalloproteinases, such as MMP-13, in periapical lesions, implicating their role in extracellular matrix degradation and periapical bone resorption [10]. Contemporary reviews of radicular cyst biology further describe the influence of inflammatory mediators on epithelial lining behavior and lesion progression [11]. Cytokine expression within cystic tissue has also been demonstrated, supporting a sustained inflammatory microenvironment capable of modulating periapical lesion dynamics over time [12].

Through our study, we aim to describe the radiographic characteristics of apical granulomas in a retrospective series of 30 cases, focusing on the morphology of the lesion, its size, and association with the status of endodontic treatment.

## Materials and Methods

### *Study design and sample selection*

We conducted an observational descriptive radiographic study on a sample of 30 retroalveolar periapical radiographs, which showed imaging features suggestive of apical granulomas. X-rays were collected from routine clinical examinations performed on patients attending dental care for endodontic or restorative evaluation. Inclusion criteria consisted of the presence of a periapical radiolucent lesion associated with the root tip of a tooth, presenting clinical or radiographic evidence of pulp necrosis, previous endodontic treatment, or inadequate root canal filling. X-rays with insufficient diagnostic quality or unclear apical anatomy were excluded.

### *Radiographic evaluation*

We evaluated all lesions using standard periapical radiographic criteria. Apical granulomas were identified by a circumscribed radiolucency in the periapical region, compatible with a chronic periapical inflammatory pathology.

Each case was evaluated as:

- Patient sex distribution (female/male)
- Dominant radiographic appearance, classified as well-defined or diffuse radiolucency
- Lesion size and periapical extension, categorized according to maximum diameter into:
  - small (<3 mm)
  - moderate (3-5 mm)
  - large (>5 mm)
- Endodontic status of the involved tooth, recorded as incomplete treatment, poor/short obturation, untreated necrotic tooth, or adequately treated canal

### *Data analysis and statistical methods*

We applied descriptive statistics to summarize categorical variables as absolute frequencies and percentages. We performed a chi-square match test to assess the prevalence of well-defined radiographic lesions compared to diffuse models. The statistical significance was set at $p < 0.05$. Data processing and statistical testing were conducted using GraphPad Prism, version 10.2.0 (GraphPad Software, Boston, MA, USA).

## Results

A total of 30 radiographically diagnosed apical granuloma cases were included in the present analysis. The evaluated lesions were assessed in terms of patient sex distribution, dominant radiographic appearance, lesion size, and periapical extension, as well as their association with the endodontic status of the affected teeth. The main findings are summarized in Tables 1-4. Table 1 summarizes the sex distribution of patients diagnosed radiographically

with apical granulomas in the evaluated sample (n = 30), with a moderate predominance among females.

**Table 1.** Sex distribution of patients presenting apical granulomas (n = 30)

| Sex | Number of cases (n) | Percentage (%) |
|---|---|---|
| Female | 18 | 60% |
| Male | 12 | 40% |
| Total | 30 | 100% |

Figure 1. Percentage distribution of apical granuloma cases according to patient sex, showing a moderate predominance among female patients.

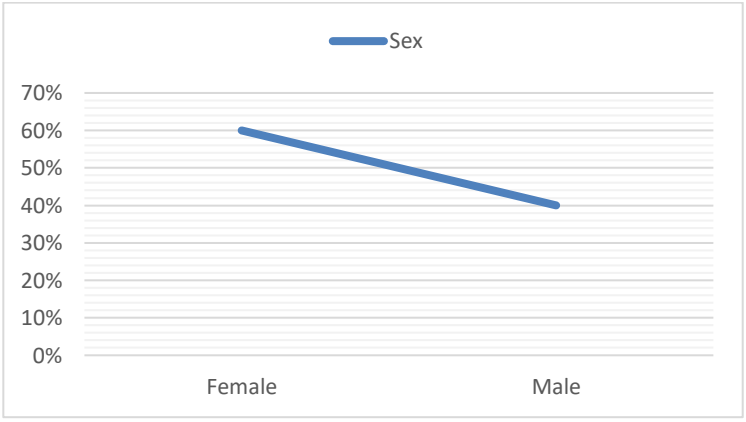


**Figure 1.** Sex distribution of apical granuloma cases

Table 2 summarizes the predominant radiographic patterns observed in apical granuloma lesions. Well-defined periapical radiotransparencies represented the most frequent imaging appearance (80.0%) in the evaluated sample, whereas diffuse or poorly demarcated lesions were less common. A chi-square goodness-of-fit test confirmed the significant predominance of circumscribed radiotransparencies over diffuse patterns ($p < 0.001$), supporting their role as the characteristic radiographic presentation of chronic apical inflammatory pathology.

**Table 2.** Radiographic pattern distribution of apical granulomas (n = 30)

| **Radiographic pattern** | **Cases (n)** | **Percentage (%)** | **Statistical test** | **p-value** |
|---|---|---|---|---|
| **Well-defined periapical radiolucency** | 24 | 80.0 | $\chi^2$ goodness-of-fit | < 0.001* |
| **Diffuse/poorly defined radiolucency** | 6 | 20.0 | - | - |

Table 3 presents the distribution of apical granuloma lesions according to radiographic size and periapical extension. Lesions were classified into small (<3 mm), moderate (3-5 mm), and large (>5 mm) categories. Moderate lesions represented the most frequent finding, while a considerable proportion exceeded 5 mm, reflecting advanced periapical bone resorption. This variability highlights different stages of chronic inflammatory progression within the evaluated radiographic cohort.

**Table 3.** Lesion size distribution and periapical extension of apical granulomas (n = 30)

| Lesion size category | Diameter range (mm) | Cases (n) | Percentage (%) | Clinical interpretation |
|---|---|---|---|---|
| **Small lesions** | < 3 mm | 10 | 33.3 | * |
| **Moderate lesions** | 3-5 mm | 12 | 40.0 | ** |
| **Large lesions** | > 5 mm | 8 | 26.7 | *** |

* Early-stage periapical rarefaction with limited bone involvement. ** Established chronic granulomatous inflammation with moderate osteolytic extension. *** Advanced periapical bone resorption, suggesting long-standing inflammatory evolution.

Table 4 summarizes the association between radiographically diagnosed apical granulomas and the endodontic status of the affected teeth. A substantial proportion of cases were linked to incomplete treatment or inadequate obturation, supporting the role of persistent intraradicular infection in maintaining chronic apical inflammation. These findings are consistent with published data reporting significantly higher prevalence of periapical lesions in teeth with poor-quality root canal fillings and compromised apical sealing.

**Table 4.** Association between apical granulomas and endodontic status (n = 30)

| Endodontic status | Cases (n) | Percentage (%) |
|---|---|---|
| **Incomplete root canal treatment** | 12 | 40.0 |
| **Poor/short root canal obturation** | 10 | 33.3 |
| **Untreated necrotic teeth** | 6 | 20.0 |
| **Adequate endodontic treatment** | 2 | 6.7 |

## Discussions

Through this retrospective radiographic analysis, we describe the morphological and dimensional characteristics of 30 cases of apical granulomas detected on retroalveolar periapical radiographs. Apical granulomas are one of the most common manifestations of chronic apical periodontitis, developing as a localized immune response to persistent intraradicular infection. Their clinical relevance derives from their often-asymptomatic evolution and ability to induce progressive periapical bone destruction when not treated or insufficiently managed [1,6].

Radiographic evaluation remains the primary diagnostic approach in routine dental practice; however, conventional periapical radiographs provide only a two-dimensional

approximation of lesion architecture. Advanced imaging techniques, including ultrasonography and cone-beam computed tomography, have demonstrated superior diagnostic value in differentiating granulomatous lesions from cystic formations, particularly in cases with extensive osteolysis [2,4]. Moreover, clinicians must consider that a wide spectrum of non-endodontic conditions may mimic inflammatory apical radiotransparencies, emphasizing the importance of careful differential diagnosis [3].

In our study, well-defined periapical radio transparencies constituted the predominant radiographic pattern, significantly exceeding diffuse or poorly demarcated aspects. Similar morphological distributions have been reported in large clinical-radiological series of apical granulomas and periapical cysts, confirming that circumscribed radio transparencies represent the most typical imaging presentation of chronic apical inflammatory pathology [4,5]. Retrospective analyses further support that inflammatory lesions remain the most common cause of radiolucent jaw findings located in the periapical region [7].

Lesion size variability was another important observation, with a subset of cases exceeding 5 mm in diameter, suggesting advanced stages of periapical osteolytic extension. Although lesion diameter has been associated with chronicity, radiographic size alone does not allow reliable differentiation between granulomas and cystic lesions. Histopathological investigations have repeatedly demonstrated substantial overlap between these entities, reinforcing that imaging findings remain presumptive without tissue confirmation [6,8].

A clinically significant finding was the strong association between apical granulomas and inadequate endodontic status. The majority of lesions were detected in teeth presenting incomplete root canal treatment or poor-quality obturation, supporting the role of persistent microbial contamination and insufficient apical sealing in maintaining chronic periapical inflammation. This is consistent with reports highlighting discrepancies between clinical-radiographic impressions and definitive histopathological diagnoses in periapical lesions [8].

From a biological perspective, chronic apical lesions constitute an active immunoinflammatory microenvironment. Immunological models suggest that epithelial proliferation and cystic transformation may be sustained by persistent inflammatory mediators even following root canal therapy [9,11]. In addition, molecular studies have identified matrix metalloproteinases such as MMP-13 in periapical lesions, contributing to extracellular matrix degradation and apical bone resorption [10]. Cytokine expression within cystic tissues further underscores the role of sustained inflammatory signaling in lesion progression [12].

Several limitations must be recognized. Our study was based exclusively on periapical radiography, which restricts three-dimensional evaluation and does not provide histopathological confirmation. In addition, the relatively small sample size limits the generalizability of the results. However, this analysis of ours provides clinically relevant descriptive data on dominant radiographic patterns, lesion extension, and the relationship between apical granulomas and the quality of endodontic treatment. Apical granulomas most frequently present as well-circumscribed periapical radiotransparencies of variable size, commonly associated with suboptimal endodontic conditions. These findings reinforce the importance of high-quality root canal therapy and appropriate radiographic follow-up in the management of chronic apical inflammatory pathology [4,6].

## Conclusions

Apical granulomas most commonly present as well-defined, variable-sized, and variable-extent periapical radiolucencies. In the present radiographic series, the majority of lesions were associated with inadequate endodontic treatment, emphasizing the role of persistent intraradicular infection in sustaining chronic apical inflammation. These findings highlight the importance of high-quality root canal therapy and systematic radiographic follow-up for the prevention and management of periapical inflammatory pathology. Further studies using three-dimensional imaging and histopathological correlation are warranted to characterize lesion evolution and treatment outcomes better better.

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