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Using Periapical Radiography to Differentiate Periapical Granuloma and Radicular Cysts

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Abstract

Background: The distinction between radicular cysts and apical granulomas is important in treatment decision.
Objectives: The current study aimed to differentiate these two lesions based on radiography images.
Patients and Methods: The material consisted of 138 radiographs obtained using Kodak E -speed, in patients aged 29 to 47, divided into two groups: 109 granulomas and 29 radicular cysts. Size of radiography images was measured; the tooth then was extracted and examined in pathologist lab. The results were analyzed by SPSS.15 and ROC curve was created to find cut-off point to differentiate periapical granuloma and radicular cysts.
Results: Average size of radiography in periapical granuloma was 7.4 mm and for a radicular cyst was 11.1 mm. Cut-off point was 8.2 mm and the area under curve (AUC) was 0.63. Also, the tests were 83% sensitive and 79% specific.
Conclusions: Based on 8.2 mm cut-off point could differentiate 83% periapical granulomas and 79% radicular cysts from radiography images.

Keywords: Periapical Granuloma, Radicular Cyst, Radiography

1. Background

The most prevalent oral lesions are periapical granuloma and radicular cysts (1). A periapical inflammatory lesion is the local response to pulp necrosis of the bone around the apex of the tooth or created in periodontal tissues destroyed by severe periodontal diseases. Apical inflammatory lesions may not show any change in bone radiography in full view. The first obvious change is a reduction in bone density, which often leads to an increase in the width of the periodontal ligament space at the apex and later involves wider area of bone. Periapical granuloma is one of the side effects of pulpitis that includes a large number of pathological radiolucencies. Radicular cysts are the second radiolucent lesion in the outbreak, which is a result of untreated periapical granulomas. Usually, periapical granuloma constitutes the majority of diagnoses of radiolucencies in root-end. In a report on 230 radiolucencies of teeth apex, 94% were related to periapical granulomas and only 6% to radicular cysts (2). Several studies are performed on radiographic differentiation of periapical granulomas and radicular cysts (3-11). Some of these studies try to show the difference between lesion sizes. But in this case there was not a certain report (1). Differentiation between periapical granulomas and radicular cysts is an important subject to decide on the treatment. Since the radiographic images cannot give an accurate picture of the environment, most of the relevant recognitions were done via the size of periapical lesions (3). Also, radiometric analysis of radiographic of periapical granuloma and radicular cysts are used to differentiate the two lesions; according to the current analysis, size of radiolucencies of periapical granulomas could differentiate these lesions (2). The study also determined that radicular cysts could be separated from periapical granulomas based on the high size of radicular cysts (more than 5.9 mm) (1).

2. Objectives

The current study aimed to differentiate periapical granuloma and radicular cysts performed by periapical radiographs.

3. Patients and Methods

3.1. Sample Size of Patients and Sample of Radiography Images

Sample size was selected according to the study by Shrout et al. (2) that α was 0.05, power at 80% and 2% difference. In this study, 138 samples were investigated; the samples were randomly selected using Rand List software. These 138 radiography images were selected out of the patients referred to the faculty of dentistry, department of oral and maxillofacial surgery of Tabriz University of Medical Science. The patients had radiolucent lesions in the root-end of the teeth and wanted to remove the teeth. After receiving the written consent of each patient, Kodak E-speed (Kodak Co., NY, USA) was used to take the periapical radiograph.

3.2. Radiographic Analysis

Radiolucencies range of root-end was traced by tracing paper. Lesion area included lucent along with 1 to 2 mm of surrounded bone. The diameter of each sample was measured by a scale ruler. When radiolucency was not circle and it was oval, the large-diameter of oval was considered as the size of lesion diameter. Receiver-operating characteristic (ROC) curve was constructed to determine cut-off point and differential size.

3.3. Histological Analysis

Tooth was luxated by special elevator and finally removed by special forceps. Lesion in root-end of tooth extracted by Allis clamp or surgical curette and transferred to pathology lab in a10% formalin. Based on histological studies, samples were categorized into two groups, first group was periapical granuloma and second group was considered as radicular cysts.

3.4. Data Analysis

Data were analyzed by descriptive statistics (mean ± SD). ROC curve was used to obtain the cut-off point and calculate the area under the curve. Statistical analysis was performed by SPSS.15. (IBM SPSS Statistics, IBM Corporation, Chicago, IL). Also, $P < 0.05$ was considered as the level of significance.

4. Results

Mean of age in the 138 patients was 33.9 years; in females the average was 33.4 years (29-45 years old) and in the males 35.1 years (30 - 47 years old) (Table 1). Results of the histopathology of lesions are shown in Table 2. According to the results, the average size of radiography in periapical granuloma was 7.4 mm with a minimum of 5.3 mm and a maximum size of 11 mm. In radicular cysts, the mean of size was 11.1 mm with a maximum and minimum of 12.5 mm and 6 mm, respectively. Mann-Whitney test showed that differences in the mean size of radiography in both lesions were statistically significant ($Z = 6.96$, $P < 0.01$). In other words, the size of radicular cysts was significantly higher than that of periapical granuloma (Table 3). ROC curves were determined the best cut-off point for periapical granulomas and radicular cysts (Figure 1, Table 4). According to Figure 1, the best cut-off point to differentiate periapical granuloma and radicular cyst was 8.2 mm that at this point the area under curve (AUC) was 0.63. Also, sensitivity and specificity were 83% and 79%, respectively. Therefore, the 8.2 mm cut-off point can correctly diagnose the 83% of periapical granuloma and 79% of radicular cysts.

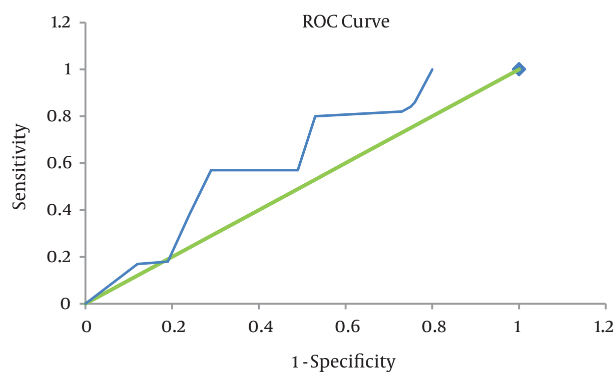

Figure 1. Receiver-Operating Characteristic Curve to Differentiate Periapical Granuloma and Radicular Cysts

5. Discussion

Cross–sectional studies are important in medical sciences. These studies could compare samples alone and the valuable results are used to improve the clinical treatment. Clinical diagnoses in periapical granuloma such as radicular cysts are low (12-15). Also, studies show that intraoral periapical radiographs are utilized for many years to determine the apical periodontitis (16). On the other hand, it was revealed that periapical lesions may only be observed on radiographs when periapical radiolucency is getting nearly 30% - 50% of mineral bone loss (17). Furthermore, different factors could impact on radiography detection of periapical lesions such as : surrounding bone density, X-ray angulations and contrast (18), position of tooth (19) and the three-dimensional figure of the lesion (20). Several histopathological studies are conducted on the radiolucent lesions of the oral cavity. However, there are no clinical methods to detect such lesions (2, 15). Therefore, most diagnoses and treatment plans were made based on the diagnoses of radiography images. Radiography images showed the 2D view of a 3D environment and could not prove the accuracy of diagnosis without intervention histopathology. The 2-D conventional radiography prepared admirable images for most dental radiography im-

Table 1. Frequency of Females and Males Involved in the Study

Gender	No. (%)	Minimum Age	Maximum Age	Mean ± SD
Female	96 (69.57)	29	45	33.4 ± 6.52
Male	42 (30.43)	30	47	35.1 ± 5.38
Total	138 (100)	29	47	33.91 ± 6.28

Table 2. Frequency of Periapical Granulomas and Radicular Cysts in Radiographic Images

	No.	Maximum	Minimum	Mean ± SD
PG	109	11	3.5	7.46 ± 2.07
RC	29	12.5	6	11.10 ± 1.37

Abbreviations: RC, Radicular Cysts; PG, Periapical Granulomas.

Table 3. Mann-Whitney Test for Comparison of Radiography Images in Periapical Granuloma and Radicular Cysts

	Value
Mann-Whitney U	252.000
Wilcoxon W	6247.000
Z	-6.968
P Value	0.0

Table 4. Point Area Under Receiver-Operating Characteristic Curve to Differentiate Periapical Granuloma and Radicular Cysts

95% Confidence Level (Minimum – Maximum)	Deviation	P Value	Area
0.634 - 0.121	0.031	0.397	0.872

ages. The periapical radiographs provided data of teeth and the adjacent tissues. It is mostly used to assess pulp and root canal morphology, alveolar bone placed in the inter-dental section, recognition of periapical pathology and crown/root breaks. In addition, most dentists believed that the radiography images were not able to correctly distinguish radicular cysts of periapical granuloma. To correctly diagnose these lesions, computed tomography (CT) scan was used to differentiate the density cavity in tissue of radicular cysts and inflammation in periapical granuloma (21).

In the current study, 69.6% of the patients were female and 30.4% male. The difference between the genders could not be the criteria to diagnose lesions and the patients were randomly selected. But in this study females had more lesions rather than males. Becconsall et al. reported different results that periapical granuloma was more common in females and radicular cyst was more common in males than females (15). The means of age in females and males were 33.4 and 35.1 years, respectively. Also, the age range in females was 29 to 45 years and in the males 30 to 47 years; it could be concluded that females were infected in younger age than males. But younger males just had one of the lesions. Histopathological analysis exhibited that out of 138 samples, 109 belonged to periapical granuloma group and 29 to radicular cysts group. These results suggested that the incidence of periapical granuloma was higher than that of radicular cysts. This finding was the same as those of other studies (15). This result could be used to treat periapical granuloma legions. Additionally, radiography size of periapical granulomas was 7.4 mm (minimum was 3.5 mm and maximum 11 mm). This result demonstrated that the lesion size of 7.45 mm could be related to periapical granuloma and lesions higher than 11 mm were attributed to radicular cysts. Mann-Whitney test also confirmed this fact, since it indicated significant differences between the radiography sizes of the lesions. Also, ROC curve determined the precise cut-off point and the differentiation point was 8.2 mm. This cut-off point could distinguish 83% of periapical granuloma and 79% of radicular cysts, which is matched with Michael's findings (12). Zain et al. investigated radiographic structures of periapical cysts and granuloma. Their results exhibited that a regular (circular or semi-circular) radiographic outline was likely to be a periapical cyst while an irregular radiographic outline was not indicative of either a cyst or a granuloma (22). Stuart C. White et al. found that the radiographic density of radicular cyst was more than that of apical granuloma (1). Also, another study expressed radiography images of an inflammatory lesion in the jaw (23). Rozylo-Kalinowska (24), by analyzing radiography images, showed that radicular cysts had more density than periapical granuloma, but again radiographic density in clinic cannot be relied on for proper evaluation of the lesion because of the vision error. Therefore, besides radiographic density, other features such as radiography size of lesions should be evaluated (24).

Regarding the advances in dentistry, there is a need for more specific diagnostic tools, generally imaging methods. A variety of equipment is established in new dentistry, ranging from the simple intra-oral periapical X-rays to progressive imaging techniques such as computed tomography, cone beam computed tomography, magnetic resonance imaging and ultrasound. Shifting from analogue to digital radiography has not only made the process simpler and faster but also made image storage, handling (brightness/contrast, image cropping, etc.) and retrieval easier. The three-dimensional imaging provided the complex structures more available for analysis and early and precise diagnosis of deep seated lesions. Also, recent advances in imaging technology and their usage in diverse disciplines of dentistry were explained (25). Among the technics ultrasound is a reliable distinguished technique to determine the pathological nature (granuloma vs. cysts) of periapical lesions (26). It is used to conduct fine-needle aspiration, dimension of tongue cancer thickness, and identification of metastasis to cervical lymph nodes.

Also, another technique named cone beam computed tomography (CBCT) can diagnose cyst from granulomas by determining the density of the contrasted images of the periapical lesion (16). Another study found that CBCT distinguished 62% more periapical lesions on different roots when compared with periapical X-ray studies. Vertical root fractures are well valued with CBCT images in comparison to periapical radiographs. CBCT can distinguish breaks in bucco-lingual or mesio-distal directions (27). On the other hand, magnetic resonance imaging (MRI) is fast outperforming any other modality for in vivo observations of soft tissues in the human body lacking resort to any invasive procedures. The key dental uses of MRI to date are the exploration of soft-tissue lesions in salivary glands, temporomandibular joint (TMJ) and tumor staging. Its remarkable soft-tissue contrast resolution makes it to discover internal disorders of TMJ. MRI can also detect joint effusions, synovitis, erosions and linked bone marrow edema. Odontogenic cysts and tumors could be distinguished better on MRI than on CT. It also identifies soft tissue diseases, especially neoplasia, involving tongue, cheek, salivary glands, neck and lymph nodes. Finally, it is mostly mentioned that modern advances in imaging technologies have developed dental diagnostics and treatment preparations. Precise use of fitting imaging technology and their exact interpretation are the principles of cost-effectiveness; newly invented radiographic techniques can help to discover pathologies in very early stages, which eventually help to decrease morbidity and mortality and improve the patients quality of life.

Consequently, due to limitations of using new methods in clinical diagnosis, authors designed the current study to use the conventional periapical radiographs that resulted in determination of the cut-off point = 8.2 mm, which could precisely distinguish 83% of periapical granuloma and 79% of radicular cysts. At the end it is suggested that the current study will be performed as a comprehensive study with a larger sample size.

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Footnotes

Authors' Contribution: Farrokh Farhadi: study concept and design and study supervision; Seyed Sina Mirinezhad: acquisition of data and statistical analysis; Farrokh Farhadi, Seyed Sina mirinezhad, Ali Zarandi: analysis and interpretation of data; Farrokh Farhadi, Seyed Sina mirinezhad: drafting of the manuscript and administrative, technical, and material support; Ali Zarandi, Farrokh Farhadi: critical revision of the manuscript for important intellectual content.

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