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Assessment of Periapical Index Scores Among Individuals Presenting with Painful Pulpal Involvement of Tooth

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Abstract

Background: The aim of this study was to assess the periapical index scores among individuals presenting with painful pulpal involvement of tooth.

Methods: A cross-sectional study was conducted among individuals visiting the dental outpatient department of Tribhuvan University Teaching Hospital, Kathmandu, Nepal with suspected painful endodontic lesions. Intraoral periapical radiographs were taken, and periapical conditions were assessed using periapical index scores. Data were analyzed in the Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA). Mean, standard deviation, frequency, and percentage were calculated according to the nature of the data. A chi-square test was done to determine the association between different characteristics and periapical involvement.

Results: Most of the study participants (284, 74%) complained of dental pain, followed by pain and swelling both (50, 13%). On oral examination, 61 (15.9%) had the presence of a draining sinus, and 182 (47.4%) had tenderness on percussion of the same tooth. The majority of them (230, 59.9%) had a normal periapical bony structure. Some (36, 9.4%) had changes in bone structure with some diffuse mineral loss, and very few (2, 0.5%) had severe apical periodontitis with exacerbating features. Periapical involvement was significantly higher in older adults ($P = .039$), those with a draining sinus ($P < .001$), intraoral swelling ($P = .001$), and lymph node involvement ($P < .001$).

Conclusion: The findings of this study concluded that most of the individuals complaining of pain in their tooth due to pulpal involvement had normal apical bony structure and very few had severe apical periodontitis with exacerbating features. Periapical involvement was significantly associated with age, draining sinus, intraoral swelling, and lymph node involvement.

Keywords: Apical periodontitis, pain, periapical index scores, radiograph

What is already known on this topic?

- *Radiographic examination is a crucial supplement to clinical evaluation in endodontics. Periapical radiographs offer comprehensive details on the teeth and the tissues that surround them.*

What this study adds on this topic?

- *Among individuals with painful pulpal involvement, the variations in bone density seen in radiographs during the assessment of the apical periodontium are the most reliable indicators of periapical inflammation.*

INTRODUCTION

One of the main reasons for emergency dental practice is due to painful symptoms caused by pathology of endodontic origin.[1] Periapical lesions commonly develop as a sequela to dental caries[2] followed by inflammation of the pulp, known as pulpitis.[3] The common sites where these periapical lesions occur are the root apex and its

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surroundings.[4] The assessment of periapical status is essential for determining the treatment needs as well as relating the treatment outcome to various technical and clinical factors of endodontic intervention.[5]

In endodontics, radiographic examination serves as an indispensable adjunct to clinical examination.[6] In particular, periapical radiographs provide detailed information about the teeth and their surrounding tissues. They are mainly utilized for the assessment of pulp and root canal morphology, supporting alveolar bone status in the interdental region, detection of periapical pathology, and crown/root fractures.[7] The bone density changes present in radiographs during the evaluation of the apical periodontium are the most consistent features for the presence, progression, or resolution of periapical inflammation.[2]

Therefore, this study was conducted to assess the periapical index (PAI) scores among individuals presenting with painful pulpal involvement of teeth by the evaluation of periapical radiographs.

MATERIAL AND METHODS

A cross-sectional study was conducted among 385 individuals in the dental outpatient department (OPD) of Tribhuvan University Teaching Hospital (TUTH), Maharajgunj, Kathmandu, Nepal, presenting with suspected painful endodontically involved teeth from November 2021 to June 2022 after obtaining ethical approval from the same teaching institution (Approval no: 145 (6-11) E2 078/079, Date: October 4, 2021). A convenience sampling method was used for the selection of the study participants based on their eligibility criteria. Individuals aged 18 years and above, with chief complaints of pain due to pulpal involvement, were included in the study. However, those under anti-inflammatory medicines, antibiotics, or immunosuppressant therapy, pregnant patients, or those with previously initiated therapy, treated teeth, or failed treatment were excluded. Additionally, the radiographs not fulfilling the quality standards for periapical assessment were excluded from the study. Informed consent was received from the study participants before data collection.

Sample size was calculated based on the prevalence of periradicular radiolucency (65%) from a study done by Archana et al[8] by using the formula, $n = z^2pq/e^2$, where n = sample size; z = 1.96 at 95% CI; p = prevalence of condition = 65%; q = 100–p; e = permissible error = 5%. Placing these values in the formula provided above, the calculated sample size = 349.58. Adding a 10% non-response rate, the total final sample = 384.54 ≈ 385.

Case history was taken for 400 individuals, including the pain history of the involved tooth. An oral examination was done with the help of a mouth mirror and explorer under magnification (Brilliance loupes 3.5×, Eighteeth Medical) to detect the involvement of the pulp and check the status of surrounding soft tissues clinically. Evaluation of tenderness on percussion, tooth mobility, and probing depth using William's periodontal probe was done for the involved tooth. The findings obtained were compared with the adjacent tooth free from any complaint, and relevant data were recorded. An intraoral periapical radiograph of the offended tooth was taken to confirm the pulpal involvement and detect the radiographic changes in the periapex of the involved tooth using the PAI scoring system provided by Orstavik et al[9] in 1986. Periapical radiographs were taken by the paralleling technique (Rinn X-tension Cone Paralleling (XCP) holder). The radiographs were evaluated in an x-ray view box. Among those 400 images assessed, 15 were excluded due to improper positioning of the film, presence of artifacts, inappropriate anatomy coverage, inferior density, or poor contrast between structures like enamel and dentin or poor contrast between the involved tooth and surrounding alveolar bone. Thus, a sample size of 385 was reached.

Periapical index scoring system depends upon the visual references provided by matching the drawings that represent typical histological stages as they are seen on the periapical radiographs.[9] This scoring system represents 5 stages of periapical inflammatory changes from non-present to highly inflamed. The scoring is as follows:

1. Normal periapical structures or normal apical periodontium.
2. Small changes in periapical bone structure or bone structural changes indicating, but not pathognomonic for, apical periodontitis.

Table 1. Chief Complaint and Characteristics of Involved Tooth in the Study Participants

Characteristics	Category	No. of Study Participants, n (%)
Chief complaint	Dental pain only	284 (73.8)
	Dental pain and swelling	51 (13.2)
	Dental trauma with pain	4 (1.0)
	Dental pain with other complaint	46 (11.9)
Draining sinus	No	324 (84.2)
	Yes	61 (15.8)
Tender on percussion	No	202 (52.5)
	Yes	183 (47.5)
Intra-oral swelling	No	335 (87.0)
	Yes	50 (13.0)
Extra-oral swelling	No	369 (95.8)
	Yes	16 (4.2)
Lymph nodes involvement	No	378 (98.2)
	Yes	7 (1.8)
Root resorption	Not present	349 (90.6)
	Present	36 (9.4)

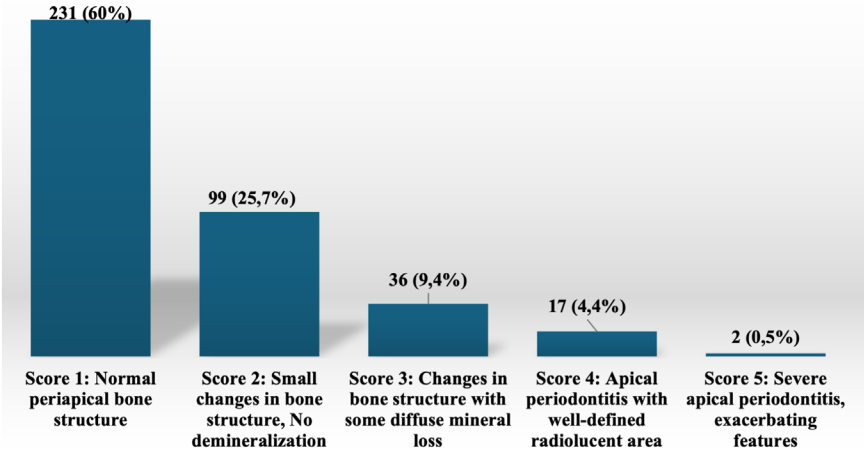

Figure 1. Assessment of periapical index (PAI) scores in the study participants (n=385).

3. Changes in periapical bone structure with some mineral loss or bone structural changes with some mineral loss are characteristic of apical periodontitis.
4. Demineralization of periapical bone with a well-defined radiolucent area or well-defined radiolucency.
5. Demineralization of periapical bone with exacerbating features or radiolucency with radiating expansions of bone structural changes.

Score 1 or 2 signified a non-diseased condition of the periapex, whereas scores from 3 to 5 indicated the presence of apical periodontitis.[10] In case of multi-rooted teeth, the root with the highest PAI score was recorded.

2 examiners were trained and calibrated to record the findings of around 10% of the periapical radiograph sample that were not included in the final data collection. Upon calculating the Kappa score to check the inter-examiner agreement while assessing the PAI system through periapical radiographs for the 40 test patients, a score of 0.82 was obtained, exhibiting almost perfect agreement. In case of disagreement during any radiographic assessment, a highly experienced oral medicine and radiology specialist was consulted for interpretation.

The data obtained were entered into the Microsoft Excel sheet and analyzed in The Statistical Package for Social Sciences version 20.0 software (IBM Corp.; Armonk, NY, USA). Mean, standard deviation, frequency, and percentage were calculated based on the nature of the data. Chi-square test was done to determine the association between different characteristics of study participants with PAI scores.

RESULTS

The participants in the study had an average age of 40.57 ± 17.16 years, among which 180 (46.8%) were males and 205 (53.2%) were females. The chief complaint and characteristics of involved tooth in the study participants is presented in Table 1. Most of the study participants (284, 73.8%) visited the dental OPD with a chief complaint of an aching tooth, followed by pain and swelling (51, 13.2%). The most common tooth involved was the lower right first molar (50, 13.0%), followed by the left upper first molar (48, 12.5%). The least involved teeth were the right upper third molar (1, 0.3%) and the left lower lateral incisor (1, 0.3%). Most of the study participants (231, 60.0%) with pulpal involvement had normal periapical bone structure, followed by small changes in the bone structure without demineralization (99, 25.7%). Very few (2, 0.5%) had severe apical periodontitis with exacerbating features (Figure 1). Figure 2 shows that 55 (14.3%) of the participants examined had apical periodontitis in the involved tooth.

Association of different characteristics of study participants with PAI scores is illustrated in Table 2. Most of the individuals aged ≥50 years had significantly higher pulpal involvement

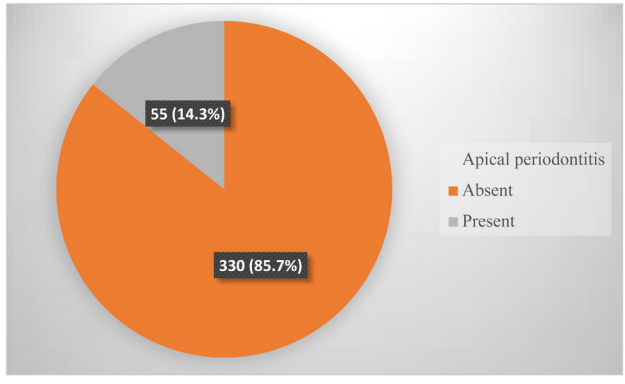

Figure 2. Distribution of study participants based on the presence or absence of apical periodontitis (PAI score 1 and 2=absence, PAI score 3-5=presence of apical periodontitis).

Table 2. Association of Various Characteristics of Study Participants with Periapical Index Scores

Characteristics	Category	Periapical Involvement, n (%)		*P*
		Absent (Score 1, 2)	Present (Score 3-5)	
Age in years	≤30	121 (89.0)	15 (11.0)	.039†
	31-50	117 (88.6)	15 (11.4)	
	≥50	92 (78.6)	25 (21.4)	
Sex	Female	180 (87.8)	25 (12.2)	.211†
	Male	150 (83.3)	30 (16.7)	
Chief complaint	Dental pain only	247 (87.0)	37 (13.0)	.126*
	Dental pain and swelling	45 (88.2)	6 (11.8)	
	Dental trauma with pain	4 (100)	–	
	Dental pain with other complaints	34 (73.9)	12 (26.1)	
Draining sinus	No	292 (90.1)	32 (9.9)	< .001†
	Yes	38 (62.3)	23 (37.7)	
Tender on percussion	No	178 (88.1)	24 (11.9)	.157†
	Yes	152 (83.1)	31 (16.9)	
Intra oral swelling	No	295 (88.1)	40 (11.9)	.001†
	Yes	35 (70.0)	15 (30.0)	
Extra oral swelling	No	316 (85.6)	53 (14.4)	.835†
	Yes	14 (87.5)	2 (12.5)	
Lymph nodes involvement	No	329 (87.0)	49 (13.0)	< .001†
	Yes	1 (14.3)	6 (85.7)	

*Fisher's exact test.
†Chi-square test.

seen than in individuals aged <50 years (*P* = .039). However, there was no association of periapical involvement with the sex distribution of the study participants (*P* = .211). The chief complaint of the individuals was not associated with periapical status (*P* = .126). Participants with draining sinus (23, 37.7%), intra-oral swelling (15, 30.0%), and lymph node involvement (6, 85.7%) had significantly higher periapical involvement than those who did not show these features.

DISCUSSION

The participants selected for this study were individuals visiting the Dental Outpatient Department of Tribhuvan University Teaching Hospital with pain in a tooth due to pulpal involvement. The PAI scoring system was used for the assessment of periapex in intraoral periapical radiographs (IOPAR) as it gives a validated and categorized description of periapical lesions confirmed by histological examination. Additionally, in the dental institution where this study was conducted, IOPAR is the only radiograph available for the assessment of periapical status.

In this study, among 385 individuals complaining of pain due to a pulpally involved tooth, more than half of them (231, 60%) had a score of 1 with normal periapical bone structure, and 154 (40%) had a score of 2 and above when assessed through periapical radiograph. This finding was in contrast to the study done by Karkevang et al[10] where out of 8744 teeth surveyed, 8361 (95.62%) scored 1 according to the PAI scoring system. On categorizing the individuals' radiographs into 2 groups depending upon whether or not they had apical periodontitis, 55 (14.3%) teeth were observed to have apical periodontitis in the current study. This finding falls within the frequency of apical periodontitis reported by other published studies, which ranges from 1% to 21%.[11-13]

In this study, most of the individuals in the older age group had significantly higher periapical involvement than in individuals with younger age group. Similarly, in a retrospective study done in Türkiye by Taşsöker and Akgünlü, the prevalence of endodontic treatment and apical periodontitis increased with age, but there was no statistically significant difference across different age groups.[14] Similarly, in a study by Andersen et al[15], the number of affected teeth rose significantly with age, with a median number of affected teeth varying from 0 for patients aged less than 18 years to 7.0 for patients aged 40+ years. These findings suggest that the need for endodontic treatment rises for the older age groups.

The current study presented no association between gender distribution and periapical status in radiographs. This was in accordance with the study done in Türkiye, where there no relationship was observed between gender and the presence of apical periodontitis.[14]

However, a study by Correia-Sousa et al[16] in Portugal showed that the probability of having apical periodontitis in men was almost 2 times higher than in women. On the other hand, 2 more epidemiological studies found that apical periodontitis was associated with female preponderance, indicating gender affects the number of root-filled teeth.[17,18] This variation in results may be due to the use of different tools in determining the periapical status. One of these studies[17] used periapical radiographs for assessment of periapex of endodontically treated teeth, and the other study[18] used panoramic radiographs for evaluating all the teeth present, whereas the current study used periapical radiographs determining scores for the tooth with chief complaint only.

On analyzing the relationship between clinical and radiographic findings in this study, it was observed that most of the individuals having draining sinus, intraoral swelling, and tender/palpable lymph nodes in the region of the involved tooth showed apical periodontitis in radiographs. A study on clinical decision-making among general dental practitioners about teeth with apical periodontitis showed that the extraction ratio increased as the size of the periapical radiolucency increased. However, the American Association of Endodontists guidelines state that the extent of a lesion does not determine case difficulty, nor does the presence of periapical radiolucency indicate a poor long-term prognosis

in itself.[19] Out of 385 individuals examined, 31 (16.9%) having teeth tender on percussion showed the presence of apical periodontitis in radiographs, which was more than those who did not have such clinical signs (24, 11.9%); but the difference was not statistically significant. However, a study by Correa et al[20] in Colombia portrayed a significant association between apical periodontitis and sensitivity to percussion.

This study has some limitations. Two-dimensional radiographs were considered for periapical assessment of the endodontically involved teeth. Although radiographic evaluation is the most widely used method to detect periapical lesions, only 2-dimensional images of the 3-dimensional structures are seen during appraisal, due to which the accuracy of lesion size, extent, and location may be lost.[21] The radiographic interpretation could also be influenced by morphologic changes, surrounding bone density, x-ray angulations, and radiographic contrast.[5,22]The use of cone-beam computed tomography (CBCT) could give a clearer picture of the periapex as it is a more objective tool that provides more accurate images than periapical radiography for the diagnosis of apical periodontitis.[23] Using CBCT, periapical lesions have been examined in a reproducible way by indices with the help of the Cone beam computed tomography PAI or a new volume-based CBCT PAI.[23-25] However, it could not be used for the assessment of periapex in this study due to its high cost and associated radiation dose.

This study concluded that most of the individuals complaining of pain in the tooth due to pulpal involvement had normal apical bony structure and very few had severe apical periodontitis with exacerbating features. Individuals of older age group, draining sinus, intra-oral swelling, and lymph node involvement showed a significantly higher occurrence of apical periodontitis.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Approval was obtained from the Institutional Review Committee of the Institute of Medicine, Maharajgunj, Kathmandu, Nepal (Approval no: 145 (6-11) E2 078/079, Date: October 4, 2021).

Informed Consent: Informed consent was received from all study participants before commencing data collection.

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Declaration of Interests: The authors have no conflict of interest to declare.

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