

A RADIOGRAPHIC STUDY OF MANDIBULAR NUTRIENT CANALS IN PATIENTS WITH PERIODONTAL DISEASES

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Abstract

Nutrient canals are intra-osseous spaces or channels containing nerves and blood vessels. They are observed more frequently in the mandibular anterior region as radiolucent horizontal lines of varying widths, usually situated interproximally and inferiorly to the teeth. The aims of this investigation were to evaluate radiographically the presence of nutrient canals in 500 patients with periodontitis and 500 controls, to correlate their presence with severity of bone loss and trabecular bone pattern and to correlate the type of trabecular bone pattern to the age of the patient, bone loss and number of nutrient canals.

Keywords: Nutrient canals - periodontal bone loss - trabecular bone pattern.

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ÉTUDE RADIOGRAPHIQUE DES CANAUX NUTRITIFS MANDIBULAIRES CHEZ LES PATIENTS ATTEINTS DE MALADIES PARODONTALES

Résumé

Les canaux nourriciers sont des espaces ou des canaux intra-osseux contenant les nerfs et les vaisseaux sanguins qui véhiculent les nutriments. Ils sont observés plus fréquemment dans la région antérieure mandibulaire sous forme de liserés, de largeurs variables, situés le plus souvent en situation interdentaire et inférieure aux dents. Ils ont une direction verticale plutôt qu'horizontale. Cette enquête a pour buts 1) d'évaluer radiologiquement la présence de ces canaux chez 500 patients atteints de parodontite et chez 500 sujets contrôles, 2) de corréler la présence de canaux nourriciers avec la gravité de la perte osseuse et le modèle d'os trabéculaire et 3) d'établir la corrélation entre le type d'os trabéculaire et l'âge du patient, la perte osseuse et le nombre de canaux nourriciers.

Mots-clés: canaux nourriciers - perte osseuse parodontale - os trabéculaire.

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Introduction

Diagnostic radiography has evolved as an inseparable branch of dentistry. It is used primarily to detect dental caries, periapical and periodontal diseases. Nutrient canals have been called interdental canals, circulating canals, vascular channels or interdental nutrient canals [1]. These are called the perforating canals of Zuckerkandl and Hirschfeld (nutrient canals), which house the interdental and interradicu-

lar arteries, veins, lymph vessels and nerves [2].

They are observed more frequently in the mandibular anterior region. Nutrient canals may also be seen in other areas such as mandibular premolar area, maxillary premolar area and within the walls of the maxillary sinus [3].

On periapical x-rays, these canals appear as linear radiolucencies and vary in size, number, prominence and in their relationship to the dental roots [1]. Nutrient canals were frequently seen in

patients with thin alveolar ridges lacking trabecular spaces [4]. Others have correlated the radiographic appearance of nutrient canals with age, race and various pathogenic conditions such as periodontal disease, hypertension, diabetes, rickets, calcium deficiency, disuse atrophy and coarctation of the aorta [1].

The aims of this study were:

1- To evaluate radiographically the presence of nutrient canals in patients with periodontitis and in controls.

2- To correlate the presence of nutrient canals with severity of bone loss and trabecular bone pattern.

3- To correlate the type of trabecular bone pattern to the age of the patient, the bone loss and the number of nutrient canals.

Material and Methods

Selection Criteria

1000 subjects were selected for the study and were divided into a study and a control groups.

The study group patients were selected from Out-Patient Department of Oral Medicine, Diagnosis and Radiology of Bangalore Institute of Dental Sciences and consisted of 500 patients suffering from periodontitis. Patients with systemic diseases known to affect nutrient canals like diabetes mellitus, hypertension, rickets, coarctation of aorta [1, 5] were excluded.

The control group consisted of 500 individuals, free from periodontal or any systemic diseases known to affect nutrient canals. It consisted of volunteers like employees of the institution and the attendants who accompanied the patients to our Department.

The study group and the control group were divided into 4 groups according to their age as follows:

- Group I: 25-34 years.
- Group II: 35-44 years.
- Group III: 45-54 years.
- Group IV: 55-64 years.

Ethical clearance was acquired from the Ethical Committee prior to the onset of the study and informed consent was also obtained from the participants.

Examination of the patients with periodontitis

Each patient was examined under artificial illumination using mouth mirror, conventional probe and Williams graduated probe. Periodontitis was diagnosed in accordance with criteria adopted by the American Academy of Periodontology [6]. Clinical findings of gingival recession, tooth mobility

and probing pocket depth (PPD) were recorded as follows:

Gingival recession (Miller's classification [7]):

Class I: The marginal tissue recession doesn't extend up to the mucogingival junction. There is no loss of bone or of soft tissue in the interdental area. This type of recession can be narrow or wide.

Class II: The marginal tissue recession extends to or beyond the mucogingival junction. There is no loss of bone or of soft tissue in the interdental areas. This type of recession can be subclassified into wide and narrow.

Class III: The marginal tissue recession extends to or beyond the mucogingival junction. There is interdental bone and/or soft tissue loss or there is malpositioning of the tooth.

Class IV: The marginal tissue recession extends to or beyond the mucogingival junction. There is interdental bone and soft tissue loss and/or severe tooth malpositioning.

Periodontal pocket depth/ Clinical attachment loss (AAP, [6]):

- Slight: 1-2 mm of clinical attachment loss.
- Moderate: 3-4 mm of clinical attachment loss.
- Severe: 3-5 mm of clinical attachment loss.

Mobility [8]:

- Class I: Tooth can be moved less than 1mm in the buccolingual or mesiodistal direction.
- Class II: Tooth can be moved 1mm or more in the buccolingual or mesiodistal direction. No mobility in the occlusoapical direction (vertical mobility).
- Class III: Tooth can be moved 1mm or more in the buccolingual or mesiodistal direction.

Mobility in the occlusoapical direction is also present.

Radiographic technique

The mandibular anterior region was selected as the site of study due to the higher frequency of occurrence of nutrient canals in this region [9]. The partially edentulous subjects were instructed to remove all removable prostheses from the mouth. The subject was then draped with a lead apron. The film was removed from film dispenser and named according to the patient's name and age. It was positioned straight behind the mandibular central incisors as close as possible to the lingual surface of teeth with apical end against lingual mucosa. The collimator of the x-ray unit was aligned in close approximation to the mandibular anterior teeth and centered to obtain the necessary vertical angulation. The intra-oral radiographs were taken using the no.2 Kodak Ektaspeed plus films. The exposure time was set at 0.3 seconds for mandibular anterior region. The intraoral bisecting angle technique was applied, with IOPAR machine (65 kVp; 10 mA).

Immediately after the exposure, the films were washed and dried. The exposed films were stored in a light-proof box with a lead lining and placed in the darkroom until they were processed.

All the films were processed manually in a well-equipped, light-proof dark room as described by White S.C. & Pharoah M.J. [10]. Each time, 30 films were taken for processing.

For processing the film, conventional developer and fixer available in the dark room were used. The developer and fixer solutions were stirred well. The hangers containing the films were immersed in the developer solution at the same time. Visual method of processing was adopted. The films were inspected for images and when the images were seen clearly, all the films were rinsed in running water for about 20 seconds. The hangers were then kept in the fixing solution for about 30 minutes. After that, the films

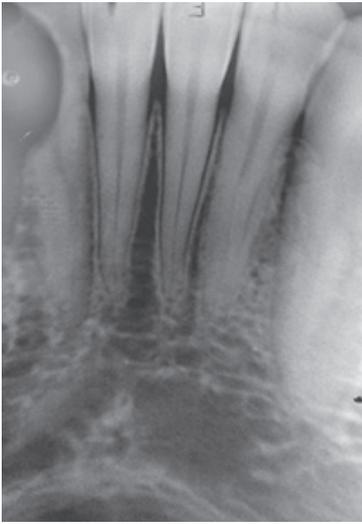


Fig. 1: Intra-oral periapical radiograph showing no bone loss (control group).

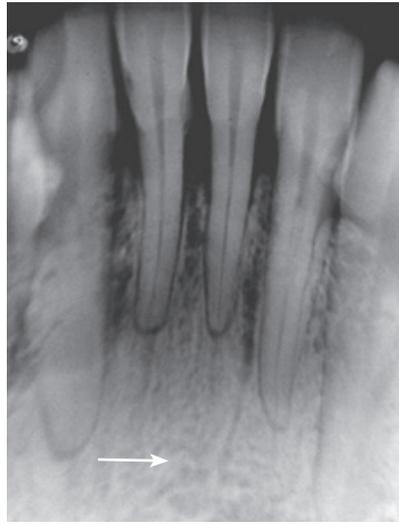


Fig. 2: Bone loss involving up to 1/3rd of root length also showing nutrient canals (white arrow).



Fig. 3: Bone loss involving up to 2/3rd of root length.



Fig. 4: Bone loss more than 2/3rd of root length.

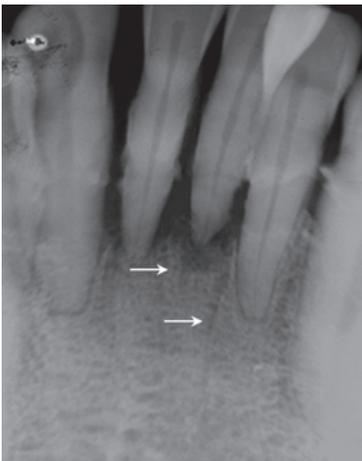


Fig. 5: Above average – Greater radiopacity and diminutive medullary spaces.

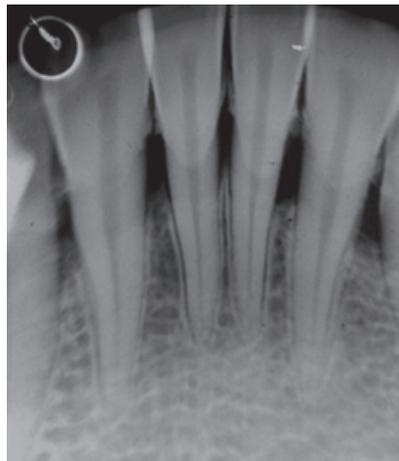


Fig. 6: Average - Normal radiopacity and normal medullary spaces.

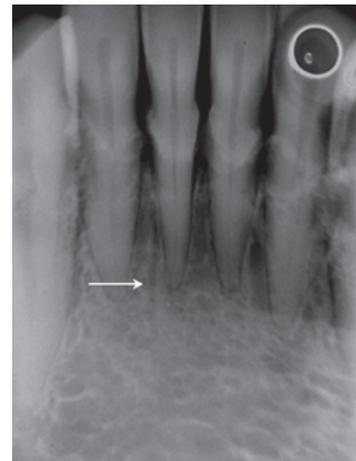


Fig. 7: Below average – Increased radiolucency, larger medullary spaces and thin individual less defined trabeculations.

Sex	Control group			Study Group		
	Nutrient Canals			Nutrient Canals		
	Present	Absent	Total	Present	Absent	Total
Male	16 (7%)*	213 (93%)	229	146 (49%)*	152 (51%)	298
Female	14 (5.2%)**	257 (94.8%)	271	98 (48.5%)**	104 (51.5%)	202
Total	30	470	500	244	256	500

Control versus study groups:

In males: $\lambda^2 = 107.3$; $p < 0.001$.

In females: $\lambda^2 = 120.3$, $p < 0.001$.

Table 1: Prevalence of nutrient canals according to patients' sex.

Age (Years)	Control group			Study Group		
	Nutrient Canals			Nutrient Canals		
	Present	Absent	Total	Present	Absent	Total
25 – 34	13 (5.8%)	228 (94.2%)	242	60 (40.3%)	89 (59.7%)	149
35 - 44	12 (7.9%)	151 (92.1%)	164	68 (46.9%)	77 (53.1%)	145
45 – 54	3 (4.5%)	64 (95.5%)	67	67 (53.2%)	59 (46.8%)	126
55 – 64	2 (7%)	25 (93%)	27	49 (61.3%)	31 (38.7%)	80
Total	30	470	500	244	256	500
	$\lambda^2 = 15.6$; $p < 0.05$			$\lambda^2 = 21.6$; $p < 0.01$		

Table 2: Prevalence of nutrient canals in control and study groups with reference to age groups.

were washed for about 30 minutes in running water and kept in dryer for 5 minutes. The dried films were placed in the respective covers. Likewise, all exposed films were processed.

Diagnostic assessment of radiographs

Radiographic evaluation of nutrient canals was done by two interpreters in a room with subdued ambient illumination using an illuminated view box and a magnifying lens. The presence or absence of nutrient canals and the frequency (number) of nutrient canals was noted. Bone loss and trabecular bone pattern were also recorded. The alveolar bone loss was recorded according to the following (Figs. 1-3):

1. No bone loss.
2. Bone loss up to 1/3rd of the length of root.
3. Bone loss up to 2/3rd of the length of root.

4. Bone loss more than 2/3rd of the length of root.

The pattern of alveolar bone trabeculae were examined and recorded according to the following [11] (Figs. 5-7):

1. Above average: The radiopacity is greater than the average and the medullary spaces are obliterated.
 2. Average: The radiopacity of the region is not extreme and the medullary spaces are relatively normal in size and shape.
 3. Below average: The radiolucency of the area is increased, the medullary spaces are large and individual trabeculae are thin and less well defined.
- Classification of trabecular space size was subjective; agreement between interpreters supported by photographs used for reference when doubt arose was the method used with no actual measurement of spaces being made.

Statistical analysis

Chi square test was used for the statistical analysis. A significance of 5% or less was considered statistically significant.

Results

With the criteria set for subject selection, the target number of subjects set for each group was achieved, i.e., 500 in each group. Among the 500 subjects of the control group, 229 were males and 271 were females; the mean age of males was 43 years and that of the females was 42 years old. Among the 500 patients with periodontitis, 298 were males and 202 were females; the mean age of males and females was 42 years and 43 years, respectively. 30 (6%) out of 500 subjects in the control group and 244 (48.8%) of the 500 chronic periodontitis patients

Age (Years)	Trabecular bone Pattern							
	Control group				Study Group			
	Above Average	Average	Below Average	Total	Above Average	Average	Below Average	Total
25-34	68 (28.0%)	117 (48.0%)	57 (24.0%)	242	69 (46.3%)	62 (41.6%)	18 (2.1%)	149
35-44	61 (36.6%)	67 (41.5%)	36 (21.9%)	164	88 (60.7%)	50 (34.5%)	7 (4.8%)	145
45-54	29 (43.3%)	31 (44.7%)	7 (12%)	67	76 (60.3%)	36 (28.6%)	14 (11.1%)	126
55-64	8 (29.6%)	13 (48.1%)	6 (22.2%)	27	59 (73.8%)	15 (18.7%)	6 (7.5%)	80
Total	166	228	106	500	292	163	45	500
	$\lambda^2 = 15.6; p < 0.05$				$\lambda^2 = 21.6; p < 0.01$			

Table 3: Relationship of trabecular bone pattern with reference to age.

Nutrient Canals	Trabecular pattern							
	Control group				Study Group			
	Above Average	Average	Below Average	Total	Above average	Average	Below Average	Total
Present	19 (11.4%)	8 (3.5%)	3 (2.9%)	30	168 (57.5%)	56 (34.4%)	20 (44.4%)	244
Absent	147 (88.6%)	220 (96.5%)	103 (97.1%)	470	124 (42.5%)	107 (65.6%)	25 (55.6%)	256
Total	166	228	106	500	292	163	45	500
	$\lambda^2 = 13.12; p < 0.01$				$\lambda^2 = 22.9; p < .001$			

Table 4: Relationship between trabecular bone pattern and nutrient canals.

revealed nutrient canals ($I^2 = 230.2$; $p < 0.001$).

In the study group, 49% of the males and 48.5% of the females showed nutrient canals. Differences in the presence of nutrient canals in males and females were not statistically significant; but when compared to the control group, it was statistically highly significant (7% and 5.2% in males and females, respectively) [Table 1].

Prevalence of nutrient canals was statistically higher in the age group of 55 – 64 years (61.3%) of the study group compared to the control group (Table 2). It was also higher in those with above average trabecular bone pattern i.e. 57.5% in study group and 11.4% in controls (statistically significant) [Table 3].

In controls, overall prevalence of 3 or more nutrient canals was 3 of 30 (6.6%) whereas in the study group, the prevalence was 61 of 244 (25%). However, the difference was not statistically significant.

The prevalence of above average trabecular bone pattern in patients with nutrient canals was higher in the study group (68.9%) than in controls (63.3%), even though the difference was not statistically significant). More specifically, in the 55-64 years age group, this prevalence of average trabecular bone pattern was 73.8% in the study group and 48.1% in the control group [Table 4].

Severity of bone loss of more than 2/3rd of root length was highest in the

age group of 55-64 years (31.2%) in the study group [Table 5].

The prevalence of nutrient canals increased as severity of bone loss increased (i.e. $> 2/3$ rd root length). In the study group, the frequency of nutrient canals of more than 3 increased (31.2%) when severity of bone loss was $> 2/3$ rd of root length compared to only 21.3% when bone loss was amounting to $< 1/3$ rd of root length. This association was found to be significant [Table 6].

Nutrient canals were absent in 470 subjects of control and 256 subjects of study group.

In controls (i.e. no bone loss), there was higher prevalence of average

Age (Years)	Control group		Study Group		
	No Bone Loss	Bone Loss			
	Total	< 1/3 n (%)	1/3 – 2/3 n (%)	>2/3 n (%)	Total n (%)
25-34	242	115 (77.2%)	22 (14.8%)	12 (8.1%)	149 (100%)
35-44	164	93 (64.1%)	32 (22%)	20 (13.9%)	145 (100%)
45-54	67	50 (39.7%)	52 (41.3%)	24 (19%)	126 (100%)
55-64	27	24 (30%)	31 (38.8%)	25 (31.2%)	80 (100%)
Total	500	282	137	81	500
$\lambda^2 = 70.3; p < 0.001$					

Table 5: Relationship between age and bone loss.

Frequency of Nutrient Canals	Control group		Study Group		
	No Bone Loss	Bone Loss			
	Total	< 1/3 n (%)	1/3 – 2/3 n (%)	>2/3 n (%)	Total
<3	28 (93.4%)	100 (78.7%)	50 (72.5%)	33 (68.8%)	183
≥ 3	2 (6.6%)	27 (21.3%)	19 (27.5%)	15 (31.2%)	61
Total	30 (100%)	127 (100%)	69 (100%)	48 (100%)	244
$\lambda^2 = 130.4; p < 0.001$					

Table 6: Relationship between bone loss and frequency of nutrient canals.

Trabecular bone pattern	Control		Study group		
	No Bone Loss	Bone Loss			
	Total	< 1/3	1/3 – 2/3	>2/3	Total
Above Average	166 (33.2%)	129 (45.7%)	91 (66.2%)	72 (88.9%)	292
Average	228 (45.8%)	120 (42.5%)	37 (27.3%)	6 (7.4%)	163
Below Average	106 (21%)	33 (11.8%)	9 (6.5%)	3 (3.7%)	45
Total	500	282	137	81	500
$\lambda^2 = 53.5; p < 0.001$					

Table 7: Relationship between bone loss and trabecular bone pattern.

trabecular bone pattern (45.8%). In the study group, there was an increased prevalence of above average trabecular bone pattern as the severity of bone loss increased (i.e. > 2/3rd of root length) – 72 of 81 (88.9%). This association was found to be statistically significant [Table 7].

Discussion

Alteration of normal structure, either in bone or in soft tissue should be assessed when establishing a diagnosis.

This study based on the evaluation of the nutrient canals on radiographs of the anterior part of the mandible can be considered an elaborative study about the prevalence of these canals in normal situations and their alterations in cases of pathologies. Nutrient canals are well visualized on intra-oral periapical radiographs, the standard x-rays in diagnosing and evaluating diseases of teeth and jaws. If established facts are available about the nutrient canals, it would be easy for any clinician to interpret the presence and the aspects of these tube-like canals because they might be considered a valid diagnostic marker for some specific systemic diseases.

In the present study, the relation between the periodontal disease and the prevalence and/or orientation of the nutrient canals was assessed. The pathologic entity was chosen because of the availability of patients and consequent cases, its relation with other systemic diseases and especially because it is considered one of the major causes of tooth loss.

Nutrient canals were observed in 6% of the individuals of the control group. This proportion is slightly low, compared to the results published by Ryder [4] (19.2%), Sweet [12] (15.8%), Lovette [13] (92%) and Patel and Wuehrmann [14] (42.5%). The difference in the results can be attributed to patient selection, since in the mentioned studies patients suffering from systemic conditions that might cause alterations in the bone anatomy and

especially in the nutrient canals morphology and/or visualisation were not excluded.

Nutrient canals were present in only 48.8% of the individuals suffering from periodontitis. This might be due to the variations in structural bone pattern and its physiological remodeling. Patel and Wuehrmann [14] reported in their study that nutrient canals tend to be associated with advanced periodontal conditions. In our study, the incidence of nutrient canals increased in the advanced age (55-64 years) among chronic periodontitis patients. The development of new blood vessels with metabolic alteration of the bone might be related to the disease process and to the better visibility of nutrient canals with the sclerotic change in the trabecular bone [11].

Among the patients who have trabecular bone pattern of above average density, 57.5% had nutrient canals, those with average trabecular bone pattern, 34.4% had nutrient canals and those with below average trabecular bone pattern, 44.4% had nutrient canals. This shows that the patients with above average trabecular bone pattern have more nutrient canals because of greater density of bone which results in better visibility of nutrient canals.

Conclusion

The present study was undertaken to determine the prevalence of radiographic appearance of nutrient canals in controls and in patients with periodontitis.

It was shown that the prevalence of nutrient canals was higher in patients with periodontitis and in the age group 55-64 years.

Further studies must be conducted with large sample size to confirm that the configuration and the prevalence of nutrient canals are related with other disease processes. Thus, it is important to identify nutrient canals in routine intra-oral periapical radiographs as they serve as a diagnostic marker of various diseases, such as chronic periodontitis.

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