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Study Of Nutrient Canals In Mandibular Anterior Region In Hypertensive Patients- A Comparative Study.

Names of all the authors- Dr. Priyanka Rodge, Dr. Sonia Sodi, Dr. Lata Kale, Dr. Vishwas Kadam, Dr. Mayuri Kulkarni, Dr. Shivani Jamode, Dr. Shivani Tawade

Names and full location of the departments and institution-

1. Dr. Priyanka Rodge, PG Student, Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.
2. Dr. Sonia Sodhi, Professor & Guide, Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.
3. Dr. Lata Kale, HOD of Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.
4. Dr. Mayuri Kulkarni, PG Student, Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.
5. Dr. Shivani Jamode, PG Student, Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.
6. Dr. Shivani Tawade, PG Student, Department of Oral Medicine, Diagnosis & Radiology, CSMSS Dental College & Hospital, Chhatrapati Sambhajinagar.

Corresponding author name- Dr. Shivani Tawade

Abstract

Background: Diagnostic radiography in dentistry not only aids in the detection of local dental pathologies but may also reveal subtle osseous changes associated with systemic diseases. Nutrient canals (NCs), seen as linear radiolucencies in the mandibular anterior region on intraoral periapical radiographs (IOPARs), have been suggested as possible indicators of systemic vascular alterations, particularly hypertension.

Aim: To compare the incidence of nutrient canals in hypertensive and non-hypertensive individuals and to assess their association with age, gender, severity, and duration of hypertension.

Materials and Methods: A cross-sectional observational comparative study was conducted on 300 subjects aged 30–70 years. The study group comprised 150 diagnosed hypertensive patients, and the control group included 150 healthy non-hypertensive individuals. Blood pressure was recorded using the auscultatory method, and IOPARs of the mandibular anterior region were obtained. Presence of nutrient canals was evaluated and statistically analyzed using SPSS version 21. Chi-square test was applied, with significance set at $p < 0.05$.

Results: Nutrient canals were observed in 81.3% of hypertensive patients compared to 12% of non-hypertensive subjects, showing a highly significant difference ($p < 0.001$). A significant association was noted with age and duration of hypertension, while gender showed no significant influence.

Conclusion: Increased visibility of nutrient canals on IOPARs is significantly associated with hypertension and may serve as an adjunctive radiographic marker for early detection of this systemic condition.

Introduction

Diagnostic radiography in dentistry plays a vital role in detecting commonly encountered jaw and dental pathologies such as caries, periapical lesions, periodontal diseases, and gross osseous changes. However, comparatively little emphasis has been placed on identifying subtle osseous alterations associated with systemic diseases manifested in the jaw bones[1].

Radiographic appearances of identical anatomic structures may vary widely, including differences in trabecular pattern, trabecular thickness, pulp chamber size, and the presence of nutrient canals[2].

Nutrient canals are radiolucent channels within bone that transmit blood vessels and nerves to surrounding structures. First described by Hirschfeld in 1923 as interdental channels[3], these canals are most frequently observed in the mandibular anterior region on intraoral periapical radiographs (IOPAR), followed by the mandibular premolar region and maxillary sinus walls[4]. They represent continuations of the mandibular canal, derived from the incisive branch of the inferior alveolar neurovascular bundle supplying the anterior mandible[5].

Radiographically, nutrient canals appear as linear radiolucencies, usually oriented vertically, and have also been referred to as vascular or circulatory canals[6]. While some investigators consider them normal anatomical features, others associate their increased visibility with pathological conditions such as periodontal disease, diabetes, hypertension, tuberculosis, rickets, and calcium deficiency[7].

Hypertension is one of the most common systemic diseases encountered in dental practice and is often asymptomatic, earning the term “silent killer”[8,9]. It is usually detected incidentally and, if left untreated, may lead to serious cardiovascular, cerebrovascular, and renal complications[10,11]. The vascular changes associated with hypertension include arteriolar dilation, vessel wall hypertrophy, hyperplasia, and arteriosclerosis, leading to narrowing of the lumen and development of collateral circulation. These vascular alterations may explain the increased incidence of nutrient canals observed in hypertensive individuals[12].

Advancements in imaging technologies such as CBCT and MRI have enhanced the understanding of mandibular vascularization and innervation[13,14]. However, periapical radiography remains a practical and effective method for identifying nutrient canals, which vary in number, size, and relation to tooth roots[15].

Thus, the present study was undertaken to compare the incidence of nutrient canals in hypertensive and non-hypertensive patients based on the severity and duration of hypertension across different age groups and genders, and to evaluate whether the presence of nutrient canals could serve as a radiographic clue for the detection of hypertension.

Material & Method-

A. **Study design:** Cross sectional observational comparative study.

B. **Study setting:** This cross-sectional analytical study was carried out in the Department of Oral Medicine and Radiology after taking informed consent from the patients. Ethics committee approval was obtained from the Institutional Ethics Committee prior to beginning of the study.

C. **Study population:** Patients under the age group 30 to 70 years visiting Department of oral medicine and radiology for routine dental care were screened and enrolled for the study as per inclusion and exclusion criteria.

D. **Sample size:** Total 300 participants will be included in the study and divided into two groups:

Group 1: comprises of 150 cases having evidence of hypertension.

Group 2: comprises of 150 cases having no evidence of hypertension.

E. **Sampling technique**: Convenience sample.

F. **Method of selection of study subject**

G. Inclusion criteria:

1. Age group- 30 to 70 years.

2. Hypertensive patient without any other medical problem.

3. Healthy Non-hypertensive patients without any other medical problem.

H. Exclusion criteria:

1. Patients below 30 years of age.

2. Medically compromised patients except hypertension.

3. Patients with lower anterior bony defects or pathologies.

4. Complete or partial edentulous patients in anterior region.

Statistical analysis:

Sample size derivation Formula of calculating sample size is: Sample size for two independent sample (outcome variable measured on nominal (percentage) scale and testing alternate hypothesis : $P1 \neq P2$ (proportions of both groups)

Assuming all the factors, calculated sample size per group comes around 146 rounded to 150 observations/subjects (n1) per group. Total sample size estimates to around 300 subjects accounting for two groups determined in the study.

Method of data analysis:

Statistical analysis will be performed using Statistical Product and Service Solutions (SPSS) version 21 for Windows (Armonk,NY:IBMcorp). Descriptive quantitative data will be expressed in mean and standard deviation respectively and nominal results will be presented in percentages. Data normality will be checked by using Shapiro – Wilk test. Confidence interval is set at 95% and probability of alpha error (level of significance) set at 5%. Power of the study set at 80%. Comparisons of incidence of nutrient canal (in percentage/proportion) between hypertensive and non – hypertensive groups will performed using Chi – square test.

Procedure-

After obtaining ethical clearance from the Institutional Ethics Committee, the study was conducted on a total of 300 individuals aged between 30 and 70 years. The study group comprised 150 known hypertensive patients, while the control group consisted of 150 apparently healthy, non-hypertensive individuals.

For all participants, blood pressure was recorded in a sitting posture using the auscultatory method with a sphygmomanometer (Diamond Deluxe BP apparatus, Model No. IS3390 CM/L-0196043) [Fig. 5]. In hypertensive patients, the duration of hypertension was also documented, and all findings were recorded in a structured proforma.

Subsequently, intraoral periapical radiographs (IOPAR) of the mandibular anterior region were obtained for all subjects.

Study instruments:

1. Dental [Intra Oral] X-ray unit -model name: trident 1070- D. License no. – 17- LOEE-237588.

2. Intra oral X-ray film [carestream dental] size 2[30.5 x 40.5 mm]. -E speed.

3. Viewer box.

4. Sphygmomanometer [diamond deluxe BP apparatus model no. IS3390 CM/L- 0196043]

Result-

Table 1 and Graph 1: Comparison of Presence of Nutrient Canals between Hypertensive and Non-Hypertensive Groups

In Group 1 (Hypertension), 28 subjects (18.7%) showed absence of nutrient canals, whereas 122 subjects (81.3%) demonstrated presence of nutrient canals. In contrast, Group 2 (Non-hypertension) showed absence of nutrient canals in 132 subjects (88%), while only 18 subjects (12%) exhibited presence of nutrient canals.

On comparison between Group 1 and Group 2, a **highly statistically significant difference** was observed ($p < 0.001$). The prevalence of nutrient canals was significantly higher in the hypertensive group compared to the non-hypertensive group.

Table 2 and Graph 2: Comparison of Presence of Nutrient Canals in Different Age Groups between Hypertensive and Non-Hypertensive Groups

In Group 1 (Hypertension), presence of nutrient canals was observed in 13 subjects (92.0%) aged 31–40 years, 23 subjects (95.8%) aged 41–50 years, 39 subjects (83%) aged 51–60 years, 43 subjects (78.2%) aged 61–70 years, and 4 subjects (40%) aged 71–80 years.

In Group 2 (Non-hypertension), no nutrient canals were observed in subjects aged 31–40, 41–50, and 51–60 years. Presence of nutrient canals was seen in 11 subjects (20%) aged 61–70 years and 7 subjects (70%) aged 71–80 years.

Comparison across age groups between the two study groups revealed a **statistically significant difference** ($p < 0.001$), with a notably higher prevalence of nutrient canals in hypertensive subjects, particularly in younger and middle age groups.

Table 3 and Graph 3: Comparison of Presence of Nutrient Canals Based on Gender between Hypertensive and Non-Hypertensive Groups

In Group 1 (Hypertension), nutrient canals were present in 90 male subjects (90.8%) and 31 female subjects (39.2%). In Group 2 (Non-hypertension), nutrient canals were present in 10 male subjects (11.1%) and 8 female subjects (13.3%).

On comparison of gender distribution between Group 1 and Group 2, **no statistically significant difference** was observed ($p > 0.05$), indicating that gender did not have a significant influence on the presence of nutrient canals.

Table 4 and Graph 4: Association and Correlation between Presence of Nutrient Canals and Duration of Hypertension

In hypertensive subjects with duration of hypertension ranging from 1–3 years, nutrient canals were present in 13 subjects (86.7%). In the 4–6 years group, 39 subjects (86.7%) showed presence of nutrient canals. In the 7–9 years group, 45 subjects (90%) exhibited nutrient canals. In the 10–12 years group, presence was observed in 14 subjects (82.4%). In the 13–15 years group, 8 subjects (66.7%) showed nutrient canals, whereas in subjects with duration greater than 15 years, only 3 subjects (27.3%) demonstrated presence of nutrient canals.

A **highly statistically significant association** was observed between duration of hypertension and presence of nutrient canals ($p < 0.001$). Additionally, a **moderate negative correlation**, which was statistically non-significant ($p < 0.05$), was noted, indicating that increasing duration of hypertension was associated with a reduction in the presence of nutrient canals.

Table 5 and Graph 5: Association of Presence of Nutrient Canals with Other Systemic Conditions in Hypertensive Subjects

Among hypertensive subjects without other systemic conditions, absence of nutrient canals was observed in 19 subjects (14.8%), while 109 subjects (85.2%) showed presence of nutrient canals. In subjects with associated systemic conditions, 9 subjects (40.9%) exhibited absence of nutrient canals and 13 subjects (59.1%) demonstrated presence of nutrient canals.

Table 1: Comparison of presence of nutrient canal between group 1 (hypertension) and group 2 (non -hypertension) respectively

Nutrient Canal	Group 1 Hypertension	Group 2 No Hypertension	Unpaired t test	P value, Significance
Absent (n=160)	28 (18.7%)	132 (88%)	Chi – 144.90	p < 0.001 **
Present (n=140)	122 (81.3%)	18 (12%)		
Total	150 (100%)	150 (100%)		

Graph 1: Comparison of presence of nutrient canal between group 1 (hypertension) and group 2 (non -hypertension) respectively

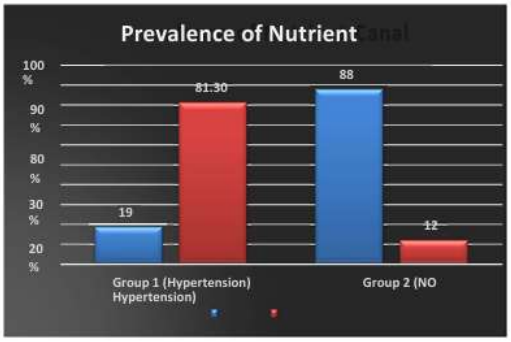


Table 2: Distribution of individual with presence of nutrient canal with age groups in group 1 (hypertension) and group 2 (non -hypertension) respectively

	Group 1 (Hypertension) N (%)	Group 2 (No Hypertension) N (%)
31-40 years	13	0
41-50 years	23	0
51-60 years	39	0
61-70 years	43	11
71-80 years	4	7
Total	122 (81.3 %)	18 (12%)

Graph 2: Distribution of individual with presence of nutrient canal with age groups in group 1 (hypertension) and group 2 (non -hypertension) respectively

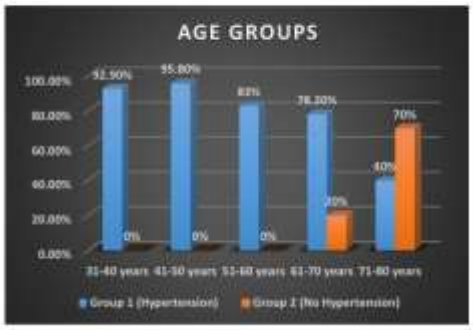


Table 3: Distribution of individual with presence of nutrient canal with gender in group 1 (hypertension) and group 2 (non -hypertension) respectively

	Group 1 (Hypertension) Mean (SD)	Group 2 (No Hypertension) Mean (SD)
Males	90	10
Females	31	8
Total	121 (81.2%)	18 (12%)

Graph 3: Distribution of individual with presence of nutrient canal with gender in group 1 (hypertension) and group 2 (non -hypertension) respectively

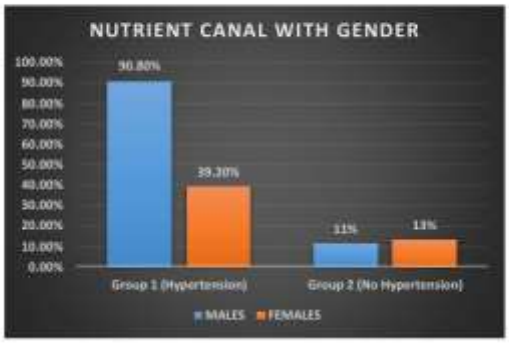


Table 4: Association and correlation of presence of nutrient canal with duration of hypertension in group 1 (hypertension) [n=150]

	Nutrient canal absent N (%)	Nutrient canal present N (%)
1-3 years	2 (13.3%)	13 (86.7%)
4-6 years	6 (15.3%)	39 (86.7%)
7-9 years	5 (10%)	45 (90%)
10-12 years	3 (17.6%)	14 (82.4%)
13-15 years	4 (33.3%)	8 (66.7%)
>15 years	8 (72.7%)	3 (27.3%)
	Chi square test =26.48 , p=0.001** (highly statistical significant association) Spearman r correlation value = -0.322, p =0.094 (statistical significant moderate negative correlation)	

Graph 4: Association and correlation of presence of nutrient canal with duration of hypertension in group 1 (hypertension) [n=150]

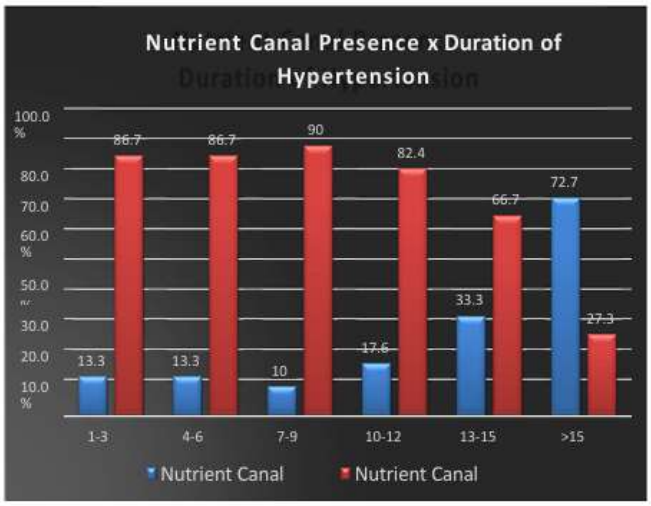


Table 5: Association and correlation of presence of nutrient canal with duration of hypertension in group 1 (hypertension) [n=150]

	Nutrient Canal absent N (%)	Nutrient Canal present N (%)
Absent (n=128) 19 (14.8%)	19 (14.8%)	109 (85.2%)
Present (n=22)	9 (40.9%)	3 (59.1%)
	Chi square test = 8.401, p=0.004* (statistical significant association) Spearman r correlation value = -0.287, p =0.098 (Statistical significant moderate negative correlation)	

Graph 5: Association and correlation of presence of nutrient canal with duration of hypertension in group 1 (hypertension) [n=150]

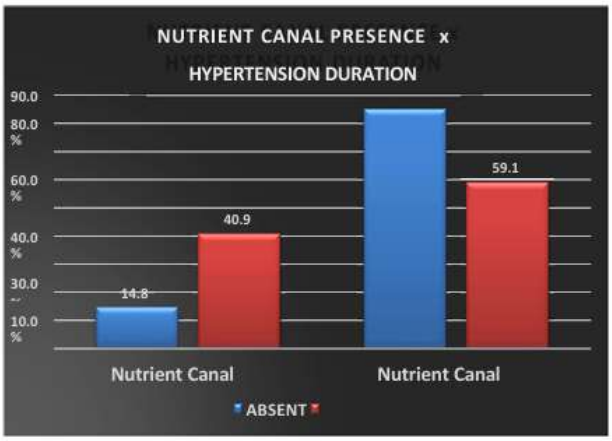
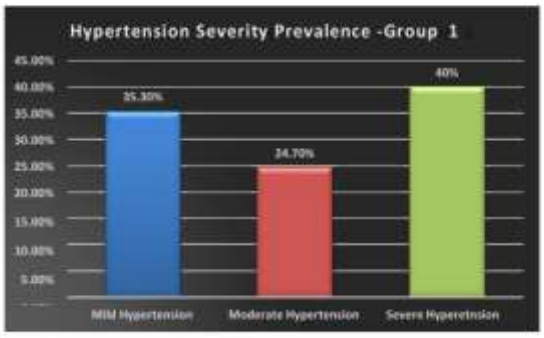


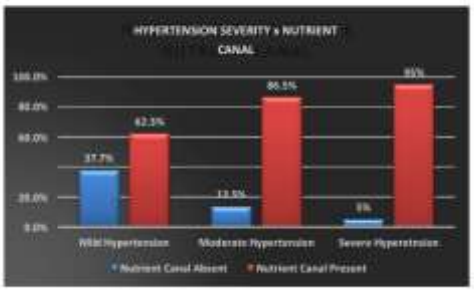
Table 6: Distribution of severity of hypertension in group 1 (hypertension) [n=150]

	Frequency (n)	Percentage (%)
Mild Hypertension	53	35.3%
Moderate Hypertension	37	24.7%
Severe Hypertension	60	40%
Total	150	100%

Graph 6: Distribution of severity of hypertension in group 1 (hypertension) [n=150]



Graph 7: Association and correlation of presence of nutrient canal with severity of hypertension in group 1 (hypertension) [n=150]



A **statistically significant association** was observed between the presence of systemic conditions and presence of nutrient canals ($p < 0.05$). A **moderate negative correlation**, which was statistically non-significant ($p < 0.05$), suggested that the presence of additional systemic conditions and increasing duration of hypertension may be associated with a decrease in nutrient canals.

Discussion-

Intraoral radiography plays a vital role in dental diagnosis by complementing clinical examination and aiding in the identification of anatomical landmarks. Variations in these landmarks, particularly the presence of nutrient canals (NCs), may indicate underlying systemic conditions. NCs are radiolucent lines representing channels for blood vessels and nerves, most commonly seen in the mandibular anterior region due to thin alveolar bone, horizontal trabecular pattern, and reduced cortical support.

Previous studies have reported a wide variation in NC incidence (5–88%). In the present study of 150 subjects, NCs were observed in 81.3% of hypertensive patients compared to 18% in controls, indicating a strong association with hypertension. The increased incidence is attributed to vascular changes in hypertension such as arteriolar dilatation, hypertrophy, hyperplasia, arteriosclerosis, and development of collateral circulation.

A higher prevalence of NCs was noted in individuals above 40 years, with a decline in patients above 60 years, possibly due to age-related vascular calcification. NCs were more frequent in hypertensive males than females, consistent with the higher prevalence of hypertension in males. A significant association was also observed between NC incidence and duration as well as severity of hypertension; however, a reduction in NCs was seen in patients with hypertension exceeding 10 years, likely due to advanced arteriosclerotic calcification.

Overall, this study demonstrates a statistically significant correlation between nutrient canals in the mandibular anterior region and hypertension in both males and females aged 30–70 years, supporting the potential role of IOPAR as an adjunctive screening tool for systemic vascular diseases.

Conclusion-

The present study demonstrates a significantly higher incidence of nutrient canals (NCs) in hypertensive patients compared to healthy individuals, particularly in the mandibular anterior region on IOPARs. NCs were more commonly observed in interproximal areas and showed a significant correlation with the severity of hypertension. These findings suggest that an increased number of NCs may serve as an adjunctive radiographic indicator for hypertension, prompting dentists to recommend further medical evaluation.

Recognition of nutrient canals on routine intraoral radiographs can aid in the early identification of systemic diseases such as hypertension. However, larger sample sizes and further studies involving other systemic conditions like diabetes and menopause are required to better understand the influence of age, sex, disease duration, and other cofactors. Overall, the study supports the potential role of nutrient canals as an additional radiographic marker in the detection of systemic vascular diseases.

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