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Prevalence Of Nutrient Canals In Mandibular Anterior Region In Hypertensive And Diabetic Patients Through Cone Beam Computed Tomography -A Radiographic Study

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ABSTRACT

INTRODUCTION: *Nutrient canals in the anterior mandible are clinically significant structures that may indicate underlying systemic diseases. The purpose of this study was to assess the presence, number, and size of nutrient canals on cone-beam computed tomography (CBCT) in individuals with diabetes mellitus, hypertension, and in healthy controls. A total of 45 patients were analyzed in groups by age and sex. The results showed that the incidence and diameter in the cohort with diabetes and the group with hypertension were significantly larger than the control group, suggesting that with CBCT evaluation of nutrient canals may allow clinicians to recognize systemic vascular alterations in these two clinical conditions.*

AIM & OBJECTIVES-

AIM:
To assess the incidence of nutrient canals in the anterior region of the mandible using Cone Beam Computed Tomography scanning in individuals with hypertension or diabetes mellitus.

OBJECTIVES:
1. *To evaluate the occurrence and count of microvascular and nutrient canals in the mandibular anterior region through CBCT in a control group, considering age and gender.*
2. *To evaluate the occurrence and size of microvascular and nutrient canals in hypertensive and diabetic individuals, in relation to age and gender.*
3. *To measure the diameter of these canals using CBCT in the control group.*
4. *To assess the periphery of neural conduits in cases diagnosed with hypertension and diabetes.*
5. *To compare the prevalence, count, and dimensions of the evaluated canals.*

MATERIALS AND METHOD: *The prospective study was conducted in the Department of Oral Medicine and Radiology in Teerthanker Mahaveer Dental College & Research Centre, Moradabad. A total of 45 patients were subdivided into three groups: diabetic (n=15), hypertensive(n=15), and a control group(n=15) for analysis. The data was analyzed using SPSS (Statistical Package for the Social Sciences), version 23.0, and the statistical analysis was done using the Chi-square test and the independent t-test.*

RESULT: *The study findings revealed a statistically significant difference in terms of incidence and number of nutrient canals between diabetic, hypertensive, and control groups. Furthermore, the* ***diabetic cohort*** *exhibited the greatest diameters of nutrient canals, followed by the* ***hypertensive group****, while the* ***control cohort*** *displayed the shortest diameters. However, there was* ***no significant difference*** *between the diabetic and hypertensive groups.*

CONCLUSION: *This study showed a positive correlation between the incidence of nutrient canals in patients with hypertension or diabetes mellitus. These findings may serve as an aid in identifying systemic diseases such as diabetes mellitus or hypertension.*

KEYWORDS: *Nutrient Canals, Hypertension, Diabetes Mellitus, CBCT.*

INTRODUCTION:

Diagnostic radiology is essential for assessing the maxillofacial skeleton and identifying conditions such as dental caries and periodontal disease. However, amid all the radiographic assessment methods, the detection of nutrient canals, which holds a diagnostic value, remained untouched. Stafne originally described them as linear radiolucent regions bordered by a radiopaque margin, most commonly in the anterior mandible, especially in the area of bone resorption. [1]

Conventionally, two-dimensional radiographic modalities, such as intraoral periapical and panoramic radiographs, show limited accessibility towards accessory canals due to their inherent three-dimensional anatomy. On the other hand, advanced imaging modalities such as magnetic resonance imaging (MRI) and computed tomography (CT) provide more detailed anatomical insight. [2] Concurrently, Cone Beam Computed Tomography is the absolute best option for assessing the nutrient canals due to its volumetric imaging at a very high resolution, a lower dose of radiation, and the avoidance of superimposed structures common in standard radiographs. [3]

Nutrient canals carry blood vessels, lymphatics, and nerve fibers from the incisive branch of the inferior alveolar nerve, supplying the anterior mandibular teeth and gingiva. They are predominantly seen in the maxillary and mandibular premolar areas, the anterior region of the mandible, and the walls of the maxillary sinus. Their presence depends on various factors such as age, ethnicity, and health conditions, like periodontal disease, hypertension, diabetes, bone disorders, and calcium metabolism disturbances.Notably, the nutrient canals are seen in cases with atrophied alveolar ridges or diminished trabecular bone density. [4]

Failure to recognize mandibular nutrient or accessory nerve canals during clinical procedures may result in incomplete anesthesia, excessive bleeding during surgery, postoperative paresthesia, or prolonged sensory deficit. [5] Damage to the mandibular incisive canal during implant placement, for instance, can cause permanent sensory loss. However, it is not safe, as standard periapical and panoramic images do not give enough information to be used alone. In contrast, CBCT provides accurate three-dimensional imaging and reliable measurement of accessory canals. Its use in routine diagnostics improves patient safety. [6]

MATERIALS AND METHODOLOGY:

This planned experimental study was conducted between May 2023 and June 2024 in the Department of Oral Medicine and Radiology, Teerthanker Mahaveer Dental College & Research Centre, Moradabad. Ethical clearance was obtained from the institutional ethical committee on 18 April 2023 (Approval No: **TMDCRC/IEC/TH/22-23/OMR 02).** Cone-beam computed tomography (CBCT) was performed on 45 patients (male and female), who were divided into three groups based on patients' health condition: Group 1= healthy controls (n=15), Group 2 = Hypertensives (n=15), and Group 3 diabetics (n=15)

The sample size was determined using G Power software (Version 3.1.9.6, Franz Faul, University of Kiel), using the confidence interval, Type I error, response distribution, as well as Z value (1.96).

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The study's inclusion and exclusion criteria are outlined in the section below:

Inclusion Criteria

- Patients aged between **20 and 65 years** were taken to determine a uniform sample distribution.
- Individuals should have **fully erupted permanent mandibular incisors** without any developmental anomalies associated with the anterior region.
- Patients with **clinically diagnosed hypertension or diabetes** (for Groups 2 and 3), with medical records confirming the diagnosis.
- Patients in the control group had **no history of systemic illness** and no reported metabolic conditions.
- CBCT scans of **good diagnostic quality.**

Exclusion Criteria:

- Patients with **cysts, tumors, or pathological lesions affecting the mandibular anterior region.**
- Individuals who had **no history of trauma or surgical interventions.**
- Patients with **any developmental disturbances** associated with the mandibular anterior segment.
- Presence of any **prostheses, metallic restoration, and orthodontic appliances** that could impair diagnostic accuracy.
- Patients with any other physiological compromise should be considered to ensure a focused comparative analysis.

Imaging Protocol

All the scans were acquired with a New Tom 3D SMART CBCT unit **[Figure 1].** Imaging settings included a tube voltage (60-85kVp), Tube current (10 mA), exposure time (3.6-26 seconds), a field of view (6x6 cm), and focal spot size (0.5mm). **[Figure 2]**The images were evaluated in axial sections using the NewTom software. The nutrient canal dimensions were measured from digital calipers, which were calibrated in mm**. [Figure 3]**

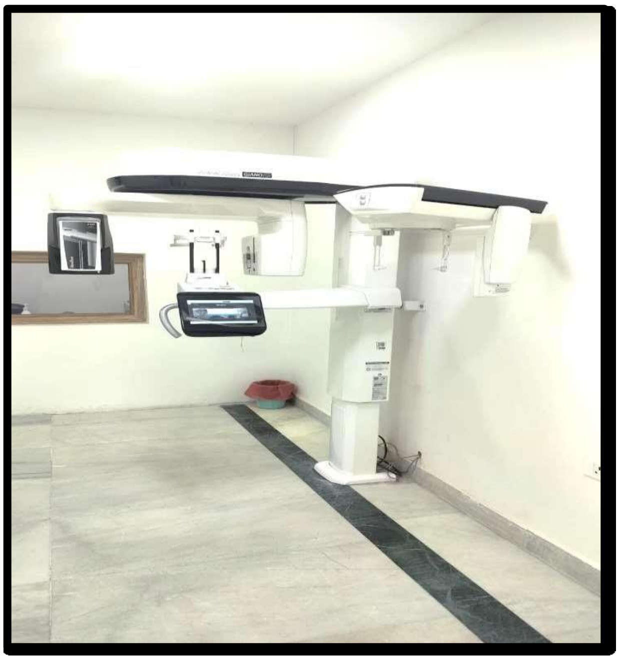

Fig. 1 CBCT Machine

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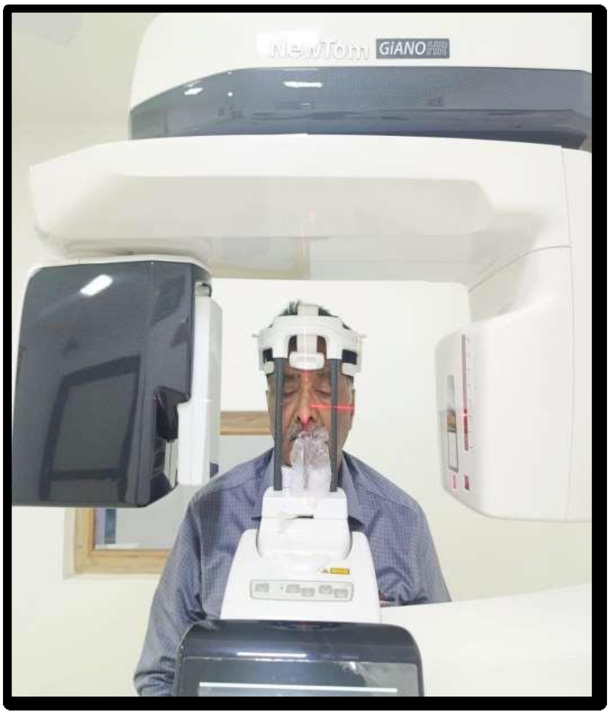

Fig. 2 Patient positioning

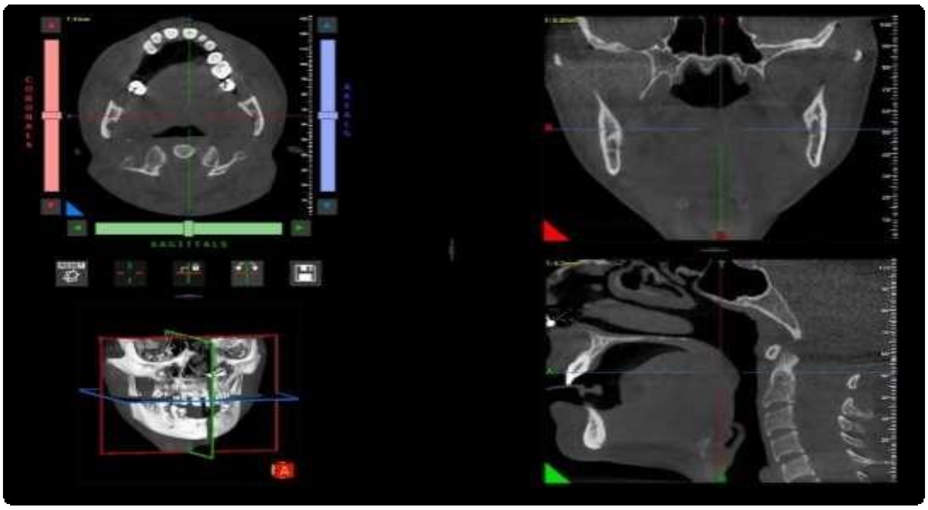

Fig. 3 Sagittal section of CBCT showing nutrient canal in mandibular anterior region

Data Analysis:

For each patient, the presence as well as the number of nutrient channels were recorded. The canal diameter was measured from the widest point on CBCT scans. To maintain accuracy and minimize observer bias, two independent experts performed the calculation work. In cases of conflict, a third senior examiner reviewed the data to reach a final decision.

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RESULT & OBSERVATION:

45 scans from the control, diabetic, and hypertensive groups were analyzed.

INTER-OBSERVER RELIABILITY:

Kappa statistics were used to evaluate the reliability of the results. An excellent agreement was shown between the two observers (κ = 0.89–0.92), confirming the consistency in the identification of canal assessment (**Table 1**).

TABLE 1 Inter-Observer Reliability (Cohen's Kappa Coefficient)

Variable	Kappa Value	Interpretation
Presence of Nutrient Canals	0.92	Excellent Agreement
Number of Nutrient Canals	0.89	Excellent Agreement
Diameter of Nutrient Canals	0.90	Excellent Agreement

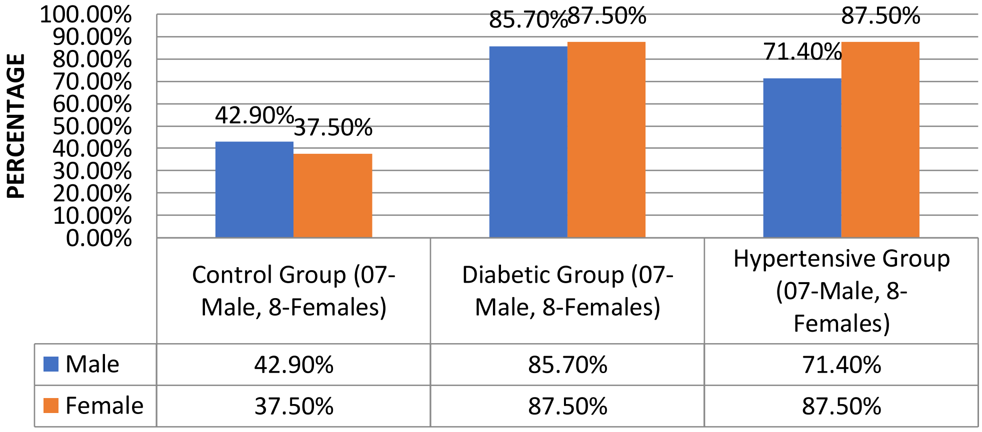
INCIDENCE OF NUTRIENT CANALS:

Nutrient canals were detected in 40% of the control participants, in 86.2% of individuals with diabetes, and in 80% of those with hypertension. The diabetic group had a slightly higher frequency, followed closely by the hypertensive cohort; however, the control group had the lowest frequency. There were minimal differences based on sex; females in the systemic disease groups tend to exhibit a slightly higher incidence than males. The outcomes are shown in **Table 2** and visualized in **Graph 1.**

Table 2: Incidence of Nutrient Canals in Mandibular Anterior Region

Group	Male	Female	Total (n)	Total Incidence (%)
Control Group(07-Males, 8-Females)	3(42.9%)	3(37.5%)	6	40.0%
Diabetic Group (07-Males, 8-Females)	6 (85.7%)	7 (87.5%)	13	86.7%
Hypertensive Group (07-Males, 8-Females)	5(71.4%)	7 (87.5%)	12	80.0%

Graph 1: Incidence of Nutrient Canals in Mandibular Anterior Region



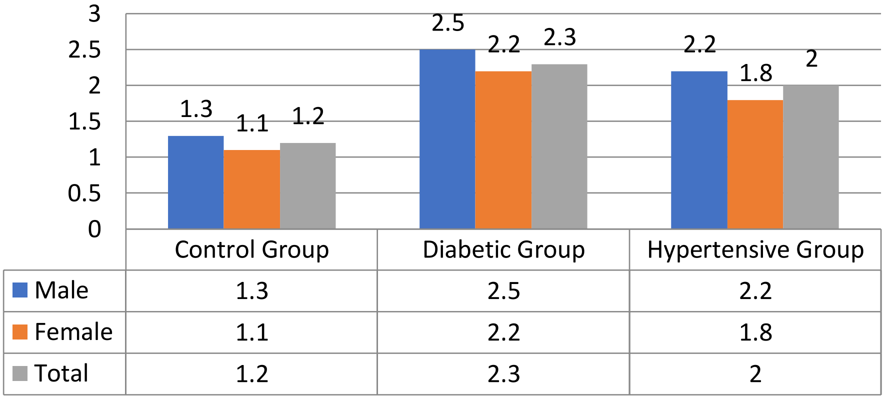
MEAN NUMBER OF NUTRIENT CANALS:

On average, diabetics had a mean of 2.3 ± 0.93, hypertensives had a mean of 2.0 ± 0.89, and a mean of 1.2 ± 0.40 in the control group. Males generally have higher counts than females across all the groups. The various results are presented in **Table 3 and Graph 2**.

Table 3: Gender-Based Mean Number of Nutrient Canals

Group	Male	Female	Total
Control Group	1.3 ± 0.45	1.1 ± 0.35	1.20 ± 0.40
Diabetic Group	2.5 ± 0.95	2.2 ± 0.90	2.3 ± 0.93
Hypertensive Group	2.2 ± 0.93	1.8 ± 0.87	2.0 ± 0.89

Graph 2: Gender-Based Mean Number of Nutrient Canals



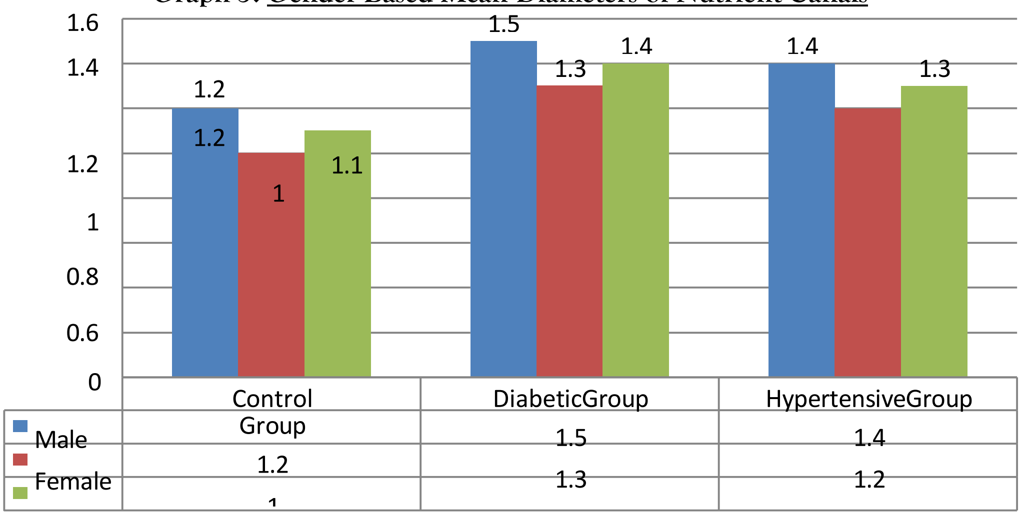
MEAN DIAMETER OF THE NUTRIENT CANALS:

When examining canal diameters, the diabetic group recorded the largest values (1.4 ± 0.27 mm), followed by the hypertensive group (1.3 ± 0.24mm), and the control group showed the smallest diameter (1.1 ± 0.20mm). Males consistently showed wider canals than females across the groups. The data are shown in **Table 4 and Graph 3**.

Table 4:Gender-Based Mean Diameters of Nutrient Canals

Group	Male	Female	Total
Control Group	1.2 ± 0.25	1.0 ± 0.15	1.1 ± 0.20
Diabetic Group	1.5 ± 0.30	1.3 ± 0.23	1.4 ± 0.27
Hypertensive Group	1.4 ± 0.30	1.2 ± 0.20	1.3 ± 0.24

Graph 3: Gender-Based Mean Diameters of Nutrient Canals



STATISTICAL ANALYSIS:

The distribution of canals differed significantly between the control group and both systemic groups (P =0.001); however, there were no significant differences observed between the diabetic and hypertensive groups

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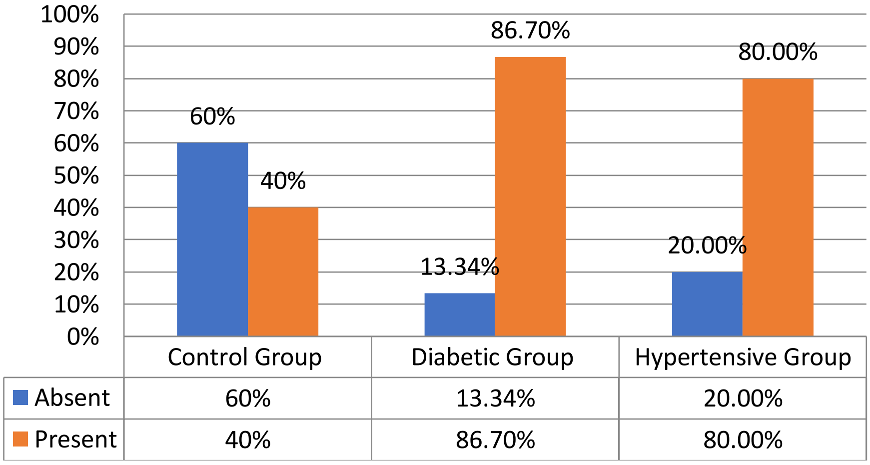
(P = 0.879) [**Table 5, Graph4**].

Table 5: Statistical Analysis Results for Incidence of Nutrient Canals

	Absent	Present	P value	Significance
Control Group	09	06	0.001	Significant
	60%	40%		
Diabetic Group	02	13		
	13.34%	86.7%		
Control Group	09	06	0.001	Significant
	60%	40%		
Hypertensive Group	03	12		
	20.00%	80.0%		
Diabetic Group	02	13	0.879	Non-Significant
	13.34%	86.7%		
Hypertensive Group	03	12		
	20.00%	80.0%		

Graph 4: Statistical Analysis Results for Incidence of Nutrient Canals



For the mean number of canals, a one–way ANOVA showed significant variation between groups (P = 0.012). The post hoc comparisons showed that the number of canals was significantly higher in both diabetic (P = 0.011) and hypertensive (P =0.032) compared to the controls, with no significant difference between the diabetic and hypertensive (P = 0.612) [**Table 6, Graph5].**

Table 6: Statistical Analysis for Number of Nutrient Canals

	Mean	Std Dev	Std Error	F value	P value
Control Group	1.20	0.47	0.081	5.269	0.012(Sig)
Diabetic Group	2.30	0.93	0.160		
Hypertensive Group	2.00	0.89	0.141		

Graph 5: Statistical Analysis for the Number of Nutrient Canals

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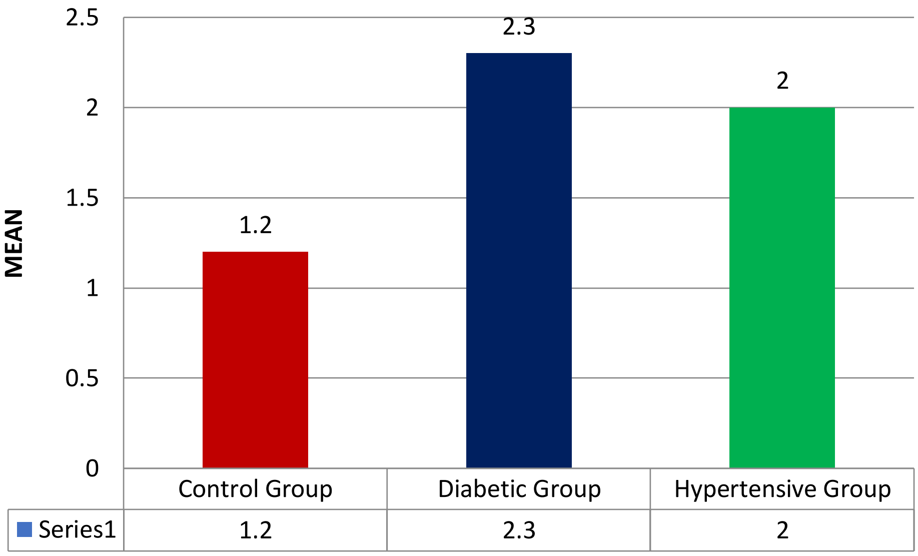
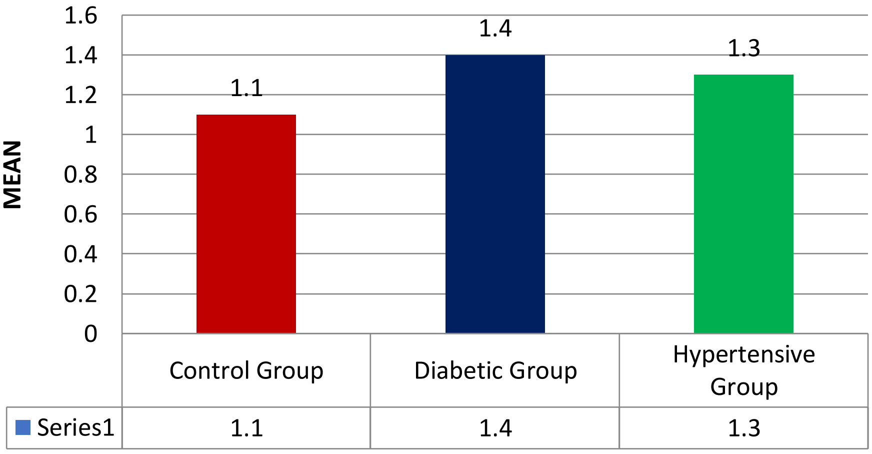


Post Hoc Analysis

Intergroup Comparison		Mean Difference	P value	Significance
Control Group	**Diabetic Group**	1.100	0.011	Significant
Control Group	**Hypertensive Group**	0.800	0.032	Significant
Diabetic Group	**Hypertensive Group**	0.30	0.612	Non-Significant

The measurements of canal diameter were similar, with both the diabetic and hypertensive groups showing significantly larger measures than the control group. **(Graph 6)**.

Graph 6: Statistical analysis of the diameter of nutrient canals



DISCUSSION

Nutrient canals may show surrogate radiographic markers of systemic and oral diseases as they are correlated with changes in both skeletal and soft tissues. [7,8] Cone-beam computed tomography (CBCT) displays higher spatial resolution, is relatively inexpensive, and offers comprehensive evaluation of nutrient canals.

Their occurrence and morphology are influenced by various factors: genetics, tooth loss, prosthetic use, and systemic conditions. At least two of these systemic conditions, diabetes and hypertension, are known to have microvascular and maxillofacial alterations (Iqubal et al., 2015; Kaul et al., 2017) [9].

There is much variability in the incidence of nutrient canals depending on systemic conditions. The control group had an incidence rate of 40% and a slightly higher prevalence for males (42.9%) than females (37.5%); the diabetic group had a much higher prevalence of 86.7%, with no observable difference in incidence by gender (85.7% in males vs. 87.5% in females). Similar to the diabetic population, the hypertensive population showed a higher prevalence at 80%, but had a notable gender difference, with a higher prevalence in females (87.5%) than in males (71.4%). This finding is comparable to the findings of Patsakas (1990) [10], who demonstrated a greater incidence in females than males, and was incongruent with the findings of Patel and Wuehrmann (1976) [11], who found no significant relationship between gender and incidence of canals. Alternatively, Kaul et al. (2017) [12] had a slightly larger percentage of canals identified in males (63.6%) than in females (61.6%), while Mani et al. (2013) [13] had a greater percentage of canals identified in females (59.32%) than in males (50.54%).

The diabetic groups had the highest mean nutrient canal counts, followed by the hypertensive group; controls had the lowest nutrient canal counts. Although men had higher mean counts in the control group and diabetic groups, there was a smaller difference in counts between genders in the hypertensive group. These results confirm the findings of Mani et al. (2013), who reinforced the contribution of anatomical and systemic vascular changes to canal proliferation.

The diabetic group exhibited the largest average canal diameter (1.40 mm ± 0.27); the mean diameter in the hypertensives (1.30 mm ± 0.24) was slightly smaller, while controls had a smaller mean (1.10 mm ± 0.20; $p = 0.002$). Males demonstrated generally larger canal diameters than females in each of the groups; however, males in the diabetic and hypertensive groups exhibited the largest diameters. The results of this study concur with the previous studies performed by Patel and Wuehrmann (1976), [11] Pierrakou and Donta (1990) [14], and Bilge et al. (1992) [15], who determined that systemic vascular changes were related to the canal size and therefore can serve as radiographic evidence of possible systemic disease.

CONCLUSION

The CBCT assessments of the anterior mandible reported increased occurrence and average sizes of nutrient canals for people with diabetes and hypertension when compared to healthy controls. The females in the systemic disease groups had a greater occurrence than males, while morphometrics confirmed the canal diameters were significantly larger in these populations. Although the diabetic subjects demonstrated the highest values, there was an insignificant difference between the diabetic and hypertensive groups. These studies have the potential to highlight nutrient canals as a radiographic preview of changes associated with systemic vascular alterations and relating their significance in terms of preoperative maxillofacial investigations.

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