An Intraoral Periapical Radiographic Study of Mandibular Nutrient Canals with Conventional and Digital Radiography in Hypertensive Patients: A Comparative Study

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ABSTRACT

Background: Hypertension is one of the most common medical problems seen in our dental profession. Nutrient canals are spaces in bones and are considered to be channels that transmit blood vessels and nerves. They are observed more frequently in the mandibular anterior region as radiolucent lines in intraoral periapical radiographs. The radiographically observable nutrient canals have been shown to have an association with various systemic diseases like hypertension. This can be used as an evidence for the detection of hypertensive patients for better diagnosis and treatment decisions.

Aim and objectives: The aim of the present study was to evaluate if any correlation exists between nutrient canals and hypertension.

Materials and methods: Two hundred patients with hypertension for 1 to 10 years (groups I and II) and 100 age matched controls (group III) were included in the study. The prevalence of nutrient canals in all the groups and with reference to age and gender was observed along with the comparison between intraoral conventional and digital radiography.

Results:
1. Differences in the prevalence of nutrient canals between groups I, II and III were found to be statistically significant.
2. In the groups I and II, prevalence of nutrient canals increased with age and also with the duration of hypertension, however it was statistically insignificant. There was no significant difference in prevalence rate among the different age groups in control group.
3. The presence of nutrient canals among the three groups in males and females was statistically significant.
4. Differences in the prevalence of nutrient canals when compared with intraoral conventional and digital radiographic method among all the three groups did not reveal statistically significant results.

Conclusion: It is evident from the present study that there is a correlation between prevalence of nutrient canals and hypertension.

Keywords: Blood pressure, Hypertension, Intraoral, Nutrient canals, Radiography.

INTRODUCTION

Diagnostic radiography has evolved as an inseparable branch of dentistry. Dental radiographs are an important diagnostic aid and are routinely used for investigating the teeth and bone disorders. It is used primarily to recognise dental caries, periapical and periodontal diseases. Certain dental radiographic findings can be of great significance if evaluated carefully, one such finding is the presence of nutrient canals (NC).

Nutrient canals have also been called interdental canals, circulating canals or vascular channels and are considered to be channels that contain blood vessels, lymph vessels and nerves. Lovette (1948) classified NC (suggested for their roentgenographic appearance) into 3 categories:

Type I
A radiolucent line, varying in size, as a fine thread-like marking to a width of 0.5 mm and in length from 1 to 2 cm. The course of this radiolucent line may be linear, circular, haphazard or a combination of any two or all three.

Type II
A moderately radiolucent line, varying from 0.5 to 1.5 mm in width and 3 mm to 2.5 cm in length. Their course is linear or circular and only occasionally haphazard.

Type III
A broad, usually only slightly radiolucent line varying in size from 1.5 to 4 mm in width and 6 mm to 7.0 cm in length. Their course is mostly linear, with smooth turns or tight circular turns in the area of the mental foramen of the mandible. They are found only in the mandible and are mandibular canals and their large branches.

Patel and Wuehrmann (1976) subjectively classified NC into 2 groups—prominent and discernible on the basis of darkness and distinctness rather than on the basis of width. In intraoral periapical radiographs (IOPAR), NC appears as linear radiolucencies and varies in size, number, prominence, and in their relationship to the roots of the teeth. They are observed more frequently in the mandibular anterior region and also seen in mandibular premolar, maxillary premolar region and in the walls of maxillary sinus.

Predominance of NC in the anterior mandibular region is attributed to the following facts:
1. Thin alveolar process,
2. Horizontally arranged trabeculae,
3. Decreased bony support of cortical and cancellous bone, and
4. More prone to irritation from calculus and trauma.

Nutrient canals have been correlated with various pathological conditions, such as periodontal disease, hypertension, diabetes, tuberculosis, rickets, calcium deficiency, disuse atrophy and coarctation of the aorta and can be used as a diagnostic marker of various systemic diseases. Thus, the role of the dentist in recognising subtle differences in the appearance of NC in diagnostic radiographs cannot be overlooked. The existing literature revealed very little information in this regard. Hence, the present study was undertaken to determine the correlation between the presence of NC in the mandibular anterior region and hypertension (HTN).

**AIM AND OBJECTIVES**

The present study was undertaken with the aim to compare the correlation between mandibular NC and HTN using conventional and digital radiography.

The objectives were:

1. To evaluate the correlation of NC in HTN patients with 1 to 5 years of history of disease.
2. To evaluate the correlation of NC in HTN patients with 6 to 10 years of history of disease.
3. To evaluate the correlation of NC in age and sex matched control group.
4. To compare the correlation of NC in patients with HTN with that of control group.
5. To compare the correlation of occurrence of NC between males and females.

**MATERIALS AND METHODS**

The research protocol for this study was reviewed and approved by the Institutional Review Board at KLE VK Institute of Dental Sciences (KLE VKIDS), Belgaum, India.

**Source of Data**

Patients of either sex reporting to the Outpatient Department of Oral Medicine and Radiology at KLE VKIDS, Belgaum, in the age range of 41 to 60 years were included in the study after obtaining a written informed consent from the patient.

**Method of Collection of Data**

The inclusion criteria included 200 clinically confirmed patients with HTN and 100 healthy subjects. The following exclusion criteria were considered:

1. Patients with history of HTN ≤1 or ≥10 years
2. Edentulous conditions
3. Any history of any orthodontic treatment

Three hundred patients fulfilling the criteria set for subject selection were included in the study and were categorised into three groups; each group consisted of 100 subjects with 50 males and 50 females, in the following manner:

1. **Group I**: Clinically diagnosed HTN patients with 1 to 5 years of duration of disease (study group) (n = 100).
2. **Group II**: Clinically diagnosed HTN patients with 6 to 10 years of duration of disease (study group) (n = 100).
3. **Group III**: Subjects without any past or present history of HTN (control group) (n = 100).

**Method**

In the present study total numbers of 300 patients were enrolled, among which 200 patients were in the study group and 100 were in the control group. All the cases underwent detailed history as per the case history proforma and thorough oral examination.

**Procedural Steps for Radiography**

In all the three groups, conventional and digital IOPAR were taken in mandibular anterior region by paralleling cone technique for the radiographic evaluation of NC. The IOPAR were made using the Kodak E speed films and the intraoral radiographic machine (IntraOs 70 Bluex) with exposure parameters of 70 kVp, 8 mA and 0.5 seconds for conventional method. Similar methodology was followed for the digital radiographs using digital sensor (Kodak) with exposure parameters of 70 kVp, 8 mA and 0.3 seconds. The subject was draped with a lead apron and thyroid collar. The film/sensor was exposed by pressing the exposure button to activate the machine. Immediately after the exposure, all the conventional films were processed manually (visual method) in a well equipped, light-proof dark room and print out of the images was taken for the digital radiographs. Six hundred intraoral periapical radiographs were taken with conventional intraoral radiographic machine and 600 intraoral periapical radiographs were taken with digital radiography. Radiographic evaluation of NC 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 NC and the frequency (number) were noted.

**Procedural Steps for Measurement of Hypertension**

Blood pressure was recorded using the auscultatory method. The systolic and diastolic pressure levels were recorded in
terms of mm Hg. The classification given by the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure VII (JNC VII) (2003) was used for the selection of hypertensive patients. The subjects who were classified as ‘pre-hypertensive’ was included in group I whereas the subjects fulfilling the criteria of ‘stage 1’ were included in group II.

**STATISTICAL ANALYSIS**

The observations made in three groups were compiled in three master charts, one for each group. The statistical analysis was done using Z-test for proportions to determine statistically significant difference between the prevalence of NC and unpaired t-test was applied to determine statistically significant difference between the average numbers of NC.

**RESULTS**

**Prevalence of nutrient canals among the three groups (Table 1 and Graph 1):** In group I, out of 100 patients, 47 (47%) revealed NC whereas in group II, 63 (63%) out of 100 patients revealed NC. However, out of 100 individuals of group III, only 25 of them (25%) revealed NC. Differences in the prevalence of NC between groups I, II and III were found to be statistically significant.

**Age wise prevalence of nutrient canals among the three groups (Tables 2A, 2B and Graph 2):** In the study group, prevalence of NC increased with age and also with the duration of HTN, however it was statistically insignificant. There was no significant difference in prevalence rate among the different age groups in control group. In groups I and II, prevalence of NC increased with age and also with the duration of the disease; however, it was statistically insignificant. There was no significant difference in prevalence rate among the different age groups in group III.

**Gender-wise prevalence of nutrient canals among three groups (Tables 3A, 3B and Graph 3):** The prevalence of NC was studied radiographically in groups I, II and III with reference to gender. Nutrient canals were observed more in males (56.7%) in groups I and II as well as in group III as compared to females (33.3%). The difference in the presence of NC among the three groups in males and females was statistically significant.

**Prevalence of nutrient canals by intraoral conventional and digital radiography among three groups (Table 4 and Graph 4) (Figs 1 and 2):** The prevalence of NC was studied radiographically in control and hypertensive patients with reference to conventional and digital radiographic method. In the present study, the prevalence of NC in groups I and II was found to be 47 and 62% respectively in digital radiographs whereas it was 41 and 54% respectively when taken by conventional method. In group III, the prevalence of NC was 23 and 25% by conventional and digital methods respectively. Differences in the prevalence of NC and the relationship between NC and intraoral conventional and digital radiograph among all the groups were not statistically significant.

**DISCUSSION**

Diagnosis is an art of identifying the disease with definite clinical procedures supported by investigations. In
Table 3A: Gender-wise prevalence of nutrient canals among three groups

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group I Nutrient canals</th>
<th>Group II Nutrient canals</th>
<th>Group III Nutrient canals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
<td>Total</td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>18</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(64%)</td>
<td>(36%)</td>
<td>(78%)</td>
</tr>
<tr>
<td>Female</td>
<td>15</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(30%)</td>
<td>(70%)</td>
<td>(48%)</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>53</td>
<td>100</td>
</tr>
</tbody>
</table>

Group I: $\chi^2 = 11.601, p = 0.0006$ (Significant); Group II: $\chi^2 = 9.652, p = 0.002$ (Significant); Group III: $\chi^2 = 0.480, p = 0.5$ (Non-significant)

Table 3B: Overall prevalence of nutrient canals in three groups with reference to gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Nutrient canals</th>
<th>Present</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>85 (56.7%)</td>
<td>65 (43.3%)</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>50 (33.3%)</td>
<td>100 (66.7%)</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 16.498, p = 0.000$ (Highly significant)

diagnosing the disease, alteration of normal structure, either in the bone or soft tissue would give a clue to diagnosis and serve as a marker of a disease. Nutrient canal in the jaw bone is one such anatomical structure in the human body which may help in diagnosing a systemic disease and can be used as a marker for evaluation of many oral and systemic diseases.

Radiolucencies that appear to represent spaces in bone through which blood vessels and nerves travel to supply surrounding structures have been termed as nutrient canals. Hirschfield (1923) first described NC on radiographs and termed them as ‘interdental channels’. Nutrient canals appear most frequently on the intraoral radiographs of the mandibular anterior region, followed by the mandibular premolar area, the maxillary premolar area, and the wall of the maxillary sinus. Nutrient canals are studied so as to know about their nature in normal individuals and their alteration in the disease process.

The present study was restricted to radiographs of the mandibular anterior cuspid central incisor region, since NC are most commonly observed in this area. They are well visible in IOPAR which is routinely used in diagnosing and evaluating diseases of teeth and jaws. Established facts about NC would enable any clinician to interpret them which would serve as a diagnostic marker for underlying systemic diseases like hypertension. Hypertension is one of the most commonly encountered medical problems in dental practice which is often asymptomatic and can lead to lethal complications if left untreated.

Hence, an attempt was made in the present study to evaluate the association of NC to hypertension. Patients with HTN were considered for this particular research not only due to the easy availability of cases but also as this disease is one of the major risk factor for other systemic diseases such as heart attack, stroke or renal failure and better control can lead to prevention of this life-threatening disease. Thus, any new aspects evolved in this study would enable early diagnosis, prevention and control of HTN.

Prevalence of nutrient canals among the three groups: In the present study, NC were present in 47% of individuals who had HTN for 1 to 5 years and 63% in individuals with HTN for 6 to 10 years whereas only 25% of the individuals without the history of HTN had shown the NC on intraoral radiographs. On comparing the three groups the differences were found to be statistically significant. This could be attributed to the variations in physiological remodelling of the bone in case of systemic diseases like HTN. The observation found in the present study was not consistent with the results of the studies carried by Sweet et al (1942) who found a prevalence of 15.8% and Bilge et al (1992) found radiographic prevalence of NC of 54.3% in general

Table 4: Evaluation of prevalence of nutrient canals by intraoral conventional and digital radiography

<table>
<thead>
<tr>
<th>Nutrient canals</th>
<th>Digital radiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional radiography</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>165</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
</tr>
</tbody>
</table>

Kappa statistics = 0.910; p = 0.000; Very strong degree of agreement between intraoral conventional and digital method
population. The present observation was compatible with the study by Patni et al (1985) who reported a prevalence of 64% (70% in cases and 56.2% in controls).

The reason for variability in the prevalence of NC among the present study and the previous studies could be attributed to the fact that in previous studies other cofactors like calcium deficiency, diseases like diabetes mellitus and periodontitis were also included which were excluded in the present study.

Age-wise prevalence of nutrient canals among three groups: On comparing NC with different age groups, NC were seen in 43.03% in 41 to 50-year-old age group, and 50.37% in 51- to 60-year-old age group. Thus, there was an association of advanced age with the presence of NC in HTN patients. In the present study prevalence of NC was higher in the age range of 41 to 50 (43.03%). According to Patel et al (2010) it was higher (31%) in age group of 45 to 54 years whereas Bilge et al (1992) noted an increased prevalence of 27.2% in 20- to 24-year-old age group.

The reason for better visibility of NC in advanced age above 51 years in hypertensive patients may be due to the dilatation of arterioles, hypertrophy and hyperplasia of the vessel wall and arteriosclerosis, along with thickening of the arterial wall. As this destructive process requires more of blood supply, the neighbouring blood vessels proliferate and accommodate in the bone as new capillaries which will result in more NC which are seen specifically in the anterior part of the mandible due to the presence of more spongy or cancellous bone in that area and that proliferation of blood vessels will be more in that area.

Relationship between nutrient canals and gender: The prevalence of NC was studied radiographically in groups I, II and III with reference to gender. Nutrient canals were observed more in males (56.7%) in groups I and II as well as in group III as compared to females (33.3%). The difference in the presence of NC among the three groups in males and females was statistically significant. In the present study, prevalence was higher in males and the observation
in the present study was consistent with the findings of Kishi et al (1982)\(^6\) but was not consistent with the study done by Donta et al (1989)\(^15\) who reported a prevalence of 60.8% in females and 39.2% in males which could be attributed to more population of female subjects in the study. However, Bilge et al (1992)\(^13\) in his radiographic study among 1040 patients found that there was no much difference in the distribution of NC in terms of gender (47.9% males and 52.1% females).

**Prevalence of nutrient canals with intraoral conventional and digital radiography:** The prevalence of NC was studied radiographically in control and HTN patients with reference to conventional and digital radiographic method. In the present study, the prevalence of NC in groups I and II was found to be 47 and 62% respectively in digital radiographs whereas it was 41 and 54% respectively when taken by conventional method. In group III, the prevalence of NC was 23 and 25% by conventional and digital methods respectively. Differences in the prevalence of NC and the relationship between NC and intraoral conventional and digital radiograph among all the groups were not statistically significant.

There is a paucity of studies in regard to the comparison between an intraoral conventional and digital radiographic method for the evaluation of NC and their correlation with HTN. Hence, extensive studies in this regard need to be carried out with an increased sample size which would serve as a valuable tool in diagnosing systemic diseases like HTN which is a burning issue especially related to the life style modification in developing countries.

In overall assessment of NC in HTN, it has been found in the present study that the prevalence of NC was higher in patients with HTN. It was also found that NC appeared more with the advancement of age especially in male subjects irrespective of the radiographic technique used.

**REFERENCES**


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