Nasopalatine Canal Position Relative to the Maxillary Central Incisors: A Cone Beam Computed Tomography Assessment

Pakawat Chatriyanuyoke, DDS, MS1*
Chun-I Lu, DDS1
Yusuke Suzuki, DDS, PhD1
Jaime L. Lozada, DDS1
Kitichai Rungcharassaeng, DDS, MS2
Joseph Y. K. Kan, DDS, MS1
Charles J. Goodacre, DDS, MSD3

The aim of this study was to determine the proximity of the nasopalatine canal (NPC) to the maxillary central incisor root (MCIR). The study included 120 cone beam computed tomography scans obtained from the Center for Implant Dentistry, Loma Linda University, between June 2006 and September 2009. They were equally distributed into six groups: (1) 21- to 40-year-old men, (2) 21- to 40-year-old women, (3) 41- to 60-year-old men, (4) 41- to 60-year-old women, (5) 61- to 80-year-old men, and (6) 61- to 80-year-old women. The closest distances between the NPC and the MCIR (NPC-to-MCIR) were measured at the midroot (bisecting palatal cementoenamel junction to root apex) and the apex levels. Differences between the groups were analyzed using a t test and 1-way analysis of variance at a significance level of \( \alpha = .05 \). The overall mean NPC-to-MCIR distances at the midroot and apex levels were 3.05 ± 1.64 and 5.22 ± 1.56 mm, respectively. The modes of the NPC-to-MCIR distances at the midroot and apex levels were in the range of 1.01–2.00 mm and 4.01–5.00 mm, respectively. The mean NPC-to-MCIR distance was significantly greater in men than in women at the midroot level \( (P < .05) \) but not at the apex level \( (P > .05) \). The mean NPC-to-MCIR distance was significantly shorter for the youngest age group than the other two age groups at the midroot level \( (P < .05) \). However, at the apex level, the youngest age group had a significantly shorter distance compared with the oldest age group \( (P < .05) \) but not the middle age group \( (P > .05) \). The results of this study suggest that, to avoid NPC penetration, more care must be exercised during immediate implant placement at the midroot level of a maxillary central incisor in women and younger patients because of the root proximity to the NPC. Tapered implants may also be beneficial in such situations.

Key Words: nasopalatine canal, incisive canal, immediate implant, root, central incisor, proximity, computed tomography, cone beam, CT, CBCT

INTRODUCTION

Implant placement immediately after tooth extraction was introduced in the late 1980s to reduce treatment time and help preserve alveolar bone.1 Recently, it has also been frequently combined with immediate provisionalization procedures, and studies have substan-
tiated its high success.\textsuperscript{2–5} However, when immediate implant placement is warranted at the maxillary central incisor positions, the presence of the nasopalatine canal (NPC) may limit the amount of available bone for primary implant stability.

Cone beam computed tomography (CBCT) has been used extensively in dentistry because of its ability to produce adequately accurate two- and three-dimensional images.\textsuperscript{6} Furthermore, the use of a cone-shaped X-ray beam and a more restricted field of view in the axial dimension produces a relatively low effective radiation dose compared with conventional medical computed tomography.\textsuperscript{7}

Moreover, linear measurements made from CBCT images were not significantly different from the actual direct measurements of anatomic structures in the dentomaxillofacial area.\textsuperscript{6}

The purpose of this study was to measure the relative proximity of the NPC to the maxillary central incisor root (MCIR) using CBCT images.

**Materials and Methods**

This study was approved by the Institutional Review Board of Loma Linda University. The CBCT data (i-CAT, Imaging Sciences International, Hatfield, Pa) for 120 patients (60 men and 60 women) receiving treatment at the Center for Implant Dentistry at Loma Linda University School of Dentistry between 2006 and 2009 were included. The following inclusion criteria was used: (1) age between 21 and 80 years old, (2) presence of both maxillary central incisors, and (3) absence of radiographic pathology associated with the maxillary central incisors and/or the NPC. The patients were categorized into three age groups: 21–40 years old (youngest), 41–60 years old (middle age), and 61–80 years old (oldest). The patients were then selected chronologically according to the time of the CBCT scan to form six equally distributed groups based on age group and gender: (1) youngest men, (2) youngest women, (3) middle-age men, (4) middle-age women, (5) oldest men, and (6) oldest women. The CBCT image was made in such a way that the palatal plane was parallel to the horizontal plane, thereby allowing the axial cuts at the measurement levels to be parallel to the palatal plane (Figure 1). Using the distance measurement tool in the i-CAT vision software (Imaging Sciences International), we measured the closest NPC-to-MCIR distances at the middle (bisecting palatal cementoenamel junction to root apex) of the root length (midroot) level (Figures 1 and 2) and at the apex level (Figures 3 and 4) of both maxillary central incisors. The NPC-to-MCIR distance is the shortest horizontal distance between the NPC wall and the root (Figures 2 and 4).

Data were analyzed using a $t$ test (for gender) and 1-way analysis of variance (for age group) at the significance level of $\alpha = .05$. A power of 85% was set for the sample-size calculation.

**Results**

The overall mean NPC-to-MCIR distances at the midroot and apex levels were $3.05 \pm 1.64$ mm (range = 0.89–8.09 mm) and $5.22 \pm 1.56$ mm (range = 1.79–8.96 mm), respectively. The modes of NPC-to-MCIR distances at the midroot and apex levels were lower and in the range of 1.01–2.00 mm (26.2%) and 4.01–5.00 mm (25.4%), respectively (Figure 5). Men demonstrated significantly greater NPC-to-MCIR root distances than women at the midroot level but not at the apex level ($p < .05$) (Table 1). The youngest age group exhibited a significantly shorter NPC-to-MCIR distance than the other two age groups at the midroot level ($P < .05$). At the apex level, however, significant differences in the NPC-to-MCIR distance were only observed between the youngest and oldest age groups ($P < .05$) (Table 2).

**Discussion**

In the esthetic zone, the success of immediate implant placement requires a sufficient amount of bone palatal and apical to the root socket for primary implant stability.\textsuperscript{8} When the maxillary central incisors are involved, it is vital that their proximity to the NPC be considered during treatment planning. At the palatal aspect, the engagement of the implant with the socket walls usually initiates around the midroot area of the extraction socket, while at the apical aspect the implant should extend at least 4 mm beyond the apex of the extraction socket.\textsuperscript{8} Therefore, the amount of palatal bone needed for implant engagement increases in the apical direction, which coincides with the results of this study, where the amount of available bone for palatal
**Figures 1–5.**

**Figure 1.** Demonstration of the cut parallel to the hard palate of the maxillary central incisor root at the midroot level. **Figure 2.** Axial view image of the measurements of the distance (D) from the nasopalatine canal to the maxillary central incisor root at the midroot level. MCIR indicates maxillary central incisor root; NPC, nasopalatine canal. **Figure 3.** Demonstration of the cut parallel of the hard palate of the maxillary central incisor root at the apex level. **Figure 4.** Axial view image of the measurements of the distance (D) from the nasopalatine canal to the maxillary central incisor root at the apex level. **Figure 5.** Frequency distribution of the distance from the nasopalatine canal to the maxillary central incisor root distance at the midroot and apex levels.
engagement (NPC-to-MCIR distance) was greater at the apex level than the midroot level (Tables 1 and 2). Although the mean NPC-to-root distances of 3.05 and 5.22 mm at the midroot and apex levels, respectively, seem to be sufficient for implant engagement without encroaching on the NPC, their modes were smaller and in the range of 1.01–2.00 mm (26.2%) and 4.01–5.00 mm (25.4%), respectively. Furthermore, close approximation between the NPC-to-MCIR distance was also observed on multiple occasions (Figure 5). Therefore, it is imperative that the NPC-MCIR distance be evaluated critically during treatment planning for immediate implant placement. The use of tapered implants might be beneficial for immediate implant placement in the maxillary central incisor positions, as they require less bone for implant engagement apically and have been shown to achieve better primary stability than cylindrical implants.9–11

In this study, the mean NPC-to-MCIR distance was significantly smaller at the midroot level in women than men. This is not surprising as it has been shown that men generally have a larger maxilla than women,12 whereas gender has no influence on the size of the NPC.13 The results of this study also showed that younger subjects had a significantly smaller NPC-to-MCIR distance compared with the older groups (middle and oldest groups). This result could be substantiated by the studies that reported the absence of a significant correlation between NPC dimensional change and age14 and the continuing change in maxilla shape until the sixth decade of life.15 It should be noted that the measurements reported in this study were not performed on the sagittal view images, which are commonly used for implant placement planning, but on the axial view images. The advantage of measuring the axial view images is that the shortest NPC-to-MCIR distance could be identified at the designated measurement levels. Therefore, the results of this study should be interpreted accordingly.

**CONCLUSIONS**

Within the confines of this study, the following conclusions are offered:

---

**TABLE 1**

Comparison of the distance from the nasopalatine canal (NPC) to the maxillary central incisor root (MCIR) between genders using a t test at a significance level of $\alpha = 0.05$

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean ± SD of the NPC-to-MCIR Distance (mm)</th>
<th>Mean ± SD of the NPC-to-MCIR Distance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Midroot Level</td>
<td>Apex Level</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td></td>
</tr>
<tr>
<td>Men (N = 60)</td>
<td>3.45 ± 1.59</td>
<td>3.27 ± 1.50</td>
</tr>
<tr>
<td>Women (N = 60)</td>
<td>2.76 ± 1.64</td>
<td>2.70 ± 1.63</td>
</tr>
<tr>
<td>P value</td>
<td>.02*</td>
<td>.04*</td>
</tr>
</tbody>
</table>

*Statistical significance

---

**TABLE 2**

Comparison of the distance from the nasopalatine canal (NPC) to the maxillary central incisor root (MCIR) among age groups using 1-way analysis of variance at a significance level of $\alpha = .05$

<table>
<thead>
<tr>
<th>Age group*</th>
<th>Mean ± SD of the NPC-to-MCIR Distance (mm)</th>
<th>Mean ± SD of the NPC-to-MCIR Distance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Midroot Level</td>
<td>Apex Level</td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td></td>
</tr>
<tr>
<td>Youngest (N = 40)</td>
<td>2.51 ± 1.23a</td>
<td>2.31 ± 1.28a</td>
</tr>
<tr>
<td>Middle (N = 40)</td>
<td>3.24 ± 1.94ab</td>
<td>3.14 ± 1.73b</td>
</tr>
<tr>
<td>Oldest (N = 40)</td>
<td>3.56 ± 1.56ab</td>
<td>3.51 ± 1.50b</td>
</tr>
</tbody>
</table>

*Youngest = 21–40 years old; middle, 41–60 years old; oldest, 61–80 years old.

**a,bDifferent letters indicate statistically significant difference (Tukey’s test).**

---

*Statistical significance.
1. Women and younger individuals have smaller amounts of bone between the NPC and the MCIR sockets than men and older patients; therefore, they require more care during the immediate implant placement in the maxillary central incisor area to avoid encroachment on the NPC.

2. Tapered implants may be beneficial for immediate implant placement in the MCI area.

**ABBREVIATIONS**

CBCT: cone beam computerized tomography  
MCIR: maxillary central incisor root  
NPC: nasopalatine canal

**REFERENCES**


