Assessment of the mandibular incisive canal by panoramic radiograph and cone-beam computed tomography

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ABSTRACT
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Background: This study aimed to evaluate the location and characteristics of mental foramen, anterior loop and mandibular incisive canal using cone beam computed tomography (CBCT) and digital panoramic radiograph (DPR).

Methods: 430 patients both DPRs and CBCTs scans for the location of mental foramen, anterior loop and mandibular incisive canal visibility were included in this retrospective study. All CBCTs were generated with a cone-beam volumetric tomography device.

Results: The mandibular incisive canal (MIC) at least one side in the interforaminal region was detected in 17.7% of panoramic images and 89.1% of CBCT images. There was statistically significant difference between two methods (p=.000) in terms of MICs detection.

Conclusion: When planning a surgical operation between the mental foraminas, possibility of the presence of MIC should be taken into consideration. Besides, DPR is not a reliable technique in detecting MIC. In critical situations, use of CBCT is recommended.

KEYWORDS
Cone-beam computed tomography, mandible, mandibular nerve

ÖZ
Mandibuler insiziv kanalin panoramik radyograf ve konik ışılı bilgisayarlı tomografi ile değerlendirilmesi

Amaç: Bu çalışmada, konik ışılı bilgisayarlı tomografi (CBCT) ve digital panoramik radyograf (DPR) kullanarak mandibular insiziv kanalın, anterior loop’un ve mental foramenin karakteristiğini ve lokalizasyonunu incelemek amaçlanmıştır.


Bulgular: Panoramik görüntüde %17.7 ve CBCT görüntüsünde %89.1 interforaminal bölgede en az bir tarafta mandibular insiziv kanalı (MIK) gözlemlenmiştir. MIK‘in fark edilmesinde kullanılan iki metod arasında istatistiksel olarak anlamli bir fark bulunmuştur (p=.000).


ANAHTAR KELİMELER
Konik ışılı bilgisayarlı tomografi, mandibula, mandibular sinir

The region between mental foramas has been considered as a safe zone for dental implants, symphyseal graft harvesting and genioplasty procedures, because no important anatomical structures are located here.¹² However, the inferior alveolar canal may give terminal branches beyond the mental foramen which is named as the mandibular incisive canal (MIC).¹ It has been advocated that some perioperative complications and postoperative morbidities can be attributed to this anatomical variation.¹³

Digital panoramic radiograph (DPR) is an extraoral radiographic technique that is widely used in oral and maxillofacial surgery. Although it is a reliable system for most cases, its accuracy in identifying the MIC is limited.⁴ Nowadays cone-beam computed tomography (CBCT) has gained popularity and in some branches, such as implant placement in critical regions, it has replaced with the DPR.

Our aim was to estimate the prevalence of MIC in Turkish population and evaluating the efficiency of DPR in detecting MIC by comparing with CBCT.

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MATERIAL AND METHODS

Local institutional research ethics committee approval was obtained for this retrospective study. We included 430 patients (245 females and 185 males, mean age 47.14, ranging between 15 and 86) from whom both DPRs and CBCTs were taken between years 2014 and 2016. Indications were evaluation for orthognathic surgery and preparation for impacted teeth, dental implants planning, and orthodontic purposes. Exclusion criteria were as follows: presence of dental implants, syndromic patients, endocrine disturbances affecting craniofacial region, patients younger than 15, mandible fractures and distorted or blurred images.

All CBCTs were generated with a cone-beam volumetric tomography device (J. Morita, 3D Accuitomo 170, MFG Co., Kyoto, Japan) adjusted at 90 kVp, 5 mA, 17.5 seconds irradiation time, voxel size of 0.25 mm and field of view of 10x10 cm. Patients were placed in a horizontal position, stabilized with custom-made head bands and chin supports, and monitored to ensure that they remained motionless throughout the 17.5 sec of scanning. The acquired images were reconstructed into multiple plane views (axial, panoramic and cross-sectional) for evaluation of the MIC. The course of the canal was located from the closure of the mental foramen up to obliteration of the MIC. Images of a radiolucent canal, within the trabecular bone, surrounded by a radiopaque cortical bone representing the canal walls, and extending to the anterior portion beyond the mental foramen were considered as being images of MIC (Figure 1,2,3).
DISCUSSION

Panoramic imaging, and later DPR as well, has gained much popularity since it was introduced. It visualizes the entire maxilla, mandible, temporomandibular joints and associated structures on a single film. It is used as a preliminary screening technique to evaluate the dentition, bone support, impacted teeth, and dental implant planning. However, it is subject to considerable and unpredictable geometric distortion and has relatively low spatial resolution. Most importantly, DPR is a 2D technique and cannot give a volumetric image of the region.

CBCT is generally used for diagnosis of pathologies, temporomandibular joint diseases, temporomandibular ankylosis, evaluation of maxiller sinus, jaw fracture, implant, maxillofacial trauma. CBCT is a radiographic imaging method that allows accurate, 3D imaging of the hard tissue. It provides sub-millimeter resolution with shorter scanning times and also it has got great dimensional accuracy (only about 2% magnification). Excellent imaging of the mandible and mandibular canal has been reported for CBCT, along with a high accuracy of linear measurements and a low radiation dose and lower cost compared to multi-slice computed tomography. Because of the reliability of the CBCT in detecting anatomical hard tissue structures, we used it to estimate the prevalence of MIC in a Turkish population. Additionally, we aimed to evaluate the efficiency of DPR for the same goal.

Loss of anterior mandibular teeth is common and the anterior mandible has been considered an ideal implant site. Although some complications have been reported in this region that is widely used for rehabilitation of both anterior teeth loss with dental implants and implant supported complete overdentures. Lee et al. described intraoperative complications resulting from injury to the structures within the MIC. Kutuk et al. and Abarca et al. reported that patients were complained of discomfort after implant surgery in the anterior mandible and they were attributed this to direct or indirect injury to the mandibular incisive nerve. Complications related to MIC have also been reported after autologous graft harvesting from this area. Neurosensory disturbances have been found to occur in the area confined to 5 mm anterior to the mental foramen, 5 mm below the tooth apex, and 5 mm above the lower border of the mandible. Nerve branches within the MIC have been suggested as the most likely reason for the paresthesia and reported to be neurapraxia when the chin bone was harvested. Instead of classically defined safety margins of 5 mm, Pommer et al. have suggested new safety margins to protect the MIC: at least 8 mm below the tooth apices and a maximum harvest depth of 4 mm.
By using panoramic radiographs, some authors detected the MIC in 15%\(^4\) and others in 38.6%\(^1\) of the images. The highest and lowest ratio was reported as 51.7%\(^{14}\) and 2.7%\(^5\) respectively. We found the ratio of MIC in DPRs as 17.7% in at least one side. CBCT results suggest much more common prevalence of the MIC. In this study, we found the MIC in 89.1% of the cases but there are some reports which claim all CBCTs showed the MIC.\(^1,16\) It has been also demonstrated that MIC was existed in all cadavers (Table 1).\(^16\)

### Table 1.
The MIC studies in the literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Population</th>
<th>Year</th>
<th>Sample Size-Source</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jacobs et al(^{18})</td>
<td>Belgium</td>
<td>2002</td>
<td>230-Spiral CT</td>
<td>93</td>
</tr>
<tr>
<td>Jacobs et al(^7)</td>
<td>Belgium</td>
<td>2004</td>
<td>545-Panoramic radiographs</td>
<td>15</td>
</tr>
<tr>
<td>Pires et al(^{19})</td>
<td>USA</td>
<td>2009</td>
<td>89-Panoramic radiographs-CBCT</td>
<td>30621</td>
</tr>
<tr>
<td>Jalili et al(^{14})</td>
<td>Iran</td>
<td>2012</td>
<td>412-Panoramic radiographs</td>
<td>51.7</td>
</tr>
<tr>
<td>Romanos et al(^{15})</td>
<td>USA</td>
<td>2012</td>
<td>1045-Panoramic radiographs</td>
<td>2.7</td>
</tr>
<tr>
<td>Orhan et al(^{20})</td>
<td>Turkey</td>
<td>2013</td>
<td>356-CBCT</td>
<td>91</td>
</tr>
<tr>
<td>Pereira et al(^{21})</td>
<td>Spain</td>
<td>2015</td>
<td>100-CBCT</td>
<td>100</td>
</tr>
<tr>
<td>Ramesh et al(^{22})</td>
<td>Indian</td>
<td>2015</td>
<td>120-CBCT</td>
<td>71.66</td>
</tr>
<tr>
<td>Panjnoush et al(^{23})</td>
<td>Iran</td>
<td>2016</td>
<td>200-CBCT</td>
<td>97.5</td>
</tr>
<tr>
<td>Present study</td>
<td>Turkey</td>
<td>2016</td>
<td>430-DPRs and CBCTs</td>
<td>17.7-89.1</td>
</tr>
</tbody>
</table>

Our results and the literature show that there is a clear difference between DPR and CBCT regarding the ability of detecting the MIC. Several factors can lead to this. First, DPRs inherently have a more distorted image in anterior mandible because of superimposition of anatomical structures, for example, cervical vertebrae\(^{19}\) that may make detecting the MIC more difficult. Second, the MIC is narrower and has less bony corticalization than inferior alveolar canal.\(^{24}\) It has also been reported\(^{17}\) that the diameter of the MIC decreased from its origin to end. These are obvious disadvantages in DPR technique. Additionally, some authors believe that the incisive nerve runs through the intramedullary spaces, and not within a bony canal, therefore, is not commonly detected by conventional radiography.\(^{21,25}\) In fact, the same limitation can be valid for CBCT as well due to the lack of well-defined MIC in the anterior part of the mandible.\(^{26}\) An incisive bundle can be seen as having complete, partial, or no cortical walls.\(^{17}\) Thus, it may be advocated that real incidence of the MIC might be even higher than the ratio found in CBCT images.

### CONCLUSION
The MIC is common in Turkish population. We can even claim that existence of the MIC is “anatomically normal”, it is not “an anatomical variation”. When planning a surgical operation between the mental foraminas, possibility of the presence of MIC should be taken into consideration. Besides, DPR is not a reliable technique in detecting MIC. In critical situations, use of CBCT is recommended.
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