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EVALUATION OF THE APPEARENCE OF MANDIBULAR INCISIVE CANAL BY PANORAMIC RADIOGRAPHS

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ABSTRACT

Objectives: The aim of this study was to evaluate the visibility of mandibular incisive canal in the mental interforaminal region on panoramic radiographs.

Materials and Methods: 1000 panoramic radiographs of the patients were obtained retrospectively from the archieved records of our radiology department.The images were evaluated by a single radiologist and the presence of mandibular incisive canal were recorded.

Results: Mandibular incisive canal was observed in 180 radiographs at least one side and account for 18%. Bilateral mandibular incisive canals were observed more frequent (61,1%).

Conclusions: The presence of mandibular incisive canal is not a rare finding and should be considered in surgical planning involving the anterior mandible so as to prevent complications.

INTRODUCTION

The mandibular incisive canal (MIC) is a continuation of the mandibular canal anterior to the mental foramen (Mardinger *et al*. 2000;Kajan and Salari 2012; Pereira-Maciel, Tavares-de-Sousa and Oliveira-Sales 2015) which was firstly described by Olivier in 1928. This canal contains the incisive (or incisor) bundle that innervates the teeth in the anterior segment of the mandible (Mardinger *et al*., 2000; Romanos *et al*., 2012; Orhan *et al*., 2014). The incisive nerve has been described as one of the terminal branches of the inferior alveolar nerve (Mraiwa *et al*., 2003). Before carrying out a surgical operation in the mandible, precise localization of anatomic landmarks are critically important. The main anatomic landmarks of special interest in the interforaminal region of the mandible are the mental nerve, the MIC and its neurovascular bundle, and the lingual foramen and its contents (Orhan *et al*., 2014). The mental interforaminal region was previously regarded to be a safe region for surgical procedures of the mandible (Pereira-Maciel, Tavares-de-Sousa and Oliveira-Sales 2015; Kajan and Salari 2012), whereas nowadays it is often considered to be an unsafe zone, and care should be taken to avoid damaging vital anatomical structures during surgery (Kajan and Salari 2012). The anatomy of the interforaminal area and especially the knowledge for the existence of the MIC is very important for the dentist and the oral surgeon because common surgical procedures performed in this area, such as insertion of endosseous implants, bone harvesting from the chin, genioplasty in orthognathic surgery, and screwing with or without plates after trauma of the anterior mandible, may cause nerve damage (Romanos *et al*., 2012; Pereira-Maciel, Tavares-de-Sousa and Oliveira-Sales 2015) neurosensory disturbances and hemorrhage (Kajan and Salari 2012). To avoid these complications, radiographic evaluations should be carefully performed at the proposed surgical site (Orhan *et al*. 2014). However a panoramic radiograph is a two dimensional (2D)image, it is simple, easily accessible, low-cost initial examination widely used in dentistry (Singh *et al*. 2014). The aim of this study was to evaluate the presence of MICs by means of digital panoramic radiographs.

MATERIALS AND METHODS

This retrospective study included a total of 1000 panoramic radiographs of patients, obtained between 2015-2016 years from the Oral and Maxillofacial Radiology Department of

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Necmettin Erbakan University, Faculty of Dentistry, located in Konya, Turkey. Presence of implant in the mandible [which produces artifact in the image], pathological process, syndromic patients and patients with congenital disorders, patients aged under 15 years, fracture in the mandible, which appear distorted or blurred due to patients' movements were the exclusion criteria. Dentate or edentulous patients were included in the study. There was no preference for sex regarding sample choice; however, only Turkish patients were included in the study. There were 535 female and 465 male, totally 1000 patients. The mean age was 46, 1 years and the range was between 15 and 85 years. The images of all patients were generated by the same devices. The radiographic examinations were performed by using J MORITA (2D Veraviewpocs, MFG corp, Kyoto, Japan) machine with a tube voltage of 65 kV, tube current of 5 mA and exposure time of 14,8 s. All the observations were accomplished with the use of the i-Dixel software Ver. 2.0 (manufactured by J. Morita MFG. Corp.). The course of the MIC was located from the closure of the mental foramen up to obliteration of the MIC (Figure 1). 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 2).

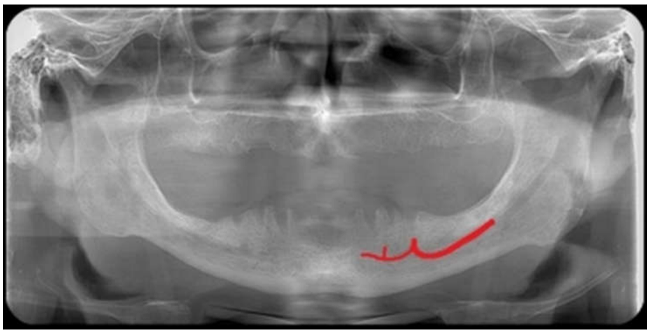

Fig. 1. Panoramic image of a patient showing bilateral MIC. Red line indicates the course of the MIC

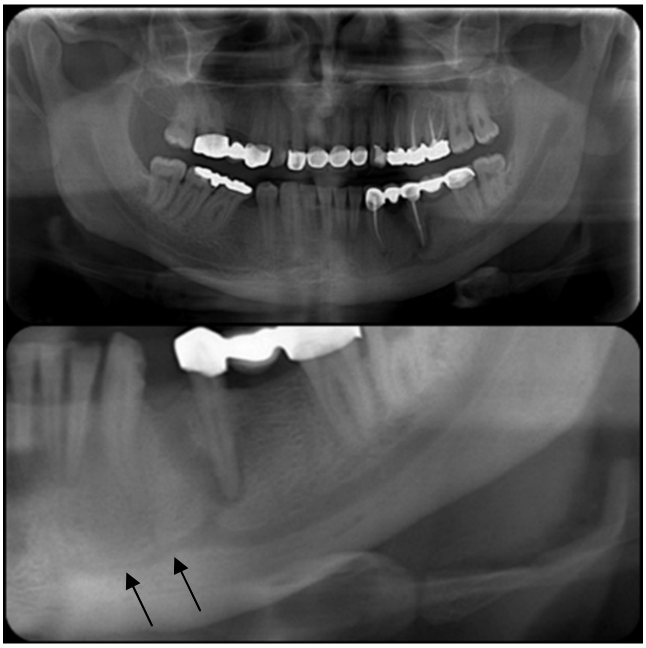

Fig. 2. Digital panoramic view of the MIC (black arrows)

All radiographic images were examined by the same observer (MT) in a dark room and in the same computer [Intel® Xeon® E5-2620, 2.0GHz; NVIDIA quadro 2000; 32" Dell T7600 workstation with a resolution of 1280 x 1024 pixels, 8GB memory, Windows 7 operatingsystem]. The observer performed re-examination in 2-week intervals to evaluate intraobserver variability. The examiner had to answer yes or no regarding the presence of MIC at least one side of the mandible in the images obtained with panoramic machines. The prevalence in percentages was calculated for MIC in panoramic radiographs. Statistical analyses were carried out using the SPSS software (ver. 21.0.; SPSS Inc., Chicago, IL, USA). Kappa statistics were applied for assessment of intraobserver agreement. Chi-squared test was used to find out the relationship between the MIC and age groups, MIC and gender. P values less than 0.05 was considered to be significant.

RESULTS

The kappa statistics indicated an score of 0.95 for the intraobserver agreement for identification of the MICs. The kappa coefficient was interpreted as being poor (0), slight (0.01–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and almost perfect (0.81–1.0), according to Landis and Koch (1977). A total of 1000 digital panoramic images were studied. Table 1 shows the distribution of the patient sample related to age and gender. The MIC at least one side in the interforaminal region was detected in 18% of panoramic images. Bilateral MICs were observed more frequent (61,1%), only right side and only left side appearence of the MIC was equal (19,4%).

Table 1. Distribution of the patient sample

years		gender		Total
		female	male	
	15-39	216	168	384
	40-59	172	140	312
	60-85	147	157	304
Total		535	465	1000

Table 2. Distribution of MICs related to gender

Gender		MIC		Total
		presence	absence	
	female	74 (13%)	461	535
	male	106 (22%)	359	465
Total		180 (18%)	820	1000

Table 3. Distribution of MICs according to age subgroups

years		MIC		Total
		presence	absence	
	15-39	68 (17%)	316	384
	40-59	71 (22%)	241	312
	60-85	41 (13%)	263	304
Total		180 (18%)	820	1000

When the panoramic images were compared based on gender, the data indicated that presence of MICswas higher in males ($p<0,05$). Table 2 shows the distribution of MICs related to gender. The presence of MICs was statistically different among different age subgroups ($p<0,05$).

Table 4. The MIC studies in the Literature

Author	Population	Year	Sample Size-Source	Percentage (%)
Jacobs *et al*	Belgium	2002	230-Spiral CT	93
Jacobs *et al*	Belgium	2004	545-Panoramic radiographs	15
Pires *et al*	USA	2009	89-Panoramic radiographs-CBCT	11-83
Kajan and Salari	Iran	2012	84-CBCT	92,3
Romanos *et al*	USA	2012	1045-Panoramic radiographs	2,7
Orhan *et al*	Turkey	2013	356-CBCT	91
Singh *et al*	Iran	2014	300-Panoramic radiographs	33
Pereira-Macieland Oliveira-Sales	Spain	2015	100-CBCT	100
Present study	Turkey	2016	1000-Panoramic radiographs	18

The highest frequency of MIC was seen in 40-59 age subgroup. Table 3 shows the distribution of MICs according to age subgroups.

DISCUSSION

With increasing application of dental implantation and genioplasty, the anatomical characterization of inferior alveolar nerve, mental nerve and incisive nerve in interforaminal region have being brought much attention of clinicians (Xu *et al*., 2015). Panoramic radiography is an extraoral radiographic technique widely used in dental practice, because it provides visibility of anatomical structures in pathological changes of the teeth, jaws and temporomandibular joints. However, a panoramic radiograph is a 2D image, lacking information in the bucco-lingual direction and magnifying in both vertical and horizontal directions (Jacobs *et al*. 2004). On the other hand, it has been shown that cross-sectional imaging (e.g. conventional spiral tomography or spiral CT) offers a better alternative for the precise visualization of anatomical structures in the oral and maxillofacial region (Jacobs *et al*., 2004). Nowadays, cone beam computed tomography (CBCT) is presented as a highly effective technique for examining vital anatomical structures. CBCT has an excellent capability for imaging mandibular anatomical structures and it ensures the high accuracy of the obtained linear measurements. The advantages of CBCT over other CT imaging methods include the ability to acquire more rapid volumetric images and the use of lower radiation doses (Kajan and Salari 2012). Our results indicated that the presence of MIC was 18%. These results in accordance with Jacobs *et al* (2004).

Some other researchers (Kajan and Salari 2012;Orhan *et al*. 2014;Jacobs *et al*. 2002) which were used CT and CBCT scans found higher percentages of MICs. Pereira-Maciel and Oliveira-Sales (2015) found MICs visible in all CBCT scans with the percent of 100%. This might be explained by the fact thattheangulation of the X-ray beam in panoramic radiography is about 7–8from below. This results in some distortion of the actual mandibular anatomy and may lead to misinterpretation (Jacobs *et al*., 2004). On the other hand, some authors believe that the incisive nerve runs through the intramedullary spaces, and not within a bony canal, therefore, is not commonly detected by panoramic radiography (Pereira-Maciel, Tavares-de-Sousa and Oliveira-Sales 2015). Our results indicated that MICs were much visible in males than females. MIC visibility was significantly related to the degree of corticalization. Better corticalization may lead to improved visibility, as has already been reported for the mandibular canal (Jacobs *et al*., 2004).

In a study of Raitz *et al*. (2014). among the 300 analyses of images the examiners did not identify MIC in about 70% of panoramic images and 10% of CBCT images. It has to be emphasized that the use of 3D imaging systems are helpful when the need for precise measurements arises during the surgical procedure. Because of variations in anatomical structure, especially in the anterior mandible, conventional radiographic techniques are of limited value because of the superimposition of anatomical structures, for example, cervical vertebra (Pires *et al*., 2012).

Conclusions

Knowledge of the exact anatomical characteristics of the mandibular interforaminal area can prevent neurovascular injuries. To avoid complications such as neurosensory disturbances, edema and hematoma, clinicians should not underestimate the presence of MIC especially in patients who require dental implants. Panoramic radiographs can provide information about the region and MIC was detected in percentage of 18% in this study. 3D imaging systems should be used when surgery is planned.

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