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RETROSPECTIVE ANALYSIS OF NEUROSENSORY DISTURBANCES RELATED TO DENTAL IMPLANT PLACEMENT IN MANDIBULAR INTERFORAMINAL REGION*
MANDİBULAR İNTERFORAMİNAL BÖLGEDE DENTAL İMPLANT TEDAVİSİ İLE İLİŞKİLİ NÖROSENSÖRİYEL BOZUKLUKLARIN RETROSPEKTİF ANALİZİ

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ABSTRACT

The aim of this study is to evaluate the risk of neurosensory disturbances resulting from the injury of the anterior loop of the inferior alveolar nerve (IAN) in dental implant surgery with panoramic radiography. Panoramic radiographs of 1614 consecutive patients treated with dental implants were examined, and patients with implants located at a distance less than 5 mm to the mental foramen were recorded. Paresthesia, anesthesia, neuropathic pain was investigated retrospectively. In 405 patients, the implants were located in a distance less than 5 mm to the mental foramen. A range of 0.6 mm to 5 mm distance was detected between the mental foramen and these dental implants. No patient complained of bilateral paresthesia. In five (2.06%) of the 242 regions, it was found that patients had permanent unilateral paresthesia in their lower lips. In conclusion, panoramic radiography is not an entirely reliable imaging method for dental implant planning in the interforaminal region. Methods that are more sophisticated may be required to assess the risk of neurosensory disorder before treatment.

Keywords: Anterior loop, dental implant, inferior alveolar nerve.

ÖZ

Bu çalışmanın amacı, dental implant cerrahisinde inferior alveoler sinirin ön loop bölgesinin hasarı kaynaklı nörosensoriyel bozukluk riskini panaromik radyografi ile değerlendirmektir. Dental implant tedavisi yapılmış 1614 hastanın panaromik radyografileri incelenmiş ve mental foramenlere 5 mm'den daha kısa bir mesafede bulunan implantları olan hastalar kayıt altına alınmıştır. Bu hastaların parestezi, anestezi, nöropatik ağrı durumları retrospektif olarak incelenmiştir. 405 hastada, dental implantların mental foramenlere 5 mm'den daha kısa bir mesafede yerleştirilmiş olduğu tespit edilmiştir. Mental foramenler ve dental implantlar arasında 0.6 mm ila 5 mm'lik mesafe olduğu ölçülmüştür. Hiçbir hastada çift taraflı parestezi şikâyeti görülmemiştir. 242 bölgenin beşinde (%2.06) hastaların tek taraflı olarak alt dudaklarında kalıcı parestezi olduğu tespit edilmiştir. Sonuç olarak panoramik radyografi, interforaminal bölgede dental implant planlaması için tamamen güvenilir bir görüntüleme yöntemi değildir. Tedavi öncesi nörosensoriyel bozukluk riskini değerlendirmek için daha ileri görüntüleme yöntemleri gereklidir.

Anahtar kelimeler: Dental implant, ön loop, panaromik radyografi.

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INTRODUCTION

Inferior alveolar nerve (IAN) supplies the mandibular molar, premolar region and neighboring gingival mucosa. Its last branch arises from mental foramen and is denominated 'mental nerve'. During surgical protocols in the interforaminal region of the mandible, mental foramen is an important landmark. It is known that IAN extends towards the anterior side of the mental foramen and then turns back, creating an anterior loop before it leaves the mental foramen (1,2). This anterior loop of the IAN is an anatomical vital structure which is under the risk of injury during surgical procedures such as placement of dental implants in the interforaminal region, bone harvesting from chin, genioplasty and rigid fixation with screws after trauma of the anterior lower jaw (3). During dental implant placement, nerve injury may be related to direct or indirect compression caused by the penetration of an implant into the mandibular canal, or of bone trabecules which are pushed onto the nerve by placing an implant close to the canal. Introducing the drills into the mandibular canal or overheating of the bone during implant site preparation may also cause IAN injury (4). Depending on the degree of the injury, nerve damage can be manifested as paresthesia, dysesthesia or complete anesthesia (5). Also, some esthetic and functional activities such as eating, drinking, speaking may be negatively influenced (6).

To avoid mental nerve damage, it is important to determine the location of the mental foramen, and whether it has an anterior loop with appropriate imaging techniques (7).

Panoramic radiography is commonly used imaging method for primary evaluation of dental implant patients, and usually adequate for surgical planning. However, it has limitations such as magnification rate, the need for correct positioning of the patients,

and lack of three dimensional information. Cone-beam computed tomography (CBCT) is the golden standard due to its three dimentional properties, along with reduced magnification rate, and decreased radiation dose in comparison to conventional computed tomography (8-11).

The purpose of this retrospective clinical study was to evaluate the risk of neurosensory disturbances (NSD) resulted from the injury of the anterior loop of the IAN during implantology procedures in the interforaminal region of the mandible.

MATERIAL AND METHODS

Data Collection

The study protocol was approved by the Local Ethics Committee of the Erciyes University, Turkey (2012/353). 4339 patients, who were treated with dental implants in the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry at Erciyes University, between 2006 and 2016, were selected for examination. Panoramic radiographs showing implants that were placed in the interforaminal region were detected. Implants located with a distance less than 5 mm to the mental foramen were included in the study. Implants placed in the posterior region of the mental foramen, implants inserted 5 mm away from the mental foramen and the failed implants were excluded from the study. The minimum linear distance between surface of dental implants and mental foramen (D) was measured on digital panoramic radiographs with 1:1 distortion rate using a scale in a 2D software programme (MedDataPacs, MedData Inc., Turkey). All scanning procedures were performed using a standard exposure and patient positioning protocol. D was classified into 3 groups: Group 1. D: 5 to 4 mm, Group 2. D: 3.9 to 3 mm, Group 3. D: less than 3 mm.

Data were obtained from the routine follow-up appointments of the patients who had undergone dental implant surgery. These patients were followed up routinely at specific intervals of immediate after dental implant surgery, 1, 2, 4 weeks, 6 months, and 1 year. Mechanoreceptive tests (two-point discrimination test and light touch sensation test) were performed to determine NSD in patients with sensory complaints after surgery and changes in IAN sensation were recorded over these periods. Abnormal sensation was considered permanent if it was present 1 year after surgery.

Dental volumetric computed tomography (DVCT) scans in a 0.25-mm slice thickness (NewTom 5G Cone Beam 3D imaging, Verona, Italy) were taken in patients with neurosensory complaints after surgery.

Statistical Analysis

Fisher's exact test was used in the comparison between groups. Data were analysed using IBM SPSS Statistics 25.0 (IBM Corp. Released 2017. IBM SPSS Statisticsfor Windows, Version 25.0. Armonk, NY: IBM Corp.) software programme. The level of significance was accepted as $p<0.05$.

RESULTS

Dental implants were placed in the interforaminal region in 1614 patients. Panoramic radiographs of 190 (112 female, 78 male) patients and 242 implants, located in a distance less than 5 mm to the mental foramen, were examined. Dental implants were placed in both regions of the lower jaw in 52 patients. The number of sample size in each group was determined as dental implants. Mean distance between dental implants and mental foramen were 3.33±1.04 (min-max: 0.6-5 mm). 84 implants (34.71%) were placed in a distance between 5 to 4 mm (group 1); 76 implants (31.40%) were placed between 3.9 to 3 mm (group 2); and 82 implants (33.88%) were placed less than 3 mm (group 3). Descriptive data of the patients with NSD were given in Table I.

Table I. Number of dental implants in each group

	Group 1	Group 2	Group 3
Distance (mm)	5-4 mm	3.9-3 mm	< 3 mm
Implant (n; %)	84; 34.71%	76; 31.40%	82; 33.88%
Region with NSD (n)	0	1	4

NSD: neurosensorial disturbances

None of the patients had bilateral NSD complaints. In five (2.06%) of the 242 regions, patients complained of NSD at their lower lip unilaterally. Impaired sensitivity in these patients were recorded as permanent paresthesia more than 12 months. The distance between dental implant and the anterior loop of the inferior alveolar nerve was differed between 0.4 to 3.1 mm on DVCT images (Table II). According to the statistical analysis, no significant difference was found between the groups in terms of NSD (p=0.64) (Table III).

Table II. Information about the five regions of the patients with NSD

	Anterior loop visibility in panoramic radiography	Implant-mental foramen (distance in DVCT images)
Region 1	No	0.4 mm
Region 2	No	3.1 mm
Region 3	No	2.5 mm
Region 4	No	0.9 mm
Region 5	No	2.8 mm

NSD: neurosensorial disturbances
DVCT: Dental volumetric computed tomography

Table III. NSD distribution among groups

Groups	NSD positive n; (%)	NSD negative n; (%)
Group 1	0; (0.0)	84; (100.0)
Group 2	1; (1.3)	75; (98.7)
Group 3	4; (4.9)	78; (95.1)
Total	5; (2.06)	237; (97.9)
χ^2=4.266, P=0.64		

NSD: neurosensorial disturbances

DISCUSSION AND CONCLUSION

Several methods and techniques are used for the detection of anterior loop of the IAN such as panoramic radiographs, computed tomography and exploration technique with a curved explorer in the operation. The most objective evidence for the existence of anterior loop is the results of cadaveric studies which reported incidence ranging from 24% to 88% (12). According to the results of a cadaveric study, 62% of anatomically detected anterior loops of IAN were not seen radiographically (13). Other than radiographic examination, the clinician can evaluate the existence of anterior loop, placing a curved probe into the foramen to detect whether its distal aspect is open. If not, the nerve goes in the foramen on mesial side and this indicates the existence of anterior loop (14). But this method can easily damage the nerve and is useless in clinical practice. Recent studies, which evaluated the anatomy and the course of the IAN, revealed more accurate and realistic results with DVCT compared to conventional radiographies. The incidence of the presence of the anterior loop changes from 7% to 83% in computed tomography (CT) based studies, whereas this ratio reduces to 27-28% in the studies using conventional radiographies (15). According to findings of the previous studies, the interpretation of panoramic views has restrictions and results in a high percentage of false negative and false positive outcomes (16). In this study, since panoramic radiographs were used to detect the presence of an anterior loop, an effective interpretation could not be performed.

There must be a 100% safety distance between the anterior border of mental foramen and the dental implant placed in the interforaminal region to avoid NSD. According to a cadaveric study by Kuzmanovic et al. (13), this safety margin is 4 mm, however, it is reported to be 5 mm in German et al's CT study (17). In the absence of DVCT, the safety distance increases up to 9 mm to avoid the anterior loop of the IAN damage (1,12). In addition, some authors suggested that there is no precise safety margin mesially from the mental foramen, therefore, the diameters of canals and foramens should be calculated and evaluated specifically for the anatomy of each patient (18). Although panoramic radiography has been used for its advantages of low radiation exposure, wide coverage of the oral structures and low expense of the equipment, it has some limitations such as image distortion and lack of precise data regarding bone quality and quantity (12,19). Therefore, it is difficult to identify mental foramen or the extension of the anterior loop correctly in some cases. On the other hand, DVCT images are more suitable and useful to evaluate the interforaminal bone quality, quantity and morphology. The main advantages of DVCT are shorter time of acquisition, higher power of resolution level and 1/15 less radiation exposure compared with CT (20). However, limited availability, complexity in image interpretation and high costs in comparison to conventional radiography are major limitations (12). In the present study, 450 patients had implants located in a distance less than 5 mm to the mental foramen. In five patients, who were examined with panoramic radiographs preoperatively,

permanent numbness occurred and were examined with DVCT after surgery. Anterior loop was not observed in any of the panoramic radiographs of these patients before surgery. In their postoperative DVCT examination, the distances between dental implants and the mental foramen were detected to be lower than 3 mm. Although the safety zone for dental implant placement in the interforaminal region was found 3 mm in present study, it should be evaluated in every patient individually.

Various methods like soft brush, 2-point discrimination, pain perception, temperature sensitivity and light touch sensation test with a questionnaire are used to evaluate the NSD after dental implant placement (21,22). In the present study we used two-point discrimination test and light touch sensation test. Damage to the anterior loop of the IAN, the mental nerve or neighboring vascular bundles which innervate and vascularize the teeth, lip, skin, and mucosa in the area may lead to numbness, dysesthesia or pain. This complication is rare during implant surgery nevertheless, may occur directly from drilling procedures, lack of care to diagnostic data, and/or direct compression of nerve during implant placement. The incidence of permanent sensory deformity after dental implant surgery is 7-10% (2). In the present study, NSD of five patients may be due to the drilling procedure and/or implant itself causing injury of anterior loop.

Panoramic radiography is not an entirely reliable imaging method for dental implant planning. Due to the fact that anterior loop of the IAN can be in three planes of the space, the accuracy of measurement is reduced in two-dimensional radiographs before implant therapy between two mental foramens. More sophisticated techniques may be required in the interforaminal region of the mandible to detect anterior loop of the IAN. NSD can be avoided using DVCT as a part of the preoperative planning of implant surgery.

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