ORIGINAL ARTICLE

EVALUATION OF INFERIOR ALVEOLAR CANAL ANATOMY BY CONE BEAM COMPUTED TOMOGRAPHY

İnferior Alveoler Kanal Anatomisinin Konik Işınlı Bilgisayarlı Tomografi ile Değerlendirilmesi

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ABSTRACT

Objective: Purpose of this study was to identify the course of inferior alveolar canal to other anatomic landmarks in mandibular third molar region, in completely dentate patients to determine relationship of the inferior alveolar canal and mandibular third molar, by using cone beam computed tomography.

Material and Methods: This study utilized 100 cone beam computed tomography images from 100 patients to obtain measurable data to determine inferior alveolar canal localization at mandibular third molar region. The spatial position and the morphologic features of the mandibular third molar teeth and their relationship with the inferior alveolar canal were revealed. The relationship of the mandibular third molar teeth with the lingual cortex of the mandible was also determined.

Results: The position of the inferior alveolar canal is correlated with the direct relation between the canal and the mandibular third molar teeth. The inferior alveolar canal is positioned predominantly at the inferior of third molars when there is no relationship, however in almost half of the directly related cases it was positioned inferiorly as the buccal and lingual positioning increased.

Conclusion: Knowing the anatomic location of inferior alveolar canal prior to surgery is imperative to achieve the desired outcome for mandibular surgical procedures and would help the practitioner avoid any nerve damage in any intervention.

Keywords: *Cone Beam Computed Tomography; Third Molar; Inferior Alveolar Canal; Inferior Alveolar Nerve Injury*

ÖZET

Amaç: Bu çalışmanın amacı, konik ışınlı bilgisayarlı tomografi cihazı kullanılarak, tam dişli hastalarda, mandibular üçüncü molar diş bölgesindeki diğer anatomik noktalar göz önünde bulundurularak inferior alveoler kanalın seyrini belirlemek ve mandibular üçüncü molar diş ve inferior alveoler kanal arasındaki ilişkiyi saptamaktır.

Gereç ve Yöntemler: Bu çalışmada mandibular üçüncü molar diş bölgesinde inferior alveoler kanal lokalizasyonunu belirlemek için ölçülebilir veriler elde etmek amacıyla 100 hastadan alınan konik ışınlı bilgisayarlı tomografi görüntüsü kullanıldı. Mandibular üçüncü molar dişlerin uzaysal pozisyonu ve morfolojik özellikleri ile inferior alveoler kanalla ilişkisi incelendi. Ayrıca mandibular üçüncü molar dişlerin mandibulanın lingual korteksiyle ilişkisi de tanımlanmıştır.

Bulgular: İnferior alveoler kanalın konumu, mandibular üçüncü molar diş ile kanalın doğrudan ilişkide olması durumu ile korelasyon göstermektedir. Mandibular üçüncü molar diş ile inferior alveoler kanal arasında doğrudan ilişki görülmediği durumlarda inferior alveoler kanal ağırlıklı olarak üçüncü molar dişin inferiorunda konumlanırken, doğrudan ilişki bulunduğu durumlarda kanalın dişin bukkal ve lingualinde konumlanma oranının arttığı görülmüştür.

Sonuç: Ameliyat öncesi inferior alveoler kanalın anatomik pozisyonunun belirlenmesi, mandibular cerrahi prosedürleri takiben istenmeyen sonuçları önlemek için gereklidir. İnferior alveoler kanalın ve bölge anatomisinin incelenmesi hekimin uygulama esnasında inferior alveoler sinir hasarından kaçınmasına yardımcı olacaktır.

Anahtar Kelimeler: *Konik Işınlı Bilgisayarlı Tomografi; Üçüncü Molar Diş; İnferior Alveoler Kanal; İnferior Alveoler Sinir Hasarı*

INTRODUCTION

Surgical removal of the third molars is the most common procedure performed by oral and maxillofacial surgeons. Even though this is a well-practiced procedure, it may carry risk of inferior alveolar nerve (IAN) injury. Current literature reports that inferior alveolar nerve injury ranges from 0.014% to 8.4% following third molar surgery (1-7). The close proximity of the third molar to the inferior alveolar canal (IAC) increases the risk for injury. 8 A close relationship can be detected with panoramic radiographs in the presence of several signs such as diversion of the canal, darkening of the roots, dilacerations of the roots, interruption of the white line of the canal and narrowing of the roots (3,9–11). However, panoramic radiographs are often inaccurate to determine the direct relationship of the tooth to IAC due to superposition of anatomical structures, magnification or distortion (2). Use of advanced techniques is suggested in such cases where conventional radiographs provide limited information. However, recent studies show that cone beam computed tomography (CBCT) is useful for locating IAC preoperatively (9,12). CBCT is a valuable method and provides accurate and reliable images that inform surgeons about the position of the IAC and its relationship with third molars. The aim of this study was to identify the course of IAC and its relationship to mandibular third molars using CBCT.

MATERIAL AND METHODS

This study followed the medical protocol established by the Declaration of Helsinki and received ethical approval from Süleyman Demirel University, Clinical Research Ethics Committee (No:2012/8). Informed consents were obtained from all patients participated in the study.

Patient Selection: The CBCT images of the patients who underwent CBCT examination for various indications such as impacted third molars, dental implant planning, evaluation of pathologic lesions, radiographic examination of paranasal sinuses and orthodontic evaluation were reviewed. One hundred patients older than 18 years of age, comprised of 50 males and 50 females were included in this study. Exclusion criteria were the presence of cyst, tumor or osteomyelitis, mandibular fracture, any pathologies affecting bone metabolism and poor quality of images due to artifacts.

Imaging: Planmeca Promax 3D MID (Planmeca Oy, Helsinki, Finland) CBCT unit was used to obtain images. The scan was set at 90 kV and 1mA, as recommended by the manufacturer. The total exposure time was 13.9 s. CBCT examinations were performed by Planmeca Romexis Viewer program (Planmeca Oy, Helsinki, Finland). Coronal, sagittal and axial sections of the third molar region were evaluated to determine relationship between the IAC and third molars.

Radiographic observation: Root formation, number of roots and perforation of lingual cortex are examined at coronal sections. The relationship of the tooth with the lingual cortex was scored as perforated or intact. In addition, angulation, relationship to the ramus and depth of the third molar teeth were observed to reveal spatial position of the third molars at sagittal sections. Pell-Gregory classification was considered for the depth of third molars and their relationship with the ramus (13). Also Winter classification was used to state the angulation (14).

Direct relationship between third molars and the IAC was detected on coronal sections, and axial sections were also analysed in need of further visualization (Figure 1 and 2). The position of the canal to the third molar was categorized as buccal, lingual, inferior and between the roots.

Statistical analyses: Relationship between properties of third molars and the IAC was analysed using chi-squared test. Twenty of the CBCT images were examined in one-month intervals, and an intraclass correlation coefficient revealed 96% repeatability.

RESULTS

A hundred CBCT images acquired from 100 patients were included in this study. The male female ratio was equally distributed. The mean age for the study population was 27.3 years (range 18-57). Age factor did not show statistical difference with gender.

Distributions of almost all parameters was independent of gender or age factor.

The anatomical features were assessed, and it was revealed that 92% of third molars showed complete root formation, and 80% of third molars had two roots, while 18% had one and 2% had three roots. Lingual cortex relationship pointed out that 18% of third

molars perforated the cortical bone.

Sagittal sections indicated that third molars showed 59% vertical, 28% mesioangular, 7% horizontal and 6% distoangular impaction.

Impacted third molars accounted for 53% of all cases. And according to the Pell-Gregory classification, Class A included 5, Class B included 38 and Class C included 10 cases. Also, Class I included 26, Class II included 26 and Class III included 1 case.

Assessment of the inferior alveolar canal position and its relationship with third molars stated that the IAC located 14% at the buccal, 9% at the lingual and 75% at the inferior of third molars. Only in 2% of the cases the canal was between the roots of third molars. Position of the IAC is statistically related to gender ($p<0.01$). In 32 cases, females had the IAC lying inferiorly. On the other hand, in male patients this number increased to 43. Also, no lingual or intraradicularly positioned IAC was detected in male patients, though age factor had no relevance with the position of the IAC.

Cone beam computed tomographic sections indicated that 35% of all cases and 56.6% of the impacted third molars had direct relationship with the canal. Also, third molars which have direct relation with the canal were evaluated according to the position of the canal. Almost in half of the cases (45.7%), the canal was positioned inferiorly, decreased through buccal (25.7%), lingual (22.9%) and inter-radicular (5.7%) positioning.

In the cases with no relation, the canal was located 7.7% buccally, 1.5% lingually and 90.8% inferiorly (Table 1). The position of the canal is correlated with the direct relation ($p<0.01$). The IAC is positioned predominantly at the inferior of third molars when there is no relation, however, almost in half of the directly related cases it was positioned inferiorly while buccal and lingual positioning increased.

Root formation or number and perforation of the lingual cortex were not statistically relevant with direct relation to the canal, but relevance between angulation and direct relation was evaluated and determined as statistically significant. As 51.4% of the cases with direct relation to the canal showed mesioangular impaction, the rest showed 25.7% vertical, 11.4% horizontal and 11.4% distoangular impaction. Direct relationship with the canal was statistically relevant with the ramus relation ($p<0.01$), while it was not relevant with the depth of the third molars.

Incidentally, 71.4% of the directly related third molars were impacted. This shows us a positive correlation between impaction and direct relation with the canal ($p<0.01$).

DISCUSSION

Surgical procedures involving the mandible poses a risk for IAN injury. Identification of the IAC course is essential prior to any surgical procedures, including third molar surgery. An accurate imaging of the IAC course and its relation with third molars plays a vital role to avoid nerve damage (15). Panoramic radiographs are the most commonly used technique in dentistry, and is the first option prior to third molar removal. Nonetheless, panoramic radiographs have limitations such as magnification, superposition or distortion, and they may prevent to have precise images of the IAC. Accuracy of panoramic radiographs have been reported between 24% and 64% about IAC imaging (2,16,17). When traditional radiographs are inaccurate to locate the IAC, usage of advanced imaging techniques is suggested (18,19). Recent reports also state that CBCT is an accurate technique to follow inferior alveolar canal course (20,21). Ghaeminia et al. evaluated third molars, in which panoramic radiographs showed close relation with the canal on CBCT images, and reported that almost half of the cases did not have relation with the canal (22).

Table 1. Inferior alveolar nerve relationship with third molar positions

	IAN positioned buccally	IAN positioned lingually	IAN positioned inferiorly	IAN inter-root position
Direct contact to IAN (%)	25.7	22.9	45.7	5.7
No contact to IAN (%)	7.7	1.5	90.8	0

IAN: Inferior alveolar nerve.

We found 35% of the cases directly related to the canal, similar with the findings of Khan et al. (33%) and Park et al. (36%) (23,24). Although higher rates have been reported, when patients presenting close relationship on panoramic radiographs are selected for study (25).

Cone beam computed tomographic sections indicated that the IAC positioned 14% at the buccal, 9% at the lingual and 75% at the inferior of third molars. Only in 2% of the cases, the canal was between the roots of third molars. Tantanapornkul et al. noted similar findings to ours as 45% inferior, 26% lingual, 25% buccal and 4% between roots positioning. Besides this, several reports noted various findings (15). Some indicated predominantly buccal positioning while others stated that lingual positioning was the most common (9,19,23,26). We speculate that these differences resulted from patient selection, because in these studies, cases with close relationship between third molars and canal have been evaluated whereas we assessed randomized patients.

When the IAC is positioned buccally, the surgeon has to be careful during surgical extractions. At the same time, drills can damage the nerve during the removal of buccal bone. Also, locating the IAC will help to determine the direction of luxation, so the injuries resulted from compression to the IAC can be avoided.

Impacted third molars displayed higher contact (57%) with the canal than erupted third molars that indicated impaction, which thereby is statistically relevant with direct relation to the canal. Miloro and DaBell also noted impacted third molars tend to be closer to the canal, compared to erupted third molars (27).

Relevance between anatomic properties and spatial location of third molars and direct relation to the IAC is evaluated. Morphologic properties and lingual cortex perforation are not correlated to the direct relation; however spatial position of the molars is positively correlated. Almost half of the directly related cases are impacted mesioangularly and only 25% are impacted vertically. Considering angulation of all cases (59% vertical, 28% mesioangular, 7% horizontal, 6% distoangular), 64% of mesioangular impacted third molars are related to the canal. Likewise, 15% of the directly related cases are impacted vertically, while vertical impaction is the most common among all cases. A study evaluated 560 third molars, and it found mesioangular impaction were generally located closely to the canal which supports our findings (27). This situation helps to consider mesioangular angulation as a risk factor for direct relation to the canal.

Ramus relation is also a risk factor for the direct relation to the canal. Twenty-seven percent of the cases with enough space for eruption are related to the canal, however 65% of the cases with inadequate space for eruption are related to the canal. From this point of view, third molars with inadequate space for eruption should be considered risky for direct relation to the canal and attention should be paid during the surgical procedure. However, considering the depth of third molars, similar rates for direct relation are attained. Even though Sharma et al. suggested that the depth of teeth might be a factor increasing nerve damage, our study indicated no relation between the direct relation to the canal and depth of third molars (8). Our cases did not show a homogeneity, considering the depth of third molars, and this can be the reason of the unexpected finding. Additional studies with cases equally distributed or increased the number of samples needed.

CONCLUSION

CBCT images help to gather accurate information about the IAC position and its relationship with third molars, which is important to improve surgical planning and to take necessary precautions that minimize the risk of nerve damage.

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