Comparisons of the Computed Tomographic Scan and Panoramic Radiography Before Mandibular Third Molar Extraction Surgery

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Background: Mandibular third molar extraction surgery has a postoperative complication of hypoesthesia of the lower lip and/or chin. The objective of the study was to determine if preoperative radiographic examination by panoramic radiography and computed tomography (CT) scan can predict postoperative complications of mandibular third molar extraction surgery.

Material/Methods: In total, 479 patients who had mandibular third molar extraction surgery were included in this cross-sectional study. Patients had panoramic radiographies and CT scans to determine the relationship of the tooth, the canal, and the buccolingual position. Inferior alveolar nerve sensory impairment was detected using a two-point discrimination method. Wilcoxon test and Tukey's test were used to compare diagnostic modalities at a 99% confidence level.

Results: Inferior alveolar nerve was more successfully quantified by CT scan compared to panoramic radiography ($p<0.0001$, q=8.062). Orthopantomography was better than the CT scan in detecting a close relationship of the tooth and the canal ($p<0.0001$, q=25.609), but the CT scan was better in detecting the buccolingual position of the teeth ($p<0.0001$, q=36.757). The age of patients ($p<0.0001$, q=36.757), postoperative bleeding ($p<0.0001$, q=15.981), and experience of the surgeon ($p<0.0001$, q=10.99) had an affected on inferior alveolar nerve sensory impairment.

Conclusions: Preoperative panoramic radiography, CT scan, age, the experience of the surgeon, and postoperative bleeding can predict postoperative complications for extraction of a mandibular third molar.

MeSH Keywords: **Fused Teeth • Mandibular Diseases • Mandibular Injuries • Mandibular Nerve • Mandibular Osteotomy • Tomography, Spiral Computed**

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Background

Mandibular third molars (MM3s) are responsible for pericoronitis, primary and/or secondary crowding of the dentition, odontogenic tumors and cysts, periodontal defects associated with the posterior part of mandibular second molars (MM2s), caries between MM2s and MM3s, and myofascial and neurogenic pain [1]. Therefore, removal of MM3s is recommended and is the most common oral surgery [2]. Nowadays, coronectomy surgery is preferred, but it is a complicated procedure and has high procedural risk [3]. The MM3 is located near the inferior alveolar nerve (IAN) [1]. Thus, surgical procedures for MM3 removal could damage the IAN and result in postoperative complications such as hypoesthesia of the lower lip and/or chin [4]. Therefore, before surgery, a radiological assessment is required to identify the proximity of the MM3 to the IAN canal to predict occurrence of hypoesthesia of the lower lip and/or chin [1].

At present, oral and maxillofacial surgeons commonly use panoramic radiography or orthopantomography (OPG) to view MM3s and estimate possible damage of the IAN [5]. However, OPG is not an accurate or precise estimation of the risk assessment of damage to the IAN canal during surgery [6]. Computed tomography (CT) scans provide high-resolution images with the exact position of the MM3 in all three planes [7].

The objective of the study was to compare preoperative radiographic examination by panoramic radiography and CT scan in the prediction of postoperative complications following MM3 extraction surgery.

Material and Methods

Inclusion criteria

In total, 479 patients who had been admitted to the Oral and Maxillofacial Surgery Department of Jining No.1 People's Hospital, Jining, Shandong, PR China for surgical resection of MM3 were included in the study. Patients who were older than 18 years of age and had difficult-to-extract MM3 (surgeon's opinion) were included in the study. Patients who had dilacerated teeth and/or hypertrophic root(s) were included in the study. Patients who had pericoronitis, primary and/or secondary crowding of the dentition, periodontal defects associated with the posterior part of MM2, caries between MM2 and MM3, and myofascial and neurogenic pain were also included in the study. Patients who had horizontally impacted, mesioangularly impacted, and vertically impacted MM3 were included in the study.

Table 1. The demographic factors of enrolled patients for diagnostic cross-sectional study.

Sample size		479
Demographic variables		Patients
Gender	Male	231 (48)
	Female	248 (52)
Age (year)	Min	22
	Max	69
	Mean ±SD	42.73±2.57
Difficult to extract MM3		55 (11)
Dilacerated teeth		57 (12)
Hypertrophic root		63 (13)
Dilacerated teeth and hypertrophic root		33 (7)
MM3 had opposed to the other teeth(s)		62 (13)
Pericoronitis		15 (3)
Primary crowding of the dentition		23 (5)
Secondary crowding of the dentition		32 (7)
Primary and secondary crowding of the dentition		17 (4)
Periodontal defects associated with the posterior part of MM2		24 (5)
Caries between MM2 and MM3		64 (13)
Myofascial pain		421 (88)
Neurogenic pain		280 (58)

Min – minimum; Max – Maximum; MM3 – mandibular third molar; MM2 – mandibular second molar. Continuous data were represented as mean ±SD and constant data were represented as a number (percentage). All patients were of PR China origin.

Exclusion criteria

Patients who were younger than 18 years of age and had easy to extract MM3 were excluded from the study. Patients who refused to sign informed consent were excluded from the study. Patients who had disorders that could influence the neurological outcome after surgery were excluded from the study. Patients who had odontogenic tumor, cyst, or existing neurological problems or sensory deficits with IAN were excluded from the study. The demographic characteristics of enrolled patients before surgery are noted in Table 1.
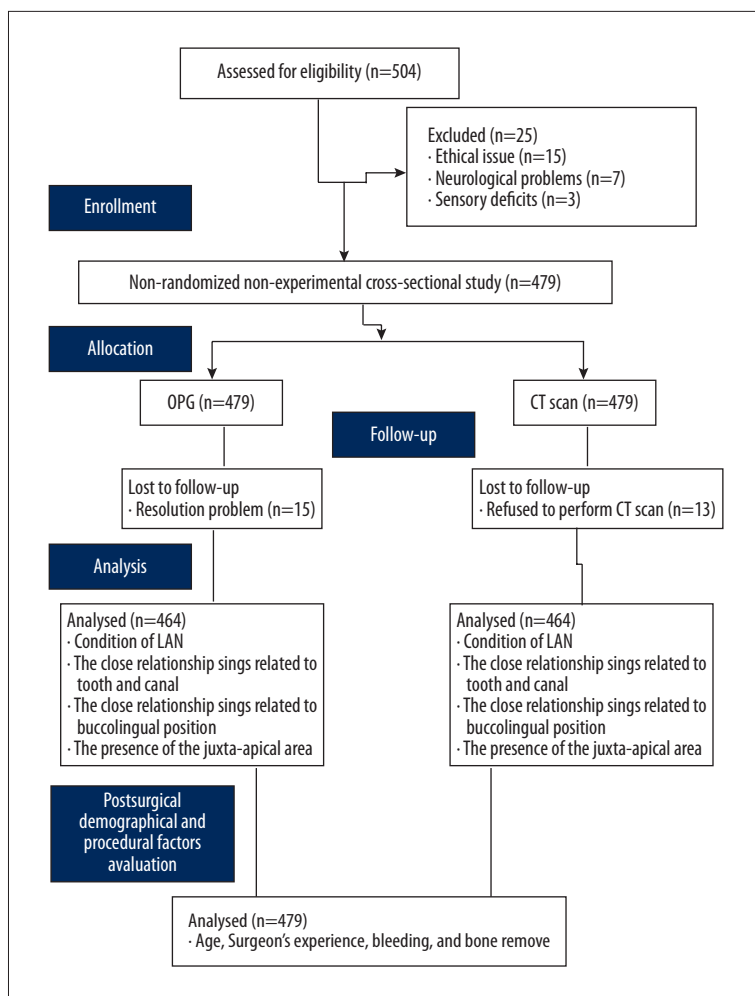
Figure 1. The flowchart of non-randomized, non-experimental cross-sectional study. CT – computed tomography; OPG – panoramic radiography or orthopantomography; IAN – inferior alveolar nerve.

Ethics approval and consent to participate

Jining No.1 People's Hospital, Jining, Shandong, PR China review board (JRB) granted an exemption for the study to register in the Chinese Clinical Trial Registry. The STARD guidelines, compliance with the World Medical Association Declaration of Helsinki on medical research protocols, and ethics for diagnostic research on the human subject were considered in accordance with the law of PR China in the protocol of this study. JRB approved the study protocol. All patients signed informed consent forms for the acquisition of diagnostic modalities. For manuscripts that contain any individual person's data in any form (including individual details and/or images), for which consent to publish (irrespective of time and language) was needed, consent was obtained from that person. The datasets used and analyzed during the current study are available from DCIOM files of patients acquired from Jining No.1 People's Hospital, Jining, Shandong, PR China.

Design of the study

The non-randomized, non-experimental cross-sectional design was applied to the enrolled patients. JRB granted an exemption for the flowchart presented in this study (Figure 1) [8]. All patients underwent OPG and CT scan.

OPG

Patients were subjected to traditional OPG (orthopantomograph OP100 D, MedWOW Ltd., Nicosia, Cyprus) at 10-bit depth acquisition. The dose of the radiation was 0.005 mSv. The images were generated in sizes of 138×270. The radiological signs of MM3 were diagnosed as per position of teeth roots (Table 2). The pictorial presentation of the condition of roots to IAN as per position of teeth roots is represented in Figure 2 [9].

CT scan

CT scans of all patients were done by Discovery LS4 CT scanner (GE Healthcare, UK) with 6.3 MHU x-ray tube, 40 mMa current.

Table 2. Diagnosis by orthopantomography for condition of the inferior alveolar nerve as per position of teeth root.

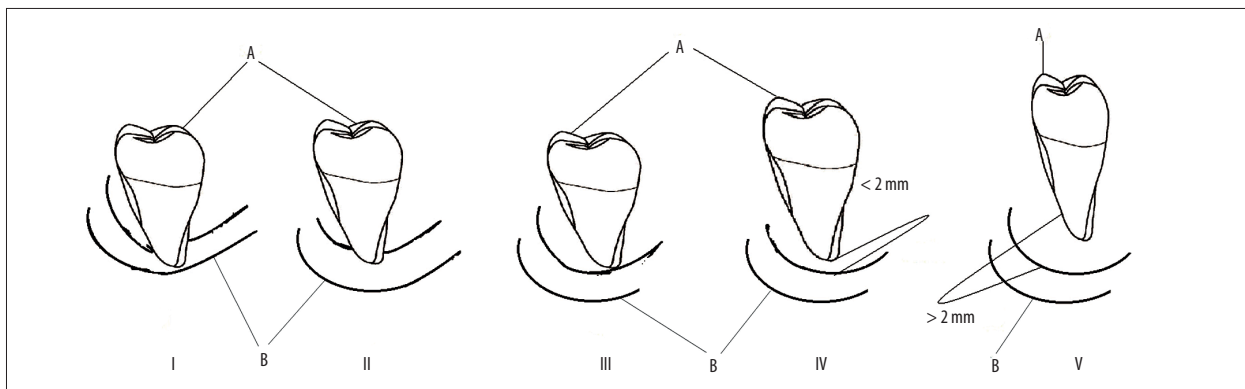| Type	Condition
I	More than half of root structure is superimposed by the canal
II	Less than half of root structure is superimposed by the canal
III	The root structure is impinged by the superior border of canal
IV	The distance between the superior border of canal and the tip of root is less than 2 mm
V	The distance between the superior border of canal and the tip of root is more than 2 mm

Figure 2. Pictorial presentation of the condition of roots to the inferior alveolar nerve as per position of teeth root by orthopantomography or panoramic radiography. A – teeth. B – the canal.

Table 3. Diagnosis by the computed tomography scan for condition of the inferior alveolar nerve as per buccolingual position.

Type	Observation	Condition
I	Cortication of canal is disappeared, displacement of nerve content	More than half of root structure is superimposed by the canal
II	Cortication of canal is disappeared	Less than half of root structure is superimposed by the canal
III	Cortication of canal appears	The root structure is impinged by the superior border of canal
IV	The distance between the superior border of canal and the tip of root is less than 2 mm	
V	The distance between the superior border of canal and the tip of root is more than 2 mm	

Sagittal and coronal images were reconstructed from the raw data (App Software CT DST DLS 1.7). The dose of the radiation was 3 mSv. CT scans of MM3s were diagnosed as per buccolingual and cortication position for each patient (Table 3). The pictorial presentation of the condition of roots to IAN is represented in Figure 3 [10].

OPG images and CT scans were assessed, observed, and analyzed by the authors. All authors were MDs in radiology. If there were differences of opinions regarding assessment, a discussion was carried out by the authors to reach a consensus.

MM3 extraction

The surgical procedures were performed for MM3 bone removal under general anesthesia (145 patients) or local anesthesia (334 patients) by the oral and maxillofacial surgeon(s) (surgeon experience ranged from one year to more than 10 years). The tooth socket was irrigated with normal saline (Baxter Healthcare Corporation, USA). The wound was closed with a non-absorbable 3–0 silk suture (Dentalcompare, USA). Patients were prescribed oral 200 mg cefixime (Cefspan, GSK China) twice a day and 500 mg paracetamol (Calpol, GSK China) thrice a day for a total of five day. After seven days, the sutures were removed and postoperative complications such as
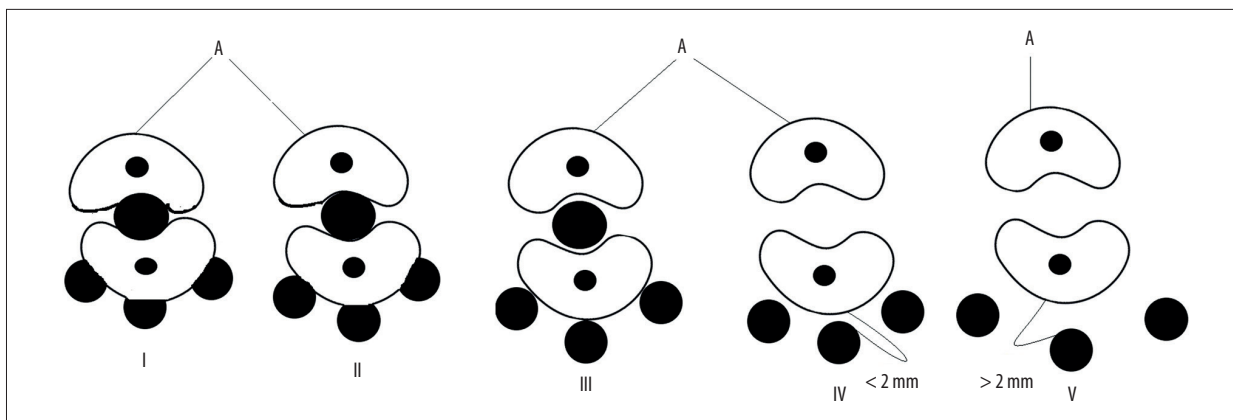
Figure 3. Pictorial presentation of the condition of roots to the inferior alveolar nerve as per buccolingual and cortication position by computed tomography scan. A – root apex.

infection, trismus, ecchymosis, IAN injury, bleeding, swelling, and dry socket were recorded [11].

Detection of IAN sensory impairment

Patients were monitored for sensory threshold of the lip and/or chin prior to surgery at 10 days, 20 days, and 30 days and after surgery at 10 days, 20 days, 30 days, and 90 days. Detection of IAN sensory impairment was done by questionnaires and two-point discrimination sensory threshold potential measurement method as per Equation 1 [12]:

$$S_T = \frac{T_{Pre}}{T_{Pos}} \qquad (1)$$

Where,
S_T – Sensory threshold potential;
T_{Pre} – Preoperative threshold;
T_{Pos} – Postoperative threshold.

Statistical analysis

Statistical analysis was performed using Instat (GrapPad Inc., USA). Two diagnostic modalities to predict the condition of IAN, the close relationship of tooth and canal, and the close relationship to the buccolingual position were compared by non-parametric Wilcoxon matched-pairs signed-ranks test [13] followed by Tukey's post hoc test considering the critical value of the studied range [q] >4.136 (*http://elvers.us/stats/tables/qprobability.html*; number of means: 3; degree of freedom: 1,000; comparing with "hypothetical gold standard") at a significant level [14]. The association of procedural factors and demographic factors with IAN sensory impairment was compared by non-parametric Mann-Whitney U test [4] followed by Tukey's post hoc test considering q >4.136 at a significant level (number of means: 3; the degree of freedom: 956, compared with "hypothetical gold standard") [14]. The results were considered significant at a 99% confidence level [15].

Results

There were 15 OPG images not used in the analysis because of resolution problems, and thus the consensus was based on CT scan only. Moreover, 13 patients refused to have a CT scan, and thus the consensus was based on OPG images only. One patient failed to be diagnosed by both OPG and CT scan, and thus the consensus was reached by surgeon's experience.

OPG was better than CT in detecting the close relationship of the tooth and the canal (p<0.0001, q=25.609), but CT was better in detecting the buccolingual position of the teeth (p<0.0001, q=36.757) (Table 4).

There were 17 patients with detection of significant IAN sensory impairment after surgery. The age of patients (p<0.0001, q=13.945), postoperative bleeding (p<0.0001, q=15.981), and experience of the surgeon (p<0.0001, q=10.99) were identified as factors leading to IAN sensory impairment during MM3 extraction surgery (Table 5).

Discussion

In this study, the condition of the IAN was more successfully quantified by CT scan than OPG. Presently, OPG is used by surgeons to estimate possible damage to the IAN during MM3 extraction surgery [5,16]. In our study, we found that high resolution of images from CT scans, and OPG alone did not provide reliable images, suggesting that it could be possible to predict the risk of IAN injury during surgery by CT scans.

The present study detected the close relationship to tooth and the canal through OPG, which might be enough to predict future hypoesthesia of the lip and/or chin. Other studies have reported that only CT scan [4,7,10,17,18] can predict IAN injury during MM3 extraction surgery and can significantly improve

Table 4. The inferior alveolar nerve position predictions by two diagnostic modalities.

Characteristics		OPG (n=464)	CT scan (n=466)	Statically analysis between OPG and CT scan	
				p-Value	q-Value
Condition of IAN	I	55 (12)	89 (19)	<0.0001	8.062
	II	66 (14)	91 (20)		
	III	67 (14)	101 (22)		
	IV	145 (32)	106 (23)		
	V	131 (28)	79 (16)		
The close relationship signs related to tooth and canal	The white line loss of IAN	77 (17)	17 (4)	<0.0001	25.609
	The canal diversion	82 (18)	13 (3)		
	The relationship of IAN to teeth root	85 (18)	16 (3)		
	The presence of the juxta-apical area	35 (8)	5 (1)		
The close relationship signs related to buccolingual position	Buccal position	5 (1)	65 (14)	<0.0001	36.757
	Inferior position	6 (1)	77 (17)		
	Lingual position	7 (1)	101 (22)		
	Inter-radicular position	9 (2)	89 (19)		

For statistical analysis, an event considered as 1 and absent of that considered as 0. Statistical significance was determined by the Wilcoxon matched-pairs signed-ranks test followed by Tukey's *post hoc* test. A p<0.01 and q>4.136 were considered statistically significant. 'Hypothetical gold standard': Condition of the inferior alveolar nerve: Type V; The close relationship signs related to tooth and canal: OPG image data; The close relationship signs related to buccolingual position: CT scan data. IAN – the inferior alveolar nerve, OPG – prthopantomography; CT – the computed tomography.

Table 5. The postoperative sensory impairment related evaluation.

Procedural factors and demographical factors		Patients		Statistical analysis	
		* IAN impairment (n=17)	Normal (n=462)	q-Value	q-Value
Age (years)	≤30	1 (6)	357 (77)	<0.0001	13.945
	>30	16 (94)	105 (23)		
Bone removed		6 (35)	95 (21)	0.2991	N/A
Bleeding		16 (94)	85 (18)	<0.0001	15.981
Surgeon experience (years)	<5	14 (82)	102 (22)	<0.0001	10.99
	≥5 but <10	2 (12)	105 (23)		
	≥10	1 (6)	255 (55)		

For statistical analysis, an event considered as 1 and absent of that considered as 0. Statistical significance was determined by the Mann-Whitney *U* test followed by Tukey's *post hoc* test. A *p*<0.01 and *q*>4.136 were considered statistically significant. 'Hypothetical gold standard': Age: ≤30 years, Bleeding: No bleeding, Bone removed: not removed, Surgeon experience: ≥10 years. IAN – the inferior alveolar nerve; N/A – not applicable. * Orthopantomography and the computed tomographic scan both had performed.

a surgeon's confidence regarding the planning of surgery [19]. With respect to the results of our study, a quality OPG image and planned surgery could avoid the risk of IAN injury.

The present study detected signs of a close relationship to the buccolingual position through CT scans. As OPG images are two-dimensional [16], sufficient reliable information is not

provided to allow for prediction of nerve lesion [6,20]. In consideration of preoperative CT scans of patients, CT scan is a more reliable method before MM3 extraction surgery.

Using both OPG and CT scan before surgery for risk assessment of hypoesthesia conditions, we found that even after the six-months postoperative period, some patients reported a loss of sensation of the lip and/or chin (17/479). Other studies have reported the event of IAN injury to be 0.26–8.4% [21]. There are multivariate factors responsible for damage of the IAN during MM3 removal surgery [1,4,16,22]. In consideration of postsurgical demographical and procedural factors, a diagnostic method alone is not quite enough to overcome the risk of damage to the IAN.

In recent years, coronectomy surgery has developed to overcome IAN injury [23]. However, this technique is not for less experienced surgeons because they often break tips of teeth roots during MM3 extraction surgery [24] and patients are required to be continuously monitor by the surgeon [25]; radiography following MM3 extraction surgery is quite simple and reproducible.

There were several limitations to this study. The intra- and inter-patient diagnostic variabilities were not evaluated. Interpretations of the CT scan and OPG images were done by the authors themselves, who were not blinded to the study. When there were differences of opinions regarding assessments of OPG images and CT scans, the discussion was limited

to the authors only, no expert opinions were sought. There are many other factors, like body mass index, sex, or diabetes that can also affected IAN injury during the MM3 extraction surgery. This study did not focus on these demographic characters. Type I errors were reported during statistical analysis of postsurgical demographical and procedural factors. All patients were from PR China. The study was limited to MM3 only.

Conclusions

This non-randomized, non-experimental cross-sectional study demonstrated that preoperative panoramic radiography, CT scan, age, experience of the surgeon, and postoperative bleeding can predict damage of the IAN during mandibular third molar extraction surgery. Panoramic radiography alone was not enough to predict future hypoesthesia of lips and/or chin. Thus, this study recommended using CT scans to assess IAN injury during surgery.

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Conflict of interest

None.

References:

1. Hasegawa T, Ri S, Umeda M, Komori T: Multivariate relationships among risk factors and hypoesthesia of the lower lip after extraction of the mandibular third molar. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2011; 111: e1–7
2. Alessandri BG, Bendandi M, Laino L et al: Orthodontic extraction: Riskless extraction of impacted lower third molars close to the mandibular canal. J Oral Maxillofac Surg, 2007; 65: 2580–86
3. Garcia-Garcia A: Letter: Is coronectomy really preferable to extraction? Br J Oral Maxillofac Surg, 2006; 44: 75; author reply 76
4. Hasegawa T, Ri S, Shigeta T et al: Risk factors associated with inferior alveolar nerve injury after extraction of the mandibular third molar – a comparative study of preoperative images by panoramic radiography and computed tomography. Int J Oral Maxillofac Surg, 2013; 42: 843–51
5. Ghaeminia H, Meijer GJ, Soehardi A et al: Position of the impacted third molar in relation to the mandibular canal: Diagnostic accuracy of cone beam computed tomography compared with panoramic radiography. Int J Oral Maxillofac Surg, 2009; 38: 964–71
6. Su N, van Wijk A, Berkhout E et al: Predictive value of panoramic radiography for injury of inferior alveolar nerve after mandibular third molar surgery. J Oral Maxillofac Surg, 2017; 75: 663–79
7. Katakam SK, Shankar U, Thakur D et al: Comparison of orthopantomography and computed tomography image for assessing the relationship between impacted mandibular third molar and mandibular canal. J Contemp Dent Pract, 2012; 13: 819–23
8. Ochodo EA, van Enst WA, Naaktgeboren CA et al: Incorporating quality assessments of primary studies in the conclusions of diagnostic accuracy reviews: A cross-sectional study. BMC Med Res Methodol, 2014; 14: 33
9. Xu GZ, Yang C, Fan XD et al: Anatomic relationship between impacted third mandibular molar and the mandibular canal as the risk factor of inferior alveolar nerve injury. Br J Oral Maxillofac Surg, 2013; 51: e215–19
10. Susarla SM, Dodson TB: Preoperative computed tomography imaging in the management of impacted mandibular third molars. J Oral Maxillofac Surg, 2007; 65: 83–88
11. Managutti A, Managutti SA, Patel J, Puthanakar NY: Evaluation of postsurgical bacteremia with use of povidone-iodine and chlorhexidine during mandibular third molar surgery. J Maxillofac Oral Surg, 2017; 16: 485–90
12. Essick GK, Phillips C, Kim SH, Zuniga J: Sensory retraining following orthognathic surgery: Effect on threshold measures of sensory function. J Oral Rehabil, 2009; 36: 415–26
13. Gastounioti A, Oustimov A, Keller BM et al: Breast parenchymal patterns in processed versus raw digital mammograms: A large population study toward assessing differences in quantitative measures across image representations. Med Phys, 2016; 43: 5862–77
14. Tada S, Ikebe K, Kamide K et al: Relationship between atherosclerosis and occlusal support of natural teeth with mediating effect of atheroprotective nutrients: From the SONIC study. PLoS One, 2017; 12(8): e0182563
15. Christell H, Birch S, Bondemark L et al.; SEDENTEXCT consortium: The impact of Cone Beam CT on financial costs and orthodontists' treatment decisions in the management of maxillary canines with eruption disturbance. Eur J Orthod, 2017 [Epub ahead of print]
16. Szalma J, Lempel E, Jeges S et al: The prognostic value of panoramic radiography of inferior alveolar nerve damage after mandibular third molar removal: Retrospective study of 400 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2010; 109: 294–302

17. Umar G, Bryant C, Obisesan O, Rood JP: Correlation of the radiological predictive factors of inferior alveolar nerve injury with cone beam computed tomography findings. Oral Surgery, 2010; 3: 72–82

18. Ishak MH, Zhun OC, Shaari R et al: Panoramic radiography in evaluating the relationship of mandibular canal and impacted third molars in comparison with cone-beam computed tomography. Mymensingh Med J, 2014; 23: 781–86

19. Alqerban A, Willems G, Bernaerts C et al: Orthodontic treatment planning for impacted maxillary canines using conventional records versus 3D CBCT. Eur J Orthod, 2014; 36: 698–707

20. Szalma J, Lempel E, Jeges S, Olasz L: Digital versus conventional panoramic radiography in predicting inferior alveolar nerve injury after mandibular third molar removal. J Craniofac Surg, 2012; 23: 155–58

21. Agbaje JO, Heijsters G, Salem AS et al: Coronectomy of deeply impacted lower third molar: Incidence of outcomes and complications after one-year follow-up. J Oral Maxillofac Res, 2015; 6(2): e1

22. Chuang SK, Perrott DH, Susarla SM, Dodson TB: Risk factors for inflammatory complications following third molar surgery in adults. J Oral Maxillofac Surg, 2008; 66: 2313–18

23. Renton T, Hankins M, Sproate C, McGurk M: A randomised controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars. Br J Oral Maxillofac Surg, 2005; 43: 7–12

24. Kouwenberg AJ, Stroy LP, Rijt ED et al: Coronectomy of the mandibular third molar: Respect for the inferior alveolar nerve. J Craniomaxillofac Surg, 2016; 44: 616–21

25. Meek MF, Coert JH, de Visscher JG: Reply to letter: Renton T, Hankins M, Sproate C, McGurk M: A randomised controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars. Br J Oral Maxillofac Surg, 2006; 44: 76–77