ADA CE Program ARTICLE 3

CrossMark

Risk of lingual plate perforation for virtual immediate implant placement in the posterior mandible

A computer simulation study

Ren-Yeong Huang, DDS, PhD; David L. Cochran, DDS, MS, PhD; Wan-Chien Cheng, DDS, MS, PhD; Ming-Hung Lin, DDS; Wen-Hui Fan, MD; Cheng-En Sung, DDS; Lian-Ping Mau, DDS, MS; Po-Hsien Huang, DDS, MS; Yi-Shing Shieh, DDS, PhD

ABSTRACT

Background. This study sought to determine which factors are correlated to a higher risk of lingual plate perforation (LPP) when placing a virtual implant in the area of the anticipated extraction site of the posterior mandible.

Methods. Computed tomographic images of 300 patients (1,279 teeth) were analyzed in regard to the shape of the mandible (convergent, parallel, or undercut type), dimensional parameters of lingual concavity (angle, height, depth) and its relation to the inferior alveolar canal (zones A, B, C), distance from root apex to inferior alveolar canal, and probability of LPP. The odds ratio of variables was determined by multiple logistic regression modeling.

Results. The overall probability of LPPs on virtual implant placement was 3.1%. This perforation was most commonly observed at the second molar and with a U-type ridge. After adjusting cofounders, a concave point located in zone A is 17.34 times more likely to have a LPP than one in zone C. The probability of LPPs was reduced by 34% for every 1-millimeter increase in distance from root apex to inferior alveolar canal on virtual implant placement of posterior mandible region.

Conclusions. Three-dimensional cone-beam computed tomographic imaging is essential for planning immediate implant placement in the anticipated extraction sites of the posterior mandible region as proved by anatomic findings that can only be understood from preoperative imaging analysis.

Practical Implications. Presurgical cross-sectional images can be analyzed to identify anatomic features relative to the lingual concavities in the posterior mandible region, which can help to avoid unpleasant complications, specifically when performing immediate implant procedures.

Key Words. Cone-beam computed tomography; dental implants; mandible; lingual plate perforation; immediate placement.

JADA 2015:146(10):735-742

http://dx.doi.org/10.1016/j.adaj.2015.04.027

Immediate placement of a dental implant into a fresh extraction socket has attracted attention since it was first described over 30 years ago.[1] Although immediate dental implant placement has been shown to be successful,[2] it is considered a technique-sensitive procedure. Therefore, the clinician should always be aware that certain risks and complications are inevitable.[3-8] For example, immediate implant placement beyond the alveolar housing may result in perforation of the lingual cortex,[6,9,10] damaging vital anatomic structures and causing neurovascular injuries.[3,8] When lingual plate perforation (LPP) occurs in the posterior mandible region, it may result in inflammation or infection that could adversely affect the outcome of the immediate implant placement and may even cause life-threatening events.[3,5,6,8-11]

Before surgery, a comprehensive assessment and detailed preextraction treatment plan is required to help prevent surgical accidents and complications, such as inferior alveolar nerve (IAN) damage and LPPs.[6,9,12] In addition to

This article has an accompanying online continuing education activity available at: http://jada.ada.org/ce/home.

traditional 2-dimensional imaging methods, multislice 3-dimensional (3-D) anatomic knowledge of the individual patient obtained through a variety of techniques, such as cone-beam computed tomography (CBCT), are needed to avoid nerve injury, penetrations of jaw boundaries, and implant proximity to adjacent teeth; such knowledge is also needed to facilitate implant alignment with the prosthetic elements and improve the potential for achieving successful outcomes.[5,6,9,13] As such, immediate implant placement could be used in carefully evaluated situations to reduce adverse effects and the chances of implant failure in mandibular molar regions.[4,12,14]

Preoperative 3-D CBCT imaging analysis may be able to provide anatomic data that can be used to generate a collaborative treatment plan, to achieve optimal outcomes by more precisely planning and placing immediate implants, and to minimize the associated risks in the posterior mandible region.[5,6,9,12,15] Moreover, virtual implant planning using CBCT data allows the clinician to create and visualize the end result before initiating treatment.

This computer simulation study was performed to evaluate the prevalence and dimensional parameters of lingual concavities and to determine whether the presence of lingual concavities is related to a higher risk of LPP when performing an immediate implant surgery in the anticipated extraction site of the posterior mandible region.

METHODS

Patient recruitment, confidentiality, and image acquisition. All patients of this study were Taiwanese patients who received treatment at the Department of Dentistry, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan, who sought care for the purpose of dental implant placement. All images were taken between November 2009 and December 2013 with a CBCT machine (NewTom 5G, QR) by board-certified radiologists. The X-ray tube was operated at an accelerated potential of 110 kilovolts peak with a beam current of 11.94 milliamperes, and the exposure time was automatically adjusted according to the area of scanning (approximately 7 seconds for full arch). The field of view was fixed at 12 × 8 square inches. The resolution and separation of each slice was 0.15 millimeters. The CBCT scans were not specifically acquired for this project and were saved in DICOM (Digital Imaging and Communications in Medicine) format, and these data were saved in an encrypted file confidentially protected and retrievable if needed. The project and protocol were approved by the institutional review board of Tri-Service General Hospital, National Defense Medical Center (2-102-05-064).

Inclusion and exclusion criteria of selected images. Images selected from anonymized preexisting images had to fulfill the following inclusion criteria as described previously[6,12]:

- one of following teeth had to be fully erupted: permanent mandibular second premolar, permanent mandibular first molar, or permanent mandibular second molar;
- each tooth had to have fully formed apexes;
- the outline of the mandible and inferior alveolar canal (IAC) had to be easily identified;
- each tooth had to be normally positioned (the imaginary line connecting the cusp tip of canines, central grooves of premolars, and molars was generally smooth);
- opposing maxillary teeth were present to provide information for implant angulation.

Images were excluded if:

- they were unclear or incomplete due to scattering, beam-hardening artifact, or other reasons;
- a pathologic lesion was found in the posterior mandible region;
- images revealed a missing tooth, an implant, or grafted alveolar ridge.

All images displayed on a 19-inch liquid crystal display monitor were reoriented and inspected by 2 calibrated examiners (R.-Y.H. and M.-H.L.). Intra- and interexaminer calibrations based on the anatomic diagnosis of CBCT images were performed to assess data reliability. After calibration, the 2 examiners evaluated the images separately, and any disagreement in image interpretation was discussed until a consensus was reached.

Assessment of cross-sectional morphology. The qualified CBCT images were analyzed by commercially available 3-D navigation software (ImplantMax version 4.0; Saturn Image). If the tooth was present and met the inclusion criteria, a cross-sectional image of the region of interest, the center section of premolar teeth or the center of the mesiodistal aspect in multirooted teeth, which most clinicians would choose to place an implant, was assessed and measured.

Classification of mandibular cross-sectional morphology. Three types of mandibular cross-sectional ridge morphology were determined according to the definition previously described by Chan and colleagues.[6,9] In brief, in terms of cross-sectional view of posterior mandible, the undercut (U) type was a ridge with narrow base to a wider crest with prominent point on the lingual plate and thus had a lingual undercut

ABBREVIATION KEY. **C:** Convergent. **CBCT:** Cone-beam computed tomography. **DICOM:** Digital Imaging and Communications in Medicine. **IAC:** Inferior alveolar canal. **IAN:** Inferior alveolar nerve. **LPP:** Lingual plate perforation. **M1:** Mandibular first molar. **M2:** Mandibular second molar. **PM2:** Mandibular second premolar. **P type:** Parallel. **RAC:** Distance from root apex to inferior alveolar canal. **U:** Undercut. **3-D:** Three-dimensional.