Avoiding Injury to the Inferior Alveolar Nerve by Routine Use of Intraoperative Radiographs During Implant Placement

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Injury to the inferior alveolar nerve during implant placement in the posterior atrophic mandible is a rare but serious complication. Although a preoperative computerized tomography scan can help determine the distance from the alveolar ridge to the nerve canal, variables such as magnification errors, ridge anatomy, and operator technique can lead to increased chance for complications. The routine use of intraoperative periapical radiographs during the drilling sequence is an inexpensive and reliable tool, allowing the operator to confidently adjust the direction and depth of the implant during placement. Most important, it helps avoid the risk of injury to the inferior alveolar nerve in cases in which there is limited vertical alveolar bone. Using this technique for 21 implants placed in the posterior atrophic mandible, with less than 10 mm of vertical bone to the inferior alveolar nerve canal, the authors observed no incidents of postoperative paresthesia.

Key Words: periapical radiographs, dental implants, nerve injury

INTRODUCTION

Oftentimes, as implant surgeons, we are presented with a preoperative computerized tomography (CT) scan of the posterior mandible showing adequate bone width for implant placement but limited vertical bone height. Presented with this scenario, and in light of the increasing number of lawsuits from damage to the inferior alveolar nerve, many surgeons refrain from placement of implants in compromised situations. Injury to the inferior alveolar nerve during implant placement is a serious complication. The incidence of altered nerve sensation following implant placement in the atrophic posterior mandible has been reported as 0% to 13%.1–3 While CT scans are an excellent preoperative tool, intraoperative periapical radiographs can offer critical information to avoid nerve injury.

Many critical factors must be kept in mind when placing implants in this region. The first is understanding the anatomy of early resorption patterns in the posterior edentulous mandible, which usually produce vertical and horizontal alveolar atrophy on the lateral aspect of the ridge (Figure 1). This irregularity can introduce inaccuracies and intraoperative difficulties even for the experienced surgeon. While a preoperative CT scan is an excellent diagnostic tool, intraoperative errors can still occur when placing implants in limited vertical bone of the posterior mandible. In the presented clinical situation (Figure 2a and b), a preoperative CT scan was done; however, an implant was placed into the inferior alveolar canal, demonstrating that the preoperative CT scan does not guarantee or verify correct placement. Operator-induced error or variation in surgical anatomy may cause distortion in already limited alveolar bone height.
A second critical factor is radiographic magnification errors. In traditional CT scans of the mandible, magnification errors are reported to be from 0% to 8% and with cone beam CT as high as 3.8%.\textsuperscript{4–6} Other diagnostic tools such as periapical radiographs have a magnification error reported at an average distortion of 14%.\textsuperscript{5} Although preoperatively, a CT scan will give a more exact distance from the alveolar ridge to the nerve canal, variables such as ridge anatomy and operator technique can lead to complications during implant placement. The routine use of intraoperative periapical radiographs during the drilling sequence, for implants placed in the atrophic posterior mandible, can help avoid the risk of injury to the inferior alveolar nerve. Periapical radiographs used intraoperatively to obtain working length measurements are similar in
concept to techniques used in root canal therapy, and the method is reliable for determining the safe
distance between the implant and the inferior alveolar
canal, thus avoiding the risk of injury to the nerve
altogether. This not only increases the accuracy of
implant placement but also helps prevent nerve
damage.

A third critical factor is the implant’s ability to
withstand occlusal load. Placing an implant that is
short yet wide can overcome the height disadvantage
in the molar region.7 The more surface area the
implant has with the bone, the better its ability to
withstand long-term occlusal load. For example,
placing a 6 × 8 mm implant (Branemark TiUnite Mark
Ill, Nobel Biocare, City, State) has roughly the same
amount of surface area as a 3.75 × 18 mm implant
with approximately the same predictable success
rate.7

### TECHNIQUE

The necessary equipment includes a PA machine,
preferably digital and portable so it can be used in any
operatory setting. The recommended distance for an
implant to the IAN is about 2 mm above the alveolar
canal.8 Periapical radiographs were taken using a long
cone paralleling technique with an endodontic film
holder (Figure 3) (Rinn Corporation, Elgin, Ill). Intraop-
erative periapical films are taken at different stages
(Figures 4a to d) during implant placement in the
atrophic posterior mandible. The first drill in the
sequence was drilled halfway to the desired depth,
followed by the placement of a guide pin within the
osteotomy and a periapical radiograph. This is
followed again by drilling halfway from the osteotomy
site to the desired depth, placing a guide pin, and
taking a second intraoperative PA. This is continued
until only 2 mm exists from the osteotomy to the
desired depth. This distance is then drilled with a final
PA taken to confirm depth and direction. This series of
radiographs is demonstrated in Figure 5a to e. Care
must be taken to ensure that the patient is not
allowed to bite down on the guide pins or drills while
the PA is being taken. This can be accomplished by
using a bite block at all times.

The magnification error using cone beam CT to
evaluate alveolar bone dimensions has been reported
to be as high as 3.8%.6 The reported magnification
error using periapical radiographs averages 14%
depending on the technique used.5 We use these
results from 2 separate studies to estimate the average
error in a preoperative CT scan to evaluate the
average error in a preoperative CT scan to evaluate the
distance to 2 mm above the IA canal located 10 mm
below the alveolar ridge as 0.3 mm (3.8% of 8 mm)
(Table). Taking a periapical radiograph approximately
2 mm above our desired osteotomy end point (Figures
4d and 5d), the average error in measurement is about
0.3 mm (14% of 2 mm; Table). Although radiographic
evaluation of the bone reaches a precision of only 0.5
mm,9 the calculation of errors in these 2 technique
demonstrates how intraoperative PAs taken at differ-
ent stages can be helpful and critical tools during
surgery.

During the past year, we have used this technique
for 21 implants placed in atrophic posterior mandibles
of 20 patients with less than 10 mm of bone to the IA
ergave canal. These implant sites all had adequate
width to accommodate at least a 5-mm implant. There
were no incidents of postoperative paresthesia.

### DISCUSSION

This technique is an inexpensive and reliable method
that allows 2-dimensional accuracy that can be similar
to CT scans in selected cases. In addition, it allows for
operator real-time data and confidence to avoid the
inferior alveolar nerve during surgery. Placing 21
implants while using this technique in atrophic
posterior mandibles this past year, we had no
incidence of nerve injury. Although additional diag-
nostic data gained from a preoperative CT scan are
useful, the periapical method has proven quite reliable
at giving up-to-the-minute accuracy of osteotomy
length. In addition, it is a critical diagnostic tool to
adjust direction and depth of the implant during
placement and to help avoid inferior alveolar nerve
FIGURES 4–5. FIGURE 4. (a) Diagram of the posterior mandible in which the distance from the alveolar ridge to the inferior alveolar canal is 10 mm. The ideal implant length is 8 mm. (b) First intraoperative PA taken with a marker in place half the distance to the desired depth. In this case, it will be taken after drilling 4 mm with pilot drill. This will allow us to determine both the depth and direction of the implant placement. (c) Second intraoperative PA taken with a marker in place after drilling an additional 2 mm (half the distance from the end of the first drill to the desired depth). (d) Third intraoperative PA taken after drilling an additional 2 mm to our safe distance of 2 mm above the inferior alveolar canal. FIGURE 5. (a) Initial periapical radiograph. (b) Following the initial osteotomy, guide pins were placed to determine the direction and parallelism of the implant as well as the depth to the IA nerve. (c) The third PA reveals the correction of the direction of the posterior implant and continued osteotomy. (d) Final osteotomy direction and depth prior to implant placement. (e) Final implant placement.
injury. The described technique might be recommended as a simple, inexpensive, and reliable method for implant placement in the atrophic alveolar ridge of the mandible.

REFERENCES


