AVOIDING INJURY TO THE INFERIOR ALVEOLAR NERVE BY ROUTINE USE OF INTRAOPERATIVE RADIOGRAPHS DURING IMPLANT PLACEMENT

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?1 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.

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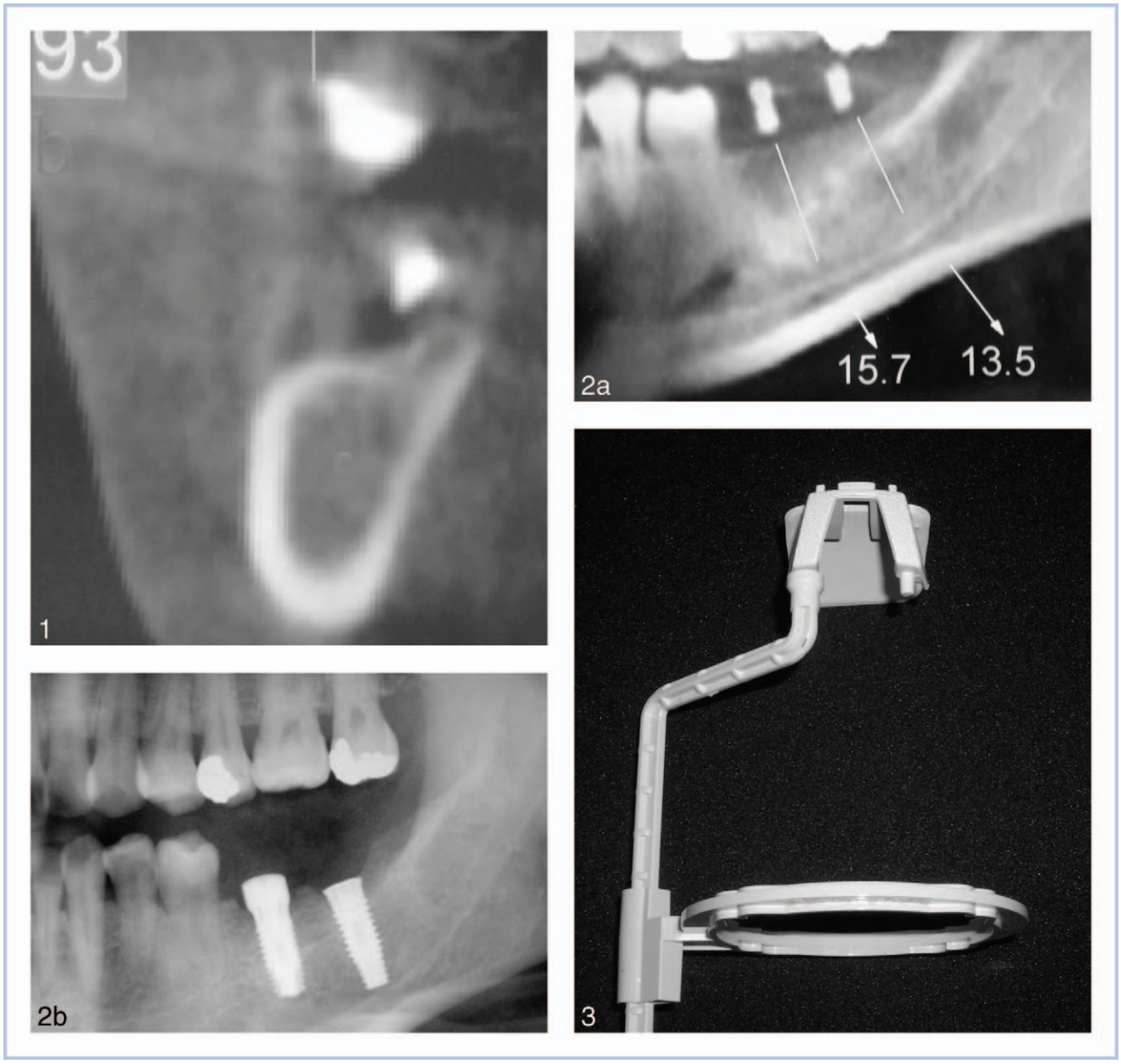


FIGURES 1–3. FIGURE 1. Computerized tomography (CT) radiograph demonstrating vertical and horizontal atrophy on the lateral aspect of the posterior mandible. FIGURE 2. (a) Preoperative CT with linear measurement of the distance between the alveolar ridge and inferior alveolar nerve. (b) Postoperative panorex reveals placement of the implant into the inferior alveolar canal. FIGURE 3. Endodontic periapical film holder allows implant drill guides to emerge from the osteotomy without interfering with film placement while using the paralleling technique.

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%.[4–6] Other diagnostic tools such as periapical radiographs have a magnification error reported at an average distortion of 14%.[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

TABLE 1

Comparisons of the average magnification error between CBCT and PA using 2 different studies*

	Computerized Tomography[6]	PA[5]
From alveolar ridge to implant depth at 8 mm	0.30 mm (3.8% of 8 mm)	1.12 mm (14% of 8 mm)
From osteotomy at 4 mm to implant depth at 8 mm	0.30 mm (3.8% of 8 mm)	0.56 mm (14% of 4 mm)
From osteotomy at 6 mm to implant depth at 8 mm	0.30 mm (3.8% of 8 mm)	0.28 mm (14% of 2 mm)

*Preoperatively, there is a much greater diagnostic accuracy using CBCT. However, as the osteotomy approaches the IA nerve, the PA technique can be a quite helpful and very accurate at determining both direction and depth to vital structures.

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 ?2 III, 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

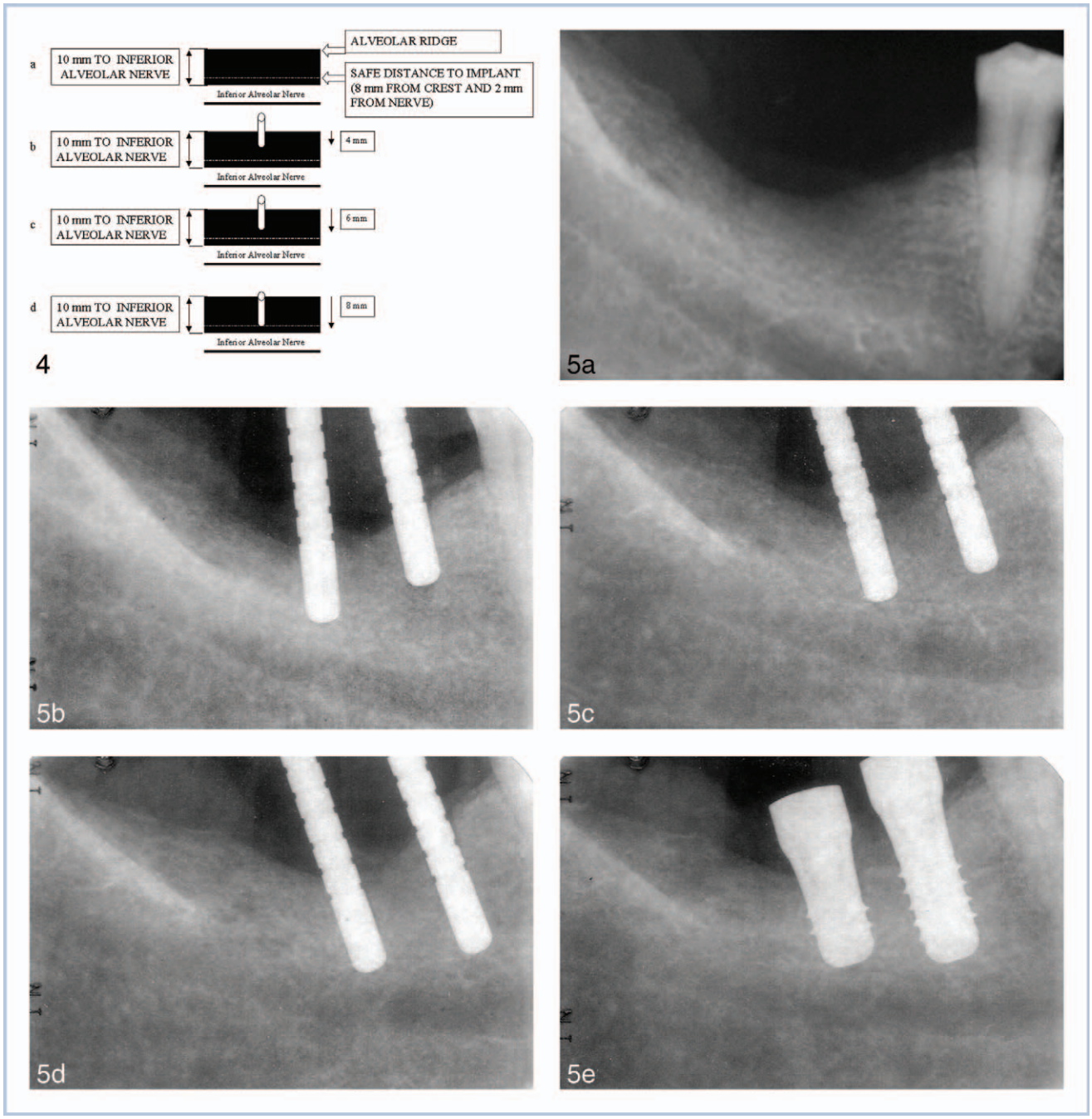
?3 The necessary equipment includes a PA machine, preferably digital and portable so it can be used in any operatory setting. The recommended distance for an ?4 implant to the IAN is about 2 mm above the alveolar canal.[8] Periapical radiographs were taken using a long cone paralleling technique with an endodontic film holder (Figure 3) (Rinn Corporation, Elgin, Ill). Intraoperative 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 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 ?5 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 different 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 nerve 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 diagnostic 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

1. Bartling R, Freeman K, Kraut RA. The incidence of altered sensation of the mental nerve after mandibular implant placement. *J Oral Maxillofac Surg.* 1999;57:1408–1410.

2. Ellies LG, Hawker PB. The prevalence of altered sensation associated with implant surgery. *Int J Oral Maxillofac Implants.* 1993;8:674–679.

3. Wismeijer D, van Waas MA, Vermeeren JI, Kalk W. Patients' perception of sensory disturbances of the mental nerve before and after implant surgery: a prospective study of 110 patients. *Br J Oral Maxillofac Surg.* 1997;35:254–259.

4. Reddy MS, Mayfield-Donahoo T, Vanderven FJ, Jefcoat MK. A comparison of the diagnostic advantages of panoramic radiography and computed tomography scanning for placement of root form dental implants. *Clin Oral Implants Res.* 1994;5:229–238.

5. Sonick M, Abrahams J, Faiella R. A comparison of the accuracy of periapical, panoramic, and computerized tomographic radiographs in locating the mandibular canal. *Int J Oral Maxillofac Implants.* 1994;9:455–460.

6. Ludlow JB, Laster WS, See M, Bailey LJ, Hershey HG. Accuracy of measurements of mandibular anatomy in cone bean ?7 computer tomography images. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007;103:534–542.

7. Griffin TJ, Cheung WS. The use of short, wide implants in posterior areas with reduced bone height: a retrospective investigation. *J Prosthet Dent.* 2004;92:139–144.

8. Misch CE, Crawford E. Predictable mandibular nerve location—a clinical zone of safety. *Int J Oral Implant.* 1990;7:37–40.

9. De Smet E, Jacobs R, Gijbels F, Naert I. The accuracy and reliability of radiographic methods for assessment of marginal bone level around oral implants. *Dentomaxillofac Radiol.* 2002;31:176–181.