A Retrospective Study of Implant Placement Lateral to the Inferior Alveolar Nerve (ILIAN) in Severely Atrophic Posterior Mandibular Ridges

Stuart J Froum, DDS.
Clinical Adjunct Professor and Director of Clinical Research*; Private Practice, New York City, USA.
dr.froum@verizon.net

Natacha Reis, DDS, MFDRCSI, DICOI.
Resident at Advanced Program for International Dentists in Implant Dentistry*.
nr1725@nyu.edu

Tanatcha Kukiratirat, DDS, DICOI.
Resident at Advanced Program for International Dentists in Implant Dentistry*.
tk2456@nyu.edu

Eduardo Gonzaléz De La Torre, DDS, DICOI.
Fellow at Advanced Program for International Dentists in Implant Dentistry*.
egd267@nyu.edu

Adam Barsoum, DMD, DICOI.
Resident at Advanced Program for International Dentists in Implant Dentistry*.
ab7675@nyu.edu

Paul Yung Chen Yu, DDS.
Clinical Assistant Professor at Advanced Program for International Dentists in Implant Dentistry*.
ycy233@nyu.edu

Maryse Manasse, BSc, DMD, MEd, FICD, DICOI.
Clinical Assistant Professor at Advanced Program for International Dentists in Implant Dentistry*.
mm5162@nyu.edu

Sang-Choon Cho, DDS.
Clinical Associate Professor and Director of Advanced Program for International Dentists in Implant Dentistry*.
scc2@nyu.edu

*Ashman Department of Periodontology and Implant Dentistry New York University College of Dentistry.
ABSTRACT

Currently, there are several techniques being used in the posterior mandible to increase alveolar bone height and width. However, each of these has potential complications and limitations. The purpose of the current study was to present the surgical technique and restorative considerations for implant placement lateral to the inferior alveolar nerve (IAN) in cases of severely atrophic edentulous posterior mandibles. In the current study, 26 implants in 16 patients were successfully placed lateral to IAN and restored with splinted screw-retained prostheses, with a follow-up time after loading that ranged from 3 months to 6 years. Two patients reported complications: one had a temporary paresthesia that resolved 3 months after implant placement, and the second had minor paresthesia, which was reduced after implant removal but remained in a small area on the left corner of her lip. Int J Periodontics Restorative Dent doi: 10.11607/prd.5625
INTRODUCTION

Dental implants have been documented as a highly successful option to support fixed restorations to replace single or multiple missing teeth in partially or fully edentulous patients. (1-3)

However, patients with severely atrophic edentulous posterior mandibles with teeth missing for greater than 3-6 months, who desire dental implants to replace those teeth, present a challenge for successful implant placement. In these cases, vertical and horizontal bone is often deficient, and subsequently, there is a need for alveolar ridge augmentation procedures to achieve sufficient bone volume prior to dental implant placement. (4) These augmentation procedures include the use of bone and bone substitute grafts (autografts, allografts, xenografts or alloplastic graft materials), guided bone regeneration (GBR) techniques with the use of bone graft and barrier membranes, the use of biologics (Emdogain, Platelet-rich plasma (PRP), Platelet-derived growth factor (PDGF) and bone morphogenic protein (BMP)), onlay/inlay grafting, the alveolar ridge splitting/expansion technique, and distraction osteogenesis. (5-12)

An additional treatment option for implant placement in these areas includes the transposition/lateralization of the IAN. However, this is a very complex technique that carries a high risk and potential complications. (13, 14)

An alternative treatment option is to place an implant lateral to the inferior alveolar nerve which may avoid alveolar ridge augmentation procedures. Presently, there are few studies regarding this alternative treatment option for the severely atrophic posterior mandible. (14, 15) Additionally,
this option may require prior or concomitant bone augmentation procedures to enable the implant to be placed lateral to the IAN.

The purpose of this retrospective study is to present and evaluate implant placement lateral to the IAN in 16 patients. The planning, technique, and limitations of using this protocol will also be discussed.

MATERIALS AND METHODS

Study Design
This retrospective study consisted of 16 patients with a total of 26 implants placed in New York University College of Dentistry, Department of Implant Dentistry between 2012 and 2019. All clinical data in this study was obtained from the Anonymous Implant Database (AID) at New York University College of Dentistry (NYUCD). This data set was extracted as de-identified information from the routine treatment of patients at the Ashman Department of Periodontology and Implant Dentistry at NYUCD. The AID was certified by the Office of Quality Assurance of NYUCD. This database was given Internal Review Board (IRB) approval and was in compliance with the Health Insurance Portability and Accountability Act (HIPAA) requirements.

Inclusion Criteria
Sixteen consecutively treated cases with severely atrophic edentulous posterior mandibular ridges treated with an implant placed lateral to the IAN were selected. Selection case criteria included patients who desired dental implants with a fixed prosthesis to replace missing teeth in the posterior
mandible. Each of these patients had a history of previously failed bone augmentation procedures or implant failure in the posterior mandibular ridge where implants were desired. Nine females and seven males with an age of 45 to 78 years old (mean age: 61 years old) were included in the study population.

Prior to surgery, each patient was explained the risks and benefits of this procedure and consented to this option verbally and in writing. Prior to surgery, patients were sent for Cone Beam Computerized Tomography (CBCT) of the area of interest, and implants were simulated in the desired position using the Simplant Software (Dentsply Sirona, Charlotte, North Caroline, USA) which allowed evaluation of the procedure. The CBCT DICOM files were used in all cases to print 3D models to track the IAN trajectory. The model was also used to simulate the surgical procedure as well as to fabricate a surgical guide for the actual surgery. (Figure 1)

All surgical procedures were carried out under local anesthesia using 2% lidocaine with 1:100000 epinephrine (Septodont, Cambridge, Canada). All patients included had all required periodontal treatment completed and a full mouth scaling and root planning prior to implant surgery. Following restoration, all patients returned for three-month recall visits, re-examination, and prophylaxis during the first year and then twice a year for maintenance and evaluation. The following three case reports will demonstrate how this technique is performed step by step in three different approaches:

Case report 1 (case 16 on Table 1):
A 52 year old male patient presented in the Ashman Department of Periodontology and Implant Dentistry at NYUCD with an edentulous ridge in the posterior right mandible (Figure 2). The patient was sent for a CBCT scan with a radiographic stent (Figure 3). From the CBCT DICOM file a 3D model was printed and the surgery was simulated in the 3D model using the surgical guide fabricated based on the 3D model (Figure 1). On the day of surgery, after anesthesia was achieved, a full-thickness flap was elevated and the surgical guide was placed for the implant drilling sequence (Figure 4). A 4.1x10 mm implant (BLT Roxolid SLActive®, Straumann, Andover, MA, USA) was placed into the osteotomy at site #30 (Figure 5) and a GBR was performed to cover a coronal buccal dehiscence using a bovine bone xenograft (BioOss® 0.5g, Geistlich, Princeton, NJ, USA) covered by a resorbable membrane (Bio-Gide®, Geistlich, Princeton, NJ, USA) secured with tacks (Figure 6). Primary closure was achieved with 4-0 vycril interrupted sutures (Figure 7). A postoperative CBCT scan was taken to confirm that the implant was placed lateral to IAN (Figure 8). Four months later, second stage surgery was performed and one month later, a final impression was taken. One month later, an implant screw retained 3-unit prostheses was delivered (Figure 9). The case was followed 3 months after placement of the prostheses.

**Case report 2 (case 6 on Table 1):**

A 71 year old male patient presented at the Ashman Department of Periodontology and Implant Dentistry at NYUCD with failed implants in the posterior right mandible (Figure 10). After removal of the failed implants, the patient was sent for a CBCT scan. From the CBCT DICOM file a 3D model was printed and the IAN was tracked. On the day of the surgery, the broken implant on site #31 was removed and the customized alveolar ridge splitting (CARS) technique was
performed to augment the ridge width (Figure 11). (16) This recently introduced technique consisted of using trephine burs in the future implant site, expanding the buccal bone, and placement of a bone graft material (BioOss® 0.5g, Geishtlich, Princeton, NJ, USA). Three weeks later, a 3.3x10 mm implant (BLT SLA®, EBi, Englewood Cliffs, NJ, USA) was placed into the osteotomy on site #31 and a postoperative CBCT scan was taken (Figure 12). Four months after, second stage surgery was performed. A 5-unit implant screw-retained prostheses was delivered and a postoperative panoramic radiograph and a CBCT scan were taken (Figures 13 and 14). The case was followed for 1 year post restoration with all implants successful and bone levels being maintained.

Case report 3 (case 4 on Table 1):

A 61 year old female patient presented at the Ashman Department of Periodontology and Implant Dentistry at NYUCD with an edentulous ridge in the posterior right mandible (Figure 15). Prior to surgery, the patient was sent for CBCT scan. During the first surgery, two narrow diameter implants (NDIs) 1.8 mm (Dentatus, New York, NY, USA) were placed on sites #30 and #31 lateral to the IAN and a postoperative CBCT scan was taken (Figures 16a and 16b). The NDIs were placed as temporary implants for at least two months to assure that there were no neurosensory problems related to the IAN. Later, the NDIs were used as a guide/shield for the placement of the standard diameter implants (SDIs) on sites #30 and #31 (Figure 17) The NDI were removed prior to SDI placement. A 4.1x10 mm and a 3.3x10 mm implants (BL Roxolid SLActive®, Straumann, Andover, MA, USA) were placed on sites #30 and #31, respectively and a postoperative CBCT was taken (Figures 18a and 18b). Three months later, second stage surgery was performed. Two months after that, a two implant screw-retained splinted crowns was delivered (Figure 19). A final
panoramic radiograph was taken 6 years post restoration (Figure 20). The implants and restoration have been well maintained.

RESULTS

Of the 16 cases, in 4 cases implants were placed lateral to IAN without need of bone augmentation procedures. In 1 case GBR was needed after implant placement lateral to IAN to cover a coronal buccal dehiscence. In 6 cases the CARS technique was performed three weeks prior to the placement of the implants lateral to IAN. In 5 cases narrow diameter implants (1.8 to 2.4 mm) were placed 1-2 mm lateral to the IAN and served as a guide for the standard diameter implants placement. Of the 26 implants placed lateral to the IAN in the posterior mandible in 16 patients, all successfully osseointegrated and were restored with splinted screw-retained restorations. The follow-up time ranged from 3 months to six years (see Table I).

Healing was uneventful in all cases and patients functioned normally without any neurosensory problems, except in two cases, where complications were reported. In one case (subject 13 in Table 1), the patient, had temporary paresthesia, which resolved within three months after implant placement without any treatment. This patient has been followed for 4 years after delivery of final restoration with no recurrence or complication. In the second case (subject 14 in table I), the patient had paresthesia after the NDI was placed. The NDI was then removed, the site was allowed to heal. Two 3.3 mm SDI were then placed lateral to the IAN after a CARS augmentation technique was performed. The paresthesia remained with a small area of numbness of the lip and alveolar mucosa from teeth #27-#29 area. However, 6 months after delivery of the provisional restoration
the patient reported that it has decreased and was present in a small area in the side of her lip and didn’t influence her daily life. Both patients are seen every three months and functioned normally.

**DISCUSSION**

Implant placement in the posterior mandible is particularly challenging because of proximity to the IAN in cases of ridge atrophy. Moreover reduced blood supply and limited bone and additional limitations to implant placement in this area. (17, 18) Various augmentation techniques have been proposed, including guided bone regeneration for horizontal and/or a vertical ridge augmentation, distraction osteogenesis, autogenous block graft, and alveolar ridge splitting. (19, 20) A comparison of different bone augmentation techniques is shown on Table 2. (21-30) More complications have been observed with the vertical augmentation procedures when compared to horizontal procedures. (26) The implant placement lateral to the IAN technique documented in this study is a potentially less invasive approach for implant placement in an atrophic posterior mandible. (26)

**CONCLUSIONS**

The implant placement lateral to IAN technique is a viable treatment option in cases of severely atrophic posterior edentulous mandibles for patients who desired dental implants with a fixed prosthesis. The advantages of this technique include less trauma, surgical less time, implant placement without ridge augmentation (most of cases), and less postoperative complications. The limitations of the present technique include that the procedure is technique sensitive, an adequate
thickness of the ridge is needed lateral to the inferior alveolar nerve prior to implant placement, and there is a risk of paresthesia. Where limited bone width existed, horizontal augmentation techniques (CARS technique and GBR) were used in this case series to increase bone volume lateral to the IAN. More research is needed to validate the results found in the current study and to compare the implant placement lateral to IAN procedure to others being used today.

ACKNOWLEDGEMENTS

The authors reported no conflicts of interest related to this study.
REFERENCES


### Table 1. Results of 26 implants placed lateral to the inferior alveolar nerve.

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<tr>
<th>Subjects</th>
<th>Age</th>
<th>Gender</th>
<th>Implant Site</th>
<th>CARS</th>
<th>Narrow Implant</th>
<th>3D Printed Simulation</th>
<th>Implant Information</th>
<th>Loading Time</th>
<th>Complications</th>
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<td>M</td>
<td>#18</td>
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<td>6 months</td>
<td>Numbness</td>
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<td>3 months</td>
<td>No</td>
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<td></td>
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<td></td>
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Table 2. Comparison of bone augmentation techniques and ILIAN technique

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<tr>
<th>Technique</th>
<th>Indications</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Limitations</th>
</tr>
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<tbody>
<tr>
<td>Guided Bone Regeneration</td>
<td>Vertical and/or horizontal</td>
<td>No donor site needed; Most well documented.</td>
<td>Membrane exposed and/or collapse.</td>
<td>Contained defects.</td>
</tr>
<tr>
<td></td>
<td>augmentation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Distraction Osteogenesis</td>
<td>Vertical augmentation only</td>
<td>Highest amount of vertical bone gain (5-15 mm); Hard and soft tissue</td>
<td>Very complex procedure with high complication rates (75.5%); Limited</td>
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<tr>
<td></td>
<td></td>
<td>augmentation; No donor site needed.</td>
<td>direction control; Difficult to provisionalized; Additional procedure for</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>device removal; Infection associated with distraction rod.</td>
<td></td>
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<tr>
<td>Autogenous Block Graft</td>
<td>Vertical and/or horizontal</td>
<td>Initial stability of grafted segment; Scaffolding effect.</td>
<td>Resorption; Tissue dehiscence; High morbidity; Increased postoperative</td>
<td>Donor site is needed.</td>
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<tr>
<td></td>
<td>augmentation</td>
<td></td>
<td>discomfort; Fracture; Difficult to provisionalized</td>
<td></td>
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<tr>
<td>Alveolar Ridge Splitting</td>
<td>Horizontal augmentation only</td>
<td>Creating intraosseous defect; Bone graft is contained; No membrane is</td>
<td>Buccal / lingual plate fracture; IAN paresthesia; Resorption; Implant</td>
<td>Minimal ridge width of 3.37 mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>needed.</td>
<td>mobility, malposition, fracture.</td>
<td></td>
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<tr>
<td>Implant Placement Lateral to the IAN</td>
<td>Horizontal and vertical atrophic</td>
<td>Less time consuming; Less invasive; Less traumatic; Less postoperative</td>
<td>IAN paresthesia.</td>
<td>Sufficient bone width lateral to the IAN.</td>
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<td>ridge with enough bone width lateral to the IAN</td>
<td>complications.</td>
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FIGURES LEGEND

Figure 1 – Simulation of the surgical procedure in the 3D printed model and fabrication of a surgical guide.

Figure 2 – Intraoral occlusal view of the posterior right mandible.

Figure 3 – Preoperative CBCT scan of site #30.

Figure 4 – Intraoral occlusal view of the use of the surgical guide for the pilot drill on site #30.

Figure 5 – Intraoral occlusal view of the implant placement on site #30 (buccal dehiscence).

Figure 6 – Intraoral occlusal view of GBR performed following implant placement to treat the buccal dehiscence on implant #30.

Figure 7 – Intraoral occlusal view of primary tension free closure after the surgical procedure on the posterior right mandible.

Figure 8 - CBCT scan showing implant #30 placed lateral to IAN.

Figure 9 – Intraoral occlusal view after delivery of the final restoration (PFM 3-unit bridge supported by implants) in the posterior right mandible.

Figure 10 – Initial panoramic radiograph (2nd clinical case).

Figure 11 – Postoperative panoramic radiograph after removal of fractured and failing mandibular right premolar and molar implants and performance of Custom Alveolar Ridge Splitting technique on site #31.

Figure 12 – Postoperative CBCT scan of implant #31 placed lateral to IAN.

Figure 13 – Panoramic radiograph 6 months after delivery of final restoration (5-unit bridge supported by 3 implants).
Figure 14 - CBCT scan of implant #31 placed lateral to IAN 6 months after delivery of final restoration.

Figure 15 – Initial panoramic radiograph (3rd Clinical Case).

Figure 16a – Postoperative CBCT scan after placement of NDIs on site #30 lateral to IAN.

Figure 16b – Postoperative CBCT scan after placement of NDIs on site #31 lateral to IAN.

Figure 17 – Intraoral occlusal and periapical radiograph when using NDIs as a guide for the osteotomy of SDIs on sites #30 and #31.

Figure 18a – Postoperative CBCT scan after implants placed on site #30 lateral to IAN.

Figure 18b – Postoperative CBCT scan after implants placed on site #31 lateral to IAN.

Figure 19 – Intraoral occlusal view after delivery of final restoration (2 splinted PFM crowns) on implants #30 and #31.

Figure 20 – Panoramic radiograph 6 years after delivery of final restoration on the implants #30 and #31 placed lateral to IAN in the posterior right mandible.
Figures #5625

Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

Fig 6

Fig 7