The use of dynamic navigation to prevent implant complications – every patient, every time

Drs. Robert W. Emery and Keith Progebin discuss navigation for accurate and precise implant planning

Complications related to dental implants fall into two broad categories: infectious and mechanical. The underlying etiology of these two categories often results from poor implant position.[1–3] Computer-assisted surgery (CAS) allows the dental team, including restorative dentist, surgeon, and dental technician, to plan and place implants more accurately and precisely. There are two forms of CAS:

- Static guidance, which uses prefabricated CAD/CAM splints, proprietary tubes, and drills to guide the surgeon's instruments. These guides cannot be altered after fabrication and are thus "static."
- Dynamic guidance, which uses a stereotactic tracking system to dynamically guide the surgeon's instruments to the correct location. The plan can be altered at any time and is thus "dynamic."

With the advent of dynamic navigation for the placement of dental implants, the dental surgeon can place implants accurately and precisely every time in an efficient and cost-effective fashion.[4] A complete digital workflow used with dynamic guidance requires no lab work. The patient can be scanned, the case planned, and the implant placed in one visit. The typical cost for a dynamically guided case is less than $100. Presently, dental surgeons often guide only the "tough" or "complex" cases. This "complex-only" approach has resulted from the difficulty and cost of using static guides. Static guides require that the guides be fabricated ahead of time. Once fabricated, the guides cannot be changed. The cost varies from $300 to $1,200 per case.

The literature clearly shows that dentists are not as accurate and precise when they place implants freehand compared with any form of guided surgery.[5–8] This case study illustrates the management of a significant complication related to the placement of a single implant in the wrong position. The "simple" becomes "complex."

This 45-year-old male presented to the surgeon with a complaint of a failed implant and loose adjacent teeth. The implant had been placed by another surgeon 3 months earlier. Initially, the patient was told he had a vertically fractured tooth No. 4 that was not restorable (Figure 1). The tooth was extracted and an immediate implant placed freehand (Figure 2). The patient described pain and tenderness that persisted following implant placement. The patient went back to the surgeon on a weekly basis and received

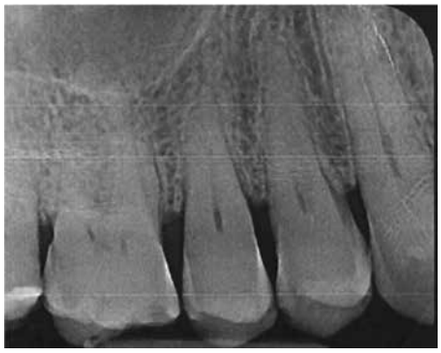

Figure 1: Pre-surgical periapical, tooth No. 4 fractured vertically

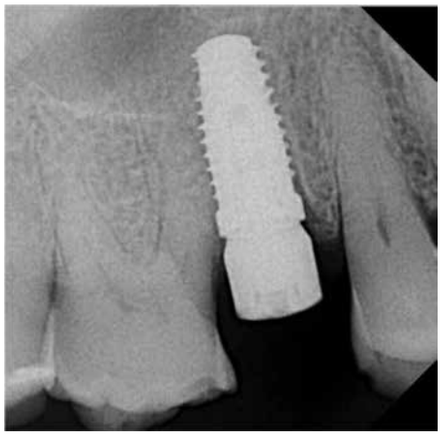

Figure 2: Postoperative periapical showing incorrect implant position with impingement of periodontal ligament of tooth No. 3

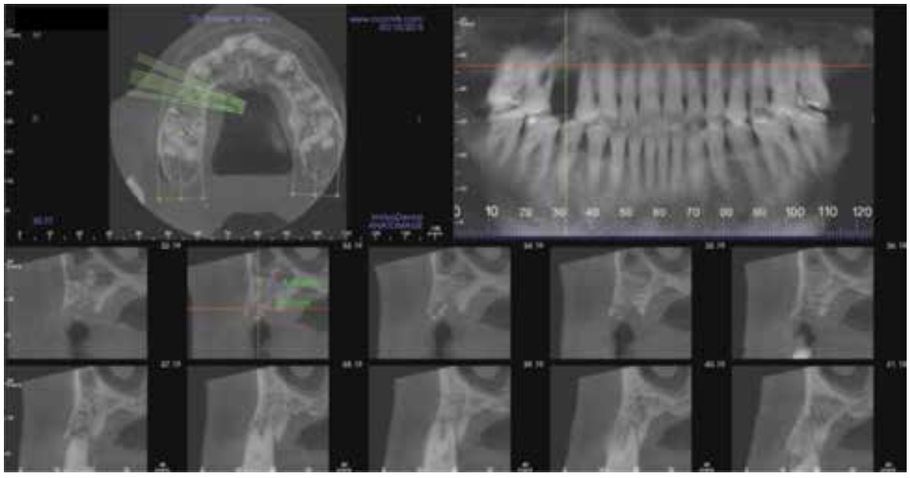

Figure 3: CBCT showing periapical abscess and attachment loss of teeth Nos. 3 and 5

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two-dimensional radiographs. The postoperative course included an infection treated with antibiotics for 1 month and eventual removal of the implant No. 4. The patient now had tenderness around the implant site with mobility and deep periodontal pockets on teeth Nos. 3 and 5. Cone beam computed tomography (CBCT) revealed periapical abscesses of teeth Nos. 3 and 5 with loss of adjacent periodontal attachments (Figure 3).

The patient was referred for prosthetic consultation, and a treatment plan was developed. The plan included the following:

1. Intraoral scanning for virtual treatment planning. Diagnostic wax-up and fabrication of a removable provisional prosthesis for areas Nos. 3, 4, 5 (Essix retainer)
2. Extraction of teeth Nos. 3 and 5 with immediate guided-tissue regeneration using cortico-cancellous allograft, PRF, and dense PTFE membrane
3. Allow the area to heal for 2 months
4. Placement of implant Nos. 3, 4, and 5 using dynamic navigation (X-Guide, X-Nav Technologies, LLC, Lansdale, Pennsylvania) and osseodensification (Densah®, Versah, LLC, Jackson, Michigan)
5. Allow 4 months for osseointegration followed by ISQ evaluation
6. Provisionalization for 2 to 4 months
7. Final fixed restoration

The patient underwent extraction and immediate guide-tissue regeneration (Figures 4 and 5). A removable provisional restoration interim appliance was placed with soft tissue conditioner, and the graft then matured for 2 months.

At 2 months, the patient underwent pre-surgical CBCT with an X-Clip. The DICOM of the CBCT was imported in the X-Guide planning software and the pre-extraction

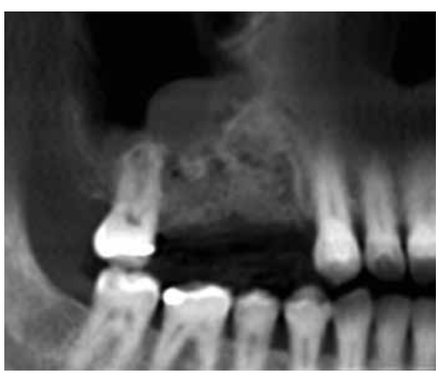

Figure 5: The immediate post-surgical panoramic

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Figure 4: Surgical view at the time of extraction and immediate guided-tissue reconstruction. Note the loss of adjacent periodontal attachment

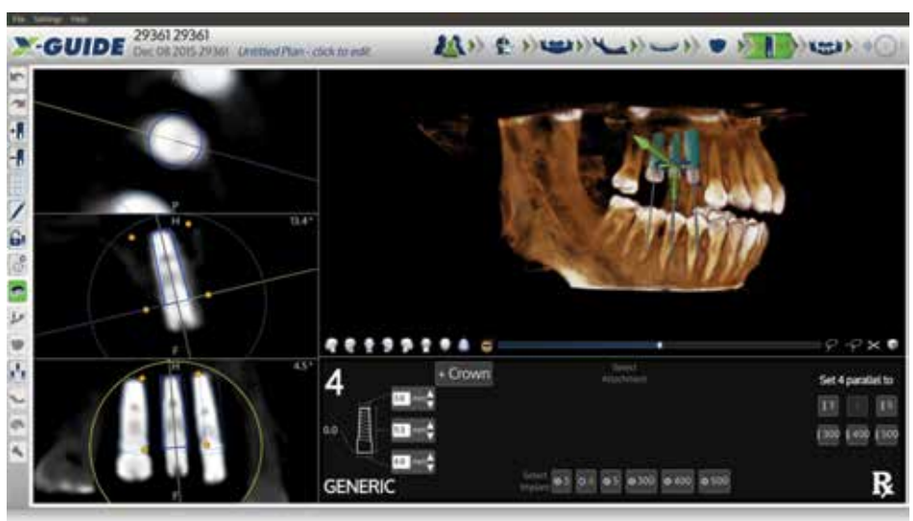

Figure 6: Post-op CBCT (dark blue) superimposed on pre-surgical plan (light blue) to illustrate accuracy of dynamic image navigation

STL file imported for planning purposes. The implants were dynamically guided into position using the X-Guide. The post-surgical CBCT was superimposed on the pre-surgical plan to evaluate the accuracy of implant placement (Figure 6). The accuracy (mean) angular deviation from the plan for all three implants was 4.2 degrees. The precision (standard deviation) was 1.6 degrees. The accuracy (mean) platform entry deviation was 0.5 mm, and the precision (standard deviation) was 0.36 mm. After a period of 4 months, ISQ values greater than 70 were found for all three implants. A fixed provisional restoration was fabricated to manipulate the tissue, transitionally load the implants, and develop an appropriate hygiene regime for the patient (Figure 7). Only after the patient's confidence and expectations were met was the definitive prosthesis fabricated and then restored. The patient is currently on a 3-month maintenance program to reevaluate his oral hygiene, restore his confidence in dentistry, and ensure a successful outcome. The final splinted ceramometal bridge was cemented with Temrex cement on gold custom abutments. (Figure 8).

Prevention is the best way to avoid complications. Published data has shown that implants placed freehand are statistically less precise and accurate in every measure.[5–7,9,10] Block showed freehand mean angular deviation was 6.5 degrees with a standard deviation of 4.21 degrees, compare to dynamically guided implants with a mean angular deviation of 2.9 degrees with a standard deviation of 1.36 degrees for fully guided.[5] This case illustrates the time efficient digital workflow with no pre-surgical laboratory work necessary to implement dynamic guidance. The efficient workflow and decreased costs relative to static guidance allow this form of guidance to be used on every patient, every time. Had this patient had this "simple" case performed with any form of guidance, this "complex" complication could have been avoided.

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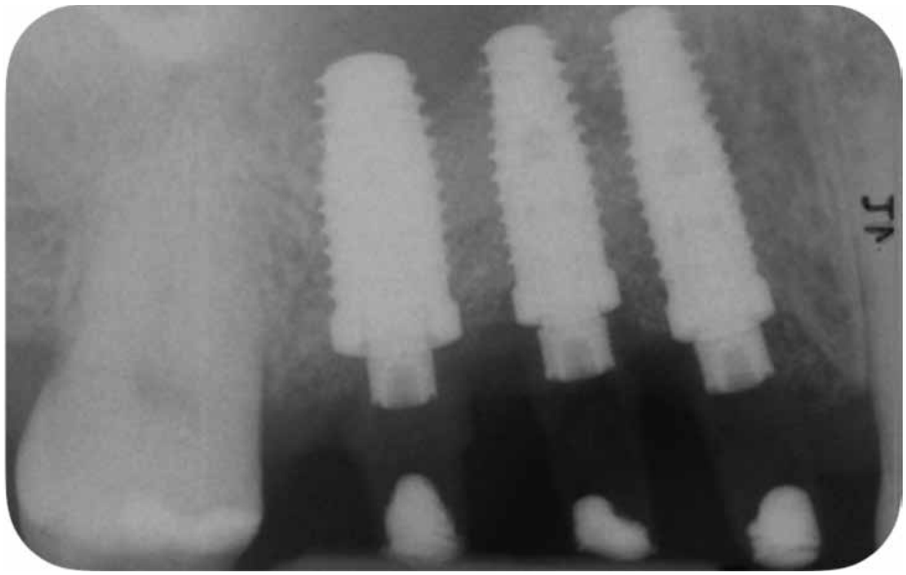

Figure 7: Fixed splinted provisional acrylic-cemented restorations

Figure 8: Fixed ceramometal bridge cemented on gold custom abutments Nos. 3I-4I-5I

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