Removal of Impacted Supernumerary Teeth Using a Dynamic Surgical Navigation System: A Case Report

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Removal of impacted supernumerary teeth can present a unique set of challenges to the dentoalveolar surgeon. Complications associated with these challenges have been well documented in the literature. The use of dynamically guided surgical navigation technology for the removal of impacted supernumerary teeth has the potential to mitigate these challenges and improve clinical outcomes. Although not a currently Food and Drug Administration–approved indication, the use of dynamic surgical navigation systems for the removal of impacted supernumerary teeth will be elucidated in this case report.

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Report of Case

A 17-year-old male patient presented for a preorthodontic extraction consultation. He was referred by his general dentist for extraction of teeth maxillary right third molar, maxillary left third molar, supernumerary maxillary right second premolar and supernumerary maxillary left central incisor. An initial cone-beam computed tomography (CBCT) scan (i-CAT, 0.3-voxel resolution; i-CAT, Hatfield, PA) was obtained (Fig 1). Radiographic and clinical examinations showed the presence of full bony impaction involving teeth supernumerary maxillary right second premolar and supernumerary maxillary left central incisor as well as gingivitis due to overcrowding in both arches. Tooth supernumerary maxillary right second premolar was notable for its proximity to the maxillary sinus, and tooth supernumerary maxillary left central incisor was notable for its proximity to the nasal cavity. A recommendation for surgical extraction of teeth maxillary right third molar, maxillary left third molar, supernumerary maxillary right second premolar and supernumerary maxillary left central incisor under intravenous sedation was rendered.

A dynamic surgical navigation system (X-Nav Technologies, Lansdale, PA) was used to perform treatment planning of the case and to guide the surgeon intraoperatively (Fig 2). Before surgery, a thermoplastic clip containing fiducials was heated in a water bath and adapted to the patient's dentition. After cooling, the fiducial apparatus was fastened to the patient's teeth, and a CBCT scan (i-CAT, 0.3-voxel resolution) was obtained. The case underwent treatment planning by importing the acquired CBCT DICOM (Digital Imaging and Communications in Medicine) data into dynamic image navigation software and planning virtual implants at sites supernumerary maxillary right second premolar and supernumerary maxillary left central incisor. Virtual implants were planned to imitate the entry angle and depth of the initial access osteotomy at each surgical site. The position, angle, and depth were planned to facilitate conservative, accurate access and to minimize the risk of iatrogenic damage to adjacent vital structures.

The patient presented for surgery approximately 2 weeks after the initial consultation visit. Both the surgical handpiece and patient tracking arrays were calibrated preoperatively in accordance with

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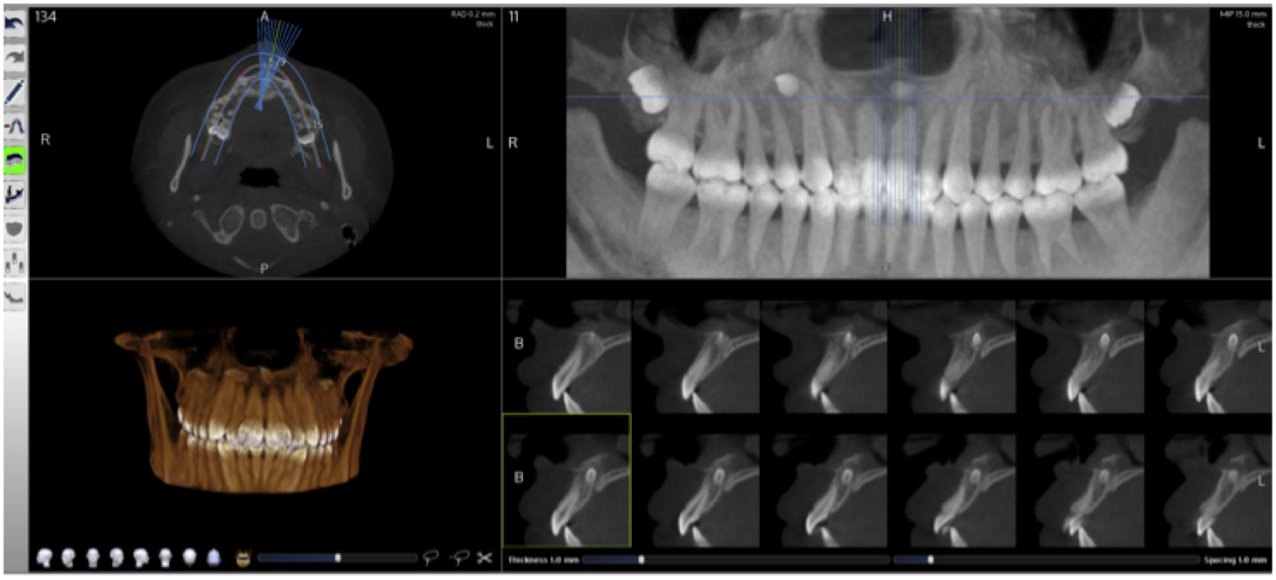

FIGURE 1. Cone-beam computed tomography scan taken at consultation visit. A 17-year-old male patient presented with full bony impaction of teeth maxillary right third molar, maxillary left third molar, supernumerary maxillary right second premolar and supernumerary maxillary left central incisor. All 4 teeth were indicated for surgical extraction to facilitate orthodontic correction of crowding in both arches. Tooth supernumerary maxillary right second premolar was notable for its proximity to the maxillary sinus; tooth supernumerary maxillary left central incisor was notable for its proximity to the nasal cavity.

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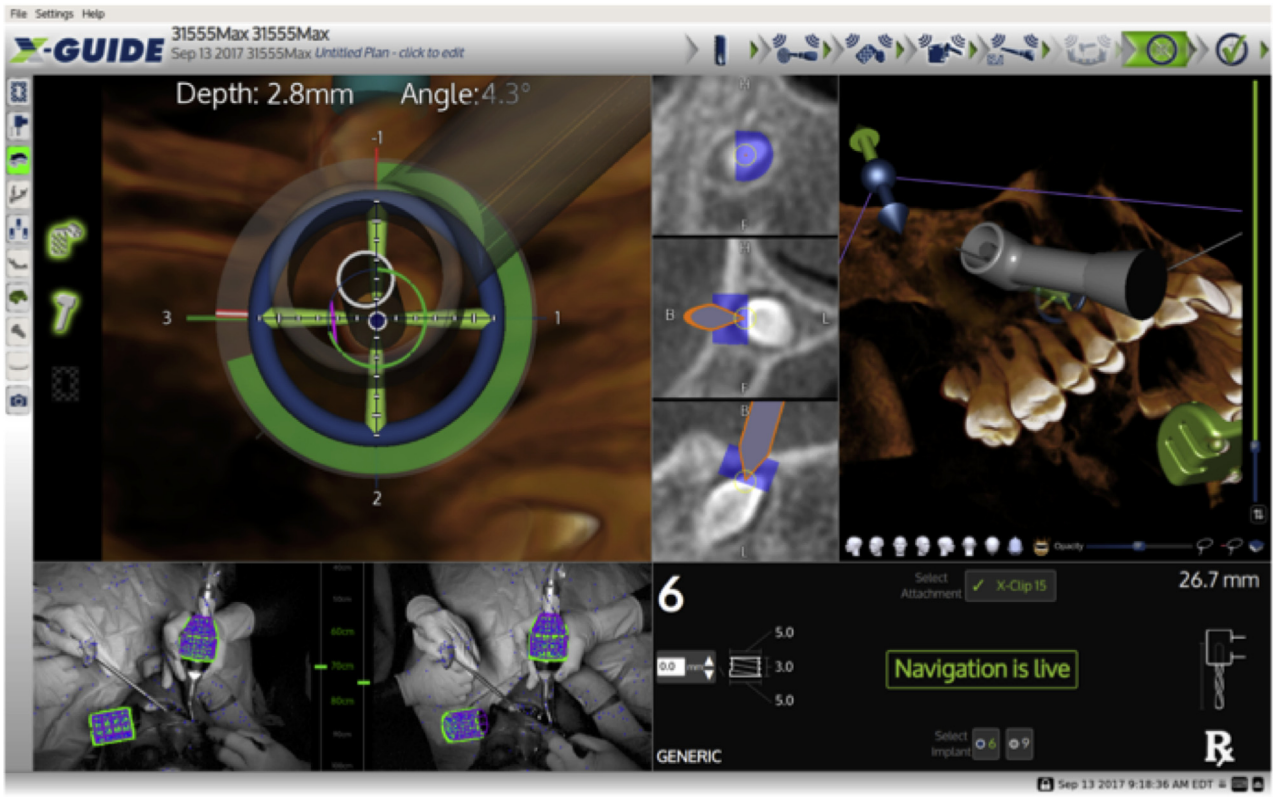

FIGURE 2. Intraoperative use of dynamic navigation to remove impacted supernumerary teeth supernumerary maxillary right second premolar and supernumerary maxillary left central incisor. Optical triangulation and fiducial registration related the position of the handpiece to cone-beam computed tomography anatomy in real time (*lower left panels*). This allowed the surgeon to guide the access osteotomies for teeth supernumerary maxillary right second premolar and supernumerary maxillary left central incisor after planning virtual implants at these sites (*upper panels*).

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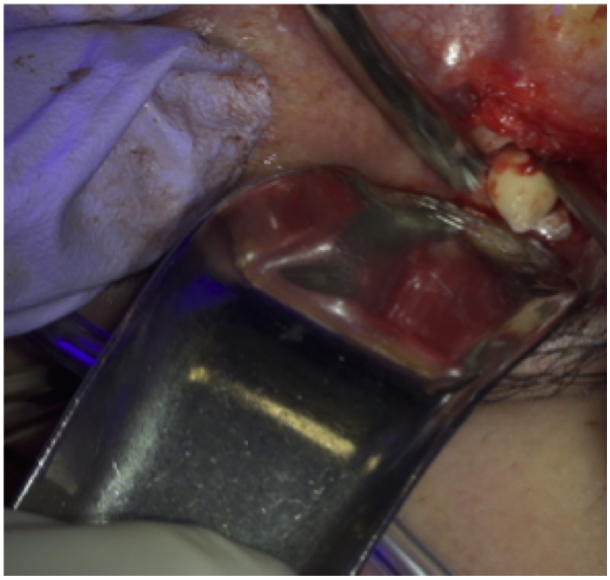

FIGURE 3. After osteotomy using dynamic image navigation, supernumerary tooth supernumerary maxillary right second premolar was visualized. Final removal was performed with elevators and forceps.

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manufacturer specifications. The prefabricated fiducial apparatus with attached patient tracking array was affixed to the patient's dentition. System checks using visible landmarks were performed throughout the procedure in accordance with manufacturer protocol to continuously verify proper positioning of the fiducials and accuracy of guidance.

Two small, 1.5-cm maxillary vestibular incisions with full-thickness elevation were used to expose surgical sites for teeth supernumerary maxillary right second premolar and supernumerary maxillary left central incisor. By use of live dynamic image surgical navigation, osteotomies to expose all impacted teeth were performed in accordance with the planned virtual implants at each surgical site. All teeth indicated were removed with elevators and forceps after access osteotomy (Figs 3, 4). No oral-antral or oral-nasal fistulas were noted during surgery. Each vestibular incision was closed with 2 simple sutures. At 1-week follow-up, the patient denied any fever or lingering discomfort. No evidence of erythema, swelling, wound dehiscence, or purulence was noted on clinical examination. The patient was referred to his orthodontist for continued therapy.

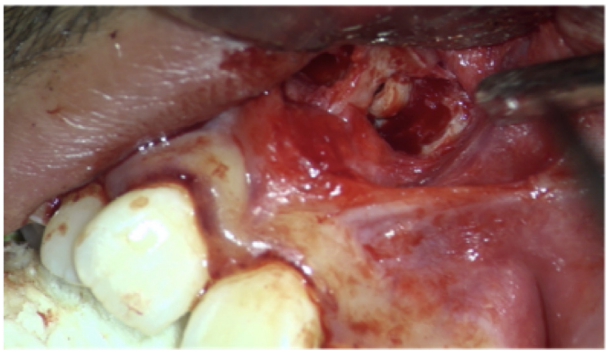

FIGURE 4. After osteotomy using dynamic image navigation, supernumerary tooth supernumerary maxillary left central incisor was visualized. Final removal was performed with elevators and forceps.

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Discussion

Supernumerary teeth are associated with several complications and pathologic processes deleterious to a patient's oral health and function. Aberrant or failed eruption, malpositioned or rotated teeth, arch crowding, malocclusion, root resorption, and fistula and cyst formation are established sequelae of supernumerary teeth.[1-4] The extraction of impacted teeth is associated with several potential complications, including damage to the adjacent structures, displacement of teeth into tissue or sinus spaces, fistula formation, and trauma to vital structures such as the inferior alveolar nerve.[5,6] Therefore, the decision to extract these teeth is made judiciously, particularly in high-risk cases. The need for orthodontic therapy, existing associated pathology, and aberrant eruption of dentition are among the most common indications for removal of supernumerary teeth.[1-4,7]

Dynamically guided navigation surgery has been used extensively in various fields of medicine such as neurosurgery, otolaryngology, and oral and maxillofacial surgery.[8-10] Dynamic image navigation systems use optical triangulation between stereotactic cameras attached to a light source and 2 tracking arrays—1 for the patient and 1 for the handpiece. The prefabricated thermoplastic device contains 3 fiducials worn by the patient during preoperative CBCT acquisition and is fastened to the patient tracking array during surgery. Therefore, while the patient and handpiece tracking arrays are used to track the patient and handpiece location during surgery, the fiducials register the optical tracking apparatus to the preoperative CBCT data. The surgeon therefore has access to real-time localization of the osteotomy drill relative to anatomic landmarks within the CBCT data. Importantly, the use of dynamic surgical guidance has been shown to be more accurate and precise than freehand approaches to implant placement.[11-15] This enhanced accuracy as well as precision allows for less invasive approaches to implant placement and better localization of adjacent structures.

The use of dynamic guidance for the extraction of impacted third molars has been reported in the literature.[16] To date, this is the first known case report showing the in-office use of dynamic navigation for the extraction of impacted supernumerary teeth. Wang et al[17] described the use of dynamic navigation with a hospital-based system. Given the superiority in accuracy of dynamic guidance over freehand approaches to dental implant placement, the use of dynamic image-guided surgical navigation technology for other high-risk dentoalveolar surgical procedures should be explored. Extraction of impacted teeth, including supernumerary teeth, is a commonly performed procedure associated with several complications and potentially substantial patient morbidity.[18-21] Many of these complications arise as a result of iatrogenic damage due to the operator's inability to directly visualize the location and position of vital structures such as the inferior alveolar nerve, maxillary sinus, nasal cavity, mandibular lingual cortex, and adjacent dentition.

This case report shows how a dynamic surgical navigation system can be used during the extraction of impacted supernumerary teeth. As can be appreciated in Figure 2, freehand access to these supernumerary teeth would have best been accomplished via a palatal approach. Although more predictable than a freehand labial or buccal approach, a palatal approach to this case likely would have resulted in more substantial bleeding, ergonomic challenges to the surgeon, and airway patency concerns related to patient positioning during sedation. In this case, dynamic image data made it possible for the surgeon to accurately localize and access these teeth using a labial or buccal approach. Dynamic guidance also made it possible to minimize reflection of soft tissue and removal of bone. Finally, dynamic guidance provided the surgeon with more accurate localization of impacted teeth and adjacent vital structures than would have been possible with a freehand surgical approach.

Our relatively straightforward case presentation showing the use of this technology for the extraction of impacted supernumerary teeth illustrates its potential use for more challenging cases, such as extraction of a mesiodens in close proximity to adjacent unerupted teeth. In-office dynamic navigation for the management of non-supernumerary impacted teeth is another promising potential use for this technology. Surgical exposure or extraction of impacted permanent maxillary canines before orthodontic therapy is a routinely performed surgical procedure often carrying substantial risks of damage to adjacent teeth.[22] The use of dynamic navigation to expose or extract impacted canines before orthodontic therapy should be explored as another potential indication for the use of dynamic surgical navigation in oral and maxillofacial surgery.

Even the most experienced surgeon may be faced with complications during the surgical removal of impacted supernumerary teeth. Although it is not possible to fully eradicate the complications inherent to any oral-maxillofacial surgical procedure, using dynamic guidance for these surgical procedures has the potential to minimize and mitigate these complications. This is particularly true of high-risk procedures such as the removal of supernumerary teeth fully impacted in bone, in which accurate localization of the tooth to be extracted is compromised during freehand surgery. These high-risk cases have the potential to introduce substantial morbidity to the patient. Therefore, it is important to consider the current capabilities of dynamic surgical navigation technologies when performing treatment planning of oral-maxillofacial surgical procedures with risks of substantial complications.

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