Feasibility of Navigation-Assisted Bone Lid Surgery for Deeply Impacted Maxillary Tooth - A Case Report

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Abstract

Rationale: Bone lid surgery (BLS) is minimally invasive surgery that removes the cortical bone and returns it to original position after removing lesions. However, jawbone lesions are completely covered with cortical bone, and it can be difficult to accurately determine the lesion position from the outside. Patient Concerns: A 24-year-old Japanese woman, identified as having an impacted maxillary canine, was referred to our department. Periapical radiolucent lesion, with lateral incisor root absorption by canine compression, was confirmed. Diagnosis: The diagnosis was incisor root absorption due to an impacted canine. Treatment: As a potential solution, we performed navigation-assisted BLS. Outcomes: Using navigation, we could confirm the state of impacted tooth under the covered bone. We could establish reliable bone cutting and the removed cortical bone was successfully returned to the presurgical position. Take-away Lessons: Navigation-assisted BLS for the removal of impacted teeth may increase surgical accuracy and minimize invasion.

Keywords: Impacted teeth, minimally invasive surgery, surgical navigation systems

Introduction

Bone lid surgery (BLS) involves cutting a window into the cortical bone and removing a portion, which is subsequently returned to its original position at the end of the surgery.[1] This surgical technique is a minimally invasive method used to access osteotomies while avoiding secondary large bone defects. This technique is particularly useful for jaw lesions within the maxillofacial region.[2] When treating lesions in this region, it is important to preserve the alveolar cortex and jawbones as much as possible; to this end, the determination of the exact location of the lesion is crucial. However, because the cortical bone completely covers jawbone lesions, accurate determination of the lesion position from the outside can be challenging.

In recent years, computer-assisted navigation has been developed to improve precision and simplify surgical procedures while minimizing the invasiveness of maxillofacial surgery.[3] The development of navigation-assisted surgery has improved the execution and predictability of these types of procedures. Thus, performing surgery on this region is now more accurate and reliable than was previously possible.[4] Herein, we present safe and minimally invasive surgical strategy using navigation-assisted BLS. We report a case of navigation-assisted surgery for the removal of a deeply impacted maxillary canine.

Case Report

Patient information and diagnosis

Patient Concerns: A 24-year-old Japanese woman was referred to our department by her local dentist. The patient consulted a dental clinic with the complaint of persistent pain and repeated swelling in the region of the anterior maxillary teeth, consistent with a diagnosis of an impacted maxillary canine. The patient had no medical or family history and was healthy.

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Diagnostic Aids: Panoramic radiography revealed an impacted canine tooth in the maxillary bone. A computed tomography (CT) scan confirmed the periapical radiolucent lesions together with the absorption of the maxillary right medial and lateral incisor roots by canine crown compression. The distance from the alveolar crest to the lesion was 7.8 mm. Further, the electric dental pulpal test revealed negative reactions from both teeth, which needed root canal treatment. The clinical diagnosis was root absorption of the incisor tooth due to an impacted canine.

Treatment: Our treatment plan involved the extraction of the impacted canine tooth and apicoectomy of the incisor teeth. We decided to perform minimally invasive BLS to preserve the maxillary bone. In addition, we applied navigation to enable precise and accurate surgery performance [Figure 1].

Navigation preparation
The imaging data were obtained in Digital Imaging and Communication in Medicine format and transferred to a Medtronic StealthStation S7 workstation using the Synergy Fusion Cranial 2.2.6 software (Medtronic Navigation Inc., Louisville, Colorado, United States). CT data from the first visit were used; therefore, we did not repeat CT for the navigation system.

We affixed a PatientTracker EM to the patient’s forehead. This acted as a reference array for tracking the navigation probe. Furthermore, AxiEM Emitter™ was fixed to the surgery table for tracking the navigation probe [Figure 2]. For performing patient-to-CT data registration, the instrumentation navigation probe was used to trace the reference array and soft tissue landmarks of the patient’s face. After data registration, continuous 3-dimensional tracking of the navigation probe was available for the surgeon in real time.

Surgical technique
The surgery was performed under local anaesthesia with intravenous sedation. Using the intrasulcular full triangular flap technique, we made a single horizontal intrasulcular incision and single vertical releasing incision. Upon tissue elevation, the maxillary bone was fully visible, with no obvious lesion evidenced on the outside of the maxilla. Since the lesion was completely covered with bone, we used the navigation system to accurately determine the position of the impacted tooth and lesion [Figure 3]. Using the navigation pointer, a bone-cutting line was established, on the basis of the adequate range for reliable lesion removal and the appropriate form for cortical bone removal [Figure 4a]. To allow access to the teeth and lesion, piezosurgery was used for the osteotomy to cut a precisely defined bone window using the computer-assisted navigation system [Figure 4b]. Piezosurgery is a device that can selectively cut only bone by using ultrasonic waves.[5]

The osteotomized bone window was removed, allowing for the clear visualization of the impacted tooth and lesion, which were then removed [Figure 4c]. Next, we performed apicoectomy on the maxillary incisor teeth. Following the visual confirmation of undamaged adjacent tissues, the bone lid, comprising the temporarily removed cortical bone, was repositioned to its presurgical position and fixed with a bioresorbable plate [Figure 4d].

Outcomes: Following the completion of surgery and restoration of the cortical bone to its original position, we observed good ossification, with the maxilla appearing as it did presurgery.

Follow-up: The postoperative clinical course was as expected and the follow-ups were satisfactory at 2 years after the operation. Postoperative CT confirmed perfect maxillary bone recovery with the same presurgical morphology [Figure 5].

Discussion
BLS appears to be a safe and valid method, with relatively high success rate for bone integration.[5] However, compared with conventional surgical methods that do not reposition cortical bone tissue, BLS has a higher incidence of postsurgical complications.[6] One such complication involves damage to surrounding tissues. BLS was adapted for removing internal lesions covered with bone. This surgery is challenging because it is impossible to directly confirm the position of the lesion inside the bone; therefore, complications may arise. Although the surgeon confirms the lesion position using presurgical CT, it is very difficult to perfectly match the patient’s actual anatomy with the surgeon’s perception.

Sivolella et al.[7] suggested the following considerations for BLS: (1) the feasibility of returning the lid to its original position, (2) the chances of fashioning a bone lid of sufficient...
The location of the impacted tooth in the maxillary bone was confirmed on the cortical bone using the navigation system. The navigation system screenshot shows a multiplane view of the surgeon’s navigation probe, positioned in relation to the impacted tooth.

Figure 3: The location of the impacted tooth in the maxillary bone was confirmed on the cortical bone using the navigation system. The navigation system screenshot shows a multiplane view of the surgeon’s navigation probe, positioned in relation to the impacted tooth.

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size to avoid sequestrum, and (3) whether the residual alveolar bone can ensure adequate bone lid vascularization. In other words, it is necessary to enlarge the bone window as much as possible for removing few bones with respect to osteotomy, taking care to not damage the surrounding tissues. Additional bone removal may interfere with bone healing. Therefore, the precise setting of the bone-cutting line is essential.

The use of a computer-assisted navigation system eliminates the difference between the surgeon’s recognition and the actual anatomy of the patient. Navigation systems are applied to various treatments in maxillofacial surgery, such as maxillofacial trauma,[4] temporomandibular joint surgery,[8] foreign body removal,[9] orthognathic surgery,[10] and deep mandibular lesion.[11] Using modern navigation systems, overall navigation accuracies of <1 mm can be reached in the midfacial area.[12] In the present case, the navigation system was reliably accurate and we could determine the exact location of the impacted tooth inside the bone. Here, the navigation played an important role in the success of BLS. Moreover, in recent years, preoperative preparation for navigation has become easier, and techniques for preoperative registration have also been developed.[13] Using navigation, it will be a great advantage even for inexperienced maxillofacial surgeon to be able to create a surgical environment that allows the lesions in the cortical bone to be seen through during surgery.

**Conclusion**

Navigation-assisted BLS for removing deeply impacted maxillary teeth could increase surgical accuracy, minimize invasion, and allow for the precise replacement of the bone into its original position.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for images and other clinical information to be reported in the journal. The patient understands that her name and initial will not be published, and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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