is increased due to the presence of hyaluronidase, thereby resulting in an increased intravascular concentration of local aesthetics.[13] Another potential reason may be that hyaluronidase is separated and purified from bovine or ovine testicular tissue. In this process, other proteins besides hyaluronidase may be co-purified, thus causing Type I and IV anaphylactic reactions.[14] To prevent these side effects, we used high purity liquid hyaluronidase without anesthetics, and have not encountered any side effects until now.

Preoperative soft tissue thickness among patients in the early operation group who did not exhibit improved swelling was significantly thicker than corresponding tissue thickness in the conventional group. The mean thickness of the soft tissue after hyaluronidase injection and massage was similar to the preoperative thickness in the conventional group. Furthermore, in the conventional group, there was not a dramatic reduction in thickness after massage because there was minimal swelling.

Between the 2 groups, the length of time in the hospital did not differ. Because of the shortened period from injury to surgery, the period needed for recovery and return to daily life after injury was shorter in the early operation group. The surgical result, determined via postoperative surveillance, showed no significant differences. In the early operation group, although there was no significant difference, the mean patient satisfaction was higher. We suspect that this increased satisfaction was because these patients were able to return to daily life much earlier.

Therefore, injection of hyaluronidase and performing the operation in patients with nasal bone fracture within 2 to 4 days resulted in no difference in outcome after swelling had improved; thus, these patients can return to daily life more rapidly without side effects. We speculate that this approach can improve patient satisfaction.

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Anterior Segmental Osteotomy Using Customized Spider-Plates Based on Computer-aided Surgery System

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Abstract: Anterior segmental osteotomy (ASO) is considered the treatment modality of choice in patients with the bimaxillary dentoalveolar protrusion. However, this meticulous surgical technique accompanies a number of possible disadvantages. The considerable time required before, during, and after the operation, limited movement of the segment, damage of the mental nerve, loss of tooth vitality, loss of a tooth or teeth, or indeed total loss of the anterior segments are those that affect the result of the surgery. Recently, the authors have devised a computer-aided surgical simulation programme and fabricated the customized osteotomy guides and the spider-shaped plates based on the programme. They were then applied to a 28-year-old patient with the complaint of a bimaxillary dentoalveolar protrusion. This approach helped to overcome several problems related to ASO reported earlier.

Key Words: Anterior segmental osteotomy, bimaxillary protrusion, computer-aided surgery

Bimaxillary protrusion is found in almost every race, with high prevalence especially in African-American and Asian.[1,2] The most prominent feature of the patients with a bimaxillary protrusion

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Received March 25, 2019.
Accepted for publication April 19, 2019.
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The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000005647

is the dentoalveolar flaring which results in the protruded lips and, consequently, a convex profile. Bimaxillary protrusion also accompanies a various degree of lip incompetence (defined as a resting lip separation of more than 4 mm[3]), mentalis strain, gummy smile. These features make the excessive bimaxillary protrusion considered unesthetic in many cultures. Of various approaches to solving bimaxillary protrusion is the anterior segmental osteotomy (ASO), which helps to overcome the limits of conventional orthodontic treatment. The conventional orthodontic treatment begins with the extraction of the first or the second premolar. However, this method can cause root resorption, linguoversion, and/or incomplete retraction of anterior teeth, bony dehiscence or fenestration, and increased exposure of gummy tissue[4]; thus requiring surgery for the treatment of bimaxillary protrusion to obtain a more esthetic and functionally stable results.[5] Besides, ASO requires a shorter treatment duration and shows lesser root resorption compared to the conventional orthodontic treatments.[6] Therefore, ASO is gaining acceptance as a better treatment modality than orthodontics alone.[7] Although ASO is considered a safe and stable osteotomy technique in general, it still has many possible disadvantages.[8] This meticulous surgery requires a skillful hand and time, shows a limited movement of the segment, damage in mental nerve, loss of tooth vitality, loss of a tooth or teeth, or indeed a total loss of the anterior segments. Thus, additional efforts should be made to perform the surgery successfully.

Meanwhile, the technologic advances in rigid internal fixation, virtual surgical planning with computer-aided manufacturing of occlusal splints and cutting guides, custom implants, and worldwide interest in the correction of dentofacial and craniofacial deformities have resulted in a highly predictable, efficient, and safe treatment.[9] Recently, we have reported a high precision and efficiency of the computer-aided surgical simulation system in orthognathic surgery.[10] In this report, we propose a modified method to resolve bimaxillary protrusion by introducing the use of the pre-fabricated surgical guide and customized plates in the actual surgery. To the best of our knowledge, this is the first report about the anterior segmental surgery using the virtual surgery with the computer-aided manufacturing.

CLINICAL REPORT

In order to determine the safe plane of the osteotomy line, cone-beam computed tomography (CBCT) (Alphard 3030; Asahi Roentgen Inc., Kyoto, Japan) was taken and converted into a DICOM file. Stone models and a wax bite in a centric relation were taken 2 weeks before the surgery. They were then scanned through a desktop model scanner (Freedom HD; Dof Inc., Seoul, Korea) and converted into Standard Tessellation Language (STL). A pair of stone models after the model surgery was also scanned and saved as an STL file. The saved files were merged in a 3-dimensional image for the virtual surgery via a specific programme (FaceGide; Megagen Co. Ltd., Daegu, Korea). The osteotomy line was determined according to the original plan as well as with the caution for the nerve and the root tips. After the virtual surgery, predicted drilling holes were punched in the osteotomy guides. The holes were fabricated to correspond to those on the customized plates. The osteotomy guides were designed with Geomagic Freeform Plus (3D Systems) and printed through D30 3D printer (Rapidshape GmbH, Heimsheim, Germany) (Fig. 1). The plates were designed as the combination of the L- and the inverted L-type, which we named as a "Spider-plate" since its form resembles the spider's shape with the drilling holes (Fig. 2). Both the intermediate and the final wafer were also fabricated. The operation was carried out under general anesthesia. A horizontal vestibular incision was made from the canine to canine in the upper jaw. No other (palatal) incision was required. After the subperiosteal dissection, the anterior maxilla up to the piriform aperture was exposed. The teeth-based guide was then applied to a surgical site on the right side. With

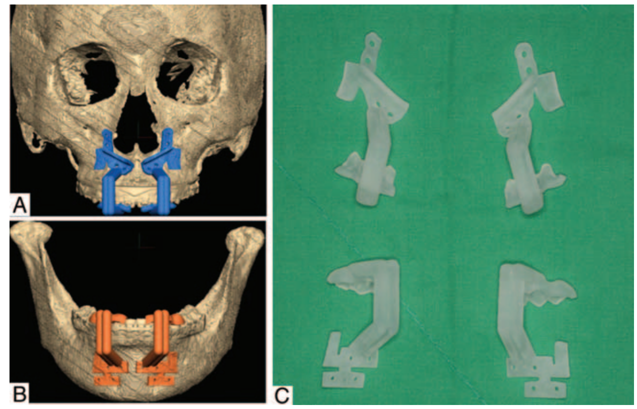

FIGURE 1. The surgical guides for the osteotomy. The pictures on the left show the virtual visualization of the surgical guides on maxilla (A) and mandible (B). (C) The printed guides. The predicted drilling holes are placed on the guides with the osteotomy line marked. For the stabilized sit on the bone, the guides are fabricated based on solid dentition.

the placement of the guide, the predicted drilling holes were indicated on the cortical bone with a low-speed bur. The guide was then removed to mark the ditches with a pencil in order not to lose track of the predicted holes. The opposite side of the maxilla went through the same procedure. With all the drilling holes marked, the guide was placed again on the right side to cut through the osteotomy line with the piezoelectric saw (Surgistar plus Dmetec Co., Seoul, Korea). The horizontal osteotomy was then followed by the extraction of the first maxillary premolar and the vertical osteotomy through the extraction site in accordance with the osteotomy line on the guide. When the osteotomy was completed on the right side, we performed the same procedure on the left side. After the osteotomy on both sides, the anterior segment of the maxilla was separated from the other segment of the maxilla. The separated anterior segment was then fit to the posterior segment, and the result was evaluated with an intermediate wafer. In the surgery, the operated maxilla showed a good occlusion with the mandible. Therefore, the pre-fabricated customized Spider-plates were applied on both sides of the maxilla, fixed with self-drilling screws through the marked drilling holes. Additional screws were implanted on the other holes afterward (Fig. 3A).

As for the mandible, a vestibular incision from canine to canine was made. No other (lingual) incision was required. The anterior part

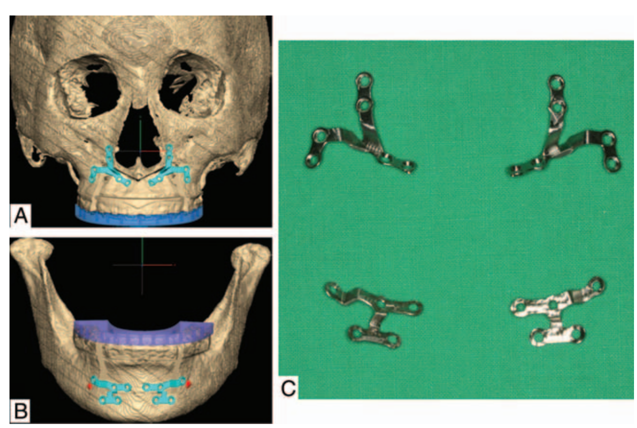

FIGURE 2. The plates for the fixation. The picture on the left shows the virtual visualization of the plates on maxilla (A) and mandible (B). (C) The customized plates. The plates are designed as the combination of the L- and the inverted L-type, which we named as a "Spider-plate" since its form resembles the spider's shape with the drilling holes.

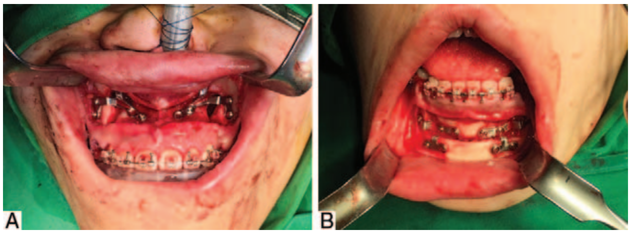

FIGURE 3. The operated maxilla (A) and mandible (B) are fixed with customized plates and self-drilling screws.

of the mandible was exposed after the periosteal dissection, and the teeth-based guide was placed on the right side of the mandible. The cortical bone of the predicted drilling hole was ditched with a low-speed bur. Then the osteotomy line was indicated on the mandible along the planned osteotomy line on the plate with a piezoelectric saw in the same manner as in the maxilla. The opposite side of the mandible was performed ditto. Afterward, the holes and the horizontal/vertical osteotomy lines were marked with a pencil. The mandible was cut along the marked line, followed by the extraction of the first premolar on both sides, which enabled the vertical excision through the extraction socket. The anterior segment of the mandible was finally separated, and the excised segments bearing the extraction socket were removed. The anterior and the posterior segment of the mandible were aligned with the maxilla with the help of the final wafer. As the osteotomy was performed as planned, the customized Spider-plates were fixed with the screw without any revision (Fig. 3B). When the fixation of the segments was completed, the mucosal incisions of the maxilla and the mandible were closed with dissolvable sutures. This report of the case is in accordance with the medical ethics of the Declaration of Helsinki.

RESULTS

The results are shown in Figures 4 and 5. The patient showed no sign of complications including temporomandibular disorder, malocclusion, infection, numbness, and devitalization of the tooth after the surgery.

DISCUSSION

A major concern for surgeons would be the possibility of devitalizing the teeth in the anterior segments. However, the guides were

FIGURE 4. A 28-year-old patient was referred to a clinic with a complaint of protruded lips. (A) Before the operation. The patient had a convex profile, acute nasolabial and mentolabial angle. (B) Two months after the operation. The patient showed less protruded lips and a wider nasolabial and mentolabial angle.

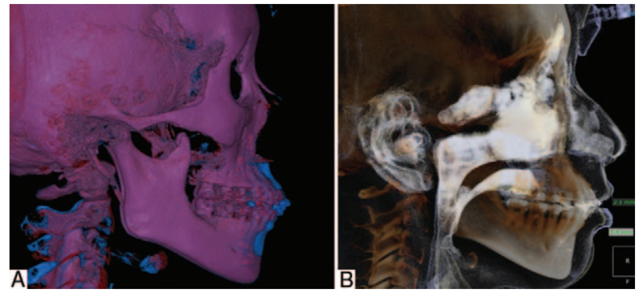

FIGURE 5. The superimposition of the 3-dimensional computed tomographic images. (A) The comparison of hard tissue. The area colored blue is the image taken before the surgery. The area colored red is that taken after the surgery. The overlapped images form the purple area. Note the difference colored blue. (B) The comparison on soft tissue. After the operation, the protruded lips were resolved. The upper lip and the lower lip retruded 2.1 mm and 3.4 mm, respectively.

carefully fabricated to maintain 3 mm from the root tips via virtual surgery using the merged images. The distance is thought to be enough to prevent damage to the tooth roots.[11] Therefore, the computer-assisted technique decreases the possibility of tooth devitalization compared to the conventional approaches without surgical guides. This applies the same to the nerve. Although ASO itself has a lower possibility of the neural damage compared to the traditional bimaxillary osteotomy, the osteotomy line on the surgical guide was originally devised to avoid the path of the nerve thus decreasing the possibility of the neural damage even more. Indeed, the patient showed no sign of the devitalization of the tooth or the numbness after the surgery.

The solid fixation between the bone segments is fundamental for favorable healing after the surgery. In research using finite element analysis, the fixation method using the inverted L-shaped plates were reported to have more stability than any other methods.[12] In this case, we have created the new type of plate called Spider-plate combining the L-shape and the inverted L-shape, printed it with the computer-aided machine to use it in the actual surgery. This series of procedure has made it possible to reproduce the planned skeletal movements in the actual surgery, which has maximized the stability of the segments.

The preparation procedure for the conventional bimaxillary orthognathic surgery requires mock surgery with conventional stone models. This manual work is inaccurate, time-consuming, and rather unclean. However, the computer-assisted simulation, merging of the digital data and 3-dimensional printing enabled the entire procedure to be highly precise, time-saving and clean.[13] Besides, the additional measurement or plate bending was not required in operation, which made the surgery more efficient and convenient.

In our report, CBCT was used to set the surgical objective. It enables a dimensionally accurate linear and angular measurement from bony maxillofacial structure and landmarks and allows accurate, 3-dimensional imaging of hard and soft tissues.[14] Furthermore, since the surgical guides and customized plates are fabricated in accordance with the original surgical plan based on CBCT, they can function as a reliable tool to make sure if the surgery was performed as planned. In other words, they prevent a significant deviation from the original surgical plan.

In a conventional ASO, unnecessary bone removal has been made to fit the teeth segment to the surgical wafer, which is problematic to the bone union. The precisely planned amount of bone removal enables the intimate bone contact between the segments and thus accelerates the postoperative healing. Also, the additional interdental wiring in the conventional ASO (usually between the canine and the second premolar) was no longer needed with the customized Spider- plate.

Few complications are exclusive to ASO that are significantly different from those encountered during a Le Fort I osteotomy.[15]

However, the success of ASO is entirely dependent upon a meticulous surgical technique. This means the skill to handle the soft and hard tissue with a high degree of precision is much required. We believe that a series of the computer-assisted system used in this research will be of great help to enhance the safety of the surgery and provide an easier surgical procedure for the surgeon.

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An Extremely Rare Cause of Headache; Osteoma of the Middle Concha Bullosa

Secaattin Gulsen, MD

Abstract: Osteomas are benign, slow-growing tumors originating from bone tissue. Osteomas of the paranasal region, which are usually asymptomatic, are detected incidentally on tomographies taken for other medical needs. Paranasal sinus osteomas frequently localized in the frontal and ethmoid sinuses are among the infrequent reasons for headaches. In this case report, the authors submit the first case of an osteoma that was localized inside the middle concha bullosa and causing headache. It was successfully excised via an endoscopic endonasal approach without any complications.

Key Words: Concha bullosa, endoscopic endonasal surgery, headache, middle turbinate, osteoma

In 90% of headaches, an underlying organic cause is not detected. Only 10% of headaches are associated with an organic pathology. Paranasal sinus osteomas are one of the uncommon reasons for headaches. Osteomas of the paranasal sinus rarely become symptomatic until their dimension reaches a certain size. Symptoms depend on localization, size, and invasion site. The most frequent symptoms reported in decreasing frequency are headache, orbital complications, dizziness, facial pain, and intracranial complications.[1] Although osteomas are commonly seen in paranasal sinuses, nasal turbinates with a limited number of cases are an unexpected location for osteomas.[2] Herein, the author reports the first case in the English literature as an extremely unusual case of osteoma located in the middle concha bullosa associated with headache.

CLINICAL REPORT

We report a case of a 15-year-old male patient who complained of an intractable headache located in the frontal region for over 1 year, with no other complaints. He had no history of head trauma or craniomaxillofacial surgery. His medical history was unremarkable. He denied nasal obstruction and discharge. The patient had intermittent attacks of headache in the frontal region and was treated with analgesics for 1 year. Otorhinolaryngologic and systemic examination of the patient did not reveal any remarkable findings. In the endoscopic nasal examination, there was no finding that suggested osteoma. Paranasal sinus computed tomography (CT) showed a hyperdense mass with dimensions of 9.5×4.5 mm inside the middle concha bullosa (Fig. 1A). The tumor originated from the lateral wall of the middle concha bullosa. The osteoma was completely removed while preserving the medial wall of the middle concha bullosa via an endonasal endoscopic approach under intravenous anesthesia (Fig. 1B). Histopathologic examination of the specimen revealed dense lamellar bone tissue, consistent with osteoma (Fig. 1C). There was no complication observed in the postoperative period. Headache resolved just after surgery, and the patient was followed up 3 months postoperatively without a headache. In our case, the postoperative follow-up period was relatively short since the headache resolved after surgery and the patient was unwilling to come for routine controls after 3 months follow-up.

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Received March 3, 2019.
Accepted for publication April 22, 2019.
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The authors report no conflicts of interest

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000005649