gland, temporomandibular joint, mandibular ramus, or infratemporal fossa.

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Three-Dimensional Visualization of Postsurgical Airway Changes Using 3D Printing Technology in a Patient With Mandibular Prognathism: A 5-Year Follow-up Study

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Abstract: This case-report described the 3-dimensional (3D) evaluation of airway changes using 3D printing technology in a patient with mandibular prognathism, treated via mandibular setback surgery with maxillary posterior impaction. The airway dimensions, following orthognathic surgery, were printed using 3D printing technology and the sequential airway changes were visualized. The patient underwent orthognathic surgery for the correction of mandibular prognathism. Five years later, the airway changes were visualized and evaluated using rapid prototyping. The 3D visualization of the airway changes following surgery alerted clinicians of patients with mandibular prognathism and facilitated effective communication with their patients. This case-report documented the long-term evaluation and visualization of the postoperative airway changes in patients with mandibular prognathism using cone-beam computed tomography and 3D printing technology.

Key Words: airway, mandibular prognathism, postsurgical change, printing

Three-dimensional (3D) printing technology is widely used in dentistry. It has been applied in digital restoration, clear aligner, and digital implant treatment.[1] Various 3D printers have met the high demands and strict requirements for clinical treatment, such as prosthodontic restorations. 3D printing technology has mostly been applied as a treatment modality. This case-report documented the application of 3D printing technology as a diagnostic tool.

Orthodontic treatment combined with orthognathic surgery is required to correct severe skeletal disharmony, preserve function, and achieve esthetic results. Orthognathic surgery improves the esthetic profile, but it alters the positions of the surrounding bony and soft tissue structures, including the tongue and hyoid bone.[2–4] The posterior repositioning of these anatomical structures reduced the airway volume in skeletal class III patients, who underwent mandibular setback surgery.[2–4] The increasing number of patients with obstructive sleep apnea has motivated the investigation of the change in airway dimensions after orthognathic surgery.[5,6] To evaluate the postoperative changes in airway dimensions, a long-term follow-up examination is required. This report aimed to describe the 3D visualization of the airway changes, using rapid prototyping technology, in a patient with mandibular prognathism, treated via mandibular setback surgery.

PATIENT

A 24-year-old man visited the Department of Oral and Maxillofacial Surgery for mandibular prognathism. His medical history was unremarkable. The pretreatment intraoral and facial photographs showed an anterior and posterior crossbite and a concave profile. The mandibular dental midline was deviated 1.5 mm to the right. The overjet and overbite were both 0.0 mm. Mild to moderate crowding was present in the maxillary and mandibular arches. After discussing the surgical options, the surgeon and orthodontist set the amount of surgical movement based on the final position of the maxilla and mandible. The definite surgical plan was to establish 6 mm of maxillary pos-

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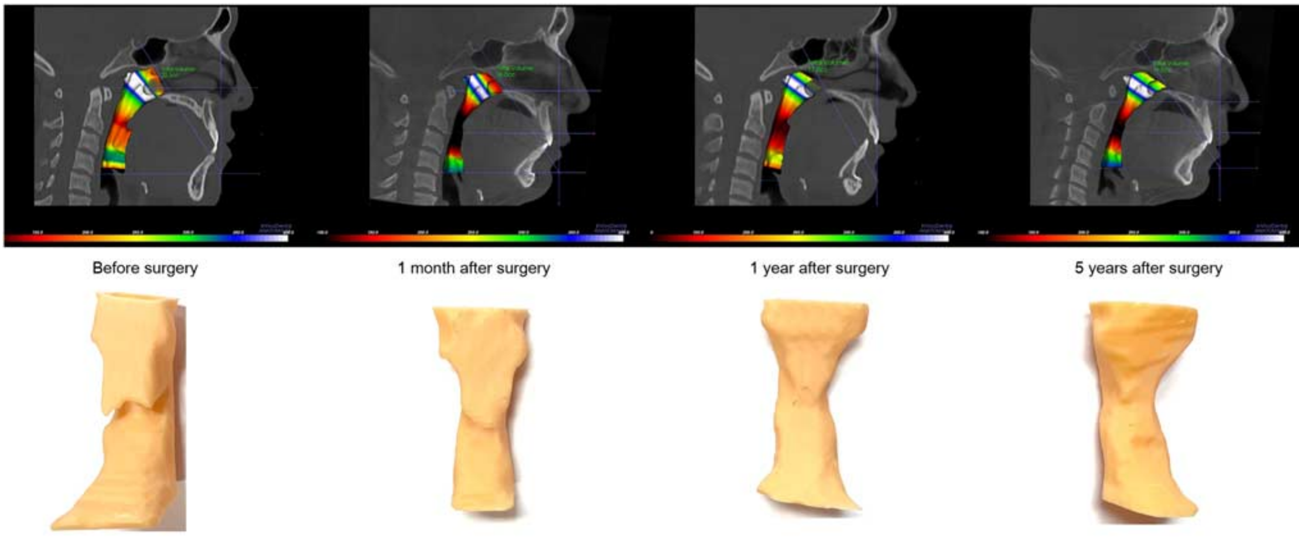

FIGURE 1. Three-dimensional visualization of postsurgical airway changes using 3-dimensional printing.

terior impaction as well as 8.0 and 11.0 mm of mandibular setback on the right and left sides, respectively.

The patient underwent Le Fort I osteotomy and mandibular setback surgery via bilateral sagittal split ramus osteotomy without preoperative orthodontic treatment. Bilateral sagittal split ramus osteotomy was performed to setback the mandible using the Obwegeser technique,[7] with the modifications of Epker.[8] Le Fort I osteotomy was also performed to achieve maxillary posterior impaction. The maxilla was operated on first, and semirigid internal fixation was applied. After setting back the distal segment, the desired occlusion was secured using a surgical wafer and intermaxillary fixation (IMF) with stainless steel wires. Thereafter, semirigid internal fixation was achieved using titanium 4 hole/L plates (Stryker Leibinger GmbH & Co. KG, Freiburg, Germany) after manual manipulation of the proximal segment into the anterior position in the glenoid fossa. The IMF was released, and the occlusion was evaluated before closure. The surgical wafer was placed, and 4 IMF screws were inserted in the alveolar regions between the canines and first premolars in all 4 quadrants. Tight intermaxillary elastics were placed to stabilize the jaw for 2 weeks.

Airway Evaluation

Cone-beam computed tomography scans were obtained using an Alphard Vega scanner (Asahi Roentgen Co., Kyoto, Japan) under the following conditions: 80 kV, 5 mA, 0.39 mm voxel size, and a 200 × 179 mm field of view and the patient was

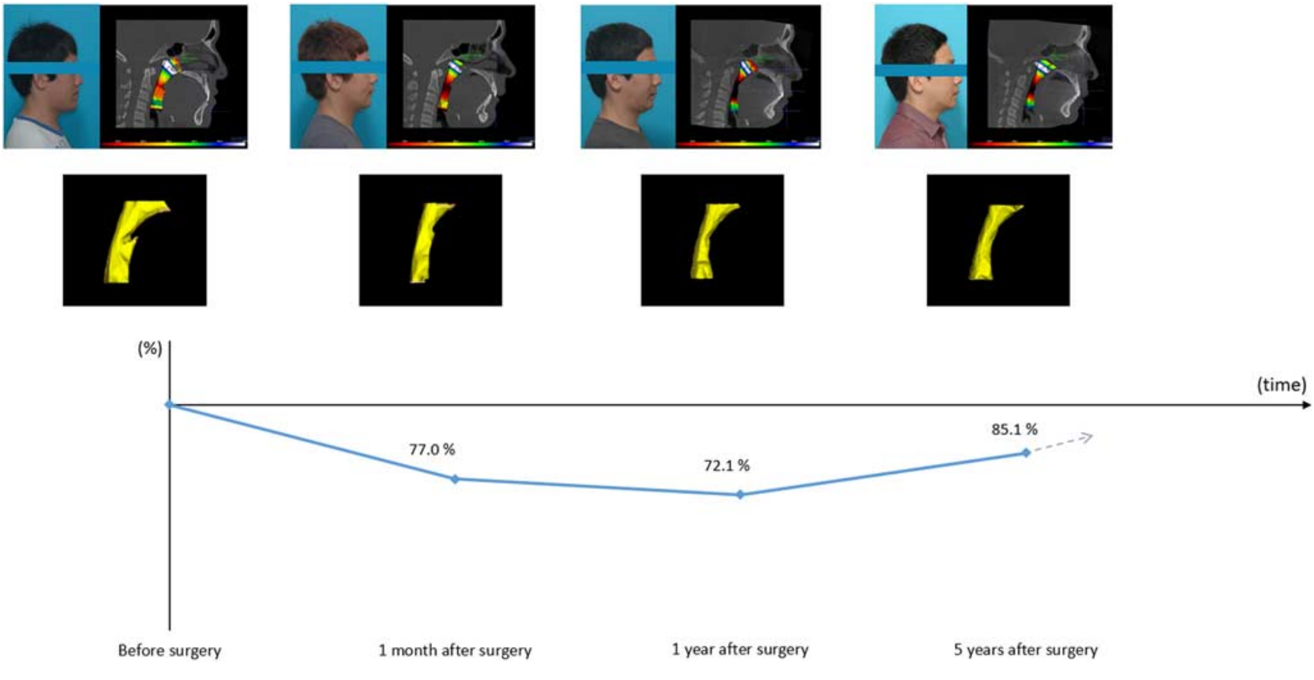

FIGURE 2. Sequential changes in airway volume following orthognathic surgery.

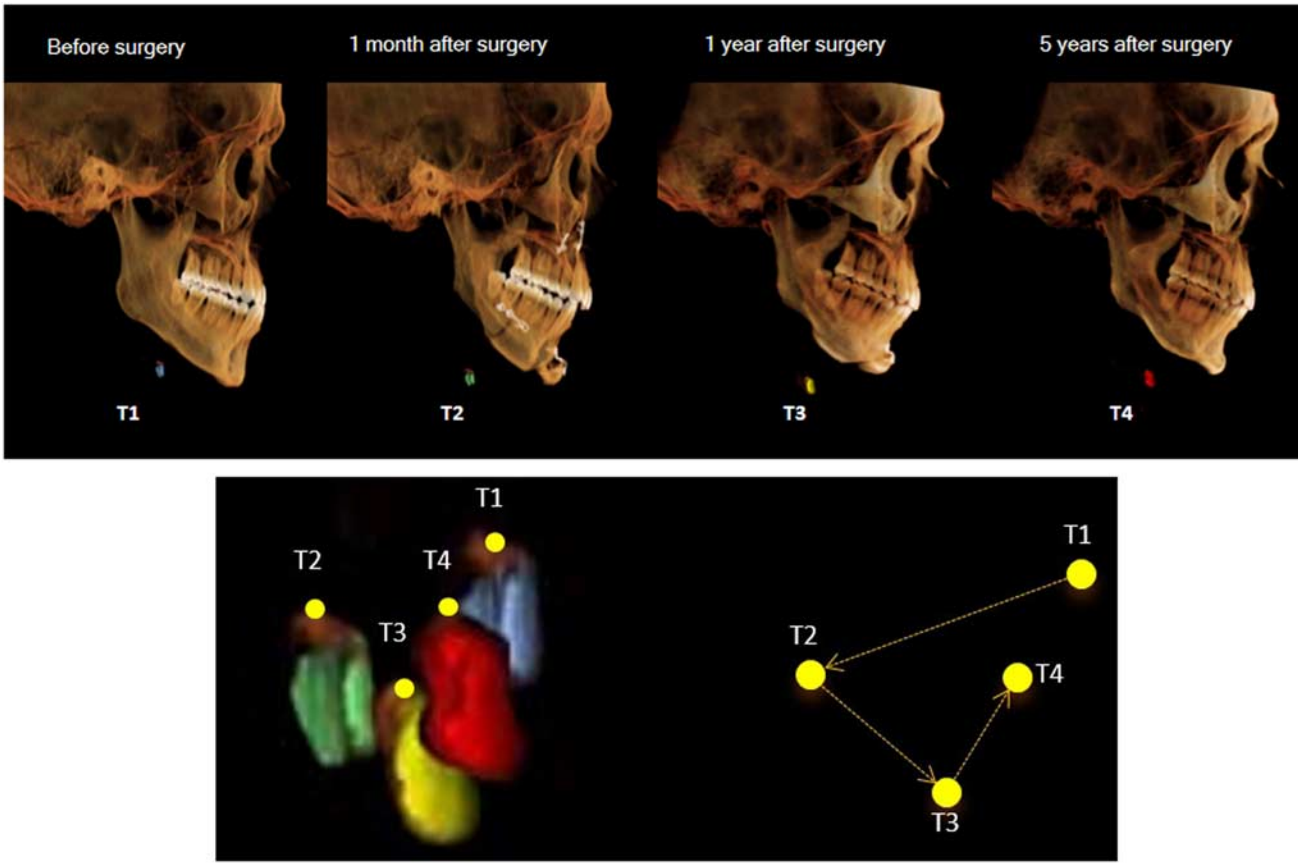

FIGURE 3. Positional changes of the hyoid bone following orthognathic surgery.

scanned in an upright position. The cone-beam computed tomography scans were obtained before surgery (T1), 1 month after surgery (T2), 1 year after surgery (T3), and 5 years after surgery (T4). The 3D imaging software program (InVivoDental version 5.3, Anatomage, San Jose, CA) was used to measure airway volume. To define the upper and lower borders of the airway, the tip of the odontoid process and the inferoanterior end of the fourth cervical vertebra were identified on the mid-sagittal plane. The upper and lower airway borders were constructed using the horizontal lines passing through each landmark. Then, several points along the airway were selected, and the airway volume was calculated. The segmented airway was exported as a stereolithographic file and printed with a 3D printer (EnvisionTEC, Detroit, MI).

Figure 1 shows the 3D visualization of postsurgical airway changes using rapid prototyping representation. The preoperative airway volume was 22.3 ml. The operative airway volumes 1 month, 1 year, and 5 years postoperatively were 16.0, 17.0, and 19.0 ml, respectively. The airway volume decreased immediately after mandibular setback surgery with maxillary posterior impaction. The decreased airway volume recovered within the 5-year follow-up period. The sequential changes in airway volume following orthognathic surgery are shown in Figure 2. The airway volume decreased to 71.7% postoperatively, and it recovered to 85.1% of the original volume 5 years postoperatively.

DISCUSSION

The increased application and accessibility of 3D printing in dentistry has resulted in its validation as a cutting-edge modality for various indications. Advances in material science have also provided the dental industry with useful and versatile tools.[9,10] In this case-report, 3D printing technology was used as a diagnostic tool to evaluate the postoperative airway changes.

The airway volume decreased to 71.7% postoperatively and recovered to 85.1% of the original volume 5 years postoperatively. On the basis of the trend of the linear graph, airway recovery up to the original volume is expected. The positional changes of hyoid bone after orthognathic surgery was traced. The hyoid bone moved anteriorly and superiorly 1 year postoperatively and this progressed 5 years postoperatively (Fig. 3). Although the mandible moved posteriorly after surgery, the tongue moved inferiorly, indicated by the positional change of the hyoid bone and the altered contour of the submental soft tissue. Consequently, the dimensions of the pharyngeal airway were maintained.

CONCLUSIONS

The decreased airway dimensions, following mandibular setback surgery, recovered within the 5-year follow-up period. This was visualized via airway printing using rapid prototyping technology.

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One Patient of Blepharoptosis Caused by Levator Palpebrae Superioris Aponeurosis Degeneration

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Abstract: Ptosis is one of the common diseases of plastic surgery, which is caused by various causes of levator palpebrae superioris dysfunction or Müller muscle insufficiency, which is manifested by the upper eyelid margin being lower than normal when level viewed. Ptosis can be divided into congenital and acquired, and the main cause of congenital ptosis is due to congenital levator palpebrae superioris dysplasia or the motor nerve innervation that innervates it is caused by abnormal oculomotor neurodevelopment and dysfunction. Acquired ptosis can be divided into traumatic, neurogenic, myogenic, senile, mechanical, and false ptosis. At present, there are few reports of ptosis due to the degeneration of the aponeurosis of the upper eyelid muscle. We received a case of ptosis caused by degeneration of the levator palpebrae superioris aponeurotic membrane, we use the method of the levator palpebrae superioris high advancement. The levator palpebrae superioris—Miller muscle was folded to form a stable composite structure by the levator palpebrae superioris high advancement. During the operation, the levator palpebrae superioris was separated along the gap, and the surrounding tissues were less damaged. Therefore, postoperative adhesion was less, and the main complications of severe blepharoptosis after the operation, such as upper eyelid hysteresis and incomplete closure, almost did not occur, and after surgery, the results were good.

Key Words: Degeneration, high advancement, ptosis, the levator palpebrae superioris

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Ptosis is one of the common diseases of plastic surgery, which is caused by various causes of levator palpebrae superioris dysfunction or Müller muscle insufficiency, which is manifested by the upper eyelid margin being lower than normal when the level is viewed.[1,2] Ptosis can be divided into congenital and acquired, and the main cause of congenital ptosis is due to congenital levator palpebrae superioris dysplasia or the motor nerve innervation that innervates it is caused by abnormal oculomotor neurodevelopment and dysfunction. Acquired ptosis can be divided into traumatic, neurogenic, myogenic, senile, mechanical, and false ptosis. At present, there are few reports of ptosis due to the degeneration of the aponeurosis of the upper eyelid muscle. We received a case of ptosis caused by degeneration of the levator palpebrae superioris aponeurotic membrane, and after surgery, the results were good. The following reports are hereby reported.

CLINICAL DATA

The patient, a 55-year-old woman, was admitted to the Plastic Surgery Hospital of Weifang Medical College in Weifang City, Shandong Province, for "left ptosis and upper eyelid depression." The patient and his family denied family history and trauma history, and the chief complained that the patient had a depression in the left upper eyelid 3 years ago, and then with increasing age, the depression deepened, and at the same time, the left side of the ptosis was continuously aggravated, and no special treatment was performed at that time. A day ago, the patient reported that the left visual range was reduced compared with the right side, and the left visual field was reduced, so he came to our hospital for treatment. Physical examination found that the patient's left upper eyelid depression and left upper eyelid margin were located in the center of the pupil, with muscle strength of 6 mm, accompanied by eyebrow lifting symptoms, the rest saw no abnormalities. Diagnosis: left ptosis with the recessed upper eyelid. Reference was made to the Helsinki Declaration, and patients signed an informed consent form agreeing to use their information for this study.

COURSE OF TREATMENT

Preoperative Design

Preoperative evaluation of patients, bilateral MRD difference of 4.5 mm, belongs to severe ptosis[3,4]; patients with left upper eyelid depression and left upper eyelid margin were located in the central position of the pupil; the upper eyelid levator muscle strength is about 6 mm, muscle strength in the middle level, with eyebrow lifting symptoms; told the patient to

