Case Report

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Three-dimensional evaluation of a giant torus in the maxilla and mandible that affected pronunciation: a case report

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Introduction and importance: Tori in the maxilla and mandible are often clinically asymptomatic, but can often lead to issues such as obstruction of denture attachment and dysarthria. The authors describe a case involving a substantial torus in the maxilla and mandible that significantly affected speech articulation.

Case presentation: A 72-year-old woman presented with a pronounced torus in the maxilla and mandible. Surgical resection of the lesion resulted in improved tongue movement. Through both pre and postoperative assessments, the authors evaluated pronunciation, generated a three-dimensional (3D) computed tomography (CT)–based image, and quantified the extent of bone removal. A 6-month follow-up demonstrated no recurrence of the condition.

Clinical discussion: Surgical intervention leads to improvements in soft palate sounds. The surgical intervention proved effective in ameliorating speech articulation difficulties, and the application of 3D-CT image construction was valuable.

Conclusion: To summarize, the authors successfully managed and treated a giant torus in the maxilla and mandible, a condition scarcely been reported in the literature. This report is the first to detail the application of 3D analysis for the evaluation a torus.

Keywords: 3D-construction image, giant torus, oral diadochokinesis, pronunciation, speech intelligibility

Introduction

Torus palatinus, torus mandibularis, and buccal exostosis represent localized, benign osseous projections manifesting within the maxilla and mandible. The etiology of these entities is multifactorial and is yet to be definitively established[1]. Tori are characterized as benign, often asymptomatic osseous growths[2,3] with a gradual clinical progression[4].

Torus mandibularis particularly poses challenges in the context of fabricating complete dentures for a patient[5]. Tori can impede pronunciation, interfere with swallowing, and induce pain in the mucosa due to ill-fitting prostheses[6,7]. Although three-dimensional (3D) reconstruction are commonly applied in orthognathic surgeries within the realm of maxillofacial surgery, their utility extends to cases involving tori. However, the litera ture lacks comprehensive documentation of the specific extent of excision in such cases. 3D reconstruction is useful for treatment planning, surgical simulation, and patient explanations.

Herein, we report a distinctive case featuring a substantial torus in both the maxilla and mandible that impacted speech articulation and pronunciation tests. Our assessment methodology encompassed evaluation utilizing pre and postoperative 3D-constructed images.

HIGHLIGHTS

- Tori in the maxilla and mandible can often lead to issues such as obstruction of dysarthria.
- Surgical resection of the lesion resulted in improved tongue movement.
- Through both pre and postoperative assessments, we evaluated pronunciation, quantified the extent of bone removal.
- The surgical intervention proved effective in ameliorating speech articulation difficulties, and the application of 3D-CT image construction was valuable.
- We successfully managed and treated a giant torus in the maxilla and mandible, a condition scarcely been reported in the literature.

Case report

Patient

A 72-year-old female patient was referred to our department from a dental clinic with complaints of eating disorders and dysarthria. She had no relevant medical history and was not

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Figure 1. Preoperative intraoral photographs. A large torus is identified in the maxilla and mandible.

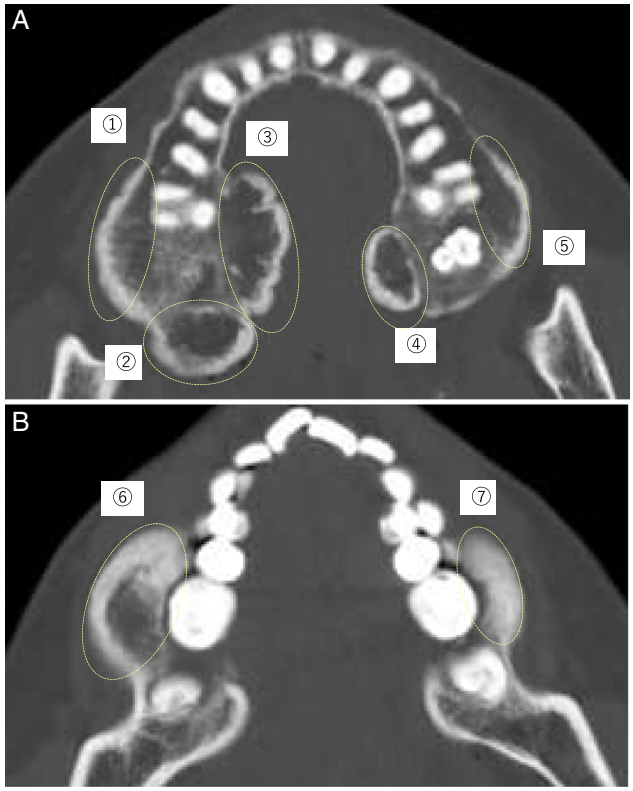

Figure 2. Preoperative examination. (A) Computed tomography reveals lesions at seven locations with Hounsfield Units equivalent to that of the maxilla (A) and mandible (B). (1) 26×11×10 mm, (2) 16×15×13 mm, (3) 26×12×12 mm, (4) 15×13×8 mm, (5) 15×12×6 mm, (6) 26×16×15 mm, (7) 20×13×9 mm.

taking medication. However, a substantial torus was identified spanning both the maxilla and mandible (Fig. 1). The patient was evaluated based on preoperative clinical manifestations and computed tomography (CT) findings. CT revealed lesions in the maxilla measuring 26×11×10, 16×15×1 3, 26×12×12, 5×13×8, and 15×12×6 mm (Fig. 2A), and lesions in the mandible measuring 26×16×15 and 20×13×9 mm (Fig. 2B). A surgical procedure was undertaken under general anesthesia to resect the giant torus, which was completely removed (Fig. 3). The surgery was performed by an oral and maxillofacial surgeon with over 20 years of experience. Histological analysis found mature cortical bone tissue with no cellular atypia. The 6-month follow-up period indicated no recurrence (Figs. 4 and 5). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request. It has been reported in line with the SCARE 2023 criteria[8]. The authors declare no conflicts of interest.

Articulation evaluation

Articulation was evaluated through four distinct methods (oral diadochokinesis, speech intelligibility, one-hundred–syllable intelligibility, and sentence intelligibility) and performed before surgery, as well as at 7 days and 3 months post-surgery.

Oral diadochokinesis was evaluated using an oral-function measurement device (KENKOUKUN handy; Takei Scientific Instruments Co., Ltd.). The patient was instructed to repeatedly enunciate a monosyllable as rapidly as possible for a duration of 5 s. The device recorded the number of repetitions for each syllable and calculated the rate of syllables produced per second. The monosyllables /pa/, /ta/, and /ka/ were used to assess articulation by involving the lips, tip of the tongue, and posterior region of the tongue, respectively[9–11].

Speech intelligibility was assessed through open-ended conversations and reading of both short and long sentences aloud. The assessment involved assigning scores ranging from 1 (completely comprehensible) to 5 (completely incomprehensible). In the one-hundred–syllable intelligibility test, the accuracy percentage for 100 syllables was calculated using a test word table in which 100 Japanese sounds were arranged randomly. For the sentence intelligibility test, the patient was instructed to audibly articulate 30 simple question-style sentences, and the listener's accurate response percentage was measured as sentence intelligibility.

3D evaluation

Evaluation of the pre and postoperative torus in the maxilla and mandible was involved postoperative helical images captured before and 3 days after surgery. The CT dataset was converted to the Digital Imaging and Communications in Medicine (DICOM) format, used for reconstruction, and analyzed through Mimics

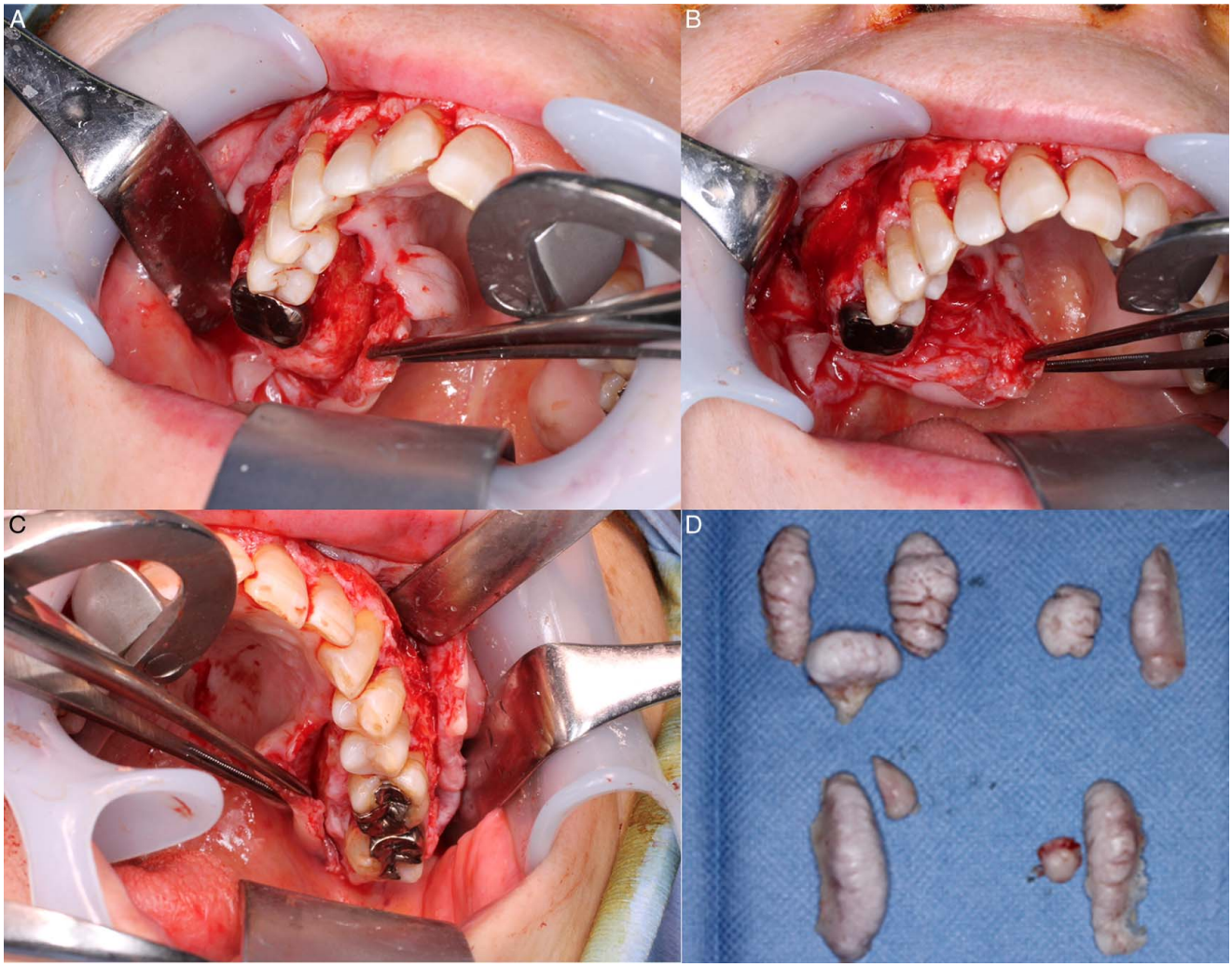

Figure 3. Intraoperative photographs. (A) Torus palatinus and buccal before resection. (B) Torus palatinus and buccal after resection. (C) Torus palatinus and buccal after resection. (D) Resected torus palatinus, torus mandibularis, and buccal.

software (version 23.0, Materialize). Data on the maxilla and mandible from pre and postoperative stages were extracted from the 3D-CT images (Figs. 6 and 7). Superposition was performed using the least-squares method (auto-registration processing) ensuring a precise alignment of bone structures before and 3 days after the surgery, yielding satisfactory visual congruence. Verification was undertaken to confirm successful superimposition. The bone removal volume was calculated as follows:

Bone removal amount = (volume of the maxillary and mandibular bone before surgery) − (volume of the maxillary and mandibular bone after surgery).

Results

Improvements were observed in oral diadochokinesis in /ta/, /ka/, speech intelligibility, and 100-syllable intelligibility (Tables 1 and 2). The superimposition of the pre and postoperative 3D-construction images is presented in Fig. 8. The bone removal volume was calculated as 15 676.4 mm^3.

Discussion

The exact cause of mandibular tori remains elusive, although a complex interplay of genetic and environmental factors such as diet, presence of teeth, and occlusal pressure, are suspected to be involved[12,13]. Occlusal stressors such as bruxism and teeth clenching have been identified as potential contributors the development of mandibular tori[13,14]. Excessive mechanical stress is responsible for the transduction signal for osteoblasts, favoring the formation of exostoses.[3] In other words, wear is said to be related to torus.[15] Mouthguards are also said to be effective in preventing recurrence. In this case, we have not followed up the patient's progress beyond 6 months after surgery, but we believe it would be useful to monitor the progress based on both clinical and imaging findings.

While some reports acknowledge articulation disorders caused by a large torus palatinus located centrally, the literature has yet to explore the relationship between a palatal alveolar region torus and articulation. Additionally, no documented cases thus far have performed a 3D-CT evaluation of

Figure 4. Postoperative intraoral photographs.

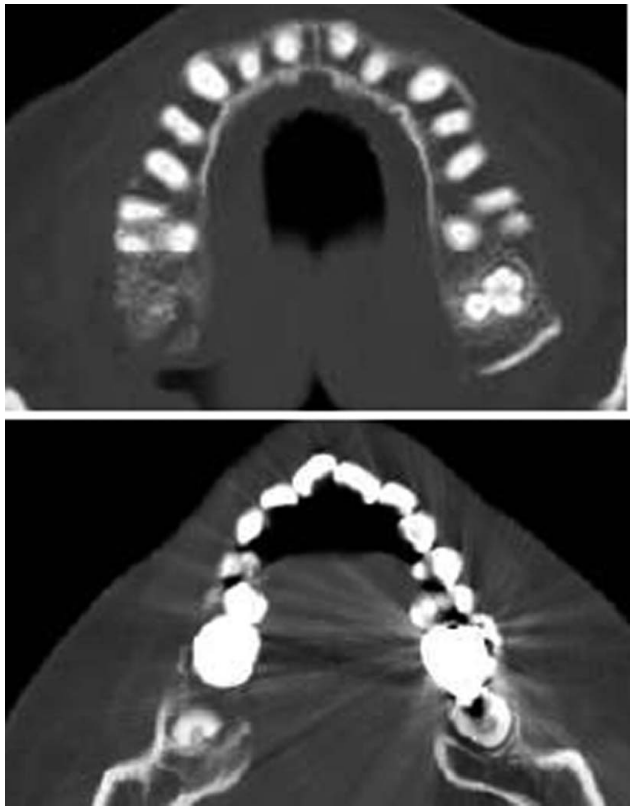

Figure 5. Postoperative examination. Computed tomography highlights seven locations where the torus has been removed.

tori situated in both the maxilla and mandible.

Surgical intervention lead to improvements in soft palate sounds during oral diadochokinesis. The prominence of the bony structure in the alveolar region was thought to have restricted tongue movement during articulation, resulting in altered exhalation airflow patterns during vocalization. Prior to surgery, the substantial torus in the maxilla restricted both the upward movement of the tongue within the coronal plane and its posterior upward movement within the sagittal plane. The surgery restored normal movement to the tongue (Fig. 9). It is plausible that the giant torus in the maxilla contributed to the divergence of the exhalation airflow from the midpalate region, thereby distorting articulation.

In this case, surgical resection of the lesion improved the tongue dyskinesia. In addition, pre and postoperative 3D-CT analyses facilitated the precise calculation of the excised bone volume. Although 3D simulation are conventionally applied in orthognathic surgery, their utility extends to patient education and surgical simulations pertaining to tori within the maxilla and mandible. This was a report of a single case, but by accumulating more cases we may be able to derive a correlation between the amount of bone resection and pronunciation, which will lead to future research.

To summarize, we successfully managed and treated a giant torus in the maxilla and mandible, a condition scarcely been reported in the literature. This report is the first to detail the application of 3D analysis for the evaluation a torus.

Ethical approval

Our hospital has determined that ethical review is not necessary for the case report.

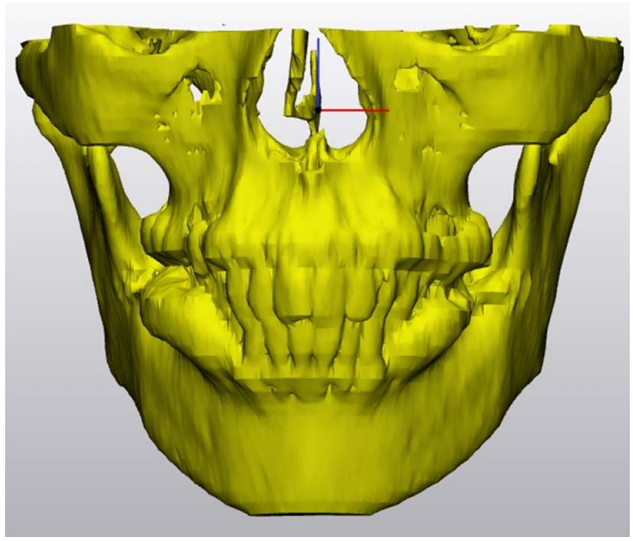

Figure 6. Three dimensional (3D)-constructed preoperative image. 3D computed tomography demonstrates a giant torus in the maxilla and mandible.

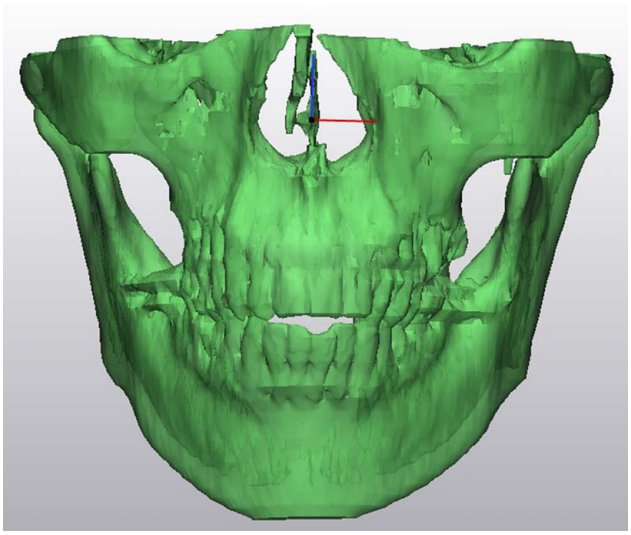

Figure 7. Three-dimensional (3D)-constructed postoperative image. 3D computed tomography depicts that the giant torus has been removed.

Table 1

Results of pre and postoperative oral diadochokinesis.

	Pre	PO-7 days	PO-3 months
Repetitions/pa/	6.0	6.0	6.0
Repetitions/ta/	5.8	6.0	6.0
Repetitions/ka/	4.8	5.4	5.6

PO-7 days, 7 days postoperative; PO-3 months, 3 months postoperative; Pre, preoperative.

Table 2

Results of pre and postoperative evaluations of oral articulation.

	Pre	PO-7 days	PO-3 months
Speech intelligibility	1.5	1.0	1.0
100-syllable intelligibility (%)	84.0	91.3	92.0
Sentence intelligibility (%)	100	98.9	100

PO-7 days, 7 days postoperative; PO-3 months, 3 months postoperative; Pre, preoperative.

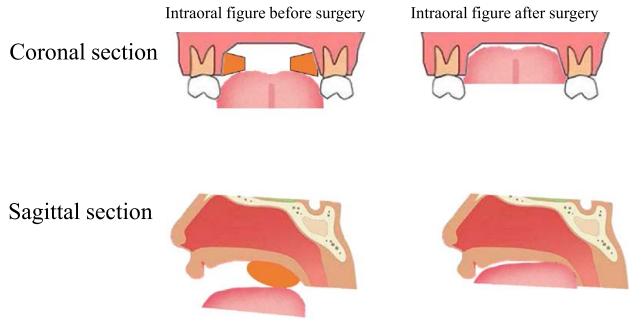

Figure 9. Movements of the tongue before and after surgery.

Consent

The patient provided written informed consent for the publication of this case report.

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Not applicable.

Author contribution

J.S.: writing the paper, study concept or design. K.S.: data collection, data analysis. S.K.: data collection, data analysis. T.S.: study concept or design.

Conflicts of interest disclosure

The authors declare no conflict of interest.

Research registration unique identifying number (UIN)

This paper is not a research but a case report and has not been registered in a database.

Guarantor

Jun Sasaki.

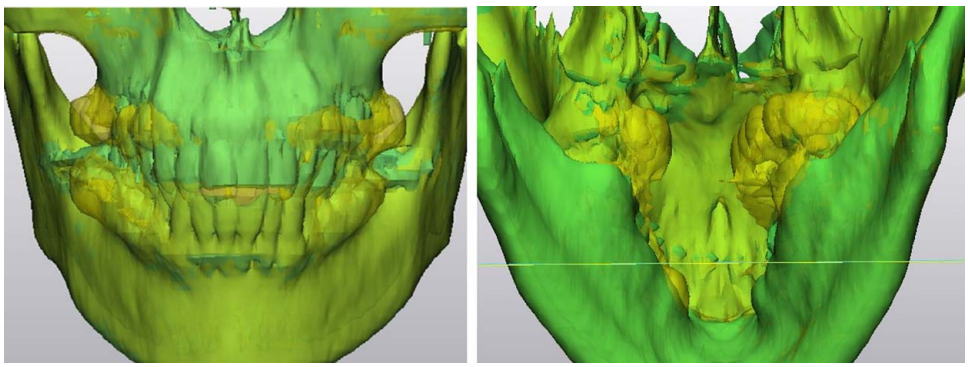

Figure 8. Superposition image of pre and postoperative three-dimensional computed tomography.

Data availability statement

Datasets generated during the current study are publicly available.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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