An adult case of unilateral posterior crossbite caused by maxillary transverse deficiency treated with miniscrew-assisted rapid palatal expansion

Toyoaki Takagi[a], Eiji Tanaka[b]

Authors' information

[a] Takagi Orthodontic Office; Pastral Takarazuka Bldg. 2F 2-5 Mukogawa-cho Takarazuka city, Hyogo 665-0844, Japan; Tel & Fax: +81-797-84-1187
E-mail: takagi-ortho1@aqua.ocn.ne.jp

[b] Department of Orthodontics and Dentofacial Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School; 3-18-15 Kuramoto-cho, Tokushima 770-8504, Japan.; Tel: +81-88-633-7356
E-mail: etanaka@toushima-u.ac.jp

Running head: Miniscrew assisted rapid palatal expansion in mandibular deviation patient

Corresponding author:
Eiji Tanaka, DDS, PhD
Professor and Chairman
Department of Orthodontics and Dentofacial Orthopedics, Tokushima University Graduate School of Biomedical Sciences, 3-18-15, Kuramoto-cho, Tokushima 770-8504, Japan
TEL: +81-88-633-7356
E-mail: etanaka@tokushima-u.ac.jp

An adult case of unilateral posterior crossbite caused by maxillary transverse deficiency treated with miniscrew-assisted rapid palatal expansion

ABSTRACT

This report describes the successful treatment of an adult case of unilateral posterior crossbite caused by maxillary transverse deficiency with miniscrew-assisted rapid palatal expansion (MARPE). A female patient aged 35.5 years presented with masticatory disturbance, facial asymmetry, and unilateral posterior crossbite. She was diagnosed with unilateral posterior crossbite with a skeletal Class III jaw-base relationship and high mandibular plane angle. Her maxillary right and mandibular bilateral second premolars were congenitally absent, and the maxillary left second premolar was impacted. After the improvement of the posterior crossbite with MARPE, 0.018" slot lingual brackets were placed on the maxillary and mandibular dentition. The total active treatment period was 22 months, and acceptable occlusion with a functional Class I relationship was achieved. Pretreatment and posttreatment cone-beam computed tomography images showed the disarticulation of the midpalatal suture after MARPE, and changes in the dental and nasomaxillary structures, nasal cavity, and pharyngeal airway. The case results demonstrate that MARPE produces greater skeletal expansion with minimal buccal tipping of the molars. MARPE may be effective for the treatment of maxillary transverse deficiency in adult patients.

Key words: orthodontic treatment, maxillary transverse deficiency, miniscrew-assisted rapid palatal expansion, lingual bracket appliance, maxillary palatal suture; skeletal Class III

1. Introduction

Maxillary transverse deficiency is encountered commonly in daily orthodontic practice.[1] Its prevalence ranges from 8% to 23% in growing patients and is <10% in adult orthodontic patients.[2,3] Many treatment modalities have been developed and are commonly used in the clinic to correct maxillomandibular transverse discrepancy. They can be classified as orthodontic, non-surgical orthopedic, and surgical correction. Rapid maxillary expansion (RME) is widely recognized as an effective non-surgical orthopedic technique for the disarticulation of the midpalatal suture before the pubertal growth spurt.[4] Conventional RME is contraindicated for skeletally mature patients, as it can induce adverse effects such as periodontal and alveolar bone bending, buccal root resorption, buccal flare-out of the posterior teeth, fenestration of the buccal cortex, and pain and discomfort.[5] In addition, RME is not likely to achieve true or stable maxillary skeletal expansion in mature patients.

Surgically assisted rapid palatal expansion is applicable to mature patients with maxillary transverse deficiencies, but surgical morbidity should be considered, as complications including gingival recession, infection, postoperative pain and discomfort, alar base flaring, and more-or-less late relapse have been reported.[6] In recent decades, the relatively simple and minimally invasive technique of miniscrew-assisted rapid palatal expansion (MARPE) has been developed to achieve successful skeletal expansion in adult patients without surgery or side effects.[7] Although data on MARPE are scarce, a few publications describe cases in which this technique effectively corrected maxillary transverse discrepancies in mature patients by delivering the expansion force directly to the midpalatal suture, thereby maximizing the skeletal effect.[6]

Here, we present a case in which MARPE was used to treat unilateral posterior crossbite caused by maxillary transverse deficiency in an adult patient. We discuss the feasibility of camouflage treatment in a skeletal Class III case with a high mandibular plane angle. We confirmed the disarticulation of the midpalatal suture by cone-beam computed tomography (CBCT) and evaluated changes in the dental and nasomaxillary structures and nasal cavity caused by MARPE.

2. Case presentation

A woman aged 35.5 years presented with masticatory disturbance, facial asymmetry, and unilateral posterior crossbite. Her facial profile was concave, with a protrusive chin,

and the frontal view was asymmetrical, with mandibular deviation to the right (Fig 1A). The right and left molar relationships were Angle classes II and I, respectively. The maxillary first molar coronal arch width (37.4 mm) was lesser than that in the mandible (39.8 mm) (Fig 1B). Anterior and right-side posterior crossbite were present due to the narrowness of the maxillary dental arch. Overjet and overbite were -1.0 and 0.5 mm, respectively. The arch length discrepancies were 0 mm in the maxilla and -2.0 mm in the mandible. The maxillary dental midline coincided with the facial midline, but the mandibular dental midline deviated 0.5 mm to the right due to premature contact and a subsequent mandibular functional shift. The patient had the habits of mouth breathing and tongue thrusting due to nasal obstruction.

A panoramic radiograph showed that the maxillary right and mandibular bilateral second premolars were congenitally absent, and the maxillary left second premolar was horizontally impacted (Fig 1C). Prolonged retention of the deciduous mandibular right second molar was observed. No periodontal problem or temporomandibular joint disorder was found. Cephalometric analysis showed a skeletal Class III jaw-base relationship with slight mandibular protrusion (ANB, -1.1°; SNB, 81.1°) relative to the Japanese norm[8] (Fig 1D, 1E; Table). The mandibular plane was obtuse, with a large Frankfort mandibular plane angle (33.8°). Lingual inclination of the maxillary central incisors (U1–SN, 93.1°), and especially the mandibular central incisors (Incisor mandibular plane angle, 74.2°) was observed. As a result, the interincisal angle (148.6°) exceeded +3.0 S.D. A frontal cephalogram revealed mandibular asymmetry with no occlusal cant, and a 2.0-mm rightward shift of menton (Fig 1F).

CBCT images showed that the midpalatal suture was closed with inter-digitation, classified into stage III based on Melsen's classification[9] (Fig 1G, 1H). The upper airway space was not very narrow (volume, 21,267 mm^3; upper pharyngeal airway minimum axial area, 258 mm^2). The maxillary right first molar was inclined 3° buccally and the contralateral tooth showed no buccal flare-out (Fig 1I). The bilateral condyles were located concentrically in the glenoid fossae (Fig 1J).

The patient was diagnosed with unilateral posterior crossbite caused by the narrowness of the maxillary dental arch and rightward mandibular deviation with a skeletal Class III jaw-base relationship and high mandibular plane angle. The treatment objectives were to improve the unilateral posterior crossbite and to achieve functional Class I occlusion. The treatment plan was as follows:

1. Application of MARPE to achieve 6.0 mm maxillary expansion for the improvement of the unilateral posterior crossbite and amelioration of the nasal obstruction through extension of the upper airway; and
2. Use of orthodontic miniscrews to achieve 2.0 mm bilateral distalization of the mandibular dentition for the improvement of crowding.

At the age of 35.7 years, maxillary skeletal expander (MSE; MSE II, Biomaterials Korea, Seoul, South Korea) was applied with four miniscrews (Fig 2A) to improve the crossbite. After a 2-week latency period, the MSE was activated twice a day (daily expansion rate, 0.5 mm). Although 7.0 mm total expansion was planned, 6.0 mm expansion at the mesiobuccal cusps of the first molars and 4.5 mm expansion at the cusps of the maxillary canines was obtained (Fig 2B). After a 2-month retention period, the MARPE was removed and a CT examination was performed to confirm that maxillary skeletal expansion had occurred (Fig 3). The midpalatal suture had opened (Fig 3A, 3B). The total volume of the upper airway space had increased to 110% and the minimum axial area of the upper airway had decreased slightly from the pretreatment baseline. The maxillary right first molar showed more buccal inclination than it had before expansion (Fig 3C). The condylar position against the glenoid fossa had not changed (Fig 4D).

After the extraction of the deciduous mandibular right second molar, preadjusted 0.018” lingual slot brackets were placed on the mandibular dentition to level it. Thereafter, a 0.016 × 0.022” stainless-steel wire was installed to close the extraction space. At 6 months after MARPE, the unilateral posterior crossbite had improved and preadjusted 0.018” lingual slot brackets were placed on the maxillary dentition. After leveling with a 0.014” nickel-titanium wire, a 0.016 × 0.022” stainless-steel wire was installed on the maxillary dentition.

At 1 year after MARPE, all extraction spaces had closed. Expansion relapses of 2.2 and 0.5 mm were observed at the maxillary canines and first molars, respectively. Detailing with 0.017 × 0.025” titanium-molybdenum wires was initiated in both arches (Fig 2C). Myofunctional therapy to reduce the patient’s parafunctional habits, including tongue thrusting, was administered throughout the orthodontic treatment period. At 24 months, including 2.5 months of maxillary expansion, acceptable and stable occlusion had been achieved. Immediately after the removal of all appliances, a wraparound

retainer was placed on the maxillary arch and a lingually bonded retainer was placed on the mandibular anterior teeth.

Posttreatment photographs showed a more balanced facial profile, although slight chin protrusion and facial asymmetry persisted (Fig 4A). The occlusion was much more stable and the tooth intercuspation was acceptable, with Class I canine and molar relationships (Fig 4B). The overjet and overbite had improved to 2.0 mm, and the unilateral posterior crossbite had improved. The maxillary and mandibular dental midlines nearly matched. From model analysis, we determined that the maxillary intercanine width had increased by 2.3 mm and the maxillary first molar coronal arch width had increased by 5.5 mm. A panoramic radiograph showed reduced or no root resorption and root parallelism for all teeth (Fig 4C). Cephalometric analysis indicated minimal clockwise rotation of the mandible (Fig 4D, 4E; Table). The maxillary central incisors were labially inclined and the mandibular central incisors were lingually inclined, resulting in no or minimal change in the interincisal angle. A frontal cephalogram showed persisting mandibular asymmetry (Figs 4F). Posttreatment CBCT images showed the retention of the expanded midpalatal suture space (Fig 4G). Although the total volume of the upper airway space was less than it had been 3 months after skeletal expansion, it remained greater than before expansion. The maxillary first molar roots were almost parallel (Fig 4H). The bilateral condyles remained in concentric positions in the glenoid fossae (Fig 4I). The patient reported that she was considerably satisfied with her masticatory performance and respiratory condition.

After 1.5 years of retention, the patient's balanced facial profile and acceptable occlusion were maintained well, with no recurrence of the anterior or unilateral posterior crossbite (Fig 5A, 5B). A panoramic radiograph showed acceptable root parallelism with no obvious apical root resorption (Fig 5C). On cephalometric analysis, the maxilla showed slight forward movement of point A and the mandible showed slight clockwise rotation (Figs 5D, 5E; Table). As a result, ANB had increased to 1.5^{o}, indicating a skeletal Class I relationship. As the mandibular incisors were lingually inclined and extruded and the maxillary incisors were labially inclined, the overbite and overjet had increased to +2.0 mm. A frontal cephalogram showed mandibular asymmetry, but matching of the maxillary and mandibular dental midlines (Fig 5F). CBCT images indicated that the total volume of the upper airway space remained larger than before treatment.

3. Discussion

A histomorphometric study showed that palatal suture obliteration begins in the fourth decade of life, and that bony fusion of the midpalatal suture is rare in subjects aged ≤ 25 years.[10] Even in prepubertal patients, nonsurgical expansion leads to the thinning of the buccal alveolar wall, which could, in turn, lead to bony dehiscence.[5] Thus, transverse expansion in postpubertal patients carries increased risks and requires stronger bone-borne anchorage than used in conventional RME. Here, we describe the use of MARPE to treat unilateral posterior crossbite caused by maxillary transverse deficiency in a 35-year-old patient. We achieved 7.0 mm expansion at the mesiobuccal cusps of the maxillary first molars with no buccal tipping of the maxillary molars, thereby meeting the treatment objective and avoiding orthognathic surgery. We followed the patient for 2 years to monitor the maxillary widths and evaluate the outcome and long-term stability of MARPE.

At 1 year after expansion, the relapse rates at the maxillary canines and first molars were 48.9% and 8.3%, respectively, in the present case. These rates are considerably more rapid and similar, respectively, to those reported previously. Ploder et al.[11] reported mean palatal expansion relapse rates at 1 year after MARPE of 7.1% at the canines and 8.6% at the molars in 13 patients with a mean age of 36.1 years. Tang et al.[12] reported mean relapse rates of 5.75% in nasal width and 19.75% at the lateral pterygoid plate after 1 year of retention.

The increase in the total upper airway volume and resolution of the patient's nasal obstruction immediately after MARPE in the present case reflect the ability of this technique to open the nasal passages, facilitating breathing. In most previous studies, MARPE has significantly increased the total airway volume.[13] Conventional RME also increases the upper airway volume, and Cistulli et al.[14] first suggested that it could be used to treat obstructive sleep apnea (OSA). However, palatal expansion with RME is not applicable to mature patients. Tang et al.[12] reported 10.0% and 20.7% enlargement of the total pharyngeal and nasopharyngeal volumes, respectively, in younger adults after MARPE. Hur et al.[15] reported that the use of MARPE to treat OSA in an adult patient resulted in improved airflow and decreased upper airway resistance. Taken together, these findings suggest that MARPE effectively improves the anatomical characteristics of the upper airway, contributing to respiratory function.

4. Conclusion

Unilateral posterior crossbite caused by maxillary transverse deficiency and nasal obstruction in an adult patient were treated successfully with MARPE. After orthodontic treatment, acceptable occlusion with Class I canine and molar relationships was achieved. During a 1.5-year retention period, no relapse of the crossbite or recurrence of nasal obstruction was observed. This case provides an example of the successful use of MARPE to treat maxillary transverse deficiency in mature patients, and highlights the applicability of MARPE for the treatment of OSA in adults.

REFERENCES

[1] McNamara JA. Maxillary transverse deficiency. Am J Orthod Dentofacial Orthop 2000;117:567–70. https://doi: 10.1016/s0889-5406(00)70202-2.

[2] da Silva Filho OG, Santamaria Jr M, Capelozza Filho L. Epidemiology of posterior crossbite in the primary dentition. J Clin Pediatr Dent 2007;32:73–8. https://doi: 10.17796/jcpd.32.1.h53g027713432102.

[3] Brurelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population, 1988–1991. J Dent Res 1996;75:706–13. https:// doi: 10.1177/00220345960750S10.

[4] Perillo L, De Rosa A, Iaselli F, d'Apuzzo F, Grassia V, Cappabianca S. Comparison between rapid and mixed maxillary expansion through an assessment of dento-skeletal effects on posteroanterior cephalometry. Prog Orthod 2014;15:46. https:// doi: 10.1186/s40510-014-0046-9.

[5] Gurel HG, Memili B, Erkan M, Sukurica Y. Long-term effects of rapid maxillary expansion followed by fixed appliances. Angle Orthod 2010;80:5–9. https://doi: 10.2319/011209-22.1.

[6] Cremonini F, Ansaloni MC, Cremonini A, Maino BG, Paoletto E, Pellitteri F, Lombardo L. Severe transverse discrepancy in adult Class III patient: parallel rapid palatal expansion with a bone-borne tandem expansion screws (TSE) followed by lingual fixed appliance for a non-surgical treatment: a case report. Int Orthod 2021;S1761-7227:00144-3. https:// doi: 10.1016/j.ortho.2021.11.001.

[7] Cantarella D, Dominguez-Mompell R, Mallya SM, Moschik C, Pan HC, Miller J, Moon W. Changes in the midpalatal and pterygopalatine sutures induced by micro-implant-supported skeletal expander, analyzed with a novel 3D method based on CBCT imaging. Prog Orthod 2017;18:34. https://doi: 10.1186/s40510-018-0240-2.

[8] Wada K, Matsushita K, Shimazaki S, Miwa Y, Hasuike Y, Susami R. An evaluation of a new case analysis of a lateral cephalometric roentgenogram. J Kanazawa Med Univ 1981;6:60–70.

[9] Melsen B. Palatal growth studied on human autopsy material. American Journal of Orthodontics 1975;68:42-54.

[10] Knaup B, Yildizhan F, Wehrbein H. Age-related changes in the midpalatal suture. J Orofac Orthop 2004;65:467–74. https://doi: 10.1007/s00056-004-0415-y.

[11] Ploder O, Winsauer H, Juengling K, Grill F, Bissinger O, Wolff KD, Kolk A. Is there a significant difference in relapse and complication rate of surgically assisted rapid palatal expansion using tooth-borne, bone-borne, and orthodontic mini-implant-borne appliances? J Oral Maxillofac Surg 2021;79:213–24. https://doi: 10.1016/j.joms.2020.04.013.

[12] Tang H, Liu P, Liu X, Hou Y, Chen W, Zhang L, Guo J. Skeletal width changes after mini-implant-assisted rapid maxillary expansion (MARME) in young adults. Angle Orthod 2021;91:301–6. https://doi: 10.2319/052920-491.1.

[13] Li Q, Tang H, Liu X, Luo Q, Jiang Z, Martin D, Guo J. Comparison of dimensions and volume of upper airway before and after mini-implant assisted rapid maxillary expansion. Angle Orthod 2020;90:432–41. https:// doi: 10.2319/080919-522.1.

[14] Cistulli PA, Palmisano RG, Poole MD. Treatment of obstructive sleep apnea syndrome by rapid maxillary expansion. Sleep 1998;21:831–5. https://doi: 10.1093/sleep/21.8.831.

[15] Hur JS, Kim HH, Choi JY, Suh SH, Baek SH. Investigation of the effects of miniscrew-assisted rapid palatal expansion on airflow in the upper airway of an adult patient with obstructive sleep apnea syndrome using computational fluid structure interaction analysis. Korean J Orthod 2017;47:353–64. https://doi: 10.4041/kjod.2017.47.6.353.

FIGURE LEGENDS

Fig 1. Pretreatment records (patient age, 35.5 years). (A) Facial photographs; (B) Intraoral photographs; (C) Panoramic radiograph; (D) Lateral cephalogram; (E) Lateral cephalometric tracing; (F) Frontal cephalogram; (G) Three-dimensional image of CBCT; (H) Axial image of CBCT; (I) Coronal image of CBCT; (J) Sagittal views of the temporomandibular joints. White dotted lines indicate the maxillary first molar axis.

Fig 2. Intraoral photographs taken before lateral expansion (A) and 1 month (B) and 1 year (C) after maxillary lateral expansion.

Fig 3. CBCT images obtained at 3 months after maxillary expansion. (A) Three-dimensional image; (B) Sagittal view; (C) Axial view; (D) Coronal view; (E) Sagittal views of the temporomandibular joints. White dotted lines indicate the maxillary first molar axis.

Fig 4. Posttreatment records. (patient age, 37.4 years). (A) Facial photographs; (B) Intraoral photographs; (C) Panoramic radiograph; (D) Lateral cephalogram; (E) Lateral cephalometric tracing; (F) Frontal cephalogram; (G) Three-dimensional image; (H) Coronal view; (I) Sagittal views of the temporomandibular joints. White dotted lines indicate the maxillary first molar axis.

Fig 5. Postretention records (patient age, 38.9 years). (A) Facial photographs; (B) Intraoral photographs; (C) Panoramic radiograph; (D) Lateral cephalogram; (E) Lateral cephalometric tracing; (F) Frontal cephalogram

Reviewer #1:

It is an interesting article showing the use of MARPE technique with lingual orthodontics,however it would be great if you add the Melsen's classification of the midpalatal suture before the treatment and after finishing the MARPE phase.

A: Thank you for your excellent advice. According to your advice, we added the Melsen’s classification of the midpalatal suture before treatment; however, we could not classify the midpalatal suture after finishing the MARPE because the expanded midpalatal suture space was retained after treatment. (revision: Page 4, lines 23-24 and Reference #9)

Reviewer #2: I consider it accepted for publication. This study is very relevant to the academy and to other professionals.

A: Thank you for your nice wording.

Figure 1

Click here to access/download;Figure;Fig 1.tif

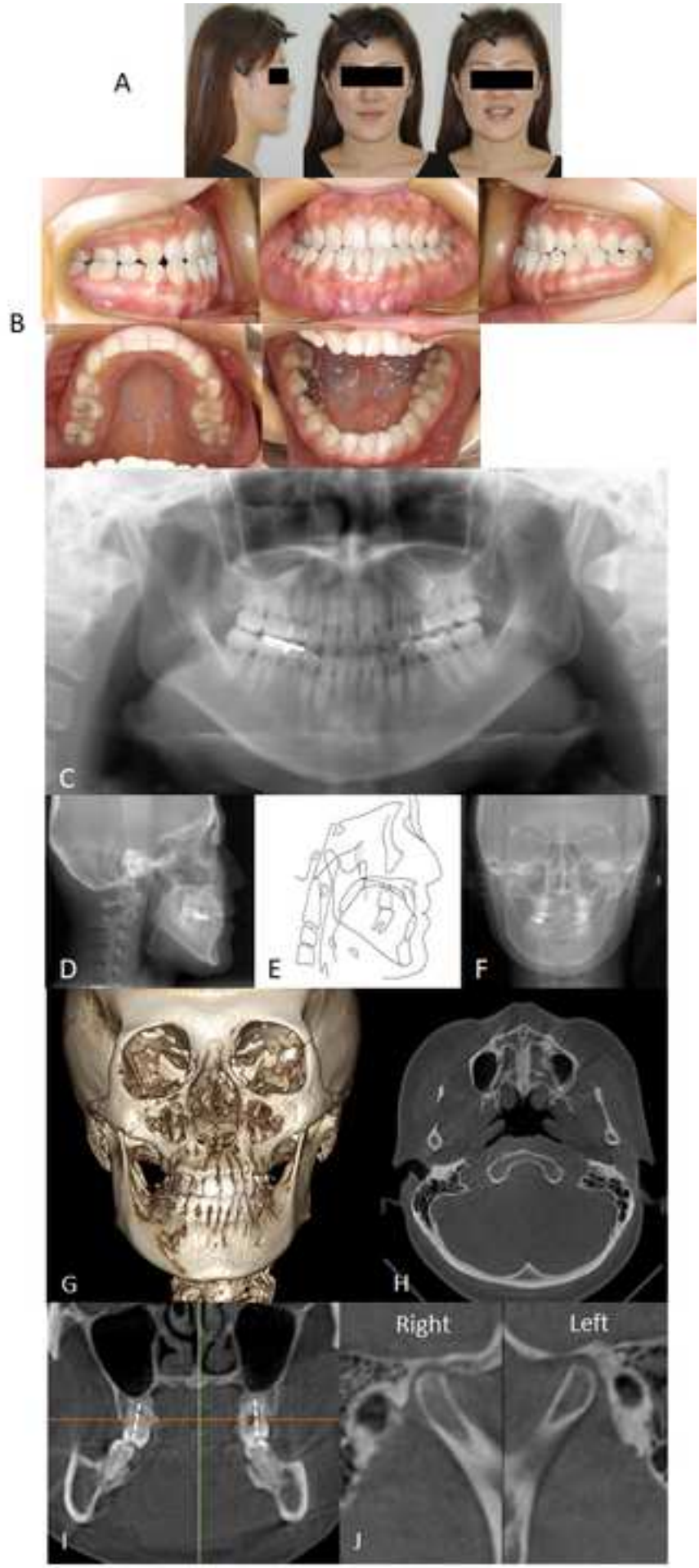

Figure 2

Click here to access/download;Figure;Fig 2.tif

Figure 3

Click here to access/download;Figure;Fig 3.tif

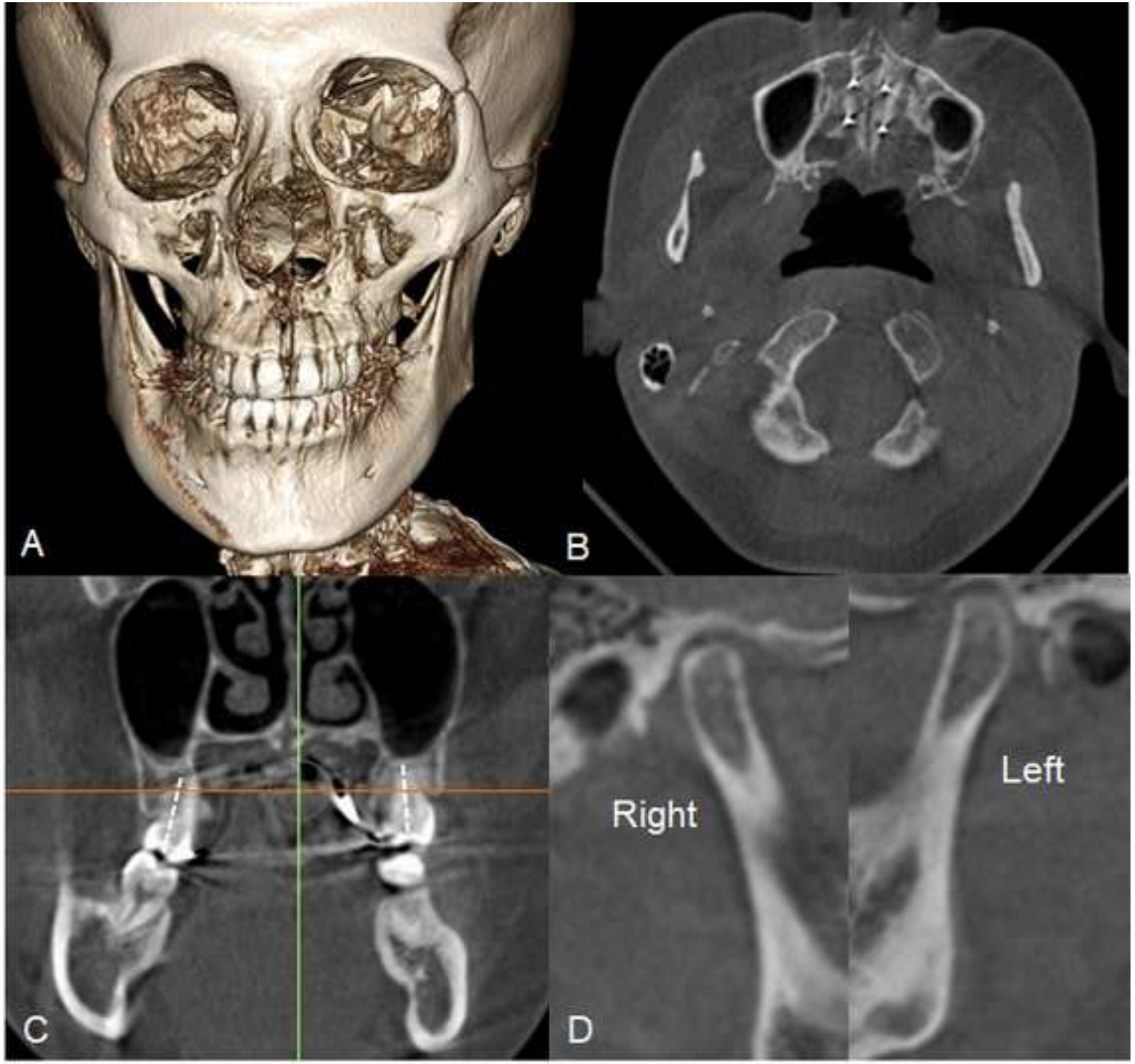

Figure 4

Click here to access/download;Figure;Fig 4.tif

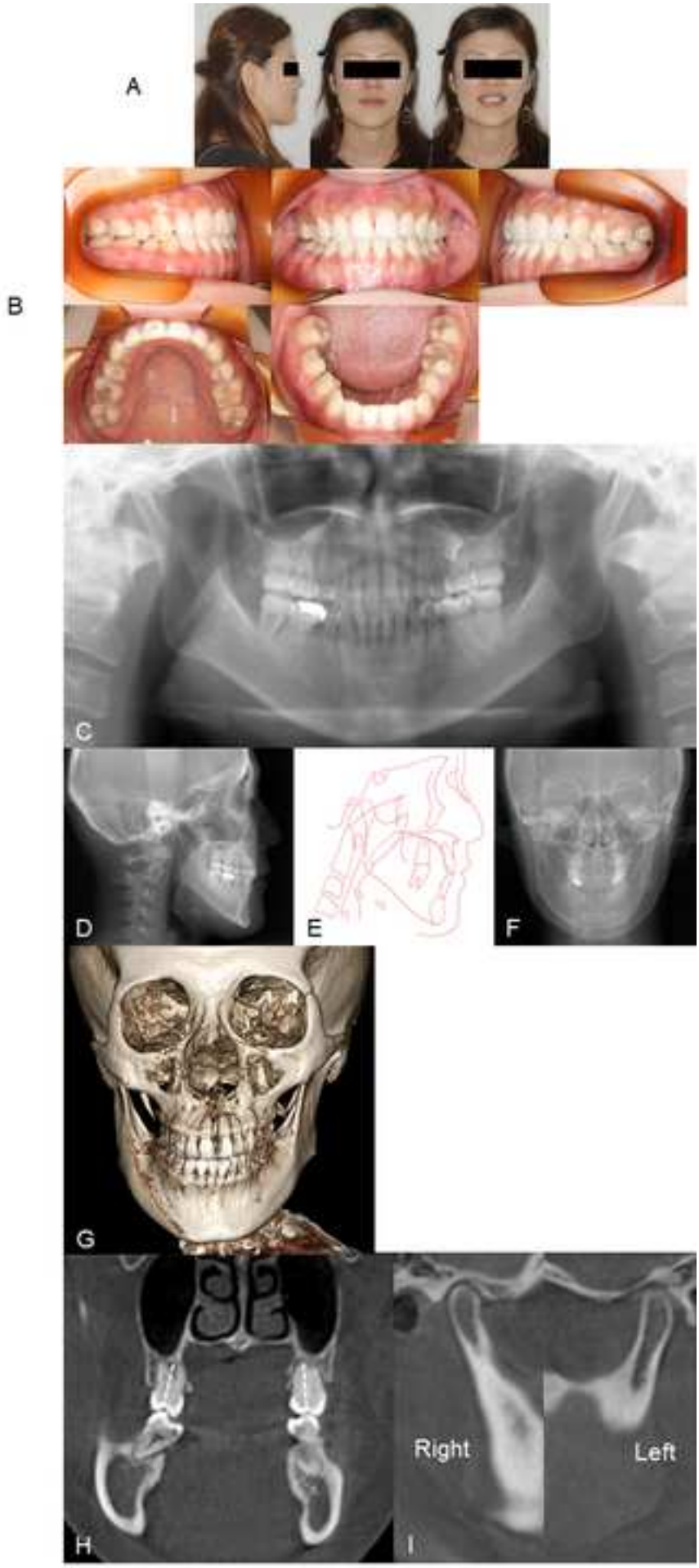

Figure 5

Click here to access/download;Figure;Fig 5.tif

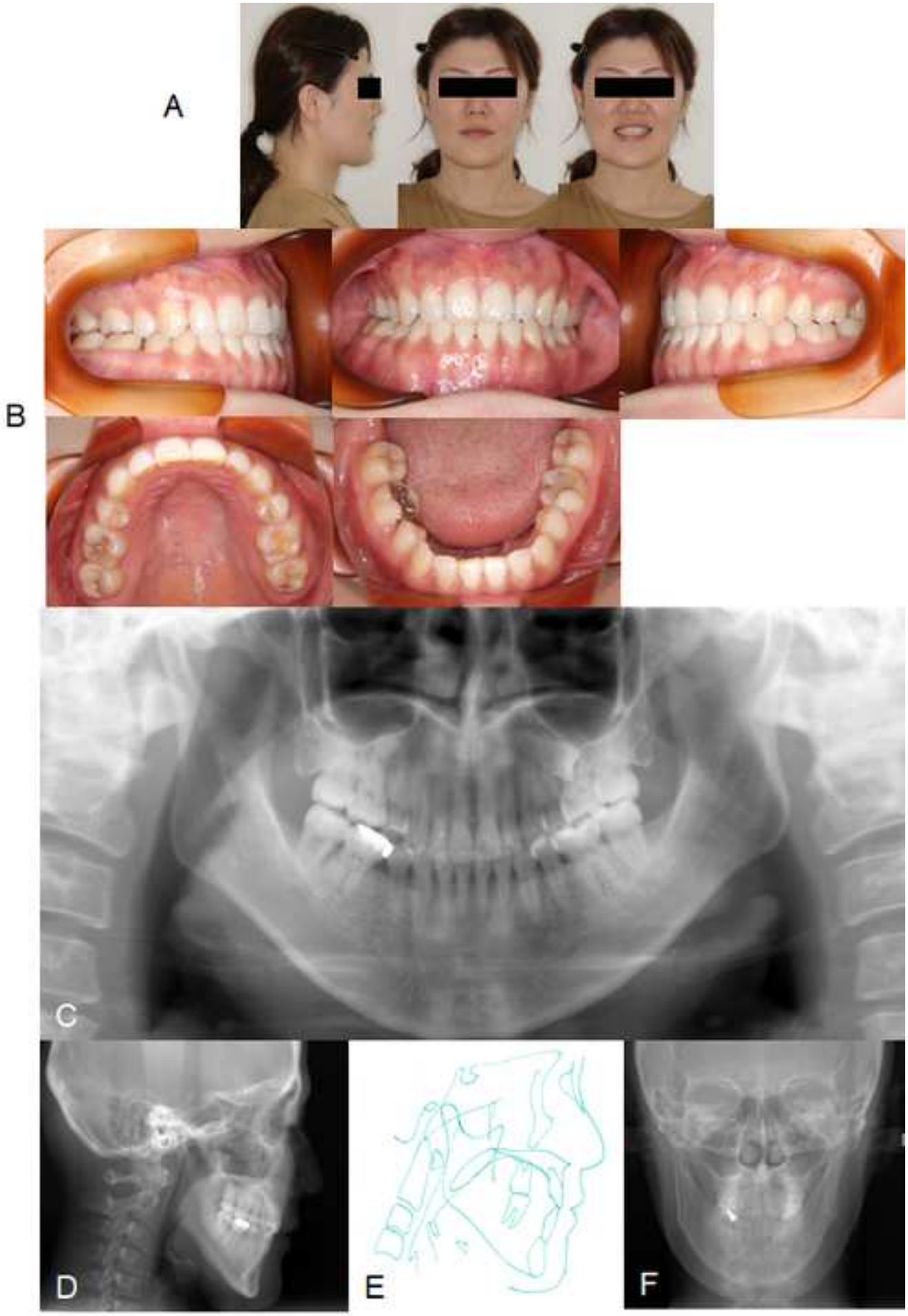

Table. Cephalometric summary

	Pretreatment	*Posttreatment*	*Retention*	*Japanese female adult*	
Measurements	*35y 6m*	*37y 6m*	*38y 11m*	*norm**	*SD*
Angular items (°)					
SNA	80.0	81.9	81.6	80.8	3.6
SNB	81.1	80.3	80.2	77.9	4.5
ANB	-1.1	1.6	1.4	2.8	2.4
FMA	33.8	34.2	34.0	30.5	3.6
Gonial angle	131.8	132.1	131.9	122.1	5.3
U1-SN	93.1	98.6	98.3	105.9	8.8
IMPA	74.2	71.7	71.9	93.4	6.8
Interincisal angle	148.6	149.0	149.1	123.6	10.6
Linear items (mm)					
Overjet	-1.0	2.0	2.0	3.1	1.1
Overbite	0.5	2.0	2.0	3.3	1.9

* Wada et al.[8]