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A case of unilateral posterior crossbite treated with modified unilateral surgically assisted rapid maxillary expansion

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A case of unilateral posterior crossbite treated with modified unilateral surgically assisted rapid maxillary expansion

ABSTRACT

In the present case, unilateral posterior crossbite with narrow maxillary arch was treated successfully with modified unilateral surgically assisted rapid maxillary expansion (SARME). The patient, a female aged 23 years and 4 months, was diagnosed with unilateral posterior crossbite due to transverse maxillary deficiency. After 1 year and 4 months of treatment with segmental arches and anchor miniscrew, modified unilateral SARME was performed. A total lateral expansion of 8.5 mm at the right maxillary posterior segment was completed without unwanted overcorrection of the unaffected side. Subsequently, 46 months of treatment with multibracket appliances achieved an acceptable and stable occlusion with no or minimal relapse through a 2-year retention period. In conclusion, modified unilateral SARME might be useful to improve unilateral posterior crossbite in mature patients without unwanted adverse effects.

Key words: Surgically assisted rapid maxillary expansion, Transverse maxillary deficiency, Unilateral posterior crossbite

INTRODUCTION

Rapid maxillary expansion (RME) is an effective procedure for expanding the maxilla transversely. Moreover, it is the standard treatment especially for growing patients with a narrow maxillary dental arch and functional posterior crossbite.[1-3] Meanwhile, conventional RME is contraindicated in patients after pubertal growth because most craniofacial sutures increase in stiffness and interdigitation,[4] resulting in the marked decrease of success rates in mature patients.[5] Thus, in late adolescent and adult patients, surgically assisted rapid maxillary expansion (SARME) and miniscrew-assisted palatal expansion (MARPE) have been commonly adopted to correct posterior crossbite involved in transversal maxillary deficiency.[6-9]

Unilateral posterior crossbite is a specific malocclusion characterized by an imbalance between the arch widths of the maxilla and mandible. Its treatment is extremely difficult in adults because unwanted overcorrection of the unaffected side commonly occurs if it is treated with RME.[3,10,11] Furthermore, overcorrection on the unaffected side may extend the total treatment duration and is sometimes difficult to correct.

Several modified appliances were developed to produce differential unilateral effects resulting in unilateral posterior crossbite correction without unwanted side effects (e.g., removable appliance with unilateral finger springs, unilateral cross elastics, and quadhelix appliance with different arm lengths).[12] However, they were not suitable due to several concerns such as patient cooperation and appearance of undesired tooth movement. Thus, surgical invasion is required to decrease bony resistance during maxillary expansion in mature adults.[13] The recommended osteotomies for unilateral posterior crossbite are anterior, lateral, and posterior osteotomies only on the crossbite side and median osteotomy of the midpalatal suture (i.e., unilateral SARME).[13,14] Unilateral SARME enables significant unilateral expansion on the crossbite side without any adverse effects such as overcorrection of the non-crossbite side.[13]

The present case report aimed to show a modified unilateral SARME for treating unilateral posterior crossbite in a non-growing patient with unilateral transverse maxillary deficiency.

DIAGNOSIS AND ETIOLOGY

The patient, a female aged 23 years and 4 months, presented with masticatory disturbance caused by anterior crowding and unilateral posterior crossbite. The patient had no marked medical or dental history including traumatic injury to the head, neck, or jaw. However, she had tongue thrusting and low tongue posture as oral parafunctional habits, and chin resting on her right hand as an abnormal posture. Her facial profile was convex with both upper and lower lip protrusion, and the frontal view was almost symmetrical (Fig 1). The patient had Angle Class I molar relationship on the right side and Angle Class II on the left side, and the overjet and overbite were 2.5 mm and 1.8 mm, respectively (Figs 1 and 2). The maxillary dental arch form was asymmetrically oval, while the mandibular dental arch form was symmetrically oval. A unilateral posterior crossbite was present on the right side caused by transverse maxillary deficiency. As inferred from the model analysis, the width of the basal arch of the maxilla was smaller than the Japanese standard,[15] while the basal arch width of the mandible was within the normal range (Fig 3). Arch length discrepancies were -8.9 and -3.2 mm in the maxillary and mandibular dentitions, respectively. The maxillary dental midline was shifted 2 mm to the right of the facial midline, whereas the mandibular dental midline matched the facial midline. Any obvious premature contact and the subsequent functional shift were not observed upon closure, and the centric relation was almost matched up to the centric occlusion.

A panoramic radiograph showed horizontally impacted mandibular third molars (Fig 4). Cephalometric analysis indicated that the patient's skeletal jaw-base relationship was Class I (ANB, 2.4°) relative to the Japanese norm (Fig 4; Table).[16] The mandibular plane was acute (FMA, 22.0°). Both the maxillary and mandibular central incisors were labially inclined (U1-SN, 112.8°; L1-Mp, 100.4°). Computed tomography (CT) indicated that the basal arch width at the premolar area was smaller on the right side (23.7 mm) than on the left side (25.8 mm), while the basal arch width at the molar region was almost the same between the right and left sides in the maxilla (31.7 mm on both sides) (Fig 5). Furthermore, the bilateral maxillary molars were inclined buccally, while the bilateral maxillary premolars were not inclined at all. On the other hand, the mandibular premolars and molars were not inclined much lingually.

To evaluate the transverse skeletal discrepancy, the horizontal distances between FA point and WALA ridge were measured using the model. [17] The horizontal distances were 0.7 mm, 1.8 mm, 2.0 mm, and 2.3 mm at the right side of the mandibular 1st premolar, 2nd premolar, 1st molar, and 2nd molar, respectively. At the left side of the mandibular 1st premolar, 2nd premolar, 1st molar, and 2nd molar, the WALA horizontal distances were 0.7 mm, 1.8 mm, 2.1 mm, and 2.3 mm, respectively. These values were close to the normal values. Furthermore, the distance between the mesio-lingual cusp tips of the maxillary first molars and between the central fossae of the mandibular first molars were 42.0 mm and 48.5 mm, respectively. Therefore, the amount of skeletal transverse discrepancy was -6.5 mm. Since the mandibular arch was almost symmetrical without transverse discrepancy, the patient exhibited maxillary transverse deficiency, resulting in unilateral posterior crossbite.

TREATMENT OBJECTIVES

The patient was diagnosed with unilateral posterior crossbite with skeletal Class I jaw-base relationship due to maxillary transverse deficiency. The treatment objectives were to 1) correct the transverse maxillary deficiency, (2) resolve crowding and unilateral posterior crossbite, (3) correct the maxillary midline deviation, and (4) achieve an acceptable occlusion with a functional Class I relationship. The treatment was planned as follows:

1. 2.0-mm bilateral distalization of the maxillary dentitions as pre-surgical preparation for the right side and to achieve Angle Class I relationship for the left side using interradicular orthodontic miniscrews.
2. 8.5 mm unilateral expansion of the right-side posterior maxillary segment by SARME.
3. 2.0 mm bilateral distalization of the mandibular dentitions to improve crowding using interradicular orthodontic miniscrews.
4. Myofunctional therapy to overcome oral parafunction and instruction to correct abnormal posture.

TREATMENT ALTERNATIVES

Regarding a lack of space necessary to improve crowding and bimaxillary protrusion, extraction of the maxillary and mandibular first premolars was considered to resolve the arch length discrepancy. However, she had tongue thrusting and low tongue posture as parafunctional habits. Therefore, premolar extraction had to be avoided to retain as much volume of the oral cavity as possible.

The maxillary arch essentially needed to be expanded to correct unilateral posterior crossbite and the considerably severe arch length discrepancy of the maxilla. The first alternative was RME to improve the insufficient maxillary arch width. However, maxillary expansion by RME can induce unwanted side effects when used in post-growing patients, such as periodontal and alveolar bone bending, buccal root resorption, fenestration of the buccal cortex, and instability of the expansion.[4,5] In addition, as described above, bilateral maxillary expansion induces overcorrection of the non-crossbite side.[3,11] The second alternative was MARPE to achieve a successful pure skeletal expansion in a skeletally mature patient. When using MARPE, surgery, which may lead to complications such as gingival recession, infection, postoperative pain and discomfort, or late relapse, can be avoided.[18] However, similar to RME, MARPE connects to the screws, which are inserted into the midpalatal area, delivering the expansion force bilaterally to the suture. This may be a disadvantage in treating unilateral posterior crossbite. Two jaw surgery was also a candidate to correct maxillary and mandibular skeletal discrepancies; however, her frontal face was almost symmetrical and she did not desire such an invasive procedure. Therefore, SARME was planned with the purpose of expanding the maxillary arch unilaterally and resolving the considerably severe arch length discrepancy.

TREATMENT PROGRESS

After the maxillary and mandibular third molars were extracted bilaterally, 0.018-in slot preadjusted edgewise appliances were placed on both the maxillary and mandibular premolars and molars. After leveling by segmental nickel-titanium alloy wires, orthodontic miniscrews (diameter, 1.6 mm; length, 6 mm; Absoanchor; Dentos, Daegu, South Korea) were placed bilaterally between the maxillary first and second molars. After a 1-month latency period, distal movement of the bilateral maxillary posterior dentitions was initiated by elastometric chains with a 2-N load in order to obtain 2 mm or more space between the maxillary right lateral incisor and canine, which are necessary for incision.

After 1 year and 4 months of segmental arch treatment, the maxillary dentition, except the maxillary right central and lateral incisors, were aligned well, and the preparation for surgery was complete (Fig 6). Cephalometric analysis showed no or minor changes in the skeletal and denture patterns, except for maxillary molar distalization (Figs 7 and 8; Table). Subsequently, a Hyrax appliance was fixed on the maxillary arch, and modified unilateral SARME was performed (Fig 9). Under general anesthesia, transverse osteotomy at the right buccal site was initiated from the piriform aperture posteriorly to the lateral maxillary buttress (Figs 9 and 10A). It was performed 5 mm above the roots of the bicuspid teeth. The second osteotomy was completed vertically between the right maxillary lateral incisor and canine (Figs 9 and 10A). Afterwards, at the palatal site, the third osteotomy was initiated between the right lateral incisor and canine and achieved through the native palatal bone to the dorsal hard palatal rim (Fig 9). After the osteotomies, approximately 3 mm of expander activation was performed intraoperatively to confirm adequate segment mobilization indicating the completion of the separation of the right maxillary posterior segment, followed by a complete backscrewing of the intraoperative activation (Fig 10B). The completion of separation was also confirmed from the occlusal radiograph (Fig 11A). After a 5-day latency period, unilateral maxillary expansion was initiated at a rate of 0.5 mm per day, and a total lateral expansion of the right-sided maxillary posterior segment of 8.5 mm was completed, resulting in the correction of unilateral posterior crossbite (Figs 10C and 11B). Since sufficient space was gained between the right maxillary central incisor and canine, the RME was replaced by the lingual arch at 1 month after surgery, and the alignment of the right maxillary lateral incisor was initiated with a 0.014-in nickel-titanium alloy wire (Fig 10D). Four months after surgery, anchor miniscrews were bilaterally placed between the mandibular second premolar and first molar, and the distalization of the bilateral posterior teeth was initiated (Fig 10E). Myofunctional therapy to reduce tongue thrusting lasted throughout the orthodontic treatment.

After 46 months of multibracket treatment, an acceptable and stable occlusion was achieved. Immediately after removal of the appliances, wraparound and Hawley type retainers were placed on the maxillary and mandibular dentitions, respectively.

TREATMENT RESULTS

On the posttreatment facial photographs, a balanced facial profile with proper positioning of the upper and lower lips was achieved (Figs 12 and 13). The maxillary dental midline was matched up to the mandibular dental midline as well as the facial midline. The right-side posterior crossbite was also corrected well, and a stable intercuspation of the teeth was accomplished with a functional Class I canine and molar relationship. The basal and coronal arch widths of the maxilla were 8.5 mm larger than those before treatment (Fig 3). A panoramic radiograph showed proper root parallelism (Fig 14). The maxillary lateral incisor showed obvious root resorption which have been caused by surgical incision at the region. Posttreatment cephalometric analysis indicated a skeletal Class I jaw-base relationship (ANB, 1.8°) and low mandibular plane angle (FMA, 21.7°) the same as pretreatment (Fig 14 and Table). The maxillary bilateral molars were moved 2.0 mm distally, while the mandibular bilateral molars were moved 1.0 mm distally. Both the maxillary and mandibular incisors were lingually inclined, resulting in a proper interincisal angle, although the upper and lower lips were still protruded slightly (Upper lip/E plane, 2.0 mm; Lower lip/E plane, 1.0 mm). The frontal cephalogram indicated the correction of the maxillary midline deviation.

At a 2-year postretention follow-up, the occlusion was stable with no or minimal relapse, and a balanced facial profile was obtained (Figs 15 and 16). A panoramic radiograph and lateral cephalogram indicated no or less changes in the dental and skeletal aspects (Fig. 17). As inferred from the cephalometric analysis, the skeletal Class I jaw-base relationship with low mandibular plane angle was retained and no or minimal relapse of the maxillary deviation was detected (Figs 17 and 18; Table).

DISCUSSION

The prevalence of maxillary transverse deficiency ranges from 8-23% in growing patients and <10% in adult orthodontic patients.[19,20] A unilateral posterior crossbite caused by a maxillary transverse deficiency is a highly challenging to treat in skeletally mature patients, wherein clinicians are commonly left with very limited procedures to consider. RME and

MARPE deliver the expansion force bilaterally to the midpalatal suture, resulting in overcorrection of the contralateral side for unilateral posterior crossbite. Therefore, to overcome the unnecessary contralateral expansion, modified unilateral SARME was adopted as an adequate treatment method for our patient.

Since the first description of SARME with midpalatal splitting in 1938, various SARME techniques have been described and several cases treated with SARME have been reported.[21] SARME was originally designed to accelerate tooth movement, subsequently reducing treatment time. It is an adequate method to treat mild-to-moderate maxillary transverse deficiency in adults with greater stability and without compromising periodontal health.[22] Anttila et al.[23] retrospectively evaluated the feasibility and long-term stability of SARME and indicated that the long-term stability of maxillary expansion following SARME was favorably comparable with the widening and stability achieved with other more invasive osteotomies. However, there was no consensus on the standard protocol for SARME (e.g., surgical procedure, latency period, expansion rate, cause and amount of relapse, and overcorrection).[21,23,24] Regarding relapse after treatment with SARME, Magnusson et al.[25] indicated that the decrease in the transverse dimensions of the expanded maxilla by SARME are most pronounced during the first 3 years of posttreatment and stable within 6. Gamage and Goss[26] investigated a case-cohort study for SARME and concluded that SARME can achieve >6 mm intermolar expansion and that overexpansion of up to 60% is required to compensate for relapse. In our patient, the minimum amount of unilateral maxillary expansion required for the correction of posterior crossbite was 6.5 mm; nevertheless, we performed 8.5 mm of estimated transverse expansion with unilateral SARME. Furthermore, the real amount of maxillary unilateral expansion after the multibracket treatment was 8.5 mm. Considering these, our patient showed no or minor relapse after 4.5 years postoperatively, indicating the long-term stability of skeletal expansion by modified unilateral SARME.

Our patient exhibited unilateral posterior crossbite which was localized at the right-side of the premolar and molar region, while her frontal view was almost symmetrical. Although Karabiber and Yilmaz[13] demonstrated that asymmetrical expansion by unilateral SARME did not lead to asymmetry in the perinasal soft tissue, asymmetry in the nasal region may occur as an adverse effect of unilateral SARME. Thus, to avoid the possibility of this adverse effect, anterior osteotomy was planned between the right maxillary lateral incisor and canine. Consequently, we performed 8.5-mm unilateral expansion of only the premolar and molar segment. As a result, the unilateral posterior crossbite could be improved without the unwanted change in the soft tissue of the nasal region. Furthermore, sufficient space was gained between the maxillary right central incisor and canine, which enabled the easy alignment of the lingually displaced lateral incisor. This indicates that modified unilateral SARME has no adverse effect on the soft tissues of the perinasal region.

Regarding the cutting line of the palatal bone, midpalatal splitting may induce a median diastema and damage to the median papilla, with potentially functional and esthetic impairment of the gingival attachment.[27] Therefore, we selected a unilateral parasagittal osteotomy through the bone and not the suture. In addition, parasagittal osteotomy to the dorsal border of the hard palate through the native palatal bone but not the midpalatal suture, decreases the tissue resistance to expansion and allows for a larger callus volume and more stable expansion results.[27] This cutting design also might contribute to maintaining the position of the columella and the centerline of symmetry as well as the nasal septum, resulting in the avoidance of perinasal asymmetry.

CONCLUSIONS

In the present case, unilateral posterior crossbite caused by a maxillary transverse skeletal discrepancy was treated successfully with modified unilateral SARME. After treatment, an acceptable occlusion with functional Class I canine and molar relationships was obtained, and no or minimal relapse was found during a 2-year retention period. This suggests that modified unilateral SARME might be useful to improve unilateral posterior crossbite in mature patients without unwanted adverse effects.

Statement of Informed Consent

Informed consent was obtained by the patient.

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Figure legends

Figure 1. Pretreatment facial and intraoral photographs at the age of 23 years and 4 months.

Figure 2. Pretreatment dental casts.

Figure 3. Model analyses.

BAL, basal arch length indicating the midline length of the basal arch from the distal point of the first molars to the most anterior point of the basal arch; CAL, coronal arch length indicating the midline length between the most anterior point of the gingiva in the mesial contact area of the central incisors and the distal point of the first molars; first BBAW, first bicuspid basal arch width indicating the width of the basal arch between the most concave points of the basal bone at the first premolar area; first BCrAW, first bicuspid coronal arch width indicating the distance between the summits of the buccal cusps of the first premolars. Black lines indicate pretreatment measurements, and red lines indicate posttreatment measurements.

Figure 4. Pretreatment panoramic radiograph, lateral and posteroanterior cephalograms, and their tracings.

Figure 5. Computed tomography taken before treatment. Red dotted lines indicate the palatal midline. Red arrows indicate the distance between the buccal alveolar bone surface and palatal midline.

Figure 6. Facial and intraoral photographs before surgery at age of 24 years and 9 months.

Figure 7. Panoramic and cephalometric radiographs before surgery at age of 24 years and 9 months.

Figure 8. Cephalometric tracings before treatment (black; at age of 23 years and 4 months), after preoperative treatment (blue; at age of 24 years and 9 months), and after treatment (red; at age of 27 years and 3 months) superimposed on the inner contour of the anterior wall of the sella turcica, anterior contour of the zygomatic process, and inner contour of the cortical plate at the lower border of the symphysis.

Figure 9. Schematic illustrations of modified unilateral SARME. Blue dotted lines indicate the surgical incision lines.

Figure 10. Intraoral photographs during and after surgery.

A) After transverse and vertical osteotomies; B) before and after a 3-mm expansion to confirm adequate segment mobilization; C) 19 days after surgery; D) two months after surgery; and E) four months after surgery.

Figure 11. Occlusal radiographs taken immediately after surgery and 19 days after the maxillary expansion.

Figure 12. Posttreatment facial and intraoral photographs after active orthodontic treatment at the age of 27 years and 3 months.

Figure 13. Posttreatment dental casts.

Figure 14. Posttreatment panoramic radiograph, lateral and posteroanterior cephalograms, and their tracings after postoperative treatment.

Figure 15. Facial and intraoral photographs after a 2-year retention at the age of 29 years and 3 months.

Figure 16. Dental casts after a 2-year retention.

Figure 17. Panoramic radiograph, lateral and posteroanterior cephalograms, and their tracings after 2-year retention.

Figure 18. Cephalometric tracings after active treatment (red; at age of 27 years and 3 months) and after a 2-year retention (green; at age of 29 years and 3 months) superimposed on the inner contour of the anterior wall of the sella turcica, anterior contour of the zygomatic process, and inner contour of the cortical plate at the lower border of the symphysis.

Figure 1

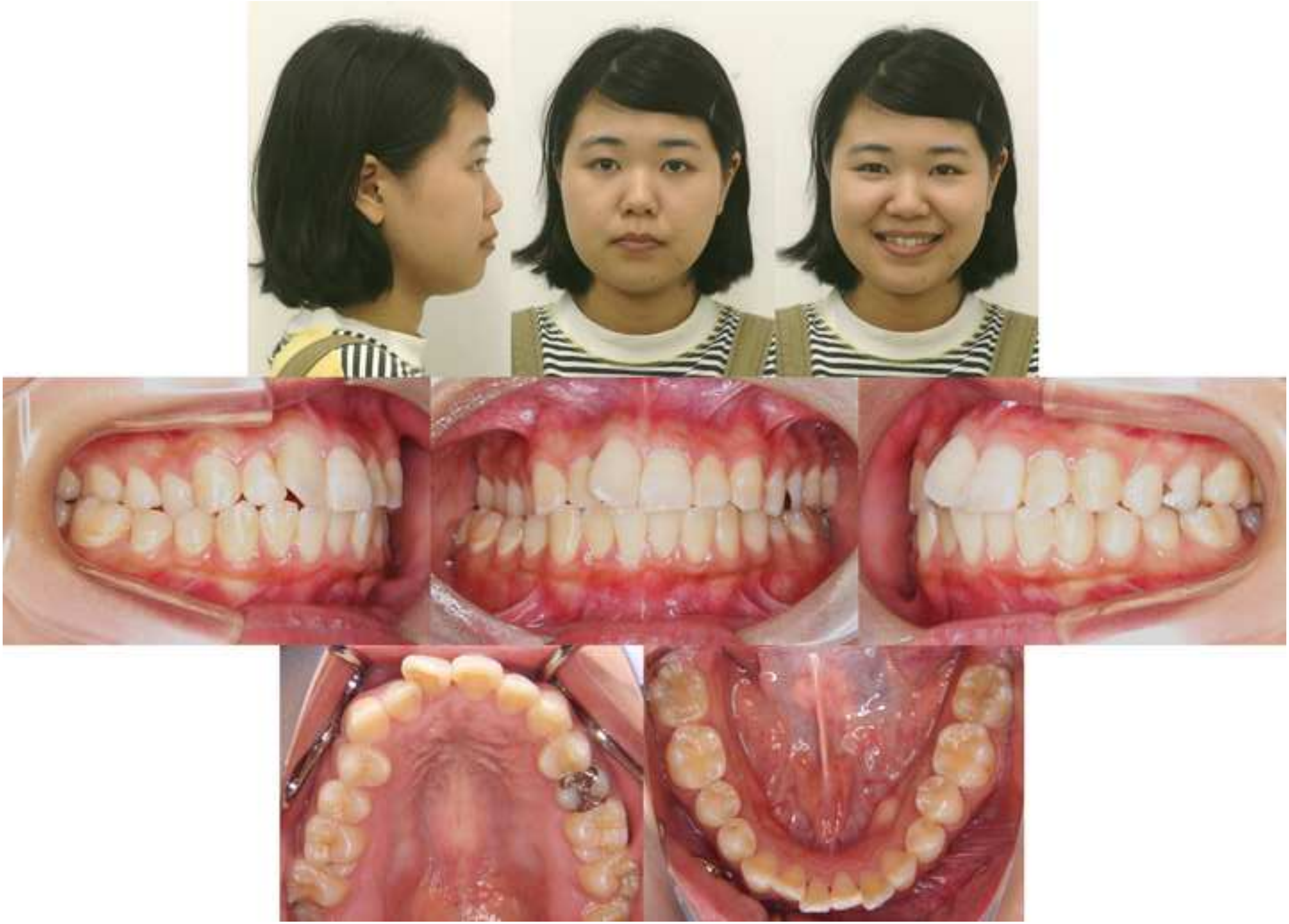

Figure 2

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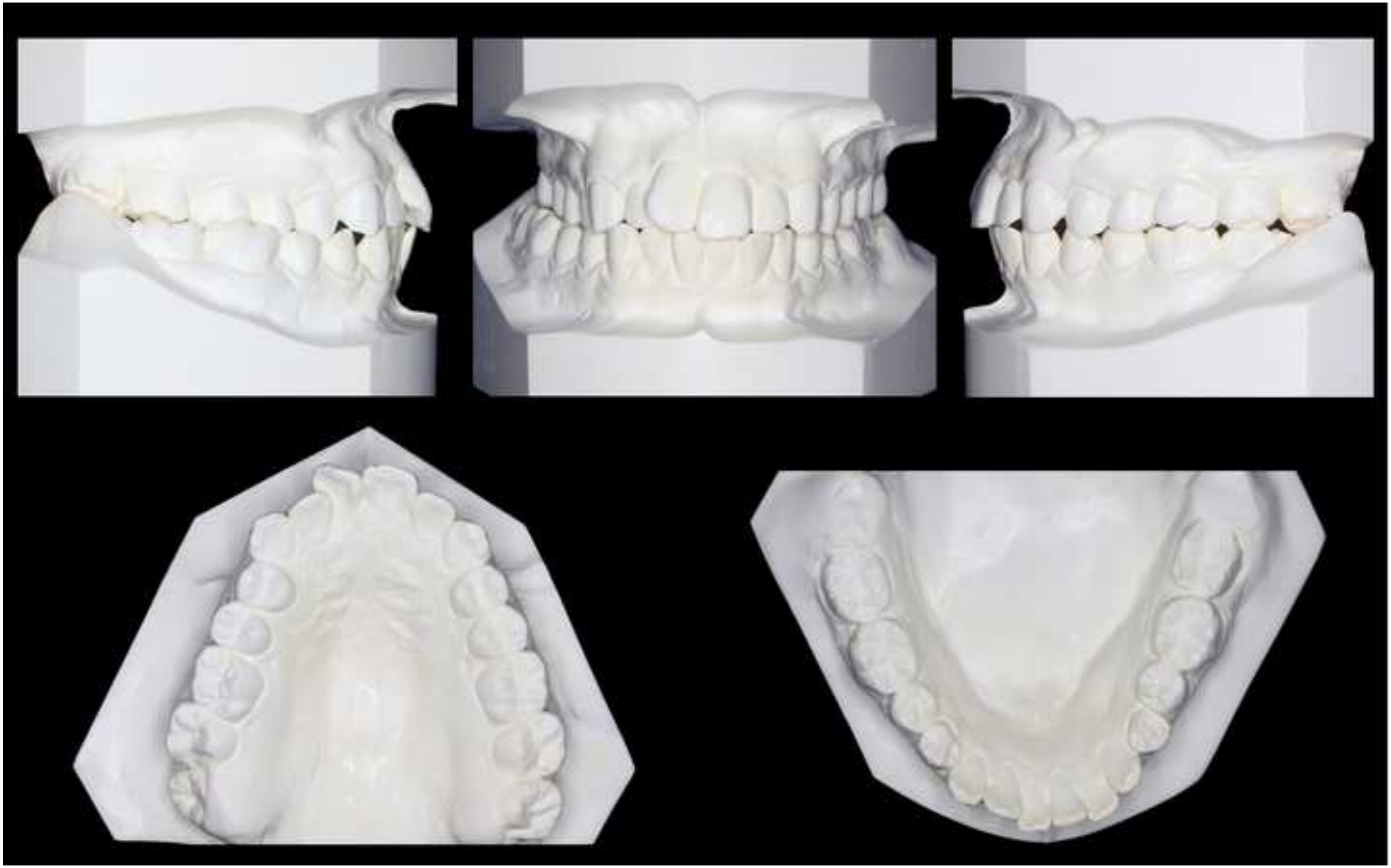

Figure 3

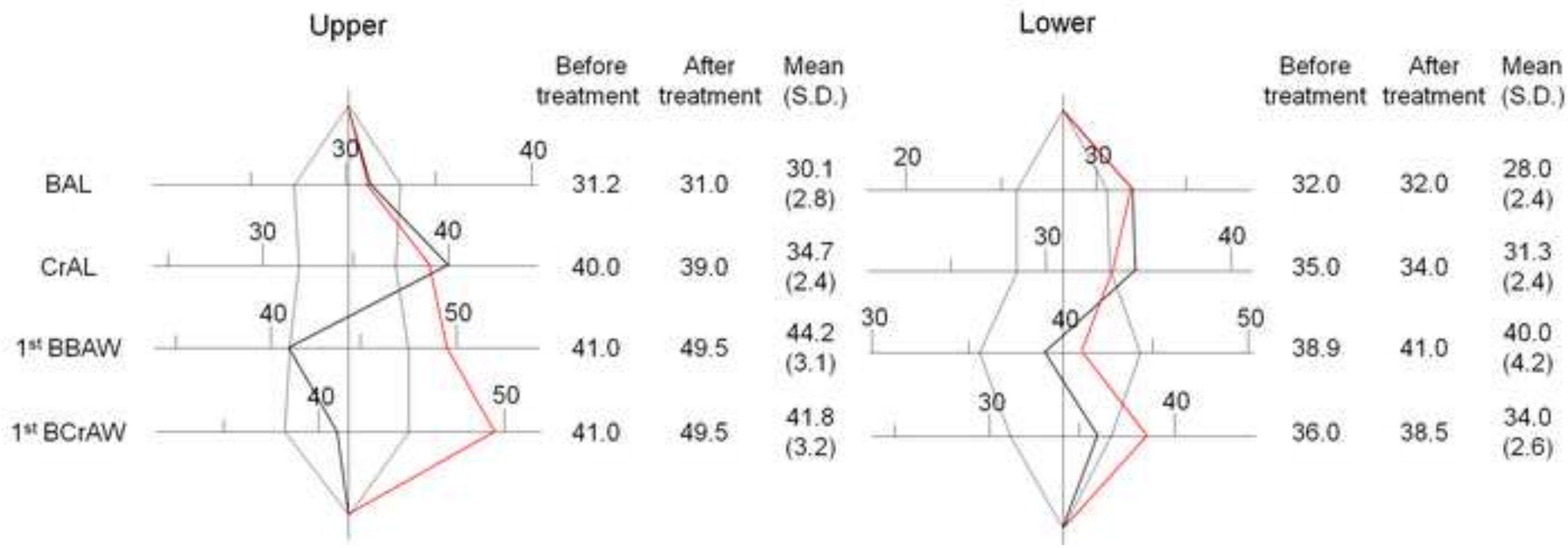
Upper
Before treatment
After treatment
Mean (S.D.)
BAL
CrAL
1st BBAW
1st BCrAW
30
40
30
40
40
50
40
50
31.2
31.0
30.1 (2.8)
40.0
39.0
34.7 (2.4)
41.0
49.5
44.2 (3.1)
41.0
49.5
41.8 (3.2)
Lower
Before treatment
After treatment
Mean (S.D.)
20
30
30
40
30
40
50
30
40
32.0
32.0
28.0 (2.4)
35.0
34.0
31.3 (2.4)
38.9
41.0
40.0 (4.2)
36.0
38.5
34.0 (2.6)

Figure 4

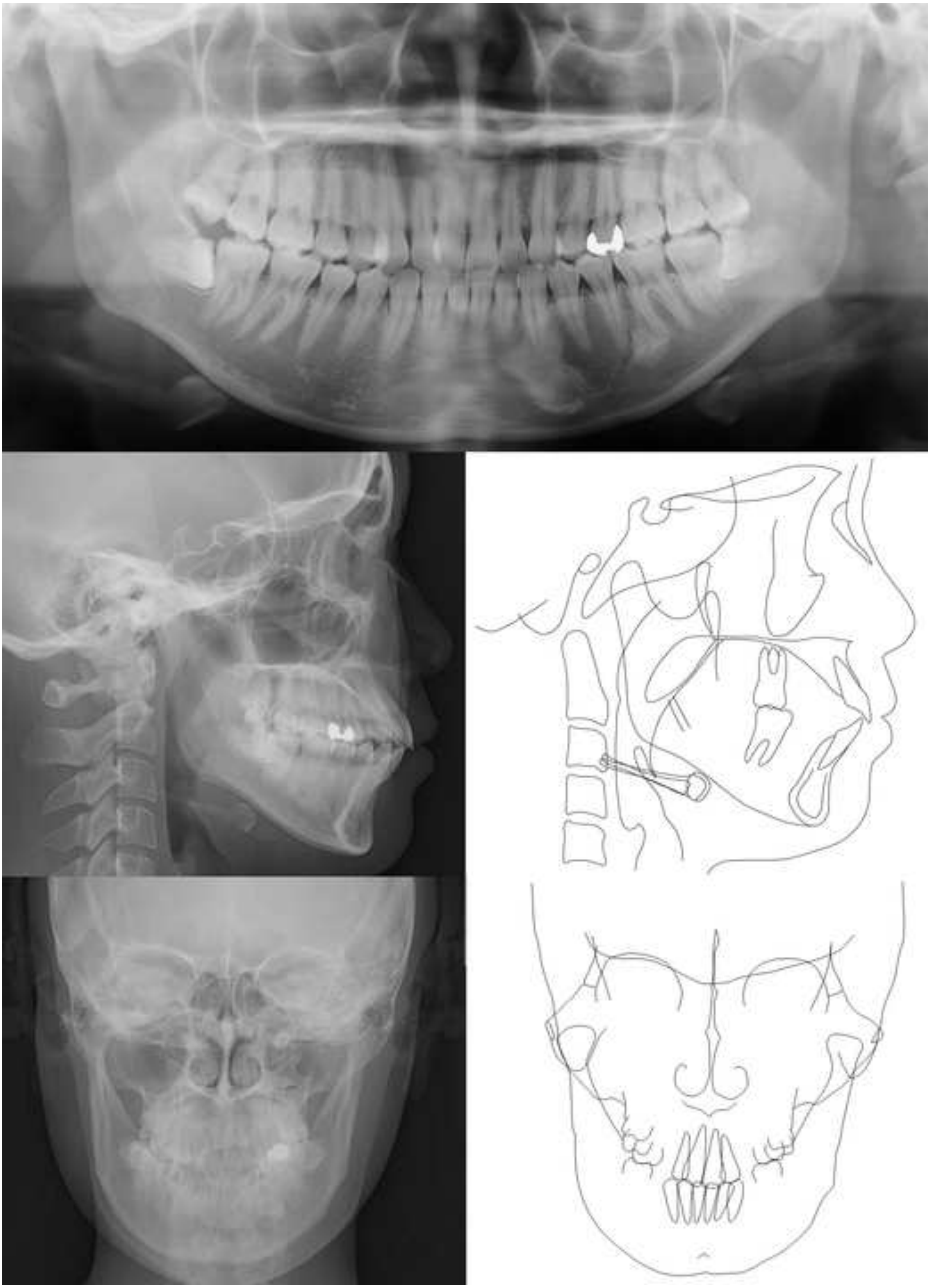

Figure 5

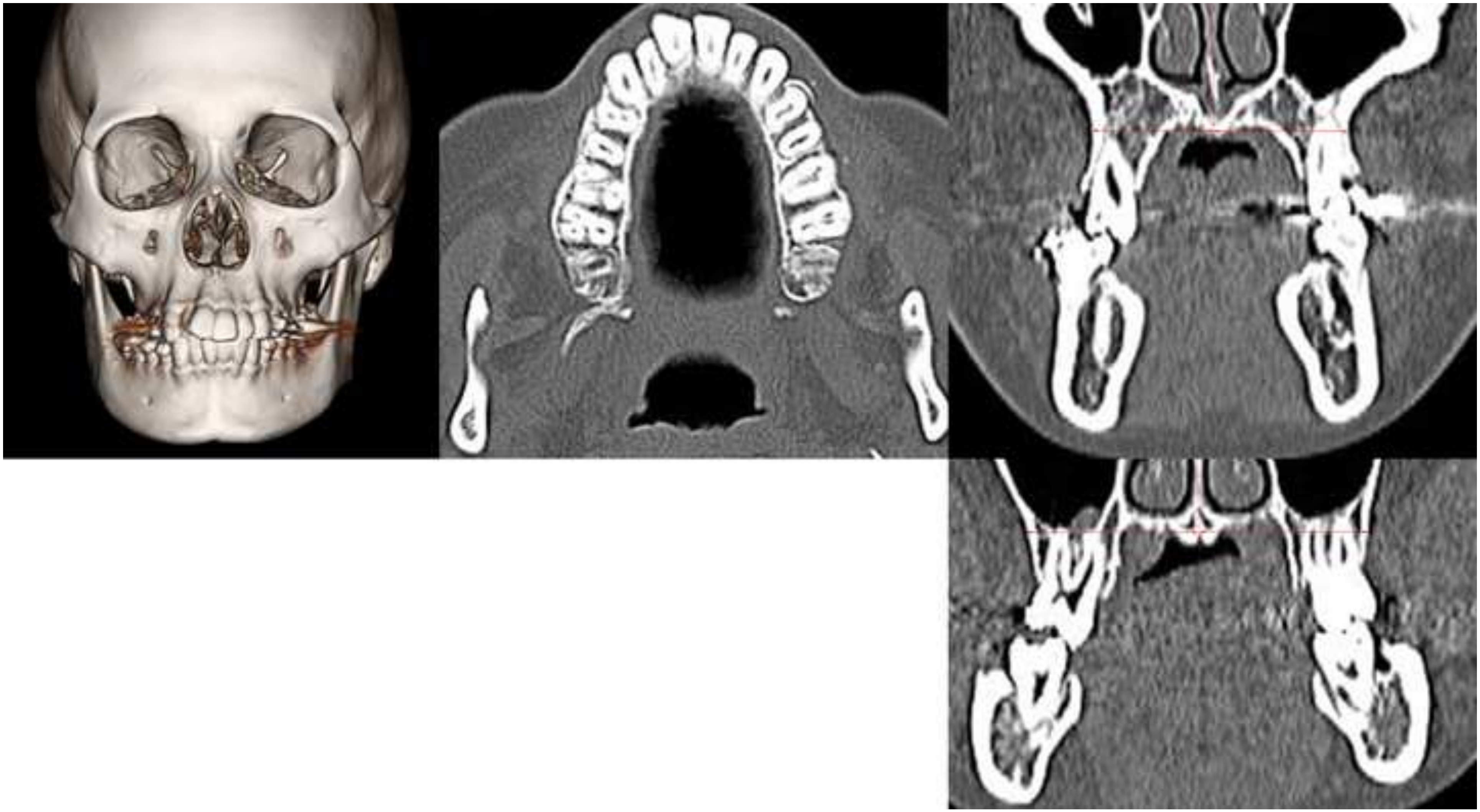

Figure 6

Figure 7

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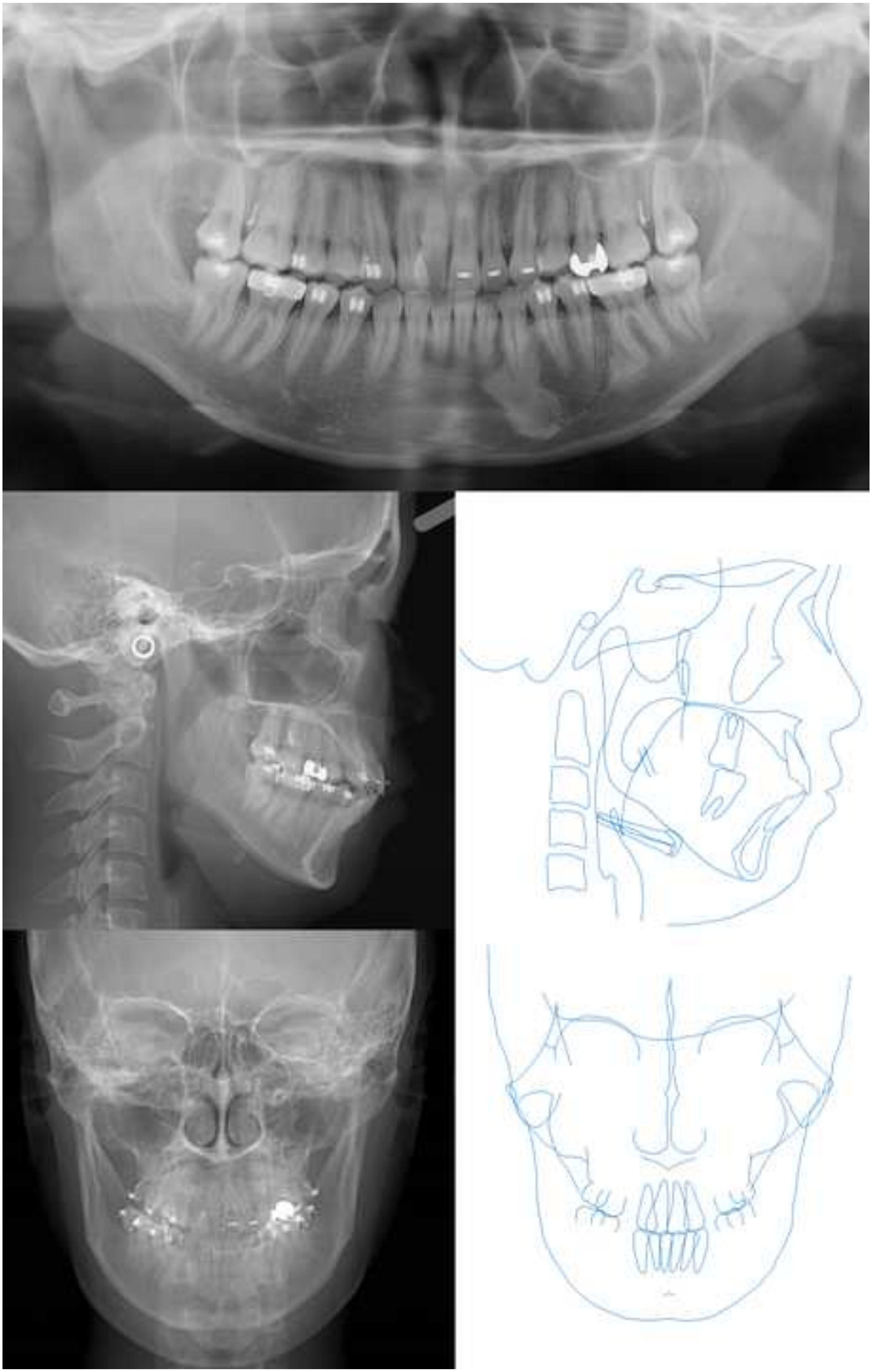

Figure 8

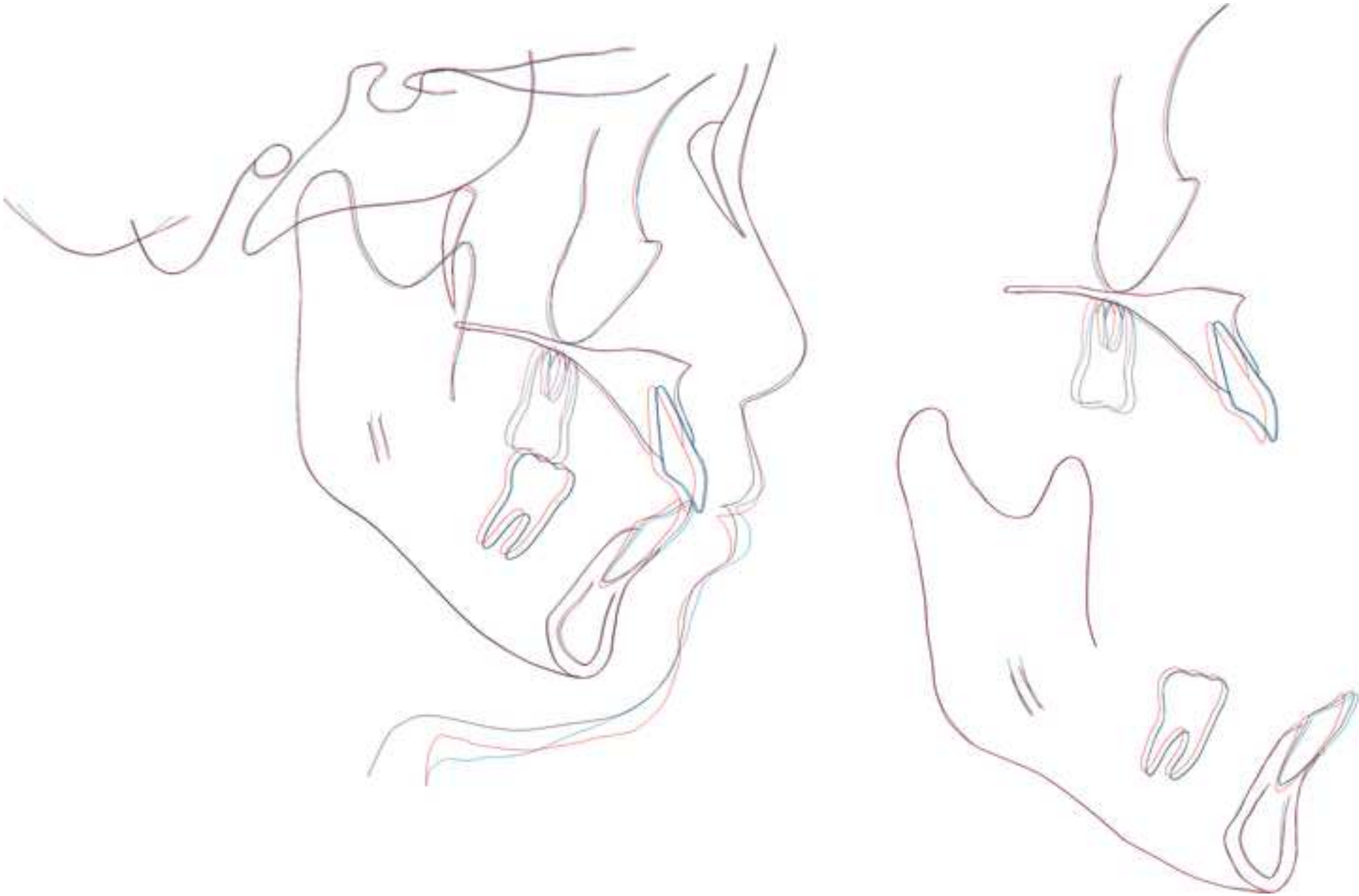

Figure 9

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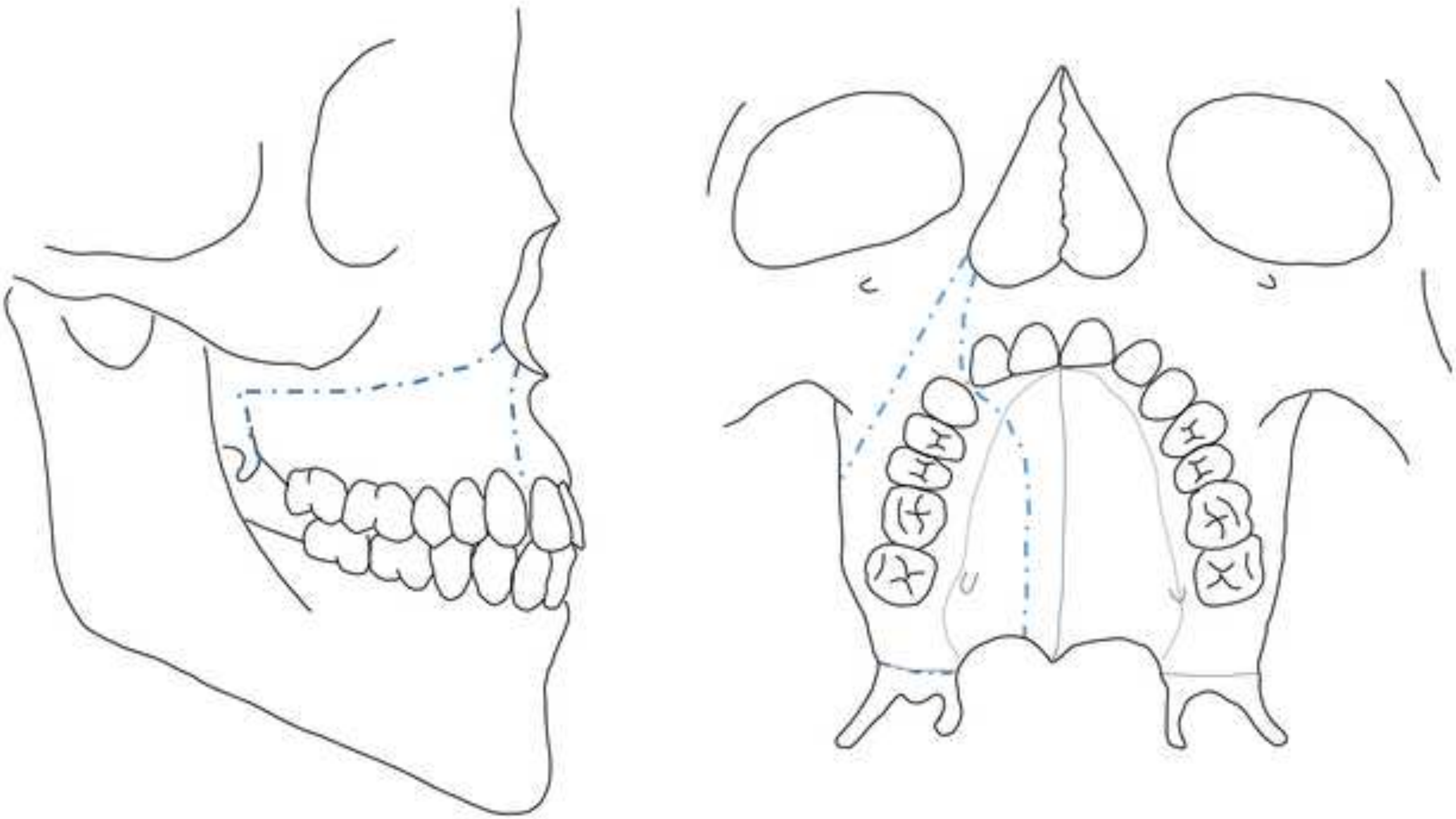

Figure 10

A

B

C

D

E

Figure 11

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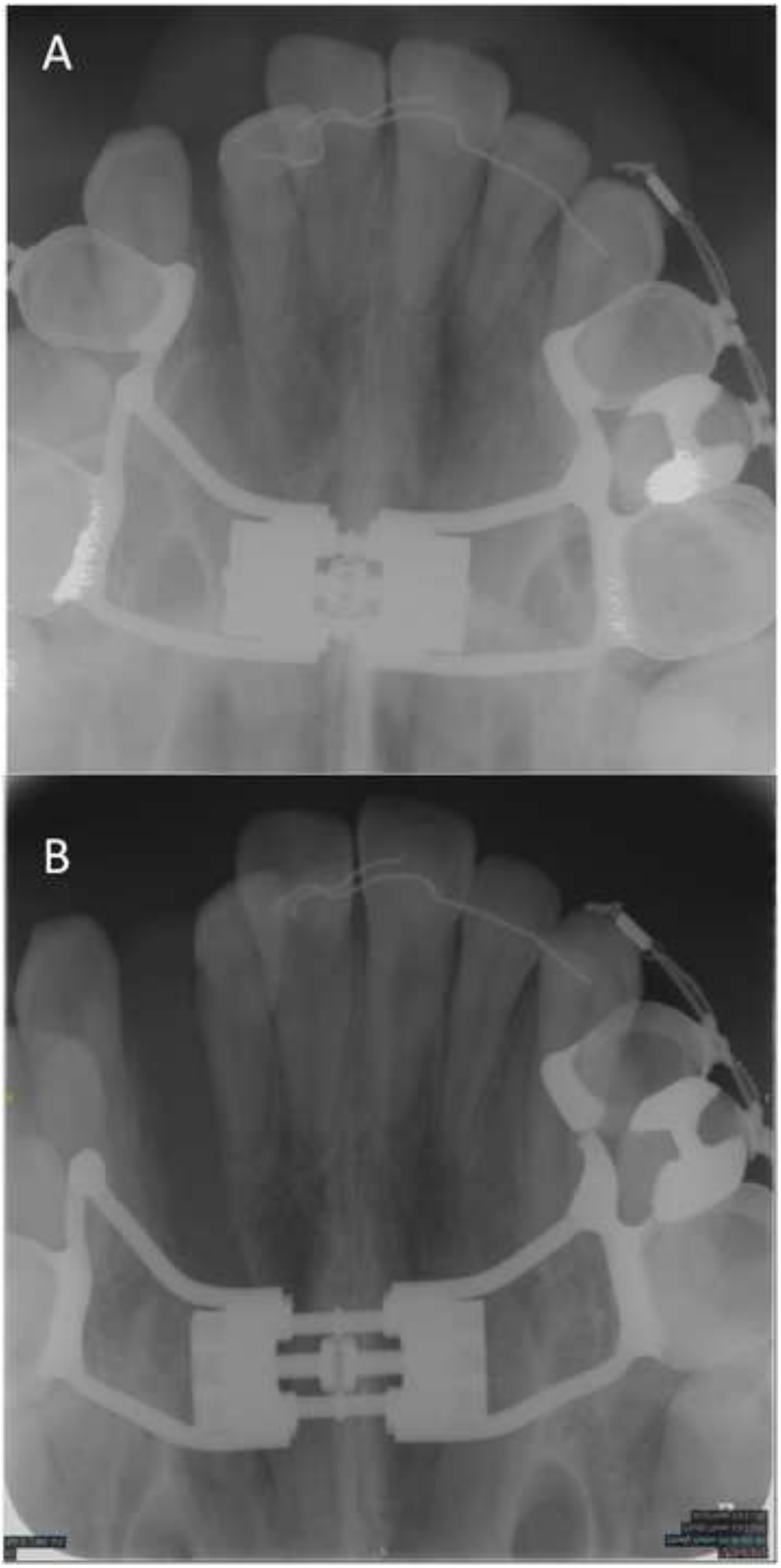


Figure 12

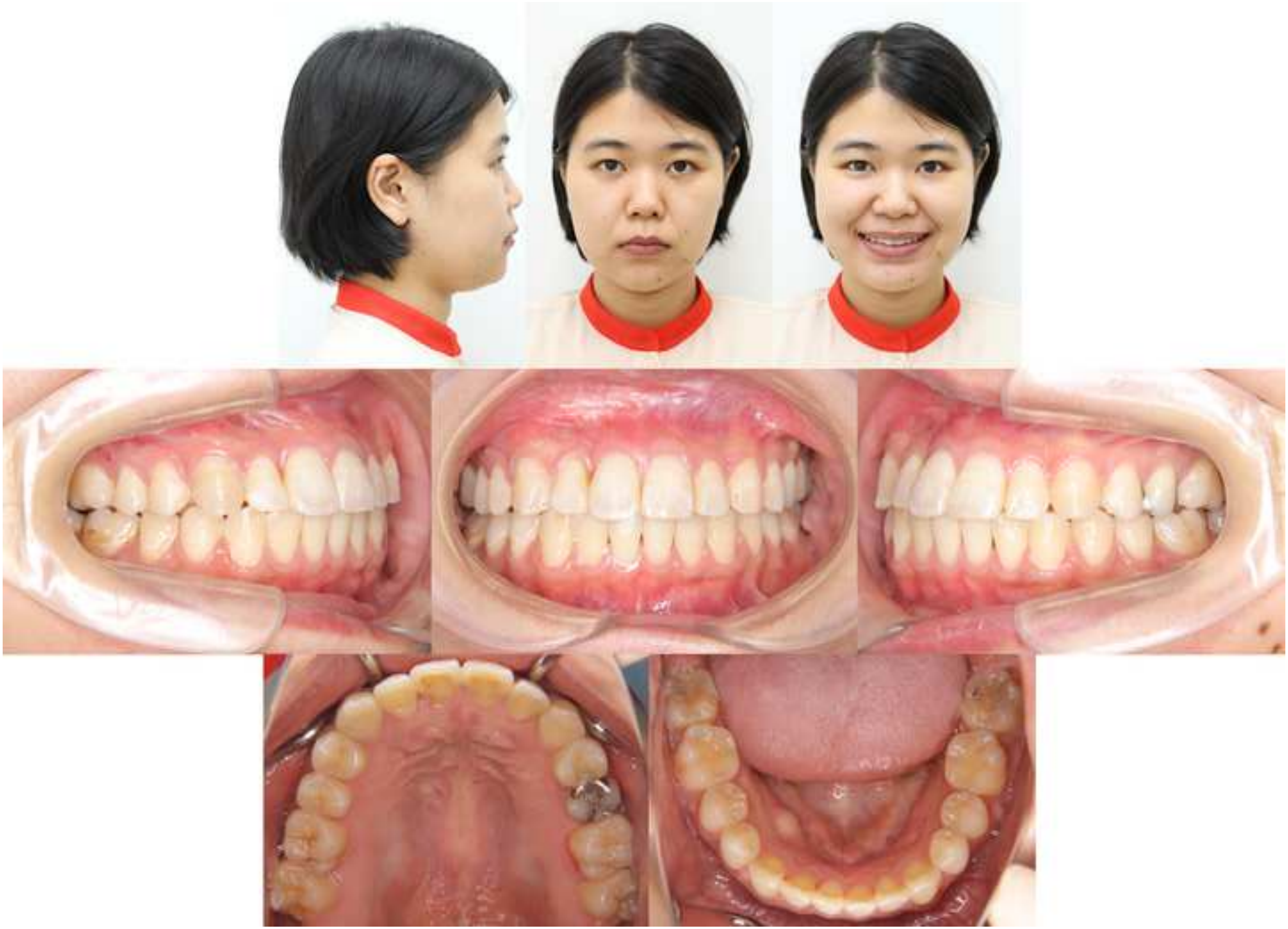


Figure 13

Click here to access/download;Figure;New Fig13.tif

Figure 14

Click here to access/download;Figure;Fig14RR.tif

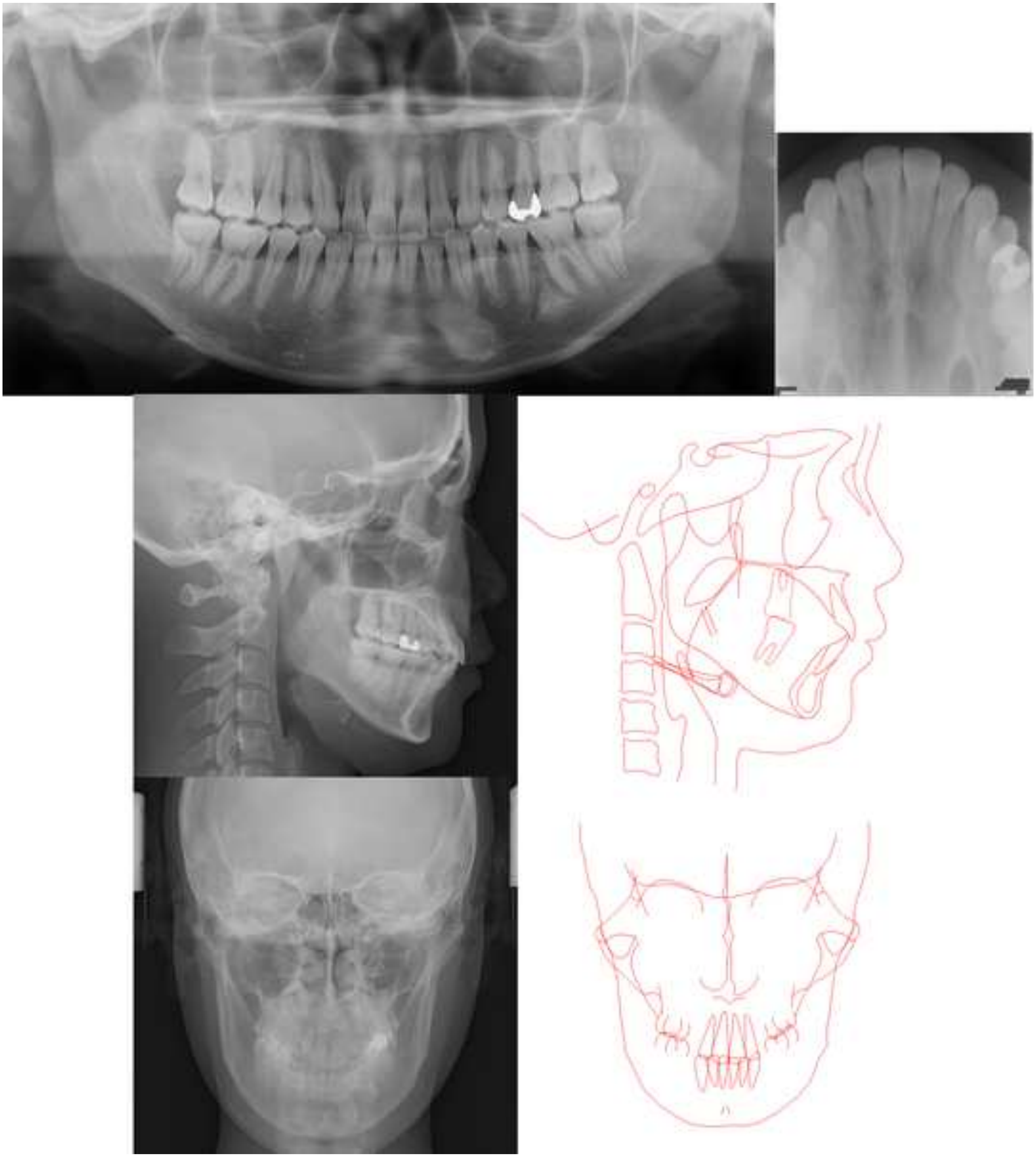
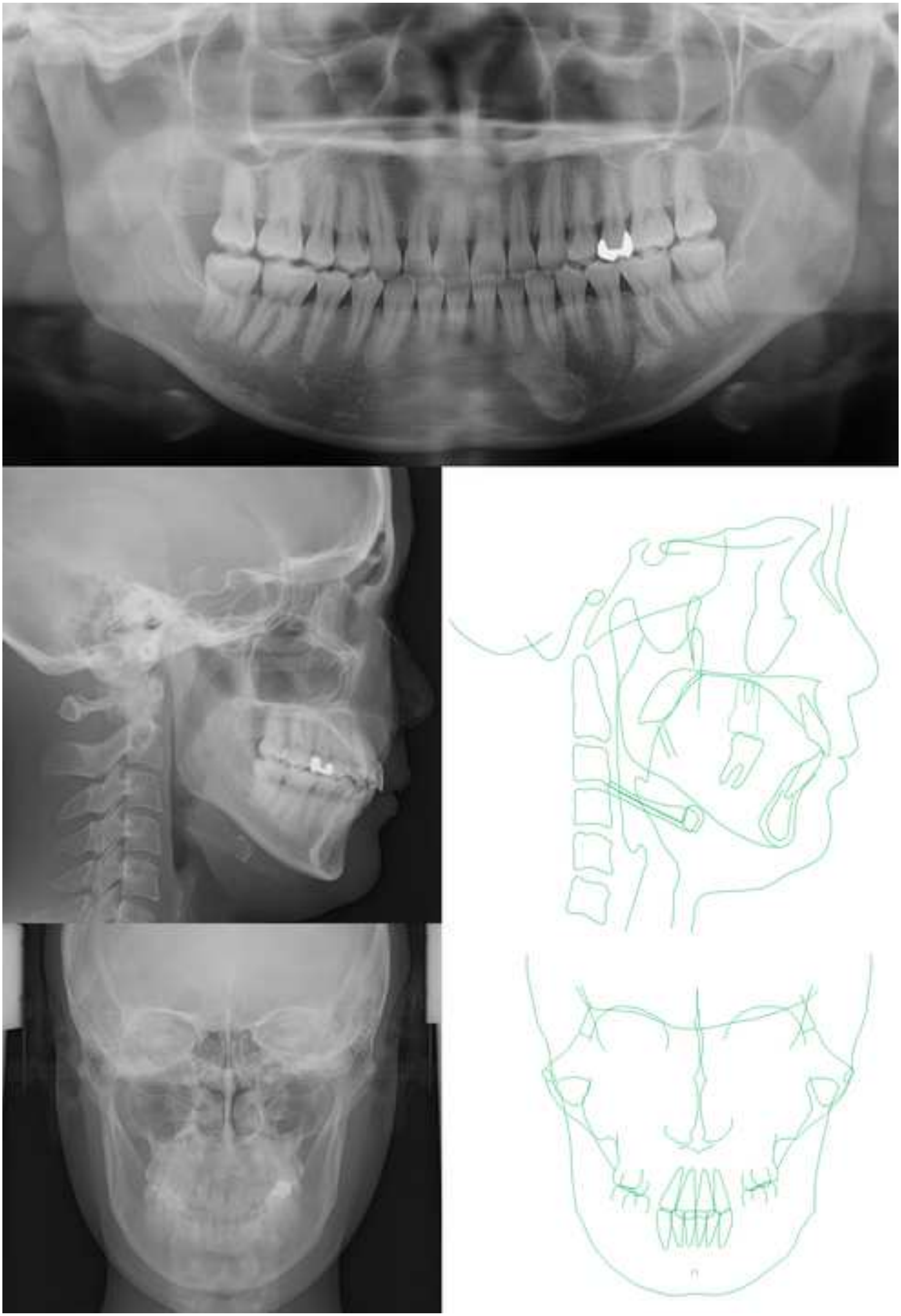


Figure 15

Figure 16

Figure 17

Click here to access/download;Figure;Fig17RR.tif



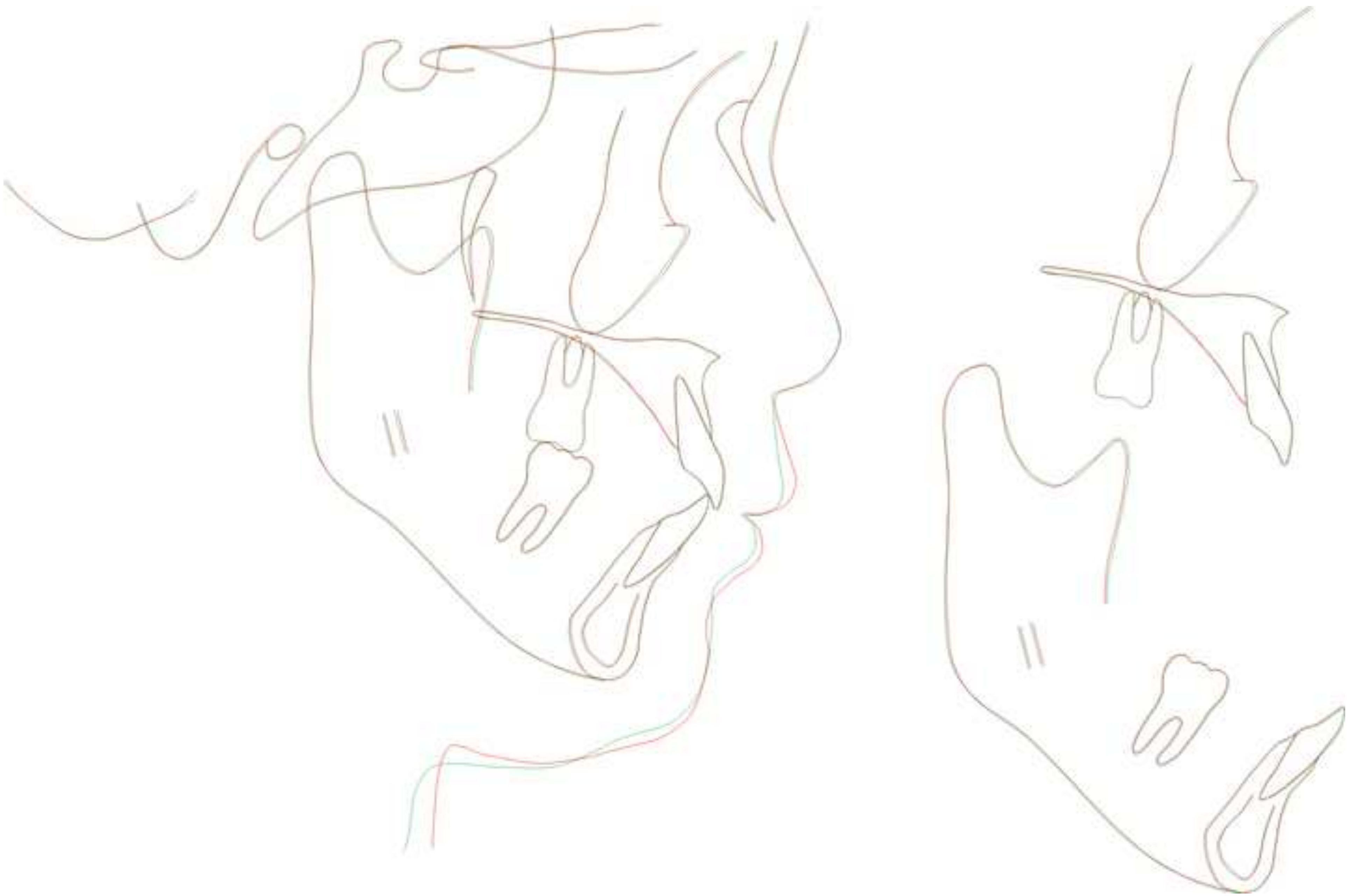


Table. Cephalometric summary

	Mean for Japanese females	Pretreatment	Presurgery	Posttreatment	2-year retention
Treatment variable	Adult (SD)	(23y5m)	(24y6m)	(27y4m)	(29y4m)
Angular measurement (°)					
ANB	3.0 (2.2)	2.4	2.4	1.8	1.8
SNA	80.7(3.4)	85.2	85.3	84.7	84.7
SNB	77.6 (4.2)	82.9	82.9	82.9	82.9
Mandibular plane/FH	29.6 (3.4)	22.0	22.2	21.7	21.7
Gonial angle	122.9 (4.4)	127.3	127.0	127.8	127.8
U1 to SN	105.2 (8.8)	112.8	112.9	110.9	110.9
L1-mandibular plane	92.5 (5.4)	100.4	101.7	95.6	95.6
Interincisal angle	125.1 (10.1)	114.9	113.5	121.8	121.8
Occlusal plane	17.6 (4.2)	12.7	14.5	15.3	15.3
Linear measurement (mm)					
S-N	66.9 (3.4)	71.2	71.2	71.2	71.2
N-Me	120.9 (4.4)	123.8	123.8	123.8	123.8
Ar-Go	44.2 (3.1)	52.7	52.7	52.7	52.7
Go-Me	69.2 (3.5)	72.0	72.0	72.0	72.0
Ar-Me	102.3 (3.5)	113.8	113.8	113.8	113.8
Me/PP	68.6 (3.7)	70.5	70.5	70.5	70.5
Overjet	3.1 (1.1)	2.5	1.8	2.7	2.7
Overbite	3.3 (1.9)	1.8	1.0	3.0	3.0
Upper lip/E plane	-0.3	1.0	2.0	2.0	0
Lower lip/E plane	2.0	2.5	4.0	1.0	-1.0

*Wada et al.[17]

ANB, Anteroposterior relation between the maxilla and mandible; SNA, Anteroposterior position of the maxilla relative to the anterior cranial base; SNB, Anteroposterior position of the mandible relative to the anetrior cranial base; FMA, Divergency of the mandibular plane relative to Frankfort horizontal plane; Gonial angle, angle between the mandibular and ramus planes; U1-SN, Maxillary central incisal axis to sella-nasion plane; L1-MP, Mandibular central incisal axis to mandibular plane; Interincisal angle, angle between maxillary and mandibular central incisal axes; Occlusal plane, occlusal plane angle to sella-nasion plane; S-N, Anteroposetrior length of the anterior cranial base; N-Me, Anterior facial height; Ar-Go, Length of the mandibular ramus; Go-Me, Length of the mandibular corpus; Ar-Me, Total length of the mandible; Me/PP, Lower anterior facial height.
E plane, Line drawn from pronasale to soft tissue Pogonion