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# Severe open bite with mandibular asymmetry treated using micro-implant anchorage

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*Background:* This case report describes the orthodontic treatment of a 20 year-old female who presented with a severe anterior open bite, increased lower facial height and mandibular asymmetry. The patient was diagnosed with a Class I skeletal pattern but a Class III dental relationship, an anterior and unilateral posterior open bite, a canted posterior occlusal plane, a clockwise rotation and vertical growth pattern of the mandible incorporating a chin deviation to the right.

*Aim:* The aim of treatment was to correct identified adverse oral habits, improve the facial profile and mandibular asymmetry, provide a satisfactory occlusion and restore TMJ health, which could not be guaranteed.

*Methods:* An occlusal splint was used in the first stage of treatment to intrude the posterior teeth, eliminate the occlusal disturbance and control the adverse oral habits. Two micro-implant anchorage devices were placed on the buccal and lingual sides of the left buccal segment to further intrude the left posterior teeth. MEAW technology was used after aligning and levelling the teeth.

*Results:* Satisfactory overbite, overjet and molar relationships were obtained and the facial profile greatly improved after orthodontic treatment, the outcome of which was stable at 24 months' review.

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## Introduction

An anterior open bite, often combined with an increased lower facial height, is known to be a challenging orthodontic problem. Patients often suffer from masticatory dysfunction as well as disturbances of respiration and speech.<sup>1,2</sup> Gingivitis due to mouth breathing and temporomandibular joint disease (TMD) due to a lack of proper anterior tooth guidance are common symptoms identified in these patients. A comprehensive collection of the patient's information and a careful analysis of photographs, radiographic records and dental casts are crucial for successful treatment and long-term stability. The treatment options available to manage a dental and functional open bite include headgear, multi-loop edgewise archwires (MEAW),<sup>3</sup> bite blocks, or functional appliances. However, a severe open bite caused by divergent growth of

the maxilla and mandible or abnormal resorption of temporomandibular joint (TMJ) can only be corrected by orthodontic treatment combined with orthognathic surgery. Recently, the increasing use of micro-implant anchorage devices (MIAs) has been proved to be a promising and effective treatment alternative in patients with moderate or severe open bites. In many cases, patient profiles have been greatly improved without the risks of two-jaw surgery and the treatment outcomes have been shown to be stable.<sup>4,5</sup>

In the present case, the treatment is reported of a 20 year-old female who suffered from an extensive open bite, a steep mandibular plane, chin deviation and TMD. A bite block was used to intrude the posterior teeth, relieve the dental disharmony and eliminate adverse oral habits. Subsequently, two MIAs were placed in the left maxillary posterior segment on the buccal and palatal sides to further intrude the molars.

A MEAW was used for uprighting the mandibular molars and delicate adjustment of the occlusion in the final stage. Satisfactory overbite, overjet and molar relationships were obtained and the facial profile improved greatly. The results remained stable after 24 months of retention.

### Diagnosis and etiology

Following referral to the Department of Orthodontics, a 20 year-old female presented in a good general state of health with chief complaints of an anterior open bite, poor masticating ability and TMJ discomfort. Her profile was straight, but the mandible displayed an obvious downward and backward rotation and her lower facial height was increased. A shallow labio-mental fold and an increased nasolabial angle were observed and an effort was required to obtain lip closure. In the frontal view, the chin deviated to the right. Obvious habits of tongue thrusting and cheek

sucking were observed. No reference to a Class III or open bite was reported in her family dental history (Figure 1).

An intraoral examination showed an Angle Class III molar relationship with a maximum open bite of 7 mm and a slightly negative overjet. The only occlusal contact was on the left first and second molars. The mandibular dental midline had shifted 2.5 mm to the right of the facial midline. Mild crowding of 3 mm was detected in the lower anterior region. A disharmony of the dental arch form was noted (Figures 1 and 2).

A lateral cephalometric analysis revealed a skeletal Class I relationship. The mandibular plane angle (MP-SN) increased to 42.5°, the S-Go/N-Me relationship decreased to 59.5%, and the lower facial height ratio was significantly increased (60.1%), indicating a vertical growth pattern. Both the maxillary and mandibular incisors were inclined labially and the interincisal angle was decreased (114.8°). The panoramic



Figure 1. Pretreatment facial and intraoral photographs.



Figure 2. Pretreatment dental casts.

radiograph showed that the four third molars were present and that the mandibular third molars were meso-angularly impacted (Figure 3, Table I).

Adverse oral habits of tongue thrusting and cheek sucking were apparent during the functional examination. The patient also suffered from clicking and discomfort of the TMJ. The magnitude of mouth opening was within the normal range, but a mandibular deviation to the right was apparent. The patient presented no canine or anterior guidance.

The case was diagnosed as a skeletal Class I with an increased mandibular plane angle, an Angle Class III dental malocclusion, a functional chin deviation to the right, an open bite, mandibular incisor crowding and TMD.

### Treatment objectives

The treatment objectives were to correct the adverse oral habits through myofunctional training and functional bite block and to subsequently improve the facial profile and mandibular symmetry. It was planned to normalise the overjet and overbite, upright

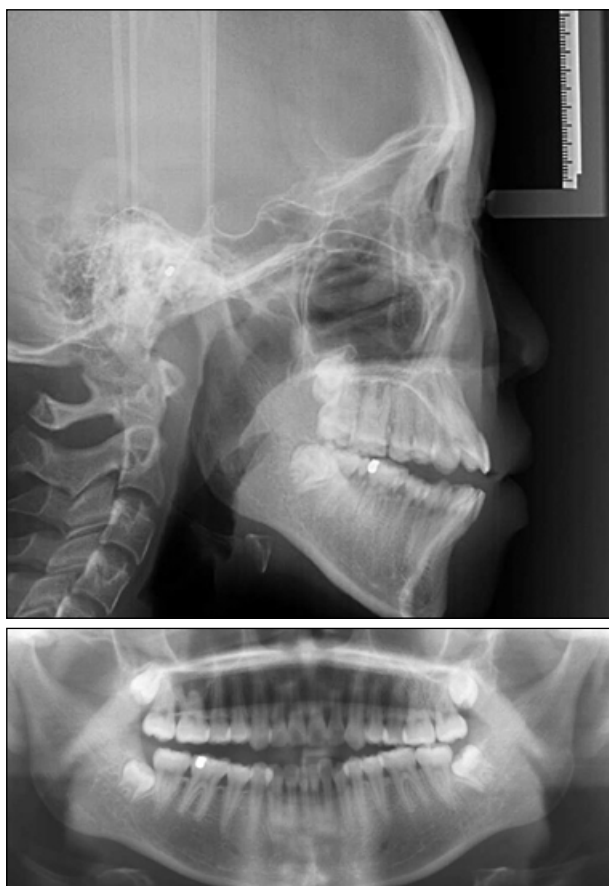
the posterior teeth and correct the canted posterior occlusal plane and molar relationship. Finally, the upper and lower dental arches would be harmonised with an expected reduction in TMJ symptoms.

### Treatment alternatives

Two treatment alternatives were offered to the patient. The first option was an orthognathic surgical approach involving a maxillary Le Fort I osteotomy and a bilateral sagittal split ramus osteotomy. This proposal would be the most effective way to correct the open bite and produce a dramatic facial profile change over a shorter treatment time. The second option was a camouflage treatment plan started by the extraction of the four third molars to alleviate the molar crowding. Additional space would be created to intrude the posterior teeth with the assistance of MIAs. The risks of implanting the MIAs and the limited improvement in facial profile were fully explained to the patient. In addition, the importance of patient compliance with the myofunctional practice was also emphasised. The first option would be carried out if the correction of the latter failed or the patient was not compliant.

**Table 1.** Skeletal and dental changes of cephalometric measurements.

Cephalometric variables	Pretreatment(T1)	Post-treatment (T2)	Change (T2-T1)
<i>Angular (°)</i>			
SNA	80.6	80.9	0.3
SNB	79.2	78.8	-0.4
ANB	1.4	2.1	0.7
OP-SN	20.0	22.4	2.4
MP-SN	42.5	41.1	-1.4
U1-FH	120.9	115.2	-5.7
L1-MP	91.9	92.0	0.1
U1-L1	114.8	119.3	4.5
<i>Linear (mm)</i>			
Overjet	-0.3	1.8	2.1
Overbite	-5.0	0.7	5.7
U1-APo	8.4	8.3	-0.1
L1-APo	8.3	6.7	-1.6
<i>Ratio (%)</i>			
S-Go/N-Me	59.5	61.1	1.6
ANS-Gn/N-Gn	60.1	58.7	-1.4

**Figure 3.** Pretreatment cephalograph and panoramic radiograph.

The patient and her parents rejected the bimaxillary surgery because the cost was unacceptable and so the second plan was chosen and informed consent obtained.

### Treatment progress

Initially, a functional occlusal splint with a unilateral bite block and tongue blocking shield was designed to intrude the posterior teeth, relieve the premature contacts in the left posterior region, and manage the tongue habit. Interdental clasps were used to control the position of the right posterior teeth (Figure 4A-C). The appliance was inserted with instructions for full-time wear (24 hours per day) except during meals and active myofunctional training. In a state of rest, the patient was coached to place the tip of her tongue on the incisive foramen and keep her lips together. To comply with active myofunctional training, the patient was instructed to remove her occlusal splint, chew gum and flatten it on the palatal vault by using her tongue. The active training was repeated for 10 minutes, five times a day. Every four weeks, the appliance was reviewed and any occlusal disturbance identified on the bite block removed. Five months later, the deviation of the lower dental midline had improved and the open bite reduced from 7 mm to

5 mm. An occlusal contact between the left maxillary second premolar and the mandibular first molar was noted at this time (Figure 4D). The patient reported relief of her TMJ discomfort and clicking. These favourable outcomes presented a promising prognosis for further orthodontic therapy.

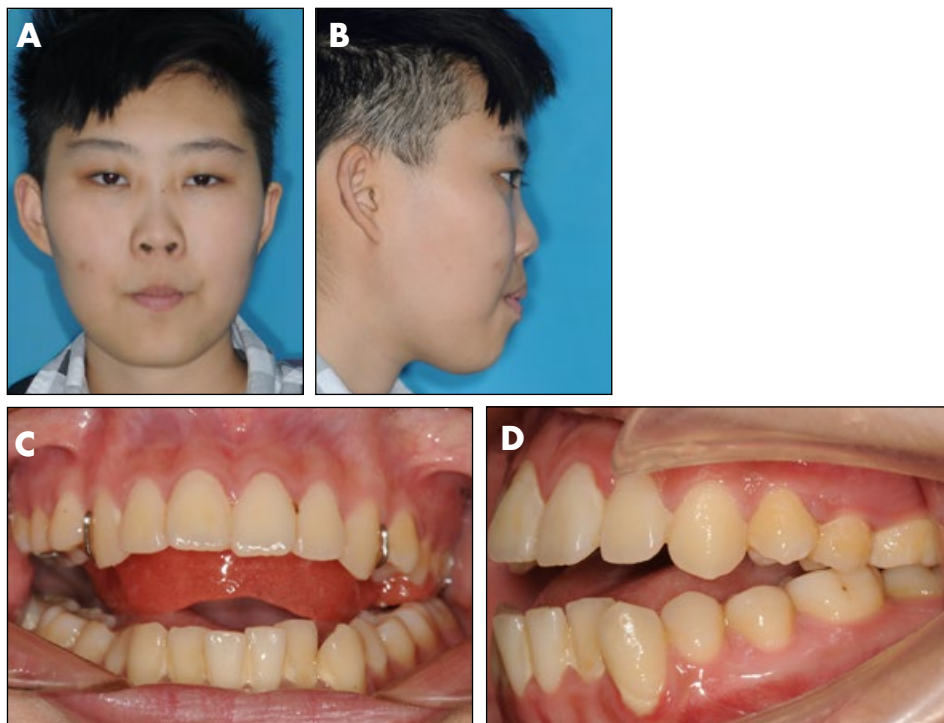
Treatment therefore continued by the bonding of Smartclip Straight-wire appliances and the placement of 0.014 inch nickel-titanium archwires for initial levelling and alignment of the arches. At the same visit and under local anaesthesia, two MIAs were inserted into the left maxillary alveolar bone on the buccal and palatal sides between the second premolar and first molar. Power chain was applied immediately from the buccal to the palatal MIA to initiate molar intrusion. Alignment and levelling took 12 months before 0.018 × 0.025 inch stainless steel archwires were placed. The upper left buccal segment was intruded whilst maintaining proper torque. The overjet and overbite gradually improved (Figure 5). The space between the mandibular central incisors was carefully used to correct the mandibular dental midline. Cross-elastics of 1/4 inch and 3.5 ounces were placed in the right premolar region to correct the lingually-tipped mandibular teeth. The patient was requested to continue the tongue exercises during treatment.

MEAWs were bent from 0.017 × 0.025 inch stainless steel archwires and formed with a reverse curve of Spee for further uprighting and intrusion of the mandibular molars, correction of the mandibular dental midline and to produce better interdigitation of the posterior teeth. Short Class III elastics (3/16 inch, 6 ounces) were worn full-time in the left canine area. Triangular elastics (3/16 inch, 6 ounces) were used in the right canine and premolar area. Finally, normal overjet and overbite and optimal interdigitation were obtained.

The total active treatment time was 31 months, at the end of which the MIAs were removed and full records were collected for treatment assessment. A clear thermoplastic retainer was suggested for full-time wear (Figures 6–8). A rhinoplasty procedure was accepted and performed during treatment.

### Treatment results

In a comparison of the records, the treatment changes revealed that SNA and SNB were stable but the ANB angle increased slightly from 1.4° to 2.1°. A 1.4° decrease of the MP-SN angle was noted, indicating that a counterclockwise rotation of the mandible occurred. The posteroanterior facial height ratio increased,



**Figure 4.** Progress facial and intraoral photographs in the first stage. A-C: facial and intraoral photographs with the functional occlusal splint in patient's mouth; D: intraoral photograph after five months of wearing occlusal splint showing the occlusal contact between the left maxillary second premolar and mandibular first molar.



Figure 5. Progress facial and intraoral photographs.

whereas the anterior lower facial height ratio decreased (Table I). The chin deviation was corrected and the initial facial asymmetry largely improved. A harmonised lip posture was achieved, which produced a better relationship to the E line. A balanced smile with adequate exposure of the maxillary incisors was also obtained (Figure 6).

The maxillary and mandibular regional superimpositions showed that the maxillary molars were intruded by 1.2 mm and the mandibular molars intruded 2.1 mm and uprighted. The canted posterior occlusal plane was corrected and bilateral Class I molar relationships were obtained. The divergent occlusal plane was corrected from 20.0° to 22.4°. The open bite was completely corrected and the overjet was restored. A harmonious relationship between the maxillary and mandibular arches was achieved. Parallelism of root position was restored and no obvious root resorption was observed in the panoramic radiograph. No tongue thrusting was reported at this time. A functional

anterior guidance developed in eccentric movements of the mandible (Figures 8, 9 and Table I).

Two years following active treatment, a review examination showed a well-proportioned soft tissue profile and a stable intermaxillary dental relationship. Continuing myofunctional exercises may have contributed to the stable outcome. No temporomandibular discomfort was reported during the treatment or retention periods. The patient was satisfied with her facial profile and her oral function recovered well. The retainer was worn at night for another year (Figure 10).

## Discussion

An open bite combined with other skeletal deformities is often considered a challenging orthodontic problem because of the difficulty in controlling the vertical dimension of the posterior teeth and the limited opportunity for profile improvement. Usually orthognathic surgery is indicated if the best



Figure 6. Post-treatment facial and intraoral photographs.



Figure 7. Post-treatment dental casts.

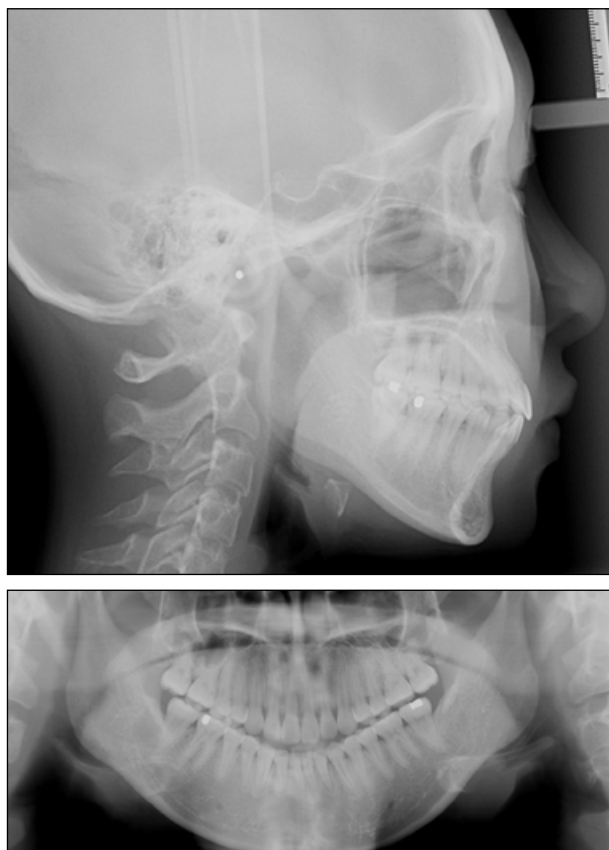


Figure 8. Post-treatment cephalograph and panoramic radiograph.

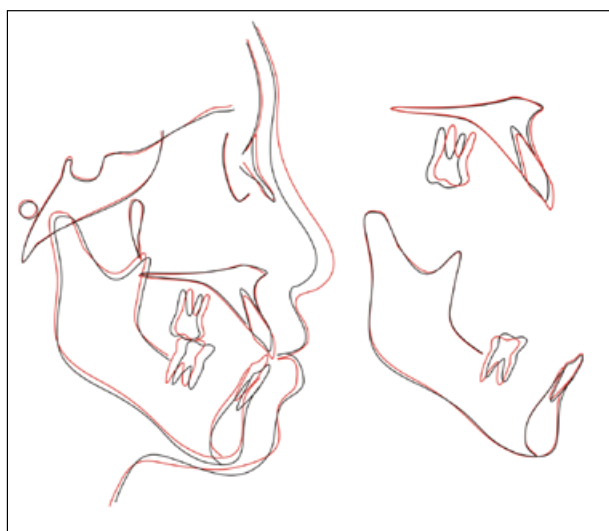


Figure 9. Superimposition of the pretreatment and post-treatment cephalometric tracings on SN plane, palatal plane and mandibular plane.

treatment outcomes are pursued. However, the risks and complications of extensive surgery might not be accepted by patients. The wide use of MIAs provides orthodontists with an effective option to intrude the molars and control vertical height. Significantly

satisfying results have been reported in many cases that would once have been managed only by surgery.<sup>5,6</sup>

The patient was an adult Chinese female who demonstrated a hyperdivergent growth pattern, a severe open bite, a Class III dental relationship, mandibular asymmetry and TMD symptoms. The choice of orthognathic surgical treatment was presented to the family but this plan was rejected and orthodontic treatment using an occlusal splint and MIAs was adopted as an alternative.

According to the clinical examination and the cephalometric analysis, the adverse oral habits and the extrusion of the posterior teeth were strongly suspected as two major causes of the open bite. The re-adaptation of tongue posture, the removal of the occlusal disturbance and intrusion of the left posterior teeth were the goals of the first stage of occlusal splint treatment. In light of the patient's compliance with myofunctional therapy, the improvement in facial symmetry and closure of the open bite provided confidence in the continuation of treatment into the fixed appliance phase. It has been reported that habit elimination is essential to prevent open bite relapse as occlusal disturbances and adverse oral habits may complicate diagnosis and management.<sup>7-9</sup> Simple functional appliances or bite blocks may be used prior to fixed orthodontic treatment, so that a more precise and detailed evaluation might be made regarding the exact skeletodental features of the patient.

Two MIAs were used for the intrusion of the maxillary left posterior segment without buccal tipping of the teeth in the initial alignment stages. During the aligning and levelling period, the overjet and overbite improved as the intrusion of the left upper molar occurred. It has been reported that a 2 mm intrusion of the posterior teeth could produce a 4 mm overbite improvement governed by jaw geometry,<sup>10</sup> and so an open bite of 5 mm might be corrected under an appropriate anchorage system by the use of MIAs. The right posterior open bite and anterior open bite were gradually eliminated during the intrusion period. The lingually-inclined right mandibular premolars were uprighted using the cross-elastics. Harmony and co-ordination of the upper and lower arches were achieved by the end of the treatment. All of these occlusal corrections were expected to contribute to the stability of final chin position.

Moreover, the MEAW technique was used because it was considered necessary to precisely control the





Figure 10. Post-treatment photographs at 24 months.

upper posterior teeth and upright the mandibular molars to obtain a more precise treatment outcome. This therapy involved extruding and uprighting the maxillary and mandibular anterior teeth, as well as intruding and uprighting the posterior teeth.<sup>3,11,12</sup> The correction of the mild shift of lower dental midline and adjustment of the final interdigitation were also facilitated. Bilateral mandibular MIAs have been recommended for better control or intrusion of the mandibular molars, but the MEAW appliance proved to be equally effective for this purpose.

Hwang et al.<sup>13,14</sup> suggested that occlusal planes associated with an anterior open bite were frequently too flat, and so treatment goals should involve achieving a steeper curve of Spee. In addition, Jacobs et al.<sup>15</sup> reported that this treatment goal should be achieved by a clockwise modification of maxillary position and a counterclockwise rotation of the mandible by intrusion of the posterior teeth. In the present case, OP-SN increased by  $2.4^\circ$  and an optimal rotation of the mandible occurred which decreased the lower facial

height significantly. This might explain the great improvement in the facial profile and the stability of the treatment outcome.

A 0.5 mm eruption of the maxillary molars occurred and possible relapse was expected to happen during the first post-treatment phase.<sup>10,16,17</sup> Deguchi et al.<sup>18</sup> and Baek et al.<sup>16</sup> reported that there was minor relapse during the retention period following mini-plate or mini-implant anchorage use during treatment. However, the present patient's overbite and overjet were stable after a 24-month review. Since normal myofunction is crucial for a stable outcome, the patient was instructed to keep practising her tongue and chewing gum exercises, which may explain why the treatment outcomes were satisfactory. A longer-term follow-up is planned.

### Conclusion

An extensive open bite with a vertical growth pattern, mandibular asymmetry and TMD was treated by the

combination of a functional bite block, MIAs and MEAW technology. The correction of the adverse tongue habits, relocation of the chin, uprighting and intrusion of the maxillary and mandibular posterior teeth, a counterclockwise rotation of the mandible and a normal overjet and overbite were achieved after active treatment. These outcomes were stable at a two-year review appointment. A removable functional appliance may still be used in adults to manage adverse oral habits or eliminate an occlusal disturbance before the commencement of fixed appliance treatment. With the aid of MIAs, comprehensive orthodontic treatment could be provided as a useful alternative to orthognathic surgery in selected open bite patients.

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