Severe facial asymmetry and unilateral lingual crossbite treated with orthodontics and 2-jaw surgery: 5-year follow-up

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A 33-year-old woman with severe facial asymmetry and unilateral lingual crossbite was treated with orthodontics combined with differential maxillary impaction and intraoral vertical ramus osteotomy. After 12 months of preoperative orthodontic treatment, 2-jaw surgery was performed. The total active treatment time was 18 months. Both her occlusion and facial appearance were significantly improved by the surgical-orthodontic treatment. The occlusion was stable after 5 years of retention. Posttreatment records after 5 years showed excellent results with good occlusion and long-term stability. (Am J Orthod Dentofacial Orthop 2012;142:509-23)

Patients with crossbite have significantly more cuspal interferences than those who have a normal transverse occlusion.1 Frequently, a functional shift occurs when an occlusal interference exists as the mandible closes into centric occlusion. It has been reported that a lateral functional shift of the mandible occurs in about 80% of deciduous and mixed dentitions with posterior unilateral lingual crossbite.2,3 Thus, the mandibular dental midline deviates toward the crossbite side relative to the maxillary midline and results in a subdivision malocclusion on the crossbite side.4 Previous studies have indicated that posterior unilateral lingual crossbite develops early and has a low rate of spontaneous correction.5,6 In addition, the condylar position becomes asymmetric when the condyle on the crossbite side is forced upward and backward, while the condyle on the noncrossbite side is distracted downward and forward relative to the glenoid fossa.7,8

In contrast to children, a functional shift is rarely found in adults with a posterior unilateral lingual crossbite. Age-related adaptive remodeling changes in the temporomandibular joint might lead to a skeletal asymmetry.9-11 However, studies that have documented the skeletal remodeling of the temporomandibular joints of untreated adults with unilateral posterior crossbite are inconsistent. Pirttiniemi et al12 concluded that complete adaptation of the temporomandibular joint did not occur in adults with posterior unilateral lingual crossbite. On the contrary, O’Byrn et al9 and Cohlimia et al13 demonstrated that the temporomandibular joint complex adapted to mandibular displacement by remodeling of the glenoid fossa and the condyle.

In growing patients, several studies have hypothesized that a functional condylar adaptation to mandibular displacement can develop into a morphologic asymmetry.14-16 Schmid et al15 found that the mandibular ramal height on the crossbite side remained relatively shorter in the growing patient. They proposed that the lateral occlusal interferences cause changes in the mandibular remodeling process. Mandibular growth modification and displacement subsequently progress into mandibular and facial asymmetry.

Although there is still a considerable lack of knowledge concerning the underlying etiology, facial asymmetry appears to originate from a combination of genetic and environmental factors.17 Correction of unilateral lingual crossbite with facial asymmetry has been a difficult treatment in orthodontics.
This article reports the treatment of a woman with severe facial asymmetry. She had mandibular deviation to the right, vertical maxillary asymmetry, severe midline deviation, and unilateral lingual crossbite. Her treatment included differential maxillary impaction and intraoral vertical ramus osteotomy combined with orthodontic therapy.

**DIAGNOSIS AND ETIOLOGY**

A 33-year-old woman was referred to an orthodontist (K.T.) for evaluation. She was healthy and had no specific medical problems. Her chief complaints were her mandibular asymmetry and unilateral crossbite. She did not have a history of injury to her head or jaw. Her frontal facial photograph showed severe facial asymmetry, and the mandible was deviated to the right. The cause of the facial asymmetry seemed to be the difference between the right and left heights of the maxilla and the length of the mandibular left and right body (Fig 1).

Clicking sounds were detectable in the right and left temporomandibular joints. However, the patient did not have muscle or joint pain or other symptoms typically associated with temporomandibular disease.

Intraorally, she had anterior and posterior crossbites from the maxillary right lateral incisor to the second molar. The maxillary left segment was constricted on the opposite side of the posterior crossbite and was asymmetric. The mandibular second premolars were severely tilted mesially and were not in occlusion. The mandibular first molars were also tilted mesially. The mandibular left third molar was not in occlusion and was positioned buccally. The maxillary right lateral incisor had a yellowish discoloration. She had moderate crowding in the maxillary arch and severe crowding in the mandibular arch. She had Class III canine and molar relationships on the left side, and a Class II canine relationship and a Class I molar relationship on the right side. The maxillary dental midline was coincident with the labial frenum when she smiled; however, compared with her facial...
Fig 2. Pretreatment dental casts.

Fig 3. Pretreatment radiographs: A, posteroanterior cephalogram; B, lateral cephalogram; C, panoramic radiograph.
midline, her maxillary dental midline was deviated to the right about 1.2 mm. Her mandibular dental midline was shifted 8.4 mm toward the right. When her mandible was guided into centric relation, a functional shift was seen, because of the anterior and posterior crossbites (Figs 1 and 2).

The posteroanterior cephalometric radiograph showed that the occlusal plane canted down on the left side. In addition, with asymmetric mandibular growth, the chin deviated to the right side (Fig 3, A). The Rocky Mountain transverse analysis showed that the difference between the expected and actual differentials of the mandibular and maxillary widths was 1.4 mm, considerably less than 5 mm. Therefore, surgically assisted rapid palatal expansion might not be indicated, even though the maxillary left segment showed constriction.

Cephalometric analysis indicated a skeletal Class II pattern (ANB, 6.2°/C14°). However, because of the clockwise rotation of the jaws relative to the sella-nasion line, the Wits appraisal was −2.1 mm, along with a hyperdivergent growth pattern (SN–MP, 45.6°/C14°). The maxillary incisors had normal inclinations (U1 to SN, 104.0°/C14°), whereas the mandibular incisors were retroclined (IMPA, 85.6°/C14°) (Fig 3, B; Table I).

In the panoramic radiographic evaluation, the left condyle was enlarged and elongated, and the left ramal height and mandibular left body length were increased. The right lower border of the mandible was bowed downward more than the left side (Figs 3, C, and 4; Table II). She was missing her mandibular right third molar. She also had root canal treatments of the maxillary right lateral incisor, the maxillary left second molar, the mandibular left second molar, and the mandibular left third molar (Table II).

### Table I. Cephalometric measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Japanese norm</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>5 years posttreatment</th>
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</thead>
<tbody>
<tr>
<td>SNA (°)</td>
<td>82.0</td>
<td>89.4</td>
<td>85.1</td>
<td>83.2</td>
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<td>SNB (°)</td>
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<td>Wits (mm)</td>
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<td>−3.3</td>
<td>−5.1</td>
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<td>SN–MP (°)</td>
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<td>FH–MP (°)</td>
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<td>39.8</td>
<td>41.5</td>
<td>38.5</td>
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<td>LH (ANS–Me/N–Me) (%)</td>
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<td>57.3</td>
<td>59.7</td>
<td>59.4</td>
</tr>
<tr>
<td>U1 to SN (°)</td>
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<td>104</td>
<td>97.3</td>
<td>94.7</td>
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<tr>
<td>U1 to NA (°)</td>
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<td>14.6</td>
<td>12.4</td>
<td>11.5</td>
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<tr>
<td>IMPA (°)</td>
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<td>84.6</td>
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<td>L1 to NB (°)</td>
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<td>32.6</td>
<td>30.7</td>
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<td>Upper lip (mm)</td>
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<td>−0.5</td>
<td>−0.3</td>
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<tr>
<td>Lower lip (mm)</td>
<td>2.0</td>
<td>0.8</td>
<td>−1.8</td>
<td>−0.2</td>
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### Table II. Comparison of pretreatment asymmetry and 5-year postretention symmetry in vertical height and asymmetry index measurements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
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<tr>
<td>CH (mm)</td>
<td>Right 3.8</td>
<td>Left 4.3</td>
</tr>
<tr>
<td>RH (mm)</td>
<td>Right 34.0</td>
<td>Left 38.3</td>
</tr>
<tr>
<td>CH + RH (mm)</td>
<td>Right 37.8</td>
<td>Left 42.6</td>
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<tr>
<td>Condylar asymmetry index</td>
<td>6.2</td>
<td>2.7</td>
</tr>
<tr>
<td>Asymmetry index</td>
<td>Right 5.9</td>
<td>Left 2.2</td>
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</tbody>
</table>

Condylar asymmetry index = |CHright − CHleft|/(CHright + CHleft)| × 100%.
Asymmetry index = |right − left|/(right + left)| × 100%.
CH, Condylar height; RH, ramal height; CH + RH, condylar + ramal height.
premolar, and the maxillary left second molar, and several restorations of her posterior teeth. Radiolucent areas were found under the crowns of the mandibular right second molar and the maxillary left third molar (Fig 3, C).

The etiology of the severe facial asymmetry and unilateral lingual crossbite appeared to be a combination of hereditary and environmental factors.

TREATMENT OBJECTIVES

The following treatment objectives were established: (1) correct the jaw deformities of the maxilla and the mandible; (2) coordinate the skeletal and dental midlines; (3) correct and coordinate the maxillary and mandibular arch forms; (4) obtain normal overjet and overbite; (5) establish Class I canine and molar relationships; (6) correct the irregularities in her teeth; and (7) improve her facial esthetics and symmetry.

TREATMENT ALTERNATIVES

Because of the severe skeletal asymmetry, orthognathic surgery was unavoidable. The Rocky Mountain transverse analysis18 indicated that a surgically assisted rapid palatal expansion would not be considered as a treatment option. However, because of the severity of the lingual unilateral crossbite, the possibility of surgically assisted rapid palatal expansion would be reevaluated after preoperative orthodontic treatment. To improve her facial symmetry, 2-jaw surgery was considered. After comprehensive assessment of the diagnostic records, because the patient had a vertical maxillary height difference and an occlusal plane cant, counterclockwise differential impaction of the maxilla and concurrent mandibular osteotomy would be performed to improve her facial symmetry. Both sagittal split ramus osteotomy and intraoral vertical ramus osteotomy have been widely used for mandibular osteotomy to set back the mandible, but intraoral vertical ramus osteotomy...
osteotomy is more likely to improve temporomandibular disorder symptoms\textsuperscript{20} and disc position.\textsuperscript{21} Therefore, an intraoral vertical ramus osteotomy was selected to improve the facial esthetics and the temporomandibular disorder symptoms. Because of the severe occlusal cant and mandibular asymmetry, the oral surgeon (A.N.) suggested additional plastic surgery, including a genioplasty after 2-jaw surgery. Since surgically assisted rapid palatal expansion and maxillary LeFort I osteotomy cannot be performed simultaneously, the patient would require 2 stages of surgery if it was deemed that the surgically assisted rapid palatal expansion was needed as an adjunctive treatment. However, many patients are reluctant to undergo multiple surgical procedures, and the demand for reducing the number of surgeries might increase. Phillips et al\textsuperscript{22} reported considerable relapse after expansion with LeFort I and concurrent segmental osteotomy. Surgically assisted rapid palatal expansion before maxillary LeFort I osteotomy cannot be performed simultaneously, the patient would require 2 stages of surgery if it was deemed that the surgically assisted rapid palatal expansion was needed as an adjunctive treatment. However, many patients are reluctant to undergo multiple surgical procedures, and the demand for reducing the number of surgeries might increase. Phillips et al\textsuperscript{22} reported considerable relapse after expansion with LeFort I and concurrent segmental osteotomy. Surgically assisted rapid palatal expansion before maxillary LeFort I osteotomy, therefore, was expected to show superior stability compared with LeFort I and concurrent segmental osteotomy, since it allows tissue adaptation during the expansion and subsequent consolidation period. However, the possible increases in surgical trauma, morbidity, and costs were concerns to both the practitioner and the patient.

Nonsurgical palatal expansion is more feasible than surgically assisted rapid palatal expansion; however, to prevent detrimental periodontal effects such as bony dehiscence and to establish proper posterior occlusion, ample orthopedic expansion of the basal bone that minimizes dentoalveolar tipping is essential.\textsuperscript{23} To achieve more basal expansion, the appliance should be designed to appropriately maximize the skeletal effects. Despite promising clinical results, miniscrew-assisted rapid palatal expansion cannot force the separation of obliterated sutures in older patients.\textsuperscript{24} The indications for miniscrew-assisted rapid palatal expansion should be confined to young adults from the late teens to the midtwenties, based on an earlier study.\textsuperscript{25} For older patients, surgically assisted rapid palatal expansion is still the treatment of choice, so a miniscrew-assisted rapid palatal expander was not proposed to this patient.\textsuperscript{26} The usefulness of titanium screws for orthodontic anchorage to correct a canted occlusal plane was presented to her, but she did not want temporary skeletal anchorage devices.\textsuperscript{27}

**TREATMENT PROGRESS**

Before orthodontic treatment, the patient was referred to specialists for evaluation of her periodontal conditions, root canal treatments, restorations, and extraction of third molars. Full fixed 0.022-in tip-edge (TP Orthodontics, LaPorte, Ind) appliances were placed in both arches. The maxillary and mandibular arches were leveled with continuous archwires, starting with 0.014-in nickel-titanium and working up to 0.019 × 0.025-in beta-titanium. During treatment, to correct the lingual crossbite, a 0.016-in Australian archwire...
omega loops was used for 3 months. The lingual cross-bite was corrected without surgically assisted rapid palatal expansion, and a complete arch alignment and coordination were done in preparation for the orthognathic surgery. Before the surgery, 0.019 × 0.025-in stainless steel archwires were placed. At 12 months, the 2-jaw orthognathic surgery was performed involving a maxillary LeFort I osteotomy for posterior differential impaction and a concurrent mandibular setback with an intraoral vertical ramus osteotomy. The distal segment of the mandible was repositioned 5 mm to the left side to correct the midline with the intraoral vertical ramus osteotomy. Maxillomandibular fixation was maintained for 2 weeks followed by neuromuscular and occlusal rehabilitation for 3 months with elastics and self-physical therapy involving mouth-opening exercises. Occlusal settling was performed with vertical elastics. All brackets and bands were removed 6 months after surgery. Fixed retainers were attached on the maxillary and mandibular anterior teeth. A maxillary circumferential retainer was also used to secure the stability of the maxillary arch (Figs 5 and 6).

Plastic surgery to correct the remaining asymmetry of the lower border of the mandible was suggested to the patient, but she rejected a second operation because she was satisfied with the treatment outcome and did not want the risk of inferior alveolar nerve damage (Fig 7).

**TREATMENT RESULTS**

The buccolingual molar inclination was slightly changed after wire expansion and alignment. Gingival recession or attachment loss was not remarkable compared with the initial status, even though the arch widths had increased (Figs 5, 6, and 8). As a result of the orthodontic and orthognathic procedures, the cant

![Fig 7. A, Different positions of the left and right inferior alveolar nerves in the body of the mandible and their distance from the inferior border of the mandible; B and C, volume-rendering 3-dimensional images show the close distance between the inferior alveolar nerves and the different types of genioplasty to correct the asymmetry.](image)
of the occlusal plane was corrected, and the asymmetries of the mandible and face were largely eliminated. Together with the correction of the sagittal relationship of the maxilla and mandible, an esthetic profile was obtained. A favorable occlusal result was achieved with acceptable interdigitation and incisor relationship.

The posttreatment posteroanterior cephalometric radiograph showed that the canted occlusal plane was corrected. In addition, mandibular symmetry was improved (Fig 9, A).

The posttreatment lateral cephalometric analysis and superimposition showed skeletal changes (ANB, 5.7°; Wits appraisal, −3.3 mm) and an increase in the mandibular plane angle (SN-MP, 47.7°). The maxillary incisors were slightly retroclined (U1 to SN, 97.3°). The inclination of the mandibular incisors remained stable (IMPA, 85.4°) (Figs 9, B, and 10; Table 1).

The posttreatment panoramic radiograph showed proper space and acceptable root parallelism with no signs of significant bone or root resorption (Fig 9, C). At the 5-year follow-up, the patient had a stable occlusion, and the results of the surgical orthodontic treatment were maintained (Figs 11 and 12). Three-dimensional images showed improvement of symmetry and fairly stable results (Figs 13-15; Table III).

**DISCUSSION**

Asymmetry is one of the most difficult problems to correct in orthodontics. A functional shift of the mandible in growing patients can be caused by various types of occlusal interference such as malposed teeth, dental crossbites, or a constricted maxillary arch in growing children. Abnormal tooth contact causes subsequent mandibular displacement in maximum intercuspation. These can be corrected by aligning teeth, occlusal adjustments, and maxillary expansion. However, in adults with facial asymmetry related to a functional shift, Joondeph suggested that muscle memory “de-programming” with diagnostic splints might be indicated to establish the centric-relation position. In contrast, dental asymmetries can be treated orthodontically at all ages by using asymmetric tooth-extraction sequences and asymmetric mechanics such as diagonal and midline elastics.

The severity and nature of the skeletal asymmetry dictate whether the discrepancy can be corrected completely or partially through orthodontic treatment.
However, skeletal asymmetries treated with orthodontics alone can result in a compromised treatment outcome, so severe discrepancies might require orthodontic treatment combined with orthognathic surgery. The correction of severe asymmetries usually requires a series of complex surgical procedures.\textsuperscript{36,38–41} A thorough...
orthodontic and surgical diagnosis and treatment plan will help to determine which jaw needs to be repositioned surgically. The treatment becomes more complicated if the asymmetry is in the sagittal, vertical, and transverse planes.

Obwegeser and Makek\(^4\) suggested classifying skeletal asymmetries as either hemimandibular hyperplasia, defined as half of the entire mandible enlarged 3-dimensionally, or hemimandibular elongation, defined as vertical elongation of the condyle or ramus and horizontal elongation of the body.\(^3\),\(^7\),\(^4\)

Hemimandibular hyperplasia is recognized by increased distances from the tooth apices to the lower border of the hemimandibular side compared with the normal contralateral side. The midline usually also deviates to the same side as the deformity, and definite notching of the mandibular lower border midline on the panoramic film is recognized.\(^3\),\(^7\),\(^4\) However, hemimandibular elongation can occur as elongation of either the condyle or the ramus in the vertical plane or the mandibular body in the horizontal plane or combinations of both. In the hemimandibular elongation, usually there are no increased distances from the tooth apices to the lower border of the hemimandibular side compared with the normal contralateral side. Hemimandibular elongation is characterized by excessive growth along normal growth axes, and the midline usually deviates to the opposite side of the deformity.\(^17\)

In hemimandibular hyperplasia, vertical differences in the mandibular borders and occlusal planes can be observed on a centric-relation cephalometric radiograph. On the other hand, in hemimandibular elongation, both planes superimpose on a centric-relation cephalometric radiograph because there is no vertical component to the asymmetry. Both deformities occur during an individual's growth stage; however, hemimandibular hyperplasia exhibits latent or continued growth instead of following a somatic growth curve like hemimandibular elongation.\(^3\),\(^7\)

Fig 11. Five-year posttreatment facial and intraoral photographs.
Evaluating a patient according to this skeletal asymmetry classification is important for both the orthodontist and the oral maxillofacial surgeon so that they can determine the preoperative orthodontic tooth movements and the type of orthognathic surgery required. Our patient was diagnosed with hemimandibular elongation because of elongation of the mandibular left body in the horizontal plane and elongation of the
left condyle and the ramus in the vertical plane. Consequently the mandible was deviated to the right. Even though the right lower border of the mandible was bowed downward more based on the panoramic radiograph, there was no notching of the mandibular lower border midline, which is a characteristic of hemimandibular hyperplasia. Although the vertical difference of the lower border of the mandible was not significant, a vertical reduction osteotomy at the right lower border of the mandible was recommended at the second-stage surgery to correct it. It is reported that a minimum of 6 mm between the inferior border of the mental nerve canal and the proximal osteotomy during sliding genioplasty can greatly reduce the chance of inferior alveolar nerve damage, although it does not completely eliminate the risk. Thus, keeping at least 6 mm of space should be a goal during surgery to protect the patient (Fig 7).

Studies have reported that the limit of maxillary dental midline deviation found to be esthetically acceptable to patients is about 2 mm relative to the facial midline. In this patient, the posttreatment results showed that the maxillary and mandibular dental midlines were coincident. However, there was approximately a 1 mm discrepancy between the facial and dental midlines, but this did not have a negative effect on dentofacial esthetics and was imperceptible to the patient.

In the preoperative orthodontic phase, tooth positioning in both arches was based on the diagnostic setup, and this determined the tooth movement goals. Correcting the malpositions of the teeth into regularly aligned maxillary and mandibular arches as well as correcting the lingual crossbites with acceptable overbite and overjet were important objectives for this patient. Consequently, in the preoperative orthodontic phase,
orthodontic decompensation of the teeth and dental arches was necessary to enable the required sagittal movement and the asymmetric correction of the maxilla and the mandible in the surgical phase.

From this case study, we found it important to thoroughly evaluate the initial history and diagnostic records and to understand the dentoalveolar compensations associated with the various types of asymmetries.

**CONCLUSIONS**

Orthodontic treatment can be combined with orthognathic surgery to achieve acceptable results. In this case study, both skeletal disharmony and
malocclusion were significantly improved, and the generalized esthetics and function were significantly improved after treatment and stable after 5 years of retention, as verified by 2-dimensional and 3-dimensional image analyses. Even so, the correction of facial asymmetries is still a major problem that needs more investigation.

REFERENCES


