Correction of an Asymmetric Maxillary Dental Arch by Alveolar Bone Distraction Osteogenesis

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ABSTRACT

This case report describes a new surgical orthodontic approach involving alveolar bone distraction osteogenesis for correction of asymmetric maxillary dental arch. The treatment was also combined with conventional orthognathic surgery to improve mandibular lateral deviation. This new treatment strategy provided an ideal dental arch and a symmetric facial appearance efficiently and effectively.

INTRODUCTION

An asymmetric dental arch associated with skeletal problem often results in an asymmetric facial appearance. To improve the distorted facial appearance is one of the most critical objectives of orthognathic surgery. Several treatment techniques have been introduced for asymmetric dental arch. A conventional non-surgical orthodontic treatment gives an acceptable outcome, if well-planned force mechanics are provided. However, it could induce root blunting, resorption, or fenestration during the treatment, if the affected teeth-bone relationships were poor (1, 2). Moreover, the treatment duration may be prolonged in a traditional orthodontic treatment because of those mechanical and physical complications. On the other hand, surgical approach such as osteotomy can correct skeletal problems immediately, although fixation of bone specimens sometime becomes difficult because it requires dexterous manipulation for

fitting. Furthermore, even in comparably simple procedure such as corticotomy, sometime the bone fixation can be challenged as well. Therefore, our new strategy for treatment of asymmetric dental arch is suggested in this article, which overcomes the above-mentioned disadvantages.

DIAGNOSIS AND ETIOLOGY

An 18-year-old Japanese woman was referred to the Department of Orthodontics, Nagasaki University Hospital in Japan for correction of her facial asymmetry. Her frontal facial appearance was not symmetry because of lateral deviation of the mandible and the lateral profile was concave with normal facial height. The maxillary dental arch showed asymmetry because the right posterior teeth from the first premolar to the second molar were palatally inclined but there was no posterior crossbite. The basal alveolar ridge on the maxillary right was collapsed to the palatal side as well. The overjet was 2.5 mm, and over bite was 2.0 mm. Mandibular midline shifted 4 mm to the left. The molar relationship was Class I on the right and class II on the left side. The canine relationship is Class III on the right and class I on the left. (Fig 1 and 2). The panoramic x-ray showed all permanent teeth were presented except first molar and third molar on the mandibular left (Fig 3). In cephalometric analysis, although the values of SNA and SNB were within one standard deviation (S.D.), the ANB was -0.4 degrees showing slightly mandibular prognathia. Besides, facial angle which represents mandibular position, and A-B plane which represents the maxilla-mandibular relationship, were 88.3 (>1 S.D.) and -0.9 (>1 S.D.), respectively (Fig 4 and Table), showing protruded mandible as well. The posterior-anterior cephalometric radiograph detected no cant of maxilla. Based on these findings, the case was diagnosed as Skeletal Class III malocclusion with mandibular prognathism, facial asymmetry with mandibular deviation, and asymmetric maxillary dental arch.

TREATMENT OBJECTIVES

The main objectives of this orthodontic treatment were to correct facial and dental asymmetry and maxilla-mandible relationship. Therefore, the orthodontic treatment objectives were (i) to achieve a symmetric maxillary arch form, repositioning the retroclined maxillary right premolars and molars with accompanying the collapsed alveolar ridge by alveolar bone distraction osteogenesis, (ii) establishing class I mutually protected occlusion, and (iii) improving facial balance and deviation combined with orthognathic surgery.

TREATMENT ALTERNATIVES

Intraoral vertical ramus osteotomy (IVRO) was selected to correct the lateral deviation of the mandible. Genioplasty was also required to correct the facial imbalance. Since there were no cant or rotation of maxilla, LeFort I osteotomy was not necessary. The following three treatment options for the asymmetric maxillary dental arch were considered in this case.

1. Conventional orthodontic treatment can be performed to acquire an ideal dental arch form. Although this would exert minimum physical strains on the patient, the involved possible risks such as root blunting, resorption, or fenestration would be induced by teeth rotation and uprighting during orthodontic treatment (3). In addition, for correction of the asymmetric facial appearance, IVRO and genioplasty would need subsequently after presurgical orthodontic treatment.
2. All surgical procedures such as alveolar bone osteotomy from the right first premolar to second molar, plate fixations, and IVRO with genioplasty can be performed at the same time. This alternative may be a standard procedure for treating such case, however creating an ideal maxillary arch form to match the lower arch is difficult during the surgical operation because finding best fit positions of bone fragments and securing them to the ideal relationships are complicated.
3. First, corticotomy of buccal and palatal alveolar bone from the first premolar to the second molar on the right side of the maxilla is performed with a 2-week time lag. Then the insecure maxillary right posterior ridge is moved buccaly by a distractor until an ideal arch shape is achieved. Finally, IVRO with genioplasty is performed for facial imbalance. This alternative would need longer treatment time than the second option. However, there are two advantages as compared to other previously explained treatment options, (i) the orthodontist or surgeon can manage the amount of teeth-bone movement during the distraction until achieving ideal relationship, and (ii) root blunting, resorption, or fenestration can be avoided because teeth-bone relationship is maintained during the teeth movement.

All three alternatives were presented and explained each risk-benefit to the patient. After the consultation, the patient, orthodontist, and oral surgeon chose the third strategy to eliminate concerns about the prolonged treatment time and complicated surgical procedures as mentioned above.

TREATMENT PROGRESS

All surgical treatment was performed at the Department of Oral and Maxillofacial

Surgery, Nagasaki University Hospital, Japan. Corticotomy was performed first on the palatal side of maxillary alveolar bone from the first premolar to the second molar under local anesthesia. Another corticotomy for the buccal side was operated after 2 weeks when blood supply to the bone fragment from palatal mucosa was recovered. The distractor (Hyrax Expansion Screw, DENTAURUM GmbH & Co. KG, Isprongen, Germany) was bonded on the maxillary first premolars and first molars bilaterally before the second corticotomy (Fig. 5). After 1 week of latency period, patient started to activate a distractor screw once a day (0.5 mm / day) for 14 days (4). After 2 weeks distraction, transverse width of the maxillary arch was increased 6.5 mm. The mandibular dental arch was maintained in a symmetric form (Fig. 6). After 2 months retention, teeth leveling and alignment were initiated with placing 0.014 inch nickel-titanium archwires, followed by 0.016 nickel-titanium and 0.017 x 0.022 stainless steel archwires. This presurgical process including distraction osteogenesis and its consolidation took 12 months. IVRO and genioplasty were performed under general anesthesia to obtain a Class I occlusion and symmetric facial appearance. Jaw opening exercise was started at the 2nd day after surgery with wearing vertical elastics in the anterior, and class II elastics in the posterior region.

TREATMENT RESULTS

The post-treatment photographs showed an improved facial appearance. The maxillary and mandibular midlines were coincident to the patient facial midline. Occlusion was also improved and established Class I relationship (Fig 7-11). Figure 12 showed the improvement of facial asymmetry. The angles, which were between the ear-rods and external border of mandibular ramus on the frontal facial photos, at the initial examination were 67 degrees on the right and 82 degrees on the left side showing the mandibule deviated to the left. There was 15 degrees of the right-left difference. The corresponding values after treatment were 71 and 75 degrees on the right and the left, respectively, and the difference was 4 degree. As decreasing these numbers before and after surgery, improvement facial asymmetry after surgery was confirmed. The occlusion was maintained stable during the 2-year follow-up.

DISCUSSION

In the present case, buccal and palatal corticotomies of the right maxillary alveolar bone were performed with a 2-week time-lag. Then the flexible segment of the dental arch was moved buccaly as one unit with teeth-bone together by a distractor until an ideal dental arch form was acquired. Since the alveolar bone was palatally inclined and

causing dental arch form asymmetry. Typically, changing the shape of alveolar ridge is seen as usual as bone remodeling process during the teeth movement (5, 6), even in this case, a symmetrical dental arch and an ideal teeth-bone relationship can be gained through the end of such routine orthodontic treatment. However, if only teeth are moved through the collapsed alveolar bone with uncontrolled orthodontic mechanics, teeth fenestration from cortical bone might be apprehended to be occurred (1, 2). Therefore, controlled orthodontic mechanics with light force is required for this complicated situation, and it usually takes a longer treatment period.

Several authors agreed that corticotomy induces tooth movements rapidly due to increased bone turnover (7-9). According to this statement, the treatment duration with corticotomy must be shorter than conventional non-surgical orthodontic treatment even for asymmetric dental arch like this case. Therefore, teeth and alveolar bone as one block without changing the original teeth-bone relationship was chosen in this case. Consequently, it took only two years to complete the whole process of corticotomies, which includes distraction osteogenesis and its retention, pre-surgical orthodontic treatment, orthognathic surgeries, and post-surgical orthodontic treatment. It was considered to be much shorter than conventional orthodontic method only.

In the present case, the buccal movement of alveolar bone at the right maxillary premolar and molar lesion was needed approximately 6.5 mm. There were no indications of transverse expansion of the paratal midline and buccal movement of the other side of maxilla. Therefore, loosening maxillary bone at the affected side only by corticotomies was important to apply maximum force to the affected side. Thus, other side of maxillary arch worked as a rigid anchor to hold a distractor, and pushed the affected side away to the buccal effectively without moving itself.

The maxillary osteotomy, including bipartite or tripartite osteotomies for maxilla, is well-known technique to reconstruct a symmetric dental arch form and still simple procedure but it is necessary to perform under general anesthesia. Furthermore, patients have to stay in a hospital for one or two weeks. According to Constantine et al, tripartite osteotomy might be preferable in this kind of case because it creates no midline diastema, while bipartite does (10). Although this procedure would reduce total treatment term, sometimes it can be difficult to adapt the bone fragments to the ideal positions during operation due to the complicated surgical techniques (10). When plate fixation is improper, the adjustment after the surgery will be severely difficult. On the other hand, alveolar bone osteotomy is a simple procedure. This technique is also well known and useful procedure to replace the alveolar bone to an ideal position with teeth by rigid fixation, simultaneously (11-14). The maxillary alveolar bone osteotomy can be

used such in this case to achieve an ideal dental arch, however it is simple technique, it is necessary to perform under general anesthesia and have a couple days of patient's hospital stay. Moreover, it is often difficult to set bone segment to the proper position after osteotomy as well as tripartite osteotomy describing above.

In contrast to these conventional surgical methods, corticotomy is quite simple. A procedure of corticotomy on each palatal and buccal surface can be completed within one hour under local anesthesia as an outpatient (Fig. 3). Moreover, our procedure of DO is reliable to acquire an ideal dental arch because the dentists can control the amount of movement precisely by giving instructions to the patient to activate a distractor manually as it goes. This is one of the benefits for both clinicians and patients because the treatment results are more reliable than osteotomy techniques. Moreover the distractor can maintain the transverse width as a retainer after acitivation by only securing the screw hole rigid during consolidation period for two months. There are only possible complain about corticotomy procedure from patients, which might be the corticotomies has to be done twice with a 2-week interval. The two-week (10-14 days) latency period is required for the tissue reconstruction and revascularization of that area (15). Therefore patients have to receive corticotomies twice within two weeks.

Post-operative skeletal stability is an important factor for successful surgical orthodontic treatment. Andrew et al. reported a systematic review of many articles about stability and complications of mandibular advancement using distraction ostegenesis (DO) and sagittal split ramus osteotomy (SSRO). They found that both techniques have similar risk factors for skeletal relapse (16). Hanada et al. reported most of relapse was occurred within 6 months post-operatively (17). Kumar et al. also reported the outcomes of one-year follow up after surgery showed great stabilities (18). Transverse width at the maxillary premolars and at the first molars was almost stable over the two years postoperatively, and overall long-term stability of this case showed excellent result.

Our procedure is considered to have less complication compared with other treatment plan. In addition to easy manipulation of the device and its simple technique, the surgical invasion is minimal to the patients.

In conclusion, the strategy using corticotomy and distraction osteogenesis to incline teeth and the accompanying alveolar bone as an one piece with a distractor device is effective and efficient treatment for correction of asymmetric maxillary dental arch.

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FIGURES AND FIGURE LEGENDS

Fig 1. Pretreatment facial and intraoral photographs.

Fig 2. Pretreatment dental casts.

Fig 3. Pretreatment panoramic and cephalometric (PA) radiography.

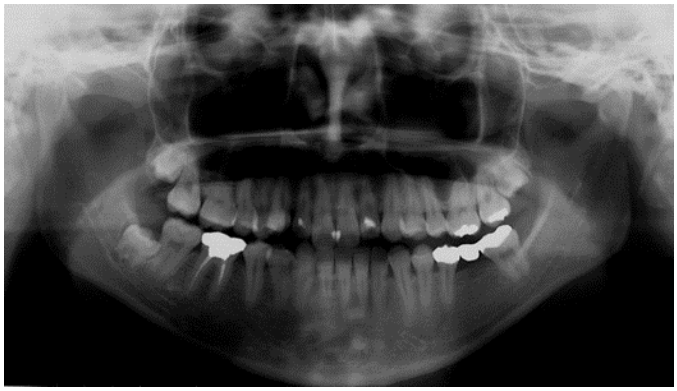

Fig 4. Pretreatment cephalometric tracing.

Fig 5. Photographs of corticomomies.

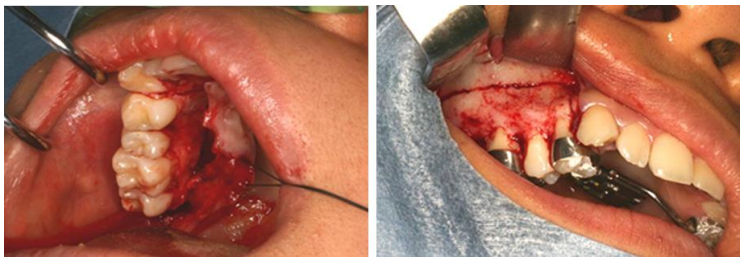

Fig 6. Progress intraoral photographs.

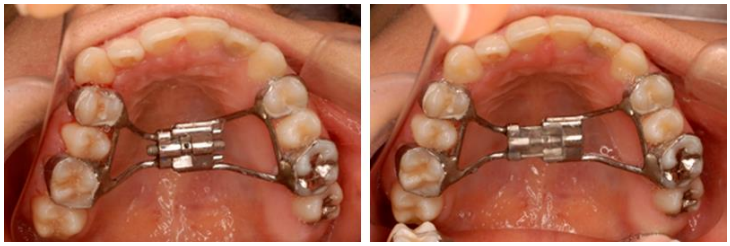

Fig 7. Posttreatment facial and intraoral photographs.

Fig 8. Posttreatment dental casts.

Fig 9. Posttreatment panoramic radiograph.

Fig 10. Posttreatment cephalometri tracing.

Fig 11. Superimpositions of tracings.

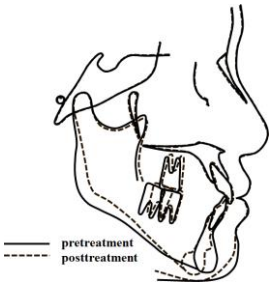

Figure 12. Estimation of facial symmetry.

	right	left	differentiation between right and left
pre treatment	67	82	15
post treatment	71	75	4

Table. Cephalometric analysis.

Title	Mean	SD	Case	SDK
FH to SN plane	6.2	5.9	**5.8**	
SNA	82.3	3.5	**80.6**	
SNB	78.9	3.5	**81**	
facial angle	84.8	3.1	**88.3**	*
gonial angle	131	5.6	**121.6**	*
ramus angle	83	4.4	**88.4**	*
A-B plane	-4.8	3.5	**-0.9**	*
ANB	3.4	1.8	**-0.4**	*
U-1 to FH plane	111.1	5.5	**117.1**	*
L-1 to mandibular plane	96.3	5.8	**84.8**	*