Tooth-borne distraction of the lower anterior subapical segment for correction of class II malocclusion, subsequent to genioplasty.

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ABSTRACT

Introduction: Alveolar distraction is mainly used to increase height and width of the alveolar crest. This technique, however, is not typically used for lengthening the perimeter of the dental arch or improving teeth axes. We applied alveolar distraction in a tooth-borne manner in the second stage of our original method and obtained favorable results. We therefore present an outline of this method.

Case report: Genioplasty was first performed to create an infrastructure for sequential advancement of the subapical alveolar segment. After bone union, anterior subapical alveolar osteotomy was performed. The stump of the osteotomized dentate segment was moved forward without changing the incisal edge position and a box-type bioabsorbable plate with 4 holes was fixed only onto the dentate segment using 2 screws. After a latency period, two distraction devices were placed bilaterally to the brackets and activated at 1.0 mm/day. After reaching the desired position, the distractor was immobilized, and then replaced by resin temporary teeth to retain the created space. After the consolidation period, orthodontic treatment was re-started and teeth moved into the newly created space. Bimaxillary

surgery was performed after completing pre-surgical orthodontic treatment. Finally, both desirable occlusion and functional masticatory function were obtained.

Conclusion: This tooth-borne distraction system is one applicable method for patients with skeletal class II and crowding of lower anterior teeth, achieving good results particularly in combination with our original method.

Introduction

In severe skeletal class II patients with crowding of lower anterior teeth on a narrow bone, desirable occlusion with proper inclination of these teeth is hard to achieve using orthodontic therapy alone. This is because the root sometimes becomes exposed from the bone surface if bone width at the symphysis is not wide enough to allow rotational movement of the teeth in the sagittal plane. Ordinary premolar extraction does not always compensate for the arch length discrepancy together with proper inclination of the incisors and proper anterior guidance. A harmonious relationship between maxillary and mandibular arch in terms of length and width concomitant with desirable angle of the tooth axis is also essential to establish desirable occlusion. As for the chin structure, reduced configuration will bring about an improper dynamic state of the stomatognathic system.

In order to conquer above problems, we have applied a three-stage operation[1] to date. The first stage involves advancement genioplasty to construct sufficient infrastructure for sequential alveolar advancement. The second stage requires alveolar osteotomy for advancement of the dentate segment. The third stage is bimaxillary surgery for the ideal

maxillo-mandibular relationship and the establishment of desirable occlusion.

Alveolar distraction osteogenesis has become an effective strategy for the management of dentofacial deformities that arise from the structure of alveolar bone itself[2]. However, this approach is not popularly used for lengthening the perimeter of the dental arch or improving teeth axes.

In the second stage of our serial procedure, we utilized distraction osteogenesis as a form of tooth-borne distraction, instead of quick repositioning of the dentate segment forward, and obtained favorable results. We describe herein the outline and advantages of this procedure.

Case report

The patient was referred to our department with complaints of masticatory disturbance. She showed severe crowding of the lower anterior teeth with mandibular hypoplasia and angle class II division 1 malocclusion (Figs. 1, 2). Although the mandible was rotated in a clockwise direction, the lower incisors were almost perpendicular to the mandibular plane and the relationship between the incisors and the mandible was fine. Overjet and

overbite were 14.3 mm and 1.9 mm, respectively. Total arch discrepancy was -22.0 mm. Other representative cephalometric values were: SNA, -3.4 SD; SNB, -4.5 SD; SN-Pog, -4.2 SD; GZN, +4.1 SD; Mp-Oc, +3.5 SD; and L1-Mp, +0.5 SD.

After estimating that the arch length discrepancy was too large to achieve proper tooth alignment, lower first premolar extraction was performed on each side to improve the relationship with the upper teeth. Ordinary initial alignment and leveling were then performed. All of the following three surgeries were performed under general anesthesia. In the early stage of pre-surgical orthodontic treatment, we advanced the chin forward by 8 mm using advancement genioplasty based on a harmonious profile (Fig. 3). The genial segment was fixed with three bioabsorbable bone screws and a titanium plate. Thin cortical bone transfer was carried out onto the osseous gaps created between the superior edge of the advanced genial segment and the alveolar bone, to stimulate osteogenesis and smooth chin configuration. The precise method has been described in our previous report[1].

About 4 months after the genioplasty, robust bone was augmented at the chin and then subapical alveolar osteotomy was performed. Removal of the

titanium plate was undertaken prior to osteotomy. A horizontal osteotomy was made about 5 mm lower to the apices of the anterior teeth. Interdental vertical alveolar osteotomy was made between the lateral incisor and canine on each side. The horizontal cutting edge of the osteotomy line of the dentate segment was positioned 7 mm anterior without changing the position of the incisal edge. At this stage, the dentate segment was retroclined. A prefabricated resin splint was placed between the maxillary and mandibular arches, and internal maxillary fixation (IMF) was applied for precise positioning of the dentate segment. A bioabsorbable plate was then adjusted to fit the surface over the osteotomy line and fixed only to the dentate segment using 2 screws, facilitating rotational movement (Figs 4, 5). After releasing the IMF, free rotation of the bone segment was confirmed and the wound closed.

After a latency period of 5 days, two distraction devices were bilaterally placed to the arch wire, bridging over the vertical osteotomy line, directly with resin. We made a minor modification of the LEAD System™ (Striker Leibinger, Kalamazoo, MI, Fig. 6) to allow use as a tooth-borne distractor by bending the transporter and basal miniplate for suitable attachment (Fig. 7).

The distractor was activated at 1.0 mm/day to lengthen the dentate segment, producing clockwise rotation of the segment about the horizontal osteotomy line in the sagittal plane.

Due to the initial midline deviation to the right, distances of 6 mm on the right and 4 mm on the left were distracted. The distractor was then immobilized by filling the threads with resin. Three days after immobilization, we confirmed no shortening of the distracted space and no further requirement for the distractor. The distractor was then moved off and a temporary resin tooth was placed in the gap to maintain the space on each side. After an 8-week consolidation period, orthodontic treatment was restarted and the anterior teeth were moved into the newly created space, reducing the mesio-distal width of the temporary resin tooth by shaving with a burr. Crowding of the anterior dentition was finally eliminated. After completing pre-surgical orthodontic treatment, bimaxillary surgery was performed. The maxillary alveolar arch was further separated into 3 pieces after Le Fort I osteotomy, with an interdental cutting line between the lateral incisor and canine on each side, to widen the maxillary basal arch and improve palatal inclination of incisors. The mandible was advanced 4 mm by

sagittal split ramus osteotomy. After bimaxillary surgery, desirable chin structure and occlusion were obtained along with proper inclination and anterior guidance (Figs. 8, 9). Overjet was improved from 14.3 mm to 2.0 mm. In combination with our original three-stage operation, this method brought about remarkable improvement with safety and certainty.

Discussion

We have already reported treatment of patients with severe class II and mandibular anterior teeth crowding using our original three-stage surgery[1]. Based on our experience, improving deformity and obtaining functional amelioration does not seem feasible using only a one-stage operation. Making space from a small structure is much harder than achieving reduction from a large structure. Conventional orthodontic procedures beginning with teeth extraction and followed by accommodation and advancement of the mandible seems an implausible method for establishing appropriate axes for lower anterior teeth straight above thin bone, with optimal guidance, proper lip function and finally long-term stabilization. Dehiscence, poor stability, periodontal disease and disruption occasionally

occur with aggressive orthodontic treatment. We have thus established a method to construct a suitable infrastructure by advancement genioplasty for sequential segmental alveolar osteotomy. The augmentation technique for the genial portion was our original concept, and one that we have been very proud of[1].

In the present case, we utilized the principal of distraction in the form of a tooth-borne approach in the second stage of our sequential three-stage surgery. Distraction osteogenesis itself offers numerous advantages: 1) no requirement for bone grafting; 2) reduced invasiveness of the procedure, with shorter operating time and reduced blood loss compared to conventional procedures; 3) no gaps at inter-dental osteotomy sites; 4) maintenance of good blood flow to the bone segment; and 5) soft-tissue expansion. Tooth-borne distraction offers the additional advantages of achieving easy settlement even after surgery and adjustment of force vectors even during activation. Initial handling of the device is also easy when the fixation comes loose. The risk of tissue inflammation or irritation is also reduced. Generally, when using two distractors, the devices should usually be applied as close to parallel as possible, to avoid damage to anchoring teeth or distortion of the

segment. However, tooth-borne distraction does not necessitate such strict settings. Furthermore, no surgical approach is required to remove the appliance and quick replacement with temporary resin teeth can maintain the space. The simplicity and reduced invasiveness of this approach increase patient acceptance.

A one-stage operation has actually been reported[3]. In cases with low vertical dimensions of the mandible, however, genioplasty and alveolar osteotomy cannot be performed concomitant, because sufficient transverse beam to preserve a resistant mandibular continuity cannot be ensured and fractures will occasionally occur. Our three-stage method for anterior mandibular apical base augmentation is beneficial to achieve sufficient strength to support occlusal force. Above all, certainty, safety and reduced difficulty with long-sighted planning are assured in this step-by-step procedure.

Mandibular widening using vertical interdental symphyseal osteotomy followed by distraction in the transverse direction may also provide the additional arch length required to resolve crowding. Although this approach can relieve the space problem, it can sometimes lead to problems with the temporomandibular joint (TMJ)[4]. Furthermore, in a teeth crowding case, it is quite difficult to perform interdental vertical osteotomy without damage to

the roots close to osteotomy line.

Mandibular corpus osteotomy and subsequent distraction is one strategy for increasing the perimeter, but is often problematic due to difficulties in controlling the desirable vector while maintaining adequate movement of the segment against the resistance of tight surrounding tissues.

Our three-stage tooth-borne distraction was successfully performed without any complications. This method enables easy forward elongation of the bone while keeping bone contact throughout the procedure. The bioabsorbable plate can provide a good material for facilitating rotational distraction. The key to this innovation was preventing the dentate segment from moving backward to the original position and facilitating rotational movement of the dentate segment about the frontal edge of the horizontal osteotomy line during distraction. We believe that this sequential procedure with tooth-borne distraction represents a reliable option for amelioration of retrognathia with crowding or proclination of the incisors, as an alternative to conventional orthodontic treatment.

Conclusion

In order to lengthen the perimeter of the dental arch, we applied an alveolar distraction in a tooth-borne manner in the second stage of our original method. Tooth-borne distraction offers more advantages than bone-borne one in a certain case. This sequential procedure consisted of genioplasty, distraction and bimaxillary surgery brings about great benefits in the standpoint of certainty and safety.

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Figure legends

Fig. 1 Pretreatment intraoral photographs.

Fig. 2 Pretreatment lateral cephalometric radiograph.

Fig. 3 Lateral cephalometric radiograph after advancement genioplasty. A thin cortical bone was identified on the genial segment for bone augmentation (arrow, see Reference 1).

Fig. 4 Anterior subapical alveolar osteotomy was performed. Arrow indicates alveolar osteotomy line. A bioabsorbable box plate was fixed with 2 screws only on the dentate segment, to facilitate rotational movement about the horizontal osteotomy line.

Fig. 5 Diagram of alveolar osteotomy. Use of a bioabsorbable box plate was a key to this method, enabling subsequent tooth-borne distraction.

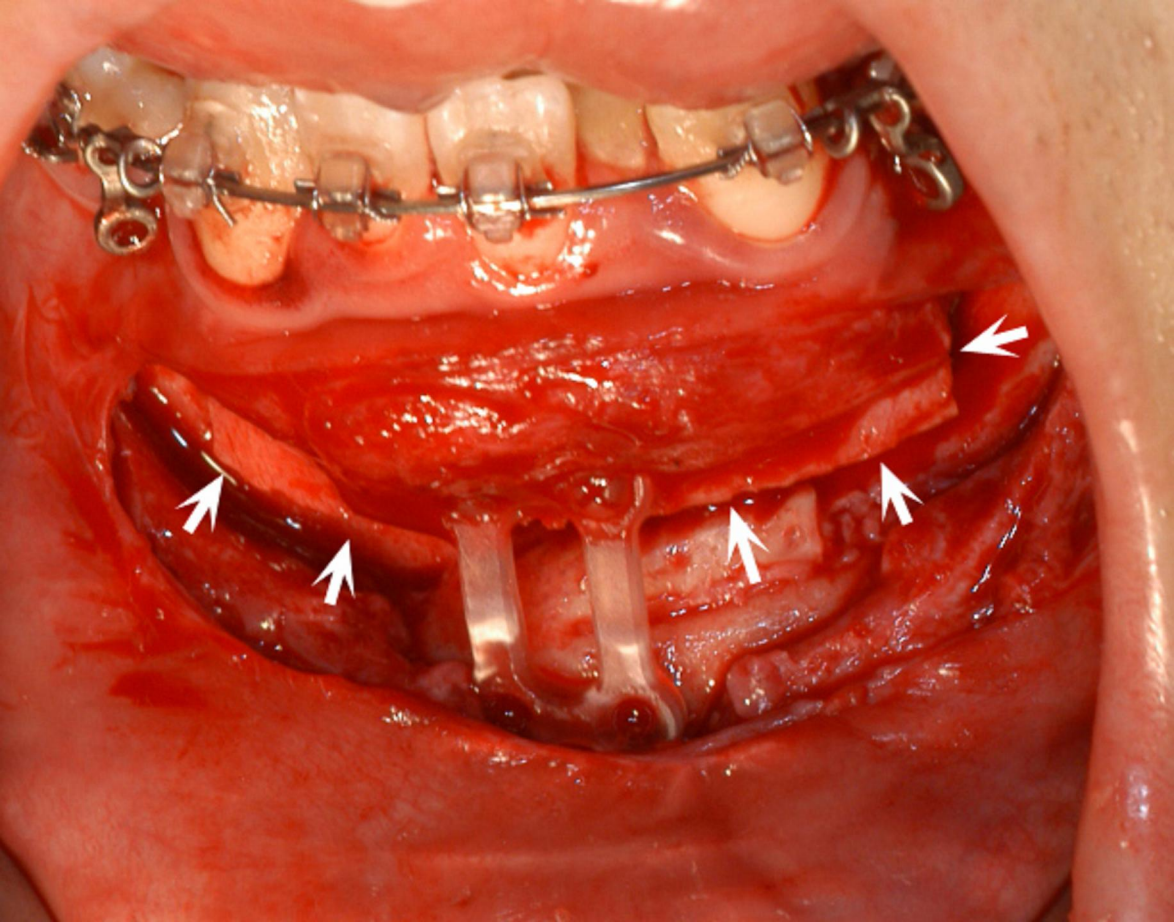
Fig. 6 An intraosseous distractor. We used it with minor modification by

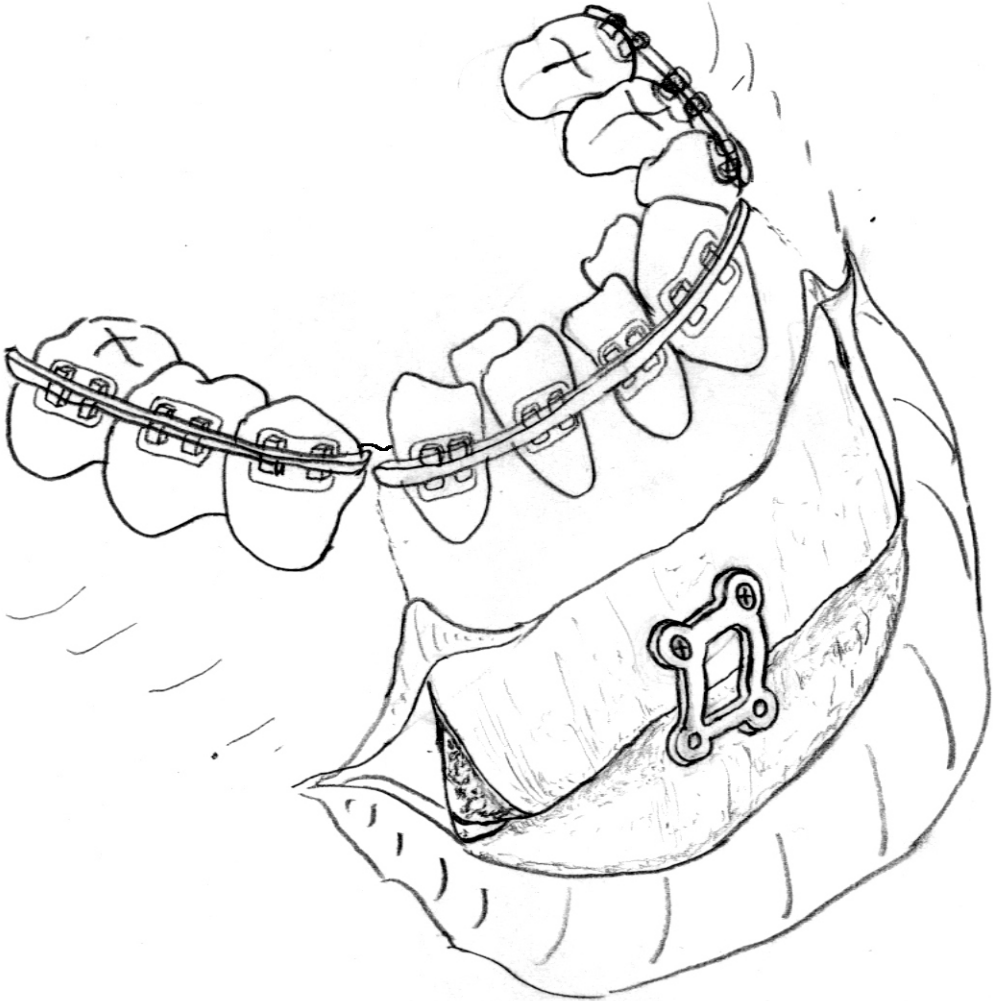
bending both transporter and basal miniplate for suitable attachment to the wire and brackets (see next Figure).

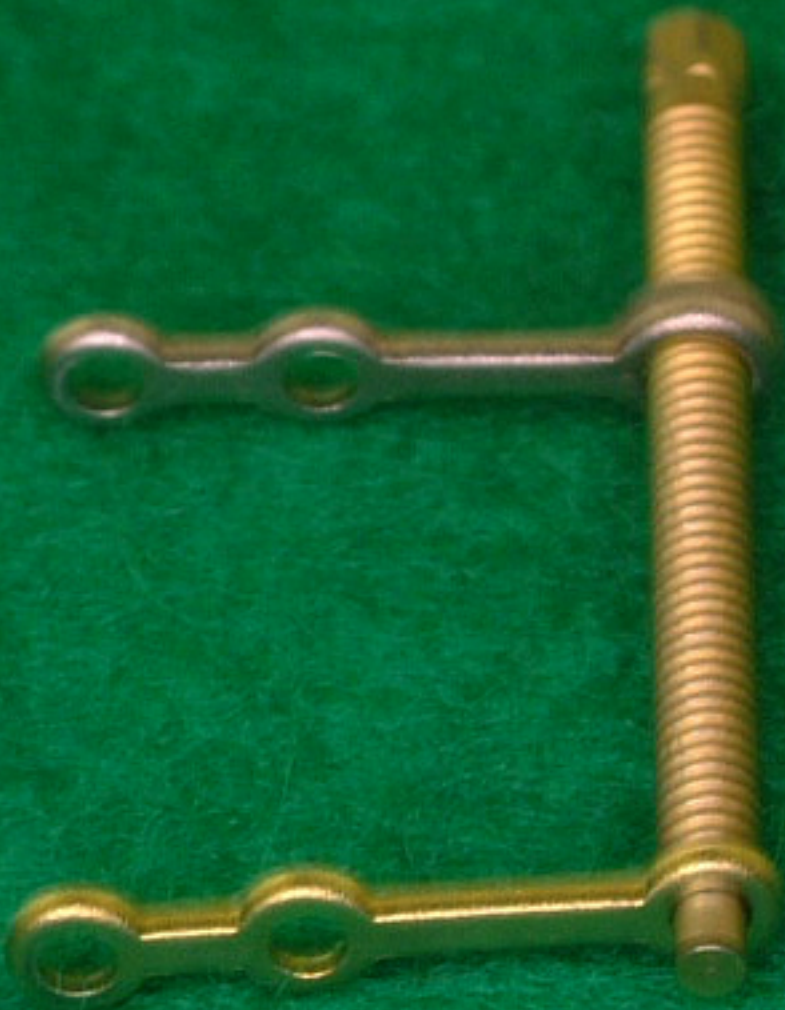
Fig. 7 Occlusal view at the beginning of distraction (A), at the end of distraction (B) and at consolidation (C). Activation was performed at 1.0 mm/day and a distance of 6 mm on the right and 4 mm on the left was distracted due to the initial midline deviation to the right. A temporary resin tooth was inserted bilaterally between canine and second pre-molar to maintain the space for 8 weeks.

Fig. 8 Lateral and postero-anterior cephalometric radiographs at debonding.

Fig. 9 Posttreatment intraoral photographs.





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