

## Segmental Multiple-Jaw Surgery without Orthodontia: Clear Aligners Alone

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**Summary:** Segmental Le Fort I osteotomy, a complex procedure with many mobile parts, has traditionally required presurgical orthodontics with conventional braces, composed of metal brackets, bands, and archwires. These appliances are not always accepted by patients, particularly older teenagers and professional adults who previously endured traditional orthodontia during adolescence, and now require retreatment because of jaw growth differences necessitating orthognathic surgery. Less obtrusive orthodontic therapies, involving clear aligners (e.g., Invisalign), are becoming increasingly popular, as they are less noticeable and less aesthetically objectionable. They are typically indicated for milder occlusal discrepancies, such as crowding and minor rotations, without significant vertical or transverse problems. Clear aligners in conjunction with orthognathic surgery for severe dentofacial problems are progressive and not widely used. Moreover, the most complicated of orthognathic sequences, segmental double-jaw surgery, has never before been described to be performed using Invisalign. Several potential challenges exist when performing segmental double-jaw surgery with Invisalign (i.e., no bonded or banded appliances, and no archwire). The purpose of this article is to review the feasibility of segmental double-jaw surgery without orthodontia (Invisalign only), report a series of cases, and review the technical steps involved. (*Plast. Reconstr. Surg.* 142: 181, 2018.)

**S**urgical treatment of malocclusion is often performed when the envelope of correction exceeds the therapeutic capacity of orthodontics. In certain cases of midface hypoplasia, an alteration in the transverse maxillary dimension is required using a segmental Le Fort I osteotomy.<sup>1</sup> This is typically preceded by preoperative orthodontic therapy with conventional braces.<sup>2</sup> These appliances facilitate intermaxillary fixation with surgical lugs or Kobayashi hooks, and can stabilize segments with a spanning archwire, but patients often report dissatisfaction with this treatment.<sup>3</sup> Clear aligners are appropriate for minor occlusal discrepancies, crowding, and rotations, and are not typically endorsed for use in orthognathic surgery. Furthermore, complicated segmental Le Fort I osteotomy, in conjunction with bilateral sagittal split osteotomy with or without genioplasty (segmental double-jaw surgery), has never been described with Invisalign (Align Technology,

Inc., San José, Calif.) alone. We hypothesized that patient experience may be improved with the use of clear aligners, such as Invisalign. This article reviews the feasibility of double-jaw surgery performed using Invisalign. The benefits, challenges, and technical steps are enumerated, along with a case series review.

### SURGICAL TECHNIQUE

Before orthognathic surgery, the surgeon may obtain stone models of the dental arches or alternatively use the three-dimensional stereolithography models obtained for Invisalign. A transverse discrepancy, and thus the need to segment the maxilla, is noted. Segmentation is completed by hand (stone models) or digitally (three-dimensional stereolithography models) to establish the desired occlusion, which is then incorporated into the computed tomographic scan for three-dimensional planning and splint fabrication.

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Intraoperatively, before performing the segmental Le Fort I procedure, an intermediate splint is placed to the native maxilla following bilateral sagittal split osteotomy in a mandible-first case. Six orthodontic bone anchor screws are inserted at the mucogingival line. This comprises two 8-mm screws between the central incisors and two between the second premolars and first molars bilaterally, used for intermaxillary fixation. In a maxilla-first case, a “splint-within-a-splint” may be used to set the intermediate position while leaving the segmental splint in place. Segmentation using horseshoe osteotomies is undertaken, with a fissure burr. Connection to the alveolar and interdental segments is performed using very fine osteotomes or a piezoelectric saw. Care is taken to avoid avulsion or luxation of teeth in the segment, or injury or fracture to the root(s) between segments. The segmentation connects the alveolar bone to the nasal floor. Maxillary segments are mobilized and widened with the aid of osteotomes and bone spreaders, with interposing bone grafts if appropriate. A final splint is then applied and wired to the orthodontic bone anchor screws in a triangular fashion in three locations. Further intermaxillary wires are placed between the maxillary and mandibular orthodontic bone anchor screws to establish the planned occlusion and maxillomandibular position (Fig. 1). The maxilla is plated in standard fashion. Following genioplasty, layered closure of the mandible and maxilla is performed.

The final splint is typically removed 3 to 6 weeks after the procedure, depending on the type and magnitude of movement. The three-dimensional stereolithographic files of the final occlusion (including maxillary position) are sent



**Fig. 1.** Wires are placed between the maxillary and mandibular orthodontic bone anchor screws and the final splint to establish the planned occlusion and maxillomandibular position.

to the orthodontist and aligner company for the construction of an aligner that will maintain the transverse dimensions of the maxilla on removal of the final splint. This differs from cases that use conventional braces, during which the splint is removed and the orthodontist places a continuous archwire in the maxilla (and a transpalatal wire if necessary). Orthodontic bone anchor screws may be left in situ if required, for vertical adjustment and bite retraining. A series of transparent trays are developed to complete the postsurgical phase of orthodontic therapy.

Our series of double-jaw surgery and Invisalign was reviewed, including seven segmental procedures using the described technique, without complication (Fig. 2). Table 1 illustrates the demographic details, diagnosis, and type of surgery performed in each patient.

## DISCUSSION

There are challenges associated with performing orthognathic surgery with clear aligners. These include the preoperative and postoperative orthodontic regimen, patient compliance, technical execution of osteotomies, and intermaxillary fixation. Fixed orthodontia inserted before orthognathic surgery provide a scaffold for fixation with wires or hooks.<sup>4</sup> Several methods adopted from maxillofacial trauma surgery, including Erich arch bars and orthodontic bone anchor screws, have been used to achieve fixation in patients with clear aligners; each method is associated with unique limitations.<sup>5,6</sup> Furthermore, an understanding, acceptance, and familiarity by the orthodontist are critical to the Invisalign surgical treatment regimen.

There are also challenges specific to clear aligner therapy before segmental Le Fort I and bilateral sagittal split osteotomy. Unlike with conventional braces, teeth adjacent to the planned segmentation are not readily moved to create space for interdental osteotomies in Invisalign patients. In addition, during segmentation, conventional brackets and archwires effectively splint the teeth in the segments together. Use of aligners does not confer this splinting effect, and the theoretical risk of tooth avulsion or root injury is increased. Fixation of the splint to the newly widened maxillary arch for stabilization during the postoperative phase is also more difficult without conventional braces. Orthodontic bone anchor screws at the mucogingival line enable a point of purchase for wiring the splint to the maxilla (to be left postoperatively) and permit temporary



**Fig. 2.** A 19-year-old woman with class II malocclusion underwent segmental double-jaw surgery with Invisalign.

**Table 1. Review of Patients Undergoing Double-Jaw Surgery with Invisalign**

Subject	Age (yr)	Sex	Diagnosis	Type of Surgery
1	19	F	Class II deep bite; transverse maxillary hypoplasia	Segmental double-jaw
2	22	M	Class III open bite; transverse maxillary hypoplasia	Segmental double-jaw
3	21	M	Class III open bite; transverse maxillary hypoplasia	Segmental double-jaw
4	29	M	Class III deep bite; transverse maxillary hypoplasia	Segmental double-jaw
5	28	M	Class III open bite; cross bite (anterior; transverse maxillary hypoplasia)	Segmental double-jaw
6	15	F	Class III open bite; cross bite (posterior; transverse maxillary hypoplasia)	Segmental double-jaw
7	18	M	Class III deep bite; transverse maxillary hypoplasia	Segmental double-jaw
8	17	F	Class III open bite; cross bite (posterior)	Double-jaw
9	17	F	Class III open bite; cross bite (anterior, posterior)	Double-jaw
10	18	F	Class III cross bite (anterior)	Double-jaw
11	23	M	Class III open bite	Double-jaw
12	18	M	Class III cross bite (anterior)	Double-jaw
13	18	F	Class III cross bite (anterior)	Double-jaw

M, male; F, female.

intermaxillary fixation intraoperatively. Once the final splint is removed postoperatively, a continuous archwire cannot be used to maintain the transverse position of the maxilla. Plans must be made for the preparation and insertion of an aligner tray to hold the new maxillary arch position.

Despite these challenges and technical modifications, segmental double-jaw surgery can be successfully performed without the need for conventional metal braces and archwires. There are several benefits to support the use of Invisalign for this procedure. The trays are removable and patients do not require frequent orthodontic appointments for apparatus adjustment. Furthermore, a recent study demonstrated significantly better gingival health and patient satisfaction in those undergoing treatment with Invisalign relative to their counterparts with braces.<sup>7</sup> In the orthognathic setting, there is less mucosal irritation, and there is the ability to present socially without the stigma of metallic braces.

## CONCLUSIONS

Although careful planning of the technical steps is necessary, segmental double-jaw surgery can be effectively performed while using Invisalign. This expands the repertoire of treatment options offered to surgical patients, where clear aligner therapy can be used, without compromising outcomes.

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## PATIENT CONSENT

*Patient provided written consent for the use of patient's images.*

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