Skeletal class III malocclusions present with a combination of various skeletal types and the severe ones warrant orthognathic surgery.\(^1\) However, mild skeletal class III malocclusions can be effectively treated with orthodontic camouflage whereby the underlying jaw discrepancy is compensated by displacing the teeth in relation to their supporting bone and to camouflage a skeletal class III malocclusion, the maxillary incisors are proclined and the mandibular incisors are retroclined.\(^2\) Fixed appliance therapy with extractions in the mandibular arch only is an effective treatment of choice for camouflaging the skeletal class III malocclusion characterized with severe reverse overjet. This has become all the more possible with the advent of micromplats as they provide absolute anchorage for en-masse retraction of the whole arch.\(^3,4\)

But this same treatment plan would be hazardous for patients with mild reverse overjet as the overjet would inadvertently increase severely. Expansion of maxillary dental arch or nonextraction would be more appropriate for mild skeletal class III malocclusion. However, if patients don’t desire metal braces, an alternative approach like invisible orthodontics is suggested. Patients in professions who are not desirous of lingual orthodontics too are presented with yet another alternative invisible orthodontic appliance such as clear aligners that are invisible, comfortable and esthetic.

Movement of teeth without the use of bands, brackets, or wires was described as early as 1945 by Dr. H. D. Kesling, who reported on the use of a flexible tooth positioning appliance. Minor tooth movements have also been achieved with a technique developed by Raintree Essix (New Orleans, LA, USA). This technique uses clear aligners formed on plaster models of the teeth. This type of appliance can be effective in correcting mild discrepancies in the alignment of teeth. However, movements are limited to 0.25–0.3 mm; beyond this range, another impression, and a new appliance is needed.

Sheridan et al.\(^5\), reported on the use of Essix thermoplastic appliances for various orthodontic uses. (Trademark of Raintree-Essix Corp., 1069 S, Jeff Davis Parkway, New Orleans, LA, 70125). This is based on the Kesling “set-up” technique, where teeth are individually cut, repositioned and appliances made to move the teeth into the “set-up” position. Another esthetic alternative for fixed labial braces was the introduction of Invisalign of Align technology, which uses computer-aided design/computer-aided...
manufacturing stereolithographic technology to forecast treatment and fabricate many custom made aligners from a single impression wherein each aligner is programmed to move a tooth or a small group of teeth 0.25–0.33 mm in 14 days.[8] The drawback of these techniques is that almost every tooth movement (or movement of a number of teeth) requires a new model “set-up” and therefore, a new set of impressions for the patient at almost every visit. This is uncomfortable for the patient, and time and labor intensive for the orthodontist.[7] With clear aligners of which the ClearPath orthodontics, clearpath trading and manufacturing co., KSA is a system, a single impression can be used to make a series of aligners for both the maxillary and mandibular dental arches simultaneously and the malocclusion is corrected by repeated change of the aligners every fortnight, thereby making adult orthodontics a reality. This case report reiterates the treatment of a mild skeletal class III malocclusion with reduced overjet and anterior cross-bite of the maxillary lateral incisors with the ClearPath system of clear aligners.

Case Report

Diagnosis and etiology

A 15-year-old female patient presented with backward placement of maxillary lateral incisors and severe crowding of maxillary anteriors.

Extraoral assessment

The patient had a mesoprosopic face, mild concave profile, mild anterior divergence, competent lips, and clinical low mandibular plane angle, with no signs of temporomandibular joint dysfunction [Figures 1a-c].

Intraoral assessment

Oral hygiene was satisfactory. The maxillary arch was U-shaped with crowded maxillary incisors. The mandibular arch was also U-shaped with imbrication of mandibular incisors. Anterior cross-bite of maxillary laterals, decreased overjet and deep bite, were observed. The maxillary and mandibular dental midlines coincided with each other and with the skeletal midlines. On both sides, the molar relation was class III, and the canine relation was class III on right side and class I on the left side. The curve of Spee was 1 mm [Figures 1d-f].

Radiographic assessment

The panoramic radiograph confirmed the presence of all permanent teeth and normal alveolar bone levels [Figure 2].

Cephalometric analysis [Table 1] revealed a mild skeletal class III pattern, with a retrognathic maxilla and an orthognathic mandible with a low mandibular plane angle [Figure 3].

Treatment objectives

The main treatment objective was to improve the soft tissue profile and enhance smile esthetics. Since the maxilla was mildly retrognathic and mandible was orthognathic, greater emphasis was laid for the correction of the crowded maxillary incisors, anterior cross-bite of maxillary laterals and deep bite. Nonextraction approach with proximal slicing was contemplated to correct the crowded maxillary anteriors to orthodontically camouflage the mild skeletal class III malocclusion.

Treatment alternatives

Conventional orthodontics with metal braces could have been performed, but the patient desired an esthetic appliance. Lingual appliance was the other alternative but as the patient was a classical singer and a professional dancer she felt that this appliance would affect her pronunciation and singing. Patient readily agreed for a removable esthetic appliance as this would be inconspicuous and invisible.

Figure 1: (a) Pretreatment extra-oral-frontal. (b) Pretreatment extra-oral-profile. (c) Pretreatment extra-oral-smiling. (d) Pretreatment intra-oral-frontal. (e) Pretreatment intra-oral-right. (f) Pretreatment intra-oral-left
Yezdani: Correction of mild skeletal class III malocclusion with transparent aligners

Table 1: Cephalometric analysis

| Variable        | Normal     | Pretreatment | Posttreatment |
|-----------------|------------|--------------|---------------|
| SNA (°)         | 82±2       | 78           | 78            |
| SNB (°)         | 80±2       | 60           | 79            |
| ANB (°)         | 2±2        | −2           | −1            |
| U1 to NA (mm)   | 4          | 6            | 5             |
| L1 to NB (mm)   | 4          | 2            | 2             |
| GoGn-SN         | 32±2       | 29           | 29            |
| N-Me (mm)       | 123±5      | 103          | 110           |
| N-ANS (mm)      | 56±3       | 50           | 55            |
| ANS-Me (mm)     | 70±5       | 53           | 55            |
| FMA (°)         | 25         | 23           | 21.5          |
| Witt’s appraisal| B0 ahead of| 2            | 1             |
| E-plane LL (mm) | 2±2        | −6           | −4            |
| N-Perp to point A (mm) | 1.1 | 0          | −2            |
| N-Perp to point B (mm) | −0.3 | 3          | −1            |
| TVL to point A’ (mm) | −3±1 | 1            | −2            |
| TVL to point B’ (mm) | −7.1±1.6 | −2        | −3            |

TVL: True vertical line

Treatment progress

Accurate impressions of the maxillary and mandibular dental arches were taken with both the putty and light bodied polyvinyl siloxane (PVS) impression material (3M ESPE) [Figure 4a-b]. Bite registration was taken with a putty PVS impression material [Figure 4c]. The impressions were then disinfected and packed carefully and sent to the ClearPath Lab. The impressions were scanned and a virtual set-up was done comprising of diagnosis, treatment planning, and interproximal reduction (IPR) estimation. The ClearPath diagnostic and treatment form, radiographs and photographs aided considerably in the virtual set-up. A movement record form was sent along with the clear aligners to the clinician, detailing the different tooth movements like mesial, distal, lingual, buccal translation; buccal, lingual, mesial distal, tipping; mesial, distal, buccal, lingual torque; intrusion, extrusion; and mesial and distal rotation. The ClearPath virtual set-up enabled the clinician to visualize the post treatment results and to add any inputs where deemed necessary. The lab then processed a series of ClearPath aligners and shipped it back to the clinician [Figure 5]. Refinement and finishing aligners were used to correct mild discrepancies found post actual treatment results.

Treatment outcome

The patient showed remarkable improvement in the correction of the crowded maxillary incisors. The anterior cross-bite of the maxillary lateral incisors and the crowded maxillary anteriors was corrected. The patient was advised to change the clear aligners
After treatment, good facial harmony and balance was achieved [Figure 7a-c]. Class I canine relationship was achieved whereas a class III molar relationship had to be inevitably maintained. Normal overjet was achieved with alignment of maxillary anteriors. The positive overbite that was obtained helped prevent relapse of the pre-existent severe anterior cross-bite [Figure 8a and b].

The posttreatment panoramic radiograph showed normal levels of alveolar bone with parallelism of the roots of the mandibular teeth well maintained with no root resorption [Figure 9]. The posttreatment lateral cephalometric radiograph was taken to gauge the treatment changes that was achieved [Figure 10].

The lateral cephalometric measurements showed mild changes post treatment. A mild decrease in SNB reading was observed. The Wits appraisal reading changed from −2 mm to −1 mm and the true vertical line to soft tissue point B reduced by −1 mm, from −3 mm to −2 mm. The lower anterior facial height showed an increase of 7 mm, but the mandibular plane angle did not increase as the vertical growth of the posterior ramus compensated for the downward and backward rotation of the mandible. There was no dramatic change in the position of the mandibular incisors. The lower lip to E-plane changed from −6 mm to −4 mm [Table 1]. Maxillary fixed lingual retainer was given to prevent relapse [Figure 11]. The occlusion was stable a year postretention, and the facial profile and smile improved dramatically [Figure 12a-c].

Discussion

ClearPath three-dimensional aligner is a removable, resilient polyurethane aligner that snaps over the teeth and the mucosa and exerts pressure until the teeth attain their predetermined positions. The first aligner is more passive in nature and gives the necessary time for the patient to get adjusted to the forthcoming series of clear aligners. ClearPath aligners are also used for arch expansion, anterior space closure, reduction of overjet, correction of deep bite, cross-bite and minor rotations. Uncontrolled tipping is the type of tooth movement that occurs with a ClearPath aligner. The amount of relative intrusion and extrusion to program can be determined by estimating the location of the center of rotation of the teeth. This is approximately 41% of the root length apical to the faciolingual crestal bone. Occlusal forces seat the appliance for a better fit as also produces the necessary forces and moments required for treatment.

Treatment efficiency results reported by Kravitz et al. [8] reported a mean overall accuracy of 41% whereas our results showed better treatment results more so for the maxillary dental arch. The full prescription may not be effectively expressed as orthodontic tooth movement may be affected by other factors such as location of center of resistance (determined by root length, root width, bone height), as also sex, age, bone quality, and tooth length. [9,10] This observation was true in the case treated with respect to the mandibular dental arch.

New materials are constantly being introduced and with the fabrication processes becoming automated with even greater accuracy, ClearPath aligners have come as a boon for those patients who desire orthodontic treatment sans the brackets and wires. No buttons, elastics or attachments are required with ClearPath three-dimensional aligners. Highly precise and controlled movements are in-built in the aligners through

![Figure 6: ClearPath aligner in situ](image)

![Figure 7: (a) Posttreatment extra-oral-frontal. (b) Posttreatment extra-oral-Smiling . (c) Posttreatment extra-oral-profile](image)
advanced software systems. Reversible deformation of the aligner produces forces when a tooth is moved by aligners. Near the misaligned tooth, the aligner tends to lift up from the teeth and then becomes deformed in the shape of a bow. This mechanism is one among others evoking the forces acting on the tooth to be moved. During swallowing an occlusal contact between the upper and lower row of teeth results in a vertically acting force, on average about 30 N. When an aligner is used to induce tooth movement the resultant force system may be modified by the occlusal forces acting during swallowing by pressing the lifted aligner back on teeth. Biting on cotton rolls is advised to effectively seat the ClearPath aligners to achieve effective distribution of forces to the teeth. An amalgamation of the above-mentioned factors could have been the cause of correction of the anterior cross-bite of maxillary lateral incisors and the crowded maxillary anteriors. Refinement and finishing aligners are prescribed if any discrepancy is found in the actual results when compared to that of the virtual set-up. This was true in the case treated too. A cardinal point to be taken care of in this treatment technique is the recording of accurate impressions with the ideal PVS rubber base impression material (addition silicone). This is so because of its high accuracy, short setting time of 5 min, minimal distortion on removal and dimensionally stable quality even after 2 weeks. Inadequate bonding with tray, putty and tray show through, incompletely set material, poor bond between heavy and light body wash, voids in the wash...
impression, last molars not fully captured and double print could be the other factors negating accurate fabrication of ClearPath aligners. However, final finishing and detailing is a goal yet to be achieved by these aligners. Future research to address these problems could make adult orthodontics with these ClearPath aligners a much desirable treatment approach.

**Conclusion**

ClearPath three-dimensional aligners, a system of clear aligners has been effective in the treatment of a mild skeletal class III malocclusion in the patient for whom an invisible treatment approach was the prime objective of seeking orthodontic treatment.

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