OCCLUSAL REHABILITATION

Functional Occlusal Rehabilitation of a Mutilated Adult Dentition Caused by a Constricted Chewing Pathway: 6-Year Follow-up

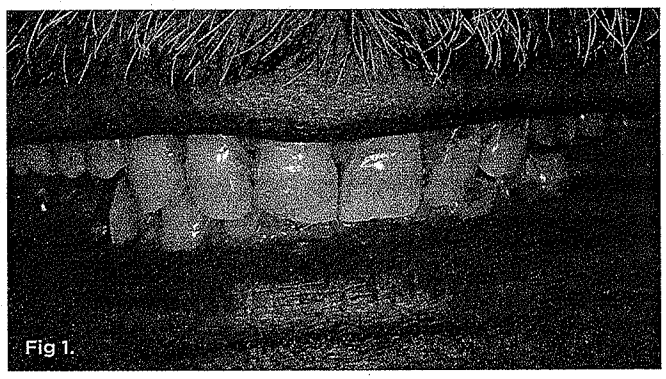
Ali Tunkiwala, MDS; Ashok Karad, MDS; Danesh Vazifdar; Priya Bijlani, MDS; and Shruti Chhajed, MDS

Abstract: Adult patients with class II division 2 malocclusion often present with several occlusal problems. Employing a singular restorative modality to fix the problems without considering the long-term prognosis can lead to disastrous outcomes. Oral rehabilitation in such mutilated dentitions is challenging and requires a holistic diagnostic approach to achieve long-term stability and a good prognosis. Systematic risk assessment of periodontal, biomechanical, functional, and dentofacial aspects can help identify the potential difficulties that may be encountered in treatment execution. An interdisciplinary approach with judicious use of orthodontics can significantly help reduce the risks. This article presents such an approach to functional occlusal rehabilitation of a mutilated adult dentition caused by a constricted chewing pathway. Cephalometric parameters were utilized to guide the overall treatment and were drastically improved at the completion of the treatment, in which restorative principles were strictly adhered to. The stable esthetic and functional rehabilitation at the 6-year follow-up highlights the importance of comprehensive treatment planning to achieve favorable clinical outcomes in cases requiring complicated oral rehabilitation.

Skeletal and dental morphologic variations in human beings play an important role in determining whether the stomatognathic system will remain disease free throughout the lifetime of a patient. While orthodontic literature clearly outlines the morphologic variations in dental arrangements, it also emphasizes the need for early diagnosis and treatment of skeletal and dental malocclusions.[1,2] When malocclusion, specifically that which is classified as class II division 2, is not treated in a timely fashion, a variety of dental occlusal problems may result as the patient enters adulthood.[3] In addition, environmental and dietary factors and in some cases patient neglect can further contribute to disease progression making the execution of treatment non-conservative or impossible without the use of adjunctive orthodontics or surgery.

In cases of severe class II division 2 malocclusion, the retroclination of the maxillary incisors, as well as their overeruption, leads to a traumatic bite and occlusal interferences during normal jaw movements. In such patients the jaw may be pushed back to avoid anterior contact and to achieve maximum intercuspation, which may lead to musculoskeletal pain. Additionally, the interincisal angle in such cases may form a nearly straight line (cephalometrically) and lead to heavy frictional contacts on the anterior teeth.

Patients are considered to have a constricted chewing envelope when an anterior tooth or restoration is in the chewing pathway and, thus, pushes the jaw backward or restricts its anterior free movement resulting in anterior friction.[4] If the initial point of contact in centric relation is on the incisors (as is typically seen with constricted chewing patterns), equilibration is not an option; either orthodontics or an additive procedure for the posterior teeth must be considered.[4] In certain cases, the vertical dimension may need to be altered. The treatment, in essence, requires the anterior teeth



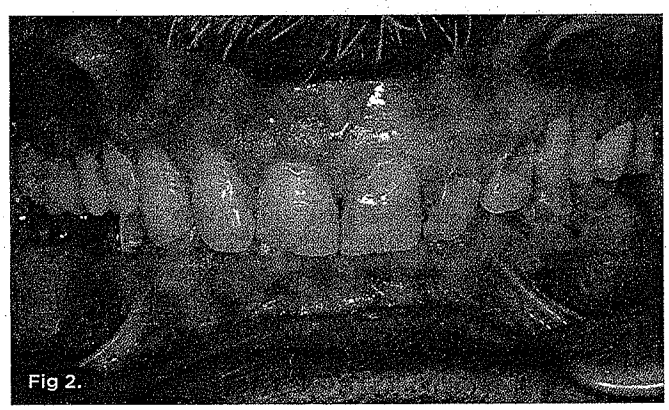


Fig 1 through Fig 3. Pretreatment smile (Fig 1); pretreatment intraoral view of teeth in occlusion (Fig 2); pretreatment intraoral view depicting wear pattern of teeth (Fig 3).

to be repositioned or restored or both to create a chewing pathway without anterior interferences.

For long-term stability and optimal function, it is critical that the increased vertical overlap of incisors is corrected to establish a proper interincisal relationship. Incisor overbite correction can be accomplished either by the intrusion of incisors, with little or no mandibular rotation (change in vertical dimension), or by the extrusion/restoration of posterior teeth, which leads to an increase in lower facial height by mandibular rotation. The clinician must determine the vertical height at which the occlusion will be reorganized and understand the resultant intermaxillary relationship to achieve precise interdisciplinary treatment planning.[5] In some adult cases the tooth morphology itself is so damaged that restoration is imminent, even after orthodontic correction.

In complex cases, such as the present one, a systematic risk assessment will help the clinician chart out the potential difficulties so that solutions may be provided that minimize failure and maximize a successful outcome.

Clinical Case Presentation

A 62-year-old healthy nonsmoking male patient presented desiring replacement of missing teeth in the lower right posterior region. He reported wear of his lower anterior teeth (Figure 1 through Figure 3). Clinical and radiographic examination and a thorough analysis of the patient's esthetic and functional problems were conducted.[6] Adequate study casts were used to evaluate occlusion, and relevant findings were summarized.

Facial analysis: The maxillary occlusal plane and dental midline were canted. The height of the lower third of the face appeared reduced.

Dentolabial analysis: The patient had a broad smile showing 12 upper and most lower anterior teeth. The occlusal plane discrepancy between the upper anterior and posterior teeth was evident.

Phonetic analysis: "M" and "s" sound pronunciation revealed a diminished vertical dimension. "F" and "v" sound pronunciation revealed incisors of adequate length.

Dental analysis: In addition to the dental midline being canted, the maxillary incisors were retroclined, and the axial inclinations of the anterior teeth were not ideal. There was a discrepancy in gingival levels between anterior and posterior teeth. Saucer-shaped defects were seen on the maxillary left lateral incisor and canine; mandibular left canine, first premolar, and first molar; and mandibular right first premolar. Mandibular incisors had severe wear facets. Moderate wear was evident on the maxillary central incisors, maxillary left lateral incisor, and maxillary left canine.

Radiographic analysis: Poor endodontic treatment had been done in the maxillary left first molar, mandibular left first molar, and mandibular right premolars and second molar. Interproximal decay was detected in the mandibular left second premolar.

Occlusal analysis: Severe wear of labial surfaces of the mandibular anterior teeth and palatal surfaces of the maxillary anterior teeth suggested frictional wear of anterior teeth. Along with a severe deep bite and reduced overjet of less than 1 mm, the patient had classic class II division 2 malocclusion. Based on these clinical observations and answers to a detailed questionnaire provided by the patient, a functional diagnosis of constricted chewing pattern was made.[3,7]

The diagnosis was confirmed by deprogramming with the use of a Kois deprogrammer, which showed that the first point of contact occurred on the anterior teeth. In such a case it would be detrimental to prepare the anterior teeth, especially the upper teeth, as achieving adequate clearance for restorations would be challenging and would put these teeth at a higher biomechanical risk. Thus, orthodontics was chosen to reposition the upper anterior teeth and obtain sufficient room for the restorative endeavor.

Risk Assessment

Periodontal, biomechanical, functional, and dentofacial risk analyses were carried out,[7,8] and the assessments were as follows:

Periodontal risk assessment: From a periodontal perspective the patient was low risk, as periodontal evaluation showed minimal bone loss and minimal bleeding on probing corresponding with American Academy of Periodontology (AAP) class II. The prognosis was good.

Biomechanical risk assessment: The patient was at a high risk from a biomechanical perspective. Several posterior teeth were structurally compromised due to previous dental treatment, making them susceptible to fracture. The maxillary right first premolar, mandibular left first molar, and mandibular right second molar had questionable prognoses. The anterior teeth were damaged because of friction, which left behind minimal enamel for bonding. In addition, saucer-shaped defects were present on the labial surfaces of several teeth. The prognosis for the aforementioned posterior teeth was questionable, but overall prognosis for the rest of the dentition was good.

Functional risk assessment: The patient presented with class II division 2 malocclusion characterized by the retroclined position of the upper incisors along with a deep bite. The temporomandibular joint (TMJ) was healthy, with load test negative at this time, although the patient reported having past episodes of pain in the TMJ region several years prior. The patient was at a high risk due to a constricted chewing pattern, which, in turn, caused anterior friction. The prognosis from an occlusal standpoint was fair.

Dentofacial risk assessment: The patient was at a high risk dentofacially, as there was maximum tooth display and marginal gingival display while smiling. There was an obvious occlusal plane discrepancy between the anterior and posterior teeth, and the gingival zeniths were uneven.

With such a high overall risk assessment, a treatment plan was needed that would conserve tooth structure with minimally invasive techniques and address the cause of the extensive mutilation.

Treatment Goals

The clinical goals of the treatment were to: correct the inclination of the maxillary anterior teeth and achieve a stable occlusal relationship using orthodontics to eliminate the constricted chewing pattern; restore the vertical dimension of occlusion (VDO); restore biomechanically compromised teeth; improve function by replacing missing posterior teeth; establish maximum intercuspation in harmony with centric relation; and establish dentofacial harmony in keeping with smile design concepts.

Treatment Phases

The treatment goals were achieved over four phases, as outlined in the following sections.

Phase 1: Orthodontics

To improve the occlusal relationship and eliminate the constricted chewing pattern, orthodontic treatment was imperative. The maxillary arch was orthodontically treated to correct the arch form to improve the labiopalatal inclination of the maxillary incisors (Figure 4). Preoperative cephalometric findings confirmed the severe retroclination of incisors with an abnormally obtuse interincisal angle.

In such a case, it is critical to set a clear goal in orthodontics prior to the restorative phase. The goal here was to correct the inclination of the upper anterior teeth and improve the overbite to eliminate anterior friction. This also would make the treatment conservative, because the overall preparation of teeth would be lessened and within the existing enamel after completion of orthodontic therapy.

A resin mock-up of incisal edges of the maxillary anterior teeth was made to provide the orthodontist guidance for repositioning these teeth. Interim fixed dental prostheses were planned on the endodontically treated mandibular left premolars and first molar, and a fixed partial denture was planned to replace the mandibular right first molar to control the vertical position of the maxillary posterior teeth and test-drive the tentative VDO.

At 6 months, the maxillary arch form was corrected (Figure 5) and favorable inclination of the maxillary incisors was achieved. It was concluded that the incisal edges of the maxillary incisors and canines were in a facially correct position when analyzed in lip repose and full smile.

Phase 2: Restorative Therapy Wax-up

After completion of the corrective pre-restorative orthodontics, a discrepancy still existed between the maxillary anterior and posterior occlusal plane. The goal, thus, was to correct the maxillary posterior occlusal plane through the addition of restorative material in the form of onlays on molars and full coverage on premolars.

Study model impressions were made. The maxillary cast was mounted on a semiadjustable articulator using a facebow record. The mandibular cast was mounted using a centric record taken at

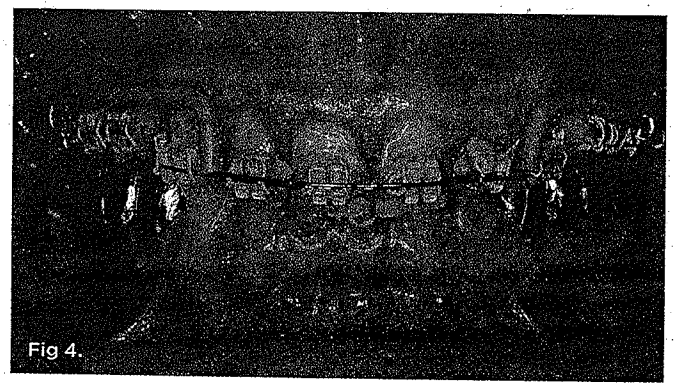


Fig 4. Orthodontic phase of treatment. **Fig 5.** Maxillary arch form improved after 6 months of orthodontic treatment.

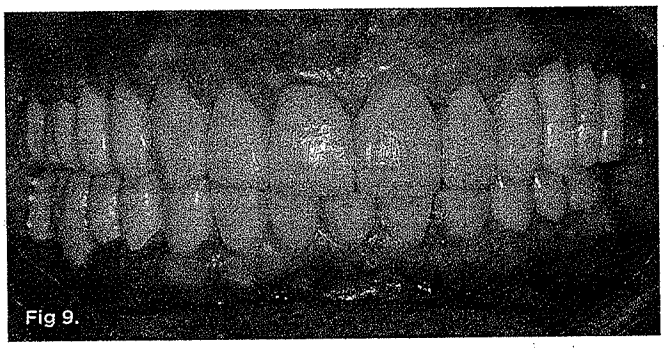
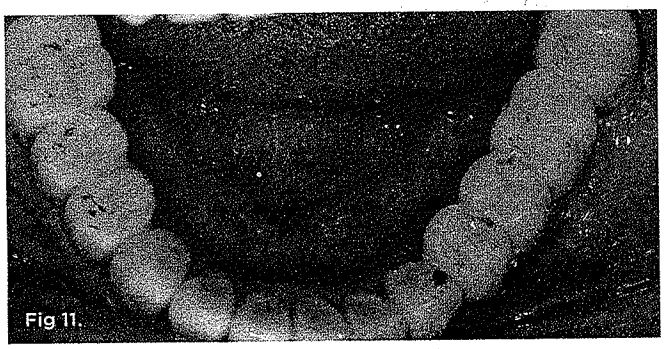


Fig 9.


Fig 10.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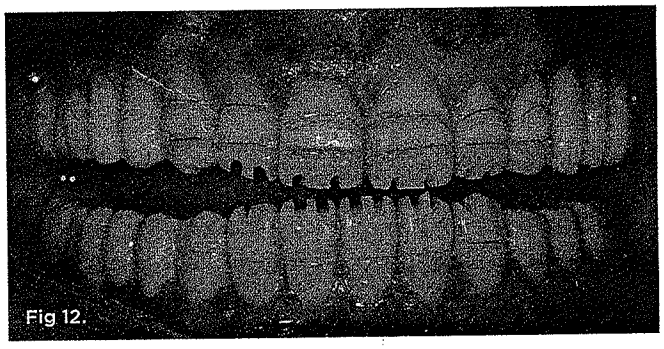
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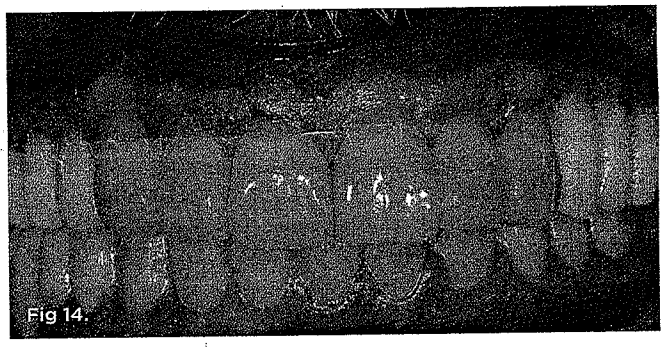
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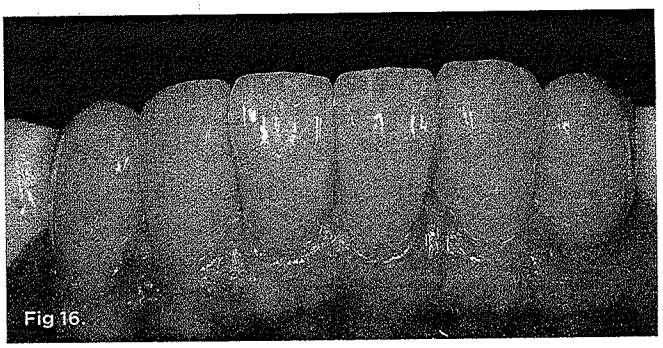


Fig 16.

Fig 9. Provisional restorations. **Fig 10 and Fig 11.** Uniform contacts of equal intensity in provisional maxillary (Fig 10) and mandibular (Fig 11) restorations. **Fig 12.** Reduction grooves made through the provisional restorations to minimize tooth reduction. **Fig 13.** Conservative maxillary tooth preparations in enamel. **Fig 14.** Bonded lithium-disilicate restorations on maxillary anterior teeth. **Fig 15.** Conservative tooth preparations for mandibular anterior teeth. **Fig 16.** Bonded lithium-disilicate restorations on mandibular anterior teeth.

an increased vertical dimension after deprogramming the patient with a Lucia jig.

The vertical dimension on the semiadjustable articulator was opened just enough to meet the minimum requirements of space for the final restorative material. Vertical occlusal dimension needed to be increased to correct the overclosure of the mandible (as determined by the post-orthodontic cephalogram) and to achieve optimal esthetics and phonetics. Increasing the vertical dimension also helped establish favorable interincisal relationship.

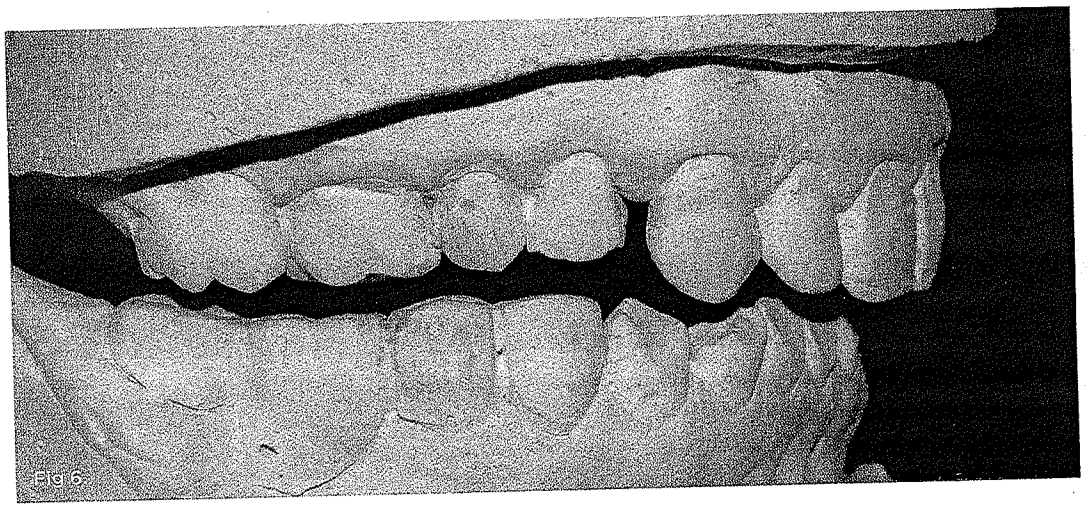
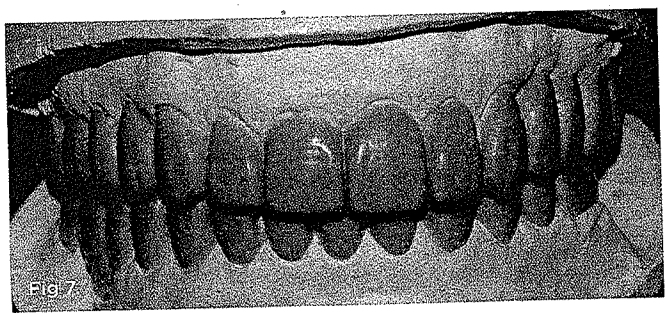
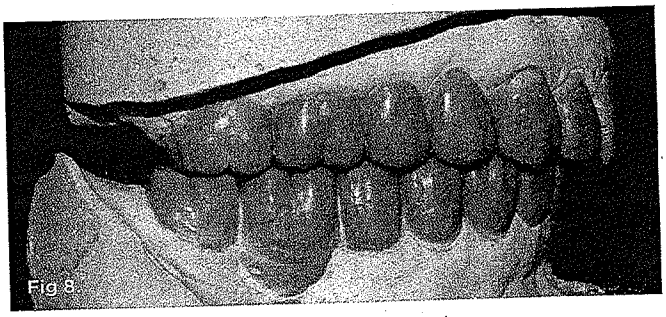


Fig 6. Discrepancy was apparent in anterior and posterior occlusal plane after orthodontics. **Fig 7 and Fig 8.** Wax-up at increased VDO (Fig 7) and eliminating the discrepancy in the occlusal plane (Fig 8).





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The casts were sent to the laboratory for a wax-up. The incisal edge position of the natural maxillary anterior teeth was to be maintained as a reference in the wax-up. The posterior occlusal plane needed addition to eliminate the discrepancy there (Figure 6). The wax-up with the increased VDO is shown in Figure 7 and Figure 8.

Phase 3: Implant Placement and Endodontics

Endodontic retreatment was carried out on the maxillary left first molar, mandibular left first molar, and mandibular right premolars and second molar. In addition, the maxillary right first premolar developed a crack and required endodontic treatment. The interim fixed dental prosthesis replacing the mandibular right first molar was removed, and an implant was placed in this region. Healing was allowed for 3 months using a submerged protocol.

Phase 4: Provisional Restorations

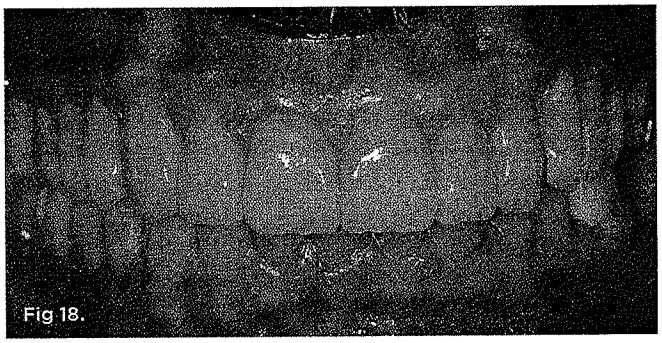
Putty and light-body silicon indices (Express™, 3M ESPE, 3m.com) of the wax-up were made. These were used as a matrix to carry chemically cured resin-based material (Protemp™, 3M ESPE) onto the teeth to act as a mock-up for the final restorations. Three weeks after implant placement, the patient was scheduled for provisional restorations. The maxillary teeth were etched with phosphoric acid, and, after drying, bonding agent was applied and cured, and the material for the provisional restorations (Protemp™ 4, 3M ESPE) was loaded in the index and placed on the teeth. No teeth were prepared at this point. Care was taken to seat the index with correct orientation and adequate pressure to achieve a very thin flash of excess material around the teeth.

A similar procedure was performed to produce the mandibular provisional restorations. A #12 blade and a 12-fluted carbide bur were used to finish the gingival and interdental aspects of the bonded provisional restorations (Figure 9). Occlusion was checked to ensure uniform contacts on posterior teeth in maximum intercuspation (Figure 10 and Figure 11). The vertical dimension was measured between the gingival margins of maxillary and mandibular canines on the right side and adjusted until it was found to be equal to the desired VDO on the wax-up. The provisional restorations were also evaluated for esthetics and phonetics, and minor adjustments for tooth positions were made to further improve the same.

The patient was then asked to test-drive the provisional restorations and report back any concerns. The lower third facial height appeared to be restored at the new vertical dimension. After 8 weeks, when the patient's comfort was ascertained, the process of making the definitive restorations was initiated. The sequence of producing these restorations was: (1) maxillary anteriors, (2) mandibular anteriors, (3) maxillary and mandibular posteriors simultaneously.

Full-coverage, monolithic, bonded lithium-disilicate restorations were planned in the anterior region to preserve maximum tooth structure and attain good esthetic results. To accommodate the desired lithium-disilicate material, depth grooves were cut through the provisional restorations to minimize tooth reduction (Figure 12). The tooth preparations for the upper anterior teeth were conservative and completely in enamel to enhance bonding and improve bond strength (Figure 13). To avoid cutting too much tooth structure while making a traditional chamfer or shoulder, vertical preparations


Fig 17.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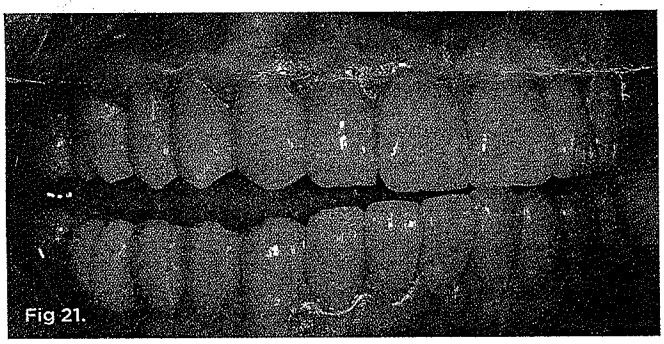
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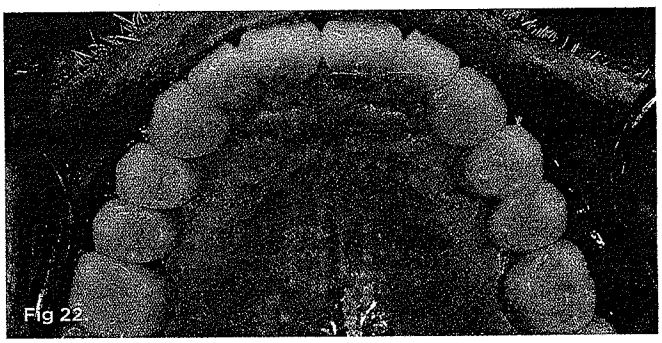
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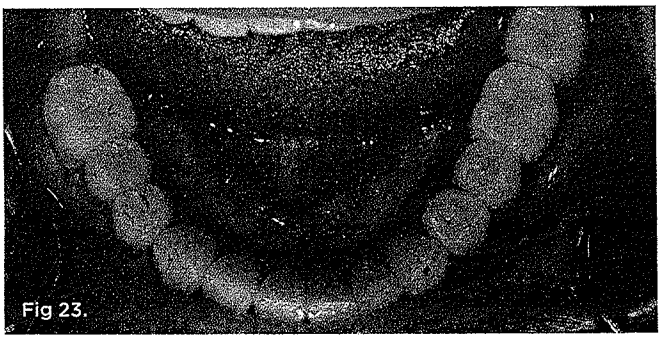
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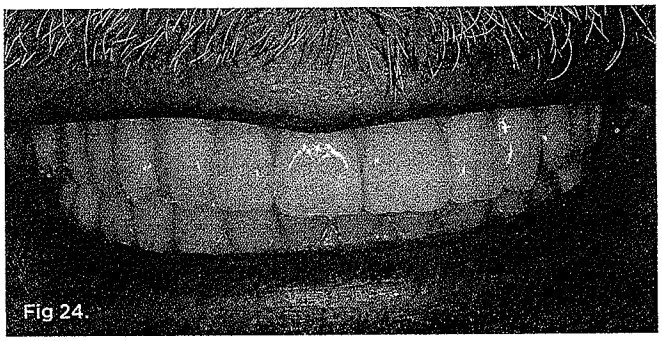
Fig 24.

Fig 17. Anterior definitive restorations served as a stop for maintaining vertical dimension when making posterior prosthesis impressions (right side is shown). **Fig 18 through Fig 20.** Definitive restorations in occlusion; frontal view (Fig 18), right lateral view (Fig 19), left lateral view (Fig 20). **Fig 21.** Posterior disclusion on protrusion of mandible. **Fig 22 and Fig 23.** Uniform occlusal contacts in the definitive restorations; maxillary (Fig 22) and mandibular (Fig 23). **Fig 24.** Post-treatment smile.

were done. Figure 14 shows the maxillary anterior definitive bonded lithium-disilicate restorations. The lower anterior teeth were then conservatively prepared in the same manner (Figure 15). Tooth preparation was within enamel. Figure 16 depicts the mandibular anterior definitive bonded lithium-disilicate restorations.

The increase in vertical dimension and improved upper arch form with orthodontics led to a horizontal overjet of about 5 mm. The palatal aspects of the maxillary anterior crowns and the labial aspects of the mandibular anterior crowns were bulked up within morphological limits to achieve good contact in the anterior segment

to prevent supraeruption of lower incisors, thereby maintaining stability. This was followed by making impressions for fabrication of definitive monolithic lithium-disilicate restorations of maxillary and mandibular posterior teeth. The anterior definitive restorations would act as a stop for maintaining VDO during this phase of treatment (Figure 17).

Occlusion was meticulously adjusted to ensure uniform contacts of equal intensity on posterior teeth. From canines to second molars, each tooth was able to hold the shimstock (12 μm) while the same shimstock passed through the incisors in maximum intercuspation. The pathway adjustments were made using a 200-μm articulating paper with the patient in the upright position[9] to ensure there was no friction on anterior teeth or constriction of the chewing envelope during function. The definitive restorations in occlusion are shown in Figure 18 through Figure 20. There was posterior disclusion on protrusive movement of the mandible (Figure 21), although the friction-free chewing pathway is more important than this static, postured protrusive position. The uniform contacts on the definitive restorations are depicted in Figure 22 and Figure 23. Figure 24 shows the patient's smile post-treatment.

A comparison of cephalometric paramaters analyzed before and after restorative treatment is summarized in Table 1. Superimpositions of the lateral cephalogram tracings before and after treatment are shown in Figure 25. The key changes were noted in the inclination of the upper and lower incisors and the interincisal angle, which was near normal post-treatment. Because the incisors were now in better relation with each other, friction was minimized and the super-eruption of lower anterior teeth was prevented due to the contact with the upper incisors in heavy bite. The overall functional and esthetic result was satisfactory to the patient. The case has been followed up for 6 years. During this time a biomechanically weak tooth, the mandibular left first molar (noted in the risk assessment), was lost and replaced with an implant.

Conclusion

This article described an interdisciplinary, methodical approach adopted after thorough analysis and risk assessment in a complex case of constricted chewing pattern that required occlusal rehabilitation. Pre-restorative orthodontic treatment was used to align the upper teeth and reduce the vertical overbite thereby allowing for conservative tooth preparations and improving the emergence and esthetics of anterior teeth. The cephalometric parameters were drastically improved after the treatment, which was carried out with strict adherance to restorative principles. Maxillary incisors were tipped anteriorly with palatal displacement of roots by 3 mm. The lower anterior facial height increased by 5.5 mm, with posterior displacement of the chin by 3 mm. Maxillary and mandibular incisors demonstrated a normal relationship.

The establishment of an appropriate interincisal angle is considered one of the key parameters for preventing deep bite relapse. Orthodontic therapy prior to restorative intervention was the key to minimizing biomechanical and functional risks. The patient has been followed up for a period of 6 years with stable results.

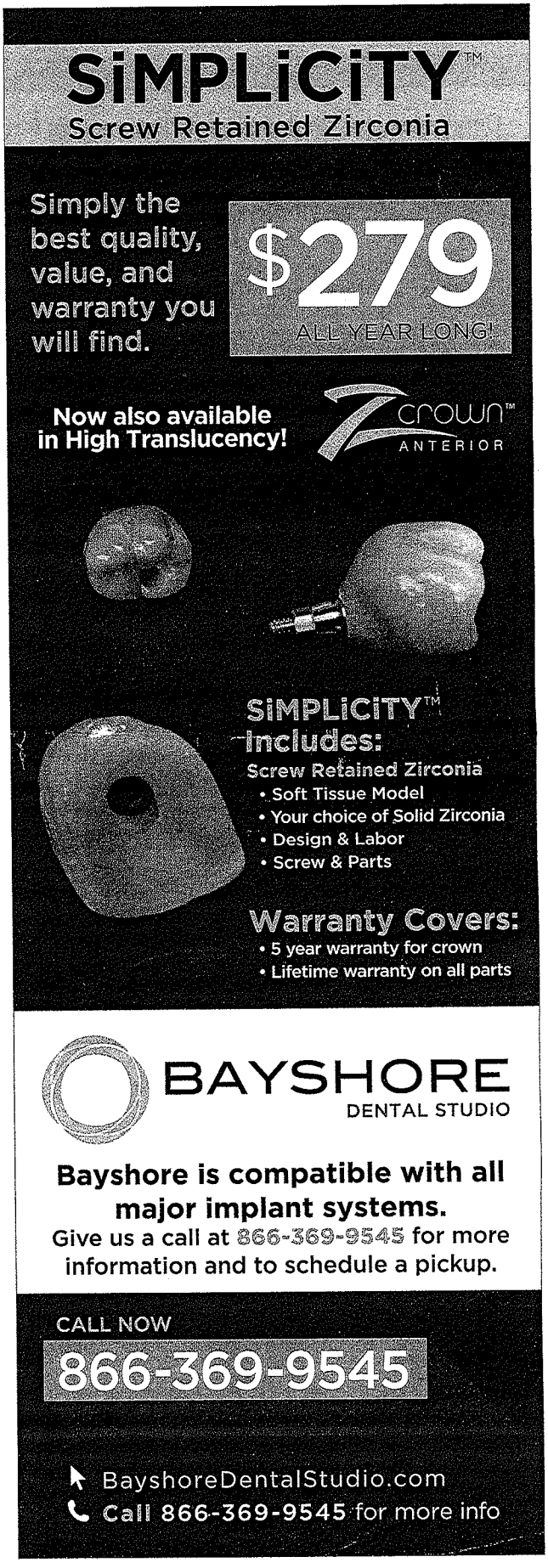

TABLE 1

Comparison of Cephalometric Parameters Before and After Treatment

Parameters	Pretreatment	Normal Values	Post-treatment
SNA	83°	82° +/- 3°	83°
SNB	78°	79° +/- 3°	77°
ANB	5°	3° +/- 2°	6°
SN-MP	30°	32° +/- 5°	36.5°
U1-SN	77°	103° +/- 6°	95°
L1-MP	83°	90° +/- 5°	92.5°
Interincisal angle	170°	135° +/- 11°	135°

ANB = point A-nasion-point B angle; L1-MP = angle between lower incisor and mandibular plane; SNA = sella-nasion-point A angle; SNB = sella-nasion-point B angle; SN-MP = sella-nasion plane and mandibular plane angle; U1-SN = angle between upper incisor and sella-nasion

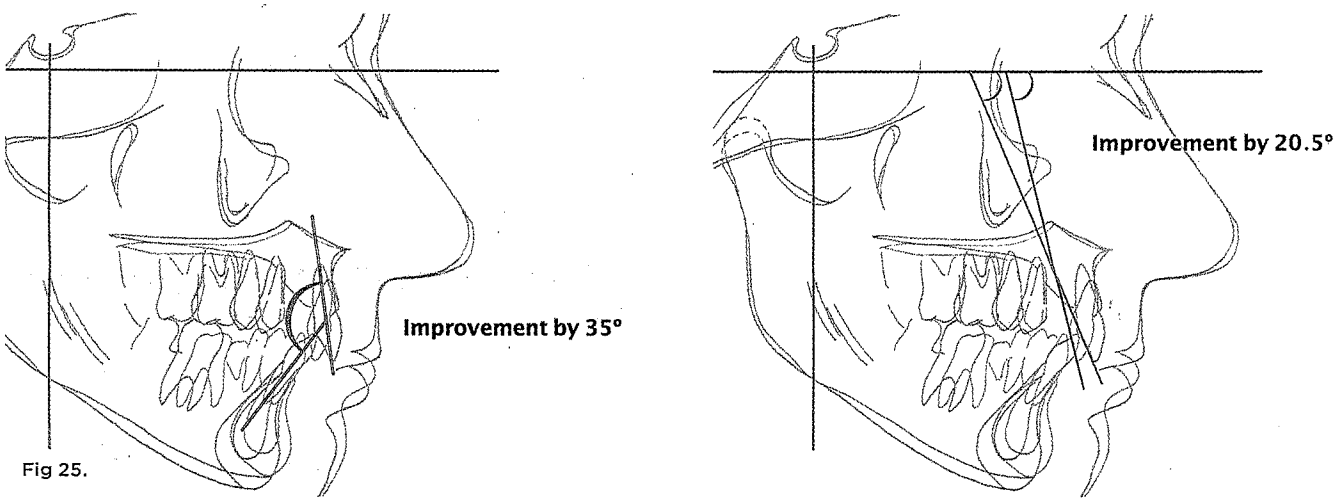

Fig 25. Superimposition of lateral cephalogram tracings depicting improvement.

ACKNOWLEDGMENT

The authors acknowledge Nidhi Gupta, MDS, for carrying out the endodontic therapy in this case where needed.

ABOUT THE AUTHORS

Ali Tunkiwala, MDS
Accredited Member, American Academy of Cosmetic Dentistry; Diplomate, Indian Society of Oral Implantologists (ISOI) and International Congress of Oral Implantologists (ICOI); Private Practice specializing in Prosthetic Dentistry and Implants, Mumbai, India

Ashok Karad, MDS
Diplomate, Indian Board of Orthodontics; Private Practice specializing in Orthodontics, Mumbai, India

Danesh Vazifdar
Owner, Adaro Dental Laboratory, Mumbai, India

Priya Bijlani, MDS
Private Practice specializing in Prosthetic Dentistry, Mumbai, India

Shruti Chhajed, MDS
Private Practice specializing in Orthodontics, Mumbai, India

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