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Case report

A novel approach for posterior bite collapse in an adult with crossbite anterior using a 3D-printed bite riser

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ABSTRACT

Background: *Managing an adult patient presenting with an anterior crossbite in conjunction with posterior bite collapse (PBC) is a difficult challenge.* ***Purpose:*** *The purpose of this case study is to highlight the accuracy that can be attained with the utilization of a three-dimensional (3D) printed bite riser in the correction of PBC accompanied by an anterior crossbite in an adult patient with Class III malocclusion.* ***Case:*** *A 64-year-old male complained of being unable to chew properly. Extraoral examination revealed a concave profile with a protrusive mandible. The patient exhibits a 5 mm anterior crossbite and has missing lower posterior molars, resulting in bilateral PBC. The cephalometric analysis revealed skeletal Class III patterns (SNA: 82.19°; SNB: 86.34°; ANB: -4.15°), with protrusion and counterclockwise rotation of the mandible (SN-OP: 3.84°).* ***Case Management:*** *By utilizing a 3D-printed bite riser in conjunction with temporary anchoring devices (TADs), it is possible to resolve the issue of an anterior crossbite accompanied by PBC. This is achieved by repositioning the elongated posterior segments on both sides of the maxilla to generate vertical space for mandibular tooth rehabilitation, retracting the anterior segment, and narrowing the lower arch.* Simultaneously, the crossbite on both sides was corrected, a Class I and ideal overbite and overjet were achieved, the occlusal vertical dimension increased, the occlusal plane angle was corrected (7.51°), and an acceptable ANB angle (-1.36°) was accomplished. *The treatment lasted 18 months and yielded sustained results after a one-year retention period.* ***Conclusion:*** *Integrating 3D printing technology in orthodontic treatment offers numerous options for managing challenging cases such as PBC while also reducing the treatment length. The patient was satisfied with the results achieved.*

Keywords: *3D-printed bite riser; adult; crossbite anterior; orthodontics; posterior bite collapse*
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INTRODUCTION

Creating a good smile can be difficult, since it involves both functional and aesthetic considerations. In many circumstances, collaborative treatment planning is essential to develop a smile that takes both facial harmony and desired dental proportions into account. Prior to esthetic rehabilitation, orthodontic techniques may be advantageous to achieve harmony between dental arches, eliminating the need for invasive preparations.[1–4] Posterior bite collapse (PBC) is a clinical phenomenon characterized by disruption of the posterior occlusion. Secondary clinical consequences may encompass the expedited progression of periodontitis, temporomandibular disorders, and a reduction in the occlusal vertical dimension (OVD). Tooth loss without replacement, orthodontic malocclusions, dentoskeletal disharmonies, periodontitis, severe caries, and iatrogenic dental procedures may cause this condition.[5] Generally, the severity of PBC increases with the quantity of afflicted teeth. Repositioning of the mandible occurs from the absence of posterior occlusal support, which complicates the process of rehabilitating the opposing teeth.[6,7]

In the event of mandibular molar absence, it is observed that the maxillary molars in opposition tend to extrusion, while the mandibular teeth exhibit tilting and migration

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towards the site of extraction.[8] As a result, the management of PBC would be further complicated by the vertical and transverse dental compensation. PBC is an inevitable result of advanced damage. The emergence of PBC frequently leads to the posterior teeth's mesial drifting and the anterior segments' flaring, which may occasionally give rise to an anterior crossbite in certain cases.[9]

Providing treatment for an adult patient who presents with PBC and an anterior crossbite is a complex and challenging endeavor. The difficulty is simultaneously regaining OVD for prosthetic preparation and retracting the anterior region to create an ideal overjet. In this case, an alternate option is the utilization of bite riser intervention. Digital technology has played a significant role in enhancing and streamlining the processes of diagnosis, treatment planning, and execution within the field of orthodontics. The digital process has improved clinical practice and patient outcomes.[10] The primary aim of implementing this technology in the field of orthodontics is to minimize the amount of time spent by professionals in both clinical and laboratory settings. The goal is also to accelerate the treatment process while making it more predictable, aesthetically pleasing, and comfortable for patients.[11] The purpose of this case report is to highlight the precision and accuracy achieved using a 3D-printed bite riser to correct PBC with anterior crossbite in an adult with Class III malocclusion.

CASE

A 64-year-old male presented with the chief complaint of difficulty in chewing properly. Clinical examination revealed a concave face profile, protrusive lower lip, and normal upper lip (Figure 1). The patient exhibited dentoalveolar extrusion of the posterior teeth in the upper jaw on both sides, which was attributed to the absence of the corresponding molars in the lower jaw. The mandibular left and right canines and premolars exhibited extrusion and buccal inclination, whereas the mandibular incisors had labial flaring, resulting in an anterior and posterior crossbite. The upper and lower dental midline coincided with the facial midline. The canine relationship revealed Class III occlusion on the right side, and spacing was distributed in both arches. Intraoral examination showed a -5 mm overjet and a 3 mm overbite (Figure 2).

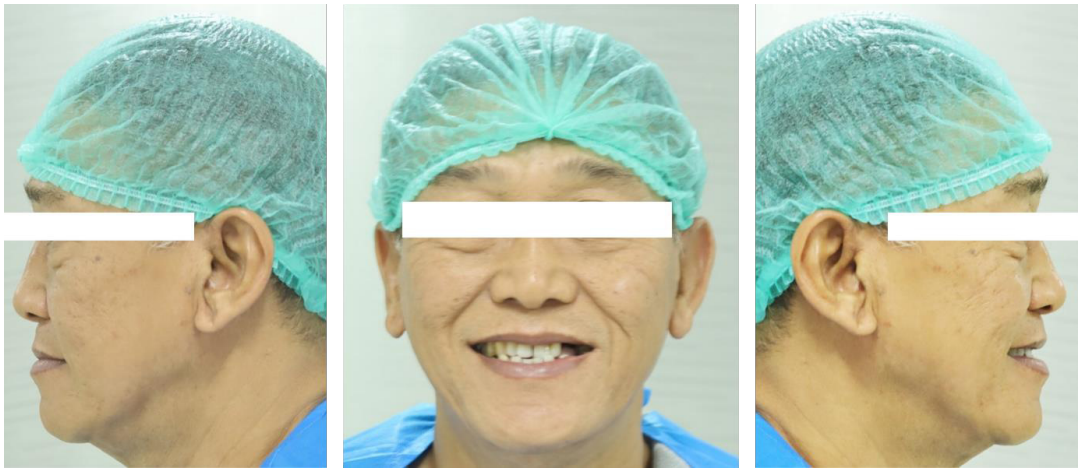

Figure 1. Pretreatment facial photographs.

Figure 2. Pretreatment intraoral photographs.

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Cephalometric analysis indicated a skeletal Class III relationship (ANB, -4.15°), with normal maxilla (SNA = 82.19°) and protrusive mandible (SNB = 86.34°), a normal inclination of the maxillary incisors and proclination of mandibular incisors (U1-FH, 116.44°; IMPA, 93.59°), a shorter anterior facial height to total facial height ratio (51.0%), and counter clockwise rotation of mandible (occlusal plane angle/SN-OP = 3.84°). The panoramic radiograph revealed an impacted tooth #18 and periodontal bone loss in the mandibular area (Figure 3). Written informed assent was obtained from the patient to publish this case report and any accompanying photographs.

CASE MANAGEMENT

The primary aim of the treatment was to address the issues of PBC and antero-posterior crossbite and establish a balanced occlusal function. This was achieved through a series of steps: (1) repositioning the elongated posterior segments on both sides of the maxilla to create vertical space for the rehabilitation of the mandibular teeth; (2) retracting the anterior segment and narrowing the lower arch; and (3) correcting the crossbite on both sides at the same time.

Correcting more than 5 mm of anterior crossbite requires a posterior bite riser. At the same time, 2 mm x

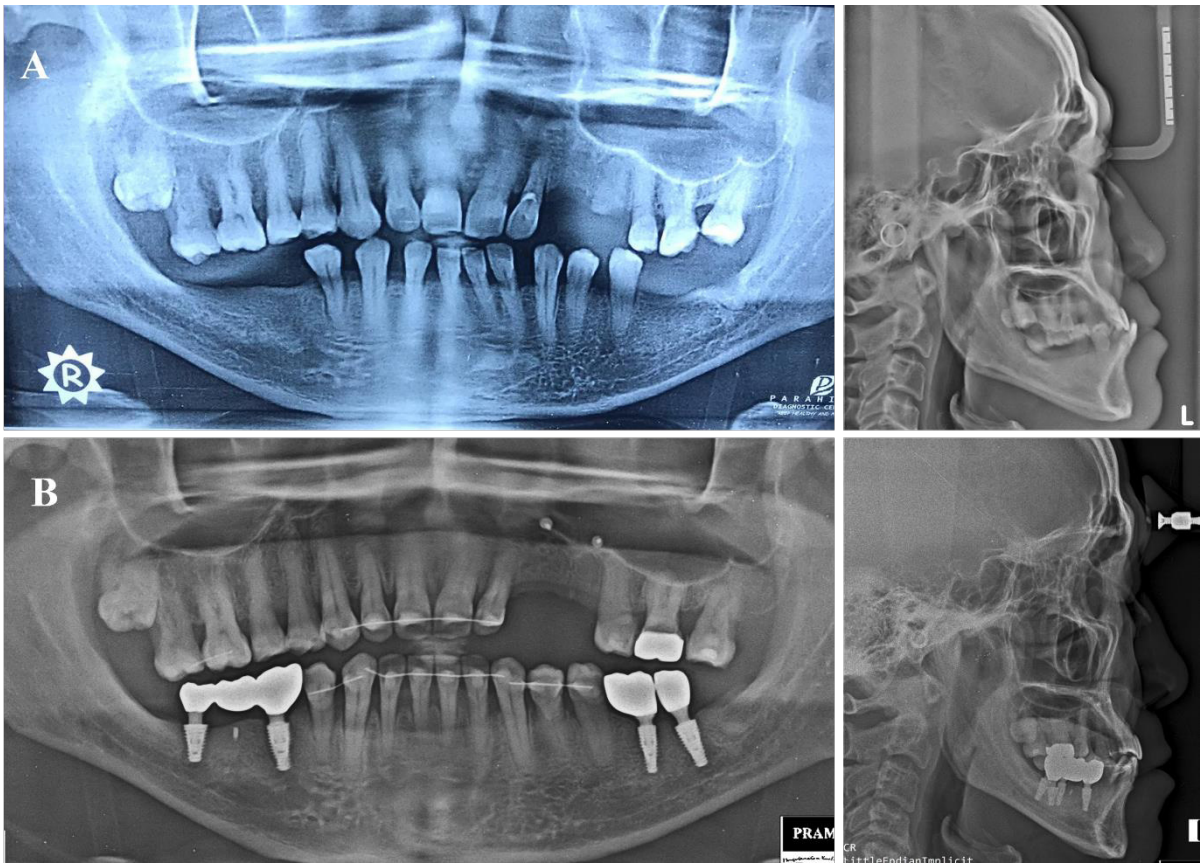

Figure 3. A. Pretreatment panoramic and lateral cephalogram; B. Post-treatment panoramic and lateral cephalogram.

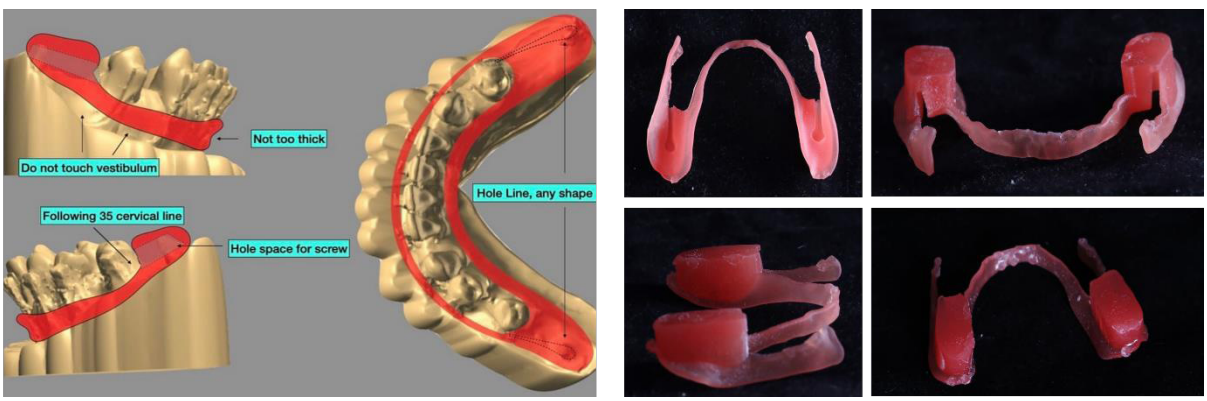

Figure 4. Design of 3D-printed bite riser.

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10 mm temporary anchoring devices (TADs) were placed on the alveolar bone ridges of missing teeth #37 and #47 to assist in retracting and narrowing the lower arch. Since we used TADs on the posterior ridge, a special 3D-printed appliance for the posterior bite riser needed to be used. It temporarily replaced the posterior prosthesis to restore OVD and reduce anterior crossbite for lower anterior retraction. Custom TAD holes and retraction chains allow this 3D-printed bite riser to be combined (Figure 4). The appliance must be used for 12 hours per day, including overnight, and must be taken off while eating.

After 18 months of treatment, the treatment objectives were effectively accomplished. Soft tissue profile changes included decreasing lower lip prominence, which reduced concavity and improved profile (Figure 5). The results documented a Class I canine and molar relationship characterized by an ideal overbite (2 mm) and overjet (2 mm), increased OVD, occlusal plane angle correction from 3.84^{o} to 7.51^{o}, and posterior contact regained from the dental implant (Figure 6). The results of the lateral cephalometric analysis and superimposition revealed a 3.0 mm intrusion of the maxillary left and right molars. Additionally, the ANB angle was found to be within the acceptable range (-1.36°). The mandibular incisors underwent a retraction of 6.0 mm (Figure 7).

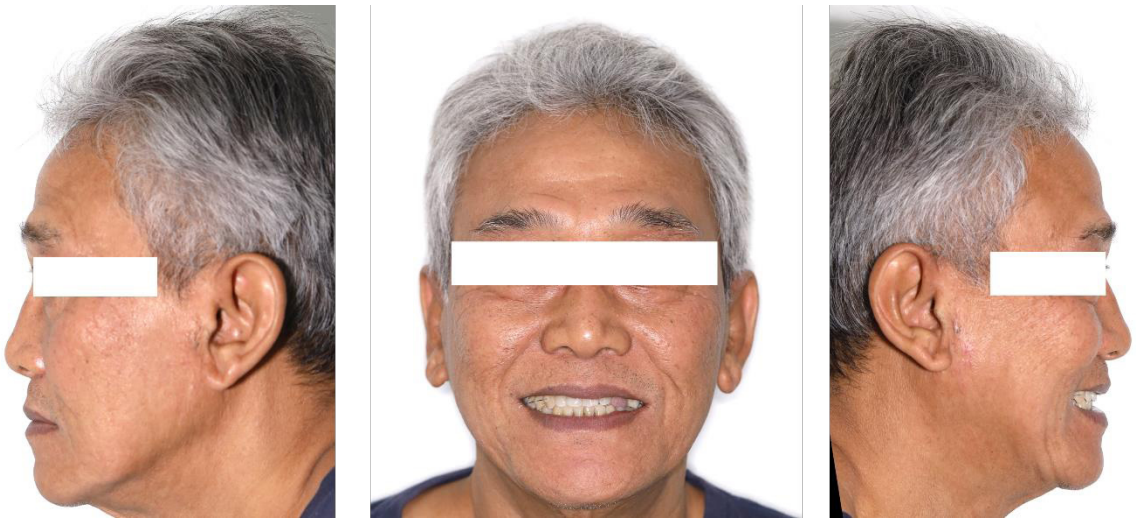

Figure 5. Post-treatment facial photographs.

Figure 6. Post-treatment intraoral photographs.

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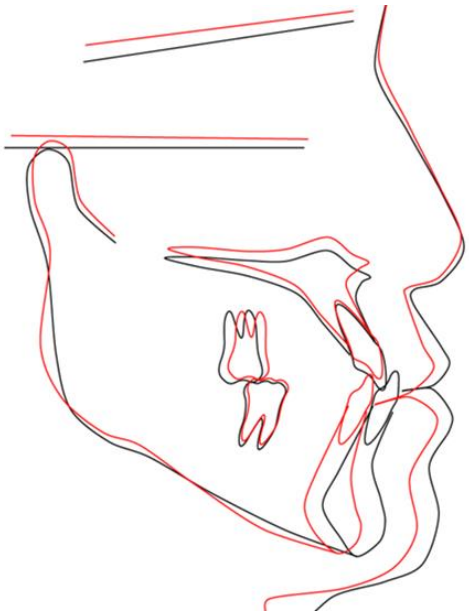

Figure 7. Lateral cephalometric superimposition of pre- (black) and post-treatment (red). Changes in maxillary and mandibular incisor angulation, as well as lip position, were observed.

DISCUSSION

The efficacy of orthodontic treatment in adults is dependent upon proper periodontal preparation and the consistent preservation of tissue health during all stages of mechanotherapy. The management of adult patients with PBC caused by premature loss of molars and subsequent shifting of adjacent teeth poses challenges in orthodontic treatment. When the PBC is accompanied by crossbite in patients, camouflage treatment requires both transverse and vertical correction. In such circumstances, a posterior bite riser can be a useful alternative surgery that streamlines orthodontic treatment. In the recent decade, digital technology has dramatically increased its accuracy and precision, allowing for a complete digital workflow in various dental applications, particularly orthodontics. This may be attributed to numerous factors, including the utilization of the least invasive impression techniques, improved time efficiency, and enhanced precision in the fabrication of orthodontic appliances.[10,12] The concept of precision can be elucidated by considering the level of accuracy exhibited by intraoral scans, as evidenced by many reports, as well as the 3D precision achieved by the multi-jet printing technique.[13–15] To restore OVD, a customized bite riser with a screw and retraction line hole is required. This customized bite riser is manufactured with a 3D printer, and the hole in the posterior ridge protects TADs from upper molar contact while retracting lower anterior teeth. The increase in OVD has various advantages, including improved oral health and overall well-being. By correcting concerns such as a collapsed bite or damaged teeth, increasing the OVD can improve face esthetics. As the restoration of normal facial proportions is generally associated with a more visually pleasing grin, this may result in a more youthful appearance.[16]

Anchorage control is a fundamental and critical determinant in orthodontics, as it significantly influences the intended result of the treatment.[17] Achieving the best possible result in patients with PBC becomes difficult in such circumstances due to the absence of posterior anchorage. Loss of anchorage constitutes a primary apprehension linked to orthodontic interventions. While some anchorage control appliances (e.g., headgear) have been established, they either necessitate patient compliance or are not particularly effective at maintaining anchorage. The utilization of TADs has experienced a surge in popularity due to the absence of patient cooperation, hence augmenting the capacity to effectively manage adult patients with intricate conditions. In this case, TADs play a crucial role in enabling the necessary control of anchorage for the retraction of lower anterior teeth. According to prior research, TADs can be regarded as a highly effective means of providing anchorage during the retraction of maxillary anterior teeth, as compared with conventional dental anchorage. TADs exhibit stability when appropriately positioned within the bone during the phase of anterior tooth retraction.[18]

The capability of the mandibular incisors to be retroclined determines the majority of the correction for adult Class III camouflage patients. Tian et al.[19] presented a study indicating that patients with a narrow symphysis are more prone to incisor root perforation caused by the thin lingual plate during orthodontic therapy. Fortunately, the patient had a sufficient amount of bone surrounding her mandibular incisors, insuring the retention of the roots within the cortical plate. To assess soft tissue changes, it is necessary to conduct routine lateral cephalometric assessments with soft tissue evaluations. Soft tissue profile modifications were seen in the lower lip positions relative to the E-line by lowering the lower lip prominence by 0.74 mm, which diminished the concavity and enhanced the profile. To prevent relapse, a combination of fixed and Hawley retainers was utilized. One-year follow-up demonstrates good stability while awaiting bone regeneration following the graft for implant procedure for teeth #23 and #24.

According to the findings, individuals classified as Class III generally exhibit an excessive lower anterior face height.[20] The patient's facial proportions could be improved by implementing Class III elastics and inducing a clockwise rotation of the jaw, since he exhibits a shorter anterior facial height to a total facial height ratio of 51.0%. At the completion of the treatment, the anterior facial height ratio exhibited a correction of 55.0%. An elevation in OVD was also associated with a concurrent increase in lower facial height, hence contributing to the normalization of the ratio between lower facial height and total face height.[21] In orthodontic treatment, Class III elastics are commonly employed to address Class III malocclusion. However, it is important to note that these elastics not

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only cause retroclination of the mandibular incisors and proclination of the maxillary incisors but also result in extrusion of the mandibular incisors and maxillary molars. The vertical alterations described in the statement result in the downward rotation of the posterior occlusal plane and the upward rotation of the anterior occlusal plane. Consequently, this causes a counterclockwise rotation of the occlusal plane.

The integration of 3D printer technology with TADs is a viable approach for addressing the issue of PBC accompanied by an anterior crossbite. The significance of 3D printer technology is in its ability to produce a posterior bite riser that can provide accurate holes for the security of TADs while also incorporating a retraction line. The technique of integrating 3D printers with orthodontic treatment has various applications for correcting complex cases and decreasing treatment time. This combination is feasible and should be considered in the future as part of treatment planning and future research.

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