Journal of Esthetic and Restorative Dentistry

CLINICAL ARTICLE

Adult Scissor Bite Case Treatment With Moving Teeth Through Maxillary Sinus

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Received: 6 November 2024 | **Revised:** 2 January 2025 | **Accepted:** 17 January 2025

Funding: The authors received no specific funding for this work.

Keywords: 3D analysis | maxillary sinus | molar intrusion | scissor bite | temporary anchorage devices (TADs)

ABSTRACT

Objective: This case report demonstrates the orthodontic treatment to correct a severe scissor bite and occlusal disharmony in a 26- year-old female patient, including the use of temporary anchorage devices (TADs) and fixed orthodontic appliances.

Clinical Considerations: Severe scissor bite is associated with vertical problems, such as molar extrusion. For orthodontic treatment, interradicular TADs were used to intrude the extruded molars, control the inclination of molars, correct dental midline, and improve dental relationships.

Conclusions: This treatment not only achieved successful correction of the scissor bite but also provided adequate occlusion function and improved facial esthetics.

Clinical Significance: TADs provided an effective orthodontic force system to correct the scissor bite. In severe scissor bite cases, a significant amount of maxillary molar intrusion is required, which can increase the risk of moving teeth through the maxillary sinus. Using CBCT images could help in treatment planning for the three- dimensional movement of teeth during the orthodontic treatment.

1 | Introduction

Scissorbite implies the maxillary posterior teeth erupt in the buccal direction along with the lingualized mandibular posterior teeth [1]. This unique occlusion is also known by different names, such as buccal crossbite, Brodie bite, telescopic bite, and buccal nonocclusion [1, 2]. These terms themselves describe the characteristics of the malocclusion.

Scissor bite patients affected in only a few teeth can be easily corrected [3–6]. However, in cases of severe type involving multiple teeth, the difficulty of treatment increases. These cases often include transverse width discrepancy of the basal bone, severe occlusal interferences, and associated functional problems [1, 2, 7–13]. As a result, it is difficult to correct with orthodontic treatment alone, and a surgical approach has been required in many cases [11–13]. However, because of its invasiveness, cost, and the risk of complications, it is not easy to apply in routine practice [11–13].

Since the introduction of temporary anchorage devices (TADs) in orthodontics, they have become a common treatment option, expanding the scope of orthodontic treatment [1, 6–9]. Among the many advantages of TADs, the most useful feature is that they can be installed in various locations, which means the orthodontist can apply a properly designed force system [6–9]. This makes it easier to control the axis and position of the teeth, leading to more predictable and improved results [14]. Given their advantages, TADs in scissor bite cases are considered the treatment of choice for treating scissor bite cases [1, 6–10, 14].

One of the challenges of treating severe scissor bites is the possibility of moving teeth through the maxillary sinus (MTTMS) [15–18]. This movement occurs during a large amount of maxillary molar intrusion, which is necessary to correct severe scissor bites using TADs. When the maxillary sinus floor has been excessively pneumatized, the possibility of MTTMS increases [16–21].

The present case report describes the treatment of a severe scissor bite in an adult female patient, including the use of TADs and fixed appliances.

2 | Diagnosis and Etiology

A 26- year-old female patient visited the orthodontic clinic of the university dental hospital with a chief complaint of disclusion on the right side. She presented with a convex profile, facial asymmetry with a chin deviation to the left side, and downward canting of an occlusal plane on the right side (Figure 1).

In the intraoral and study model examination, extrusion of maxillary posterior teeth was observed and thought to be the primary reason for the scissor bite. The right mandibular molars were almost invisible due to the buccally positioned right maxillary molars. The maxillary and mandibular dental midline were deviated to the right and left side, respectively. Notably, the whole mandibular dentition showed translation to the left side. Crowding in both arches was also observed, with the missing left mandibular molars, which had been extracted 3 years ago (Figures 1 and 2).

In 3D CBCT analysis, approximately 5.3 mm of right side down occlusal plane canting was recognized and the right ramal height was 4.6 mm longer than the left side. Chin point deviation to the left side measured 5.4 mm (Figure 3). A transverse basal bone discrepancy was also evaluated by measuring the distance between the furcation of the molars and the estimated furcation for the missing mandibular left molar. The distances were

FIGURE 1 | Pretreatment photographs.

FIGURE 2 | Pretreatment digital study models.

FIGURE 3 | Reconstructed 3D model. Mandibular asymmetry and occlusal plane canting can be observed.

56.2 and 45.6 mm for the maxilla and mandible. The difference in distance was 10.6 mm, which was considered the transverse discrepancy [22].

Through overall skeletal and dental analysis, the transverse basal bone discrepancy was identified as a key factor contributing to the scissor bite and resulting skeletal asymmetry in this patient.

Analysis of a lateral cephalogram showed the patient had a skeletal Class II relationship with a hyperdivergent facial pattern. The maxillary incisors were slightly retroclined. Maxillary sinus pneumatization was also observed in the panoramic radiograph (Figure 4; Table 1).

Her temporomandibular joint (TMJ) status was also examined. She had no pain or discomfort in the muscles or joints, but

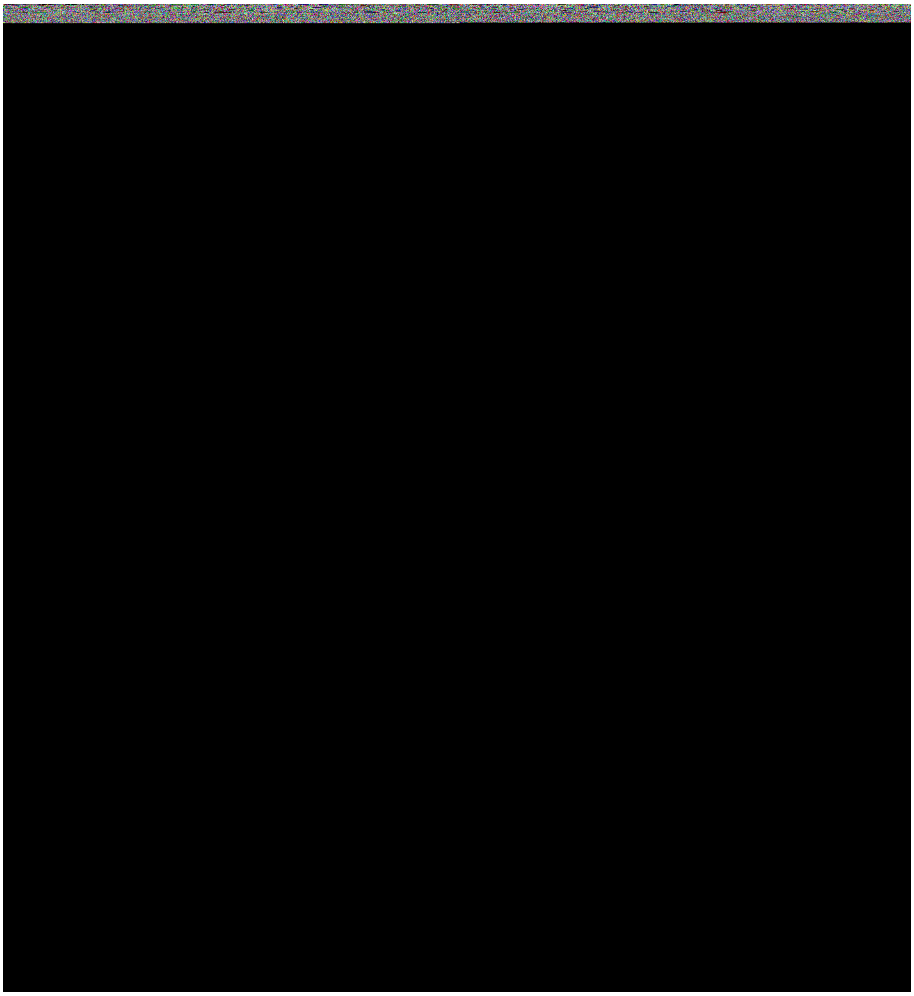

FIGURE 4 | Pretreatment lateral cephalogram, tracing, and panoramic radiograph.

TABLE 1 | Cephalometric measurements.

Measurements	Norm	Pretreatment	Posttreatment
SNA (°)	81.1	85.2	84.9
SNB (°)	78.1	77.4	77.0
ANB (°)	3.5	7.8	7.9
Wits (mm)	−2.7	5.6	0.9
Anterior facial height (mm)	128.7	135.0	135.4
Posterior facial height (mm)	82.8	85.5	85.5
FMA (°)	29.6	39.7	38.7
Mandibular plane angle (°)	33.3	39.5	38.9
Overjet (mm)	3.5	3.5	3.3
Overbite (mm)	6.1	6.1	4.3
U1 to SN (°)	105.3	95.5	104.0
L1 to MP (°)	91.6	100.6	103.9

intermittent clicking in the left TMJ was confirmed. The condyle showed asymmetric in shape and height, but its cortical surfaces remained intact, as seen in a panoramic radiograph and reconstructed 3D models. The patient was regarded as having mild right condylar hyperplasia with no active pathologic lesion (Figures 3–5).

FIGURE 5 | Panoramic images limited in TMJ field of right (R) and left (L) side in the mouth closed (C) and open (O) at initial.

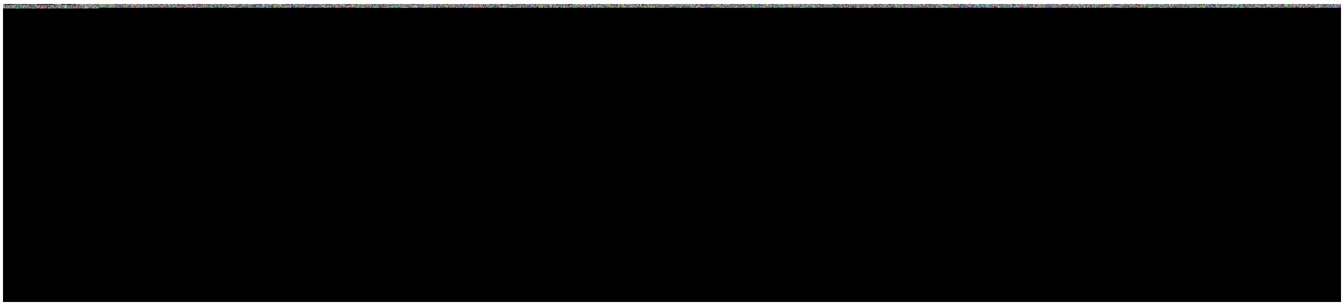

FIGURE 6 | One month after the use of stabilization splint.

The patient might have had a centric relation (CR)- maximum intercuspation (MIP) discrepancy. Therefore, evaluating her chin position at CR was necessary before starting treatment. After 1 month of stabilization splint application, a functional shift to the right was observed. However, no further occlusal changes were seen. Thus, the mandibular functional shift was considered not severe, and due to the patient's poor cooperation in wearing the appliance, its use was limited to the short term (Figure 6) [23].

3 | Treatment Objectives

The treatment objectives were to (1) correct the unilateral scissor bite and achieve normal buccal overjet, (2) establish Class I canine and molar relationships, (3) restore occlusal function and (4) improve the facial esthetics.

4 | Treatment Alternatives

In a patient's diagnosis procedure, we confirmed a scissor bite with over- erupted molars, transverse width discrepancy of a dental arch including basal bone, no symptom of TMD, and facial asymmetry. Based on these, orthodontics treatment combined with orthognathic surgery was regarded first option. Multiple segmental and Le Fort I osteotomy in the maxilla and symphyseal distraction osteotomy in the mandible were considered surgery plans to correct transverse width discrepancy and skeletal asymmetry [1, 11–13]. However, the patient did not accept the surgical option because of its invasiveness and risk of complications.

As an alternative treatment plan, the intrusion of molars and changes in their inclination using TADs were considered [7–10]. On the right side with a scissor bite, the maxillary molars were planned for intrusion and linguoversion. In the mandible, because TADs could only be placed in the buccal alveolar bone, buccoversion of molars was planned as the primary movement. The left maxillary teeth needed to be intruded to implant prosthesis in the left mandibular molars. After the intrusion of the teeth, distalization of the maxillary dentition was planned for midline correction and establishment of Class I molar relationship.

This treatment plan was explained, and informed consent was obtained from the patient.

5 | Treatment Progress

At first, TADs were installed in the interdental spaces in both jaws. To avoid occlusal interferences that could arise from buccoversion of mandibular molars in the early stages, intrusion force was first applied in the maxillary arch. Lingual buttons were attached to the maxillary molars, and elastic chains were engaged. To avoid contact with the opposing teeth on the right side, the buttons were placed on the occlusal surface (Figure 7). All these procedures were performed without bite raising to minimize the patient's discomfort and occlusal changes in the nonaffected side.

After 7 months of molar intrusion, vertical changes in the maxillary molars were observed. After interocclusal space was obtained, buttons could be attached to the buccal side of the mandibular right posterior teeth. In the mandible, the intrusion and buccoversion of the molar mandibular posterior teeth were

FIGURE 7 | Intraoral photographs during intrusion of maxillary molars.

FIGURE 8 | Intraoral photographs during intrusion of maxillary and mandibular molars.

initiated. Additional TADs were installed to intrude on the right maxillary canine (Figure 8).

After 9 months, 0.022 in pre- adjusted edgewise brackets were placed on the mandibular teeth. As soon as sufficient molar intrusion reduced occlusal interferences, the mandible moved to the right side about a millimeter, which was the same amount as what we had seen after the CR splint was used before starting the treatment (Figure 9).

After 16 months of treatment, fixed appliances were attached to the maxillary arch. Following the leveling, crimpable retraction hooks were located between the lateral incisors and canines. The maxillary dentition was distalized using elastic chains and TADs placed between the posterior molars to correct the dental midline and improve the dental relationship. However, the patient moved to another place, resulting in irregular visits, and it was decided to conclude the treatment with compromised and acceptable outcomes.

At 30 months of treatment, the implant restorations for the left mandibular molar were completed, and finishing and detailing were also processed.

At 42 months of the treatment, the fixed appliances were removed. Circumferential retainers for maxillary and mandibular

FIGURE 9 | Intraoral photographs during leveling of mandibular teeth with fixed appliances after molar intrusion.

arch were delivered, and the patient was instructed to wear the retainer full-time.

6 | Treatment Results

Although the Class I dental relationship was not obtained, proper occlusion function was obtained. Through intrusion and tilting of molars, scissor bites were successfully corrected, and proper buccal overjet in the posterior area were also attained. No periodontal and pulpal problems were observed (Figures 10 and 11).

In lateral cephalogram analysis and superimposition, there were significant molar intrusion and changes in the inclination of incisors and overbite, but no significant skeletal changes were confirmed (Figures 12 and 13; Table 1). The patient's overall facial profile was also well maintained in both lateral and frontal views (Figures 10 and 13).

Adequate root parallelism and no significant root resorption were seen in the posttreatment panoramic radiograph. When comparing the pre- and posttreatment panoramic radiographs based on the maxillary sinus floor and the maxillary tuberosity, a significant amount of intrusion can be confirmed (Figure 12).

Superimposition of pre- and posttreatment digital study models, using best- fit algorithms based on the anterior palatal rugae and mandibular torus, demonstrated overall changes including intrusion of the molars (Figure 14).

Because of the discrepancy in basal bone width, molars on the right side were compensated by the buccal inclination of the mandibular molars and the palatal inclination of the maxillary molars. When comparing the CBCT images, these changes were confirmed (Figure 15).

In reconstructed CBCT images, the roots of maxillary molars were observed to intrude into the maxillary sinus after the treatment (Figure 16).

Due to defects and interference from contact with opposing teeth in CBCT images, it was difficult to identify the position of the cusp tips and measure the changes. To overcome these problems, digital study models were superimposed onto 3D CBCT images (Figure 17). The amount of intrusion was measured by establishing a coordinate system based on the FH plane. The mesial cusp tips of bilateral maxillary first molars were measured, showing an intrusion of approximately 4–6 mm. The greatest intrusion was performed in the mesio- buccal cusp of the maxillary left first molar (Table 2). The amount of root resorption was also measured in the maxillary first molars and found to be less in the palatal roots and more in the buccal roots (Table 3).

7 | Discussion

Scissor bite shows typical features, including buccally or lingually malpositioned molars and extrusion, due to continuous eruption until the teeth occlude with their opposing teeth [1, 2]. These make occlusal interferences causing patients to have a preferred chewing side on a nonaffected side [7, 8, 10, 24]. This restricted lateral jaw movement causes a functional shift and asymmetric occlusion, resulting in TMJ structure deformation and facial asymmetry [25, 26]. This patient exhibited features of a scissor bite, as well as occlusal plane canting, mandibular asymmetry, basal bone width discrepancy, and mandibular arch translation to the left side. These findings were analyzed using CBCT and contributed to planning the appropriate tooth movements (Figure 3).

During the diagnosis and treatment planning stages, the need for mandibular molar intrusion might be underestimated.

FIGURE 10 | Posttreatment photographs.

This is because the degree of extrusion of the mandibular molar may not be properly evaluated due to the overlapping of the maxillary and mandibular molars (Figures 1 and 2). The amount of extrusion of the molars should be evaluated within each arch, and observing the gingival margin can be helpful [1].

In growing patients, functional appliances such as a Frankel appliance, lip bumper, or removable plate can be chosen for correcting scissor bites. A relatively simple scissor bite can be corrected with intermaxillary cross elastics or a single TAD [1–5]. However, these methods use extrusive mechanics, which may cause problems in stability and facial esthetics, and this was more problematic because our patient no longer had growth potential and showed a hyper- divergent pattern [7, 10]. Intrusion of over- erupted teeth using TADs was needed to prevent these complications, and there was no significant increase in vertical dimension and deterioration of lateral profile after the treatment (Figures 10 and 13).

TADs can be installed in various areas, and orthodontic forces can be applied in multiple directions [6–10]. This allows the orthodontist to design a precise force system to achieve the desired tooth movement [14]. In this case, properly placed interradicular TADs and a planned force system were used to control the bucco- lingual inclination of the molars in the maxilla and mandible simultaneously, as well as to intrude the molar (Figures 7 and 8) [1, 6–9]. The change in inclination could be confirmed through the differences in the amount of intrusion between the buccal and palatal cusps and the images (Figure 15; Table 2). As a result, the transverse width of the maxillary molar constricted, while the mandibular arch width increased, and the dental arches were coordinated despite the basal bone discrepancy (Figure 14).

There is a case report of a similar scissor bite patient but with different TAD mechanics compared to this case [7]. In that report, only one extra- alveolar TAD was placed in both dental arches, minimizing the use of TADs. The authors described

FIGURE 11 | Posttreatment digital study models.

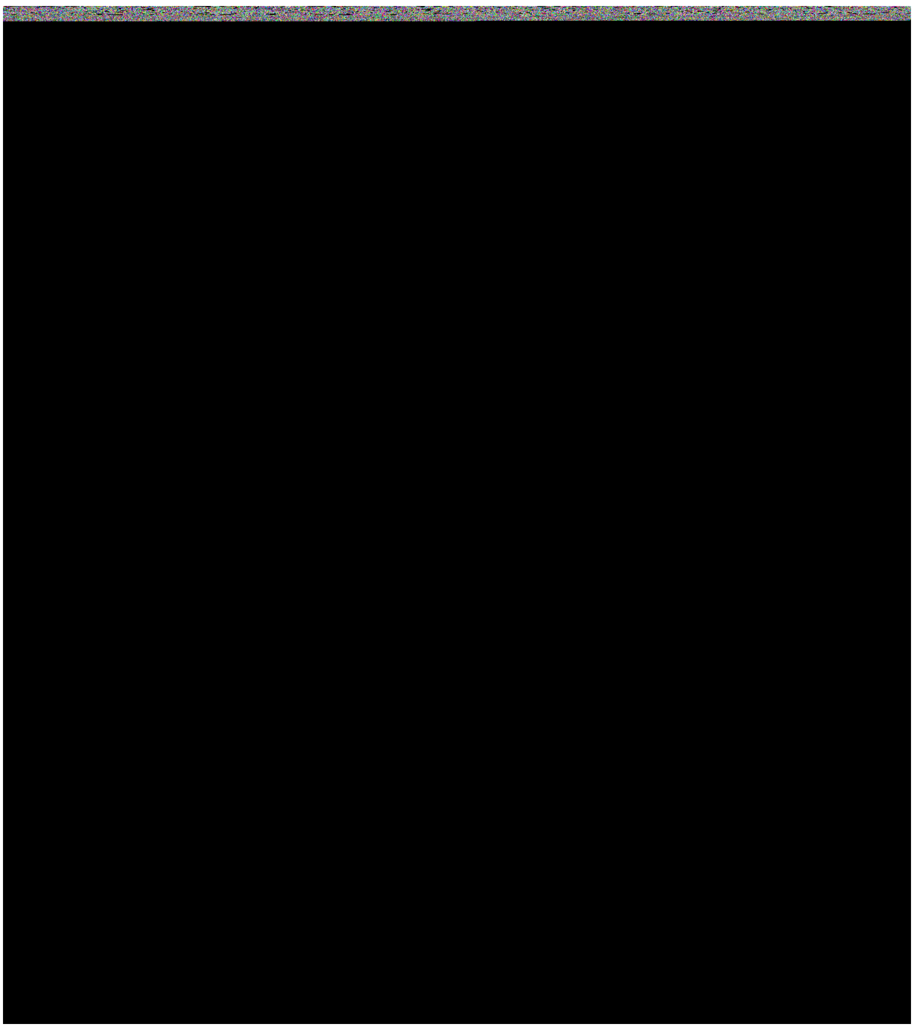

FIGURE 12 | Posttreatment lateral cephalogram, tracing, and panoramic radiograph.

FIGURE 13 | Superimposition of lateral cephalometric tracings. (A): Overall superimposition; (B): Maxillary superimposition; (C): Mandibular superimposition. Black: Pretreatment; Red: Posttreatment.

FIGURE 14 | Superimposition of digital study models. (A): Maxillary superimposition; (B): Mandibular superimposition. Yellow: Pretreatment; White: Posttreatment.

FIGURE 15 | CBCT images showing changes in the inclination of the right posterior teeth.

the several benefits of this approach compared to interradicular TAD; a lower risk of interference between roots and TAD and easier to make favorable force design. However, extra-alveolar TADs require clinical skills for placement and have been associated with a higher chance of gingival irritation and initial pain [27]. Furthermore, there was an increase in vertical dimension due to bite opening for the attachment of the braces, which the authors pointed out as a shortcoming [7]. In contrast, in this case, we aimed to avoid an increase in the vertical dimension and minimize patient discomfort caused by bite raising. To achieve this, the intrusion was performed first to create vertical space for the braces. However, this approach required the use of multiple TADs to apply forces directly to target teeth.

FIGURE 16 | Reconstructed CBCT images showing intrusion of the posterior teeth. (A): Pretreatment, right side; (B): Posttreatment, right side; (C): Pretreatment, left side; (D): Posttreatment, left side. The dotted line indicates the maxillary sinus floor.

FIGURE 17 | Dental study models were integrated with CT images to accurately localize the cusp tip. The amount of intrusion of the cusp tip was calculated, using a coordinate system based on the FH plane. Yellow line: FH plane, red line: Perpendicular line to FH plane connecting the cusp. These lines were drawn by the author to aid in visual understanding.

TABLE 2 | Amount of intrusion (mm) at cusp tips of the maxillary molars.

Right first molar	MB	4.1
	MP	5.9
Left first molar	MB	6.2
	MP	5.2

Abbreviations: MB, meio- buccal cusp; MP, mesio-palatal cusp.

Pneumatization is closely related to the growth of the maxillary sinus. As the permanent molars begin to erupt after the age of 12, the sinus floor descends, leaving a thin layer of cortical bone over the root apex [28]. This pneumatization can also occur when maxillary posterior teeth are extruded because of the absence of opposing mandibular teeth [16, 29]. Considering that extrusion can lead to pneumatization, the overeruption of maxillary molars in severe scissor bite patients could also be associated with pneumatization.

Several studies have investigated the relationship between the maxillary sinus and roots using panoramic radiographs or CBCT images, concluding that a 3- dimensional analysis is required to evaluate the true relationship [17–19]. According to the previous classification [19], our patient showed a Type 2 or 3 relationship, which means the roots contact the sinus floor, and the root apex is projected laterally or into it before the treatment (Figure 18). Therefore, the roots of the molar were expected to contact the sinus cortical bone as soon as teeth movement started.

The conventional theory of tooth movement in orthodontics explains bone remodeling in response to mechanical loading [15, 30]. However, tooth movement in the maxillary sinus could not be fully explained by this theory alone. This is because, if there is only bone resorption on the pressure side, bone fenestration around the root apex would occur, and the structure of the maxillary sinus would be destroyed. Instead, one study showed that mechanical stress can induce new bone formation in the sinus wall as well [31]. This compensatory bone apposition plays an important role in maintaining the integrity and thickness of the sinus.

MTTMS requires a low speed of teeth movement. First, compensatory bone formation within the periosteum of the maxillary sinus takes time. Second, molars tend to be more easily tipped during MTTMS due to different resistance between the cortical bone around the root apex and the cancellous bone near the cervical area of the root [15]. However, these issues are primarily related to sagittal tooth movement. In this patient, because the primary movement was a molar intrusion, the mentioned issues did not occur. The maxillary molars were intruded ranged from 4 to 6 mm over 9 months, meaning an estimated rate was 0.44–0.67 mm/month. This rate is consistent with a previous study (0.6–0.7 mm/month) and faster than the rate of sagittal movement (0.1–0.2 mm/month) [15]. Root parallelism was also acceptable. Therefore, it is important to know that the response in the maxillary sinus differs depending on the type of teeth movement.

In severe scissor bite cases like this patient, a much larger amount of molar intrusion was required, which increases the risk of complications [32–35]. Although orthodontically induced root resorption during intrusion has been reported [32–34], no significant damage has been described in cases of scissor bite treatment [6–10]. Our patient also did not experience discomfort and related symptoms during the treatment. However, in the posttreatment CBCT images, the smaller roots like mesio- buccal and disto-buccal roots exhibited more resorption than the larger palatal root. Additionally, the maxillary left molar, intruded more than the right, showed greater root resorption [34] (Figure 19; Table 3).

There are several periodontal considerations associated with this patient. First, intrusion can result in an infrabony defects and increase the risk of inflammation. However, with controlled periodontal conditions, further periodontal bone loss can be prevented, and connective tissue attachment might even increase, benefiting periodontal health [35]. Another concern is a gingival recession in the compensated teeth. Orthodontic treatment accompanied by changes in inclination has been associated with gingival recession. However, long- term studies have indicated that the severity of recession remains low, suggesting that the effects of orthodontics treatment on periodontal health are limited [36, 37]. Moreover, our patient maintained good oral hygiene throughout the treatment and no periodontal deterioration was observed after the treatment.

This patient experienced significant changes in dental arch width to compensate for the transverse basal bone discrepancy, with changes in the inclination of the posterior teeth, especially on the right side. Although there are no studies on the long- term stability of these compensations, it has been reported that greater changes in dental arch width are associated with a lack of stability [38]. Both fixed and removable retainers for both arches were prescribed to this patient, and long- term retention might be necessary.

TABLE 3 | Amount of root resorption (mm) of the maxillary molars.

Right first molar	MB	2.5
	DB	2.4
	P	1.4
Left first molar	MB	3.3
	DB	4.7
	P	3.1

Abbreviations: DB, disto- buccal root; MB, mesio-buccal root; P, palatal root.

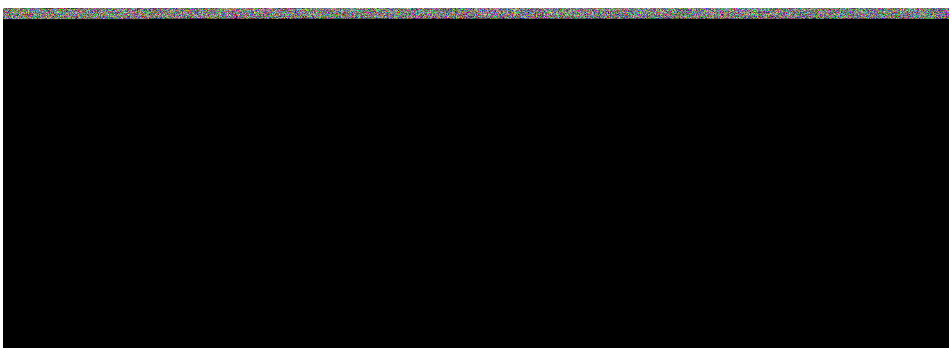

FIGURE 18 | A superior view from the top of the maxillary sinus displays the molar root apex before (A) and after (B) the treatment. Yellow arrow: maxillary palatal roots.

FIGURE 19 | Reconstructed images showing the root of the left maxillary first molar before (A) and after (B) treatment.

8 | Conclusion

Orthodontic treatment with TADs is a feasible option for severe scissor bites in adults. In this patient, interradicular TADs were successfully used for a large amount of molar intrusion and control of the molar inclination. Understanding tooth movement through the maxillary sinus is essential when it is planned, and the actual changes and outcomes of the treatment could be accurately evaluated by 3D analysis with CBCT images.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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