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Maxillary Molar Intrusion with Fixed Appliances and Mini-implant Anchorage Studied in Three Di

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ABSTRACT

The intrusion of an overerupted maxillary molar using traditional orthodontic treatment is a real challenge. The aim of this study was to investigate the envelope of intrusive movements of a maxillary molar in cases using min fixed edgewise appliances. The cusp tips of the pretreatment and postintrusion dental casts were recorded by a three-dimensional (3D) digitizer. The 3D data of the serial dental casts were analyzed to distinguish the direction mean intrusive movement of the maxillary first molars was three to four mm, with a maximum of over eight mm. For the adjacent maxillary second molars and second premolars, the amount of intrusion was two mm and 1–2 m significant true intrusion of maxillary molars could be obtained in a well-controlled manner by using fixed appliances with titanium mini-implants as bony anchorage.

KEY WORDS: Maxillary molar intrusion, Bony anchorage, Miniplate, Miniscrew.

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INTRODUCTION Return to TOC

The overeruption of maxillary molars usually results from early loss of antagonistic teeth. The elongated dentoalveolar process may cause problems of occlusal interferences and functional disturbances and may result in great diffi

Generally, several conventional options are available to increase occlusal clearance. Coronal reduction often requires crown restorations at the expense of tooth vitality. Another alternative raised by Schoeman and Subramanian[1] is the elongated segment, but patients must undergo the risk of general anesthesia and high cost associated with this procedure.

To intrude overerupted maxillary molars, orthodontic anchorage could be prepared by incorporating multiunit teeth, adding extraoral headgear wear, or using newly adopted mini-implants as bony anchorage. High-pull headgear may treatment result depends heavily on patient compliance.

Recent reports have demonstrated the clinical efficiency of mini-implants in providing sufficient anchorage against orthodontic forces.[2–8] The advantages of using mini-implant as orthodontic anchorage include ease of application, r immediately load after initial wound healing.[5–7] The surgical procedure for inserting or removing the miniscrew is simple, with minimal unfavorable complications. In contrast, miniplates require flap surgery often done by oral surgeons

Our previous report demonstrated the use of mini-implants with a fixed edgewise appliance to intrude maxillary molars and level an uneven occlusal plane.[8] The titanium miniscrews (Leibinger, Freiburg, Germany), two mm in diame Tuttlingen, Germany) were adopted by our department to prepare bony anchorage in various adult cases, especially when molar intrusion is required (Figure 1).

The precise quantitative assessment of the envelope of motion associated with molar intrusion with mini-implants has not been explored. The aim of this study was to investigate the envelope of intrusive movement of maxillary mol during orthodontic treatment with partial or full-mouth fixed edgewise appliances.

MATERIALS AND METHODS Return to TOC

Patient characteristics

Data were obtained from the records of 22 patients in our department, who had undergone orthodontic treatment to intrude overerupted maxillary molars (Table 1). Their ages ranged from 15 to 42 years, with a mean of 27.6 yea relationships, and nine cases were hyperdivergent (SN-MP > 37°), with only two cases being hypodivergent (SN-MP < 28°). Six of the 22 patients had local treatment with partial fixed orthodontic appliances. The other 16 patients init teeth, followed by full-mouth fixed appliances to correct the malocclusion. Eighteen of the 22 patients received implantation of both a buccal miniplate and palatal miniscrew. The other four patients had buccal and palatal miniscrews i was 7.6 months with a range of five to 12 months. A pretreatment and postintrusion maxillary dental cast was collected for each patient.

To prepare bony anchorage for maxillary molar intrusion, a titanium L-shaped miniplate and a miniscrew were implanted onto the buccal and palatal sides of the overerupted molars. Miniscrews were implanted without flap elevatio mucoperiosteal flap was elevated under local anesthesia. The miniplate was adjusted to fit the contour of the cortical bony surface and was fixed by bone screws with the intention to expose the free fixation hole to the oral cavity fron attached gingiva. Sufficient distance was left between root apex and mini-implant to avoid interference with the intended intrusive tooth movement. After initial healing of the soft tissue around the mini-implants, a medium intrusive forc the buccal miniplate and the attachment on the first molar band, and also between the palatal miniscrew and the cleat of the molar attachment (Figure 1c,d).

When adjacent teeth need to be intruded, those teeth were bonded and a sectional archwire was inserted with the intrusive force primarily applied only on the maxillary first molar. After sufficient intrusion was attained, their vertica miniscrew and the miniplate (Figure 2). In those cases where posterior occlusion could be restored immediately after the overerupted tooth was leveled, no retainer was required (Figure 2d). Otherwise, full-coverage retention w therapy was performed.

Model analysis

The bases of the before- and after-treatment dental casts for each of the 22 patients were trimmed, with the occlusal plane and the horizontal plane parallel. The tip of the mesiobuccal cusp, mesiopalatal cusp, distobuccal cusp, a and palatal cusps of the premolars were marked with a sharp pencil. To compare the movement of cusp tips on the serial models, a minimum of four palatal rugae points were registered as the reference landmarks.

The spatial data on the pretreatment and postintrusion maxillary dental casts were recorded by a mechanical desktop three-dimensional (3D) digitizer (Microscribe G2, Immersion Corporation, San Jose, Calif) (Figure 3) through a full range of movements. The 3D coordinate data of unique points on the two casts were analyzed by a Rhinoceros software program (Robert McNeel & Associates, Seattle, Wash) (Figure 4). With this information, it was possib maxillary teeth by superimposing two sets of coordinate data to assess the relocation of specific cusp tips. The difference in the z-coordinates of the cusp tips on the serial dental casts reflected the amount and direction of the move intrusion and "negative" sign extrusion.

To examine the reliability of measurements by the 3D digitizer, 20 maxillary dental models were chosen randomly and digitized a second time after a two-week interval. The landmarks digitized included eight points on the cusp tip landmarks on the palatal rugae.

The reliability of measurement with the 3D digitizer was 0.41 mm for the cusp tip and 0.45 mm for landmark on the palatal rugae. Their means and deviations on x-, y-, and z-coordinates, both individually and collectively, are show established by digitizing the comparable landmarks on serial dental models to assess the magnitude and direction of tooth movement was considered clinically acceptable.

Statistical methods

The SPSS statistical package program for Windows was used for the evaluation of measurements. The amount of maxillary molar intrusion was represented by the changes in the z-coordinate at the mesiobuccal cusp, distobucca the data were expressed as means with standard deviations and the range for maximal and minimal values. The statistical significance of crown tipping, both in the buccal-palatal direction and the mesial-distal direction, was assesse

RESULTS Return to TOC

The maxillary molars were successfully intruded with the mini-implant system in all the patients. The intrusion was also noted at the maxillary teeth adjacent to the first molar, ie, at the second molar and at the first and the secon assessment for intrusion of 26 maxillary first molars, 17 maxillary second molars, 11 maxillary first premolars, and 21 maxillary second premolars. The amount of intrusion was expressed as the difference of the z-coordinates betwe was equivalent to the positional change of each cusp tip. The positive value denoted intrusion of the cusp tip.

The variation of the maxillary molar intrusion was considerable, ranging from −3.68 to 8.67 mm. The amount of intrusion at the maxillary second molar was generally less than that of the first molar. The mean amount of intrusion a at the maxillary second molar. The larger variation in the second molar intrusion resulted from extrusion of the buccal cusps usually noted in cases with buccal tipping of second molars before treatment. The amount of maxillary prem generally less than that of the maxillary molars. The mean intrusion of the maxillary premolar was around 2 mm at the second premolar and 1 mm at the first premolar.

The maximum amount of intrusion (8.67 mm at mesiobuccal cusp of right maxillary first molar and 8.04 mm at second premolar) was noted in a case of a 23-year-old female patient with all her right mandibular molars missing (Fig overerupted. The gingival line of the right maxillary posterior teeth was obviously below that of the anterior teeth. Intrusion was started with a sectional-arch fixed appliance with mini-implant anchorage and completed in seven months. retention and full-mouth orthodontic treatment followed (Figure 5b–d).

The buccal-lingual tipping of the intruded maxillary posterior tooth was quantitatively assessed by subtracting the difference between the intrusion of the buccal and palatal cusps (Table 4). A positive value denoted buccal tippin buccal and palatal cusps and either the mesial or distal position of the crown was generally small compared with the total intrusion achieved. Similar to the negligible tipping of the maxillary molar, the difference between the buccal a little. None of the differences in intrusion between the buccal and palatal cusps reached the level of significance (*t*-test with expected value = 0, $P < .05$). This indicated that the intrusion was achieved without significant buccal-palata

The wide range of values resulted from the initial malposition of some teeth, especially buccoversion of the maxillary second molars. Correction of a buccally tipped second molar requires changing the tooth's axis by intruding pala case, the mesiobuccal cusp of the left maxillary second molar was extruded 3.68 mm. The initial position of this second molar was in a severe buccal version, with buccal cusps out of occlusal contact. Indeed in this type of case, the palatal tipping with buccal cusp extrusion and palatal cusp intrusion.

DISCUSSION Return to TOC

Anchorage control plays an important role in orthodontic mechanics. During conventional orthodontic treatment for intruding overerupted molars, it is difficult to avoid the side effect of extrusion of the anchorage teeth. Some applian intrusion, but the patient's compliance is essential.

In contrast to traditional orthodontics, the molar intrusion facilitated with the mini-implants causes minimum extrusion of the adjacent teeth. Incorporation of mini-implants can achieve a significant amount of maxillary molar intrusio [12] The results of this study demonstrate that the intrusive movement of maxillary premolars could also be anticipated even when the bony anchorage was set originally for the maxillary first molar only. This enables the orthodontist to anchorage.

To quantify the amount of intrusion, we adopted a 3D digitizer to measure the movement of cusp tips of specific teeth relative to the stable structures on the dental casts. The superimposition of lateral cephalometric radiographs m image of posterior teeth is often blurred and buccal-palatal crown tipping could not be assessed. Panoramic radiographs offer a better alternative because no image overlapping of contralateral posterior teeth occurs. Recently, panora with miniplate anchorage.[3] Contrary to analysis using 2D images, the 3D approach could quantify the tooth movement by analyzing spatial data from the serial models.[13]

In this study, palatal rugae were used as references to evaluate the positional change of maxillary teeth on serial dental casts. Almedia et al[14] reported that the medial rugae point is more stable than the lateral point for longitudin and lateral points of the third rugae could be used as the reference points in longitudinal cast analysis. In our study, to track the tooth movement by superimposing two sets of dental casts, a minimum of four identical and reliable ref rugae points. Despite some controversy regarding the long-term stability of rugae during growth, the stability of rugae points was not an issue because the subjects in our study were mostly adult and the observation period was withi

Various implant systems have been used for orthodontic intrusion. Southard et al[10] reported that molar intrusion is possible using dental implants. Sherwood et al[3] reported four cases with miniplate anchorage to close skeletal op tracings showed that a mean molar intrusion of 1.99 mm. Kanomi[16] reported an adult patient with a deep bite, which was corrected with six mm of lower incisor intrusion by an intrusive force from a mini-implant. Umemori et al[2] prese open bite. They implanted the titanium miniplates at buccal aspects of the mandibular molars and intruded the molars about three to five mm. Daimaruya et al[17] intruded the mandibular molars 3.4 mm by the intrusive force from bucc reported that the zygomatic area was a useful anchorage site for maxillary molar intrusion. A cephalometric study demonstrated the effectiveness of skeletal anchorage for intrusion of maxillary posterior teeth to correct anterior open successful intrusion of molars can be consistently achieved with mini-implants as anchorage.

In this study, the severity of the overeruption of individual maxillary teeth varied among the 22 cases. The intrusion mechanics were terminated when the overerupted tooth was leveled. Therefore, the large individual variation of our case was different. In addition to intruding the overerupted maxillary posterior teeth, we also used the mini-implant anchorage system to correct the Class II malocclusion with excessive dentoalveolar height and anterior open bite. Th counterclockwise rotation of the mandible with a decrease in the sagittal jaw discrepancy. Our clinical observation indicated successful orthodontic management of these Class II hyperdivergent patients without orthognathic surgeries these patients requires long-term follow-up.

Intrusion of molars by only applying an apically directed force to the buccal tooth attachment will tip molars to the buccal. There are several ways to counteract the buccal tipping moment produced by the intrusive force applied fro

Most commonly a transpalatal arch is used to help minimize the tendency of buccal tipping. This appliance should be kept well away from the palate to avoid soft tissue impingement. A second option for minimizing buccal tipping al[3] used an overlay round archwire to provide a counterbalancing moment and control the buccal crown tipping. However, the most efficient control may result from simultaneous application of intrusive force from buccal and palatal a system, the intrusive force can be applied by elastic chains between the buccal miniplate and attachment on first molar band, and between the palatal miniscrew and the cleat of the molar attachment. The levels of buccal and palata tendency for crown tipping, which is usually not desirable. In this study, the palatal cusp responded faster and the intrusive movement occurred earlier than that of buccal cusp. The interradicular septum between the two buccal roots buccal and palatal cusps.

This retrospective study has certain limitations. First, its retrospective nature does not allow a detailed analysis of the sequence of events such as a temporary halt for better torque control. Second, tracking the movement of the c of movement but not the type of movement (tip or torque).[13] Third, we observed noticeable clinical crown shortening of the intruded teeth but little was known regarding changes of the surrounding periodontal tissues. Indeed, deepenin frequently noted. The deepened sulcus may prevent proper cleansing and predispose the gingiva to inflammation. We recommend an intense oral hygiene regimen for these intruded teeth to resolve the redundant soft tissue spontan of periodontal tissue around the intruded teeth.

CONCLUSIONS Return to TOC

This study revealed that the average intrusion of maxillary molars was more than three to four mm. A combination of mini-implants and fixed appliances is a predictable and effective procedure to achieve maxillary molar intrusion.

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TABLES Return to TOC

TABLE 1. Demographic Information of 22 Subjects in This Study

Gender (Male/female)	20/2
Age (y) (Mean ± SD)	27.6 ± 8.11
(Range)	15–42
Malocclusion (Class I/II/III)	12/10/0
Facial divergency	
Hyperdivergent (SN-MP > 37°)	9
Hypodivergent (SN-MP < 28°)	2
Normal divergent	11
Combination of mini-implant for anchorage preparation	
Buccal miniplates and palatal miniscrews	
Bilateral/unilateral	8/10
Buccal miniscrews and palatal miniscrews	
Bilateral/unilateral	1/3

TABLE 2. Reliability of Measurements (mm): Individual and Collective Means and Standard Deviations of x, y, and z Coordinates

	x Coordinate	y Coordinate	z Coordinate	Point Measurement
Point on cusp tip	0.15 ± 0.38	0.11 ± 0.49	0.23 ± 0.24	0.41 ± 0.54
Point on palatal rugae	0.16 ± 0.32	0.10 ± 0.29	0.05 ± 0.21	0.45 ± 0.23

TABLE 3. Amount of Intrusion (mm) at Various Cusp Tips of Maxillary Teeth[a]

Tooth	Cusp	Mean ± SD	Maximum	Minimum
First molar (n = 26)	Mesiobuccal	3.17 ± 1.70	8.67	0.42
	Mesiopalatal	3.25 ± 1.74	8.34	0.64
	Distobuccal	3.42 ± 1.94	8.35	0.34
	Distopalatal	3.39 ± 1.90	8.12	0.55
Second molar (n = 17)	Mesiobuccal	1.86 ± 2.73	7.27	−3.68
	Mesiopalatal	2.09 ± 2.06	6.56	−1.39
	Distobuccal	2.18 ± 2.26	6.64	−1.38
	Distopalatal	2.23 ± 2.32	8.34	−1.25
First premolar (n = 11)	Buccal	1.44 ± 2.12	5.86	−1.06
	Palatal	1.08 ± 1.58	3.98	−0.84
Second premolar (n = 21)	Buccal	1.93 ± 2.03	8.04	−1.50
	Palatal	1.86 ± 1.69	5.86	−0.83

[a] Positive value: intrusion; negative value: extrusion.

TABLE 4. Assessment of Crown Tipping (mm) of Maxillary Posterior Teeth[a]

	Difference in Intrusion[b]	Mean ± SD	Maximum	Minimum
First molar (n = 26)	MB-MP	−0.08 ± 0.92	1.40	−1.61
	DB-DP	0.03 ± 1.05	2.68	−1.39
Second molar (n = 17)	MB-MP	−0.22 ± 2.02	1.78	−7.65
	DB-DP	−0.05 ± 0.83	1.39	−1.71
First premolar (n = 11)	B-P	0.36 ± 0.69	1.88	−0.41
Second premolar (n = 21)	B-P	0.07 ± 1.14	2.18	−2.51

[a] Positive value: buccal tipping; negative value: palatal tipping.
[b] MB indicates mesiobuccal cusp; MP, mesiopalatal cusp; DB, distobuccal cusp; DP, distopalatal cusp; B, buccal cusp; and P, palatal cu

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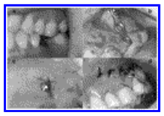

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FIGURE 1. Mini-implant anchorage preparation. (a) Left maxillary first molar elongation due to loss of antagonist. (b) Miniplate was implanted by a flap surgery. (c) Palatal miniscrew. (d) Buccal miniplate

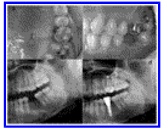

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FIGURE 2. Intrusion of left maxillary first molar. (a) Elastic chain between miniscrew and palatal cleat of first molar. (b) Elastic chain between miniplate and buccal attachment. (c) Initial radiographic image. (d) Postintrusion radiog

Click on thumbnail for full-sized image.

FIGURE 3. Desktop mechanical 3D digitizer

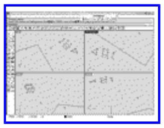

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FIGURE 4. Rhinoceros program to analyze 3D point data

Click on thumbnail for full-sized image.

FIGURE 5. Intrusion of maxillary posterior teeth with the mini-implant anchorage. (a) Significant elongation of maxillary teeth. (b) Maxillary posterior teeth were intruded. (c) Initial radiographic image. (d) Postintrusion radiographic i

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