Molar Intrusion with Implants Using a Bite Plane Appliance: A Case Report

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ABSTRACT

Background: Orthodontic forces for tooth intrusion ought to be continuous and low, which may be achieved with the help of osseointegrated implants.

Purpose: The aims of this study were to describe a method to intrude supererupted maxillary molars using interarch intrusion mechanics (a bite plane appliance) with implants and to assess anchor implant stability through resonance frequency analysis (RFA; Osstell™, Mentor version 2, Integration Diagnostics AB, Göteborg, Sweden) in comparison with nonanchorage control implants during orthodontic intrusion.

Materials and Methods: A 48-year-old female patient was treated with implants (36 and 37 regions, Brånemark Implant System®, MkIII TiUNite™, Nobel Biocare AB, Göteborg, Sweden; lengths, 13 and 10 mm; diameter, 5 mm) serving as orthodontic anchorage for intrusion of supraerupted teeth in the maxilla (teeth 26 and 27) using a bite plane appliance. The force of intrusion applied was individual discontinuous bite force in the present case. The control implants were in the sites 45, 46, and 47 with healing abutments out of loading. Stability of both the anchorage and control implants was assessed by RFA from the commencement of orthodontic intrusion (7 months after the first-stage surgery) to the end of the study (19 months after the first-stage surgery). Marginal bone height measurements of both implants were performed on radiographs at the same time.

Results: The treatment was completed without complications or abnormalities of the intruded teeth or the opposite anchorage implants. However, implant stability quotient values of the anchored implants obviously changed during the initial 4 months after commencement of intrusion compared with control implants. In the present case, an intrusion of 2.2 mm was achieved in 12 months.

Conclusions: The present method made it possible to intrude molars successfully. However, further studies with more cases are needed to clarify the reliability of the method and determine how to control the bite forces applied as orthodontic load.

KEY WORDS: bite forces, implant anchorage, intrusion, osseoperception, RFA

Orthodontic applications of osseointegrated implants have been discussed in the literature.[1–3] Osseointegrated implants have been widely and successfully used for rigid intraoral anchorage in orthodontic therapy.[1,3] Implants that served as orthodontic anchorage also functioned effectively when they were later used as prosthetic abutments.[1,4,5]

Orthodontic tooth movement is often compromised in partially edentulous adult patients, as problems with anchorage may arise. The use of osseointegrated implants as anchorage, which enables various tooth movements, may solve this clinical problem.[1,4] Effective molar intrusion with removable or conventional orthodontic appliances is considered to be difficult.[6] If implants can be used as anchorage for molar intrusion, it may be possible to intrude supererupted molars without injuring the anchor implants or intruded molars.[7] Successful intrusion of molars with implants used as anchorage has been reported.[7–10] Intrusive forces applied for molar intrusion were all continuous and controversial in these reports.[7–13] Many orthodontists might agree with the contention of Melsen[14] that the orthodontic force for tooth intrusion must be continuous and low.

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The present case report illustrates interarch molar intrusion mechanics (a bite plane appliance) with surface-modified implant anchorage, which produced indirect intrusive force on supererupted maxillary molars by individual intermittent bite forces that are not easily controlled and considered inappropriate to move teeth. Moreover, the stability of anchor implants during orthodontic treatment was clinically assessed and compared with that of control implants in the same jaw through resonance frequency analysis (RFA).[15–17] Marginal bone-height measurements of both implants were performed on radiographs at the same time.

MATERIALS AND METHODS

The Technique that was Used in the Patient

Interarch intrusion mechanics with implants have been reported by Kokich[18] as far as we know. The intrusion mechanics with implants by Kokich consist of three parts: (1) osseointegrated implants with abutments initially serving as an orthodontic anchorage and later as a prosthetic abutment, with the abutment consisting of metal attachments, (2) plastic provisional crowns on anchor implants with samarium–cobalt magnets, and (3) a plastic bite plane with samarium–cobalt magnets on the opposing supraerupted teeth. The implants and samarium–cobalt magnets are used to provide continuous intrusive force for interarch-teeth intrusion. A provisional plastic, transparent bridge with samarium–cobalt magnets on the anchor implants exerts intrusive force on the opposing supraerupted teeth through a removable bite plane that receives the impact of the magnets as continuous and discontinuous bite forces. However, no forces for teeth intrusion were described.

Interarch intrusion mechanics with implants used in the present case consisted of basically the same parts mentioned earlier. The differences between the two methods were as follows: (1) screw-retained implants with a provisional restoration were used directly as the orthodontic anchorage, and (2) no magnets, that is, only a bite plane was used (Figure 1, A and B).

The supraerupted molars must be covered by the bite plane for as long as possible, except during meals. We recommended rational deliberate clenching that would exert intrusive orthodontic forces on the supraerupted molars through the bite plane. For control of the bite force, in other words, clenching force control, the patient is instructed as follows: "Clench until you perceive that your lower implants begin to receive load, the force level of which you feel is an optimal intrusive force for your molars. Remember the force level and repeatedly apply the forces to the bite plane, whenever you become conscious." The tactile threshold transmitted through the prostheses in patients with osseointegrated implants is termed *osseoperception*.[19] Mericske-Stern and Zarb[20] detected the threshold of minimal pressure while wearing complete maxillary dentures and mandibular fixed prostheses supported by Brånemark implants (Brånemark Implant System®, Nobel Biocare AB, Göteborg, Sweden), which was 330 g in the horizontal and 388 g in the vertical direction. The load on implants that the patient begins to perceive might be near this level, that is, 388 g in the vertical direction.

Patient Presentation

A 48-year-old female visited our hospital for implant therapy in 2005. She was systemically healthy and had no periodontal problems, but tooth 37 had to be extracted because of root fracture. She had lost teeth 17, 16, 36, 45, 46, and 47 before the initial visit. There

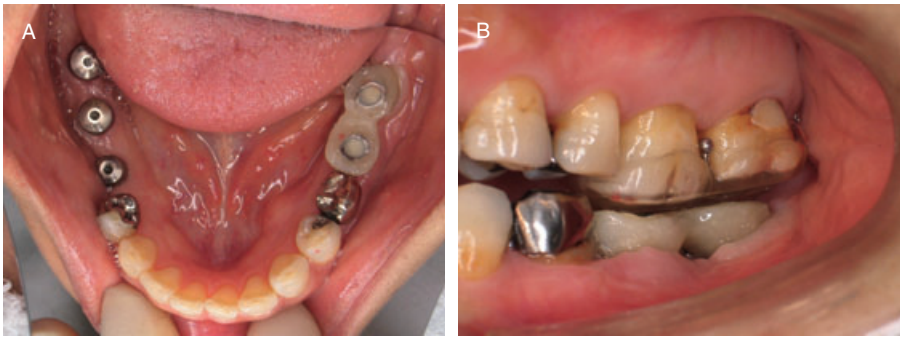

Figure 1 *A*, Occlusal view of the implants providing anchorage and control implants. *B*, Bite forces produced by the patient transforms into intrusive forces for molars through the occlusal bite plane.

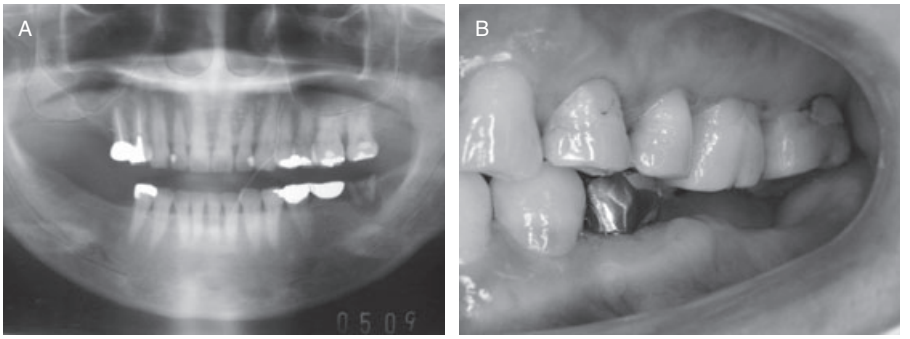

Figure 2 *A*, Panoramic X-ray taken at the initial visit. *B*, Left-side view after extraction of tooth 37. Supraeruption of the maxillary molars was observed.

was marked supraeruption of teeth 26 and 27, and, as a result, there was no prosthetic space for 36 and 37 (Figure 2, A and B). The patient requested prosthodontic replacement with implants at 16, 17, 36, 37, 45, 46, and 47 regions after extraction of tooth 37.

The implant surgery was performed at the sites of 36 and 37 under local anesthesia (2% lidocaine with 0.0125 mg/mL epinephrine, Xylocaine® cartridge for dental use, Dentsply-Sankin, Tochigi, Japan) with conscious intravenous sedation (1% Propofol injection "Maruishi," Maruishi Pharmaceutical Co., Ltd., Osaka, Japan, and Dormicam®, Astellas Pharma Inc., Tokyo, Japan). A crestal incision, which extended to the ramus area for bone harvesting, was made, and a full-thickness mucoperiosteal flap was raised. Two implants (Brånemark Implant System®, MkIII TiUnite™, one with a diameter of 5.0 mm and length of 13 mm at site 36, the other with a diameter of 5.0 mm and length of 10 mm at site 37) were placed according to manufacturer's instructions. A bone defect was observed at site 37 between the implant and the remaining bone wall following the implant placement (Figure 3A). The bone defect was filled with autogenous bone tissue harvested from the ramus (see Figure 3B). Suturing was carried out with 5-0 Vicryl sutures (Johnson & Johnson K.K., Tokyo, Japan). Postoperative drugs prescribed included an antibiotic (cefteram pivoxil, 100 mg potency, Tomiron®, Tomiyama Chemical Co., Ltd., Tokyo, Japan), an analgesic (Diclofenac sodium, 25 mg/tab, Voltaren®, Novartis Pharma K.K., Tokyo, Japan), and 0.1% chlorhexidine gluconate solution (Hibitane® concentrate, Dainippon Sumitomo Pharma, Osaka, Japan) for rinsing.

The next implant surgery was performed at sites 45, 46, 47, 16, 17, and 18. Three implants (Brånemark Implant System, MkIII TiUnite site 45, diameter 4.0 mm, length 13 mm, site 45; diameter 5.0 mm, length 13 mm, site 46; diameter 5.0 mm, length 10 mm, site 47) were placed in the mandible according to manufacturer's instructions. Three implants (Brånemark Implant System, MkIII TiUnite; implant diameter 5.0 mm, length 15 mm, site 16; diameter 5.0 mm, length 15 mm, site 17; diameter 4.0 mm, length 13 mm, site 18) were placed in the maxilla with sinus bone graft.

Six months later, a second-stage surgery was performed for uncovering all the implants except the implant at site 18. A provisional bridge adjusted by the patient's own occlusion was fabricated immediately at

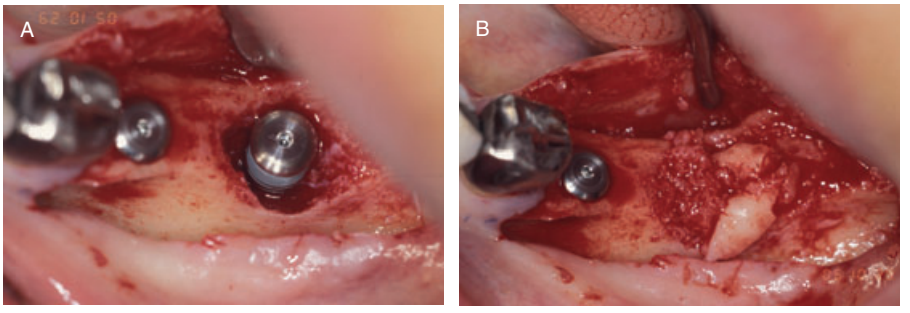

Figure 3 *A*, A bone defect was observed around the implant. *B*, The defect was filled with autogenous bone chips.

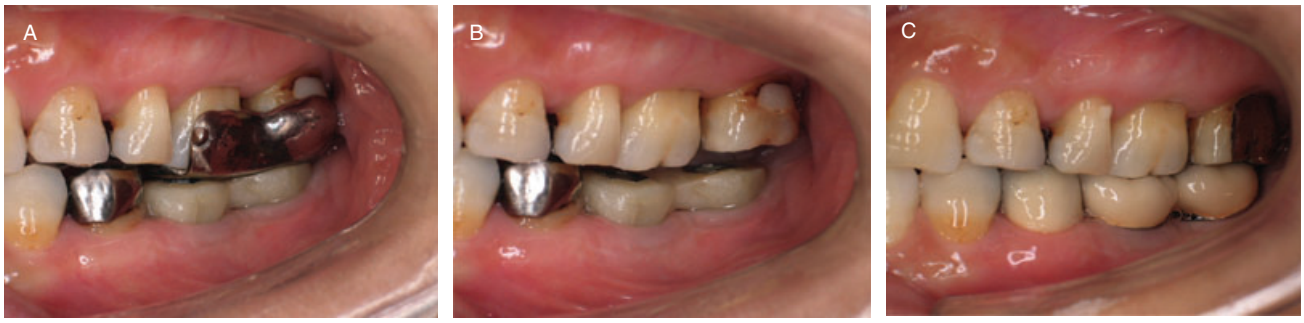

Figure 4 *A* and *B*, Adequate prosthetic space was obtained 12 months from orthodontic intrusion commencement. *C*, A PFM implant restoration was placed on the anchor implants under the corrected occlusal plane.

sites 36 and 37 with nonengaging temporary abutments (Brånemark Implant System) at the fixture level. The provisional bridge functioned as orthodontic anchorage for opposite molar intrusion (see Figure 1, A and B). Meanwhile, cover screws of the uncovered implants at sites 45, 46, 47, 16, and 17 were replaced by healing abutments (Brånemark Implant System). The implants at 45, 46, and 47 with healing abutments and with no occlusal contacts were used as control in this study (see Figure 1A).

The removable plastic occlusal bite plane on the supraerupted molars was fabricated 1 month after the second-stage surgery. Molar intrusion by the bite plane appliance using individual bite force was initiated at that time. During intrusion, particular attention was paid to maintain oral hygiene,[21] and the teeth were professionally cleaned once a month.[5]

From the time of second surgery (6 months after implant placement) to 19 months after implant placement, the two anchor implants and three control implants were checked by a resonance frequency analysis device (Osstell™ Mentor version 2, Integration Diagnostics AB, Göteborg, Sweden) every month, according to manufacturer's instructions.[22]

The marginal bone level around each implant was evaluated on periapical radiographs taken at the second-stage surgery (baseline, 6 months after implant placement) and after 19 months at completion of orthodontic intrusion.

The implants were assessed by using the criteria of success, which was a modification of the proposal by Albrektsson and colleagues.[23]

RESULTS AND DISCUSSION

Molar intrusion of 2.2 mm, which was measured by interarch bite registration putty (Express™, 3 M ESPE Dental Products, Saint Paul, MN) taken at the time to completion of the intrusion, with implants using the bite plane appliance mentioned was achieved in 12 months (Figure 4, A and B). During the course of treatment, however, recurrent fracture of the plastic bite plane occurred (Figure 5, A and B). A new metal bite plane was fabricated instead (see Figure 5C). We thus recommend a metal bite plane in this situation. The

Figure 5 *A*, Left-side view 2 months after commencement of orthodontic intrusion. A small space was made between the implant provisional restoration and maxillary molars. *B*, The plastic bite plane that was fractured repeatedly. *C*, The metal bite plane placed on supraerupted maxillary molars.

TABLE 1 ISQ Value of the Anchorage Implants and Control Implants

Site	6* Months	7†	8	9	10	11	12	13	14	15	16	17	18	19‡
36	85	83	76	71	75	86	84	84	80	88	85	84	84	85
37	87	87	74	70	80	84	76	85	82	85	86	87	84	83
45	78	59	70	67	75	76	75	80	73	74	79	79	80	75
46	87	72	84	78	82	85	71	77	81	80	85	80	79	79
47	87	74	74	74	82	85	70	80	81	82	80	77	80	83

*At second surgery.
†Intrusion commencement.
‡Completion of intrusion.

intruded molars 26 and 27 exhibited no abnormalities in the periodontal tissue or tooth pulp. There were no symptoms[24] of temporomandibular disorder. To avoid relapse, provisional restorations were fabricated and attached to the implants opposing the intruded molars soon after the metal bite plane was removed. The final implant restorations were placed 3 months later (see Figure 4C).

The RFA measurements of mandibular anchorage and control implants expressed in ISQ (implant stability quotient) values from 6 months after surgery to 19 months at the end of orthodontic intrusion are presented in Table 1. The anchorage implants at sites 36 and 37 showed a steady decrease in ISQ value from 7 to 9 months since orthodontic intrusion commencement and an increase from 9 to 11 months in ISQ value, thus reaching the baseline level. The control implants at sites 45, 46, and 47, with healing abutments out of loading in ISQ showed a zigzag pattern until 13 months. ISQ values showed a decrease at 7 months, one month after the second surgery, and remained nearly constant after 13 months.

The results from the radiographic evaluation of the marginal bone level and its change from second surgery (6 months) to 19 months are presented in Table 2. No differences were observed between anchor implants and control implants in the present case.

Previous studies[4,5,7–10,25] on orthodontic treatment with implants involved less than 6 N and/or continuous orthodontic load, whereas orthodontic load in the present case was intermittent and patient dependent. It is important to control the occlusal bite forces of the patient to provide an optimum orthodontic load without jeopardizing the stability of anchor implants and to assess the mentioned "bite force," that is, minimal pressure threshold of 388 g in the vertical direction[20] to find whether it is a practical orthodontic force for molar intrusion. The optimal forces for molar intrusion have been reported to range from 50 to 1000 g.[7–13] These values are controversial, but we think that the optimal intrusion forces per maxillary molar are 150 to 200 g. Bite forces used as orthodontic load were about 400 g and vertical in the present case. We assume that the intentionally controlled bite forces could cause effective molar intrusion even with discontinuous and unsteady load.

The anchor implants appeared to have no problem under the orthodontic load in the case. However, the ISQ values of anchor implants changed in the initial 4 months of orthodontic intrusion, from 7 months after

TABLE 2 Marginal Bone Height Measurement from the Starting Day of Orthodontic Intrusion to the End of the Study

	Implant				Marginal Bone Resorption (mm)		
Site	Surface	Type	Diameter (mm)	Length (mm)	Mesial	Distal	Average
36	TiU	III	5.00	13.0	0.60	1.00	0.80
37	TiU	III	5.00	10.0	1.10	0.20	0.65
45	TiU	III	4.00	13.0	0.80	0.60	0.70
46	TiU	III	5.00	13.0	1.40	0.60	1.00
47	TiU	III	5.00	10.0	0.80	0.70	0.75

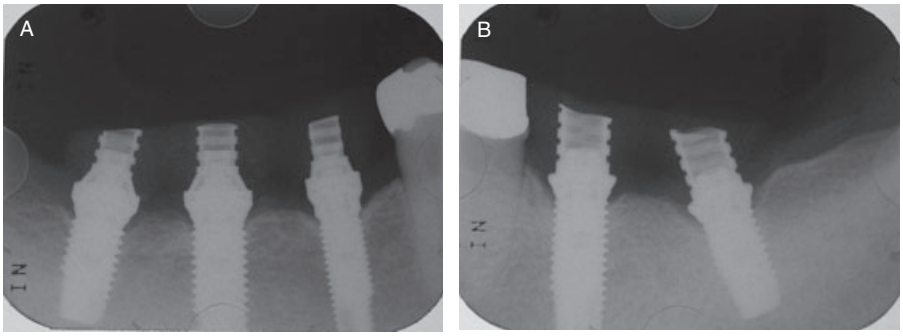

Figure 6 *A* and *B*, radiographic view after completion of orthodontic intrusion. *A*, Control implants at sites 45, 46, and 47 after prosthetic abutments were placed. *B*, Anchor implants at sites 36 and 37. Perifixtural bone condensation was observed around the implants.

implant placements to after 11 months. It is not known whether the orthodontic load had an effect on the bone-implant interface in maintaining implant stability or simply the remodeling cycle,[26–29] referred as sigma,[28] was responsible for the initial decrease in ISQ value. However, periapical radiographic view of the anchor implants compared with control implants after the orthodontic intrusion might indicate an adaptation of the bone-implant interface[30] induced by orthodontic forces (Figure 6, A and B). The implant stability expressed by RFA after bone healing, that is, after gaining secondary stability under orthodontic loading, is unknown. Meticulous observation may be needed for orthodontic anchor implants during the treatment even if the implants seem to have no obvious problems.

The fact that bite forces, along with implant anchorage, can intrude natural teeth without symptoms of temporomandibular disorder[24] might indicate the possibility of "natural occlusal adjustment" by natural tooth intrusion if the implant prosthesis is placed in the supraocclusal condition compared with the proper occlusal position. The forces of intrusion applied in the case might be "occlusal trauma" in a sense. Therefore, we think the method should be applied to the molar with healthy periodontal tissue only.

The prosthetic space in the present case was mostly gained by molar intrusion with osseointegrated implants as anchorage. However, as a result of placing a bite plane on molars for a long time, slight eruption of the unopposed teeth may have occurred.[31,32] The factors that could have contributed to the treatment result might be the molar intrusion with implants anchorage and the slight eruption of the unopposed teeth. Intrusion of maxillary molars was achieved with osseointegrated implant anchorage under an orthodontic load, the nature of which is considered inappropriate to move teeth. However, further studies with more subjects are needed to clarify the reliability of this method or to control the bite forces applied as orthodontic load.

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