

# Six-year follow-up of maxillary anterior rehabilitation with forced orthodontic extrusion: Achieving esthetic excellence with a multidisciplinary approach

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Orthodontic extrusion with multidisciplinary treatment can provide predictable outcomes in selected situations, reducing the costs and the adaptation times of gingival tissues after implant integration. Forced orthodontic extrusion is strongly related to interactions of teeth with their supportive periodontal tissues. This article reports a case of orthodontic extrusion of the maxillary incisors for later implant rehabilitation in a patient with periodontal disease. Slow forces were applied for 14 months. After this time, the teeth were extracted, and the implants were placed on the same day. Also in the same session, the provisional crown was fabricated for restoration of the anterior maxillary interdental papillae loss and for gingival contouring. Clinical and radiographic examinations at the 6-year follow-up showed successful tooth replacement and an improved esthetic appearance achieved by this multidisciplinary treatment. The decision to perform orthodontic extrusion for implant placement in adult patients should be multidisciplinary. (*Am J Orthod Dentofacial Orthop* 2013;144:607-15)

Periodontal disease is characterized by inflammation of the supporting tissues of the teeth, resulting in gingival recession and apical migration of the junctional epithelium with pocket formation and alveolar bone loss.<sup>1</sup> In the maxillary anterior teeth, these conditions cause functional discomfort and compromise the esthetics.<sup>2</sup>

Since the immune and inflammatory responses are critical factors in the pathogenesis of periodontitis and

are related to countless aerobic and anaerobic bacteria, the rehabilitation of these patients becomes a challenge to the professional because of the need to restore function and especially esthetics.<sup>3</sup> Unfortunately, periodontal regeneration procedures, onlay bone grafts, and mucogingival therapy do not have entirely predictable outcomes, especially when systemic disease such as diabetes mellitus is present because this condition impairs the bone healing around dental implants,<sup>4</sup> mainly in relation to bone and tissue height gain in the anterior maxilla.<sup>1</sup>

Orthodontic extrusion to correct periodontal infrabony defects can be successful when there is no inflammation and with adequate control of dental plaque.<sup>5</sup> According to Taba et al,<sup>6</sup> the success of periodontal regeneration depends on 4 elements: cells, appropriate signals, scaffold, and blood supply. The establishment of a new vascular supply is essential for periodontal regeneration because this provides nutrients for cell growth. During orthodontic extrusion, mechanical stresses exerted on the alveolar bone lead to activation of angiogenic growth factors, which would contribute to the formation of new supporting tissues.<sup>7</sup> The regeneration of periodontal tissue support allows implant placement and predictable treatment results. However, it is recommended that

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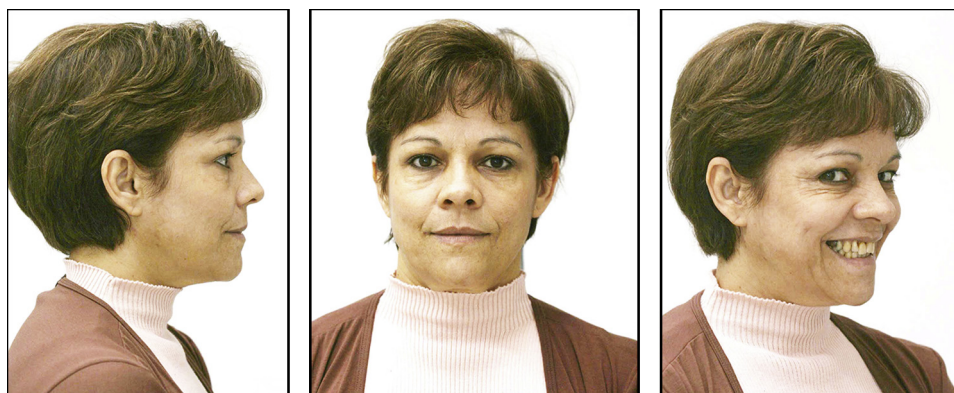
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**Fig 1.** Facial pretreatment photographs.



**Fig 2.** Intraoral photographs showing that most teeth were periodontally compromised.

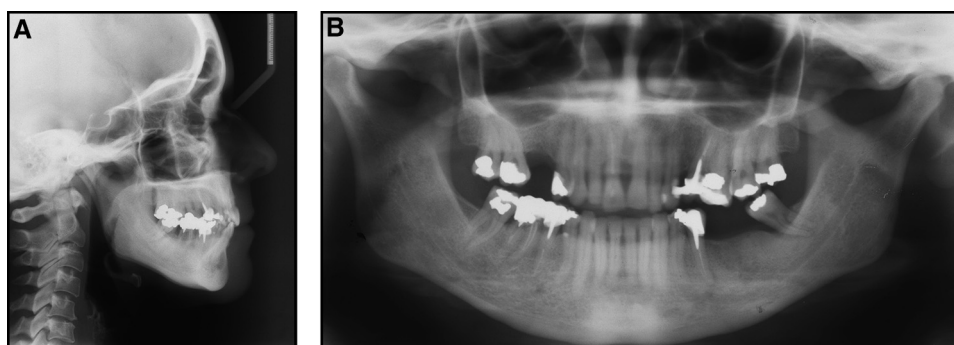
in patients with periodontal disease, orthodontic treatment should start 2 to 6 months after periodontal therapy to allow for periodontal healing and stabilization.<sup>8</sup> At the same time, light continuous forces should be implemented for efficient tooth movement in a compromised periodontium: ie, the ideal constant orthodontic forces during extrusion should allow movement of  $\geq 2$  mm per month.<sup>9</sup>

According to Gkantidis et al,<sup>10</sup> the harmonious cooperation of a general dentist, a periodontist, and an orthodontist offers great possibilities for successful treatment. Although there are many studies in the scientific dental literature about orthodontic extrusion, only a few cases of placing dental implants after orthodontic extrusion have been reported.<sup>11</sup> Therefore, we report on a case of orthodontic extrusion of the maxillary

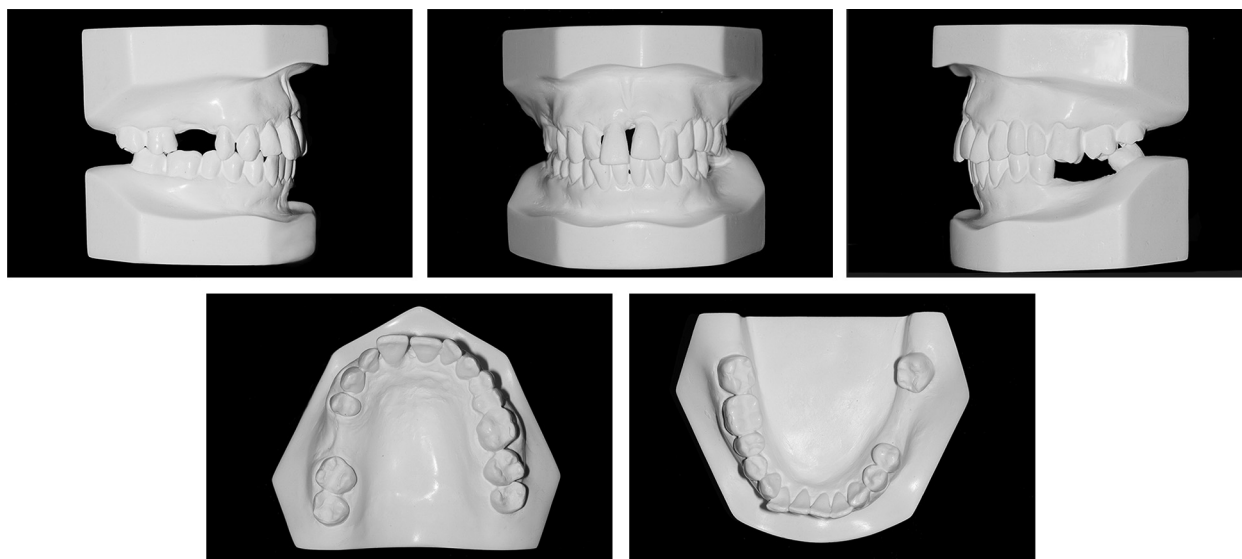
anterior incisors to facilitate implant placement in a patient with periodontal disease.

#### DIAGNOSIS AND ETIOLOGY

A 56-year-old woman was seen in the prosthodontic clinic in the Department of Dental Materials and Prosthodontics at Araraquara School of Dentistry, São Paulo, Brazil, for extraction of her maxillary central incisors and replacement with endosseous implants. The patient had no systemic problems and did not smoke. However, she had periodontal disease characterized by loss of supporting alveolar bone and tissue, mainly around the maxillary anterior teeth. This condition prevented the rehabilitation before a new treatment plan was considered.



**Fig 3.** A, Class I cephalometric characteristics; B, panoramic radiographs showing generalized peri-odontal bone loss.



**Fig 4.** Pretreatment dental casts.

The initial facial photographs showed a Class I pattern with good facial relationships and a normal profile (Fig 1). In the clinical examination, the probing pocket depth was 8 mm around the maxillary central incisors. In the other areas, probing depths ranged from 3 to 5 mm. The periodontal examination showed gingival recession of the maxillary right central and lateral incisors, canine, and first premolar, and the maxillary left central and lateral incisors, canine, and first molar (Fig 2). The first appointment was scheduled for orthodontic documentation for multidisciplinary planning.

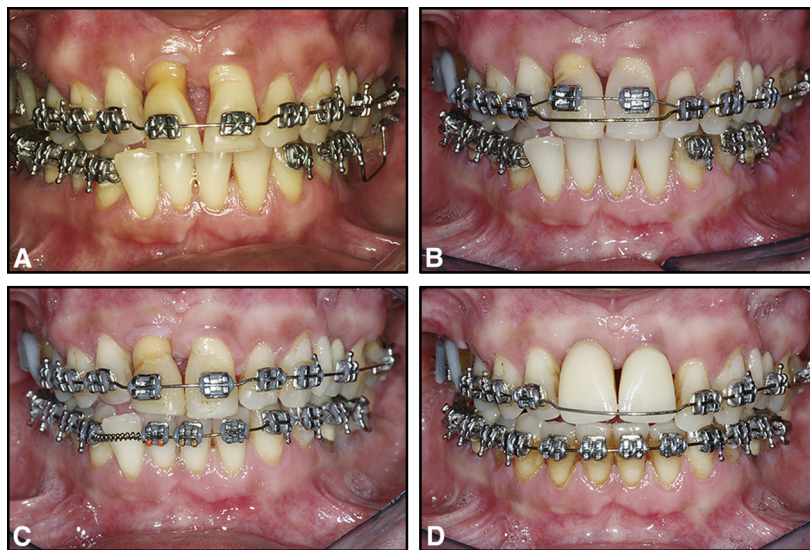
The cephalometric characteristics were normal without clinically significant skeletal deviations (Fig 3, A). The panoramic radiograph showed generalized horizontal bone loss and vertical bony defects on

the distal aspect of the maxillary right first premolar, the distal aspect of the mandibular right first molar, and the mesial aspect of the mandibular left third molar (Fig 3, B). However, the dental casts showed a complete Class II molar relationship on the left side (Fig 4).

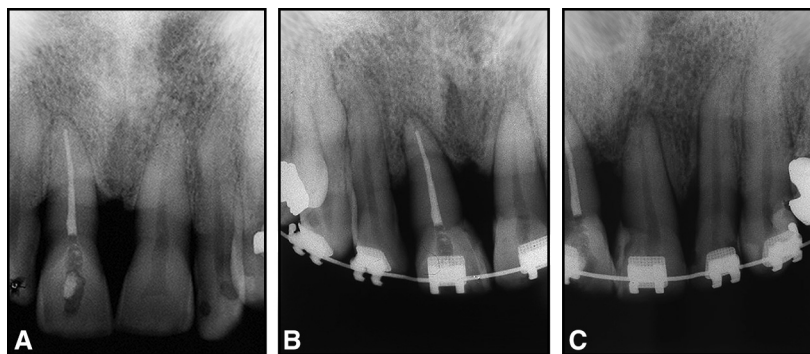
#### TREATMENT OBJECTIVES

The treatment plan consisted of 4 stages. In the first stage, periodontal therapy was provided, and plaque control was encouraged. In the second stage, orthodontic extrusion was to gain bone in the vertical direction. Therefore, it was possible to reduce the vertical bone defects around the maxillary central incisors before implant placement. The third stage consisted of extraction of the





**Fig 5.** **A**, Onset of orthodontic extrusion treatment; **B**, intraoral progress photograph after 7 months; **C**, eruptive phase followed by stabilization; **D**, provisional titanium cylinders connected to the implant central incisors after the orthodontic treatment was finalized.



**Fig 6.** **A**, Initial periapical radiographic examination; **B** and **C**, periapical radiographic examination showing the complete orthodontic treatment after 14 months. Note that the bone migrated in the apical direction when an orthodontic force was applied.

maxillary central incisors and immediate implant placement. In the fourth stage, the definitive restoration of the maxillary central incisor implants was completed.

#### TREATMENT ALTERNATIVES

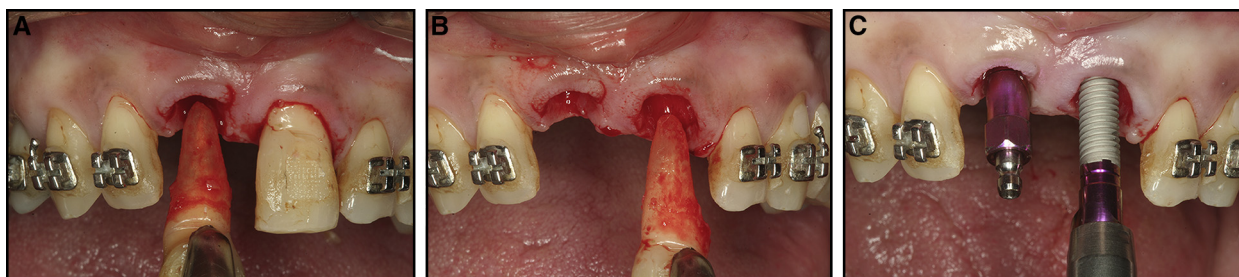
An alternative to orthodontic extrusion would be extraction of the anterior teeth, then implant placement followed by compensation of the defect with soft tissue and/or increasing the prosthetic crown length. This hypothesis, although immediate and without orthodontic treatment, was rejected because of the risk of marked bone loss and the possibility of unfavorable esthetic results related to papillae leveling.

The second option would be block bone graft surgery to increase the alveolar bone thickness. This procedure would favor the implant surgery and esthetics. In this case, the patient would have 2 surgeries, with the additional risk of worsening the bone loss.

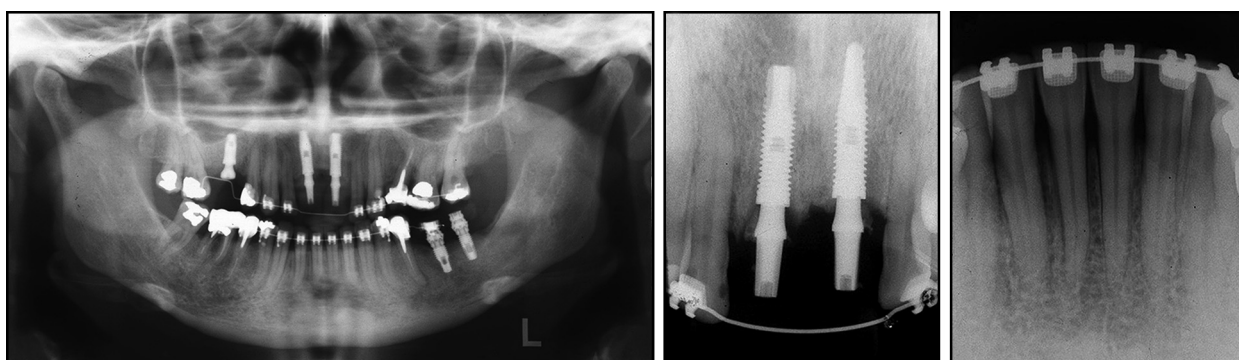
Another option of more conservative treatment would be to keep the maxillary central incisors and to rehabilitate with facets. However, the esthetics in this patient would have been compromised.

#### TREATMENT PROGRESS

The initial treatment stage comprised plaque control and gingival inflammation reduction. For this patient,



**Fig 7.** A and B, Atraumatic extractions of the maxillary right and left lateral incisors; C, placement of implants.



**Fig 8.** Panoramic and periapical radiographic examinations showed the correct angulations of adjacent teeth as well as the correct positions of the implants in the maxillary arch.



**Fig 9.** Removal of the orthodontic appliances after 22 months of initial treatment.

periodontal treatment and oral hygiene instructions were performed according to the study of Gkanditis et al.<sup>8</sup> After 4 months, a careful clinical examination was performed before the orthodontic treatment.

The orthodontic treatment began by placement of fixed appliances in the maxillary arch with brackets and archwires. The maxillary right and left second molars received bonded tubes, providing comfort and the possibility of complete individualization of bonding. The maxillary right and left central incisor brackets were placed more apically to facilitate the extrusive movement.

The incisal and distal surfaces of the maxillary right central incisor and the distal surface of the maxillary left central incisor were equilibrated. On the same day, a 0.014-in Nitinol wire (3M Unitek, Monrovia, Calif) was placed. One month later, treatment began in the mandibular arch with direct bonding of brackets, including the mandibular right first molar and left third molar. The mandibular central and lateral incisors did not receive brackets to prevent protrusion (Fig 5, A).

After 7 months, the mandibular left third molar became mobile and was extracted; 2 implants were placed





**Fig 10.** Follow-up facial photographs at 6 years.



**Fig 11.** Definitive restorations with feldspathic porcelain crowns.

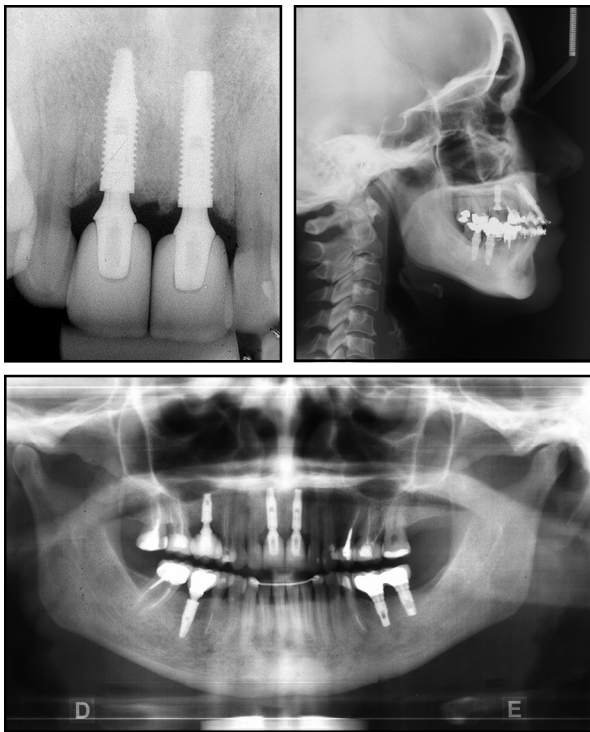
in the region of the mandibular left first and second molars. In the next month, the brackets on the maxillary right and left central incisors were repositioned cervically, and a 0.014-in Nitinol wire was placed to potentiate the extrusion mechanics. To prevent intrusion of the anchorage teeth, an 0.018-in stainless steel auxiliary arch was used to stabilize the segmented wire (Fig 5, B).

In the tenth month, implant surgery was performed in the region of the maxillary right second premolar. The periapical radiographs showed bone gain achieved by the vertical mechanical extrusion. At this time, the patient was referred for implant evaluation.

The patient was seen 2 weeks later for reduction of the incisal surfaces of the extruded teeth and apical repositioning of the lateral incisor bracket along the root

surface. After 10 weeks, the segmented arch had stabilized. This eruptive stage was followed by 4 weeks of stabilization (Fig 5, C). Orthodontic treatment was completed after 14 months. Radiographic examinations showed the preorthodontic and postorthodontic extrusion treatment (Fig 6).

In the third stage and after 14 months, atraumatic extractions were performed on the maxillary right and left central incisors without flap elevation (Fig 7, A and B), and 2 implants were placed: Alvin Cone Morse, 3.5 × 13 mm, on the right side, and Titamax Cone Morse, 3.5 × 13 mm, on the left side (Neodent, Curitiba, Paraná, Brazil) (Fig 7, C). Adequate insertion torque (<40 Ncm) allowed for immediate placement of 2 screw-retained provisional restorations. After 8 months, the implants had attained



**Fig 12.** Follow-up cephalometric, periapical, and panoramic radiographs at 6 years.

adequate stability, and 2 provisional titanium cylinders were connected to the central incisor implants to create sufficient space and allow rehabilitation with definitive prostheses (Fig 5, D). Radiographs showed the correct angulations of the adjacent teeth as well as the correct positions of the implants in the maxillary arch (Fig 8).

After 22 months of initial treatment, the orthodontic appliances were removed, plaque control was performed, and a Hawley plate was placed to maintain the teeth in the correct positions (Fig 9).

Four months after the removal of the devices, the mandibular first right molar had a furcation defect, and the multidisciplinary team decided that extraction of the tooth and placement of an osseointegrated implant were indicated.

In the fourth stage, 8 months after implant surgery, the prosthetic procedures were started by transfer impression for fabrication of the coping. The universal Neodent screwed abutment of  $4.5 \times 2.5 \times 6.0$  mm was customized to create an esthetic gingival contour within the limitations of the biologic distances. Then feldspathic porcelain crowns (IPS Empress II lithium-disilicate glass-ceramic restorations; Ivoclar Vivadent, Amherst, NY) were prepared

and placed over the implants to obtain excellent esthetic results.

## TREATMENT RESULTS

Six years postoperatively, the facial (Fig 10), clinical (Fig 11), panoramic, cephalometric, and periapical radiographic (Fig 12), and cephalometric superimpositions (Fig 13) showed excellent esthetic results, and the patient was highly satisfied. Posttreatment dental casts taken after 6 years (Fig 14) showed the stable relationship between the dental arches.

## DISCUSSION

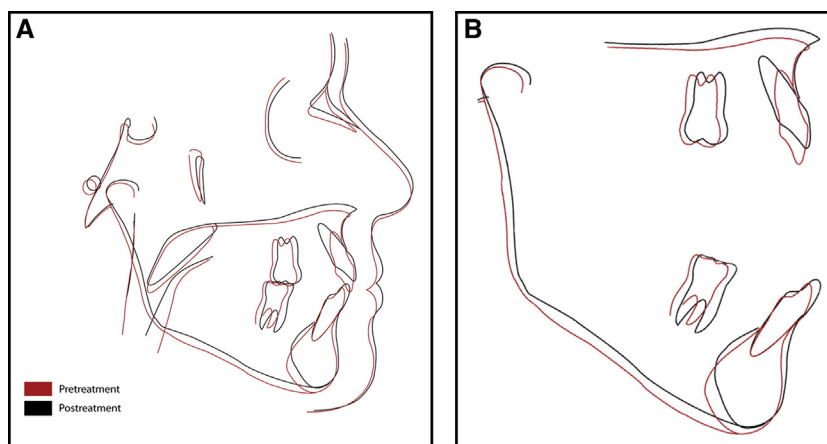
One of the most difficult challenges in dentistry is rehabilitation of the anterior maxilla with implants when there are periodontally compromised teeth.<sup>12</sup> The main discussion is how to manage the residual defects associated with extraction of periodontally compromised teeth and then to place implants successfully in those sites. A complicating factor is the need to maintain functional and esthetic harmony with the adjacent natural teeth.<sup>13</sup> Extraction followed by immediate implant placement has been advocated as a faster approach to replace hopeless teeth with implants. This procedure can be effectively used in many situations with excellent results, but it might be ineffective when the periodontal breakdown around the hopeless teeth is particularly severe in areas with bone defects, as in our patient.<sup>14,15</sup>

Other treatment possibilities would be a bone graft before implant placement. However, a literature review indicated that the bone graft technique is extremely demanding and might be more useful in fully edentulous arches than in areas with small edentulous spaces.<sup>16,17</sup>

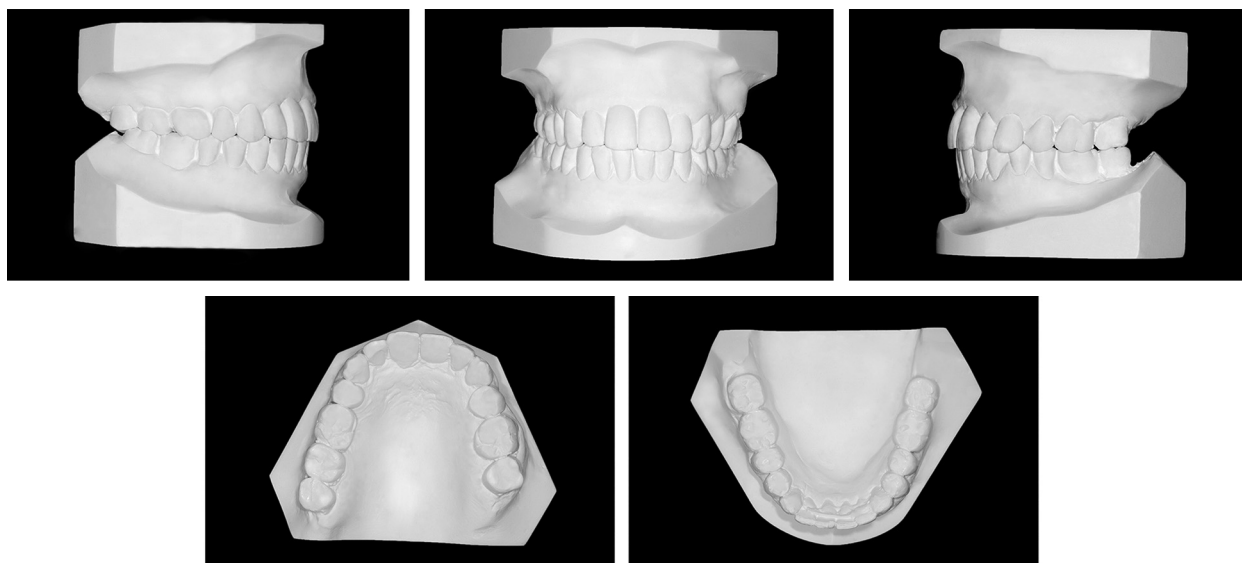
In this patient, the treatment option was forced orthodontic extrusion. This method associated with other multidisciplinary treatment can provide predictable outcomes in some situations, minimizing the need for costly and time-consuming alterations of gingival tissues after implant integration.<sup>11</sup>

This treatment alternative depends on several factors, including the absence of ankylosed teeth, inadequate periodontal support, and patient cooperation, and in situations where hard-tissue augmentation is mandatory. The possibilities of correction of isolated infrabony defects and repositioning of the gingival margin without surgery and before implant placement define this as a conservative treatment.

A therapeutic goal for adults should be individualized treatment. The aim of orthodontic treatment is to create the necessary conditions for rehabilitation and replacement of missing teeth. Orthodontic extrusion reduces



**Fig 13.** **A**, Superimposed cephalometric tracings show the changes from pretreatment (red line) to posttreatment (black line); **B**, partial superimpositions: maxilla and mandible.



**Fig 14.** Posttreatment dental casts after 6 years.

the probing depth, increases the attachment, and consequently changes the periodontal structure: ie, it promotes the growth of periodontal tissues, thus correcting infrabony defects and craters caused by periodontal disease.<sup>18,19</sup> According to the scientific literature, the coronal formation of gingival tissues is stimulated under extrusive force; in most clinical situations, the gingival margin follows tooth movement.<sup>1,20,21</sup>

During forced eruption, the bone and gingiva surrounding the extruded tooth migrate coronally when a light force is used.<sup>19,22</sup> Salama and Salama<sup>13</sup> showed that the attachment could be used to increase bone and gingiva in an occlusal direction to improve a potential

implant site. They also suggested that forced eruption of hopeless teeth was an effective method for bone augmentation in sites where alveolar ridge defects complicate the correct implant placement and increase the keratinized gingiva with the augmented alveolar bone.<sup>13</sup>

Forced eruption has also been used to restore imperfect papillae in teeth with periodontal disease and for implant site development before implant placement.<sup>11,23-25</sup> Gingival and periodontal ligament fibers are stretched during forced eruption, promoting coronal gingival repositioning and new bone apposition in the direction of movement.<sup>26,27</sup> The provisional crown, after implant placement, can be fabricated for restoration of



anterior maxillary interdental papillae loss and gingival conditioning.<sup>28</sup>

For our patient, slow forced orthodontic eruption allowed occlusal movement of the periodontal tissues and thereby increased the bone height. The forced orthodontic extrusion associated with other procedures provided easier and more predictable results. Furthermore, the therapeutic goals for the treatment of adults should be individualized, and the treatment planning must be done in detail, considering the necessity of acting professionally from related areas in an integrated way to predict the best results.

## CONCLUSIONS

The decision to perform orthodontic extrusion for implant site development in older patients should be multidisciplinary because the ultimate treatment success depends on the sequential clinical stages described. Combination treatment, including forced eruption, tooth extraction, and immediate implant placement with fabrication of a provisional crown, was used to make an esthetic and functional restoration of hopeless teeth compromised by periodontitis.

## REFERENCES

- de Molon RS, de Avila ED, Nogueira AV, de Souza JA, Avila-Campos MJ, de Andrade CR, Cirelli JA. Evaluation of the host response in various models of induced periodontal disease in mice. *J Periodontol* 2013 Jun 27; <http://dx.doi.org/10.1902/jop.2013.130225> [Epub ahead of print].
- de Molon RS, de Avila ED, Cirelli JA. Host responses induced by different animal models of periodontal disease: a literature review. *J Investig Clin Dent* 2012 Nov 27; <http://dx.doi.org/10.1111/jicd.12018> [Epub ahead of print].
- Taubman MA, Kawai T, Han X. The new concept of periodontal disease pathogenesis requires new and novel therapeutic strategies. *J Clin Periodontol* 2007;34:367-9.
- de Molon RS, Morais-Camilo JA, Verzola MH, Faeda RS, Pepato MT, Marcantonio E Jr. Impact of diabetes mellitus and metabolic control on bone healing around osseointegrated implants: removal torque and histomorphometric analysis in rats. *Clin Oral Implants Res* 2013;24:831-7.
- Corrente G, Abundo R, Re S, Cardaropoli D, Cardaropoli G. Orthodontic movement into infrabony defects in patients with advanced periodontal disease: a clinical and radiological study. *J Periodontol* 2003;74:1104-9.
- Taba M Jr, Jin Q, Sugai JV, Giannobile WV. Current concepts in periodontal bioengineering. *Orthod Craniofac Res* 2005;8:292-302.
- Chiu PP, McNamara JA Jr, Franchi L. A comparison of two intraoral molar distalization appliances: distal jet versus pendulum. *Am J Orthod Dentofacial Orthop* 2005;128:353-65.
- Gkantidis N, Christou P, Topouzelis N. The orthodontic-periodontic interrelationship in integrated treatment challenges: a systematic review. *J Oral Rehabil* 2010;37:377-90.
- Korayem M, Flores-Mir C, Nassar U, Olfert K. Implant site development by orthodontic extrusion. A systematic review. *Angle Orthod* 2008;78:752-60.
- Gkantidis N, Halazonetis DJ, Alexandropoulos E, Haralabakis NB. Treatment strategies for patients with hyperdivergent Class II Division 1 malocclusion: is vertical dimension affected? *Am J Orthod Dentofacial Orthop* 2011;140:346-55.
- de Molon RS, de Avila ED, de Souza JA, Nogueira AV, Cirelli CC, Margonar R, et al. Forced orthodontic eruption for augmentation of soft and hard tissue prior to implant placement. *Contemp Clin Dentistry* 2013;4:243-7.
- Avila ED, Molon RS, Assio Mollo F Jr, Barros LA, Capelozza Filho L, Almeida Cardoso M, et al. Multidisciplinary approach for the aesthetic treatment of maxillary lateral incisors agenesis: thinking about implants? *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012; 114:e22-8.
- Salama H, Salama M. The role of orthodontic extrusive remodeling in the enhancement of soft and hard tissue profiles prior to implant placement: a systematic approach to the management of extraction site defects. *Int J Periodontics Restorative Dent* 1993;13: 312-33.
- Barzilay I, Graser GN, Caton J, Shenkle G. Immediate implantation of pure titanium threaded implants into extraction sockets [abstract]. *J Dent Res* 1988;67:234.
- Becker W, Becker B. Guided tissue regeneration for implants placed into extraction sockets and for implant dehiscence: surgical techniques and case reports. *Int J Periodontics Restorative Dent* 1990; 10:377-91.
- Listrom RD, Symington JM. Osseointegrated dental implants in conjunction with bone grafts. *Int J Oral Maxillofac Surg* 1988; 17:116-8.
- Keiler EE, Von Roeki NB, Desjardins RP, Tolman DE. Prosthetic-surgical reconstruction of the severely resorbed maxilla with iliac bone grafting and tissue-integrated prosthesis. *Int J Oral Maxillofac Implants* 1987;2:155-65.
- Heithersay GS. Combined endodontic-orthodontic treatment of transverse root fractures in the region of the alveolar crest. *Oral Surg Oral Med Oral Pathol* 1973;36:404-15.
- Brown IS. The effect of orthodontic therapy on certain types of periodontal defects. *J Periodontol* 1973;44:742-56.
- Batenhorst KF, Bowers GM, Williams JE Jr. Tissue changes resulting from facial tipping and extrusion of incisors in monkeys. *J Periodontol* 1974;45:660-8.
- Stern N, Becker A. Forced eruption: biological and clinical considerations. *J Oral Rehabil* 1980;7:395-402.
- Ingber JS. Forced eruption: part II. A method of treating nonresorable teeth—periodontal and restorative considerations. *J Periodontol* 1976;47:203-16.
- Mantzikos T, Shamus I. Forced eruption and implant site development: soft tissue response. *Am J Orthod Dentofacial Orthop* 1997; 112:596-606.
- Mantzikos T, Shamus I. Forced eruption and implant site development: an osteophysiologic response. *Am J Orthod Dentofacial Orthop* 1999;115:583-91.
- Covani U, Cornellini R, Barone A. Bucco-lingual bone remodeling around implants placed into immediate extraction sockets: a case series. *J Periodontol* 2003;74:268-73.
- Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. *Am J Orthod* 1967;53: 721-45.
- Lin CD, Chang SS, Liou CS, Dong DR. Management of interdental papillae loss with forced eruption, immediate implantation, and root-form pontic. *J Periodontol* 2006;77:135-41.
- Chee WW. Provisional restorations in soft tissue management around dental implants. *Periodontol* 2000 2001;27:139-47.