An Interdisciplinary Treatment Approach Combining Orthodontic Forced Eruption with Immediate Implant Placement to Achieve a Satisfactory Treatment Outcome: A Case Report

Yu-Hsiang Chou, MD;* Je-Kang Du, MD;† Szu-Ting Chou, MD;‡ Kai-Fang Hu, MD;§ Chi-Cheng Tsai, PhD;¶ Kun-Yen Ho, PhD;** Yi-Min Wu, PhD;†† Ya-Ping Ho, PhD‡‡

ABSTRACT

Background: Periodontal disease often results in severely bony defects around the teeth and leads to eventual extraction. Remaining bone morphology often compromises ideally restoration-driven positions and deteriorates the success rates for dental implants.

Purpose: The present investigation illustrates the clinical outcome of immediately installing an implant following orthodontic forced eruption and atraumatic extraction.

Material and Methods: The subject of this study is a 40-year-old Asian female with a right mandibular first molar that had a deep probing depth on the mesial side and mobility. Via the aid of radiographic examination, the tooth that had an angular bony defect and apical lesion was diagnosed as having deep caries and chronic periodontitis with a poor prognosis. After consultation with the patient, we developed a treatment plan incorporating a forced eruption with immediate implantation, intended to augment the alveolar bone volume and increase the width of keratinized gingivae, in a nonsurgical manner.

Results: Following 12 months of orthodontic treatment, the tooth was successfully moved occlusally in conjunction with an 8 mm vertical interdental bone augmentation. Because of sufficient volume of bone and satisfactory gingival dimensions, the implant showed adequate initial stability in the correct position to facilitate physiological and aesthetic prerequisites. After 6 months of ossteointegration, a customized impression coping was utilized to transfer the established emergence profile to a definitive cast for the fabrication of a customized abutment. The final prosthesis was made using a customized metal abutment and ceramometal crown.

Conclusion: In the face of difficult clinical challenges, meticulous inspection and a comprehensive treatment plan were crucial. Interdisciplinary treatment through the careful integration of multiple specialists suggests the possibility of optimal results with high predictability.

KEY WORDS: atraumatic extraction, immediate implant placement, interdisciplinary treatment, mandibular first molar, orthodontic forced eruption

*Attending staff of Division of Periodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; †attending staff of Division of Prosthodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; ‡attending staff of Division of Orthodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; §chief resident of Division of Periodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan; ¶professor of College of Oral Medicine, Chung Shan Medical University, Taichung, Taiwan; **chairman of Division of Periodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan, and associate professor of School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan; ††attending staff of Division of Periodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan, and associate professor of School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan; ‡‡attending staff of Division of Periodontics, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan, and assistant professor of School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan

Reprint requests: Dr. Ya-Ping Ho, School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, No. 100 Shih-Chuan 1st Road, Kaohsiung 807, Taiwan; e-mail: phho@kmu.edu.tw

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INTRODUCTION

Severe periodontitis, leading to the destruction of sustained periodontium around the teeth, usually develops into tooth loss as well as the eventual deformity of residual bone and gingiva. The results are often associated with a collapse of the alveolar process and alteration of the soft tissue, reflected in an absence of interproximal papillae that compromises subsequent prosthetic restoration.[1] In cases with severe resorption, success rates have been relatively low, and treatment has tended to be lengthy and riddled with challenges, regardless of the methods of ridge augmentation used. Numerous techniques such as bone grafts,[2] guided bone regeneration,[3,4] ridge splitting,[5] and distraction osteogenesis[6] have been performed serially or simultaneously to prepare the implant site. Nevertheless, multiple surgical interventions, aesthetic compromises, and unpredictable outcomes were inevitable.

The replacement of missing teeth with endosseous dental implants has become a fundamental part of dentistry worldwide.[7] Despite the benefits of implants in oral rehabilitation, this protocol is slow and negatively influences patients' motivation, particularly in cases of severe damage. Therefore, prevention of alveolar collapse associated with any dental extraction is now regarded to be of great importance to enhance the installation of implant in the future.[8] We have taken into consideration the shift in opinion where it was once believed that total bone regeneration in the socket prior to implant placement was required to the now commonly held opinion that the best bone-preserving method is immediate placement of the implant.[9] Scientific evidence has demonstrated that immediate implantation may preserve the alveolar anatomy and that the placement of a fixture in a fresh extraction socket may avoid the marginal bone reduction that typically follows the healing of extraction sockets.[10,11]

Under certain circumstances, a nonsurgical approach, such as orthodontic extrusion of nonviable teeth, may be adopted. Such an approach is intended to increase the amount of bone and soft tissue at the proposed implant site. Traditionally, forced eruptions have been performed for clinical crown lengthening procedures, but Salama and Salama introduced this procedure for the development of bone at the site of implant.[12] By means of physiologically increasing bone and gingival volume, orthodontic traction force pulls the tooth along with the supporting bone and gingiva covering the tooth, to improve the three-dimensional topography of the implant recipient site before extracting the remaining teeth and placing implants.[13]

The aim of the following report is to describe a case in which the incorporation of multiple specialists enabled the reversal of various negative factors, despite the fact that prospective implant sites had been severely destroyed.

CASE REPORT

During her initial visit to the Periodontal Clinic in Kaohsiung Medical University Hospital, Taiwan, a 40-year-old Asian female complained of dull pain over the mandibular right posterior segment. According to her statement, she had received endodontic and periodontal treatment previously; however, the chief complaint remained.

Following radiographic examination and periodontal probing, it was found that the mandibular right first molar had 8-mm probing depth on the mesial side and 6-mm probing depth on the distal surface, respectively; periodontally sustained angular bone defect; and buccal and lingual grade II furcation involvement combined with apical lesion, resulting in horizontal and vertical mobility. Deep caries adjacent to alveolar crest at a distal aspect were also noticed (Figure 1). While executing protrusive and lateral movement, occlusal interference associated with mesial tilting of the mandibular right second molar was substantiated. From the occlusal view,

Figure 1 The mandibular right first molar had mesial and distal angular bone defects, and buccal and lingual grade II furcation involvement combined with chronic apical periodontitis. Deep caries adjacent to the alveolar crest at the distal aspect were also noticed.

extensive dental caries with composite resin filling and a lack of residual tooth structure jeopardize prosthetic strategies and the longevity of the abutment. These teeth were diagnosed with chronic periodontitis and asymptomatic apical periodontitis. A poor prognosis because of diminished periodontal support and deterioration of tooth structure indicated that a restoration of the teeth was not a viable alternative; therefore, extraction and a prosthetic replacement over the mandibular right first molar site were the treatment of choice.

There is wide consensus that all interventions should be sequentially scheduled, deciding first on the final form of the restoration and planning all subsequent procedures to that end.[14] Hence, consideration was given to the size of the resultant defect prior to extracting the tooth. To improve the bony architecture and compensate for expected recession of tissue because of deficiencies in hard and soft tissue, numerous treatment options for vertical ridge augmentation, and the possible advantages and disadvantages of each modality were clearly explained to the patient. In addition, the patient was presented another treatment modality, which involved forced eruption and the orthodontic extrusion of the root prior to surgery, for the development of the implant site. It was explained that the advantages of forced eruption include the preservation of soft tissue contour and bone gain at the implant site, all accomplished without complex surgery. The disadvantages of this technique are the prolonging of treatment and additional orthodontic treatment.

While a tooth was extruded orthodontically, there will be an intrusive force applied to the adjacent anchored teeth that will cause unwanted tooth movement. Forced eruption of mandibular first molar by sectional arch wire should be carefully monitored if any side effects like buccoversion and lateral open bite occurred at the premolar area. Besides forced eruption of mandibular right first molar, the patient also needs leveling and alignment of the crowded anterior teeth to improve both aesthetics and occlusion. Therefore, we suggest full mouth orthodontic treatment for this patient. She decided to allow forced eruption followed by the eventual placement of an implant-supported single crown, and signed an informed consent statement prior to initiation of the treatment.

Applied tension to a tooth results in elongation of periodontal ligament fiber bundles and the induction of osteoblasts to deposit new bone in the areas of the alveolus. The prerequisite for this treatment modality is intact periodontal attachment surrounding the apical third of the tooth. For this reason, initial endodontic treatment was utilized to overcome apical destruction, and a temporary crown was fabricated to secure ideal coronal seal. After 3 months of observation, a radiographic examination revealed an improvement in bone density in the furcation area as well as diminished apical radiolucent area (Figure 2).

Figure 2 Initial endodontic treatment was performed to solve the apical destruction, and a temporary crown was fabricated to secure ideal coronal seal.

Following thorough scaling and root planing, full-mouth fixed edgewise appliances were applied. After initial leveling, a forced eruption of mandibular right first molar was performed every month through the activation of an L-shaped loop (0.016" × 0.016" stainless steel wire). The rate of forced eruption was approximately 0.5 mm per month. After 12 months of active treatment, an 8-mm increase in the level of bone was noted over the mandibular right first molar on the mesial side and a 6-mm increase at the distal surface, respectively. The L-shaped loop was maintained in place for retention for an additional 6 months before all orthodontic appliances were removed (Figure 3).

Atraumatic extraction of these two teeth was meticulously performed to maximize the preservation of the alveolar bone. The periotome helped in dissecting the periodontal ligament fibers from the tooth, thereby preventing a fracture of the bony wall. The integrity of the buccal and lingual cortical plate, using instruments that apply minimal trauma to the first molar, was surveyed. After careful inspection of the extraction socket, the walls were thoroughly curetted to remove all

Figure 3 Through the use of orthodontic extrusion, the circumferential osseous level converts deep angular bony defects into a flat alveolar crest adjacent to neighboring tooth; furthermore, sufficient apical alveolar bone was gained to facilitate the initial stability of the implant.

remnants of the periodontal ligament (Figure 4). An implant 5.0 mm in diameter and 11.5 mm in length (Osseotite®, BIOMET 3i, FL, USA) was placed, in a flapless manner, with a 1.5 to 2-mm gap between the implant surface and the bone to the desired depth. There was no bony dehiscence or detection of exposed threads of titanium surfaces. Initial stability was obtained from the furcal septum and apically intimate implant-to-bone contact around mandibular first molar extraction socket along with intact circumferential bone walls fulfilling blood clots. No subsequent bone grafts or sutures were utilized to solidify the implant or wound, and the covering screw was tightened cautiously (Figures 5 and 6).

A customized temporary abutment and immediate fixed provisionalization facilitated the formation of

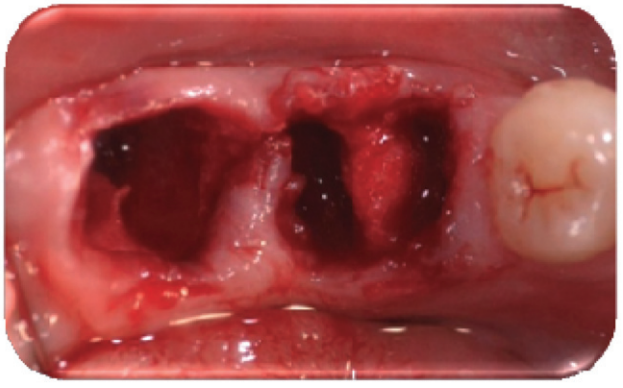

Figure 4 Atraumatic extraction was performed meticulously to maximize preservation of the alveolar bone and the integrity of the buccal and lingual cortical plates.

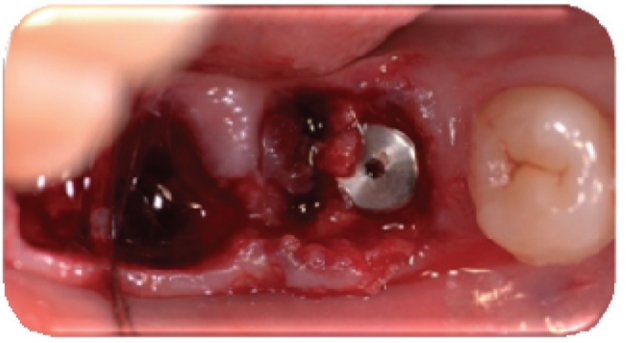

Figure 5 An implant 5.0 mm in diameter and 11.5 mm in length (Osseotite®, BIOMET 3i) was placed in a flapless manner with a minimal gap between the surface of the implant and the bone, to the desired depth.

correct gingival architecture and provided the necessary support for the surrounding soft and hard tissue during the healing phase[15] (Figure 7). After 6 months of osseointegration, an individual impression coping was created to transfer the established emergence profile to the definitive cast (Figure 8). The gold screw was subsequently tightened to a torque of 32 N/cm^2 using a dynamometric wrench. The ultimate prosthesis was manufactured with a customized abutment and ceramometal crown (Figure 9).

Following 2 years of follow-up clinical and radiographic examination, the bony gap gradually filled with radiopaque bone-like substance along the threaded surface of the fixture. A flat architecture along the alveolar crest between the implant-supported single crown

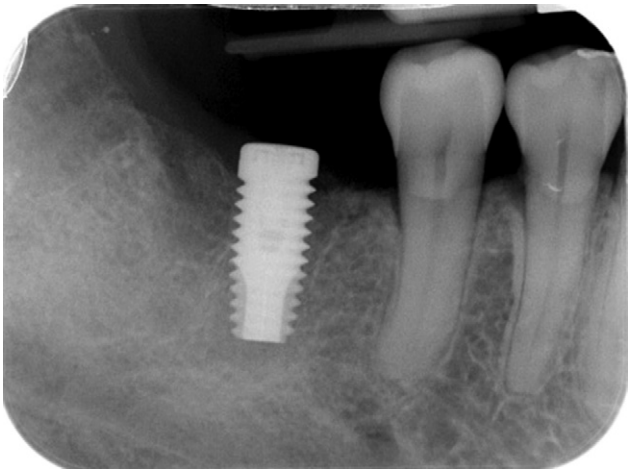

Figure 6 An implant 5.0 mm in diameter and 11.5 mm in length (Osseotite®, BIOMET 3i) was placed in a flapless manner with a minimal gap between the surface of the implant and the bone, to the desired depth.

Figure 7 Fabrication of a provisional restoration allowed for shape and stability of peri-implant interdental papillae.

Figure 9 The final prosthesis was made using a customized metal abutment and ceramometal crown.

and adjacent natural tooth was achieved, and papillae were stuffed into the interdental space satisfactorily (Figure 10).

DISCUSSION

For many clinical cases of single tooth loss, the implant-supported crown has become the treatment of choice.[16,17] Dental implants are no longer placed according to available alveolar bone but are based on ideal positioning for proper function and aesthetics.

Following extraction of a natural tooth, the residual bony housing begins to absorb both buccal and palatal/lingual plates toward the apex; the first 6 months post-extraction are critical, carrying the highest rate of bone resorption in either direction.[18] Pietrokovski and Massler used stents from 149 subjects and measured the buccolingual/palatal width of extraction sites, and compared this dimension to that of a contralateral tooth site. They observed that both the buccal and palatal/lingual walls underwent marked resorption following tooth extraction, but the reduction on the buccal side was more pronounced. Substantial bone loss has been shown in conjunction with socket healing; the edentulous site shrinks, and bone is lost sequentially.[19]

To maintain bone height and achieve more rapid rehabilitation, several ridge augmentation techniques, and multiple bone grafts and membranes have been

Figure 8 After 6 months of ossteointegration, a customized impression coping was utilized to transfer the established emergence profile to the definitive cast.

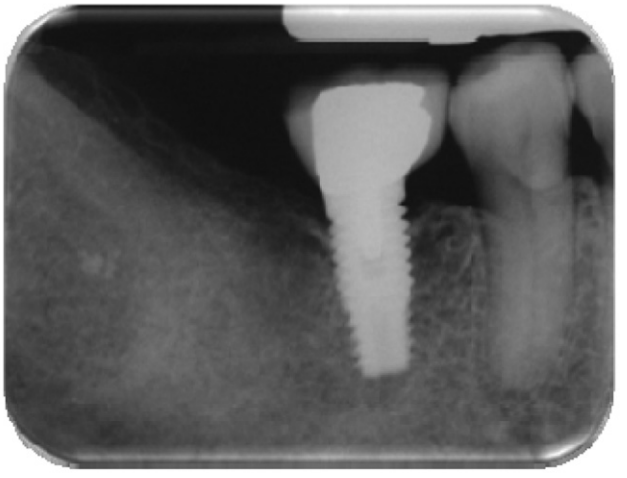

Figure 10 Clear radiopaque bone-like image along the threads of implant demonstrates mature osseointegration adjacent to the implant, and the gap diminishes in radiographic examination.

utilized. Among these published methods, the immediate placement of implants in connection with tooth extraction (as first utilized by Lazzara[20]) is commonly practiced today.[10,11] It has been stated that bone tissue following implant installation in an extraction socket may heal predictably, providing the formation of new bone and resolution of the defect. Several clinical human studies have demonstrated that the immediate placement of dental implants into carefully selected extraction sockets has a high rate of survival (94 to 100%), compared with implants placed in healed sites.[21,22] Establishing good primary stability is a major concern, as it is for the standard protocol for the placement of implants. This can be accomplished when long implants are used, crossing the apical portion of the extraction socket; thus, sufficient bone volume in this area is a prerequisite.[23]

Recent studies have shown that peri-implant marginal defect that occurs following the insertion of implants after tooth extraction can benefit from complete healing of the bone without guided bone regeneration procedures. These defects are often four-wall socket sites without fenestration and dehiscence, showing a discrepancy between the surface of the implant and the surrounding bone walls of less than 2 mm.[22,24] There have been a number of interpretations elucidating how bone formation was attributable to proper clot maturation in the protected environment, which was confined to the surface of the implant and the integrity of bone walls. Studies have shown that if a wide gap exists between the implant and the socket, bone bridging may be incomplete or delayed; osseointegration may be compromised, and connective tissue appears between the coronal implant aspect and the surrounding bone.[25] Thus, implant surgery should pack the large marginal void using various grafts as fillers with or without barrier membranes[26,27] to support the contours of soft tissue. In the present study, the dimensions of the implant are close to that of the extraction socket between the furcal septum and mesial bony wall, leaving a gap of less than 2 mm. Consequently, the gap was reserved for stable blood clots and gingival tissue migrates over the exposed wound, and provides an uneventful healing.

Bone augmentation at the implant recipient site by orthodontic extrusion is always preferable to mechanical and surgical modification, which pays insufficient attention to the biologic situation.[28] This technique is often mentioned in cases with deep subgingival decay or a fracture incorporated with crown lengthening procedure. New bone formation occurred at tension side. Osteoblasts apposite new bone over the socket wall around root apex, while the molar was forced erupted. It is used to obtain an improved interdental crest level and papillae filling, along with ideal crown–root ratio in prosthetic and aesthetic evaluation.[29,30] The prerequisite for this procedure is intact periodontal attachment around the apex of root. Another crucial determinant influencing clinical results is a discrepancy in the vertical level between neighboring teeth. The more apical the attachment level of a diseased tooth and the more coronal the level of an adjacent healthy tooth, the more bone and gingivae that can be harvested. Because the tooth is erupted to the predetermined level with compensation of bony defects, it had to be stabilized to avoid intrusion to incipient alveolar position. The reintrusion results from the orientation of the principal fibers in the periodontium, which become oriented obliquely and extend during coronal movement of the root. Generally, these fibers reorient after 6 months, and the root reintrudes significantly. Hence, an adequate period to 6 months of retention is critical to prevent a relapse of the tooth.

To date, multidisciplinary treatment approaches combining orthodontic forced eruption and immediate implant placement have provided predictable treatment outcomes in selected situations, minimizing the need for costly and time-consuming alterations of gingival tissues after implant integration, as well as rendering satisfactory bone volume with regard to primary stability. In the present case, we converted deep angular bony defects into a flat alveolar crest level with neighboring teeth, and sufficient apical alveolar bone was gained to facilitate the initial stability of implant installation. If pretreatment could reduce the number of surgical interventions, less scarring and a more stable and predictable long-term outcome would result. Even though additional guided bone regeneration was obligatory, the progressive increase in gingiva was conducive to flap management and primary closure of the operation wound, rather than sacrificing vestibular depth because of the extreme coronal position of the flap.

In conclusion, the collaboration of forced eruption and immediate implant placement was chosen to reduce the number of surgical stages and promote sufficient bone and gingivae beneficial to osseointegration and

interdentally aesthetic demand. Future controlled clinical studies would be needed to substantiate the promising results.

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REFERENCES

1. Price RB, Price DE. Esthetic restoration of a single-tooth dental implant using a subepithelial connective tissue graft: a case report with 3-year follow-up. Int J Periodontics Restorative Dent 1999; 19:92–101.
2. Urbani G, Lombardo G, Santi E, Tarnow D. Localized ridge augmentation with chin grafts and resorbable pins: case reports. Int J Periodontics Restorative Dent 1998; 18:363–375.
3. Becker W, Hujoel P, Becker BE. Effect of barrier membranes and autologous bone grafts on ridge width preservation around implants. Clin Implant Dent Relat Res 2002; 4:143–149.
4. Friedmann A, Strietzel FP, Maretzki B, Pitaru S, Bernimoulin JP. Histological assessment of augmented jaw bone utilizing a new collagen barrier membrane compared to a standard barrier membrane to protect a granular bone substitute material. Clin Oral Implants Res 2002; 13:587–594.
5. Shimoyama T, Kaneko T, Shimizu S, Kasai D, Tojo T, Horie N. Ridge widening and immediate implant placement: a case report. Implant Dent 2001; 10:108–112.
6. Aparicio C, Jensen OT. Alveolar ridge widening by distraction osteogenesis: a case report. Pract Proced Aesthet Dent 2001; 13:663–668, quiz 670.
7. Adell R, Lekholm U, Rockler B, Branemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981; 10:387–416.
8. Gonzalez Lopez S, Olmedo Gaya MV, Vallecillo Capilla M. Esthetic restoration with orthodontic traction and single-tooth implant: case report. Int J Periodontics Restorative Dent 2005; 25:239–245.
9. Kahnberg KE. Immediate implant placement in fresh extraction sockets: a clinical report. Int J Oral Maxillofac Implants 2009; 24:282–288.
10. Polizzi G, Grunder U, Goene R, et al. Immediate and delayed implant placement into extraction sockets: a 5-year report. Clin Implant Dent Relat Res 2000; 2:93–99.
11. Schultes G, Gaggl A. Histologic evaluation of immediate versus delayed placement of implants after tooth extraction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92:17–22.
12. 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; 13:312–333.
13. Mantzikos T, Shamus I. Forced eruption and implant site development: soft tissue response. Am J Orthod Dentofacial Orthop 1997; 112:596–606.
14. Garber DA. The esthetic dental implant: letting restoration be the guide. J Am Dent Assoc 1995; 126:319–325.
15. Kan JY, Rungcharassaeng K. Immediate placement and provisionalization of maxillary anterior single implants: a surgical and prosthodontic rationale. Pract Periodontics Aesthet Dent 2000; 12:817–824, quiz 826.
16. Andersson B, Odman P, Lindvall AM, Branemark PI. Five-year prospective study of prosthodontic and surgical single-tooth implant treatment in general practices and at a specialist clinic. Int J Prosthodont 1998; 11:351–355.
17. Henry PJ, Laney WR, Jemt T, et al. Osseointegrated implants for single-tooth replacement: a prospective 5-year multicenter study. Int J Oral Maxillofac Implants 1996; 11:450–455.
18. Pietrokovski J, Massler M. Alveolar ridge resorption following tooth extraction. J Prosthet Dent 1967; 17:21–27.
19. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restorative Dent 2003; 23:313–323.
20. Lazzara RJ. Immediate implant placement into extraction sites: surgical and restorative advantages. Int J Periodontics Restorative Dent 1989; 9:332–343.
21. Evian CI, Emling R, Rosenberg ES, et al. Retrospective analysis of implant survival and the influence of periodontal disease and immediate placement on long-term results. Int J Oral Maxillofac Implants 2004; 19:393–398.
22. Paolantonio M, Dolci M, Scarano A, et al. Immediate implantation in fresh extraction sockets. A controlled clinical and histological study in man. J Periodontol 2001; 72:1560–1571.
23. De Rouck T, Collys K, Cosyn J. Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization: a review. Int J Oral Maxillofac Implants 2008; 23:897–904.
24. Covani U, Cornelini R, Barone A. Bucco-lingual bone remodeling around implants placed into immediate extraction sockets: a case series. J Periodontol 2003; 74:268–273.
25. Knox R, Caudill R, Meffert R. Histologic evaluation of dental endosseous implants placed in surgically created extraction defects. Int J Periodontics Restorative Dent 1991; 11:364–375.

26. Prosper L, Gherlone EF, Redaelli S, Quaranta M. Four-year follow-up of larger-diameter implants placed in fresh extraction sockets using a resorbable membrane or a resorbable alloplastic material. Int J Oral Maxillofac Implants 2003; 18:856–864.
27. Tehemar S, Hanes P, Sharawy M. Enhancement of osseointegration of implants placed into extraction sockets of healthy and periodontally diseased teeth by using graft material, an ePTFE membrane, or a combination. Clin Implant Dent Relat Res 2003; 5:193–211.
28. Mantzikos T, Shamus I. Forced eruption and implant site development: an osteophysiologic response. Am J Orthod Dentofacial Orthop 1999; 115:583–591.
29. Heithersay GS. Combined endodontic-orthodontic treatment of transverse root fractures in the region of the alveolar crest. Oral Surg Oral Med Oral Pathol 1973; 36:404–415.
30. Ingber JS. Forced eruption: alteration of soft tissue cosmetic deformities. Int J Periodontics Restorative Dent 1989; 9:416–425.