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Forced eruption and implant site development in the aesthetic zone: A case report

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ABSTRACT

A multidisciplinary approach to develop the future implant site in the aesthetic zone was illustrated. A patient with perio-endo combined lesion at her upper central incisors was treated. Before extraction, forced eruption was performed and 12 months later, satisfactory amount of bone apposition was detected. At 2 weeks after atraumatic extraction, implants were placed and loaded with implant-supported restorations following osseous healing. Variables related to crown dimensions, periodontal/peri-implanter soft-tissue health and patient's aesthetic satisfaction were recorded at baseline, before extraction and after prosthetic treatment. At 12-month control, crown dimensions in the implant site were identical to the baseline and in addition to the healthy peri-implant tissues, successful aesthetics were obtained. Forced eruption is a successful non-invasive method to develop the aesthetics of the peri-implant tissues and implant-supported restorations.

Key words: Augmentation, aesthetics, forced eruption, implant, implant-supported crown, multidisciplinary approach

INTRODUCTION

The treatment of aesthetic areas with implants represents a challenge for the clinician. Tooth extractions in the anterior maxillary area generally cause simultaneous alveolar ridge deficiencies.[1,2] The maxilla resorbs in palatal and apical directions following extraction of a tooth and residual ridge resorption is most rapid during first 3-4 months.[3,4] It was noted that the most common ridge defect has both horizontal and vertical components.[5]

Various surgical procedures such as distraction osteogenesis,[6] guided bone regeneration[7] and graft procedures[8] have been developed to preserve or reconstruct the alveolar ridge. The ridge defect can be treated by these options either at the time of extraction or at a later date. Although these techniques have many advantages in alveolar ridge augmentation, some complications such as bleeding, neurosensory deficits, soft-tissue injury, block fracture and mandibular fracture, trismus, pain, swelling, bruising, infection, bone resorption, dehiscence, and graft failure may also occur.[9] Moreover, when using block grafts, several teeth in the graft site need to be extracted. This alone would preclude the patient from receiving such treatment modalities.

Due to the variable pattern of bone resorption and related soft-tissue deficiencies, a detailed evaluation and comprehensive treatment plan should always precede an extraction in the aesthetic zone. Dimensions of the hard and soft-tissue surrounding periodontally compromised teeth can be improved by orthodontic tooth movement.[10,11] This technique, defined as forced eruption, is a non-surgical treatment option that may facilitate hard and soft-tissue remodeling and accordingly, potentiate new bone development at the future implant site.[12-15] Bone volume increase is provided by the applied tension to the periodontal

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ligament during orthodontic treatment and this tension is the inducer of the new bone deposition via osteoblastic activity where the periodontal attachment exists.[12] The coronal movement of the tooth causes migration of the soft-tissue and the bone attached by the periodontal ligament fibers in the direction of the movement.[16] In many clinical reports, hard and soft-tissue development guided by forced eruption have been shown as a successful non-surgical treatment option in augmenting the prospective implant zone.[17-20] Recently, in a study by Mirmarashi *et al*.[20] illustrated the use of non-maintainable teeth to develop the site for future implant placement.

To successfully meet the challenge of aesthetic implant dentistry, a team approach is advantageous and highly recommended. In this case report, a multidisciplinary treatment involving an orthodontic tooth movement to develop the future implant site in the aesthetic zone was illustrated. Clinical parameters related to clinical conditions, crown and soft-tissue dimensions were also analyzed at both the hopeless teeth and the implant-supported final restorations.

CASE REPORT

The present case is about a 27-year-old woman who referred to the private dental clinic in June 2009. Her complaints were slight pain, gum swelling and bleeding on tooth brushing from the upper incisor teeth. She was also dissatisfied with the color of the anterior gingiva. Medical history of the patient was not remarkable. As learnt from her dental history, dental filling, root-canal treatment, apical resection and metal-ceramic crown restoration procedures had been carried out for the upper central incisors from 2006 to 2009. Periodontal evaluation revealed findings of gingival hyperemia, edema, bleeding on probing (BOP), slightly increased pocket depths and first degree mobility at teeth #11 and #21 [Figure 1]. Tenderness to percussion and fistula were also identified at her same teeth. Remaining teeth were healthy and few amount of supragingival deposit existed in lingual aspect of lower anterior teeth. Only an asymptomatic, extensive dental filling was located at tooth #24. In her orthodontic examination, Class I occlusion in the posterior region with slight mandibular anterior crowding was present and there were no occlusal contacts between the maxillary and mandibular anterior teeth in the intercuspal position. The maxillary central incisors were slightly proclined and minimal deep-bite was also present; however, the lips were competent, lower border of the upper lip generated a normal smile-line and there was no speech impediment. Radiographic examination revealed no alveolar bone loss in the anterior maxilla associated with the maxillary incisors and remaining part of the dentition was intact except endodontically treated tooth #24 with no pathological view [Figure 2].

A multidisciplinary treatment was planned following clinical and radiographic examinations. It was decided to perform forced eruption before extraction of two incisor teeth to augment the future implant site. The patient was also informed about other treatment options. Before orthodontic phase of treatment, complete-mouth scaling and polishing was performed and oral hygiene instructions were given.

Orthodontic treatment was made for the extrusion of the right and left upper central incisors. 0.018 slot ceramic brackets with Roth prescription were placed in maxillary teeth from the right second premolar to the left second premolar and molar bands were placed to the first right and left molars. The brackets on the central incisors were positioned more apically, at the location of the cemento-enamel junction, to provide an extrusive component (approximately 50 g of force). To avoid intrusion of the anchorage teeth 0.017 × 0.0.25 stainless steel auxiliary arch was used to stabilize the segmented wire and 016″ ×0.22″ blue elgiloy utility arch was used for extrusion of incisors. The patient was seen every 3 weeks for reduction of the incisal surface of the extruded tooth. Activation of the utility arch was made every 6 weeks to extrude upper incisors. After 36 weeks, stabilization arch wire was applied. This eruptive phase was followed by 12 weeks of stabilization. In total, orthodontic phase took approximately 12 months and it was observed that radiographic assessment revealed significant improvement in

Figure 1: Patient's initial clinical view

the vertical amount of bone between teeth #11 and #21 [Figure 3].

Then, the patient was scheduled for extraction. After orthodontic treatment, the relevant teeth were extracted atraumatically [Figure 4]. Although an immediate placement might have reduce the treatment time, morbidity of the patient and risk of bone resorption, dental implants were inserted 2 weeks after extraction with full-thickness flap technique without vertical releasing incisions according to early implant placement protocol [Figures 5 and 6].[21] Since mesiodistal distance of edentulous area was relatively high (9 mm), 4 mm (13 mm length) diameter cylindrical implants with tapered apex and regular neck were chosen (OsseoSpeed™ Astra Tech Implant System, Mölndal, Sweden). After implant insertion, antibiotic, analgesic medications and a mouth rinse were prescribed. Sutures were removed at 2 weeks post-operatively.

After an osseointegration period of 4 months, the implants were uncovered by means of a punch technique and appropriate healing abutments were connected, followed by 2-3 weeks of soft-tissue healing. Thereupon, a closed tray impression coping (Implant Transfer, Astra Tech Implant System, Mölndal, Sweden) was attached and the impression of the implants was made using a c-silicone impression material (Swisstec, Coltene, Altstätten, Switzerland). Special attention was paid to an accurate replication of the soft-tissue architecture. On the master model, the final configuration of the restorations was defined by means of a wax-up, irrespective of the underlying implant position and inclination. After this preparatory step, a 20° aesthetic zirconium abutment (No: 24706, ZirDesign, Astra Tech Implant System, Mölndal, Sweden) was selected on the basis of the implant angulations and depth of the implant shoulders in reference to the midfacial soft-tissue margin. A distance of the latter to the abutment – crown interface of about 1 mm was pursued to avoid deep cementation of the crown. Zirconia – ceramic restorations (Lava, 3M ESPE, Istanbul, Turkey) were fabricated. As an unfavorable condition, the minor buccal position of the implants in reference to the point of emergence at the adjacent teeth slightly downgraded the ceramist to create a flat to a slightly concave emergence profile of the cosmetic porcelain. No attempt was needed to make a conditioning by means of a provisional crown due to the stabilized contours of the surrounding

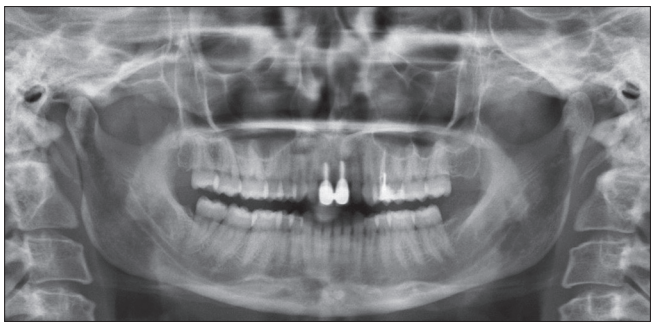

Figure 2: Patient's initial panoramic radiographic view

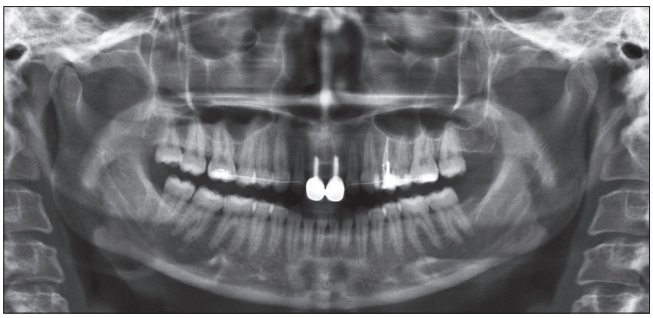

Figure 3: Panoramic radiographic view after orthodontic extrusion

Figure 4: Extracted teeth before implant surgery

Figure 5: Intraoral view of patient before implant placement

gingival tissues. Splinted restorations were cemented using temporary cement (Rely Temp NE, 3M ESPE, Seefeld, Germany) [Figure 7]. Oral hygiene instructions were reinforced following installation of the implant-supported crown.

Clinical measurements at baseline, teeth extraction appointment, 4 weeks and 12 months after prosthetic treatment, periodontal parameters (plaque index, probing depth [PD], BOP) related to clinical conditions, crown (papilla height [PH], crown length, crown width, bucco-lingual crown dimension) and soft-tissue dimensions (keratinized tissue width [KTW], mid-buccal margin level) were recorded using a Michigan O periodontal probe (Hu-Friedy, Chicago, IL, USA), measurements about crown dimensions were made by using a measuring caliper.

At 12 months after delivering, the final prosthesis clinical and radiographic assessments were made [Figures 8 and 9]. Patient was asked to express her satisfaction in reference to the aesthetic outcome on the basis of a 10 cm visual analogue scale labeled with "not at all satisfied" at the zero point and "completely satisfied" at the right end point. The question of "How would you rate your satisfaction with respect to the aesthetic outcome of your treatment?" was asked to the patient.

Figure 6: Patient's intraoral view after implant placement

Figure 8: At 12 months after restoration

Except a usual post-operative swelling that occurred within the first day of the surgery, post-operative healing was generally uneventful. During implant placement surgery, thick and considerably high crestal bone level was detected in the surgical region. Baseline and post-periodontal and peri-implanter health variables were given in Table 1.

Follow-up scores related to implant site were almost similar to the baseline findings belonging to the extracted teeth. Inflammation signs were completely disappeared. Although, a slight increase in mid-buccal soft-tissue level and KTW was detected following orthodontic extrusion, the tissue demonstrated a significant shrinkage immediately after extraction of the hopeless teeth. PH and crown dimensions could be maintained in addition to a slight impairment in emergence profile during whole treatment and follow-up period [Tables 2 and 3]. Patient rated her satisfaction as eight points with respect to the aesthetic outcome of her treatment. In her radiographic follow-up, marked increase was noticed in the level of alveolar crest between

Figure 7: Clinical view at the end of prosthetic restoration

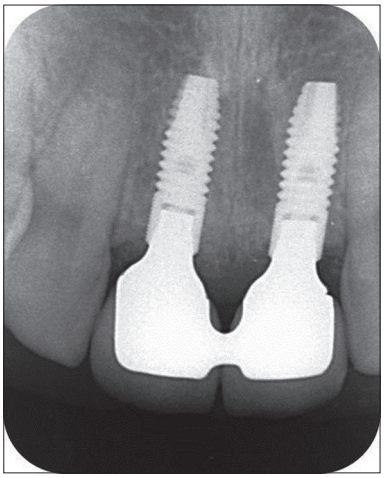

Figure 9: Radiographic evaluation at 12 months follow-up

Table 1: Clinical parameters showing periodontal/ peri-implanter health

	Surface	Baseline			Restoration		
		PI	PD	BOP	PI	PD	BOP
#11	Mesial	2	2	+	1	2	−
	Buccal	2	4	+	0	1	−
	Distal	2	3	+	1	2	−
	Palatinal	1	3	+	0	1	−
# 21	Mesial	2	3	+	1	2	−
	Buccal	2	4	+	0	1	−
	Distal	1	2	+	0	1	−
	Palatinal	1	3	+	0	1	−

PI: Plaque index, PD: Probing depth, BOP: Bleeding on probing, #: Tooth/ implant number

Table 2: Clinical parameters showing soft tissue amounts and positions

Parameter	Baseline		Extraction		Restoration	
	# 11	# 21	# 11	# 21	# 11	# 21
KTW	4	5.5	5	6	4	5
MID	−1	−2	0.5	0	−1	−1.5
PH						
Mesial	3.5	2.5	3.5	2.5	3	2
Distal	2.5	3.5	2.5	3.5	2	3.5

KTW: Keratinized tissue width, MID: Mid-buccal margin level, Ph: Papilla height, #: Tooth/implant number

Table 3: Clinical parameters showing tooth/implant dimensions

Parameter	Baseline		Restoration	
	# 11	# 21	# 11	# 21
CL	9.5	9.5	10	9.5
CW	9	9	9	9
BLC	7.5	7.5	7	7.5

CL: Crown length, CW: Crown width, BLC: Bucco-lingual crown dimension, #: Tooth/implant number

implants and adjacent to the distal surfaces of the implants.

DISCUSSION

Although one-stage approaches, e.g. implant placement, at the initial visit may offer comfortable timing, they are characterized by more complex secondary surgical procedures aimed at obtaining the primary stability, bone regeneration and an adequate soft-tissue management. In this case, a conventional regenerative multiphase approach has been able to assure an aesthetic result, which reduced the need for expensive and time-consuming alterations of surrounding tissues after implant integration.[22]

One of the purposes of orthodontic treatment is to obtain the proper conditions for replacement of missing teeth. As an orthodontic approach, forced eruption provides several periodontal outcomes including increase in the attachment level, reduction of PD and correction of the bony defects by promoting the growth of periodontal tissues.[10,23] As a mechanism, extrusive forces stimulate the formation of gingival tissues in coronal direction and ordinarily, the marginal tissues follow this movement.[24-26] During eruption process, the fibers in gingival and periodontal tissues are elongated by stretching and new bone is formed in the direction of movement.[16,19]

Achieving an aesthetic and functional implant-supported restoration in the maxillary anterior segment can be challenging. Basic requirements for an optimal final restoration include having adequate volume of supporting alveolar osseous and soft-tissues. Forced eruption is a successful non-invasive method to increase amount of bone and soft-tissue around dental implants and therefore developing the aesthetics of the implant-supported restoration. 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. Further, it was noted that the total treatment time is no longer with forced eruption than with surgical augmentation.[18-20,27-29] In this case report; a multidisciplinary treatment approach including forced eruption to develop the future implant site in the aesthetic zone has been illustrated. As a result, even if the total treatment duration did not take shorter time, clinical parameters related to inflammatory conditions were ameliorated and during therapeutic stage, a possible deficiency in crown and soft tissue dimensions could be prevented with a non-invasive and comfortable process.

In a study by Buser *et al*.[27] discussed the need for planning implant placement correctly in a three dimensional model and how implant placement relates directly to the restorative outcome. When there are intact alveolar and gingival tissues, a satisfactory aesthetic outcome can be achieved whether immediate or delayed implant placement is used at the time of tooth extraction.[29,30] In the present report involving forced eruption procedure, bone thickness and crestal bone level was considerably high in the residual ridge. Although a slightly more palatal placement would give better results, by means of this gain, implants with correct dimensions could be placed to the desired three-dimensional positions as described by Buser *et al*.[27]

The volume of hard and soft tissue contours plays an important role in the treatment with dental implants.[31] Two anatomical structures are important for long-term prognosis of implants: bone height in the adjacent interproximal areas[32] and bone height and thickness of the facial bone.[33] In this follow-up case, bone height and thickness increased more specifically in the facial and interproximal bone areas and therefore, soft tissue and final cervicoocclusal crown dimensions were protected when compared to the baseline clinical values.

In the year 2004, a consensus report describing issues related to the timing of implant placement in extraction was published by Hämmerle *et al*.[21] In this report, several advantages and disadvantages of immediate, early or late implant placement were presented. Since an increased soft-tissue volume was desired for an optimal flap management and need for the resolution of the local periapical pathology, early placement method was preferred treatment period was extended and probably due to crestal resorption, a minor collapse occurred in marginal keratinized tissue immediately after extraction. Regarding aesthetics, it is considered as important to form an interdental papillary shape between implants.[34] In addition to the vertical bone augmentation and soft tissue grafting techniques, conditioning the soft-tissue by fabricating a provisional crown may also be considered in such cases. Because satisfying amount of bone apposition was obtained in the interproximal region of two adjacent implants, no attempt was made to condition the soft tissues by means of a provisional crown in the present case.

Following augmentation procedures the alterations in hard tissues are often evaluated by using standardized periapical radiographs or volumetric tomography images. Even though the measurements involving post-treatment loss in PH and crown dimensions may have slightly increased the precise of the analysis in our case, the subjective analyze of ortopantomographs was performed limitation. In addition, the present case report has limitation in selection of the implant system (narrow-neck implant or morse-taper implant-abutment connection could provide better aesthetic outcomes), bucco-palatal position of the implants and absence of clinical photographs taken on intermediate sessions of the therapy.

CONCLUSION

Based on the above case it can be concluded that different surgical treatment procedures have been established such as distraction osteogenesis, guided bone regeneration and graft procedures to augment and reconstruct for desired alveolar ridge. However, these techniques have many disadvantages that may cause be patient discomforted.

Beside of these, forced eruption method may be a choice for clinicians to develop the aesthetics of the peri-implant tissues and implant-supported restorations especially at anterior regions.

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