Case Report

Full Mouth Rehabilitation with Digital Impression And CAD/CAM Technology: A Clinical Report

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Abstract

To restore with fixed prosthesis in full mouth rehabilitation, the chance to achieve a satisfactory impression by a conventional impression technique in one time is rare. Moreover, transferring of patient's well-adapted occlusal scheme from the provisional phase to definitive prostheses may not be easy compared to the digital workflow. In the case report presented herein, a digital method and digital reference models were used to take the final impressions, after which full mouth zirconia-based FDPs were fabricated with CAD/CAM technology combined with porcelain layering on anterior teeth.

Key words: CAD/CAM, digital impression, monolithic, zirconia

Introduction

The ongoing advances in digital technology and dental processing have expanded the possibilities in the field of fixed prosthodontics.

Traditionally, the process of manufacturing metal or porcelainfused-to-metal restorations required first taking conventional impressions and pouring stone casts, followed by the completion of wax-up and casting procedures. However, recent technological advances mean that the fabrication of fixed dental prostheses (FDPs) can be simplified through the use of digital impressions and CAD/CAM systems[1]. The major advantages of using digital techniques include more consistent results, including more consistent quality with respect to restoration efforts. Especially when performing full mouth rehabilitation with FDPs, the likelihood of obtaining a satisfactory impression in a single attempt using a conventional impression technique is low. Moreover, it may also be more difficult to transfer a patient's well-adapted occlusal scheme from the provisional phase to definitive prostheses when using conventional techniques rather than a CAD/CAM system. A digital impression, by virtue of its consistency, is an appropriate tool for obtaining an ideal impression. Digital methods also allow for duplication of the morphology of provisional restorations. However, due to the limitations of CAD/CAM systems, prosthesis fabrication cannot depend solely on the use of digital methods. In fact, neither digital nor conventional methods alone can currently meet the requirements of functional and esthetic quality[2]. Rather, the combined use of both analog and digital workflow techniques is required to achieve the best possible results[3].

The case report presented herein demonstrates how to take final impressions using the intraoral scanner method along with a digital reference model. It further details the fabrication of monolithic zirconia fixed prostheses with CAD/CAM technology in posterior areas combined with the application of porcelain layering on anterior teeth.

Case Report

An 80-year-old male patient with a medical history of cerebrovascular disease and Parkinsonism presented with full mouth FDPs. He complained about throbbing pain over his upper right back teeth, and he had his right maxillary molars extracted due to extensive undermining caries and pulpitis. The patient was referred from the general dental practitioner with the objective of restoring his missing teeth. Routine radiographic examinations consisting of periapical and bite-wing films were taken (Fig. 1). Intra-oral examination showed that most of the prostheses presented with overhang combined secondary caries (Fig. 2). Thus, the decision was made to remove all the ill-fitted splinting prostheses and then conduct a further evaluation (Fig. 3). Tooth 21 and tooth 31 were extracted due to compromised structure resulting in poor prognosis (Fig. 4). In discussions with the patient, a final treatment plan consisting of FDPs and implants was advised, and teeth 28, 38, and 48 were extracted because of the difficulty of self-maintenance. Moreover, endodontic treatments were arranged as indicated in Table 1, and periodontal phase I therapies were arranged as indicated in Table 2.

Fig. 1: Dental radiographic images before treatment

Fig. 2: Initial photographs illustrating obvious gingival inflammation

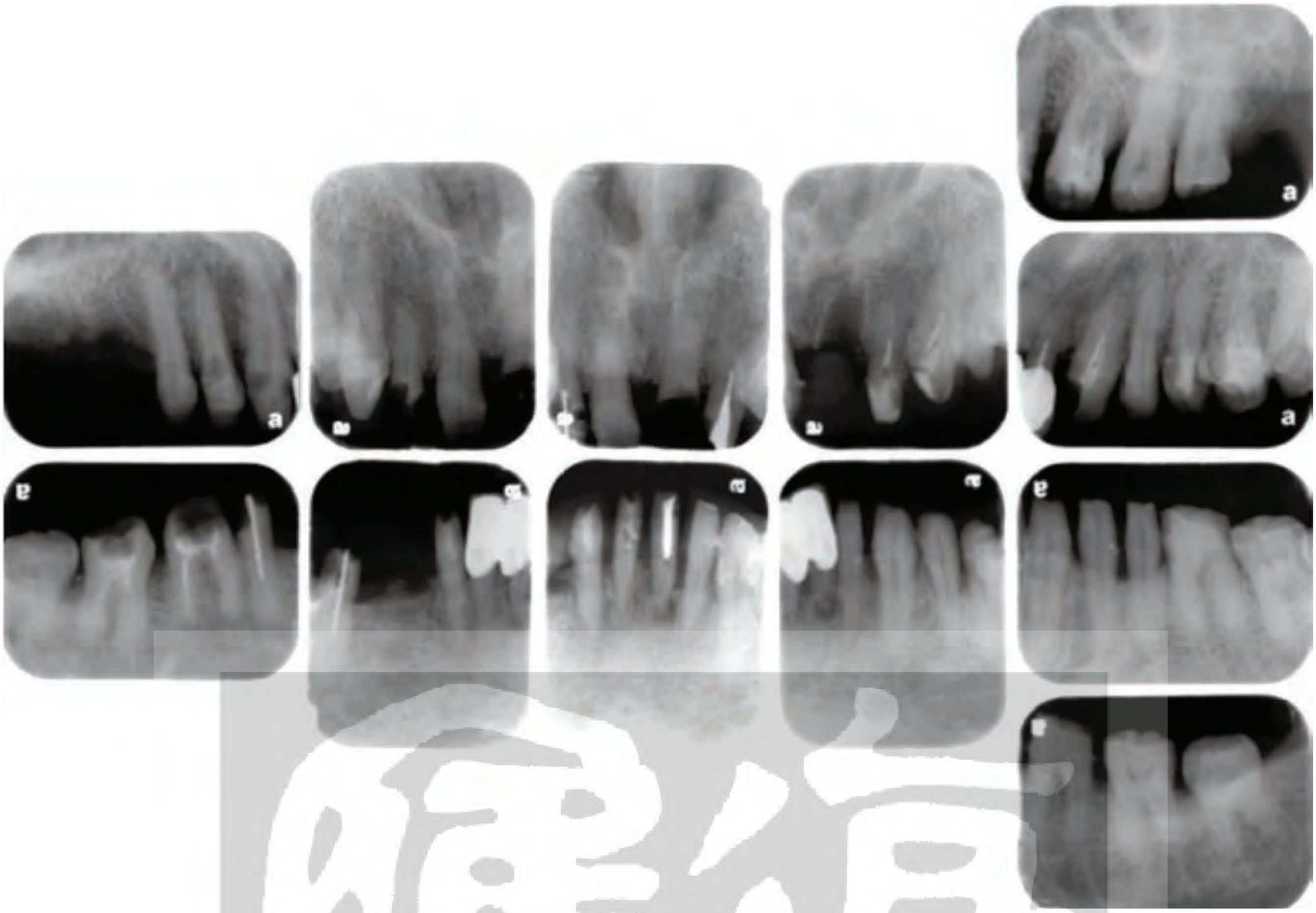

Fig. 3: Dental radiographic images after removal of FDPs

Fig. 4: Tooth structure evaluation after removal of FDPs and extraction of teeth 21 and 31

Table 1

Previous endodontic treatment	12, 22, 23, 25, 26, 31, 41, 42, 45, 46, 47
Pulp necrosis	14, 27, 34, 36
Pulpitis	11, 13, 35
Endodontic retreatment	12, 22, 23, 25, 26, 41, 42, 45, 46, 47
Endodontic treatment	11, 13, 14, 27, 34, 35, 36

After the removal of all the ill-fitted FDPs, primary impressions were made using irreversible hydrocolloid impression material (CA38, CAVEX, Holland) and were then poured with dental stone (NEO PRIMESTONE, Mutsumi, Japan) to fabricate the study casts. The study casts were then mounted in centric relation on a semiadjustable articulator (Artex Arcon CPR, Amann Girrbach AG, Austria) using a facebow transfer technique. A diagnostic wax-up was then made in order to fabricate the provisional restorations and to analyze the space of the implant areas (Fig. 5). The occlusal scheme was designed using the group function. The space between the tooth 43 and 44 areas was 2 mm too short for two 4-mm-diameter implants (Fig. 6). The definitive plan was therefore modified from two implant-supported FDPs to a tooth-implant-supported fixed prosthesis.

The PMMA (Alike, GC America) provisional restorations were fabricated with the indirect-direct technique. Cone beam CT images were taken with vacuum form surgical

Table 2

Distal			Buccal			Mesial		
	18	17	16	15	14	13	12	11
A.L.				6 2 4	3 4 6	5 2 5	4 3 3	4 3 6
P.D.				3 2 3	3 4 6	5 2 5	4 2 2	3 3 5
P.D.				2 2 3	3 2 6	4 2 3	4 2 3	3 2 2
A.L.				4 4 3	5 4 6	5 4 5	5 3 3	3 3 3
Mobility				0	0	0	0	0
F.I.				0 0	0 0			
Palatal								

Mesial			Buccal			Distal		
	21	22	23	24	25	26	27	28
A.L.		2 2 3	2 2 3	3 3 3	3 2 2	2 2 2	4 3 3	4 3 3
P.D.		2 2 3	2 2 3	3 3 3	3 2 2	2 2 2	4 3 3	4 3 3
P.D.		3 2 3	4 2 3	3 2 3	3 3 3	3 2 3	3 2 3	3 3 3
A.L.		3 2 3	4 2 3	3 2 3	3 3 3	3 2 3	3 2 3	3 3 3
Mobility		0	0	0	0	0	0	0
F.I.				0 0	0 0	0 0	0 I 0	0 0 0
Palatal								

Mesial			Lingual			Distal		
	31	32	33	34	35	36	37	38
A.L.	2 2 8	3 3 3	3 2 3	3 2 4	4 3 3	3 3 3	3 3 4	4 3 4
P.D.	2 2 8	3 3 3	3 2 3	3 2 4	4 3 3	3 3 3	3 3 4	4 3 4
P.D.	4 2 3	3 2 3	3 2 3	3 2 4	5 4 3	3 3 3	3 4 4	5 6 5
A.L.	4 2 3	3 2 3	3 2 3	3 2 4	5 4 3	3 3 3	3 4 4	5 6 5
Mobility	I	0	0	0	0	0	0	0
F.I.						I I	0 0	I I
Buccal								

Mesial			Lingual			Distal		
	48	47	46	45	44	43	42	41
A.L.	5 3 4	5 4 4	4 4 3	2 2 3			2 2 3	3 2 3
P.D.	5 3 4	5 4 4	4 4 3	2 2 3			2 2 3	3 2 3
P.D.	3 4 3	6 2 4	3 3 3	3 2 3			2 2 4	4 2 3
A.L.	3 4 3	6 2 4	3 3 3	3 2 3			2 2 4	4 2 3
Mobility	I	0	0	0			0	1
F.I.	I I	0 0	I I					
Buccal								

Fig. 5: Full mouth diagnostic wax-up

stents placed on the provisional restorations to determine the proper site for dental implant placement (Fig. 7). The Astra Tech implant system was selected according to the available bone. An OsseoSpeedTM TX implant (4.0 x 10mm) (Astra Tech, Dentsply Sirona, USA) was inserted over the tooth 43 area combined with the GBR technique by FDBA and resorbable collagen membrane (EZ CureTM, Biomatlante, France). Another implant (5.0 x 10mm) was placed over the tooth 16 area. Both implants were inserted using the surgical stent. The provisional prostheses were delivered after 4 months of osseointegration (Fig. 8). The occlusion evenly contacted in the central fossa in the maximum intercuspal position (MICP), while the anterior teeth and implants 16 and 43 exhibited light contact with the opposing teeth. Furthermore, the occlusal scheme was set using the group function: teeth 13, 14, and 15 were in contact with teeth 43-X- 45 and 46, except that implant 16 was disoccluded when the lateral excursion was processing (Fig. 9).

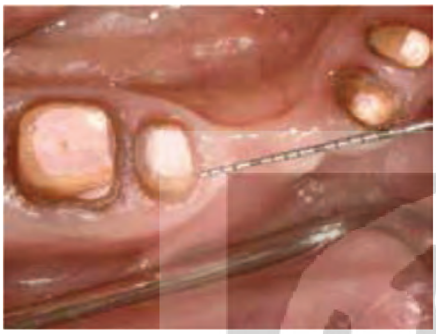

Fig. 6: Space analysis showing the space was 12mm

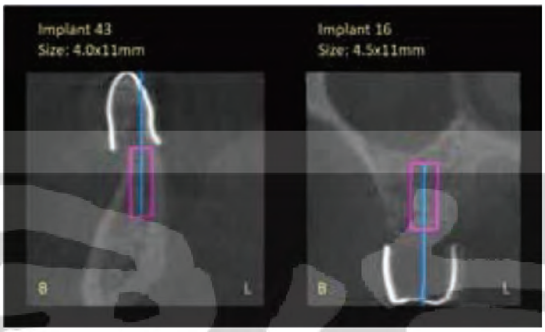

Fig. 7: Implant site and implant size planning in computer software

Fig. 8: Implant site and implant size planning in computer software

Fig. 9: Provisional restorations in MICP

To ensure that no complications occurred, periodic follow-ups were carried out for 6 months. Afterward, the patient was ready for the final impressions.

A digital impression of the provisional restorations was taken using an intraoral scanner (CS 3500, Carestream, USA) and served as a reference (Fig. 10), after which digital final impressions were taken using the double-cord technique and scan-bodies (Fig. 11). A dentition framework was scanned first to minimize the distortion, after which the marginal area of the virtual impression was cut. The second retraction cords were then removed one by one, after which scanning of the exposed marginal area was performed. In order to maintain the vertical dimension and occlusal relationship, the occlusal record on one side was scanned with provisional restorations on the other side. As for the emergence profiles of the implant restorations, the provisional restorations were attached to implant-analogs and scanned extraorally, and then the images were matched with the digital reference models (Fig. 12).

A dental CAD software (exocadTM, Germany) was used to design the restorations. Matching the virtual reference casts with the virtual working casts by using the digital cross mounting technique (Fig. 13) makes the function and the contours of the digital wax-up just the same as those of the provisional restorations[4] (Fig. 14). The anterior FDPs had a zirconia framework with porcelain veneering, and the posterior FDPs were monolithic prostheses (Fig. 15). It should be noted that the guidance area of maxillary incisors should remain untouched

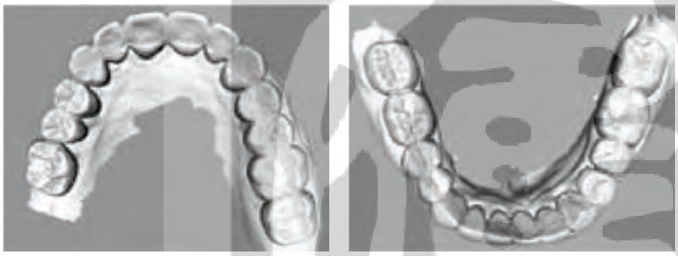

Fig. 10: Digital reference models

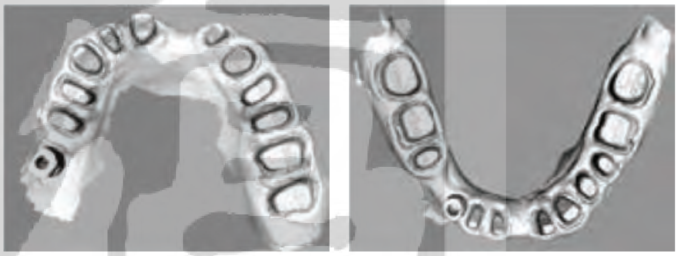

Fig. 11: Digital final impressions

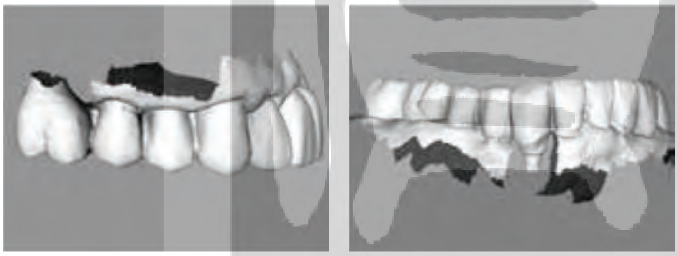

Fig. 12: Duplication of emergence profile

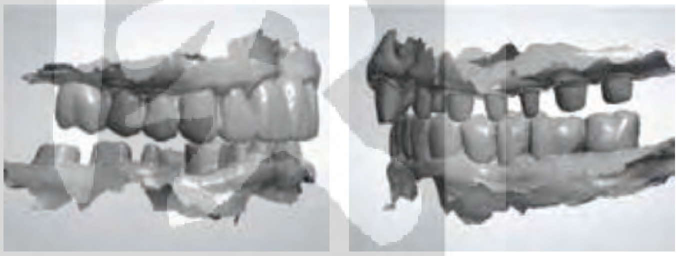

Fig. 13: Digital cross mounting

Fig. 14: CAD file of full mouth digital wax-up

Fig. 15: CAD file after virtual cutback, prior to milling

while performing the virtual cutback to precisely preserve the functional morphology of the provisional restorations. In order to maintain the original anterior guidance, a traditional customized incisal guide table was fabricated by using reference models of the provisional restorations.

In order to obtain retrievability and rigid fixation of the tooth-implant-supported FDP simultaneously, a customized abutment of implant 43 and a coping of tooth 45 were fabricated (Fig. 16). All the prostheses were fabricated in zirconia using CAD/CAM technology.

The posterior monolithic crowns, frameworks, coping, and customized abutments were tried in. Once all the restorations were adjusted and the occlusion was stable, a conventional pick-up impression was performed by using a stock tray with polyvinyl siloxane impression material (Aquasil Ultra, DENTSPLY Caulk, USA) (Fig. 17). In addition, facebow records were taken to assist in determining the incisal plane. Porcelain was then fired onto the zirconia frameworks of the anterior teeth.

Finally, all the restorations were tried in again and delivered. The customized implant abutments of 43 and 16 were torqued to 20N and 25N, respectively, as recommended by the manufacturer. A second torque was applied ten minutes after the initial tightening torque. The coping of tooth 45 was cemented using self-adhesive resin cement, and the final implant restorations were cemented with polycarboxylate cement. The rest of the FDPs were cemented using self-adhesive resin cement (RelyXTM Unicem, 3M ESPE, Seefeld, Germany), and all the restorations exhibited accurate marginal fitness, as well as stable occlusion with satisfactory esthetic outcomes (Figs. 18-19).

Discussion

At present, digital technology plays a major role in our daily lives, both in society in general and in dentistry in particular. In the latter area, digital protocols are gradually influencing prosthodontic treatment concepts[5].

The CAD/CAM production of monolithic prostheses, originated from intraoral scanning

Fig. 16: SPhotograph showing a customized abutment of implant 43 and a coping of tooth 45

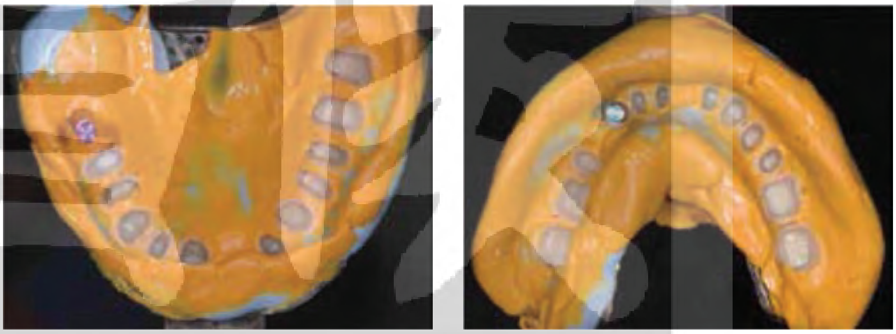

Fig. 17: Pick-up impression

Fig. 18: Definitive zirconia prostheses, after insertion

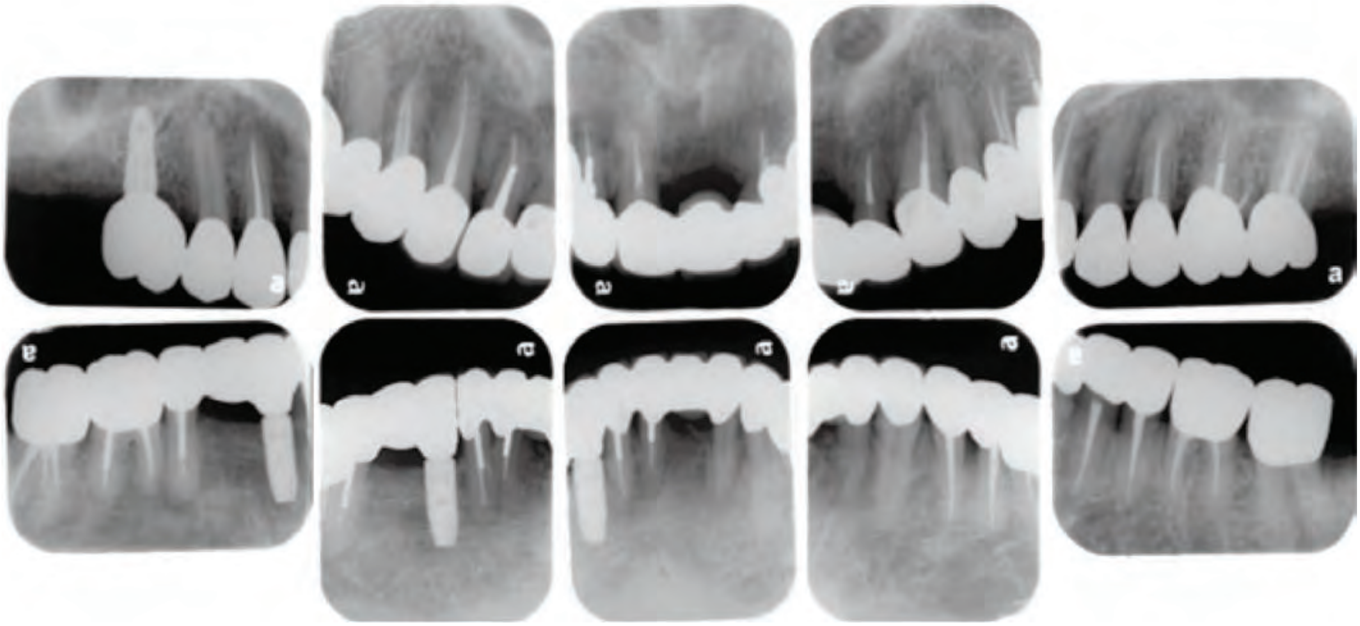

Fig. 19: Dental radiographic images after treatment

followed by a virtual design and production, might benefit from the use of the digital workflow[1]. By using digital procedures, clinicians can avoid the need for physical models and the space needed to store them. Moreover, the delicate abutment margins on the working cast will not be chipped off during laboratory processing. Also, the digital data can be saved, such that the exact same prosthesis can be fabricated immediately if a remake is needed.

However, with the inherent limitations of zirconia, it is difficult to achieve a natural appearance in the esthetic zones. Besides, the chipping rate of porcelain in porcelain-fused-to-zirconia (PFZ) prostheses is higher than that of porcelain-fused-to-metal (PFM) ones[6]. To overcome these problems, mild cutbacks for porcelain veneering in nonfunctional areas can be performed to achieve more esthetic and durable outcomes[7]. Consequently, combining analog with digital work steps might offer the best results[1].

An experienced technician is needed to participate in the actual handcrafting process. Therefore, it is necessary to have a physical working cast made either by a conventional impression method or 3D printing technology. A conventional impression procedure is simple to perform when the number of abutments is small. However, the greater the number of abutments, the more difficult such a procedure will be. In complex cases, utilizing 3D printing technology to fabricate the working casts seems to be an ideal option, but the cost of this approach is higher than that of using conventional impression methods. An alternative method entails taking a pick-up impression when the frameworks are tried. Then the porcelain layer can be applied on the framework.

In order to duplicate the emergence profile of an implant provisional restoration, the gingival contours from the provisional prosthesis need to be transferred. Nowadays, an intraoral scanning device can be used to scan the soft tissue. However, the surrounding peri-implant tissues collapse soon when the provisional prosthesis is removed, which means that only a part of the established emergence profile can be accurately captured. Therefore, it is important to perform such scanning without delay[8].

In this case, provisional restorations were attached to analogs and scanned extra-orally from top to bottom. The images were then matched with the digital reference models. With CAD/CAM technology and the correct methodology, the established emergence profile of an implant provisional restoration can be duplicated in the final restoration in an accurate way.

Because of the inherent differences between teeth and implants, especially in their supporting mechanisms and survival rate, the subject of connecting implants to teeth has been a controversial in the last several decades[9]. Complications associated with tooth-implantconnected prostheses have been categorized into biological and technical types. Previous short-term clinical studies have reported that the tooth-implant-supported prostheses did not have a higher risk of technical or biological failure than implant-supported ones for up to 5 years of clinical usage[10]. On the other hand, tooth-implant-supported prostheses have been reported by one study to have a higher failure rate than implant-supported prostheses after 10 years of follow-up[11]. However, no statistical analysis has substantiated that finding.

The implant-supported fixed prosthesis seemed to be the ideal option in this case. However, the space between the tooth 43 and 44 areas was 2 mm too short for two regular 4-mm-diameter implants. So, the treatment plan was modified from two implant-supported prostheses to a tooth-implant-supported fixed prosthesis. In such a scenario, nonrigid attachments and temporary cements should be avoided as they will increase the incidence of tooth intrusion. Therefore, polycarboxylate cement (DurelonTM polycarboxylate cement, 3M ESPE, Seefeld, Germany) was used to cement the tooth and implant to avoid the intrusion complication[12]. Furthermore, lateral forces and unbalanced tooth contacts should be minimized in centric and excursive movement, and frequent occlusal adjustment is an important follow-up step[9]. Consequently, implant 16 was disoccluded during lateral excursion, and the occlusal scheme was set using the group function in order to make sure that premature occlusal contacts were avoided.

An alternative treatment plan for restoring a mandibular second premolar consists of making a mesial cantilever FDP reaching from the mandibular first molar. According to Pjetursson BE et al., the 5-year and 10-year survival rates of cantilever FDPs are similar to those of tooth-implant-supported FDPs[10]. However, a single cantilevered pontic requires at least two abutments[14]. This means that the first and second molar must be splinted for a second premolar cantilevered pontic. In this circumstance, those splinted molars become an area for which hygiene would be difficult to maintain for an elderly individual with Parkinsonism.

Taking a conventional impression of multiple abutments is a difficult task. The approved "occlusion" of provisional restorations should be transferred by a cross-mounting technique, which is time consuming. Moreover, even such a technique cannot transfer the whole "contour". With the help of CAD/CAM technology, however, the prosthetic contours of provisional restorations can easily be duplicated to the definitive prostheses[13].

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