

# Mock-Up Driven Designing of Full-Mouth Implant-Supported Metal-ceramic Fixed Prostheses

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## Abstract

**Objectives:** Planning of the treatment steps and designing of the implant-supported fixed final prosthesis are primarily important to respond the esthetic and functional requirements of the fully edentulous patient.

**Clinical considerations:** Pre-operative planning of the treatment steps and the surgical and prosthetic applications provide the post-operative satisfaction.

**Conclusions:** Mock-up provides a simple, quick, improvable and an inexpensive solution in the planning of the implant-supported full-mouth restorations and guarantees the successful results.

**Clinical implications:** Mock-up driven planning was found simple, quick, improvable, inexpensive and successful in prosthetic treatment of a fully edentulous case with the implant-supported, full-mouth, metal-ceramic, fixed prostheses.

**Keywords:** Full-mouth; Implant-supported; Metal-ceramic; Fixed prostheses; Treatment planning; Mock-up

## Introduction

Implant supported prosthodontic rehabilitation of total edentulism remains one of the most complex restorative challenges because of the number of variables that affect both the aesthetic and functional aspects of the prosthesis. Among the prosthesis designs used for the treatment of the edentulous mouth are fixed or removable implant-supported restorations. Since the aesthetic requirements and preoperative situation of each patient varies, considerable time should be devoted on accurate diagnosis to ensure patient desires are satisfied and predictable outcomes are achieved [1].

Implant survival and marginal bone-level changes of the implant-supported full arch fixed prostheses were evaluated in detail and were reported as highly successful in reviewed literature in particular with respect to patient satisfaction [2-13].

Advantages and disadvantages of implant-supported fixed and removable prostheses are well described and discussed. When deciding whether to use a fixed or removable implant-supported full-arch restoration, a multitude of factors should be considered [14,15].

Following the reliable osseointegration is achieved; sequential application of the final impressions, maxillo-mandibular relation records, fabrication and try-in of the framework, confirmation of the maxillo-mandibular relation by using a second record and ceramic veneering of the framework; were mentioned as a classical protocol for such restorations [16-28]. However, in some circumstances the complex esthetic, functional and hygienic requirements of the total edentulism may not be addressed appropriately by employing the mentioned protocol. Improper implant positioning can result in significant difficulty for patient comfort and fabrication of a functional prosthesis. Corrective interventions even though the situation is managed successfully, result in increased time and treatment expenses, additional appointments, and elaborative steps [29,30]. It was mostly advocated that, treatment should be planned prior to the surgical intervention and implants should be placed according to this plan [31-40]. Computer aided designed and computer aided manufactured (CAD-CAM) surgical guides are generally employed for this purpose [34,36-39]. Either titanium or zirconia frameworks of the implant-supported full-mouth restorations

and anatomically contoured monolithic zirconia restorations may also be CAD-CAMed [12,33,35,36,40-48].

Various esthetic and functional concepts involved in diagnosis and treatment planning for implant-supported fixed prostheses in the edentulous cases, were evaluated in reviewed literature [49-52]. Determining gnathologic points and recognizing anatomic landmarks found in the edentulous jaws aid in correct tooth positioning, resulting in appropriate function, speech, esthetics, comfort, and a prearranged occlusal scheme, all of which are critical factors behind a successful implant-supported restoration [53]. Important soft-tissue landmarks such as nasolabial, mentolabial, and interlabial angles, labial prominence, vermilion area vertical and anteroposterior labial dimensions, location of the incisal edges and their interactions with the lips and the amount of gingival display were reported [1,5,29,49,54-64].

Obtaining a proper occlusion and providing a functioning articulation in a suitable relationship with the dento-facial esthetics are mentioned as the other challenges in constructing full-mouth implant-supported fixed prostheses [30,65,66].

Location and position of the remaining teeth, provisional prostheses, previous dentures, and stereolithographic templates were described and advised to guide the planning of the final prosthesis [32,53,57-59,61,67-74]. Mock-up and wax-up applications were also reported as useful instruments in the planning of the definitive full-mouth implant-supported prosthesis [75-81].

Under the lights of the mentioned studies, the aim of this paper is

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Figure 1: Removable mock-up of the implant-supported full-mouth metal-ceramic fixed upper and lower definitive prostheses.



Figure 2: Mock-up exhibits the esthetic performance and the maxillo-mandibular relations of the forthcoming definitive prostheses.

to report the mock-up driven design of a full-mouth implant supported metal ceramic fixed prostheses of a fully edentulous case.

## Case Report

Fifty-seven years old female patient referred to our clinic with complaints about her previous dental treatments and demand an implant supported fixed prostheses. She had no medical history about systemic health problems. Intraoral and radiographic examinations revealed periodontally compromised mobile teeth, and a fistula related to tooth 35, some metal-ceramic crowns, and removable partial dentures.

Total extraction of the hopeless teeth, eradication of the pathological tissues, augmentation of the edentulous arches, installation of implants and construction of full-mouth implant-supported metal-ceramic, fixed prostheses, were planned.

Prior to the extractions, immediate dentures were made for provisionalizing. For this purpose, preliminary impressions were made with an irreversible hydrocolloid material (CA-37, Cavex Holland BV, Haarlem, The Netherlands) and stock trays. Preliminary impressions were poured in dental plaster. Custom trays were made on these diagnostic casts. Final impressions were made with vinyl polysiloxane elastomeric impression material (Pentsoft Duo-Mix, 3M-ESPE, Seefeld, Germany)

and custom trays. Final impressions were poured in type IV dental stone (Glastone, Dentsply Co., Milford, USA). Maxillomandibular relation was recorded. Master casts were mounted on a semi-adjustable articulator. Remaining teeth were cut-off, artificial teeth were set according to the previous dentition. Interim dentures were manufactured in conventional manner. After processing, denture intaglios were grinded in order to maintain adequate spacing for the post-operative soft relining.

In the first surgical intervention total extraction of the remaining teeth were accomplished. Apical regions were curetted, sharp bony edges were trimmed and the mandible was augmented with spongy bone substitute (Bio Oss, Geistlich Pharma AG, Wolhusen, Switzerland) mixed with the patient's own blood and saline. Recipient bone is fenestrated by a small round bur and the prepared graft material is packed to form an alveolar process. Then the augmented area was covered by a resorbable membrane (Bioguide, Geistlich Pharma AG) and closed after the immobilization of the vestibular soft tissue with interrupted sutures. After healing of the soft tissues, the same protocol is carried out for the maxilla. Following the surgical interventions, interim dentures were applied to the mouth as lined with tissue-conditioner (Visco-Gel, Dentsply De Trey GmbH, Konstanz, Germany).

Following the integration of the graft material with the host tissues, diagnostic templates with steel balls 5mm in diameter were made on the diagnostic casts obtained from the preliminary impressions made with stock trays and irreversible hydrocolloid impression material (CA-37, Cavex Holland BV). Computerized Tomographic (CT) images of the maxillary and mandibular structures with diagnostic templates were taken. Host tissues were evaluated and the implant locations were decided according to the CT scan. Four endosseous screw type implants (Laser-Lok, BioHorizons, Birmingham, AL, USA) 4mm in diameter and 10,5 to 12 mm height were installed to the mandible and six implants (Laser-Lok, BioHorizons) 5 mm in diameter and 9 to 12 mm height were installed to the maxilla according to the recommendations' of the manufacturer. Interim dentures were relined with tissue conditioner (Visco-Gel, Dentsply De Trey GmbH) again and the relining procedure was renewed with four weeks interval postoperatively. After each operation, amoxicillin clavulonic acid 2 gr. daily for four days, diclofenac sodium 75 mg. twice a day for two days, chlorhexidine gluconat mouthwash for five days was prescribed. Following the radiological confirmation of osseointegration, installation of the healing caps was accomplished.

Upper and lower final impressions were taken with the vinyl polysiloxane elastomeric impression material (Pentsoft Duo-Mix, 3M-ESPE), mixed by an automatic mixer (Pentamix 2, 3M-ESPE) and the individual impression trays by using closed tray impression technique. Implant analogs fixed to the abutments, were placed into their own replicas and the impressions were poured with type IV dental stone (Glastone, Dentsply Co.) in order to obtain the master casts. Base-plates were made from autopolymerizing methacrylate material (Meliodent, Heraus Kulzer GmbH, Hanau, Germany). Buccal flanges were used to check the fitting of the base plate but labial flanges were cut-off in order to avoid the excessive lip support. Holes were drilled for each of the implants. Occlusal rims were constructed on the base-plates from the pink modeling wax (Cavex Set Up Regular Modelling Wax, Cavex Holland BV), and the maxillo-mandibular relation was estimated three dimensionally. Afterwards, master casts were mounted on a semi-adjustable articulator. Artificial teeth were chosen and were set up in order to demonstrate the dimensions, location, position and occlusion of the forthcoming fixed prostheses (Figure 1). Attention was paid that they shouldn't be confused with denture set-ups. Dento-facial anatomical landmarks, lip support, smile line, relation between the incisal edges and



Figure 3: Upper labial index made by putty silicone elastomer.



Figure 4: Lower labial index made by putty silicone elastomer .

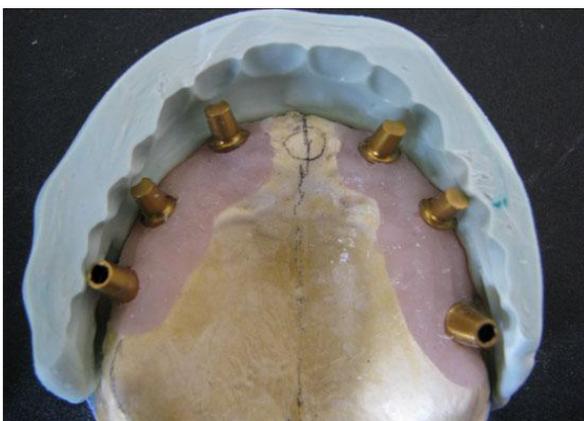


Figure 5: Upper index shows the location, position and the vertical dimension of the definitive upper fixed prosthesis and its units. Amount of the ridge lapping and the pink-colored porcelain were also indicated.

the lower lip, location of the cervical level, gingival appearance, ridge-lapping and the necessity of pink-colored porcelain, were considered as the dominating morphological variants and addressed on the mock-

ups (Figure 2). Occlusal relation of the definitive fixed prostheses was also constructed by employing the mock-ups and an anterior protected articulation was constructed.

Following the try-in and corrections, mock-ups were mounted on the master casts again. A putty silicone elastomer (Stabilisil, Cavex Dental BV) index was made labially, in order to cover the mock-up and the master cast together (Figures 3 and 4). Mock-ups were detached and the remaining space used for the construction of the definitive prostheses (Figures 5 and 6).

Some of the maxillary abutments were replaced with the angled ones to be in accordance with the esthetic requirements and the path of insertion of the cement-retaining upper prosthesis. On the other hand, castable abutments and the screw type prosthesis were preferred for the mandible. Distal cantilevers were limited to 10 mm bilaterally.

Wax patterns of the frameworks were made in order to obtain an adequate space for the veneering ceramic in between the wax pattern and the silicone index. Then, they were sprued, invested, cast, trimmed and adjusted (Figures 7, 8 and 9). After the clinical try-in and the minor corrections, the frameworks were veneered with dental ceramic. Cervical

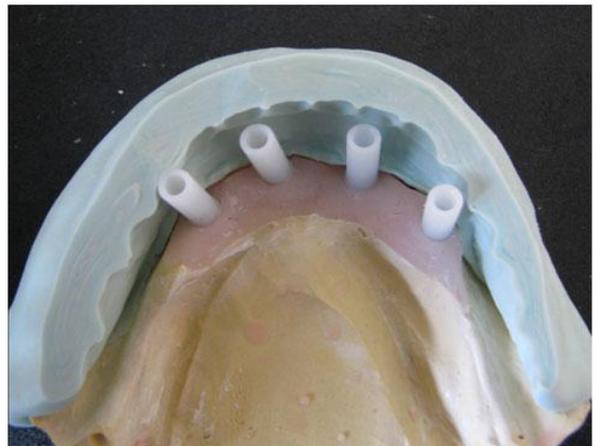


Figure 6: Castable abutments of the lower prosthesis and their relation with the putty elastomer index.



Figure 7: Cast-metal upper framework within the index. Note the spacing for porcelain veneering.



**Figure 8:** Cast-metal lower framework within the index. Distal cantilevers were limited with 10 mm bilaterally.



**Figure 9:** Upper and lower frameworks adjusted on the abutments on the master casts mounted on the articulator according to the maxillo-mandibular relation recorded previously during the mock-up stage. Note the interocclusal spacing for porcelain veneering.

level, gingival appearance and ridge-lapping were located and created by using pink-colored ceramic according to the guidance of the silicone index. Restorations were tried again before glazing. Further corrections were made, centric and eccentric relations were improved, and interferences were eliminated prior to the glazing. Finally, full-mouth, implant-supported, metal-ceramic upper prosthesis was luted with temporary cement (Premier Implant Cement, MDSS GmbH, Hannover, Germany) and the lower one was screwed. Screw holes were closed with a resin composite restorative material (Tetric-N Ceram, Ivoclar-Vivadent, Schaan, Liechtenstein) (Figures 10 and 11).

## Discussion

Full-arch implant-supported fixed dental prostheses are well-documented therapeutic applications for completely edentulous patients [75]. Reconstructing the edentulous mouth with opposing, fixed, implant-supported metal-ceramic restorations demands great attention to detail [53]. Planning of the treatment steps and designing of the final prosthesis are primarily important to respond to these demands. Anatomically based approaches like “13-23-30” may help clinician with

the initial selection of implant sites when contemplating an implant treatment of edentulous maxilla [56]; but it is better to plan the surgical and prosthetic applications pre-surgically [31-40].

Pre-operative planning of the surgical intervention requires pre-operative computerized tomography (CT), computer softwares to determine the final position of the implants and CAD-CAM systems including stereolithographic armamentarium to design and manufacturing of the surgical guides [33-40]. CAD-CAM technology has broadened the scope and application for this treatment option [44]. It was reported that, the use of technologies that merge computerized tomography X-ray imaging and 3D planning software allow the surgeon to digitally elaborate on the computer the position, length, and diameter of every implant to be placed. Following this approach, the placement is guided in a 3D digital model, and the implants are placed in the final position avoiding eventual anatomic structures. The planning allows placement of



**Figure 10:** Implant-supported, full-mouth, metal-ceramic fixed definitive prostheses in-situ.



**Figure 11:** Facial view of the final restoration.

parallel implants to optimize the prosthetic procedure and outcome [36]. CAD/CAM technology has been used in implant restorative dentistry for more than 25 years. Today this technology is preferred for means of milled frameworks that fit more accurately [33]. CAD-CAM of long-span full-arch titanium and zirconia frameworks [43-45,47], cement-retained all-ceramic restorations [48] and anatomically contoured monolithic zirconia prostheses [35,41] were reported in the related literature.

The impact of various esthetic parameters such as facial forms and profiles, teeth positions and proportions, smile line, lip support, gingival display, facial and dental midline, horizontal cant, and smile width were discussed in reviewed literature [49]. Numerous authors advised that, the main parameters of the facial and dental esthetics; dental, mucosal and facial anatomical landmarks should be recorded, considered and reflected in the final design of the prostheses [30,31,33,34,41,54-61,67-69]. Assessment of the smile or lip line is especially imperative when implant therapy is carried out in the esthetic zone. The smile is generally defined as high, average, or low. Females are reported to have higher lip lines than males, which mean that they are at greater risk when placing and restoring implants in the esthetic zone. Maximum upper lip elevation, usually observed during a strained posed smile, should be assessed [63]. The lip line and lip support influence the esthetics [59]. It was reported that, full-arch implant-supported fixed dental prostheses might negatively influence the upper lip support and lower facial features of the patient. Soft tissue defects in the upper lip philtrum area may develop in patients treated with full-arch implant-retained fixed dental prostheses and who share certain etiologic factors [75].

The transitional phase between a tooth-supported occlusion and an implant-supported occlusion was described as a major obstacle in the treatment with implants. This is of particular concern when a patient with a failing dentition has not worn a removable prosthesis before and is planned to have a reconstruction supported by implants [68]. With implants, in the absence of the periodontium and periodontal mechanoreceptor feedback, fine motor control of mastication is reduced, but patients are still able to function adequately. Further, there is no significant difference in function with full-arch fixed prostheses on teeth in comparison with implants. Predictable implant outcomes depend on bone support. Optimum restoration design appears to be significant for bone remodeling and bone strains around implants with occlusal loading. Load concentration increased with steeper cusp inclination and broader occlusal table and decreased with central fossa loading and narrower occlusal table size. It is recommended that occlusal design should follow a narrow occlusal table, with central fossa loading in intercusp contact and low cusp inclination to minimize lateral loading in function and parafunction. Acknowledging these features should address potential problems associated with the occlusion in implant therapy [30,66].

The implementation of the prosthesis-directed treatment-planning principle for the patients requesting full-mouth implant-supported fixed prosthetics was described and the concept of prosthesis-directed implant-supported restoration was well accepted [48,80]. Definitive prostheses may be constructed pre-surgically by employing the restorative-driven treatment protocols [31,32]. Nevertheless, pre-surgically planned and constructed interim or provisional prostheses have a wider acceptance [33-40].

Provisional restorations provide the treatment team with a valuable means of addressing criteria that are required throughout the surgical, prosthetic, and technical stages. They also enable the clinician to place and evaluate a prototype of the definitive restoration in the patient's intraoral environment [72], and may serve to guide the final restoration [57]. Construction of the provisional restoration precisely reproducing

the patient's hard and soft tissues before implant surgery was reported to improve the esthetic and function of the implant-supported full-mouth prostheses [32]. The provisional phase of treatment can be the most challenging in implant dentistry. The choice of provisional restoration should be based on esthetic demands, functional requirements, duration, and ease of fabrication [68]. It was advocated that, this application maintains soft tissue health and support following immediate implant placement [58]. It was reported that, the incisive edge could be placed for esthetics and function in the provisional restoration, allowing patients to evaluate comfort and test their ability to speak with the contour of the provisional restoration. Patients can evaluate both the ease of cleaning the restoration and how tissue esthetics can be duplicated to their satisfaction. By adding acrylic resin to or removing it from the provisional, the dentist can easily change the restoration until the patient is satisfied with the esthetic and functional result [57]. After the incisive edges of the planned maxillary central incisors are determined, the most apical buccal bone level in the esthetic zone serves to guide complete arch rehabilitation [31].

Patients presenting with debilitated dentitions were reported as excellent candidates for implant-supported reconstructions [73]. Their existing teeth, even if compromised structurally, help preserve the ridge anatomy and can be used to support fixed, interim prostheses. While the result is often a straightforward, treatment-planning decision, the diagnosis and interim stages of sequential extraction cases leave numerous decisions to be made [73]. Basic principles of tooth position in dentate patients and in complete dentures were investigated and related to the edentulous patient undergoing implant restorations. Determining gnathologic points and recognizing anatomic landmarks found in the edentulous jaws reported as useful in correct tooth positioning, resulting in proper comfort, function, speech, esthetics, and a prearranged occlusal scheme, all of which are critical factors behind restorative-driven implant dentistry [53]. Failing dentition and/or restorations may be used to guide the provisional prostheses as well as the implant-supported final prostheses [53,61,67,68]. Existing denture of the patient may be used to analyze the esthetic parameters and potential limitations [59]. Also, a method of converting an interim maxillary removable complete denture to an interim implant-supported fixed complete denture was described [70]. The advantages of this method were reported as to provide the opportunity to evaluate the patient's function and esthetics, and to help the accurate transfer of the maxillo-mandibular relationship to the laboratory [70]. An easy and timesaving procedure to fabricate a complete-arch, implant-supported, cement-retained, fixed provisional restoration indirectly from the radiographic guide was described [71]. A procedure to analyze the influence of lip line and lip support on the esthetics of an existing maxillary complete denture, revealing potential limitations when planning a fixed implant-supported prosthesis; was defined [59]. In many cases, the esthetic needs of patients can be successfully addressed as well. This is achieved by restoring both the dental and facial esthetic components. It was reported that, appearance of the facial soft tissues while planning the provisional prosthetic restoration, provides quantitative information to prepare the best definitive prosthesis and dental prostheses induced significant reductions in the nasolabial, mentolabial, and interlabial angles, with increased labial prominence. Lip vermilion area and volume significantly increased; significant increments were found in the vertical and anteroposterior labial dimensions. The presence of the dental prostheses modified the three-dimensional positions of several soft-tissue facial landmarks [54]. However, in some instances full-arch implant-supported fixed dental prostheses may negatively influence the upper lip support and lower facial features of the patient [75]. Rehabilitation of edentulous spaces in esthetic areas is a challenge to the clinician due to the loss of soft tissues [76].

Accompanying the loss of supporting alveolar structure due to resorption is the necessity for lip support, often provided by a denture flange. Attempts to provide a fixed restoration can result in compromises to oral hygiene based on designs with ridge laps. Ridge lapping of the prosthesis over abutments promotes pleasing aesthetic results almost regardless of the vestibulo-lingual and mesio-distal location of the abutment relative to the required position of the crown. The technique-sensitive procedures associated with the creation and maintenance of acceptable emergent profiles is rendered unnecessary. Ridge lapping is compatible with abutment heads of any diameter and configuration and with cementable or screw-retained fixed prostheses [60]. While the prosthesis was ridge lapped, gingival aesthetics may be improved by using contemporary materials such as gingiva-colored composite or porcelain in addition to more traditional materials such as standard prosthetic acrylic [64].

Recovering of the evaluation and prediction of the gingival architecture in the oral rehabilitation was found desirable [76]. To fulfill this need, the diagnostic wax should anticipate the final rehabilitation with the integration of hard and soft tissue. A diagnostic wax-up that integrates these two components that are simultaneously seeking to recreate the harmony of white and pink esthetic was advised. Diagnostic wax-up described as the basis for the creation of the provisional prosthesis and a soft tissue mock-up. After placing the provisional prosthesis in the mouth, the soft tissue mock-up can be applied to assess its esthetic impact at facial and intraoral level. Dentist and patient should objectively assess the appearance of the final result [76]. A diagnostic wax-up may also be used for the chair-side fabrication of implant-supported fixed prostheses [79]. Fabrication of a screw-retained, implant-supported wax pattern enables the clinician to predict the outcome of the final prosthesis and also affords the patient an opportunity to evaluate and approve the design of the planned prosthesis, thereby enhancing communication between the dentist and patient [81]. The importance of the wax-up and soft tissue mock-up was described in a case report [69,76]. Dentist and patient should objectively assess the appearance of the final result. After approval of this rehabilitation concept, the virtual surgical planning can be performed and the surgical guide can be designed, allowing the treatment to take place. This protocol allows the development of a rigorous treatment plan based on the integration of teeth and gingiva component. The wax-up and the soft tissue mock-up play a significant role, since they allow an earlier evaluation of the esthetic result, better prosthetic and surgical planning, and it allows us to anticipate the need for gingiva-colored ceramics use [76]. Management of the gingival appearance is especially important for the patients displaying gummy smile. Edentulous patients displaying gummy smile, may be candidates for implant supported fixed prosthesis, require meticulous treatment planning and additional pre-prosthetic interventions before the placement of dental implants [55]. Prior to implant placement, the gingival frame was also established, enhancing the overall appearance of the final, full-arch implant rehabilitation, by using a transitional prosthesis [61].

In present study, upper and lower mock-ups were made, labial borders of them were indexed with silicone elastomer and the definitive fixed prostheses were constructed within the limits of the silicone indexes. Facial and dental esthetics, teeth diameters and proportions, location and position of the teeth, their interrelation with the lips, occlusion and articulation and the functions as mastication and phonetics were improved successfully by employing the described treatment protocol. Expectations of the patient were responded satisfactorily.

## Conclusions

A clinical case about the importance of the mock-up in designing of the full-mouth implant-supported metal-ceramic fixed prostheses

was reported. The following conclusions can be drawn from this clinical study:

1. The mock-up plays a significant role in designing the definitive prostheses.
2. Allows an earlier evaluation of the esthetic result and better prosthetic planning.
3. Guides the definitive prostheses in a most functional and most esthetic location.
4. Helps to decision making about the anterior appearance, eventually proportions of the anterior teeth.
5. Allows anticipating the need for gingiva-colored ceramics use.
6. Guides to maintain comfortable centric and eccentric intermaxillary relations.
7. Permits the patient to improve the anterior appearance interactively.
8. Guarantees the patient satisfaction.
9. It is simple, fast, helpful and affordable.

## References

1. Jivraj S, Chee W, Corrado P (2006) Treatment planning of the edentulous maxilla. *Br Dent J* 201: 261-279.
2. Mertens C, Steveling HG (2011) Implant-supported fixed prostheses in the edentulous maxilla: 8-year prospective results. *Clin Oral Implants Res* 22: 464-472.
3. Att W, Bernhart J, Strub JR (2009) Fixed rehabilitation of the edentulous maxilla: possibilities and clinical outcome. *J Oral Maxillofac Surg* 67: 60-73.
4. Lambert FE, Weber HP, Susarla SM, Belser UC, Gallucci GO (2009) Descriptive analysis of implant and prosthodontic survival rates with fixed implant-supported rehabilitations in the edentulous maxilla. *J Periodontol* 80: 1220-1230.
5. Fortin Y, Sullivan RM, Rangert BR (2002) The Marius implant bridge: surgical and prosthetic rehabilitation for the completely edentulous upper jaw with moderate to severe resorption: a 5-year retrospective clinical study. *Clin Implant Dent Relat Res* 4: 69-77.
6. Rohlin M, Nilner K, Davidson T, Gynther G, Hultin M, et al. (2012) Treatment of adult patients with edentulous arches: a systematic review. *Int J Prosthodont* 25: 553-567.
7. Cavalli N, Barbaro B, Spasari D, Azzola F, Ciatti A, et al. (2012) Tilted implants for full-arch rehabilitations in completely edentulous maxilla: a retrospective study. *Int J Dent* 2012: 180379.
8. Crespi R, Vinci R, Capparé P, Romanos GE, Gherlone E (2012) A clinical study of edentulous patients rehabilitated according to the "all on four" immediate function protocol. *Int J Oral Maxillofac Implants* 27: 428-434.
9. Mertens C, Steveling HG, Stucke K, Pretzl B, Meyer-Bäumer A (2012) Fixed implant-retained rehabilitation of the edentulous maxilla: 11-year results of a prospective study. *Clin Implant Dent Relat Res* 14: 816-827.
10. Bozini T, Petridis H, Garefis K, Garefis P (2011) A meta-analysis of prosthodontic complication rates of implant-supported fixed dental prostheses in edentulous patients after an observation period of at least 5 years. *Int J Oral Maxillofac Implants* 26: 304-318.
11. Astrand P, Ahlqvist J, Gunne J, Nilson H (2008) Implant treatment of patients with edentulous jaws: a 20-year follow-up. *Clin Implant Dent Relat Res* 10: 207-217.
12. Larsson C, Vult Von Steyern P (2013) Implant-supported full-arch zirconia-based mandibular fixed dental prostheses. Eight-year results from a clinical pilot study. *Acta Odontol Scand* 71: 1118-1122.
13. Purcell BA, McGlumphy EA, Holloway JA, Beck FM (2008) Prosthetic complications in mandibular metal-resin implant-fixed complete dental prostheses: a 5- to 9-year analysis. *Int J Oral Maxillofac Implants* 23: 847-857.

14. Zafiroopoulos GG, Hoffman O (2011) Implant-retained dentures for full-arch rehabilitation: a case report comparing fixed and removable restorations. *Gen Dent* 59: 137-143.
15. Barão VA, Delben JA, Lima J, Cabral T, Assunção WG (2013) Comparison of different designs of implant-retained overdentures and fixed full-arch implant-supported prosthesis on stress distribution in edentulous mandible—a computed tomography-based three-dimensional finite element analysis. *J Biomech* 46: 1312-1320.
16. Gallucci GO, Bernard JP, Belser UC (2005) Treatment of completely edentulous patients with fixed implant-supported restorations: three consecutive cases of simultaneous immediate loading in both maxilla and mandible. *Int J Periodontics Restorative Dent* 25: 27-37.
17. Proussaefs P (2004) Clinical and laboratory steps for the fabrication of a fixed, cement-retained, implant-supported, complete-arch maxillary prosthesis. *Int J Periodontics Restorative Dent* 24: 344-351.
18. Rosenbaum N (2012) Full-arch implant-retained prosthetics in general dental practice. *Dent Update* 39: 108-110.
19. Tischler M (2012) A maxillary fixed bridge supported by dental implants: treatment sequence and soft-tissue considerations. *Compend Contin Educ Dent* 33: 340-344.
20. Yilmaz B, McGlumphy E, Purcell B (2012) An alternative direct technique for the fabrication of an implant-supported, screw-retained fixed interim restoration. *J Prosthet Dent* 107: 137-139.
21. Ahmadian L, Monzavi A, Arbabi R, Hashemi HM (2011) Full-mouth rehabilitation of an edentulous patient with Papillon-Lefèvre syndrome using dental implants: a clinical report. *J Prosthodont* 20: 643-648.
22. Zigdon H, Gutmacher Z, Teich S, Levin L (2011) Full-mouth rehabilitation using dental implants in a patient with scleroderma. *Quintessence Int* 42: 781-785.
23. Peñarrocha-Oltra D, Peñarrocha-Diago M, Balaguer-Martínez J, Ata-Ali J, Peñarrocha-Diago M (2011) Full-arch fixed prosthesis supported by four implants in patients with recessive dystrophic epidermolysis bullosa. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 112: 4-10.
24. Bencharit S, Misiek DJ, Simon LA, Malone-Trahey A (2012) Full mouth rehabilitation with dental implants for a patient with skeletal class III malocclusion: a case report. *J Oral Implantol* 38: 63-70.
25. Cauble DA (2011) Full-mouth rehabilitation of a patient with Crohn's disease. *Compend Contin Educ Dent* 32: 58-63.
26. Bencharit S, Schardt-Sacco D, Border MB, Barbaro CP (2010) Full mouth rehabilitation with implant-supported prostheses for severe periodontitis: a case report. *Open Dent J* 4: 165-171.
27. Schneider R (2009) Full mouth restoration on dental implants utilizing titanium laser-welded frameworks. *J Esthet Restor Dent* 21: 215-226.
28. Khatami AH, Smith CR (2008) "All-on-Four" immediate function concept and clinical report of treatment of an edentulous mandible with a fixed complete denture and milled titanium framework. *J Prosthodont* 17: 47-51.
29. Bidra AS (2010) Surgical and prosthodontic consequences of inadequate treatment planning for fixed implant-supported prosthesis in the edentulous mandible. *J Oral Maxillofac Surg* 68: 2528-2536.
30. Jacobson N, Hagen MB (2011) The use of a porcelain repair technique to improve the plane of occlusion of an existing restoration. *Gen Dent* 59: 207-209.
31. Rojas-Vizcaya F (2012) Rehabilitation of the maxillary arch with implant-supported fixed restorations guided by the most apical buccal bone level in the esthetic zone: a clinical report. *J Prosthet Dent* 107: 213-220.
32. Rebaudi A, Pascetta R, Rebaudi O, Rebaudi F (2006) Presurgical implant-supported prosthesis: technique for cementation of a definitive prosthesis immediately after surgery. *Int J Periodontics Restorative Dent* 26: 439-451.
33. Meulen Pv, Linden Wv, Eeden Rv (2012) Optimal restoration of dental esthetics and function with advanced implant-supported prostheses: a clinical report. *J Prosthodont* 21: 393-399.
34. Ozkurt Z, Duygu G, Canpolat C, Kazazoğlu E (2008) Reconstruction of edentulous maxillary and mandibular arches with implant-supported fixed restorations using a digital treatment planning technique: a clinical report. *J Oral Implantol* 34: 161-168.
35. Sadid-Zadeh R, Liu PR, Aponte-Wesson R, O'Neal SJ (2013) Maxillary cement retained implant supported monolithic zirconia prosthesis in full mouth rehabilitation: a clinical report. *J Adv Prosthodont* 5: 209-217.
36. Amorfini L, Storelli S, Romeo E (2011) Rehabilitation of a dentate mandible requiring a full arch rehabilitation. Immediate loading of a fixed complete denture on 8 implants placed with a bone-supported surgical computer-planned guide: a case report. *J Oral Implantol* 37: 106-113.
37. Abbo B (2009) Fixed complete denture using implants and computer-guided technology. *Dent Today* 28: 92-93.
38. Allum SR (2008) Immediately loaded full-arch provisional implant restorations using CAD/CAM and guided placement: maxillary and mandibular case reports. *Br Dent J* 204: 377-381.
39. Marchack CB (2007) CAD/CAM-guided implant surgery and fabrication of an immediately loaded prosthesis for a partially edentulous patient. *J Prosthet Dent* 97: 389-394.
40. Drago CJ, Peterson T (2007) Treatment of an edentulous patient with CAD/CAM technology: a clinical report. *J Prosthodont* 16: 200-208.
41. Kleinman A, Avendano S, Leyva F (2008) Aesthetic treatment option for completely edentulous patients using CAD/CAM technology. *Pract Proced Aesthet Dent* 20: 185-191.
42. Karl M, Graef F, Wichmann M, Krafft T (2012) Passivity of fit of CAD/CAM and copy-milled frameworks, veneered frameworks, and anatomically contoured, zirconia ceramic, implant-supported fixed prostheses. *J Prosthet Dent* 107: 232-238.
43. Strong SM (2011) New CAD/CAM designs for fixed implant restorations. *Dent Today* 30: 134-135.
44. Peché WA, Van Vuuren LJ, Park C (2011) Full-arch milled titanium Implant Bridge: technical report. *N Z Dent J* 107: 101-103.
45. Reshad M, Cascione D, Aalam AA (2009) Fabrication of the mandibular implant-supported fixed restoration using CAD/CAM technology: a clinical report. *J Prosthet Dent* 102: 271-278.
46. Hassel AJ, Shahin R, Kreuter A, Rammelsberg P (2008) Rehabilitation of an edentulous mandible with an implant-supported fixed prosthesis using an all-ceramic framework: a case report. *Quintessence Int* 39: 421-426.
47. Piermatti J (2007) Using CAD-CAM technology for the full-mouth, fixed, retrievable implant restoration: a clinical report. *J Oral Implantol* 33: 23-27.
48. Mitrani R, Vasilic M, Bruguera A (2005) Fabrication of an implant-supported reconstruction utilizing CAD/CAM technology. *Pract Proced Aesthet Dent* 17: 71-78.
49. Bidra AS (2011) Three-dimensional esthetic analysis in treatment planning for implant-supported fixed prosthesis in the edentulous maxilla: review of the esthetics literature. *J Esthet Restor Dent* 23: 219-236.
50. Tipton PA (2002) Maximizing aesthetics, fit, and maintenance of the full-arch implant-supported porcelain-fused-to-metal restoration. *Pract Proced Aesthet Dent* 14: 395-400.
51. Sabattini VB, Mascolo A, Patel PB (2013) Solving complex full-arch cases with simple solutions. *Dent Today* 32: 86-88.
52. Garavaglia G, Mojon P, Belser U (2012) Modern treatment planning approach facing a failure of conventional treatment. Part I: Analysis of treatment options. *Eur J Esthet Dent* 7: 372-381.
53. Piermatti J (2006) Tooth position in full-mouth implant restorations—a case report. *Gen Dent* 54: 209-213.
54. Tartaglia GM, Dolci C, Sidequersky FV, Ferrario VF, Sforza C (2012) Soft tissue facial morphometry before and after total oral rehabilitation with implant-supported prostheses. *J Craniofac Surg* 23: 1610-1614.
55. Bidra AS, Agar JR, Parel SM (2012) Management of patients with excessive gingival display for maxillary complete arch fixed implant-supported prostheses. *J Prosthet Dent* 108: 324-331.
56. Tolstunov L (2010) "13-23-30" anatomic approach for maxillary full-arch implant reconstruction: a case report and surgical-prosthetic considerations. *J Oral Maxillofac Surg* 68: 818-824.
57. Hansen PA, Kim E (2010) A provisional fixed partial denture for an implant prosthesis. *Gen Dent* 58: 26-29.

58. Harvey BV (2007) Optimizing the esthetic potential of implant restorations through the use of immediate implants with immediate provisionals. *J Periodontol* 78: 770-776.
59. Neves FD, Mendonça G, Fernandes Neto AJ (2004) Analysis of influence of lip line and lip support in esthetics and selection of maxillary implant-supported prosthesis design. *J Prosthet Dent* 91: 286-288.
60. Weiss CM (2001) Ridge-lapping restorative crowns over endosteal and subperiosteal implant abutments. *J Oral Implantol* 27: 89-97.
61. Kinsel RP, Lamb RE (2001) Development of gingival esthetics in the terminal dentition patient prior to dental implant placement using a full-arch transitional fixed prosthesis: a case report. *Int J Oral Maxillofac Implants* 16: 583-589.
62. Levine RA, Nack G (2011) Team treatment planning for the replacement of esthetic zone teeth with dental implants. *Compend Contin Educ Dent* 32: 44-50.
63. Kourkouta S (2011) Implant therapy in the esthetic zone: smile line assessment. *Int J Periodontics Restorative Dent* 31: 195-201.
64. Alani A, Maglad A, Nohl F (2011) The prosthetic management of gingival aesthetics. *Br Dent J* 210: 63-69.
65. Davies SJ (2011) Occlusal considerations in implantology: good occlusal practice in implantology. *SADJ* 66: 62-69.
66. Klineberg IJ, Trulsson M, Murray GM (2012) Occlusion on implants - is there a problem? *J Oral Rehabil* 39: 522-537.
67. Wittneben JG, Avdic M, Wright RF, Radics A, Gallucci GO, et al. (2009) Fixed mandibular and maxillary implant rehabilitation in a fully edentulous patient: a case report. *Int J Periodontics Restorative Dent* 29: 615-623.
68. Jivraj S, Reshad M, Chee WW (2008) Transitioning patients from teeth to implants utilizing fixed restorations. *J Calif Dent Assoc* 36: 599-606.
69. Bergkvist G, Nilner K, Sahlholm S, Karlsson U, Lindh C (2009) Immediate loading of implants in the edentulous maxilla: use of an interim fixed prosthesis followed by a permanent fixed prosthesis: a 32-month prospective radiological and clinical study. *Clin Implant Dent Relat Res* 11: 1-10.
70. Michalakis KX, Touloumi F, Calvani L, Bedi A, Hirayama H (2011) Simplifying prosthetic procedures while converting an interim maxillary removable complete denture to an interim implant-supported fixed complete denture. *J Prosthodont* 20: 408-413.
71. Spyropoulou PE, Razzoog M, Sierraalta M (2010) A technique for indirect fabrication of a complete-arch, implant-supported, fixed provisional restoration from a radiographic template. *J Prosthet Dent* 104: 199-203.
72. Mitrani R, Phillips K, Escudero F (2003) Prototype provisional restorations for implant-supported, full-mouth, metal-ceramic reconstructions: the hybrid technique. *Pract Proced Aesthet Dent* 15: 807-814.
73. Waliszewski M, Janakievski J (2005) Sequencing patients to implant-supported, full-mouth reconstructions: a case report. *Pract Proced Aesthet Dent* 17: 267-272.
74. Duff RE (2010) Technique: fabricating and indexing a provisional restoration. *Dent Today* 29: 76-78.
75. Calvani L, Michalakis K, Hirayama H (2007) The influence of full-arch implant-retained fixed dental prostheses on upper lip support and lower facial esthetics: preliminary clinical observations. *Eur J Esthet Dent* 2: 420-428.
76. Viana PC, Correia A, Neves M, Kovacs Z, Neugbauer R (2012) Soft tissue waxup and mock-up as key factors in a treatment plan: case presentation. *Eur J Esthet Dent* 7: 310-323.
77. Margonar R, de Almeida EO, Queiroz TP, Marcantonio E (2010) Wax teeth and metallic superstructure trials at the same session: simplified technique for implant-supported prosthesis. *J Craniofac Surg* 21: 1960-1962.
78. LuBovich R Sr (2010) Smile designing for the malcontent patient. *Compend Contin Educ Dent* 31: 412-416.
79. Bidra AS (2012) Chair-side fabrication of a fixed implant-supported prosthesis in an edentulous mandible from a diagnostic wax-up: a clinical report. *J Oral Implantol* 38: 291-297.
80. Ellis E 3rd, McFadden D (2007) The value of a diagnostic setup for full fixed maxillary implant prosthetics. *J Oral Maxillofac Surg* 65: 1764-1771.
81. Proussaefs P (2002) A maxillary screw-retained, implant-supported diagnostic wax pattern. *J Prosthet Dent* 87: 403-406.