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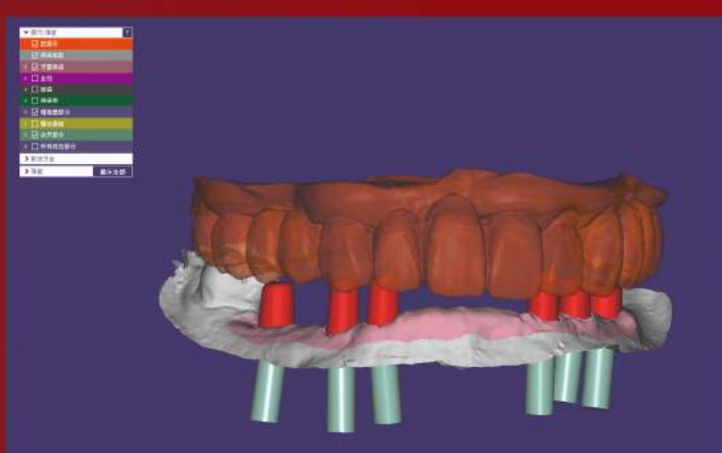
Journal of Prosthodontics and Implantology



Full-Arch Mandibular Implant Rehabilitation with Use of Cerec Omnicam Scanner. Page 14 Fig. 10

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Editorial

"To be or not to be", A famous saying written by Shakespeare in his famous novel "Hamlet" in 1602. Today, we are facing the challenge of "To change or not to change".

The specialist of our association in terms of "The Academy of Prosthetic Dentistry, ROC Taiwan" has been announced as specialist appointed by Ministry of Public health and welfare. There are two main purposes for a specialist train: 1. To elevate the standard of a prosthodontist both in academic and clinic. 2. For education and foster talent. Journal of the prosthodontics and Implantology takes part of these responsibilities to enhance the advance of our association and even spread the glorious production global wide.

To meet the requirements for these purposes we should face the challenge of this changing world. There are three main challenges for our society in the coming decade: 1.Faster growing of the aging society. Number of population with age above 65 in Taiwan is 14% in 2017. It is estimated to be 20% in 2025. Number of elder people will increase up to 4.5 million 2025 in Taiwan. Thus geriatric dentistry becomes an important issue in the near future. Not only to improve the technique for prostheses construction but target should also be aimed to advance the preventive geriatric dentistry both in academic and clinical skill. 2.Globalization, the distance between different countries becomes much shorter than before. Communication among people from different countries becomes important. To speak the same tongue as another people in the world can break down the language barriers. In order to spread the knowledge and information of this Journal without boundary, the Journal will be changed into an English edition. Manuscript will be published in English only begins from this volume, to reach the goal of globalization. 3.Faster development of computer science, today's update knowledge may become traceable information in the season. Dental education and research should take the advantage of the advanced computer science to fast the efficiency and achievement both in dental education and research.

Changing seems to be the only way to survive in this easy changing world.

Ming-Lun Hsu Dr.Med.Dent., FICD
Editor in Chief

Case Report

The Application of the Root Submergence Technique for Pontic Site Development in Esthetic Implant Restorations

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Abstract

Maxillary anterior teeth play an important role in terms of esthetics. In the event that these teeth are extracted, the collapsed arch form will occur due to bone resorption in both the vertical and horizontal directions. Many surgical techniques have been used to attempt to compensate for such bone resorption; however, the results have not always been satisfactory, especially in the pontic areas. The root submergence technique refers to the practice of resecting the crown of a tooth in order to preserve the root. This approach allows for the original ridge profile to be maintained without additional periodontal surgery. This case report describes how to develop the pontic area in the implant esthetic area through use of the root submergence technique.

Key words: root submergence technique, esthetic, pontic development

Introduction

Maxillary anterior teeth play a key role in esthetics. Not only do they provide lip support, but they also help to maintain the facial profile. In the event that these teeth are extracted, the collapsed arch form will occur due to bone resorption in both the vertical and horizontal directions.[1] Relatedly, a prosthesis in the pontic area will be longer and narrower compared to natural dentition. Consequently, a compromised esthetic appearance will result.

Many surgical techniques have been used in order to compensate for bone resorption after tooth extraction, including socket preservation, guided bone regeneration, and immediate implant placement. Although the use of these techniques is prevalent, the effectiveness of such treatments is limited.[2-5] It has been suggested, for example, that the socket preservation technique may not totally preserve the alveolar ridge at the extraction site.[6,7] Meanwhile, although guided bone regeneration has been used in localized ridge augmentation, the results in terms of preservation of interproximal bone are compromised.[2,5] Furthermore, while immediate implant placement has been used to minimize bone resorption at the extraction site, the end result is still heavily dependent on the gingival biotype and buccal bone thickness.[8]

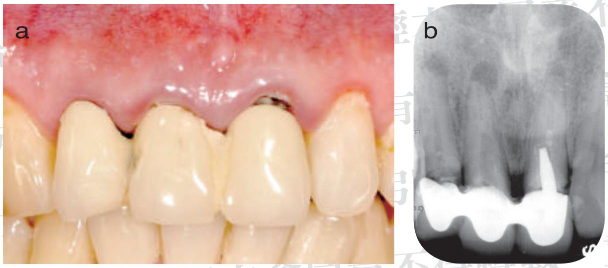

Fig. 1 Intra-oral view before treatment (a) Clinical view, (b) Periapical radiograph

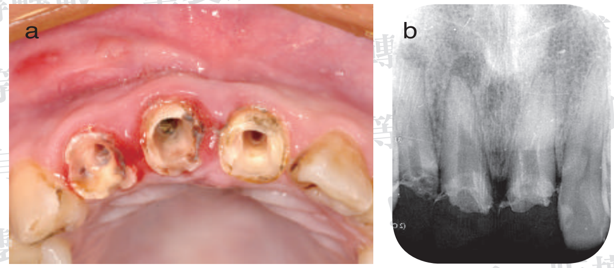

Fig. 2 Remaining tooth structure after post and core removing (a) Clinical view, (b) periapical radiograph

Fig. 3 Periapical radiograph after root canal treatment

Fig. 4 Extraction of maxillary right lateral incisor and left central incisor.

The root submergence technique refers to the practice of resecting the crown of a tooth in order to preserve the root, which is covered with secondary healing or a soft tissue flap. The purpose of this technique is to prevent bone resorption, maintaining the papilla height and width without additional periodontal surgery. In the late 1950s, the technique was initially advocated to improve the retention and resistance of complete dentures.[9-11] Likewise, it can be applied to a fixed prosthesis in the pontic area by removing the crown of a tooth and leaving the root to yield an improved esthetic result.[12,13] The root can be removed to 2 mm subgingivally, and then covered by soft tissue graft or left alone until secondary wound healing occurs. Although the technique is easier to perform than extensive periodontal surgery, the degree of success depends on the conditions of the roots. The technique should not be used in cases of unhealthy roots, including roots with caries; external root resorption; or progressive endodontic and periodontal combined lesions.[14]

The case reported on below involved the use of the root submergence technique in the pontic site development of anterior maxilla implant restorations.

Case report

A 35-year-old woman sought dental treatment due to a toothache in the anterior maxilla lasting for many days. She denied any systemic diseases or drug allergies. A clinical examination revealed an ill-fitting prosthesis and recurrent caries on both maxillary central incisors and the right lateral incisor. Also, a post and core with periapical lesions were noted on the periapical radiograph (Fig. 1). These teeth were diagnosed with symptomatic apical pathosis and generalized gingivitis.

Two treatment options, namely, the use of either a fixed partial denture or implant, were discussed with the patient. She agreed to remove the existing prosthesis first and then to undergo further evaluation of her dental conditions. After removing the prosthesis with the post and core, the maxillary right lateral incisor and left central incisor revealed subgingival decay with insufficient tooth structures. Meanwhile, a vertical fracture line was noted on the palatal side of the maxillary left central incisor. Both teeth showed an unfavorable prognosis, and extraction of both was indicated. The tooth structure of the maxillary right central incisor was compromised due to the thin dental wall and limited length of the root (Fig. 2). The definitive treatment plan involved extraction of the maxillary right lateral incisor and left central incisor and their replacement with implants. Due to financial considerations, the patient preferred straightforward treatment to extensive periodontal surgery. In order to maintain the dimension and arch form of the maxillary right central incisor, the root submergence technique was chosen at the pontic area without extensive periodontal surgery.

To relieve the symptoms of the patient, endodontic therapy was performed on these teeth (Fig. 3). When the periapical pathology subsided on the radiograph, the maxillary right

Fig. 5 Implant placement on maxillary right lateral and left central incisor areas

Fig. 6 Maxillary right central incisor served as an abutment to support the interim prosthesis

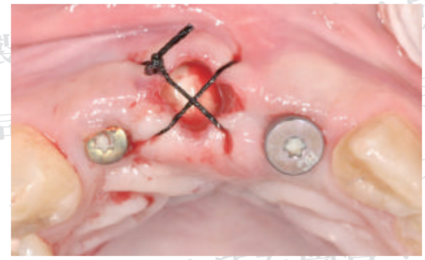

Fig. 7 Clinical view of maxillary right incisors after decoronation

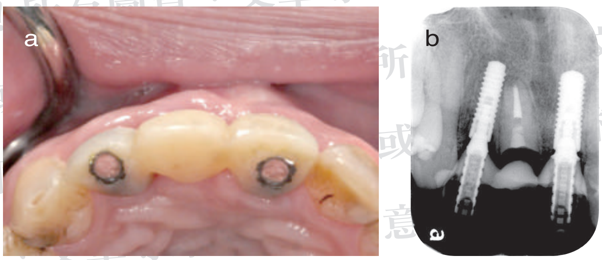

Fig. 8 Delivery of implant-supported interim prosthesis. (a) clinical view, (b) periapical radiograph

Fig. 9 Complete coverage of soft tissue at pontic site 3 months after root submergence

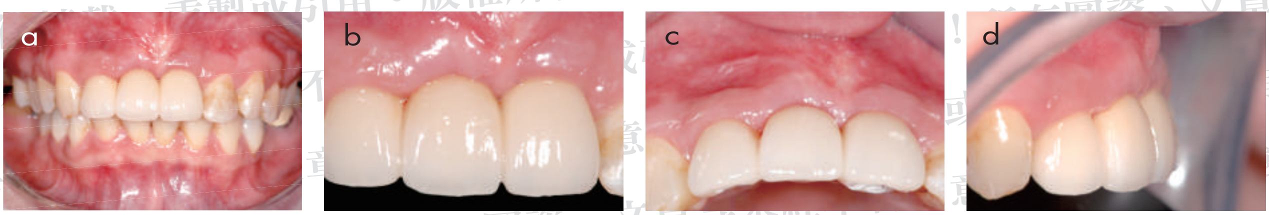

Fig. 10 Delivery of implant-supported screw-retained prosthesis (a) clinical view, (b) frontal view, (c) occlusal view, (d) lateral view

lateral and left central incisor were extracted (Fig. 4). After wound healing for 6 weeks, two implants (Bone level implant, SLA, Straumann, Switzerland) were placed at the site of the previous extraction areas (ϕ 3.3 mm X 12 mm for #7 site, ϕ 4.1 mm X 12 mme for #9 site), and time was then allowed for osseointegration (Fig. 5). To avoid the embarrassment of missing teeth during the healing period, the maxillary right central incisor was used as a temporary abutment to support the interim prosthesis after extraction of the maxillary right lateral and left central incisors (Fig. 6).

During the second-stage surgery, an open tray impression was taken with polyvinylsiloxane impression material (Aquasil, Dentsply, Germany). The implant-supported interim prosthesis was then fabricated with a bis-acryl composite resin by the indirect method. When the interim prosthesis was ready, the maxillary right central incisor was decoronated to about 2 mm subgingivally and filled with glass ionomer cement on the top of the root surface (Fig. 7). The root was allowed to undergo secondary wound healing without an additional soft tissue graft. At the same appointment, the implant-supported interim prosthesis was delivered. The fitness of the implant-supported interim prosthesis was checked by taking a periapical radiograph (Fig. 8). The bottom part of the pontic area on the interim prosthesis was relieved in order to allow space for the growth of adjacent soft tissue. The ovate pontic form started to mold when the root was covered by soft tissue after 2 weeks. Follow-up appointments were arranged on a monthly basis. The patient was instructed on how to maintain oral hygiene, especially for the pontic area.

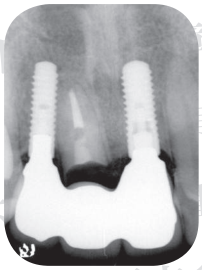

Fig. 11 Periapical radiograph when implant-supported prosthesis was delivered

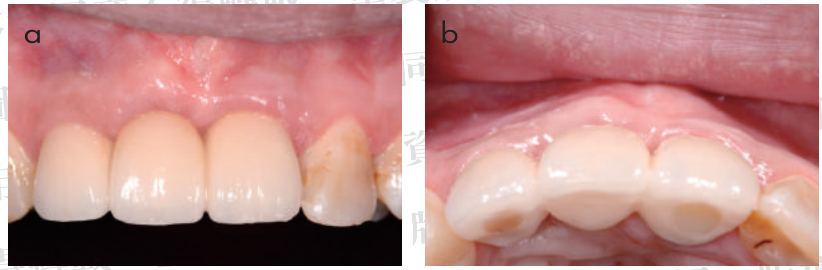

Fig. 12 Follow up after one year. (a) frontal view, (b) occlusal view

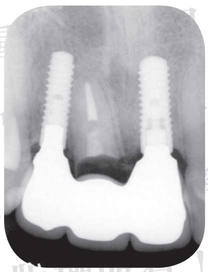

Fig. 13 Periapical radiograph check after one year

After a 3-month healing period, the pontic site development was stable, with the site completely covered by soft tissue (Fig. 9). The original ridge contour and arch form at the pontic area were preserved. A final impression was taken with a polyvinylsiloxane impression material (Aquasil, Dentsply, Germany). The screw-retained implant-supported prosthesis was then delivered (Fig. 10). A periapical radiograph was taken to check the fitness of the definitive prosthesis (Fig. 11). The pontic area was stable after 1-year of follow-up due to the use of the root submergence technique (Fig. 12, 13), and the patient was satisfied with the esthetic result.

Discussion

The root submergence technique can be used to preserve the arch form and ridge profile at the pontic site without the need for extensive periodontal surgery. Studies have indicated that both vital and non-vital roots can be submerged into the alveolar bone throughout the treatment period.[15-17]

Although the root submergence technique can maintain the gingival profile and alveolar contour, some complications may be cause for concern, including root caries, root resorption, periapical lesions, and gingival tissue perforation. In a 4-year clinical study, Von Wowern et al. showed soft tissue perforation in 11 out of 20 non-vital submerged roots under overdenture.[18] Nevertheless, other studies have indicated that submerged roots were uneventful when these were retained underneath a tooth-supported prosthesis.[12,19]

The keys to the success of the root submergence technique are complete soft tissue coverage, no direct occlusal load, and a lack of any periapical pathology. The crown of the tooth should be docoronated subgingivally and allowed sufficient time for complete soft tissue coverage. It is also important to note that the space should be left between the pontic area and the underlying mucosa for the first 2 weeks. In addition, the sharp edges of the roots also need to be reduced to avoid soft tissue perforation. The pontic site will start to mold when coverage of the soft tissue is completed. On the other hand, any occlusion of the pontic part should be adjusted for in order to eliminate direct loading on the submerged root. In addition, the root submergence technique should not be performed if the periapical pathology cannot be controlled in advance. Relatedly, the periapical conditions of the submerged root should be monitored throughout the follow-up period.

The retrievability of the prosthesis needs to be considered before using the root emergence technique in treatment, especially when dental implants are involved. Although the occurrence of complications involving the submerged root is not common under the conditions of well-controlled periapical pathology and occlusal loading, the importance of the preventive protocol cannot be overemphasized. In the current case, the screw-type implant prosthesis was chosen for reasons of retrievability. If unexpected complications of the emergence root were to have happened during the follow-up period, the prosthesis could have been relatively easily to allow for periodontal surgery.

Summary

The root submergence technique can be used to preserve the height and width of the alveolar ridge. The present case report described how to develop the pontic site for an implant-supported prosthesis by using this technique. Due to the retention of the root, the original ridge profile can be maintained without further bone resorption. Also, acceptable esthetic results in the pontic area can be achieved without extensive surgical intervention.

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Case Report

A Technique to Correct Single Denture with Uneven Occlusal Plane in Interim Complete Dentures Therapy

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Abstract

Using existing single denture to fabricate interim maxillary and mandible complete dentures may be difficult. Due to wearing of artificial teeth and uneven occlusal plane in existing single denture, occlusal equilibrium may be difficult to achieve. Even though fabrication of maxillary and mandibular complete dentures concurrently may reach an ideal occlusal plane but it is less cost effective. The present report is related to how to correct occlusal plane to achieve equilibrium when we fabricated the interim complete dentures. After duplication mandibular cast with corrected occlusal plane, use poly methyl methacrylate to correct occlusion plane in chair side.

Keywords: single denture, occlusal plane, wear

Introduction

The single denture opposing all or some of natural dentition is not an uncommon occurrence. Many difficulties confront the dentist rehabilitating patients with this clinical situation. Malposed, tipped, or supererupted teeth in the antagonist arch make it difficult to achieve harmonious balanced occlusion. Another problem with denture opposing natural teeth is the abrasion of the artificial teeth if acrylic resin is used[1-2].

When all the remain teeth need to be extracted, patient who wear single denture is going to accept complete dentures. In this transition stage, interim dentures are necessary. Even though fabrication of maxillary and mandibular interim dentures concurrently may reach an ideal occlusal plane but it is less cost effective; If only fabricate maxillary denture without correct existing mandibular denture, there would be occlusal disharmonies, occlusal interference, dentures displacement, sore spots, and even esthetic problem1. Reuse of existing denture after compensatory chair side correction could have some advantages, such as proper border extension, and easy to adapt.

Sadowsky et al[3] recommended a technique to correct incisal plane error when interim denture was fabricated. The technique can only be applied in midline shift or incisal plane canting but not in wearing of artificial teeth or uneven occlusal plane. This article describes a predictable technique to rectify the undesirable mandibular occlusal plane when fabricate maxillary interim denture.

Fig. 1 Existing single denture with wearing of artificial teeth and uneven occlusal plane

Fig. 2 Arrange maxillary artificial teeth following ideal occlusal plane

Fig. 3 Wax up mandibular posterior teeth in the cast

Fig. 4 Duplicate mandibular cast with corrected occlusal plane

Fig. 5 Check no interference between thermoplastic sheet and denture

Technique

1. When wearing of artificial teeth and uneven occlusal plane in existing single denture after evaluation (Fig. 1), taking centric relation by maxillary occlusal rim and existing mandibular denture. Facebow transfer and then mount the casts in the articulator.
2. According ala-tragus line for the ideal occlusal plane[4-5] (Fig. 2), arrange maxillary prosthetic teeth and wax up mandibular posterior teeth in the cast (Fig. 3).
3. Duplicate mandibular cast with corrected occlusal plane (Fig. 4), and then use pressure molding technique to fabricate mandible occlusal index by pressure forming unit (MINISTA, SCHEU) and thermoplastic appliances (COPYPLAST®,SCHEU). Waxing and processing maxillary interim denture.
4. In the try-in appointment, insert the thermoplastic sheet on the existing single denture to check no interference . (Fig. 5)

Fig. 6 Put PMMA into thermoplastic sheet and insert it back to existing single denture

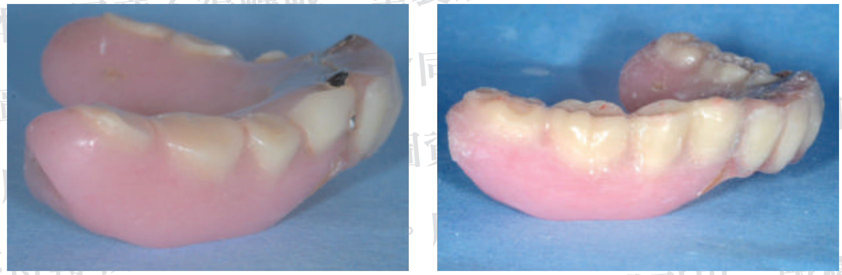

Fig. 7 Rectified existing mandible denture before and after. (lateral view)

Fig. 8 Prosthesis in place after correction. (frontal view and occlusal view)

5. Pour poly methyl methacrylate (Alike™, GC) into the thermoplastic sheet and insert it back to existing single denture (Fig. 6). Rectify existing mandible denture in chair side. (Fig. 7)
6. Insert the prosthesis, adjust occlusion, and polish the prosthesis. (Fig. 8)

Conclusion

The report offers a convenient technique to correct an occlusal plane discrepancy. After simple laboratory and chairside procedure, delivery maxillary interim denture and simultaneously rectify existing single denture occlusal plane in one appointment.

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Case Report

Full-Arch Mandibular Implant Rehabilitation with Use of Cerec Omnicam Scanner

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Abstract

The high success rates and good functional performances of dental implants have made them one of main treatment options for the full mouth rehabilitation of edentulous patients. However, a successful full-arch implant prosthesis requires a passively fitting superstructure on the implant-abutment connection for proper stress distribution. The completion of the associated conventional implant impression and soft tissue contour transferring requires multiple appointments, as well as lab work. The overall process is very technique-sensitive, and dimensional distortion of the master casts may occur due to impression material shrinkage and distortion, stone setting expansion, casting alloy shrinkage, or the use of non-parallel abutments made free-hand.

The use of digital dentistry can reduce the associated work time, lab work, and material expenses, facilitating clinical practice. The appropriate 3-dimensional position for an implant can be detected with an optical scanner and implant scanbodies. In addition, software can be used to process the scan data provided by a scanner in order to produce a virtual model for implant superstructure design. This report presents a case in which a full-arch mandibular implant fixed prosthesis was fabricated using a digital method. After six implants were placed on the mandibular arch, an intraoral optical impression was taken at implant level. A full-contour tooth setup and abutment/zirconia framework design were then processed on a virtual model. Next, custom titanium abutments were milled and then placed intraorally in order to evaluate their marginal positions and gingival support, after which three cemented-retained zirconia fixed partial dentures were fabricated. The final prostheses were well fitted and only required minor occlusal adjustment. There were no complications after one year of follow-up.

Keywords: CAD/CAM, digital dentistry, custom abutment, implant, Cerec Omnicam

Introduction

Implant fixed prostheses are one of the main treatment options for edentulous patients. However, the conventional

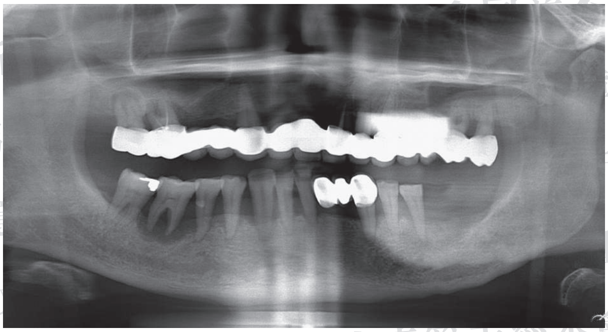

Fig.1 Panoramic film - first visit

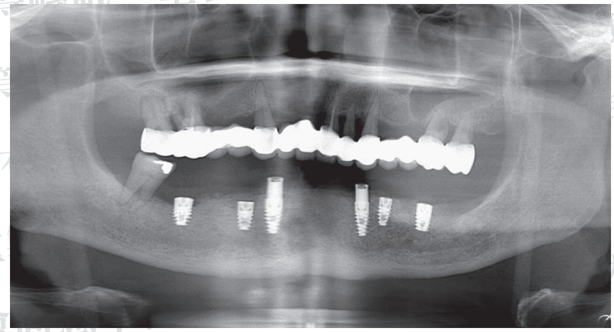

Fig.2 Panoramic film - after implant placement

method used to obtain accurate master casts and a proper implant emergence profile requires complicated chairside procedures, substantial lab work, and meticulous technique. Various problems can occur during the overall process, including impression material shrinkage and distortion, stone setting expansion, casting alloy shrinkage, and the fabrication of non-parallel abutments made by free-hand milling.

With ongoing advancements in digital dentistry, however, treatment plans and restorative procedures can be simplified, reducing chair time and lab work. Intraoral scanners are designed to eliminate the influence of impression materials and stone casts[1,2]. The optical data provided by such scanners can be processed and reconstructed into a virtual model for the design of implant restorations. Compared with the conventional impression/casting technique, this digital prosthetic procedure also provides a more convenient means of communication between dentists and technicians. The associated computer-aided milling ensures the optimal quality of the final products, in addition to allowing for the simultaneous fabrication of multiple restorations. On the other hand, frequent upgrades of the necessary equipment and design software may increase laboratory costs. Nonetheless, a successful digital workflow can simplify treatment planning, surgical procedures, and restoration fabrication when used in the context of comprehensive implant treatment.

Case report

A sixty-year-old female patient was diagnosed as having generalized moderate to severe chronic periodontitis and several teeth with chronic apical periodontitis. The present maxillary dentition was restored with an ill-fitting long span fixed partial denture from tooth 17 to 27 (missing teeth: 15, 14, 12, 11, 24, and 25) without mobility. The remaining teeth of the lower dentition were tooth 35 to 47, including a PFM bridge of 31-x-33 that was periodontally compromised with severe mobility. After the clinical and radiographic examination and a discussion regarding the treatment plan, the patient decided to have her lower teeth restored first.

All of the lower teeth were extracted, except for teeth 34, 35, 44, and 47, which were kept as interim denture abutments to maintain chewing function. Two implants (3.75 mm in diameter, BenQ AB) were placed at 33 and 43. Guided bone regeneration (GBR) was also performed in the tooth 45-46 region. After three months of healing, the remaining lower teeth were extracted, except for 47, which served as a final vertical stop. Implants 33/43 were uncovered and Locator attachments (Zest Anchor) were placed to provide retention of the second interim overdenture. Four implants were placed at the 34, 36, 44, and 46 positions with bone grafting and submerged.

After a further three months of healing, the implants were all exposed for the final impression. With six scanbodies in place, a Cerec Omnicam (Dentsply Sirona) was used to scan and record the implant position, soft tissue contour, opposite dentition, and interocclusal relationship. The scan data was then transmitted to the lab and reconstructed into a virtual model. A tooth arrangement setup and proper parallel axes and abutment profile were then designed with the use of a virtual articulator. This digital design was then sent back to the dentist for re-evaluation. Next, customized titanium abutments and temporary PMMA restorations were milled out. Almost no adjustment was needed for the abutment profile,

Fig.3 Six scan bodies in place with 47 as vertical stop

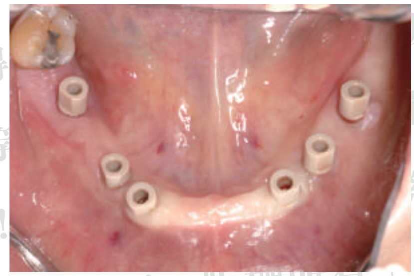

Fig.4 Six scan bodies (occlusal view)

Fig.5 Virtual model-lower

Fig.6 Virtual model-upper

Fig.7 Interocclusal relationship

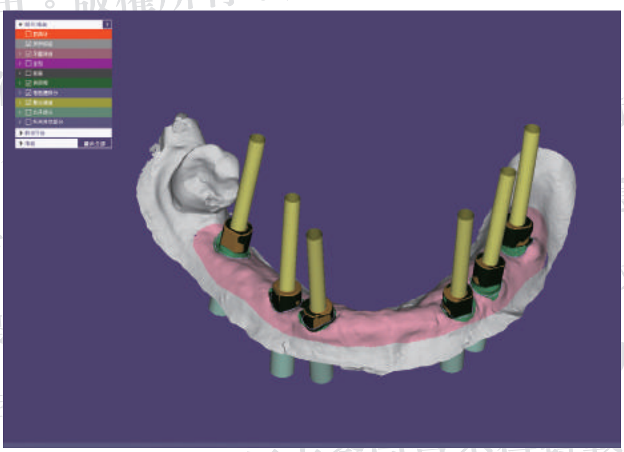

Fig.8 Matching the implant system database

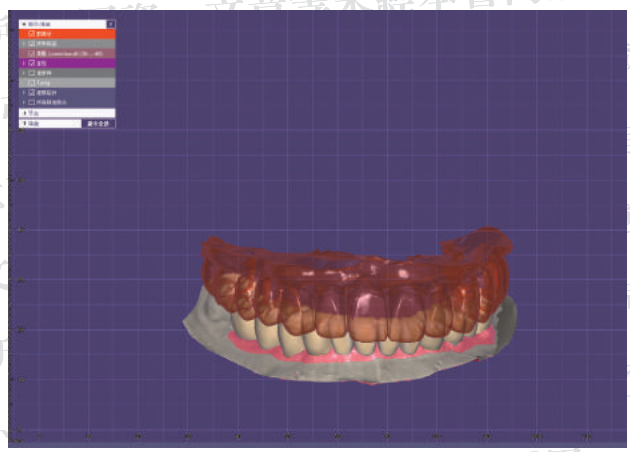

Fig.9 Virtual tooth arrangement of lower dentition

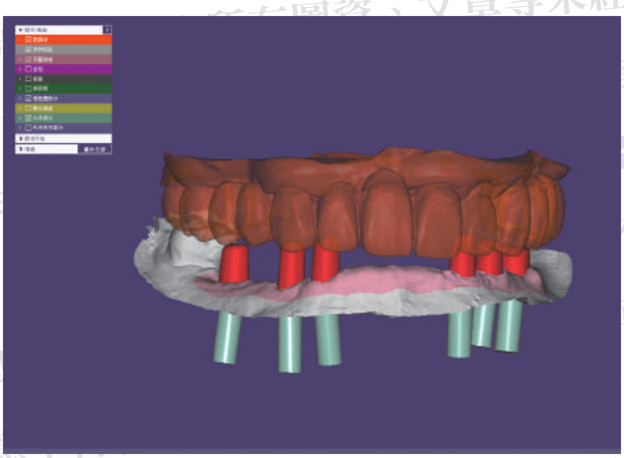

Fig.10 Custom abutment design

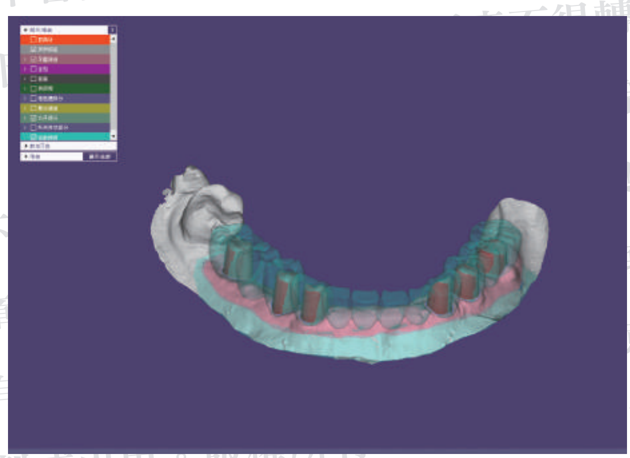

Fig.11 Temporary restoration and custom abutment

Fig.12 Custom abutment

Fig.13 Custom abutment (occlusal view)

Fig.14-16 Custom abutment

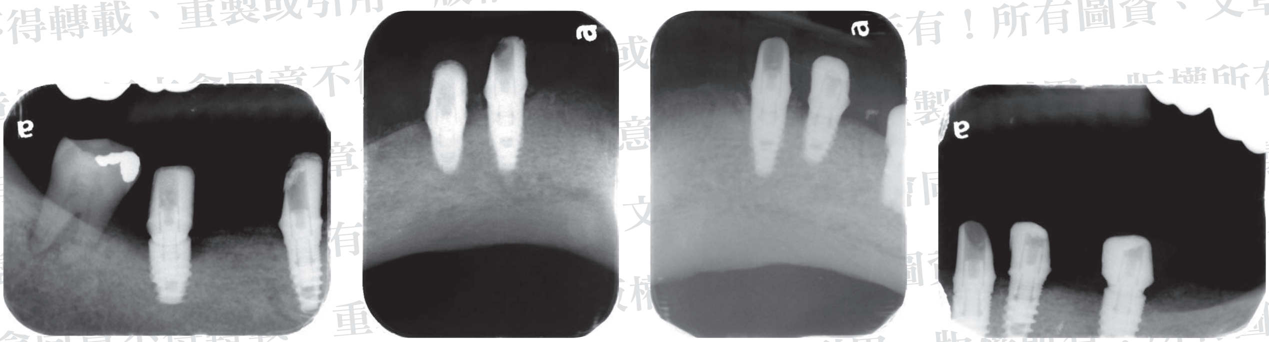

Fig.17-20 Custom abutment- PA film

marginal fit, and occlusion at the time of clinical insertion. A three-month period of observation thereafter demonstrated that the temporary restorations were stable for functional purposes, and the patient also reported being satisfied with the resulting esthetics. However, gingival recession was found at the 43 implant abutment, and a new abutment with marginal alteration was fabricated to replace the previous one.

The permanent restorations were designed as 46-x-44, 43-x-x-x-x-33, and 34-x-36 porcelain-fused-to-zirconia (Metoxit AG) FPDs based on the virtual models from the previous optical impression. In addition, a conventional impression with polyether (Impregum soft, 3M ESPE) was made for supplementary solid working casts. The interocclusal relationship was obtained with the use of a baseplate and Stonebite (Dreve Dentamid). The mounted stone casts were used to evaluate the marginal fit and occlusal relationship of the milled zirconia framework. A clinical try-in of the final restorations showed good marginal/internal adaptation, and only minor occlusal adjustment was needed. No functional or esthetic problem was found during the first year of follow-up.

Discussion

The longevity of an implant prosthesis depends on the framework design and the capacity of the framework to bear occlusal forces without inducing excessive stress-strain states around the peri-implant bone region[3,4]. The

Fig.21 Temporary restoration

Fig.22 Temporary restoration (occlusal view)

Fig.23-25 Temporary restoration

Fig.26 Permanent restoration (occlusal view)

passivity of the superstructure on the abutments of implant-supported prostheses is an important aspect of their success[5]. Therefore, it is crucial to obtain an accurate working cast. When utilizing the conventional implant prosthetic procedures, inaccurate working casts can be caused by several factors, such as dimensional distortion of the impression material, non-parallel implants/abutments, the impression coping design, and cast stone expansion[6-8].

The ideal features of intraoral scanners were first explored by Duet and Preston in the 1970s, followed by Mormann in the 1980s, with their investigations leading to the development of the CEREC system6. The most popular intraoral optical impression systems currently in commercial use are the CEREC AC (Sirona, Bensheim, Germany), Lava Chairside Oral Scanner (Lava COS; 3M ESPE, St. Paul, MN), E4D Dentist (D4D Technologies, LLC, Richardson, TX) and iTero (Cadent, Carlstadt, NJ), TRIOS (3Shape A/S, Copenhagen, Denmark), CEREC Omnicam (Sirona) 3D Progress (MHT, Verona, Italy), and True Definition (3M ESPE). These optical devices are now integrated into the digital workflows for implant prosthetic fabrication. As such, conventional impressions have been replaced by digital data acquisition with intraoral scanners and scanbodies specified for the implant system used. The scan data is then be processed into virtual models via computer reconstruction. If needed, the given virtual model can be printed out in the form of a solid working cast with stereolithographic or computer-aided milling techniques. The prosthetic design is evaluated with coordination between the relevant technicians and dentists before the fabrication of the final superstructure.

Fig.27-29 Permanent restoration - MI

Fig.30-32 Permanent restoration - Protrusion

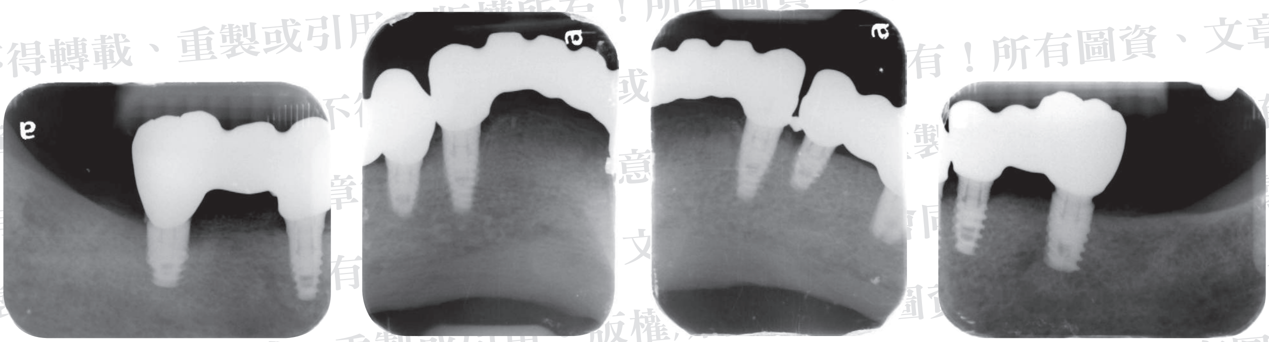

Fig.33-36 Permanent restoration - PA film

Recent studies have shown that full-arch digital acquisition is acceptable for clinical use[9,10]. Amin et al. compared splinted open-tray technique, CEREC Omnicam, 3M True Definition by 3 parallel implants and 2 angle implants and found the digital impression method was significantly more accurate than conventional technique[11]. Also, digital acquisition has been found to reduce the time and treatment costs for rehabilitation, and to improve patient compliance[12-15]. Kurz et al.[16] studied Cerec Omnicam intra-oral scanners and reported that the inaccuracies between the tooth and material surfaces, as well as the scan noise for the materials, were within the range of error for measurements used for conventional impressions and are therefore negligible. It is a powder-free system and less prone to soiling by the powder, therefore, it is not always necessary to have a dental assistant present[17]. Moreover, the improvement yielded by the minimized scanner tip makes the procedure less uncomfortable, particularly for patients with a sensitive gag reflex or fear of choking[18,19].

Digital prosthetic workflows also improve the efficiency and accuracy of framework designs. In this approach, design software automatically generates the initial design, and technicians can then fine-tune the structural details to achieve personalization for each patient. Furthermore, the transmission of digital data between technicians and dentists is low in cost, rapid, and reliable[12].

Computer-aided manufacturing (CAM) had been used in the fabrication of dental restorations for years prior to the widespread use of intra-oral scanners. In fact, the development of high-strength ceramic restorations benefited substantially from the use of CAD/

CAM manufacturing processes. A 2004 comprehensive review discussing the passive fit of implant superstructures concluded that CAD/CAM processing is either superior to or at least equivalent to the other manufacturing techniques and that both titanium and zirconia can be fabricated in highly accurate frameworks. However, due to concerns regarding the high percentage of veneering ceramic failure, that review did not recommend that zirconia be used for long-term restorations[20].

Atieh et al.[21] assessed the accuracy of intraoral optical impressions and concluded that although optical impressions obtained by the CEREC Omnicam were less accurate than those obtained in a conventional manner with vinylsiloxanether, they may be sufficiently accurate for quadrant impressions. In the present case report, the full-arch fixed implant prostheses were designed as three separate segments. The interimplant relationship within the span of a quadrant was accurate enough to allow for the simultaneous fabrication of abutments and zirconia prostheses. The outcome of these prostheses was found to be clinically acceptable after one year of follow-up. Intraoral optical impressions thus seem to constitute a new treatment alternative to the use of conventional elastomer impressions.

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Case Report

The Application of Maxillary Orthognathic Surgery and Implant Supported Fixed Dental Prostheses to Reconstruct a Patient with Skeletal Class III Jaw Relationship

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Abstract

In patients with a maxillary partially edentulous ridge and Class III jaw relationship, it is difficult to establish a clinical outcome with adequate esthetics and function by using implant-supported fixed dental prostheses (FDPs). This report presents the case of a female patient with a skeletal Class III jaw relationship whose maxillary teeth, other than the third molars, had all been extracted because of advanced chronic periodontitis. Because the patient did not want to wear removable prostheses, implant-supported FDPs were planned for her. An interdisciplinary treatment approach combining maxillary orthognathic surgery (i.e., Le Fort I osteotomy) for maxilla advancement with subsequent iliac onlay bone grafting and computer-guided flapless implant surgery and reconstruction with modified monolithic zirconia implant-supported FDPs was used to treat the patient. The pre-surgical, surgical, laboratory, and prosthetic stages and 18-month follow-up outcomes are described, with the outcomes indicating complete arch rehabilitation. Finally, we met the treatment goals of rehabilitation of the patient's chewing function and a satisfactory appearance when smiling.

Keywards: **orthognathic surgery, Class III jaw relationship, modified monolithic zirconia, computer-guided implant surgery**

Introduction

Adequate bone volume and an ideal interarch relationship are the basic criteria for restoration of the edentulous maxilla with implant-supported fixed dental prostheses (FDPs). An ideal alveolar bone position in a Class I relationship with an opposing arch is suitable for optimal implant placement and restoration. Implant prosthetic horizontal cantilever can be minimized and cross-bite occlusion can be prevented.[1] However, in patients with a maxillary fully edentulous ridge and Class III jaw relationship, it is difficult to establish a clinical outcome with adequate esthetics and function by using implant-supported fixed dental prostheses (FDPs). When the horizontal discrepancy of the ridge relationship is too large, a Class I ridge relationship is unachievable with bone graft reconstruction alone.[2] Rather, an interdisciplinary treatment approach combining maxillary orthognathic surgery (i.e., Le Fort I osteotomy) for maxilla

Fig. 1: Patient with Class III jaw relationship with concave lateral profile and obtuse nasolabial angle.

advancement with onlay bone grafting and implant therapy should be applied in such cases in order to achieve an ideal clinical outcome.

To improve the esthetic outcome of implant-supported FDPs, all-ceramic materials have become popular. However, although these materials are superior to metals in terms of their biocompatibility, esthetics, and lower thermal conductivity, their load bearing capacity is relatively low. As such, higher failure rates have been reported for ceramic partial FDPs and posterior single crowns compared with traditional metal ceramic prostheses.[3,4] The most frequent reason for the failure of FDPs made out of glass-ceramics or glass-infiltrated ceramics has been reported to be fracture of the reconstruction (i.e., the framework and veneering ceramic)[4].

Compared to glass-ceramics, Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) ceramics have excellent mechanical properties because of the stress-induced phase transformation[5]. According to previous clinical studies, zirconia framework fracture was found in 0%~2.2% of zirconia FDPs[6] after 3~5 years of clinical service. However, the complication rate of veneering porcelain chipping was 15.2%~32% in zirconia-based FDPs[6-8], which was much higher than the chipping rate of metal-ceramic FDPs (5%~19.4%)[6,9]. There are, however, some solutions for decreasing the rate of ceramic chipping. These methods include the use of CAD/CAM-fabricated high-strength anatomically shaped veneering caps sintered onto zirconia coping[10,11], slow cooling and heating regimens when firing porcelain to zirconia[12], and monolithic zirconia restorations without the application of veneering porcelain[13]. However, reduced light transmission may compromise the esthetic outcome of FDPs made from monolithic zirconia. Therefore, zirconia-based FDPs with modified monolithic designs were introduced.[14] The occlusal surfaces of these FDPs are made from zirconia, with veneering porcelain being applied on the facial surfaces only. This framework design can improve esthetics and reduce veneering porcelain fracture.

This case report introduces the method of maxillary orthognathic surgery (i.e., Le Fort I osteotomy) for maxilla advancement, followed by iliac onlay bone grafting and computer-aided implant placement, to reconstruct a patient with a Class III jaw relationship. A modified monolithic zirconia design was adopted for the fabrication of definitive prostheses in order to improve their esthetics and reduce mechanical complications.

Clinical report

A 50-year-old female patient came to the Department of Prosthodontics at Chi Mei Medical Center with the chief complaints of severe mobility of her upper anterior FDP and impaired chewing function. Extra-oral examination revealed a Class III jaw relationship with a concave lateral profile (Fig. 1). The patient's lip support was insufficient and the

Fig. 2: initial photographs illustrates the maxillary teeth were in a retrognathic position related to mandible and with an anterior crossbite occlusion.

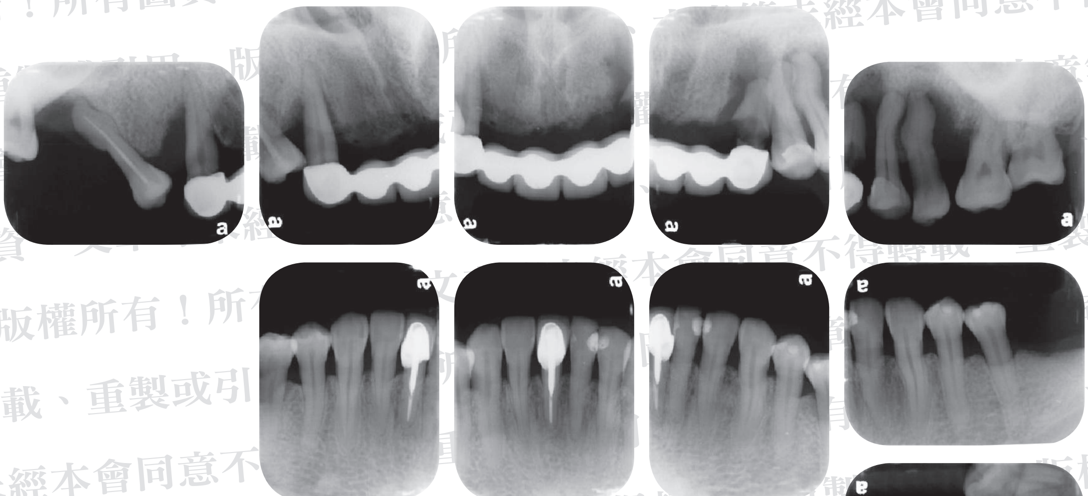


Fig. 3: Pretreatment periapical radiographs revealed severe periodontal destruction of maxillary teeth 13, 15, 23, 24, 25, 26.

Fig. 4: Clinical examination 4 months after tooth extraction. Maxilla was in a retrognathic position related to mandible.

nasolabial angle was obtuse. Intra-oral examination showed an ill-fitted long span metal-ceramic FDP with an anterior crossbite occlusion (Fig. 2). The periapical radiographs revealed severe periodontal destruction of teeth 13, 15, 23, 24, 25, and 26 (Fig. 3). Treatment began with the extraction of all the patient's maxillary teeth except the third molar. The interim denture was delivered immediately after this tooth extraction. Insufficient bone volume was noted 4 months after the extraction of the maxillary teeth. The maxilla was in a retrognathic position related to the mandible (Fig. 4) and a lateral cephalometric radiograph and cast analysis revealed a skeletal Class III jaw relationship (Fig. 5).

After comprehensive clinical and radiographic examinations, the following potential treatment plans for the maxilla were developed and explained to the patient: (1) an implant-

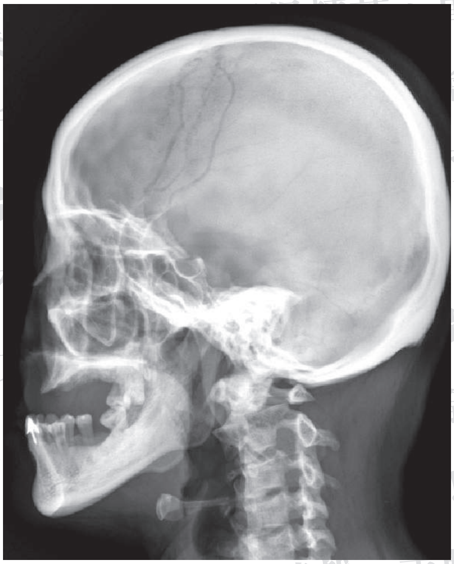

Fig. 5: Lateral cephalometric radiograph revealed skeletal Class III jaw relationship.

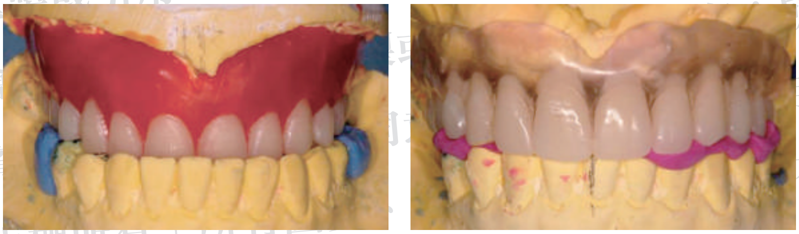

Fig. 6: Surgical stent fabrication and model surgery for orthognathic surgery.

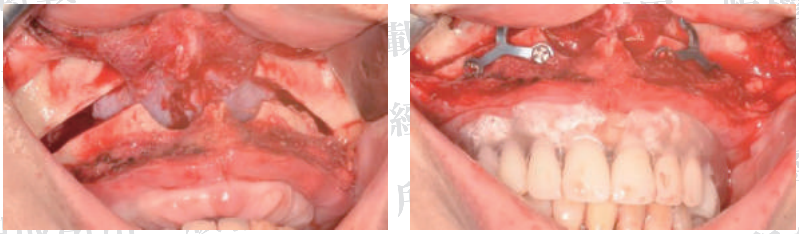

Fig. 7: Maxillary orthognathic surgery (Le-Fort I osteotomy) with the aid of surgical stent.

supported overdenture, (2) implant-supported FDPs with crossbite occlusion, (3) guided bone regeneration with iliac bone block to correct the large horizontal discrepancy and implant-supported FDPs with normal overbite and overjet, and (4) orthognathic surgical correction combined with iliac bone grafting and implant-supported FDPs with normal overbite and overjet. Because the patient did not want to wear a removable prosthesis, she decided to receive implant therapy with implant-supported FDPs. An interocclusal centric relation record was taken with a maxillary occlusion rim, and 2 different kinds of diagnostic wax patterns were established with crossbite and positive overjet occlusions, respectively. Two radiographic stents were fabricated based on the diagnostic wax patterns and then tried out clinically. Because the patient's lip support was insufficient and the nasolabial angle was obtuse with the stent with anterior crossbite, it was expected that it could be difficult to achieve an esthetic outcome with an occlusal scheme with anterior crossbite. In addition, there was no anterior guidance to help disocclude the posterior teeth during eccentric movement.

A computed tomography (CT) scan was taken with the stent with normal overbite and overjet. The CT image of the normal overbite and overjet showed a large horizontal discrepancy and revealed that a large quantity of bone graft was needed for a normal occlusal scheme. If, on the other hand, a normal occlusal scheme was planned without orthognathic surgery, the horizontal discrepancy would be too large, and the outcome of any guided bone regeneration might be unpredictable. The CT images also showed a narrow maxillary anterior alveolar ridge (about 4 mm) and insufficient bone width for adequate primary implant stability.

Based on the above-mentioned conditions, it was concluded that a maxillary orthognathic surgery (i.e., Le Fort I osteotomy) combined with iliac bone grafting should be conducted for implant site development and to achieve a Class I jaw relationship with adequate overbite and overjet. Guided bone regeneration with iliac bone block would then still be needed after the orthognathic surgery because of the insufficient bone width. However, the amount of guided bone regeneration required could largely be decreased with the aid of maxilla advancement. The centric relation record was registered with a maxillary occlusion rim, and a new surgical stent was made based on the position of the maxillary alveolar ridge and the CT image. In addition, the surgical stent was made in the new maxillary position. Moreover, a model surgery was performed to simulate the utilization of the Le Fort I osteotomy to advance the maxilla anteriorly, and the surgical stent was positioned with normal overbite and overjet in the new maxillary position. (Fig. 6)

During the maxillary orthognathic surgery, the Le Fort I osteotomy was performed for maxillary advancement with the aid of the surgical stent (Fig. 7). Thereafter, the maxilla was secured with internal rigid fixation by using

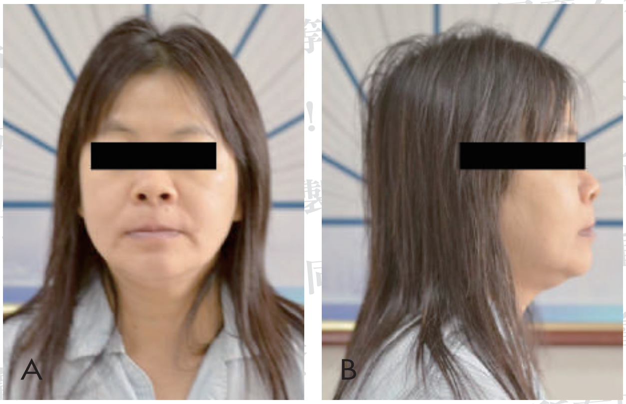

Fig. 8: Facial profile after orthognathic surgery (Post OgS 6 months).
Class I jaw relationship with apropriate nasolabial angle was achieved.

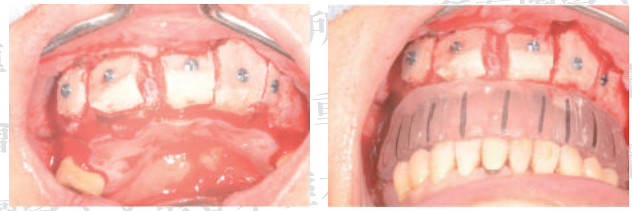

Fig. 9: Ridge augmentation with iliac onlay bone graft was performed due to insufficient bone volume for implant placement.

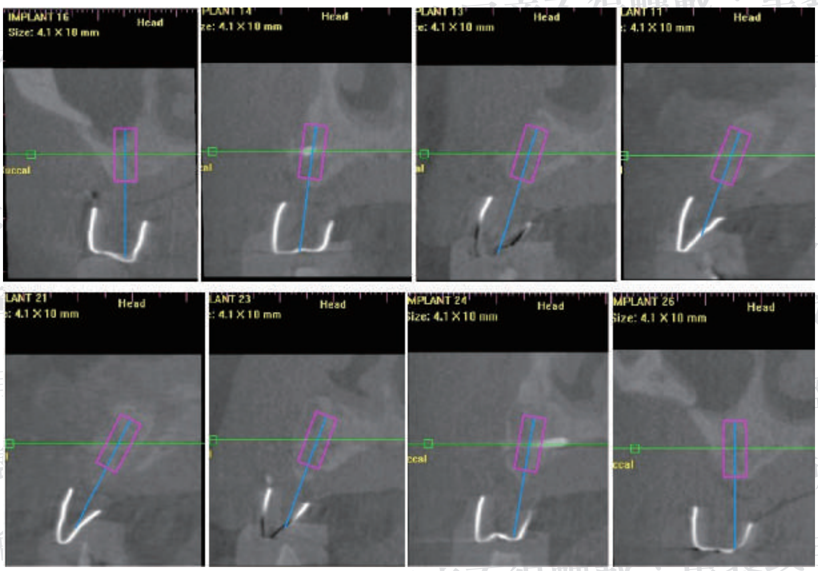

Fig. 10: Implant planning in computer software.

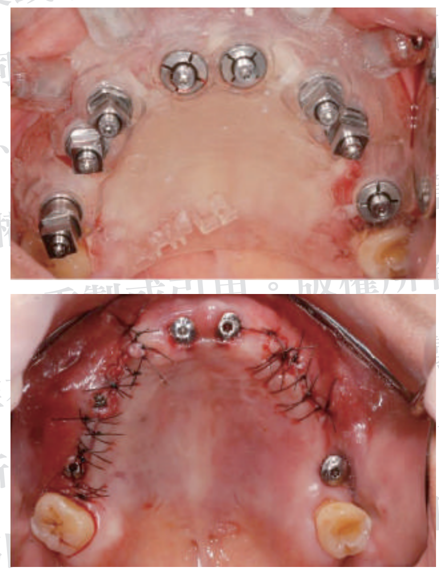

Fig. 11: Computer-guided implant surgery.

titanium miniplates and screws. After wound healing, a second interim denture was delivered for the patient. A Class I jaw relationship with a better nasolabial angle was achieved after the orthognathic surgery (Fig. 8). Ridge augmentation via the use of iliac onlay bone grafting was then performed 6 months after the orthognathic surgery due to the insufficient bone volume for implant placement (Fig. 9).

5 months after the iliac bone grafting, a radiographic stent was fabricated based on the diagnostic wax patterns and then tried out clinically at an evaluation appointment, and a double CT scan was performed. The data from the CT scan were reformatted, and a 3-D implant planning software program (Nobel Guide; Nobel Biocare USA, Yorba Linda, Calif)15 was used to plan the ideal implant locations virtually. The CT images showed adequate bone width and height for implant placement (Fig. 10). Subsequently, the virtual implant planning was sent via email to a rapid prototyping manufacturing facility (Procera; Nobel Biocare USA) for fabrication of the maxillary stereolithographic surgical template. After receipt of the stereolithographic template and associated laboratory prosthodontic procedures, the maxillary CAD/CAM-guided flapless implant surgery was scheduled and performed with strict adherence to the surgical protocol. Eight implants (Branemark System MKIII or NobelSpeedy™ Groovy, Nobel Biocare) were placed in the maxilla with the aid of the computer-guided surgical stent (Fig. 11).

Fig12: Complete-arch implant-supported provisional restoration was inserted clinically.

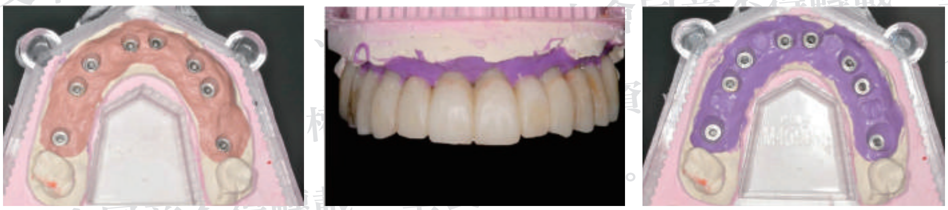

Fig. 13: Provisional prosthesis was utilized to make definitive cast with accurate soft tissue profile.

Fig. 14: Accurate interocclusal registration was recorded by using provisional prosthesis.

After 3 months of osseointegration, a complete-arch impression was made with polyvinyl siloxane (Aquasil Ultra XLV and Aquasil Soft Putty; Dentsply Caulk, Milford, Del) using an open tray technique. An interocclusal centric relation record (Futar D; Kettenbach GmbH & Co KG, Eschenburg, Germany) was taken with an occlusion rim to fabricate the provisional prosthesis, and a complete-arch implant-supported provisional restoration was inserted clinically (Fig. 12). A periapical radiograph showed an accurate marginal fit for the provisional FDPs. Two implants (NobelReplace™ Conical Connection) were inserted into the edentulous sites of the 36 and 46 positions. No technical complications, such as screw loosening or prosthetic fractures, were noted during the follow-up period.

Provisional prosthesis was utilized to transfer the emergence profile with polyvinyl siloxane (Panasil, light body, Kettenbach Dental, Eschenburg, Germany) and to transform the original model used for the fabrication of the provisional FDPs to the definitive model (Fig. 13). The provisional prostheses were also utilized to take the interocclusal record instead of the maxillary occlusion rim (Fig. 14). Subsequently, the maxillary and mandibular definitive models along with the provisional prosthesis were mounted in a semiadjustable articulator to obtain an accurate maxillomandibular relationship (Hanau Modular Articulator System 190; Whip Mix Corp, Louisville, Ky). The maxillary definitive implant-supported FDPs were designed with a segmented modified monolithic zirconia framework. The framework was milled from partially sintered zirconia blocks (Ceramil zi; Amann Girrbach AG) and fully sintered at a temperature of 1450°C and was then evaluated intraorally. The accuracy of the marginal fit was confirmed clinically and with periapical radiographs. The facial surfaces of the zirconia framework were veneered with feldspathic porcelain (Vita VM9; Vita Zahnfabrik, Bad Sackingen, Germany) to complete the modified monolithic zirconia FDPs. Red articulating paper (AccuFilm II; Parkell Inc, Edgewood, NY) and shimstock foil (GMH; Hanel Medizinal, Nurtingen, Germany) were used for occlusal assessment, and minor occlusal adjustments was performed with a zirconia polishing kit (Ceramil polish - lab kit; Amann Girrbach AG). The eccentric occlusal scheme of bilateral group function was thus established.

The implant-supported zirconia-based FDPs with modified monolithic design were then inserted and a radiographic examination confirmed their accurate marginal adaptation. The screw-retained FDPs were tightened with 35 Ncm torque, and the screw-access channels were sealed with gutta percha (Temporary

Fig. 15: Intraoral photographs after insertion of modified monolithic zirconia implant-supported FDPs.

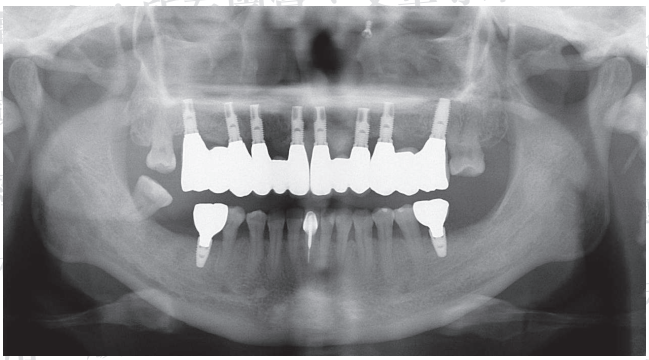

Fig. 16: Panoramic radiograph after insertion of definitive FDPs.

Fig. 17: Facial profile after delivery of definitive FDPs. Adequate lip support and favorable facial profile was achieved.

stopping; GC) and light-polymerized composite resin (Filtek Z250; 3M ESPE). After delivery of the definitive FDPs, the patient, who had originally had a skeletal Class III jaw relationship, had adequate lip support and a favorable profile (Figs. 15-17). No biological or technical complication was found during the subsequent 18-month follow-up period (Figs. 18 and 19).

Discussion

In cases with atrophic maxilla and a Class III jaw relationship, as the extent of resorption increases, the vertical and horizontal deficiencies become more pronounced. For this reason, not only the available bone volume but also the three-dimensional interarch relationship should be evaluated when implant therapy is considered for the atrophic maxilla.[16]

Implant treatments for patients in this situation include the following options: (1) an implant overdenture, (2) implant-supported FDPs with crossbite occlusion, and (3) surgical correction to achieve a Class I jaw relationship

Fig. 18: Clinical examinations 18 months after definitive prostheses insertion.

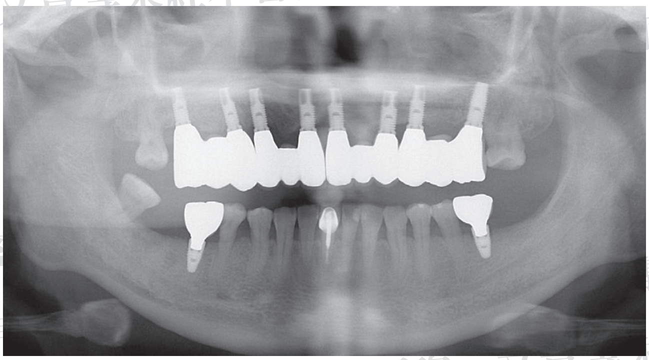

Fig. 19: Panoramic examination 18 months after definitive prostheses insertion

in conjunction with implant-supported FDPs with adequate overbite and overjet. Because the patient in this case did not want to wear a removable prosthesis, the implant overdenture option was excluded. Although implant-supported FDPs with crossbite occlusion can restore occlusion, some problems may arise in terms of anterior crossbite. Also, acceptable esthetic outcomes may be difficult to achieve if the retrognathism of the maxilla is severe. No anterior guidance to help disocclude posterior teeth upon anterior movement.[17] A buccal cantilever would be presented if normal overbite and overjet is required. The presence of a large cantilever with implant prostheses can generate overloading, possibly resulting in peri-implant bone loss and prosthetic failure.[18,19] Therefore, surgical correction to achieve a Class I jaw relationship and implant-supported FDPs with adequate overbite and overjet may be appropriate for this kind of patient. Maxillary orthognathic surgery (i.e., Le Fort I osteotomy) for maxilla advancement combined with onlay bone grafting can be used to improve the ridge relation and increase the bone quantity. In this case, an interdisciplinary treatment approach combining maxillary orthognathic surgery (i.e., Le Fort I osteotomy) for maxilla advancement with subsequent iliac onlay bone grafting and reconstruction with modified monolithic zirconia implant-supported FDPs was used to treat the patient exhibiting skeletal class III malocclusion. As a result, the following outcomes were achieved: adequate lip support, a favorable profile, a Class I jaw relationship, and appropriate anterior guidance.

With conventional surgery, the information from the CT image is not directly transferred to the actual implant surgery.[20] A computer-guided implant surgery, in contrast, uses CT scans to aid in the planning of the surgery and to produce surgical drilling guides. This kind of surgical template allows for the placement of the implants only at well-defined points, because the drills are guided precisely by corresponding sleeves.[21] This method is therefore more precise than the conventional approach and can decrease the rate of complications such as nerve damage, sinus perforation, and dehiscence.[20] Because the prosthetics used in this case consisted of segmental FDPs, the accuracy of the implant locations was more critical than it would be for other treatment options such as an implant overdenture, hybrid denture, or complete-arch implant-supported FDPs. Therefore, computer-guided implant surgery was conducted in this case.

Veneering porcelain chipping rates for zirconia-based tooth-supported FDPs have been reported to range from 15.2% to 32%.[6-8] In the present clinical report, the framework was designed with monolithic zirconia occlusal surfaces to minimize the possibility of the veneering porcelain being chipped, and the veneering porcelain was applied only on the facial surfaces to improve the esthetic outcome.[12] Stress-generated surface treatments of zirconia such as occlusal adjustment will trigger the tetragonal and monoclinic phase transformation, which may compromise the mechanical properties of the zirconia. A screw-retained provisional prosthesis instead of an occlusion rim was thus used to obtain an accurate interarch relationship in this case in order to minimize the possible occlusal errors and decrease the amount of occlusal adjustment required.[22]

There are several methods for replicating the healed tissue morphology around an implant. One method consists of connecting customized impression copings fabricated by autopolymerizing acrylic resin (Pattern Resin; GC America, Inc, Alsip, IL) to an implant intraorally in order to make a definitive impression.[23] The present case, however, involved the use of multiple segmental implant-supported FDPs, such that it would have been overly time-consuming to use the customized impression coping method. Therefore, provisional prostheses were utilized to transfer the soft tissue morphology and emergence profile.[24] Such provisional prostheses can also be utilized for mounting a definitive cast at the same appointment, thus decreasing appointment times and simplifying the treatment.

Recent systematic reviews have shown that biological and technical complications of complete-arch implant-supported FDPs occur frequently.[25] Therefore, a segmented prosthetic design with multiple short-span FDPs may be recommended for complete-arch implant rehabilitation because of their greater hygiene, greater ease of fabrication, and easier prosthetic maintenance. For the present clinical report, a segmented prosthetic design was adopted accordingly.

The treatment strategy involving orthognathic surgery described in this case could be an alternative to prosthetic rehabilitation for patients with a Class III jaw relationship. Although this approach may require more extensive surgery initially, the resulting prognosis may be more promising in the long-term. However, longitudinal follow-ups and evaluations are still necessary to ensure a predictable outcome.

Conclusion

In order to achieve an ideal clinical outcome by using implant-supported FDPs to reconstruct a patient with a skeletal Class III jaw relationship, an interdisciplinary treatment combining orthognathic surgery with iliac bone grafting should be considered to achieve sufficient bone volume and an adequate three-dimensional interarch relationship.

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