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Full-Mouth Rehabilitation of a Patient with Severely Worn Dentition and Uneven Occlusal Plane: A Clinical Report

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Abstract

Severe tooth wear is frequently multifactorial and variable. Successful management is a subject of interest in dentistry. A critical aspect is to determine the occlusal vertical dimension (OVD) and a systematic approach that can lead to a predictable and favorable treatment prognosis. Management of patients with worn dentition is complex and difficult. Accurate clinical and radiographic examinations, a diagnostic wax-up, and determining OVD are crucial. Using mini-implants as orthodontic anchorage may facilitate orthodontic movement of teeth to improve their position, which is necessary for favorable prosthetic treatment. A 46-year-old man was referred for restoration of his worn and missing teeth. After diagnostic work-up, provisional removable prostheses were fabricated for both jaws, evaluated clinically, and adjusted according to esthetic, phonetic, and vertical dimension criteria. Clinical crown lengthening and free gingival graft procedures were performed in appropriate areas. Drifting of the left posterior mandibular teeth was corrected using mini-implants as orthodontic anchorage. Two conventional implants were inserted in the right mandibular edentulous area. After endodontic therapy of worn teeth, custom-cast gold dowels and cores were fabricated, and provisional removable prostheses were replaced with fixed provisional restorations. Metal-ceramic restorations were fabricated, and a removable partial denture with attachments was fabricated for maxillary edentulous areas. An occlusal splint was used to protect the restorations. Full-mouth rehabilitation of the patient with severely worn dentition and an uneven occlusal plane was found to be successful after 3 years of follow-up. This result can encourage clinicians to seek accurate diagnosis and treatment planning to treat such patients.

Tooth wear is an increasingly important clinical problem in aging populations.[1,2] Many factors may combine to result in a worn dentition, and often the etiology of the wear remains unidentified. There is growing consensus that tooth wear observed in any individual may be the result of a combination of all the possible etiological factors over the lifetime of the dentition.[3] Tooth surface loss has been classified as erosion (dissolution of hard tissue by acidic substances), attrition (wear through tooth-tooth contact), abrasion (wear produced by interaction between teeth and other materials), and abfraction.[4-8] Abfraction has also been described as wedge-shaped defects,[9] noncarious cervical lesions,[10-13] and stress-induced cervical lesions.[14-15]

The management of tooth wear, especially attrition, is becoming a subject of increasing interest in the prosthodontic literature, both from a preventive and a restorative point of view.[16] Loss of occlusal vertical dimension (OVD) caused by physiologic tooth wear is usually compensated by continuous tooth eruption and alveolar growth.[17] In situations where tooth wear exceeds compensatory mechanisms, loss of OVD occurs; however, more commonly, the rate of tooth wear is slow, and compensatory eruption of the opposing teeth eliminates space for restoration.[18,19]

Management of patients with worn and missing teeth using fixed or removable prostheses is complex and difficult. Careful and comprehensive treatment planning is required for each individual case, and an assessment of the vertical dimension at rest and in occlusion is essential. Articulated study casts, together with a diagnostic wax-up, provide the necessary information required to evaluate the treatment options, and tolerance of changes to the OVD is usually confirmed with a diagnostic splint or prosthesis.[20,21]

Figure 1 Frontal view of the dentition before treatment.

Figure 2 Right lateral view of the dentition before treatment.

Figure 3 Left lateral view of the dentition before treatment.

Figure 5 Maxillary occlusal view before treatment.

Figure 6 Mandibular occlusal view before treatment.

Figure 8 Mini-implants used as orthodontic anchorage; the load was applied on the second mandibular premolar using a customized wire.

Figure 9 Mini-implants used as orthodontic anchorage; the load was applied on the second mandibular left molar using a coil spring.

The inclusion of implants as anchor units dramatically alters the balance between anchorage and active segments and can be managed in ways that offer significant advantages to the practitioner. Implants have proven to be reliable and effective sources of orthodontic anchorage, so much so that a new category of anchorage has arisen.[22] One treatment option that employs implants in anchorage is defined as "indirect anchorage," the enhanced anchorage using an implant to stabilize dental units, which in turn serve as the anchor units. This employs an implant in a location other than a dental one, such as the retromolar region or mid-palatal area joined to a tooth or teeth by virtue of a rigid connector. This article presents an approach to rehabilitating a worn dentition with metal ceramic restorations (MCR), a removable partial denture (RPD), and use of implants for anchorage and regaining the space for dental implants in addition to the restoration.

Clinical report

A 46-year-old man was referred to the Department of Prosthodontics, Faculty of Dentistry, Tehran University of Medical Sciences, Iran, for prosthetic restoration of his worn anterior teeth, as well as replacement of missing teeth. The patient was in good general health, and the medical and dental history indicated no contraindications for dental treatment. Clinical and radiographic examinations revealed severe tooth surface loss on the maxillary anterior teeth and to some degree on the mandibular anterior teeth. Other teeth had drifted into edentulous areas. Inappropriate spacing between the teeth, a remaining root of maxillary right first premolar, and an uneven occlusal plane were observed (Figs 1–6). No signs and symptoms were found in the temporomandibular joints, and the patient reported no parafunctional habits. A periodontal examination revealed that the attached gingiva around the mandibular left second molar was inadequate, no mobility was noted, and the furcation was involved in the right maxillary first molar (Fig 7).

Diagnostic procedures

The differential diagnosis included mechanical attrition of anterior teeth, possibly resulting from inadequate posterior occlusion. The patient had acceptable oral hygiene. The vertical dimension was assessed clinically. Physiologic rest position was determined by facial measurements and confirmed by phonetics.[23,24] The interocclusal distance was judged to be approximately 4 mm, and the OVD could be restored by increasing it approximately 1 mm. In addition, the wear resulted in protrusive deviation of the mandible. By guiding the mandible into centric relation, there was some space in the anterior region for rehabilitation.[25] Prior to definitive treatment, diagnostic casts (Moldano, Bayer, Leverkusen, Germany) were obtained from primary impressions (Alginate, Tropicalgin, Zhermack, Rovigo, Italy).

The bite registration procedure was accomplished using an acrylic anterior programming device (Duralay, Reliance Dental Mfg Co., Worth, IL) in the anterior region and baseplate wax (Cavex Setup Regular Modelling Wax, Cavex Holland BV, Haarlem, The Netherlands) supported by the acrylic baseplate (Acropars 200, Marlic, Tehran, Iran) in the posterior region when the mandible was guided into centric relation (CR) by bimanual manipulation technique. To confirm the record, a small amount of zinc oxide eugenol paste (Luralite, Kerr Corp., Orange, CA) was placed on the wax over each indented area, and the mandible was held in CR until the paste set. Using this record and an arbitrary facebow (Dentatus Face Bow; Dentatus AB, Stockholm, Sweden), the casts were mounted on a semiadjustable articulator (Dentatus ARH-Type; Dentatus AB). The incisal pin was adjusted for a 1 mm opening. After a primary wax-up, the interim prostheses were fabricated at this new OVD. The patient used these prostheses for 3 months to check the proposed vertical dimension. After 3 months the patient was satisfied with this new OVD without any signs and/or symptoms.

The hinge axis was determined using a pantograph (Denar, Denar Corp., Anaheim, CA), and a second series of diagnostic casts obtained from impressions (Alginate, Tropicalgin) was mounted in a fully adjustable articulator (Denar D5A Series; Waterpik Technologies, Ft. Collins, CO) using an interocclusal registration in CR when the mandible was guided into CR using the bimanual manipulation technique as mentioned before.

The condylar guidance of the articulator was set using the tracing. The curves of Spee and Wilson as well as the orientation of the occlusal plane were determined using a Broadrick occlusal plane analyzer. A diagnostic waxing of this plane revealed that the left mandibular third molar was above the ideal plane, and the spaces for replacement of the left first molar and the right first premolar in the mandible were insufficient. In addition, the width-to-length ratio in the maxillary incisors was 3:2 instead of the ideal 4:5. It was determined that this ratio was inappropriate esthetically.[26]

The patient was categorized as class IV according to the classification system for partial edentulism developed by the American College of Prosthodontists.[27] Therefore, a treatment plan was developed with the aim of improving occlusion, restoring masticatory function, and improving the patient's appearance. During the following visit, treatment options were discussed with the patient, including root canal therapy (RCT) of the right maxillary second premolar and the right first molar, extraction of the right maxillary first premolar, periodontal therapy (including treating the furcation involvement of the first maxillary molar and performing a free gingival graft in the left mandibular second molar), crown lengthening of maxillary incisors for better esthetic results, orthodontic therapy to regain space, implant placement in suitable areas, and prosthetic treatment (MCR and RPD). Because of pneumatization of the left maxillary sinus, sinus lifting surgery was needed in this area for fixed prosthetic rehabilitation, but the patient did not accept this surgery, and construction of an RPD was planned. The patient accepted the treatment plan.

Preprosthetic procedures

After RCT and periodontal therapy, the orthodontic treatment plan was scheduled. The space analysis for the right mandibular first premolar and the left mandibular first molar was completed; 5 and 4 mm were required in the right and left, respectively. Three 12 mm long and 2 mm wide mini-implants (Jelenko Co., Armonk, NY) were placed between the right mandibular

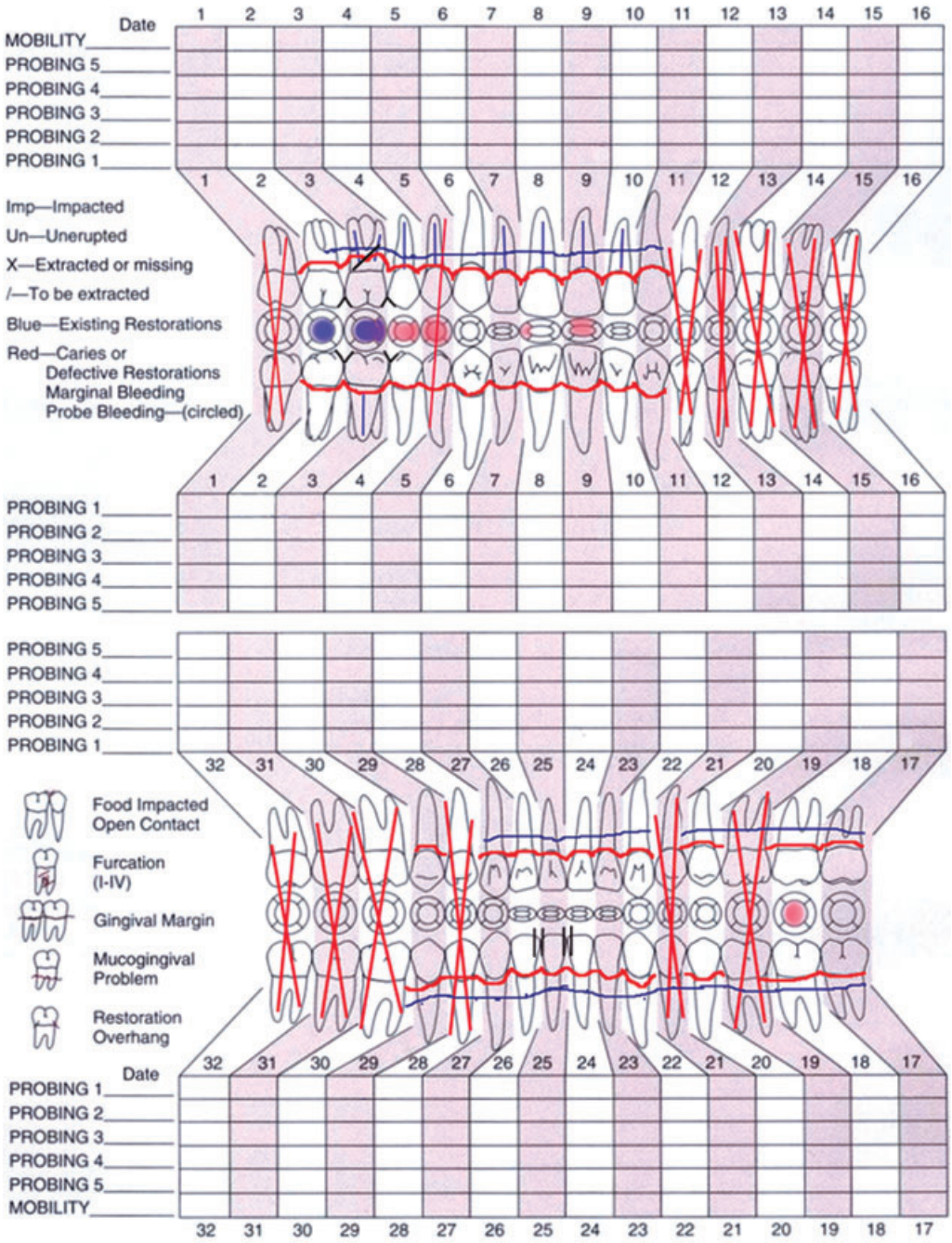

Figure 7 Perio chart before treatment.

canine and second premolar, distal to the left mandibular second premolar and distobuccal to the left mandibular second molar simultaneous with third molar extraction. During surgery, a 0.009″ ligature wire was extended out of the retromolar area for force application. After 2 weeks, loads were applied by coil spring and then an elastic chain on the second molar and a customized wire on the second mandibular right premolar (Figs 8 and 9).

Dental implant placement

Using the panoramic film and by considering the amount of distal bodily movement of the second mandibular right premolar, the position of the right mandibular implants was estimated, and a radiographic stent was fabricated with drill holes coated with barium sulfate (Barium Sulfate, Daroupakhsh Co., Tehran, Iran); cone-beam CT scan (Picasso Trio, E-WOO Technology,

Gyeonggi-Do, South Korea) was used for meticulous evaluation of dental implant position to restore the right mandibular molars. After determining that no correction was needed, implant placement surgery was scheduled. This stent was used during implant surgery, and two implants were placed in the right mandibular segment to replace the mandibular right first and second molars (ITI Implants, 4.1 mm diameter, 10 mm long, Straumann AG, Waldenburg, Switzerland).

Endodontic and periodontal procedures and restoration of teeth

During the healing phase after implant placement, mandibular incisors were prepared using the diagnostic wax-up index, and it was determined that the right and left mandibular central incisors and the left lateral incisor required endodontic therapy because of pulp exposure during tooth preparation according to the putty index obtained from the wax-up. After completion of RCT, custom-cast gold dowels and cores (Degubond 4; DeguDent, Hanau, Germany) were fabricated for the right and left mandibular central incisors and the left lateral incisor. Tooth preparation with a circumferential shoulder-bevel margin configuration was performed on the mandibular anterior teeth. Interim prostheses were fabricated and cemented with noneugenol zinc oxide cement (TempBond NE; Kerr Corp.). Next, maxillary anterior custom-cast gold dowels and cores were fabricated, and tooth preparation was performed.

In this stage, esthetic crown lengthening of the maxillary anterior segment was performed using a vacuum shell guide according to the diagnostic wax-up. After 1 week, the interim prostheses were adjusted according the new margin. During 2 months of gingival healing, the already delivered interim removable prosthesis was relined with resilient lining material (Soft Liner, Kerr Dental, Romulus, MI) to fulfill the functional needs of the patient. The preparation of mandibular posterior teeth with a chamfer margin configuration was then performed.

A period of healing is necessary before applying load to conventional dental implants. This period varies from 4 to 6 months in humans. After 4 months, the dental implants were ready for loading. According to the wax-up index and ideal occlusal plane, the implant abutment heights were determined (two solid abutments, 7 mm height, Straumann AG). The abutments were tightened with a torque wrench to 35 N cm, and interim prostheses were cemented with temporary cement (TempBond NE).

Custom-cast gold dowels and cores were fabricated for the right maxillary posterior teeth, and the preparation was performed with shoulder-bevel margins in the buccal and chamfer margin in the palatal aspects. For the occlusal plane correction, the maxillary second molar was prepared for an onlay restoration, and interim prostheses were cemented (TempBond NE). After completion of the preparations, irreversible hydrocolloid impressions (Alginate, Tropicalgin) for interim prostheses were made and mounted on the articulator with the facebow record index and interocclusal registration. The wax-up for interim prostheses was performed.

New laboratory-processed interim prostheses (Tempron, GC Corp., Tokyo, Japan) and interim removable prostheses were fabricated by the laboratory and delivered. The canine-protected articulation was established bilaterally (Figs 10 and 11). After adjusting and cementing these interim prostheses, hydrocolloid impressions of the restorations were made, the stone casts were mounted on the articulator, and the anterior guide table was customized (Duralay) (Fig 12).

Final replacement of missing teeth

The orthodontic treatment took 2 months to complete. The retention period for orthodontic therapy was completed in 3 months. Then, preparation of the teeth was completed. The mini-implants were removed simply by unscrewing in the opposite direction. The final impressions were made with light body silicone impression material (Speedex, Coltene AG, Altstatten, Switzerland) in a custom acrylic tray (Acropars 200), and the casts were mounted on the articulator using interocclusal registrations, which recorded CR by guiding the mandible using bimanual manipulation using an anterior programming device and record bases with wax occlusion rims in the posterior.

A full contour wax-up was accomplished for the MCRs. A nonrigid connector (Interlock type cylindrical, Bredent, Seden, Witzighausen, Germany) was inserted in the distal of the pier abutment (the left mandibular second premolar). The rest seats were carved on the cingulums of both canines, the mesial occlusal of the maxillary premolar, and the distal occlusal of the right maxillary molar; in addition, guide planes were created using a surveyor. For esthetic reasons, two extracoronal castable attachments (Rhein 83, Bologna, Italy) were placed on the distal side of both maxillary canines using a surveyor to eliminate the need for clasp arms in the labial aspect. Then cut-back was performed according to the index, and the precious metal frameworks (Degudent U, Degudent GmbH) were fabricated.

The frameworks were evaluated radiographically and intraorally for fit, occlusion, retention, and stability (Fig 13). Porcelain (Ceramco, Dentsply Ceramco, Burlington, NJ) was applied to complete the crowns. The lingual contours of the maxillary incisors were adjusted according to the anterior guide table. The MCRS were provisionally cemented using temporary cement, and the onlay was bonded using an adhesive luting agent (Panavia F 2.0, Kurary, Osaka, Japan) (Fig 14).

To begin the RPD phase of treatment, an impression of the maxilla (Wash, Speedex) was made in a custom acrylic tray (Acropars 200) after border molding (Impression Compound, Richter & Hoffmann, Harvard Dental Gmbh, Berlin, Germany). The framework was cast from Ni-Cr material (Verabond II, Aalba Dent, Cordelia, CA), and the fit was checked intraorally. The keyways of the attachments (pink cap, soft retention) were placed in the RPD framework. Then the acrylic heat-processed teeth (SR Orthosit PE, Ivoclar Vivadent, Amherst, NY) were arranged in occlusion, and canine-protected articulation was adjusted. The RPD was completed; occlusal contacts were adjusted, and the RPD delivered to the patient (Figs 15 and 16).

A hard acrylic resin occlusal splint (Acropars) was fabricated for night use to prevent parafunctional occlusal wear. Minor adjustments were required at four postinsertion visits. After 2 months, the temporary cement was changed with polycarboxylate cement (Hoffmann's, Berlin, Germany), and the patient was placed on a 6-month recall. The 3-year evaluation of the esthetics and function of the restorations showed no

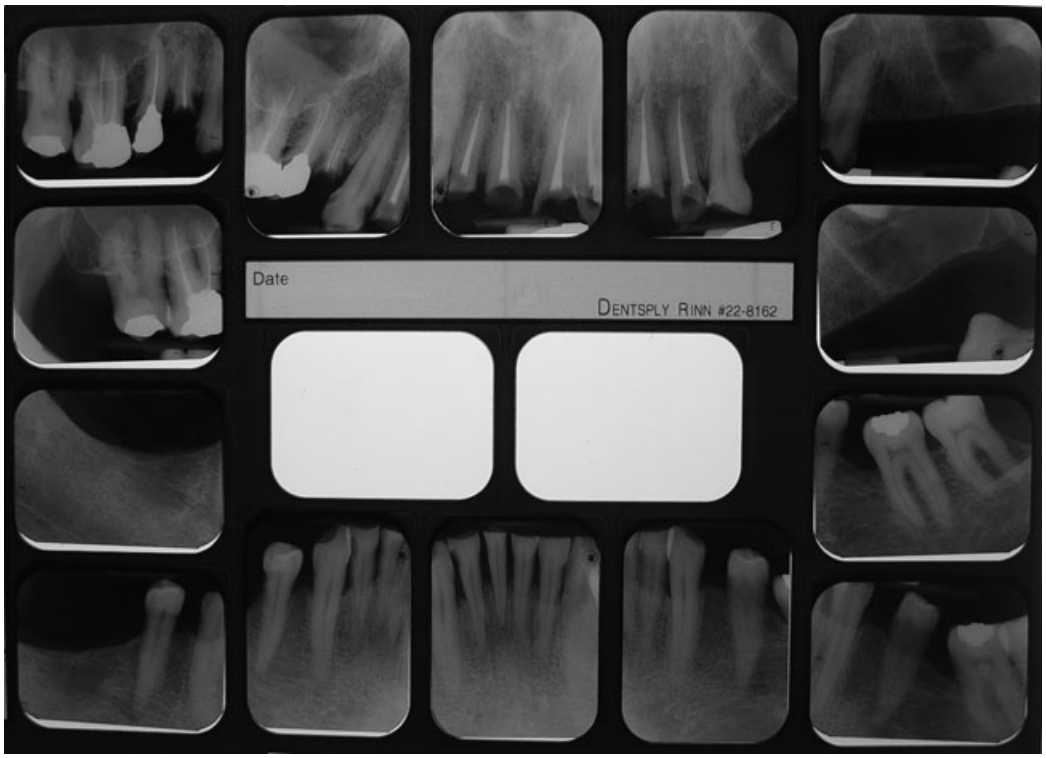

Figure 4 Periapical radiographs before treatment.

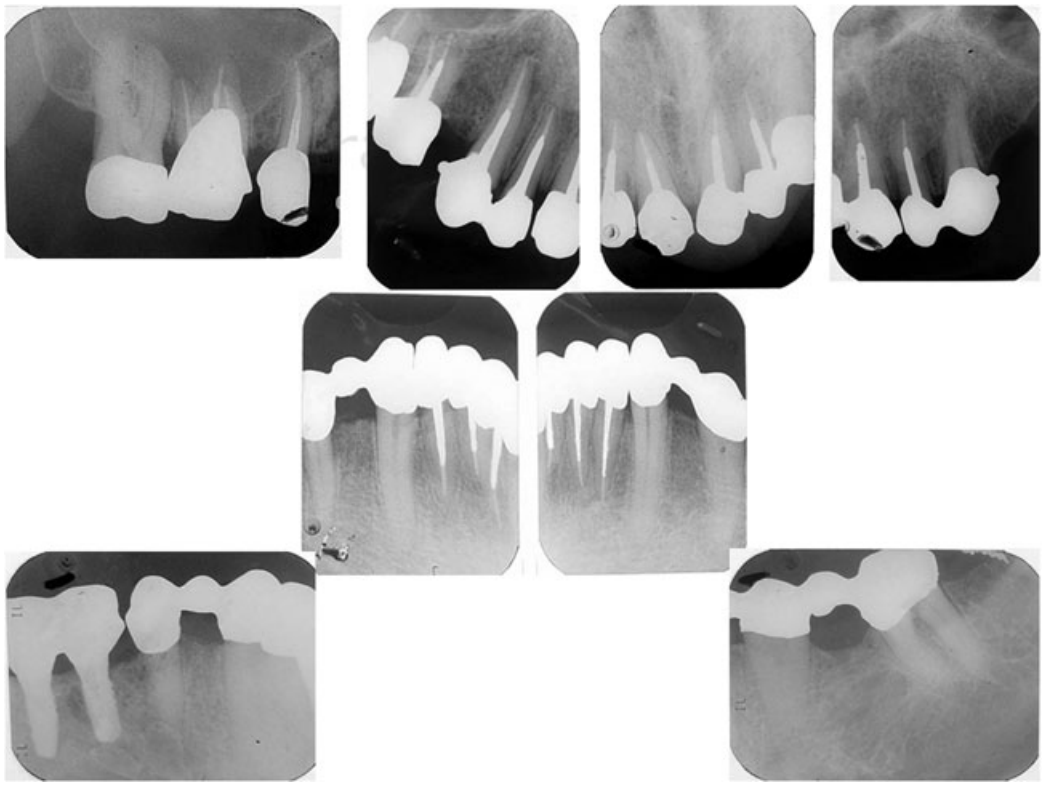

Figure 13 Periapical radiographs of metal frameworks.

Figure 10 Occlusal view of maxillary interim prostheses.

Figure 11 Occlusal view of mandibular interim prostheses.

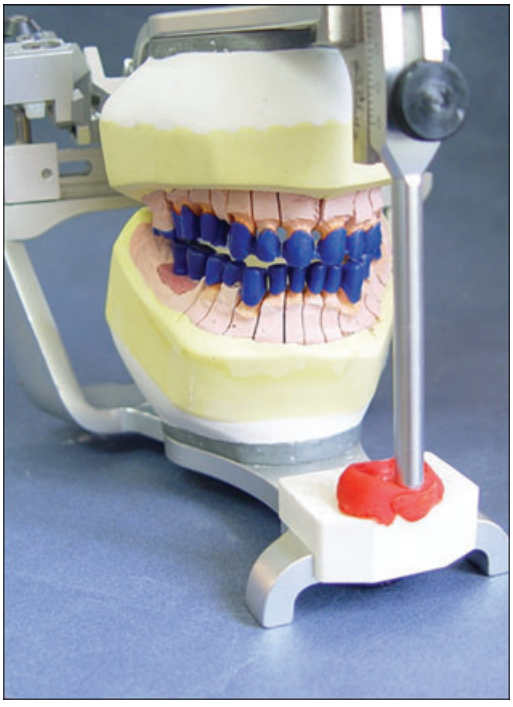

Figure 12 Working casts on the articulator.

Figure 14 Frontal view of the completed treatment with MCRs and RPD.

Figure 15 Occlusal view of the maxillary arch after treatment.

Figure 16 Occlusal view of the mandibular arch after treatment.

evidence of temporomandibular joint problems, fractures in the teeth, or MCRs.

Discussion

Tooth surface loss has been classified[28] into erosion, attrition, abrasion, and abfraction. Tooth wear has a multifactorial

cause[29] and may be generalized throughout the dentition, but is often localized to incisors and canines. Niswonger, cited by Tallgren,[30] found that 80% of severe tooth wear patients have a normal interocclusal rest space. The distribution of wear in the dentition is not even, as is evidenced by the difference between the anterior and posterior teeth. Inadequate or unstable posterior support has been identified as a factor in severe anterior attrition and decreased OVD.[31] Posterior occlusal prematurities, too, may cause increased function on anterior teeth, resulting in increased wear.

Clinical judgment plays a major role in the assessment of this important component in rehabilitation. A variety of techniques, such as phonetics, interocclusal distance, swallowing, and patient preferences, have been proposed to determine measurements for the correct OVD.[32-34]

Interocclusal rest space can be generated by the following methods:

1. Occlusal adjustment if necessary.
2. Reduction of the opposing teeth. Periodontal crown lengthening surgery can increase the clinical crown height, thereby allowing further tooth reduction.
3. Increasing the OVD by restoring the posterior teeth in one or both jaws.
4. Elective endodontic treatment, followed by dowel-retained restorations.
5. Orthodontic movement of teeth to create interocclusal space.[35]

It is important to establish the cause of wear before intervention to help improve the effectiveness of any preventive and restorative care.[29] Standard dental implants as the anchorage for orthodontic treatment have drawbacks such as the difficulty of selecting proper implant sites in most patients, the need to wait for osseointegration before force loading, the invasiveness of the surgical procedure, difficulty of maintaining oral hygiene, and high cost.[36] Also these implants can only be placed in limited sites, such as the retromolar and edentulous areas. Removable osseointegrated titanium mini-implants have been successfully used as anchorage. The Ti-6Al-4V alloy was used instead of commercially pure Ti due to its superior strength.[37] In this case mini-implants were used for anchorage. The mini-implants generally do not move during treatment. At the end of orthodontic treatment, or when the anchorage is no longer needed, the screw is simply removed under local anesthesia, using a screwdriver. The oral mucosa around the surgical site will usually recover within 10 to 14 days.[38] Contrary to other methods, in this method the tooth moves bodily, and it is not necessary to apply interarch stabilization to minimize side effects. Simultaneous molar intrusion can be performed, eliminating the need for occlusal reduction.[39]

In this case the cone-beam CT was used to evaluate the meticulous placement of the implants because of low dose radiation during CT scan; however, CT examinations are expensive and deliver a relatively high radiation dose to the patient. The most recently introduced imaging modality is cone beam volumetric tomography (CBVT), which seems very promising with regard to preimplant imaging. CBVT generally delivers a lower radiation dose to the patient compared to CT and provides reasonably sharp images with 3D information. Recent studies indicate that CBVT images have sufficient accuracy to be used for preimplant assessments.[40,41] It has been demonstrated that the error in measurements obtained from CBVT scans is less than 0.5 mm.[42] The low exposure parameters of CBVT result in poor soft-tissue contrast compared with CT.[43,44] Reports indicate that low-dose CT protocols result in significantly less exposure than previously thought, without compromising image quality significantly.[45]

Conclusion

Management of patients with a worn dentition is complex and difficult. Accurate clinical and radiographic examinations, a diagnostic wax-up, and determining OVD are crucial. Using mini-implants as orthodontic anchorage may facilitate orthodontic movement of teeth to improve their position, which is necessary for favorable prosthetic treatment. Full-mouth rehabilitation of the patient with severely worn dentition and an uneven occlusal plane was found to be successful after 3 years of follow-up. This result can encourage clinicians to seek accurate diagnosis and treatment planning to treat such patients.

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