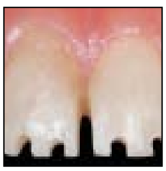
Esthetic Rehabilitation of a Severely Worn Dentition with Minimally Invasive Prosthetic Procedures (MIPP)



Mauro Fradeani, MD, DDS/Giancarlo Barducci, MDT***
*Leonardo Bacherini, DDS***/Myra Brennan, DMD*****

Restorative treatment of the severely worn dentition is typically indicated to replace deficient tooth structure, limit the advancement of tooth destruction, improve oral function, and enhance the appearance of the teeth. Minimizing removal of additional tooth structure while also fulfilling the desire of patients to have highly esthetic restorations can present a prosthetic challenge when the existing tooth structure is already diminished. This article presents a comprehensive minimally invasive prosthetic treatment approach using a lithium disilicate all-ceramic material for the esthetic rehabilitation of a severely worn dentition for a female patient diagnosed with Sjögren syndrome. (Int J Periodontics Restorative Dent 2012;32:135–147.)

*Private Practice, Pesaro, Italy.
**Private Laboratory, Ancona, Italy.
***Private Practice, Firenze, Italy.
****Private Practice, Hingham, Massachusetts, USA.

Correspondence to: Dr Mauro Fradeani, Corso XI Settembre 92, 61121 Pesaro, Italy; fax: +39(0)721 32796; email: info@maurofradeani.it.

It has been suggested that the decision to rehabilitate the severely worn dentition should be guided by the patient's stated and perceived esthetic and functional needs and the severity of wear, as determined by the morphologic changes and the potential for progressive wear.[1] The aims of therapy are to restore the jaw and tooth relationships essential for occlusal harmony,[2] whereby the joint position is located in centric relation and the anterior teeth protect the posterior teeth in eccentric movements and conversely have the posterior teeth protect the anterior teeth in centric occlusion without any deflective occlusal contacts or interferences during function[3]; to reduce tooth sensitivity; and to enhance the overall esthetic appearance of the patient. The prosthetic challenge with restoring severely worn dentitions is to preserve as much of the already diminished tooth structure as possible for retention while also providing enough interocclusal space for the restorative material.

Vertical dimension of occlusion

Clinical procedures to improve the mechanical retention of restorations for severely worn dentitions typically consist of devitalizing the pulp with endodontic therapy, insertion of a post-and-core restoration, and removal of bone and soft tissue with crown-lengthening surgery. Historically, increasing the interocclusal space by altering the vertical dimension of occlusion (VDO) was not a commonly used treatment modality because it was formerly thought that the rest position of the mandible was fixed and not able to be altered.[4,5] Moreover, sometimes it may not be possible to significantly alter the VDO because tooth eruption can occur at the same rate as tooth wear, and the VDO of the patient can remain unchanged. However, if the eruption does not keep pace with tooth wear, the VDO may decrease over time.[6] Regardless, in the presence of a worn dentition with or without signs of altered passive eruption, there is still the need to maintain as much of the remaining tooth structure as possible and attempt to alter the VDO to create space for the restorative material prior to tooth preparation. This would be beneficial to avoid the aggressive reduction of tooth structure and preserve the maximum amount of enamel.

Ceramic system

Though traditional metal-ceramic restorations have predictable strength and reasonable esthetics,[7] all-ceramic crowns have been reported to have better optical properties and a superior gingival response.[8] The desire for improved esthetics has advanced the developments of all-ceramic systems and core materials, such as lithium disilicate, aluminum oxide, and zirconium oxide.[9] A review of the literature on treatment considerations for esthetic restorations reported that longitudinal clinical studies evaluating glass-ceramic crowns have shown similar success rates to conventional metal-ceramic crowns of 94% over 10 years.[10] There is no evidence to support the selection of only one ceramic system or material for all clinical cases. The selection of an appropriate ceramic system, whether metal-ceramic or all-ceramic, depends on several clinical criteria, such as the location and type of the restoration, color of the tooth preparation, the desired color of the restoration, configuration of the remaining tooth structure, design of the marginal finish line, and the luting agent and cementation technique. The minimum amount of tooth structure removed and the tooth preparation design required to achieve optimal physical and optical properties of the restoration also can vary between ceramic systems.[9] The tooth preparation depth for most traditional all-ceramic systems is similar to that for porcelain-fused-to-metal restorations, varying in thickness from 1.2 to 1.5 mm axially and 1.5 to 2.0 mm occlusally.[11] Presently, new all-ceramic systems require a lesser amount of tooth structure to be removed because of the increased strength and improved light transmission properties of the material. This ability to minimize overall crown tooth preparations with the selection of an all-ceramic material promotes the preservation of the enamel tooth structure and dentoenamel junction, which has a significant role in redistributing stress and resisting enamel crack propagation.[12]

Silica-based ceramic system and adhesive bonding

With respect to the various core material ceramic systems available, silica-based glass-ceramics, unlike alumina- and zirconia-based ceramics, can be acid etched to increase the intaglio surface area and surface roughness and improve the mechanical interaction with adhesive resin cements.[13] This results in a stronger resin bond for higher retention, better marginal accuracy to prevent microleakage, and greater fracture resistance of the restoration and tooth.[14] Nevertheless, with bilayered all-ceramic restorations, cohesive fracture within the veneering porcelain and adhesive fracture of the ceramic core material have been the most commonly reported clinical complications.[8]

Lithium disilicate

A monolithic silica-based ceramic material was introduced in 2005 as IPS e.max (Ivoclar Vivadent), formerly IPS Empress 2, with enhanced physical properties and translucency through a different firing process.[15] It can be pressed or milled using computer-aided design/computer-assisted manufacturing, allowing for a traditional occlusal surface reduction of 1.5 mm,[16] which can be reduced to 0.8 mm if additional veneering porcelain is layered over the coping.[17,18] The results of an in vitro study comparing the fracture frequency of monolithic pressed crowns fabricated from leucite glass (IPS Empress) and lithium disilicate (e.max) and luted with glass ionomer or adhesive resin cements reported no fractures or cracks observed for the lithium disilicate crowns.[19]

Posterior occlusion on monolithic lithium disilicate

According to the manufacturer, there are two modalities used to fabricate e.max all-ceramic restorations: full-contour lithium disilicate (monolithic ceramic) with a 1.5-mm-thick occlusal dimension without the need for veneering porcelain and fabrication of a lithium disilicate coping (minimum, 0.8 mm) covered with veneering porcelain (maximum, 0.7 mm).

More research is needed to investigate the potential capabilities of this ceramic material. What is the minimum thickness of lithium disilicate ceramic needed to be in occlusion with respect to fracture resistance? Is it possible to reduce the overall ceramic thickness to a range of 0.8 to 1.0 mm? The manufacturer reports that a 0.8-mm thickness for the core and 0.7-mm thickness for the veneering material are required when using a bilayered modality, or a minimum of 1.5 mm for a monolithic lithium disilicate restoration. However, if the final fracture resistance is related to the use of the lithium disilicate material (approximately 400 MPa), it could be hypothesized that the addition of a veneering layer (approximately 100 MPa) may not significantly increase the fracture resistance of the overall restoration. As such, the use of the monolithic material in occlusion with a full-contour design, even with reduced thickness (0.8 to 1.0 mm), may provide sufficient strength, even in the posterior areas.

Is it possible to leave the lithium disilicate ceramic material in occlusion without causing excessive wear of the antagonist tooth or restoration? The literature shows that the behavior of dental materials is associated with some specific factors and mechanisms that are not yet well identified. However, recent clinical studies investigating the enamel wear of monolithic lithium disilicate demonstrate that it seems to be within the range of normal enamel wear.[20]

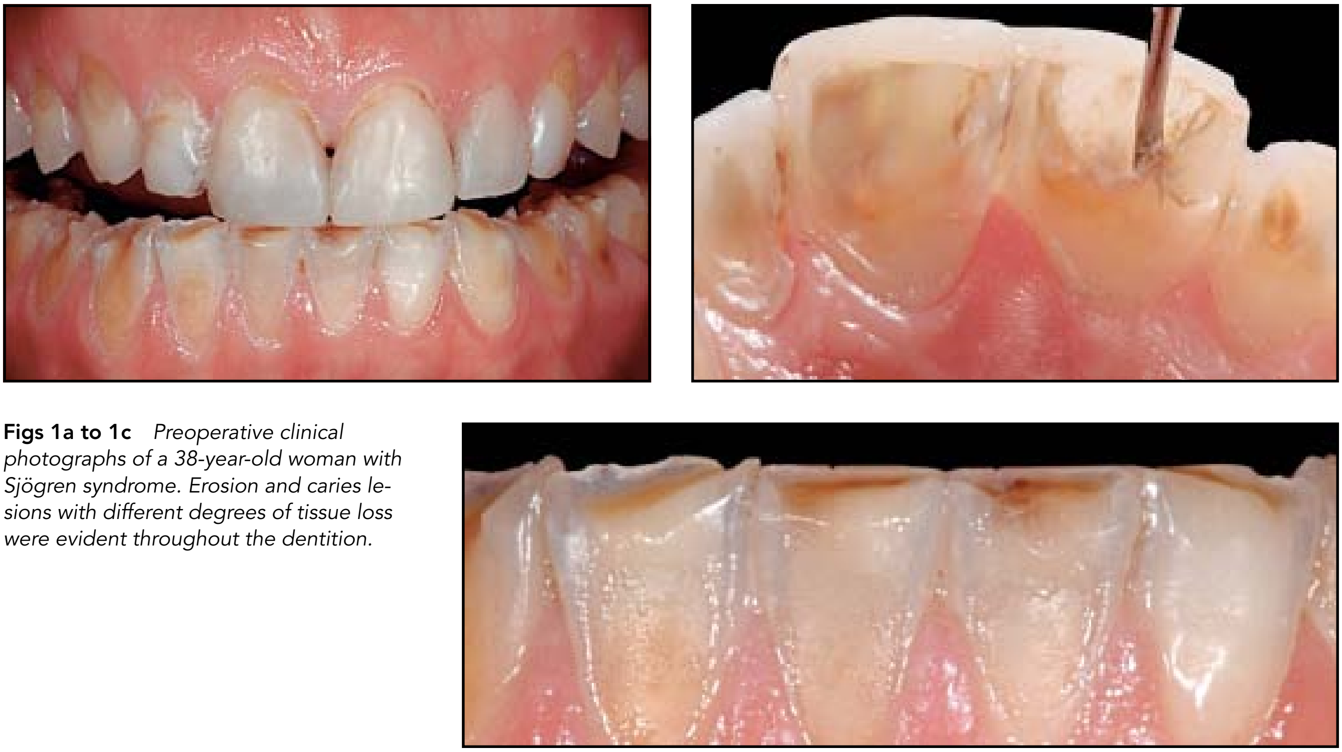
MIPP: Key elements

The minimally invasive prosthetic procedure (MIPP) is a comprehensive treatment modality recommended especially in cases of severely worn dentition involving the following procedures:

- Increase of the VDO. In extensive rehabilitations, alteration of the VDO is possible if the restorative treatment plan involves at least one arch. The interocclusal space gained enables the clinician to reduce the occlusal tooth preparation depth and to maintain tooth structure and vitality.
- Minimally invasive tooth preparation. The goal is to reduce tooth structure removal, especially in the occlusal area, to create a restoration with a thickness not exceeding 0.8 to 1.0 mm and to preserve more enamel surfaces along the axial walls and the light chamfer finish line for a superior bond over dentin.[21]
- Monolithic lithium disilicate posterior restorations. It is hypothesized that a monolithic lithium disilicate material with a reduced thickness (0.8 to 1.0 mm) can be used with a full-contour design for partial- and full-coverage restorations without adding veneering porcelain.
- Bonding the restorations. Adhesively bonding the restorations, mainly in enamel with an etchable ceramic material, is likely the key element for the success of this restoration.

Case presentation

A 38-year-old woman presented to the first author's clinic stating that she was unhappy with the appearance of her teeth and she experienced difficulty in chewing and sensitivity to cold. She was diagnosed with Sjögren syndrome and was being treated with cortisone and azathioprine. In the clinical interview regarding her expectations to improve her smile, she emphasized her desire to have highly esthetic restorations without the use of metal. A thorough clinical oral examination and radiographic evaluation were performed. There were no adverse findings during the musculoskeletal examination. Significant intraoral findings included generalized moderate-severe erosion of the cervical, midfacial, anterior incisal, and posterior occlusal surfaces; caries lesions; minimal plaque accumulation; and low salivary flow (Fig 1). It was proposed to increase the incisal length of the maxillary anterior incisors, together with alteration of the VDO 3 mm anteriorly. These modifications were evaluated with a direct mock-up in the anterior segment using a flowable composite resin material (Systemp Flow, Ivoclar Vivadent) (Fig 2). The initial study casts were mounted at the new VDO on a semiadjustable articulator (Denar Mark II, Denar) using an arbitrary facebow transfer and posterior wax (Beauty Pink, Moyco Union Broach), and the diagnostic wax-up was completed in accordance with the clinical findings. After duplicating the wax-up, the transparent matrix was fabricated and the final composite resin mock-up was performed prior to the initial tooth preparation to evaluate function and esthetics (Fig 3). Subsequently, an impression of the two arches with the composite resin mock-up was taken using irreversible hydrocolloid (Jeltrate, Dentsply/Caulk) to fabricate the provisional acrylic resin restoration. Tooth preparation was performed with the appropriate burs to achieve overall reductions of 0.8 mm occlusally and 0.4 to 0.6 mm axially (Fig 4). Tooth structure removal on the occlusal surface was limited to only 0.3 mm in the posterior teeth because 0.5 mm of space was gained in both arches by increasing the VDO by 1 mm posteriorly. Therefore, 0.8 mm of occlusal clearance was achieved for the use of the monolithic material. As a result, it was also possible to maintain most of the remaining enamel on the abutment previously built with the composite resin reconstruction (Fig 5). The finish line on the cervical area was positioned in the sulcus (intracrevicular preparation) to optimize the esthetic result and to include any possible existing tooth structure deficiency in the restoration design. The shell of the provisional restorations was fabricated at the new VDO with the modified indirect technique, then relined and cemented temporarily with zinc oxide noneugenol cement (Freegenol, GC Dental). The patient's comfort, speech, and appearance were reassessed after 1 month, and the final impression was fabricated. After placement of double



Figs 1a to 1c *Preoperative clinical photographs of a 38-year-old woman with Sjögren syndrome. Erosion and caries lesions with different degrees of tissue loss were evident throughout the dentition.*

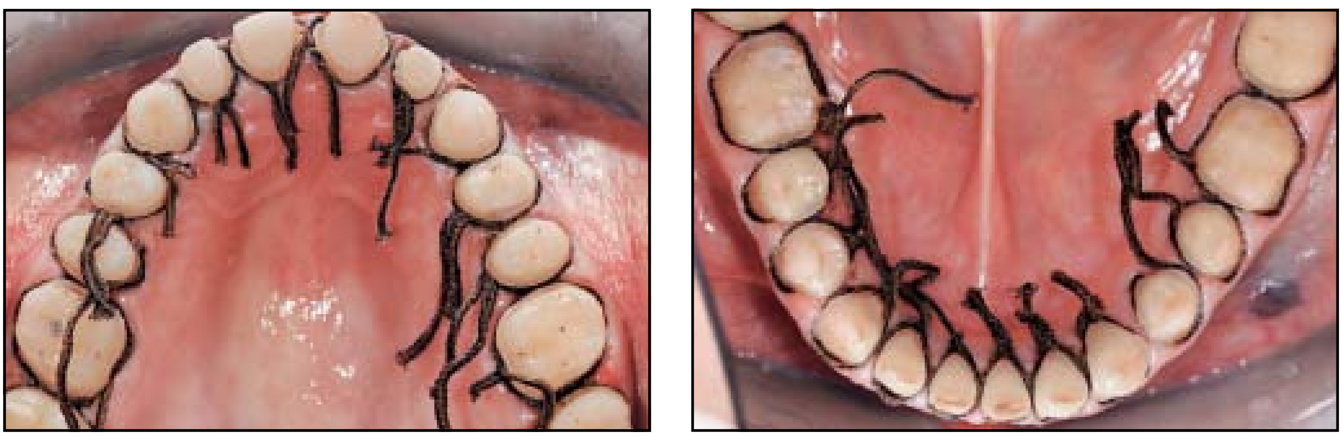
Figs 2a and 2b *Anterior direct mock-up allowed the clinician to evaluate the amount of increase in VDO that would have to be performed to fulfill the esthetic and functional needs of the patient.*

cord in the sulcus (Ultrapack, Ultradent), the final impression was taken with a polyether material (Impregum Penta Duo Soft, 3M ESPE) using a light-activated custom tray (Palatray LC, Haraeus Kulzer) and the single-impression double-mixing technique (Fig 6). Then, an intraoral facebow and centric relation records were taken at the new VDO such that the stone cast replicas of the provisional restoration were able to be cross-mounted with the master cast of the tooth preparation.

Fig 3 *Transparent matrix obtained from the wax-up filled with light-curing composite resin.*

Figs 4a to 4c *Once the volume of the final restoration was defined by the complete mock-up, the preparation of teeth for the definitive crown could be performed with calibrated burs to achieve an occlusal reduction of* (a and b) *1.5 to 2.0 mm in the incisal aspect of the anterior teeth and* (c) *0.8 to 1.0 mm in the occlusal aspect of the posterior teeth.*

Figs 5a and 5b *A very light chamfer preparation was performed, slightly deepening the margin in the intrasulcular position. Note the minimum preparation thickness and remarkable maintenance of enamel.*



Figs 6a and 6b *Occlusal view of the final preparation. Note the minimum amount of tooth reduction performed.*

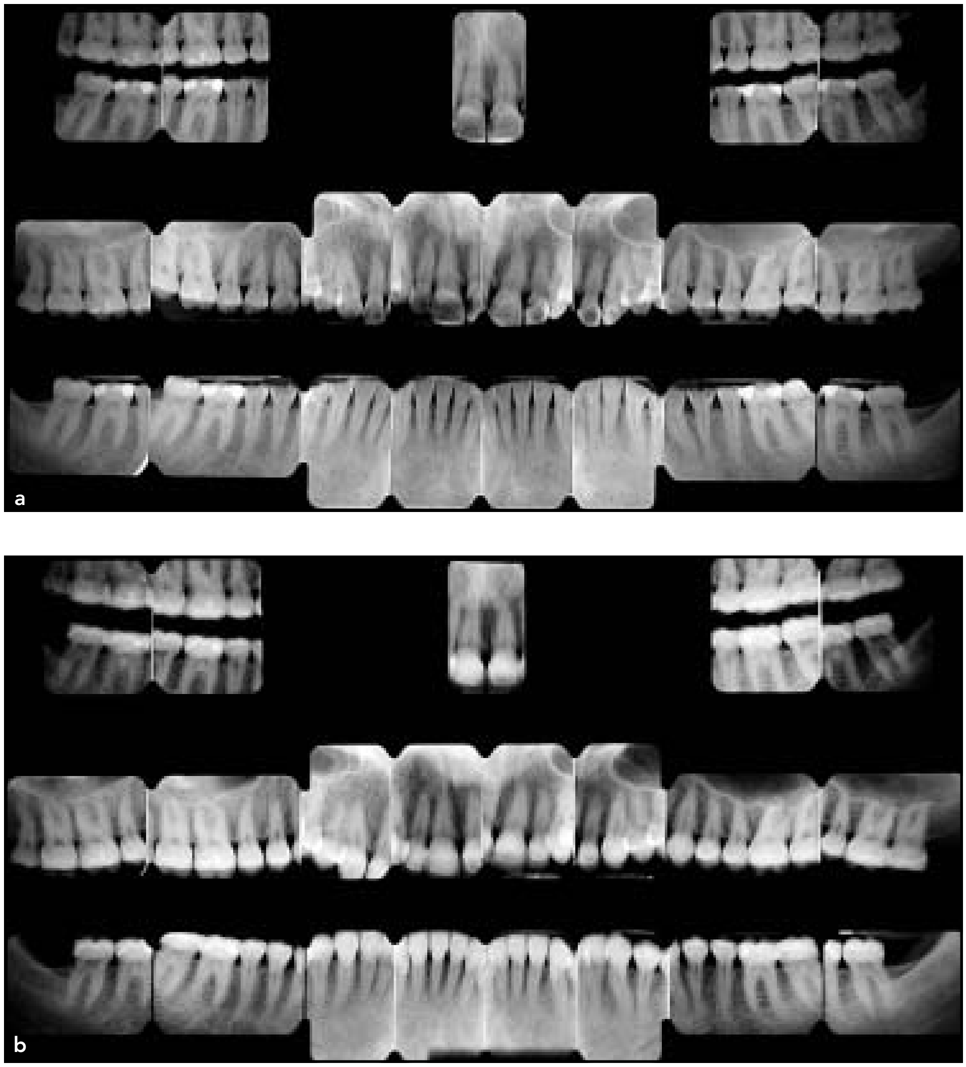
Adhesive cementation

Cementation followed a precise protocol. Retraction cords were placed in the sulcus of every abutment to minimize the humidity from the crevicular fluid and to act as a barrier for the penetration of the resin cement to the base of the sulcus. The inner surfaces of the restorations were etched with hydrofluoric acid 4.5% (Ivoclar Vivadent) for 20 seconds, thoroughly rinsed with water, and put in an ultrasonic bath with distilled water for 3 minutes. After thorough air drying, the intaglio surface was silanized (Monobond-S, Ivoclar Vivadent) and dried for

Figs 7a and 7b *Finished and polished lithium disilicate restorations.*

Figs 8a and 8b *Occlusal view after cementation.*

60 seconds (Fig 7). Tooth preparations were cleaned with pumice and rubber burs (Opticlean, KerrHawe), etched for 30 seconds on enamel and 10 seconds on dentin with 37.5% phosphoric acid (Ultra-Etch, Ultradent Products), rinsed, and dried. Both fitting surfaces, restorations, and teeth were coated with the adhesive system (Syntac, Ivoclar Vivadent), and because of the reduced thickness of the ceramic restoration, a light-polymerized composite resin cement (Variolink II, Ivoclar Vivadent) was selected to lute the restorations (Figs 8 and 9).



Figs 9a and 9b (a) *Initial and* (b) *final full-mouth radiographs. The ultraconservative MIPP approach guaranteed the maintenance of vitality of all the teeth.*

Discussion

Sjögren syndrome has been proven to be a progressive disease, since patients have shown deteriorating lacrimal and salivary secretion over time. Saliva is protective of enamel by its supersaturation with calcium phosphate ions; less saliva predisposes patients to caries, especially on smooth surfaces that are usually well protected. Saliva contains antimicrobial proteins and immunoglobulins that help to limit the adherence and growth of plaque bacteria. Sjögren syndrome is a complex and challenging condition for the dentist to diagnose and manage.[22] There is no evidence in the literature that suggests prosthetic treatment for this type of patient and no indication whether a complete-coverage restoration design can reduce the incidence

Figs 10a and 10b *The final result shows a satisfactory biologic, functional, and esthetic integration of the full-mouth rehabilitation.*

Figs 11a and 11b *Anterior guidance shows a correct disclusion of posterior teeth.*

of caries in long-term follow-up. Since patients with this condition are at a higher risk for caries, they need to be seen more regularly for examinations, given preventive treatment such as home fluoride regimens to follow, and maintain excellent oral hygiene that should be regularly reinforced by the dental practitioner.

Maintenance of tooth structure is the approach that guides the dentist during treatment, especially in this particular clinical case.[23] It is sensible and beneficial to maintain pulpal vitality and prevent endodontic treatment and the need for a post-and-core restoration because these more invasive approaches violate the biomechanical balance and compromise the performance of restored teeth over time.[24] An all-ceramic layered material over a lithium disilicate coping (e.max Press) was chosen to achieve high esthetics in the anterior teeth, and the monolithic form of this ceramic material with a reduced thickness (0.8 mm) was used for the posterior teeth. Monolithic glass-ceramic structures offer some distinct advantages in that they provide exceptional esthetics without requiring a veneering ceramic (Figs 10 to 12). Therefore, by eliminating the veneered ceramic and using only a 0.8-mm-thick core material with 360 to 400 MPa of flexural strength, greater structural integrity can be achieved with minimal removal of tooth structure.

Figs 12a to 12d *Appropriate function helped maintain the integration achieved after 3 years of service.*

There is a lack of data on the selection of the appropriate material, specifically regarding the influence on the fatigue resistance of such thin (0.8-mm thick), nonretentive restorations. However, recent studies comparing different materials suggest that lithium disilicate seems to be more effective when it is fabricated in its monolithic form.[20,24–27] The critical elements for successful use of this restorative material in full-coverage restorations may likely be the superior adhesion achieved by using a strong etchable ceramic material bonded to the presence of enamel resulting from the minimal amount of tooth structure removed.

Use of this monolithic material eliminates concerns regarding chipping of the overlay porcelain, which has been shown to occur with bilayered ceramic systems. Bilayered ceramic restorations consist of a strong ceramic core (eg, zirconia) veneered with a weaker overlay porcelain and have been reported to show chipping, fracture, or delamination of the veneering porcelain between 3% and 25% in the first 5 years.[28] In contrast, a recent study demonstrated no fracture and no chipping of lithium disilicate crowns after a 2-year period[29] and no chipping of monolithic lithium disilicate below 900 N and 180,000 cycles. In comparison, 90% of porcelain-veneered zirconia crowns failed from veneer chip-off fracture by 100,000 cycles at 350 N.[26] Bindl et al[16] evaluated 208 monolithic posterior ceramic crowns and showed high survival rates across 5 years of clinical service. Although a monolithic crown design might help the clinician to avoid any potential problems inherent to a bilayered system,[30] additional long-term clinical studies are required to further document this conclusion.

Wear of enamel caused by a ceramic restoration is a major concern. This has not yet been investigated fully with lithium disilicate, and more clinical studies are needed to assess the wear over time for a monolithic full-contour crown design. Even though precise data about wear characteristics of different ceramic materials are not available in the current dental literature, preliminary data from a recent in vitro study show that the new breed of ceramics is promising in that in vivo wear rates are within the range of normal enamel wear.[20]

Conclusion

The MIPP technique was proposed in this case of severely worn dentition with the aim of replacing tooth structure with the least amount of trauma to the already structurally compromised dentition. The increase in VDO requires less tooth structure removal and permits the creation of more interocclusal space that can be used for the restorative material. The preservation of tooth structure and remaining enamel should provide sufficient resistance strength, even in the presence of a reduced thickness of the ceramic monolithic material. Long-term studies using a minimal thickness of lithium disilicate materials to assess wear and fracture are needed to further understand the potential of this technique.

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