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Clinical Technique/Case Report

Minimally Invasive Multidisciplinary Restorative Approach to the Esthetic Zone Including a Single Discolored Tooth

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Clinical Significance

A minimally invasive multidisciplinary approach in the esthetic zone, which includes internal bleaching using Washi, a gingivoplasty with a three-dimensional (3D) printed surgical guide, and ultrathin feldspathic porcelain veneers, resulted in successful esthetic improvements to anterior teeth, including a single discolored tooth.

SUMMARY

Objectives: The case report describes a minimally invasive, multidisciplinary approach to a single discolored anterior tooth, with internal bleaching using traditional Japanese paper (Washi), a gingivoplasty with a three-dimensional (3D) printed surgical guide, and ultrathin feldspathic porcelain veneers.

Clinical consideration: The patient's primary concern was improving her smile. After clinical

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evaluation, internal tooth bleaching for the discolored tooth and gingivoplasty with restoration of the maxillary anterior six teeth and first premolars was recommended. The internal tooth whitening was accomplished with sodium perborate mixed with 30% hydrogen peroxide impregnated in Washi and sealed in the root canal with glass ionomer. Once the tooth bleaching was completed, the 3D printed surgical guide was placed in the patient's maxillary anterior region and used to guide soft tissue recontouring. After 6 months, ultrathin feldspathic porcelain veneers were placed.

Conclusion: Well-planned restorative procedures combining internal tooth bleaching using Washi, gingivoplasty performed with electrosurgery using a 3D printed surgical guide, and ultrathin feldspathic porcelain veneers can achieve the desired results in the esthetic zone and remain successful for 4 years.

INTRODUCTION

Currently, patients demand dental improvements with high esthetic quality.[1] Esthetics in maxillary anterior teeth are particularly challenging due to high esthetic consciousness and demands of patients.[2] In many complex cases, optimal esthetic outcomes require an interdisciplinary approach from periodontists and restorative dentists to achieve gingival health, harmonious anatomy, and color, alongside restorative treatments.[3] Many kinds of esthetic restorative procedures are available as state-of-the-art techniques, such as bleaching,[4] periodontal surgery,[5] and veneers.[6] Although case reports combining the use of highly skilled techniques called multidisciplinary approaches have showed significant esthetic outcomes,[7] there is still room to improve those treatments with the benefit of current material development and new technical procedures.

Esthetic treatment of anterior teeth, including a single discolored tooth presents challenges,[8] especially if internal bleaching, gingival surgery, and veneers are planned. Internal tooth bleaching runs the risks of weakening the tooth structure[9] and cytotoxicity in the periodontal tissues.[10] Therefore, there is a demand for bleaching procedures that are both minimally invasive, limiting the detrimental effects on teeth and periodontal tissue, and effective. In addition, the esthetic harmony of maxillary anterior teeth depends on the gingival tissue level and gingival morphology.[11] Sometimes the gingival tissues surrounding a nonvital discolored tooth become irregular, and gingivoplasty is necessary to restore the esthetics. Further, as these teeth are nonvital, there is a possibility that the substrate will be weaker than that in a vital tooth.[12] Finally, the use of veneers, particularly thin veneers, places demands on the color and structural integrity of the underlying tooth.[13] Meeting all these requirements is challenging and reinforces the need for minimally invasive techniques. A further motivation for such an approach is the patients' desire to avoid extensive reduction in both nonvital and vital teeth. Given both these factors, restorative procedures that involve reduced tooth preparation are always in demand.

This clinical report describes a minimally invasive approach for the esthetic zone involving internal bleaching using a traditional Japanese paper (Washi), a gingivoplasty with a three-dimensional (3D) printed surgical guide, and an ultrathin feldspathic porcelain veneer placement.

CASE REPORT

A 40-year-old female patient presented to the clinic with the chief complaint of wanting to improve her smile (Figure 1). The patient was diagnosed with worn teeth from #5 to #12, uneven incisal edges of teeth from #7 to #10, and extensive discoloration of tooth #8, which had previously undergone root canal treatment followed by resin composite restoration. The periodontal pocket depths of teeth from #5 to #12 were less than 3.0 mm. The patient was offered an internal tooth bleaching, a gingivoplasty, and a veneer treatment. The patient requested that treatment start, beginning with internal bleaching of tooth #8, in anticipation of veneer treatment later.

A rubber dam (Nic Tone Dental Dam, MDC Dental, Guadalajara, Jalisco, Mexico) was placed, and the prior resin composite restoration was removed (Round #2, Patterson Dental Co, 1031 Mendota Heights Road, Saint Paul, MN 55120, USA) (Figure 2). Pulpal horns were exposed during removal of the existing resin composite to ensure optimal bleaching outcomes. A glass ionomer cement (GC Fuji GP, Tokyo, Japan) was placed (1 mm) over the existing gutta-percha (GP) to protect the periodontal ligaments from cytotoxic diffusion and allowed to set for 8 minutes. A mixture of sodium perborate and 30% hydrogen peroxide was wrapped in Washi (Washi Arts, Blaine, WA, USA) and then placed in the chamber (Figures 3 and 4). Finally, phosphoric acid-etched enamel margins were sealed with the glass ionomer cement. The patient was recalled at 2 weeks for assessment and repetition of the bleaching procedure. This step was repeated 2 weeks later. At this point, the discoloration had been removed,

Figure 1. *Preoperative views. (A): Front view. (B): Side view (right). (C): Side View (left).*

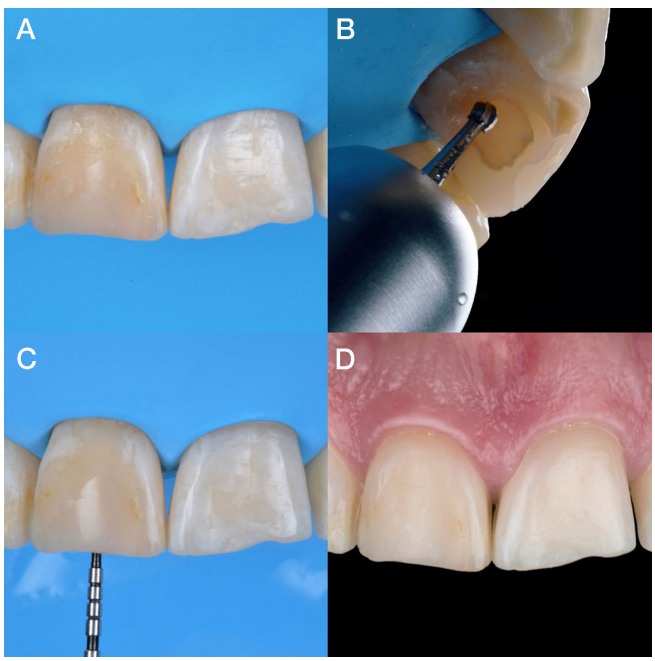

Figure 2. *Internal tooth bleaching using Washi. (A): Placing rubber dam. (B): Preparation of chamber space. (C): Confirmation of chamber depth. (D): Post internal bleaching.*

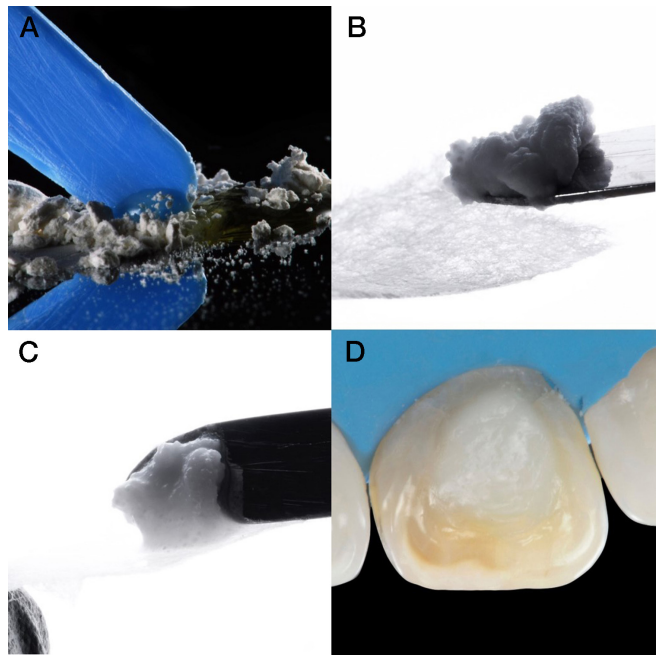

Figure 3. *Mixing bleaching material wrapped with Washi. (A): Mixing of materials. (B): Transfering to Washi. (C): Wrapping with Washi. (D): Temporary sealing.*

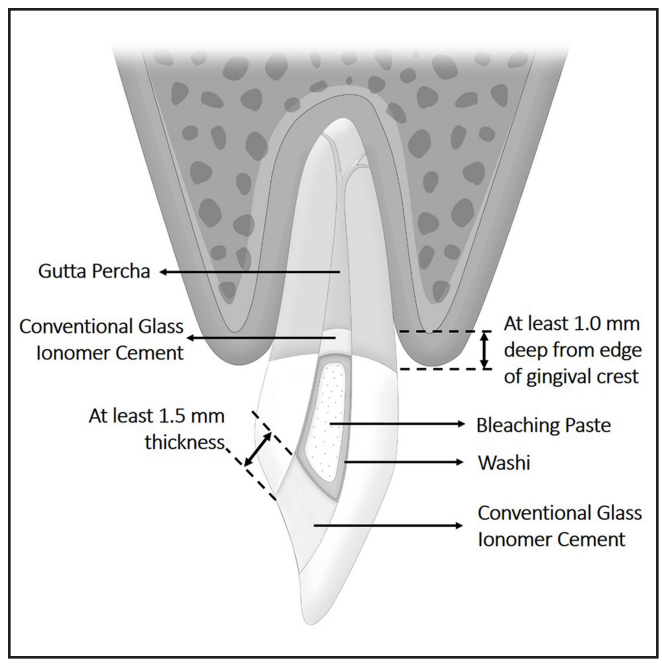

Figure 4. *Schematic drawing of internal bleaching using Washi.*

and the tooth's shade was enhanced. A conventional glass ionomer cement (GC Fuji GP) and flowable resin composite (G-ænial Universal Flow, GC) were used with a sandwich technique for filling the cavity. After the glass ionomer cement had set, 1 mm of the superficial surface of the ionomer filling was removed, the surface was etched with phosphoric acid, and the surface cavity was restored with universal adhesive and flowable composite. The patient was satisfied and agreed to continue treatment with the gingivoplasty.

A gingivoplasty was selected instead of crown lengthening, based on the adequate thickness of

the attached gingiva. First, diagnostic casts were made, and a wax-up (Wax GEO Classic, Renfert, Hilzingen, Germany) was fabricated to provide the patient with a harmonious smile that met her desires. The diagnostic wax-up was scanned (D2000, 3Shape A/S, Copenhagen, Denmark), and a surgical guide was designed and printed out of resin (Dental LT Clear Resin V2, Form 2, FormLabs, Somerville, MA, USA) using a 3D printer (Form 3, FormLabs) (Figure 4). The surgical guide was placed over the teeth to provide guidance for the desired contour during gingivoplasty with an electrosurgical unit (Sensimatic 700SE Electrosurge, Parkell Inc, Edgewood, NY, USA) (Figure 5). The interproximal soft tissue was separated from the interdental gingiva with a gingivectomy knife (KB5/6 Buck Periodontal Knife, Hu-Friedy, Chicago, IL USA).

After 6 months, to allow for proper healing of the periodontal tissues, the mock-up was inserted in the patient's mouth, and the patient was satisfied. Depth grooves were cut (LVS1 FG Medium Depth Cutting Diamond 834.31.021, Brasseler Dental, One Brasseler Boulevard Savannah, GA 31419, USA). A clear reduction guide (0.5-mm thickness, Keystone Industries, 480 South Democrat Road, Gibbstown, NJ, USA) was made with a vacuum machine (Pro-Vac Machine 110V, Keystone Industries). Veneer preparations were performed on the six anterior teeth and first premolars. The guide was placed, and preparations were checked with hole-shaped perforations through which a periodontal probe was inserted to determine the reduction (Figure 6). A silicone putty reduction guide matrix was also fabricated to evaluate the reduction, again using a periodontal probe to measure the reduction (Figure 6). Afterwards, the teeth were polished and smoothed using discs (OptiDisc, Kerr, Orange, CA, USA).

A double cord impression technique was used in anticipation of the final impression. Cord #00 and then #0 (Ultrapak, Ultradent Products Inc, South Jordan, UT, USA) were packed. The final impression was taken using polyvinylsiloxane (Virtual 380, Ivoclar Vivadent AG, Schaan, Liechtenstein). Ultrathin ceramic veneers (less than 0.5-mm thick) were fabricated from feldspathic porcelain (Super Porcelain Ex-3, Kuraray Noritake Dental, Tokyo, Japan) (Figure 7). A try-in of the final ceramic veneers was performed to evaluate the fit and contours; the patient approved the final appearance. For the bonding of the veneers, isolation was performed with a rubber dam. The teeth receiving veneers were surface treated with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 15 seconds and then rinsed with water (Figure 8). Adhese Universal (Ivoclar

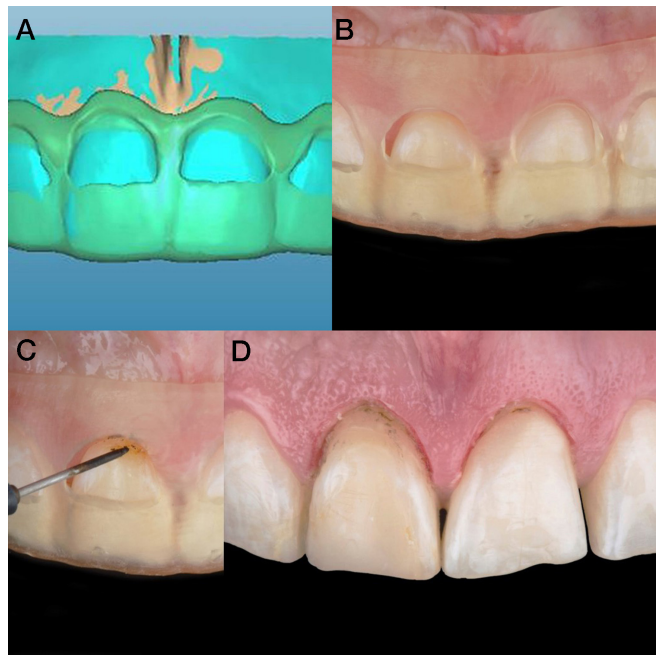

Figure 5. *Gingivectomy using a three-dimensional (3D) printed surgical guide over the teeth. (A): Digital designing for 3D printing surgical guide. (B): Placing a printed surgical guide. (C): Gingivoplasty using printed surgical guide. (D): Post surgery.*

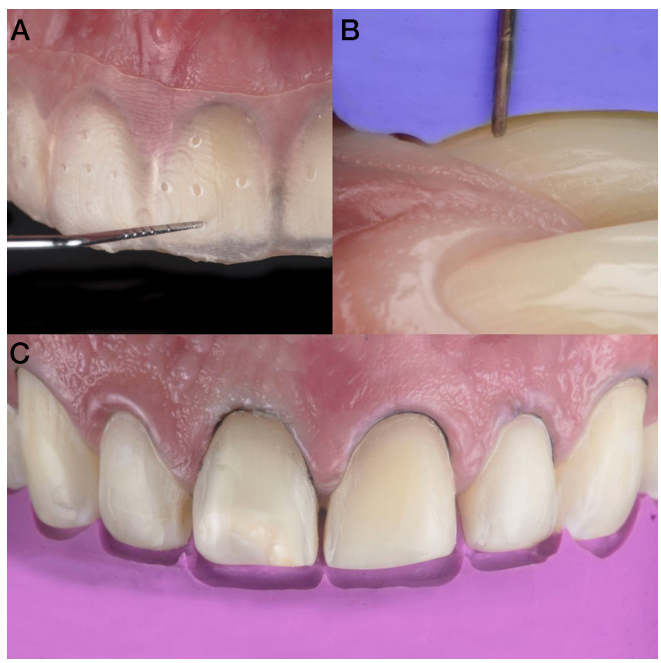

Figure 6. *Ultrathin veneer preparations. (A): Checking reduction depth with a clear reduction guide. (B): Checking reduction thickness with a silicone putty reduction guide. (C): Checking incisal reduction using a silicone putty reduction guide.*

Vivadent) was applied to the etched enamel surfaces. The intaglio surfaces of the ceramic restorations were etched with 5% hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar Vivadent) for 20 seconds, and Monobond

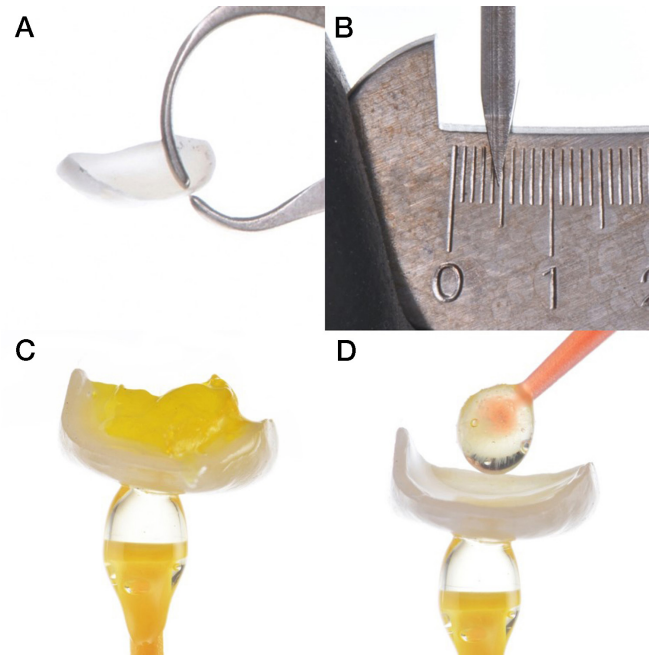

Figure 7. *Measurement for the thickness and pretreatments of veneers. (A): Checking a veneer thickness. (B): Measurement of a veneer thickness (less than 0.5 mm). (C): Hydrofluoric acid etching. (D): Primer applicaion.*

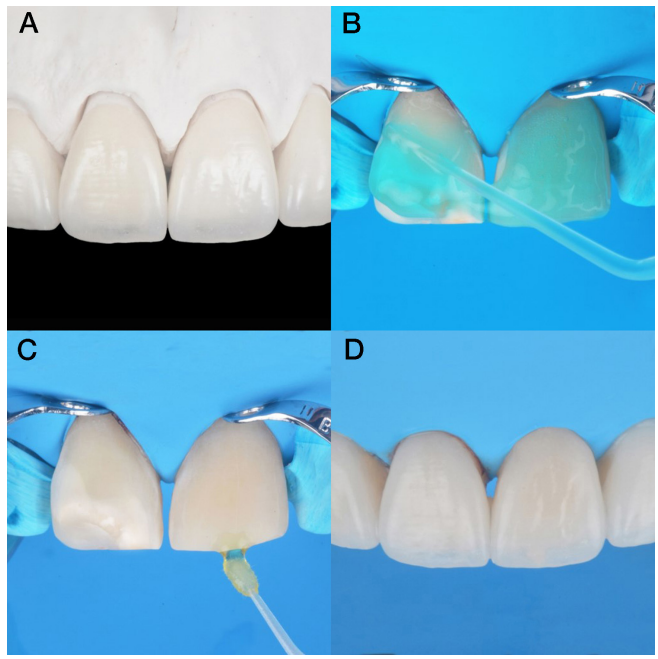

Figure 8. *Bonding ultrathin veneers. (A): Fabricated veneer.; (B): Phosphoric acid etching with rubber dam. (C): Adhesive application. (D): Cementation veneers with light-cured resin luting cement.*

Plus (Ivoclar Vivadent) was applied to the etched surfaces (Figures 7 and 8). Light-cured resin luting cement (Variolink Esthetic LC, Ivoclar Vivadent) was applied to the veneers, and they were seated. Excess cement was removed, and the restorations were cured using an LED light curing unit (VALO Cordless, Ultradent) on each surface (facial, palatal, mesial, and distal) for 40 seconds.

The patient approved the color, shape, and size of the final restorations, and the treatment fulfilled her esthetic requirements (Figure 9). An occlusal night guard was also provided in order to prevent any damage to the final restorations. At the patient's 4-year follow-up, she was highly pleased with the clinical outcome, including the closure of black triangles (Figures 9 and 10).

DISCUSSION

This clinical report presented a minimally invasive approach in the esthetic zone. The patient had two main complaints: spaces between teeth and a discolored tooth #8. The patient was informed of the need for nonvital tooth bleaching prior to any other treatment. The patient previously had an endodontic treatment of the tooth, and it has been demonstrated that, during endodontic therapy, blood content, such as hemosiderin, hemin, hematin, and memoidin, can penetrate the dentinal tubules causing discoloration of the tooth.[14] Internal tooth bleaching with a minimally invasive approach is needed, if thin ceramic veneers are planned. For this patient, internal tooth bleaching was provided with sodium perborate mixed with 30% hydrogen peroxide to form a paste, wrapped using Washi, and replaced every two weeks over a period of 6 weeks. Jurado and others[15] have reported a minimally invasive technique for nonvital tooth bleaching using Washi. Mixed bleaching paste wrapped with Washi, which is made using fibers from the inner bark of the gampi tree, the mitsumata shrub (*Edgeworthia chrysantha*), or the paper mulberry (kōzo) bush, can stay wet within the pulp chamber and release the ingredients slowly. This slow release minimizes the damage to organic and inorganic components of the tooth through the dentinal tubules and ensures that the peroxide does not reach the periodontal tissues, while providing an effective bleaching treatment. As in the previous case report,[15] the clinical results of the internal bleaching using Washi satisfied the clinician and patient without any side effects, such as external and internal resorption. This is a promising technique for minimally invasive bleaching. Another important merit of using Washi paper is that it is easier to apply the temporary sealing more accurately. Temporary sealing often debonds due to the moisture from the mixed paste. If the paste is enclosed in Washi paper, this can control the moisture level of the surface and

Figure 9. *Postoperative views and views of the restorations 4 years after cementation. (A): Postoperative view 1 week after cementation. (B): 4-year follow-up view.*

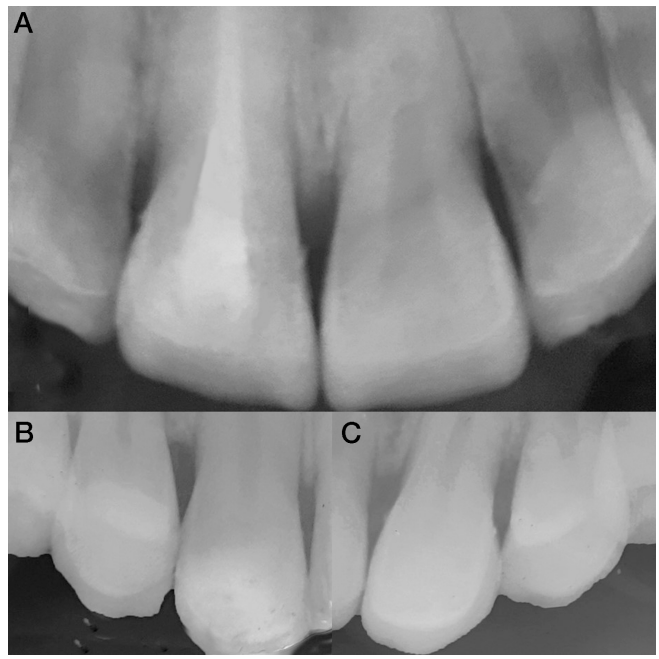

Figure 10. *Postoperative X-ray photos of restorations 4 years after cementation. (A): Front view. (B): Side view (right). (C): Side view (left).*

assist with temporary sealing. In this case, we did not see any debonding of the temporary sealing during treatment.

After achieving the desired tooth color, gingivoplasty was performed. Novel guides for improving the gingival architecture can be printed out based on a scanned diagnostic wax-up or based on bone level evaluation through cone beam computer tomography. Although some clinicians have reported creating a 3D printed surgical guide for crown lengthening, when cutting off the gingiva and trimming the alveolar bone,[16,17] there have been no reports of the use of a printed guide for gingivoplasty. For this patient, the diagnostic wax-up was scanned, and the gingivectomy guide was designed following its shape before being printed out in resin. 3D printing techniques can be used with computer-aided design and rapid prototyping, and applications of this technology are expanding in dentistry. In this case report, the use of a 3D-printed surgical guide helped the operating dentist perform precise surgery due to the good fit of the guide and also improved the patient's comfort during the gingivoplasty, as the guide was thinner. In this case, a stone model was used as the basis for the printed surgical guide, which could serve as a good transitional step to fully digital based surgical guides. Although fully digital based surgical guides will be the major form of guide in the future, clinicians have to become familiar with digital impressions and computer design. However, clinicians who are not familiar with digital dentistry can order guides from a stone model base mock-up. In addition, the printed guide showed good fitting and, thus, should be a good gateway to digital dentistry for clinicians who are not yet familiar with the technique.

Currently, the market offers a wide variety of dental ceramics, such as feldspathic porcelain, feldspathic porcelain reinforced with leucite and lithium dislicate.[18] Bonded veneer restorations to enamel have shown high survival rates with low failure numbers.[19] Moreover, laboratory techniques have evolved to produce ultrathin ceramic veneers from high-strength ceramic materials in recent years.[20] In this clinical case, a feldspathic porcelain was selected due to its high esthetic quality, but there is only a small number of clinical reports for ultrathin veneers made from feldspathic porcelain. One laboratory study reported that ultrathin ceramic veneers (less than 0.5 mm) were a potential option for clinical use from the fracture strength point of view.[21] However, every restoration is a combination of the restorative materials and the bonding system. Recently, the bonding and mechanical strengths of resin luting cement have been improved,[18,22] which makes the restoration stronger. This opened the possibility of using feldspathic porcelain of less than 0.5-mm thickness as an ultrathin veneer. Clinical monitoring of these ultrathin veneers confirmed satisfactory results over 4 years.

This case report combines three developments of existing techniques—the use of Washi in bleaching,

the use of a printed guide for gingivoplasty, and the use of feldspathic porcelain ultrathin veneers—to successfully achieve minimally invasive and highly esthetic restoration of a difficult case.

CONCLUSIONS

Minimally invasive treatment involving internal bleaching with Washi, gingivoplasty with a 3D printed surgical guide, and ultrathin feldspathic porcelain veneers can achieve fully acceptable results in the esthetic zone for 4 years.

Regulatory Statement

This study was conducted in accordance with all the provisions of the human subjects oversight committee guidelines and policies of the Human Research Ethic Office of Centro de Estudios Odontologicos de Queretaro. The approval code issued for this study is DENT/0031-06152015.

Conflict of Interest

The authors have no financial interest in any of the companies or products mentioned in this article.

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