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CLINICAL REPORT

Application of digital prosthodontics and connective tissue grafting in the management of peri-implant mucosal recession around a malpositioned 1-piece implant: A clinical report

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ABSTRACT

This clinical report describes a conservative approach to improve an unesthetic implant-supported crown and peri-implant mucosal recession around a malpositioned, 1-piece implant in the maxillary right central incisor region by using digital technology. In such clinical situations, the implants are usually removed because of an unpredictable definitive esthetic outcome. However, this clinical report describes the preservation of such a compromised implant by improving the esthetic outcome with a connective-tissue graft, and a digital approach used a 1-step preformed zirconia coping technique with an appropriate emergence profile. (J Prosthet Dent 2022;128:1145-51)

The popularity of dental implants in tooth replacement has led to a rise in associated complications.[1] Appropriate positioning of implants to achieve an optimal prosthetic result is paramount to the definitive esthetic outcome.[2,3] Likewise, adequate peri-implant soft-tissue architecture is required to attain acceptable esthetics, with soft-tissue alterations resulting in esthetic problems and a reduced success rate.[4] In particular, mucosal recession leads to a longer prosthetic crown and abutment exposure, which complicates plaque control.[4] Multiple factors, such as implant malpositioning, abutment shape or size, discrepancies in the prosthetic materials, bone dehiscence, insufficient quality and quantity of keratinized tissue, and occlusal trauma, have been implicated in peri-implant mucosal recession.[5-7] In addition, craniofacial growth has been reported to cause esthetic complications in implants of the maxillary anterior region similar to those of ankylosed teeth that have been reimplanted after trauma.[8,9]

Shibli et al[7] proposed peri-implant mucosal recession management by using a combination of prosthetic and periodontal surgical procedures. They recommended adjusting an inadequately shaped abutment before surgery. Ideally, the abutment should have a concave contour and narrow diameter, and the finishing line should be located corresponding to the free gingival margin of the adjacent tooth and/or implant. Other factors include the 3-dimensional (3D) position of the implant, tissue thickness, the amount of peri-implant mucosal recession, the distance from the implant platform to the bone crest, interproximal tissue loss, and the implant adjacent to tooth or implant.[4] González-Martín et al[10] emphasized that 2 distinct areas, the critical and subcritical contours,

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Figure 1. Clinical condition before treatment. A, Frontal view. B, Smile view.

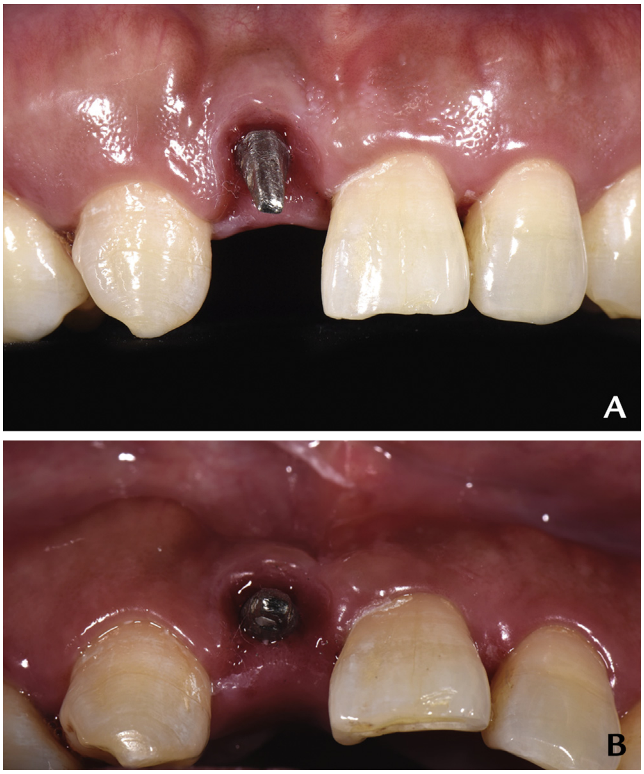

Figure 2. Abutment after crown removal. A, Frontal view. B, Occlusal view.

within the abutment and crown influenced soft-tissue adaptation. An adequate critical contour was reported to maintain the form and height of the free gingival margin, while an adequate subcritical contour ensured that sufficient regenerative space was available to achieve thick peri-implant tissue.[10]

The establishment of peri-implant tissue with custom architecture is important for a predictable esthetic outcome.[11] Joda et al[12] reported that 1-step formation of the ideal emergence profile using computer-aided design and computer-aided manufacturing (CAD-CAM) healing abutments helped promote good esthetic results. This method can prevent time-consuming steps and repeated destruction of epithelial attachment.[12]

This clinical report describes a conservative treatment approach to a malpositioned, 1-piece implant with peri-implant mucosal recession by using a combination of different digital technologies and periodontal surgical procedures.

CLINICAL REPORT

A 50-year-old man presented to the OASIS International Hospital in Beijing with the chief complaint of an unsatisfactory maxillary right central incisor implant-supported crown. He was systemically healthy, not receiving medications, and a nonsmoker. He had lost the tooth subsequent to trauma 13 years previously, and an implant had been placed 3 years subsequently. The 1-piece dental implant had a diameter of 3.5 mm and length of 12 mm, but the implant system could not be identified. Clinical examination revealed a short, interim composite resin implant-supported crown and a significant depression in the labial soft tissue (Fig. 1A). He had a low smile line (Fig. 1B). After removing the interim crown, severe gingival recession was evident, with peri-implant mucositis with bleeding on probing and a probing depth of 3 mm (Fig. 2A). Furthermore, the titanium abutment protruded buccally compared with the curve of the dental arch (Fig. 2B). The long axis of the implant abutment was buccally tilted by approximately 20 degrees compared with the long axis of the maxillary left central incisor. A cone beam computed tomography (CBCT) (3D Accuitomo; J Morita Mfg Corp) scan showed that the implant was positioned parallel to the labial contour of the alveolar bone, with 1.5 to 2.3 mm of labial bone covering the implant. The marginal bone height surrounding the implant was slightly unsatisfactory in comparison with that of adjacent teeth, although there was no bone resorption (Fig. 3). The contour of the labial plate was concave and corresponded with the clinical findings.

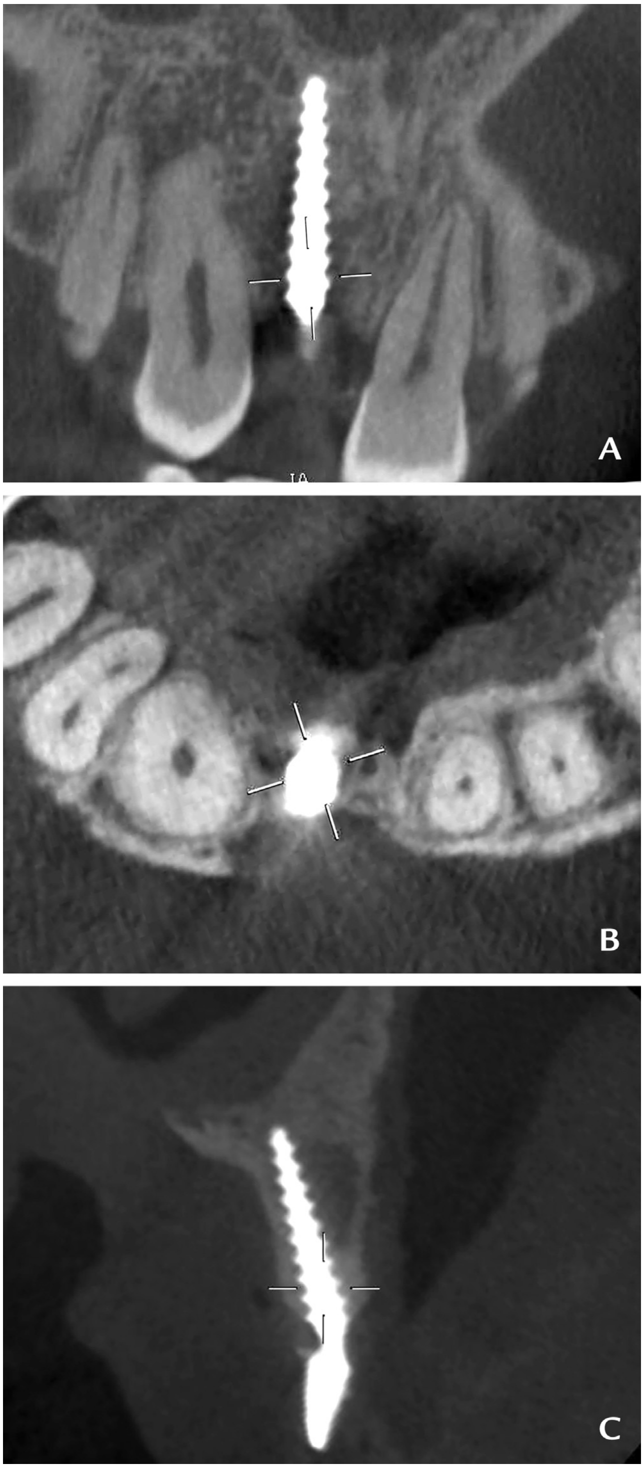

Figure 3. Cone beam computed tomography images of implant at right maxillary central incisor position. A, Coronal view. B, Axial view. C, Sagittal view.

The maxillary and mandibular arches were scanned by using an intraoral optical scanner (TRIOS; 3Shape A/S) for digital analysis and treatment planning. The 3D images from CBCT and intraoral scanning were merged

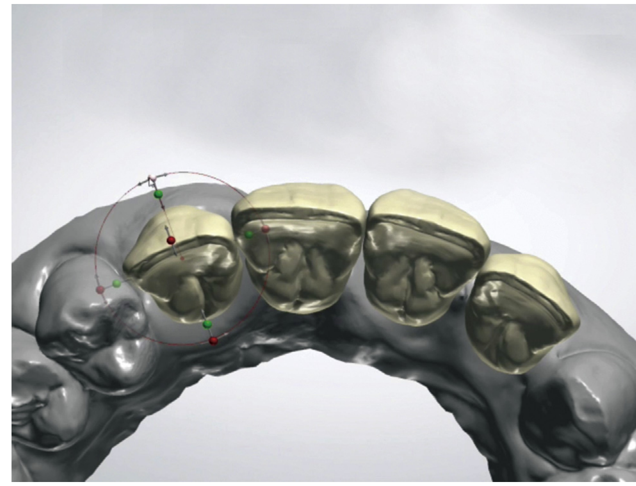

Figure 4. Digital waxing.

by using a software program (Dental System; 3Shape A/S) to generate a 3D digital replica depicting the hard- and soft-tissue contours. The patient declined orthodontic treatment, which was initially considered. Therefore, 4 other treatment plans were presented, removal of the implant, segmental osteotomy to reposition the implant, subepithelial connective-tissue graft (SCTG) to improve the peri-implant mucosal recession, and submergence of the implant. The definitive prosthetic restorations considered in the 3 surgical plans included a ceramic implant-supported crown and veneers on the adjacent teeth, whereas with implant submergence, a 3-unit fixed partial denture from the maxillary right canine to left central incisor and a single veneer on the maxillary left lateral incisor were considered. He declined the option of a 3-unit fixed prosthesis and wished to avoid major surgeries. Finally, the conservative treatment plan detailed in this clinical report was selected by him.

A diagnostic virtual waxing allowed for the simultaneous evaluation of the minimal thickness required for the implant crown, the feasibility of retaining the original implant, abutment shape, optimal prosthetic form, and the amount of soft tissue (Fig. 4). The results indicated that the implant could be retained and used by modifying the abutment shape. Based on the diagnostic virtual waxing, the distance between the ideal free gingival margin and bone margin was calculated, and the space available between the abutment structure and labial contour of the definitive restoration was measured. The distance between the interproximal bone crest and tip of the ideal interdental papilla between the left maxillary central incisor and the implant was 3.6 mm. Furthermore, the difference between pretreatment and the proposed labial free gingival margin was 3.3 mm. The space available between the abutment structure and labial contour of the definitive restoration was measured to be 0.77 mm (Fig. 5). Cutting back the virtual waxing allowed

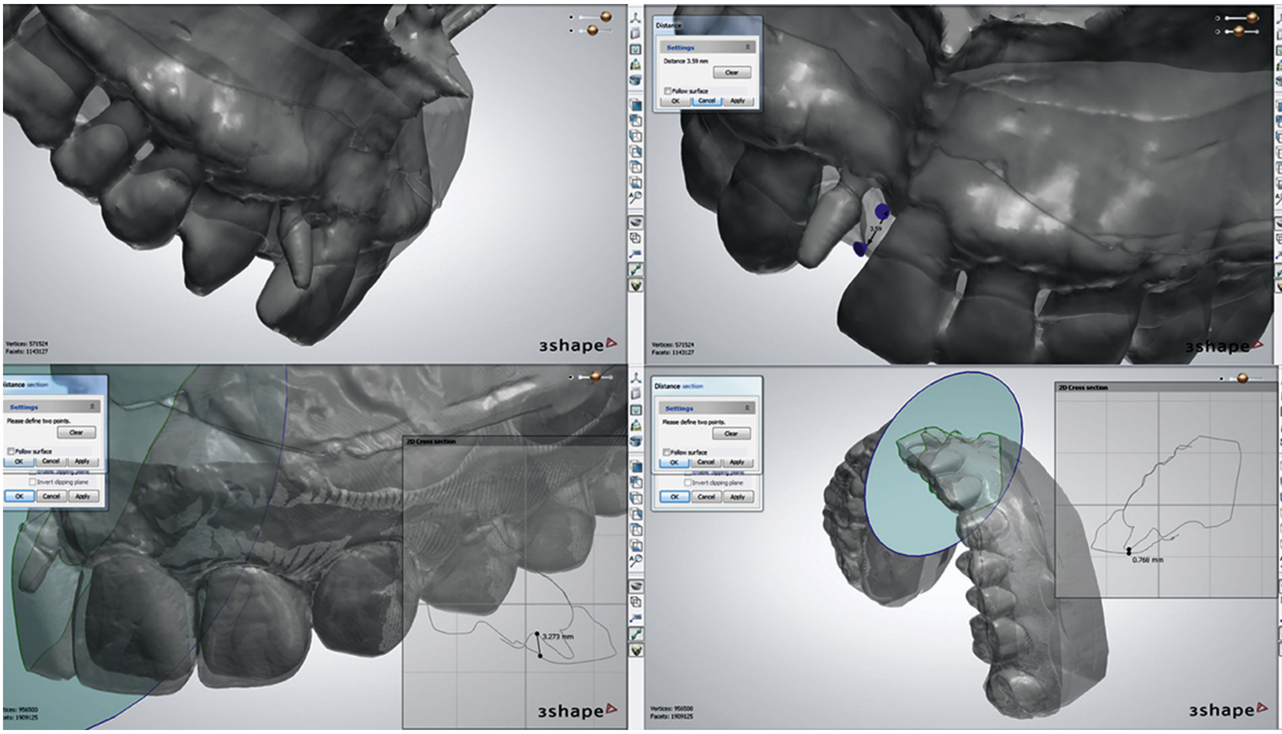

Figure 5. Digital analysis.

optimal position assessment of the transmucosal structure relative to its original position.

The abutment needed to be adjusted 20 degrees lingually for sufficient space to place the definitive crown. An adjustment guide was fabricated by using 3D printing technology (D4K Pro Dental; EnvisionTEC), and the angulation of the abutment was adjusted intraorally with pliers (Abutment Removal Forceps; Bicon) to conform precisely with the predetermined position (Fig. 6). A zirconia coping (Procera Custom Zirconia Abutment; Nobel Biocare)[13] was then milled to mask the metallic color and alter the abutment shape by using the 1-step preformed zirconia coping technique (Fig. 7).[12] It was cemented over the titanium abutment with a resin cement (Super-Bond C&B; Sun Medical) (Fig. 8). The excess cement was easily removed because the bonding surface was far from the free gingival margin.

After coping cementation, the soft tissue was grafted. Under local anesthesia, a vertical incision was made along the labial frenulum, and a partial thickness tunnel flap was raised over the maxillary right central incisor region with a tunneling instrument (Tunneling Knives; Helmut Zepf). Aligning with the digital diagnosis, a 18×10-mm SCTG with a thickness of 1.5 mm was harvested from the right palate, inserted into the tunnel, and fixed with a single sling suture with 6-0 nylon (Prolene; Ethicon Inc) (Fig. 9). Primary closure of the vestibular vertical incision was obtained with 6-0 nylon simple-interrupted sutures.

Figure 6. Intraoral adjustment of transmucosal abutment of implant in maxillary right central incisor position by using guide.

The free gingival margin and the shape of the malpositioned right maxillary canine were asymmetric compared with the left lateral incisor. Gingival excision and prosthetic correction were required for the right canine as per digital waxing. Three months postoperatively, the maxillary right canine and left central and lateral incisors were prepared for veneers and optically scanned by using an intraoral optical scanner (TRIOS; 3Shape A/S), and a lithium disilicate crown and veneers were digitally designed. The probing depth of the right canine was approximately 4 mm because of altered passive eruption. To improve the length-to-width ratio,

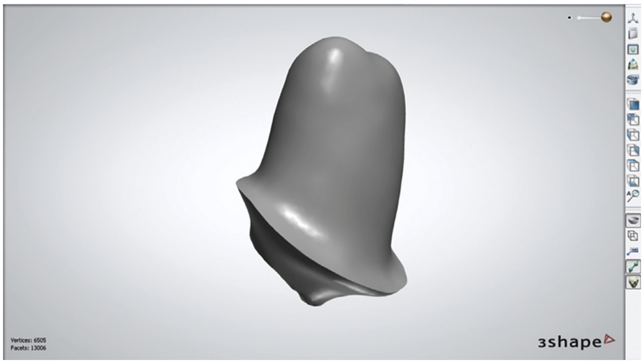

Figure 7. Digital design of zirconia coping.

Figure 9. Soft tissue around dental implant in maxillary right central position augmented with vestibular incision, partial thickness dissection, subepithelial connective tissue graft harvested from right side of palate, and sutures of 6-0 nylon.

Figure 8. Frontal view of zirconia coping after cementation. Zirconia coping digitally designed and milled.

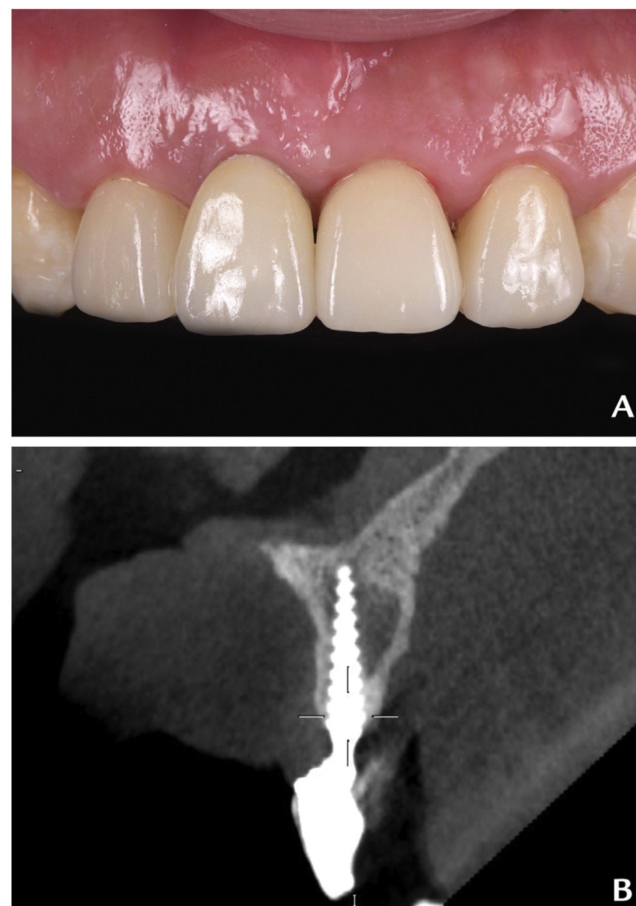

Figure 10. Immediately after cementation of veneers on maxillary right canine, maxillary left central and lateral incisors, and implant-supported crown over zirconia coping in maxillary right central incisor position. A, Frontal view. B, Cone beam computed tomography image, sagittal view.

the gingiva around the right canine was excised before tooth preparation. Eight weeks after preparation, all restorations were cemented with a resin cement (Variolink N; Ivoclar AG) (Fig. 10), and an intraoral scan was made to evaluate changes in the labial soft tissue contour. The labial contour had been augmented by 2.9 mm, and the gingival margin repositioned 2.9 mm coronally. At the 3-year posttreatment follow-up, the esthetic result was stable, with no signs of inflammation (Fig. 11). Gingival recession of less than 0.5 mm on the buccal aspect of the implant-supported crown was recorded, and he was satisfied with the overall treatment outcome.

DISCUSSION

The primary advantage of treating peri-implant mucosal recession around a malpositioned, 1-piece implant with the 1-step preformed zirconia coping technique and SCTG is that the procedure is less invasive than new implant placement. Continued craniofacial growth has been reported to cause esthetic complications in implant therapy.[8,9] In the present patient, peri-implant mucosal recession appeared to dominate craniofacial growth because the difference in the free gingival margin between the implant and the adjacent teeth was greater

Figure 11. Frontal view at 3-year follow-up.

than the difference in marginal bone height. An excellent outcome was achieved because the prosthetic and esthetic goals were set in advance by using digital technologies. A good outcome for implant coverage by using SCTG was anticipated as the prosthetic contour was concave, the implant diameter was narrow, peri-implant recession was shallow, and the distance between the implant platform and the bone crest was less than 3 mm.[4] In addition, interproximal tissue loss was absent, both adjacent teeth were present, and the implant was positioned within the bony envelope.[4] Research has indicated a mean ±standard deviation peri-implant recession decrease from 1.9 ±0.7 mm to 0.2 ±0.3 mm at the 1-year follow-up when a shallow buccal soft-tissue dehiscence around a single implant was treated by SCTG, and the free gingival margin was reported to still be stable 5 years postoperatively.[14,15] However, the peri-implant biotype is important to prevent peri-implant recession.[16] In this patient, the peri-implant biotype changed from thin to thick, and a thickened buccal soft tissue of 2.9 mm was obtained, which may prevent future peri-implant recession. Soft-tissue shrinkage of 40% or more might occur after peri-implant soft-tissue grafting.[17] Therefore, the amount of SCTG required was digitally predicted after taking into consideration the expected shrinkage of the graft.

Jung et al[18] reported that color discrepancies, irrespective of the material used (metal or zirconia), were not perceived with a mucosal thickness of 3 mm or more. Therefore, the color of the metal abutment could be masked in this patient. However, a zirconia abutment coping has been reported to be more esthetic than a metal abutment in terms of altering the gingival color.[18] In addition, zirconia materials have been reported to promote soft-tissue healing and cell proliferation.[19-21] Therefore, a zirconia coping with the optimal critical and subcritical contours was designed to provide optimal soft-tissue architecture.[7,8] The adjustment in abutment shape was followed by cementation of the zirconia coping over the metal abutment to mask the metal color. The subcritical contour was designed to be as concave as possible to create sufficient space for the regeneration of an adequate volume of soft tissue. The vertical position of the finishing line of the coping was adjusted coronally to a level comparable with the soft-tissue margin of the contralateral tooth.[4,7,8] In addition, this line functioned as a stop for the SCTG.

Limitations of this treatment include a cement-retained implant crown with compromised retrievability and slight irregularity of the gingival margin in the final outcome; the treatment demonstrated the effectiveness of digital technologies for managing peri-implant mucosal recession.

SUMMARY

This clinical report described a conservative approach to managing an unesthetic implant-supported crown and peri-implant mucosal recession resulting from a malpositioned, 1-piece implant and inadequate abutment shape. Application of digital technologies in combination with SCTG improved the pink and white esthetics.

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Noteworthy Abstracts of the Current Literature

Color stability and mechanical properties of two commonly used silicone elastomers with e-skin and reality coloring systems

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Purpose. To evaluate the color stability and mechanical properties of two commonly used maxillofacial silicone elastomers after addition of pigments and opacifiers and before and after artificial aging.

Material and methods. This study evaluated two maxillofacial silicone elastomers: A-2000 and M511. Two different pigment and opacifier systems (e-Skin and Reality Series) were used with the elastomers. Control groups (no pigment or opacifier) and experimental groups (each with subgroups containing additional pigments and/ or opacifiers) were fabricated for each of the silicone elastomers. A total of 51 specimens were evaluated for color stability, and 100 for mechanical properties. A spectrophotometer was used to assess CIE L*a*b* values before and after aging. CIELAB 50:50% perceptibility threshold ($\Delta E^*=1.1$) and acceptability threshold ($\Delta E^*=3.0$) were used to interpret color changes. A durometer and universal testing machine were used to evaluate the mechanical properties. ANOVA and Fisher least significant difference (LSD) test were performed to determine the statistical significance of the results ($P<.05$).

Results. Significant differences in color measurements (ΔE^*) were found for all silicone groups following artificial aging ($P<.05$). ΔE^* values for the mixed pigment/opacifier subgroups of both elastomers were below the perceptibility threshold. Additionally, after aging, the hardness, tear strength, and tensile strength significantly increased for all silicone groups ($P<.05$), while percent elongation significantly decreased ($P<.05$).

Conclusions. Artificial aging affected the color stability and mechanical properties of the pigmented silicone elastomers with added opacifier. Overall, A-2000 with e-Skin group displayed the most color stability, with its mechanical properties being the least affected by artificial aging.