

## Facial Esthetic Considerations with All-on-4: A Report on Two Cases



Ernest S. Orphanos, DDS<sup>1</sup>

*This article describes two case reports of immediate full-arch dental implant-supported prostheses using facial parameters to determine the anticipated incisal edge (AIE) position. Treatment planning the terminal dentition is driven by several facial parameters. A frontal photo is obtained to assess the facial thirds and the symmetry in the lower third. A profile photo allows the clinician to measure Holdaway's angle, nasolabial angle, and labiomental sulcus depth and anatomy. Facial assessment is a diagnostic tool that assists the clinician in addressing the challenges of ideal tooth position in the absence of dental landmarks to achieve dentofacial esthetics. Int J Periodontics Restorative Dent 2019;39:57–64. doi: 10.11607/prd.3563*

Restorative dentists strive to recreate the beauty of ideally proportioned, natural-looking teeth. To that end, numerous esthetic proportions have been defined, such as the golden proportion, the recurring esthetic dental proportion, and golden percentages.<sup>1–4</sup> Feminine and masculine designs have been described and correlated to facial form.<sup>5–9</sup> Tooth position as it relates to the frame of the smile has also become subject to analysis, and the position of the gingival margins with respect to one another and to the lip line also must be considered.

Full-arch restorations enable clinicians to recreate not only beautiful smiles but also ideal facial esthetic proportions. Facial analysis has been undertaken to determine the occlusal vertical dimension (OVD).<sup>10,11</sup> Clinicians can alter the OVD and other facial parameters, such as the facial proportions; the nasolabial angle; Holdaway's angle; the labiomental groove; and the lip support, position, and symmetry. All these elements can substantially improve overall esthetics.<sup>12,13</sup>

The ability to use the face as a diagnostic tool can help clinicians achieve optimal dental and facial results. This article presents an approach to facial analysis employed in combination with All-on-4 implant restoration. Two case reports illustrate the methodology.

<sup>1</sup>Board of Periodontology, Boca Raton, Florida, USA.

Correspondence to: Dr Ernest S. Orphanos, 9291 Glades Rd, Suite 301, Boca Raton, FL 33434, USA. Fax: 561-477-7577.  
Email: dro@center4smiles.com

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## Preoperative Protocol

In conjunction with a comprehensive periodontal and oral exam, a cone beam computed tomographic (CBCT) scan is obtained to assess the status of any existing dentition, along with the bone quantity and arch form. Facial photographs are obtained to evaluate symmetry and proportion. Images of the patient in Case 1 are used to show the preoperative and surgical protocols and implant-placement procedures.

A frontal photo provides information about the facial thirds, the proportion in the lower facial third, the lip length, and lip mobility (Fig 1a). The upper facial third is measured from trichion to glabella, the middle third from glabella to subnasale, and the lower third from subnasale to menton. The lower facial third is further evaluated to measure the proper upper one-third (subnasale to stomion) to the lower two-thirds proportion (stomion to menton). Average lip lengths from the junction of the lip and columella to the inferior border of the upper lip have been recorded as 23.0 mm (for males) and 20.0 mm (females). Average vertical movement of the upper lip from rest to maximal smile position falls within the range of 6.0 to 8.0 mm.<sup>14</sup>

A profile photo is used to assess Holdaway's angle, the nasolabial angle, the labiomental groove depth and anatomy, and upper and lower lip flaring (Figs 1b to 1d). Holdaway's angle is a measurement from nasion to pogonion and from pogonion to anterior projection of the upper lip. Ideally, this is 10 degrees.<sup>15</sup> Various

ways of measuring the nasolabial angle have been reported in the plastic surgery literature.<sup>16,17</sup> The present author prefers to measure from the projection of the columella to the projection of the body of the upper lip. For males, the ideal angle is 93 to 98 degrees; for females, it is 95 to 100 degrees.<sup>18</sup> The depth of the labiomental groove is measured by a straight line from the pogonion to the most anterior portion of the lower lip. This concavity should not exceed 4.0 mm. Furthermore, ideal labiomental groove anatomy would have the straight line from pogonion to anterior projection of the lip in a vertical position that, if extended upward, would intersect with the subnasale.<sup>15</sup> Finally, the anterior-posterior position of the lips are evaluated to assess any flaring or deficiency.

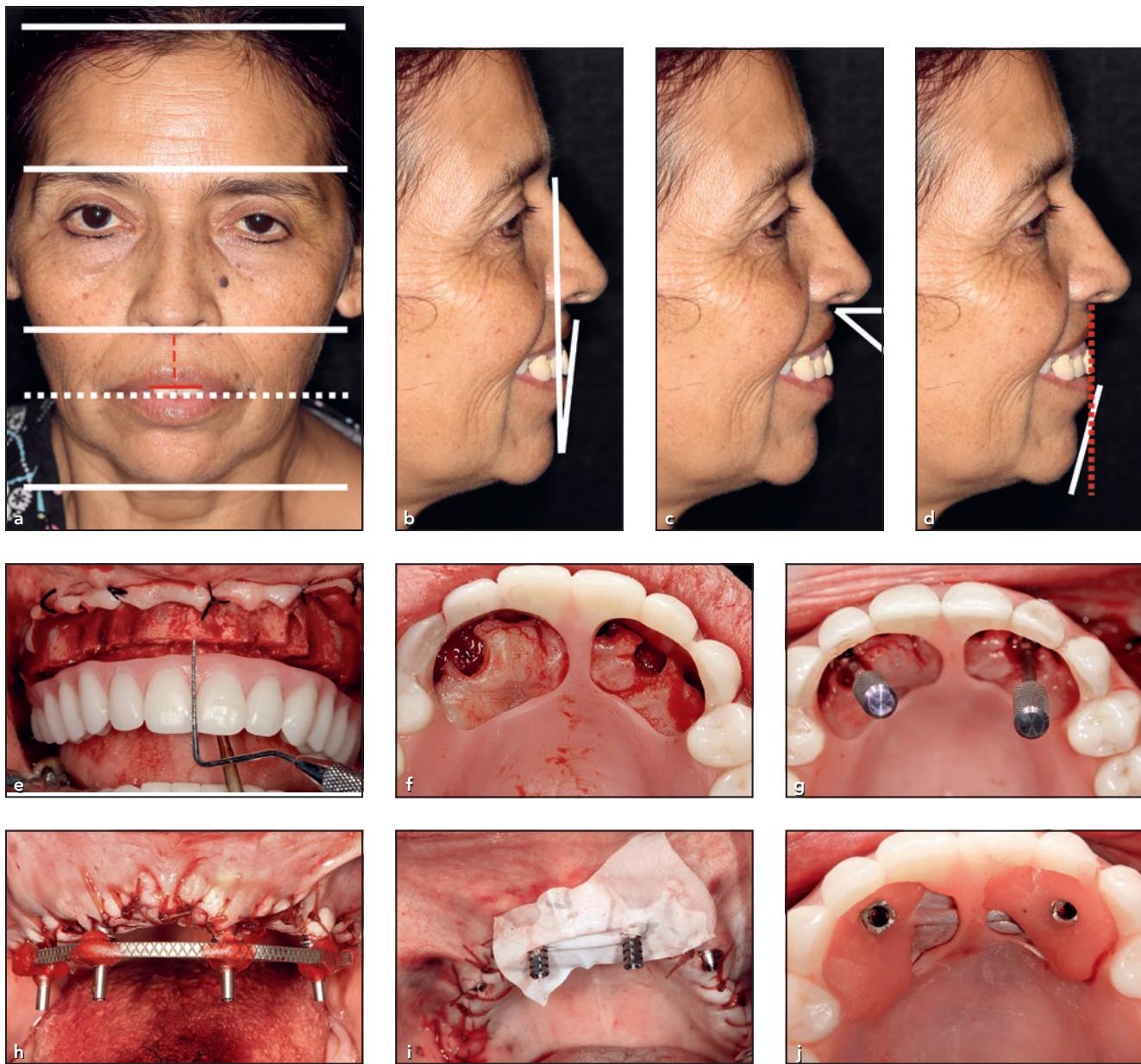
A Lucia jig is used to record centric relation (CR) with a centric relation bite registration, and impressions are obtained. A facebow is taken so that the casts can be mounted in CR.

The process of planning the anticipated incisal edge (AIE) position can then begin. A number of factors must be considered. With increasing age, maxillary tooth exposure is minimized<sup>19</sup> due to loss of elasticity<sup>20</sup> and volume.<sup>21</sup> Lip length,<sup>22</sup> lip mobility,<sup>23</sup> and the presence of lip fillers also can affect incisal edge display. If only one arch is being treated, any grossly malpositioned teeth in the opposing arch should first be corrected, along with any acute pathology. Gross debridement typically is performed prior to the surgical procedure, and chlorhexidine is administered for 1 week preoperatively.

## Surgical Protocol

Intrasulcular incisions are performed around teeth, and crestal incisions are made in edentulous areas. Releasing incisions are created distal to the maxillary tuberosity, and a buccal releasing incision is performed by the retromolar pad. Full-thickness flaps are reflected, and the remaining teeth are extracted. If necessary, ridge reduction is performed to achieve the minimum of 15.0 mm from the AIE (Fig 1e) that was determined preoperatively. The flangeless denture is then inserted to assess the facial support. If a deficiency is anticipated, it can be moved in a horizontal, vertical, and/or anterior-posterior (A-P) direction to improve facial support and symmetry. Vertical repositioning may entail relining with a bite registration material to enhance OVD or rotate the axis of the inclination of teeth. Should the OVD require reduction, the intaglio surface of the denture can be reduced or removed.

The final incisal edge display at rest and on smiling should be commensurate with the patient's age or with a rejuvenated appearance, provided that lip length or mobility doesn't deviate from normal architecture and function.<sup>19-23</sup> Proper alveolar reduction should accommodate adequate restorative material for the final restoration (NobelProcera milled bar and acrylic restoration, or a milled zirconia restoration) and should ensure that the transition zone of the prosthesis to the gingiva will not be evident on maximal smiling.



**Fig 1** Preoperative and surgical protocols and implant-placement procedures in Case 1. (a) Facial proportions: facial thirds are represented by solid white lines, which ideally would be of equal length. The lower facial third is defined by the upper portion located at the base of the nose (subnasale) and the inferior border of the chin (menton) and is separated into an upper and a lower portion by the striped white horizontal line across the position of the stomion. The ideal measurements should be a ratio of one-third to two-thirds upper to lower. Lip length is measured by the solid red line, depicting the junction of the columella to the body of the lip and the most superior portion of the vermillion border of the upper lip. (b) Holdaway's angle: the angle formed between a line from nasion to pogonion and from pogonion to the most anterior part of the upper lip. (c) Nasolabial angle: the angle formed from the intersecting lines created by the projection of the lip and the columella. (d) Labiomental groove. This groove should range from 2.0 to 4.0 mm depth when a straight line is drawn from pogonion to the anterior border of the lower lip. This straight line should also be in a vertical plane and coincident with subnasale, indicated by the striped red line. (e) Measurement of 15.0 mm of distance from the AIE and crest of bone. (f) Tissue punch in the clinical area of ideal bone with the prosthesis in place. (g) Anterior implant placed with appropriate multiunit abutments selected. (h) Open tray impression coping technique for chairside conversion. (i) Temporary abutments screwed into anterior implants to attach the flangeless denture to the abutments. (j) Luting the flangeless denture to the temporary abutment.

## Implant Placement

The palatal flap is positioned over the anterior implant sites in the regions of the most ideal bone (Fig 1f), and a tissue punch is employed to establish a landmark for the two anterior implants. After these are placed, a multiunit abutment (MUA) is attached to each. With the abutment holding pins in place, the prosthesis is inserted to confirm that the eventual screw access channels will be ideally located, not too far palatal or labial (Fig 1g). At the anticipated posterior implant sites, the bone should then be beveled to ensure that the implants' coronal portion will be flush with the bone crest. The posterior implants are then placed. If there are no posterior landmarks, such as extraction sockets, a surgical guide should be employed to ensure that the posterior implant placement maximizes the A-P spread.

Prior to tissue closure with 3-0 chromic gut sutures, open tray impression copings are placed to ensure no soft tissue entrapment. A plate-strengthening bar (Yates Motloid) connected with pattern resin (GC) is luted to the impression copings (Fig 1h), and an open tray impression is taken (Miratray, Hager & Werken). While the laboratory technician fabricates a soft tissue model from the impression, two temporary copings are screwed into the anterior MUAs and covered with a piece of sterile glove (Fig 1i). Unifast denture acrylic (GC) is injected around the copings, and the maxillary prosthesis is seated against the palate (Fig 1j). There should be ample Unifast material to engage both the copings and the prosthesis.

Once the denture acrylic sets, a bite registration is obtained. The copings are engaged into the prosthesis with the denture acrylic, a facebow is obtained, and the laboratory technician mounts the maxillary prosthesis onto the cast. Note that when this procedure is carried out in the mandibular arch, gingival reflection may allow for visualization of the mental foramina, guiding posterior placement of the tilted implants. Careful attention should be paid to the possibility of an anterior loop of the mental foramen.<sup>24</sup>

## Case 1

A 54-year-old woman presented with terminal dentition requiring maxillary and mandibular All-on-4 restoration. Frontal facial analysis revealed an excessive lower facial third. Within it, excessive display due to vertical maxillary excess was evident (Fig 2a). The lip length at rest also appeared short due to resting on the flared maxilla. Lip mobility from rest to maximal smile was hard to determine due to the lack of upper lip patency resulting from the protruded maxilla.

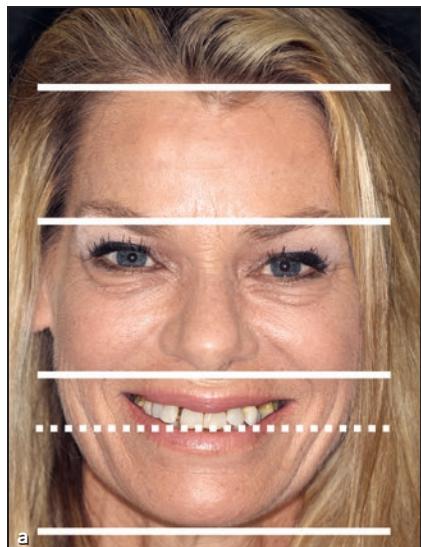
Profile analysis showed Holdaway's angle to be 3 degrees, indicating a need for repositioning of the maxillary lip and the chin (Fig 2b). The nasolabial angle was quite acute due to the labial flare and the projection of the columella. Retraction of the upper lip seemed likely to open and improve the nasolabial angle. The labiomental groove was excessively deep, with the key landmarks (the pogonion and anterior projec-

tion of the lower lip) deviating from a vertical position, requiring retraction of the lower lip, advancement of the chin, and prosthetic support of the groove. The patient's age dictated that, at rest, her AIE position ideally should reveal 1.0 to 2.0 mm. While smiling, the incisal edges needed to be repositioned apically approximately 4.0 mm. Close up, her profile revealed that her maxillary incisors were 2.0 mm anterior to her wet-dry line. Her lower lip was flared by about 3.0 mm, based on the exaggerated labiomental groove and her lower lip vermillion border with respect to her subnasale. The maxillary incisors thus needed to be posteriorly repositioned by 5.0 mm. This seemed likely to improve both her nasolabial angle and her facial profile. Her maxillary central incisor position would dictate her mandibular incisor position and improve her mandibular lip position. This in turn would improve her labiomental groove anatomy.

The patient's lower facial third was measured to determine the existing OVD and establish the deviation from ideal. Since her lower facial third was found to be approximately 4.0 mm longer than her middle and upper thirds, the aim for her new restorations was to decrease her OVD by 4.0 mm anteriorly and re-establish lower third symmetry. The above-described surgical protocol was followed, and by the provisional phase a dramatic change in the patient's appearance was evident. If necessary, minor changes in the final restoration could have been made to achieve ideal facial and dental esthetics (Figs 2c to 2g).

**Fig 2** Case 1. (a) Frontal view illustrating excessive maxillary display and a deviation of one-third to two-thirds ratio of upper to lower portion of the lower facial third. (b) Profile photo to assess Holdaway's angle, nasolabial angle, labiomental groove depth, and lip position. Frontal photos of (c) initial, (d) provisional, and (e) final phases of treatment. (f and g) Profile photos illustrating the dramatic changes in facial form.





**Fig 3** Case 2. (a) Frontal analysis reveals a deficiency in the lower facial third. (b) Profile view illustrating deviations from the ideal Holdaway's angle, nasolabial angle, labiomental groove, and lip position. Progression of treatment and improvement of facial form of (c and f) initial, (d and g) 2 weeks postoperative, and (e and h) final phases of treatment.



## Case 2

Frontal facial analysis of this 55-year-old woman revealed a deficient lower facial third (Fig 3a). A collapse due to labially flared teeth was evident. Profile analysis showed Holdaway's angle to be more acute than 10 degrees due to the over-rotation of the patient's mandible, which in turn had moved her chin too far forward (Fig 3b). An exaggerated nasolabial angle was present due to the labially flared teeth. This necessitated retraction of the incisors and possible reduction of her labially displaced alveolus to retract the lip. Her labiomental groove was much deeper than the ideal 4.0 mm concavity due to the labial flaring of her lower incisors and collapsed dentition. The compression of her lower facial third also exaggerated her nasolabial fold and her Marionette lines. A close-up of her profile revealed that her maxillary incisors were 2.0 mm anterior to her wet-dry line and her lower lip was flared by about 2.0 mm based on the exaggerated labiomental groove and her lower lip vermillion border with respect to her subnasale. The maxillary incisors thus needed to be repositioned posteriorly by 4.0 mm, with her maxillary AIE position moving 4.0 mm more incisally and 4.0 mm more posteriorly.

Her existing OVD was measured, and the lower facial third was found to be about 6.0 mm shorter than her middle and upper thirds. The new restorations were thus designed to increase her OVD by 6.0 mm anteriorly. The surgical protocol was followed, and the patient's dental and facial esthetics substantially improved (Figs 3c to 3h).

## Discussion

Long-term data supports the use of All-on-4 implant restoration as a treatment-planning option.<sup>25-32</sup> Treatment planning for this approach should be based not only on facial anatomy but also on consideration of the patient's age. Lip length changes over time and dictates the incisal display at rest. Facial fillers can both shorten and lengthen the lip. While the plastic surgery literature indicates that the nasolabial angle for women should be less obtuse than that discussed in the dental literature, labiomental grooves are rarely reported (if ever) in the dental literature. Yet they have a clearly defined anatomical definition.

Facial aging can occur even without dental contributing factors. Some skeletal aging factors entail a decrease in ramus height and mandibular body length and an increase in mandibular angle.<sup>33-35</sup> These bony alterations in conjunction with soft tissue loss contribute to the facial aging process. Edentulism, pathologic migration of teeth, vertical maxillary excess, posterior bite collapse, oligodontia, tooth developmental anomalies (ie, amelogenesis imperfecta), and iatrogenic dentistry are but a few of the factors that can alter facial anatomy. Understanding the facial aging process and age-appropriate dental esthetics can enable clinicians to better control not only the dental but also the facial impacts of dental restorations.

There are challenges when treatment planning with a dentofacial approach to the use of All-on-4. Severe skeletal discrepancies can

limit or impair the desired goal. Class III skeletal relationships where the SNA angle approaches 70 degrees will prevent a desired dentofacial outcome due to an inability to achieve an esthetic anterior tooth set-up without a proclined maxillary tooth appearance. The position of the fixtures may be too far posterior or palatal with respect to the mandibular arch and result in prosthesis flanges that impair speech. A severe skeletal Class II discrepancy requiring a restoration that involves increasing the OVD can exacerbate the skeletal discrepancy and encroach upon tongue space.

## Conclusions

The ideal goal of All-on-4 full-arch solutions is to restore dental and facial esthetics, phonetics, and function. An understanding of facial anatomy can help clinicians determine optimal incisal position. This in turn can enhance the dental and facial outcomes.

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