Comprehensive restoration and mandibular incisor esthetic exposure: a clinical report

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Complete mouth rehabilitation allows the dentist to solve multiple problems by controlling the restoration of many teeth. Guidelines and objective criteria for each area to be treated are essential when planning an extensive case. Esthetics, phonetics, and anterior guidance are affected by the height and inclination of the mandibular incisors. Placement of the mandibular incisal plane is important, as the mandibular anterior teeth may be more visible than the maxillary anterior teeth during speaking or when at rest. Provisional restorations can be adjusted and recorded so that the final restorations are predictably successful. This case illustrates the use of a trial incisal edge and digital videography of the provisional restoration to facilitate correct placement of the mandibular incisal plane.

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Patients with multiple restorative problems may benefit from a complete mouth rehabilitation which requires careful planning by the dental team. Some problems, such as the location and dimension of arc of closure interferences, are assessed most accurately on an articulator with diagnostic casts verified in centric relation. Other concerns, such as the length of maxillary incisors, and the palatal contours that dictate anterior guidance must be customized intraorally. The dentist must confirm that the initial plan (as derived from a diagnostic wax-up) is appropriate and coordinates with the patient’s lip function, speech, and mandibular motion.

The Pankey-Mann-Schuyler method of occlusal reconstruction involves restoring the mandibular anterior teeth with the correct incisal plane, the maxillary anterior teeth with a coordinated anterior guidance of the mandibular anterior teeth, the mandibular posterior teeth with the correct occlusal plane, and the maxillary posterior teeth with posterior teeth occlusion. It is critical to properly perform the first step in this sequence, since each subsequent aspect of the treatment and the final esthetic and functional results depend on it. Many dentists are familiar with the ideal esthetic exposure of the maxillary incisors relative to the lips in repose and full smile, as well as the phonetic “F” and “V” sounds that relate their incisal edge position to lip contact. In 50% of the resting and speaking facial expressions, mandibular anterior teeth are found to be more visible than the maxillary anterior teeth, indicating the importance of the mandibular incisal plane placement. The guidelines for mandibular incisor length are less well-known and can be more difficult to evaluate, since these teeth are not visible during occlusion or the making of “F” and “V” sounds. A mandibular incisal plane of insufficient height may present problems such as less visible teeth, distorted palatal surfaces of the maxillary anterior teeth, and extension of the maxillary incisal plane for proper phonetics with sibilant sounds. A mandibular incisal plane of excessive height may present problems such as unesthetic prominent teeth, a steeper anterior guidance, and elevation of the maxillary incisal plane for proper phonetics.

Although a dentist may gauge by direct inspection whether a patient’s mandibular incisor esthetic exposure is normal, deficient, or excessive, a clinical assessment of these teeth during speech and smiling is compromised by the rapid movement of the lower lip. Placing an instrument to measure this exposure interferes with normal lip movement. Photography is dependent on the short time window of the shutter speed and may not accurately record the maximum depth of lip movement. Having the patient hold a posed smile or speech sound (such as “E” or “M”) alters the esthetic exposure of the maxillary and mandibular incisors when compared to spontaneous smiling and speech.

The average length of a mandibular incisor is not an accurate guideline for a correct incisal plane height if the gingival margin level has been altered by orthodontics, periodontal surgery, or extrusion of the dentogingival complex with incisal wear. The incisal plane can be straight or it can form a convex or concave curve, precluding a simple guideline for all patients. When patients use an atypical mandibular protrusion during speech to make the “S” sound, the standard speaking space of <1 mm cannot be used as a guide for determining mandibular incisor height. Orthodontic movement may alter both the lower lip-tooth relationship and the esthetic exposure. Age and gender are other variables, as more of the mandibular incisor is visible among men and older patients with lips in repose. Race may influence the inclination of the mandibular incisors as well. Digital videography is a practical way to assess mandibular incisor esthetic exposure, since the patient can speak and smile normally during conversation, while a frame-by-frame measurement of the downloaded computer image can be obtained using a digital caliper or software program.

Burstone suggested that a relaxed lower lip should contact the mandibular incisors at the junction of the incisal and middle thirds. The placement of restorations to define the optimal mandibular incisal plane requires that dentists use multiple criteria—speech, esthetic exposure, tooth proportion, average tooth size, and comfort during function—to establish the length, inclination, and arrangement of the provisional restorations. The provisional restorations can then be tested over time, refined, and recorded to form mounted provisional casts that are a template for the porcelain restorations.

This case report describes the esthetic rehabilitation of a post-orthodontic, implant-assisted, maxillary arch intrusion, and planned anterior open occlusal relationship. Two techniques were utilized.
in the correct placement of the mandibular incisal plane. Prior to tooth preparation, the height and level of the mandibular incisors were tested clinically with a bonded trial incisal edge. After the placement of provisional restorations, digital videography was used to measure the esthetic exposure of the mandibular incisors during speaking and smiling.

**Case report**

A 58-year-old woman was referred by an orthodontist for evaluation of vertical maxillary excess, moderately severe wear of the teeth, and compromised esthetics (Fig. 1 and 2). She had no systemic health problems, pain, caries, or periodontal disease. A significant gingival recession/abfraction defect was present on tooth No. 8. After consultation with an orthodontist, it was concluded that maxillary arch intrusion with mini-implant anchorage would be preferable to maxillary arch impaction by LeFort I orthognathic surgery (Fig. 3). The goal of this intrusion was the full enamel exposure of the maxillary anterior teeth, while leaving a minimal amount of visible gingiva when smiling. The maxillary posterior teeth would also be intruded to maintain a harmonious occlusal plane and gingival levels. Intrusion of the mandibular anterior teeth would correct gingival levels and provide space for the bonded porcelain restoration without incisal tooth reduction. Occlusal analysis and diagnostic wax-up of the planned restoration was scheduled after the completion of orthodontics, when the actual amount of repositioning would be known. Orthodontic treatment was finalized after 27 months.

An anterior acrylic platform and bimanual guidance were used to obtain diagnostic casts verified in centric relation (CR). These casts demonstrated a postorthodontic anterior open occlusal relationship of 2.5 mm at the central incisors due to intrusion of both the maxillary and mandibular teeth. The casts helped the patient to visualize the severity of occlusal wear (Fig. 4). A diagnostic wax-up and trial equilibration of duplicate casts achieved normalization of tooth proportion, even bilateral anterior and posterior teeth contact, and canine guidance with posterior teeth disclusion (Fig. 5). Routine post-orthodontic occlusal equilibration was planned for the second and third molars, with comprehensive restoration of all teeth on both arches from first molar to first molar. Duplicate casts of the diagnostic wax-up were used to generate reduction guides, to preserve enamel during porcelain veneer preparation, and a clear matrix (Memosil, Heraeus-Kulzer). These casts were then prepared, and microfill composite resin (Charisma, Heraeus-Kulzer) provisional restoration shells were fabricated with the correct incisal and occlusal planes transferred from the diagnostic wax-up via the Memosil matrix.
The vertical reduction of teeth during preparation for porcelain veneers relates directly to the dimension of the final restoration. The first step of the restorative plan was to confirm the proper mandibular incisor length on the wax-up, as these teeth had been repositioned during orthodontics. A trial incisal edge was fabricated using the same clear Memosil matrix. The matrix was filled with hybrid composite resin (Renamel, Cosmedent), in sites No. 22-27, placed over a duplicate cast of the initial diagnostic cast, and photopolymerized. Using unfilled resin (Complete, Cosmedent), the trial incisal edge was bonded to the non-etched enamel of teeth No. 22-27. Rapid vertical reduction of the trial incisal edge adjusted the incisal edge position without concern for the contour details associated with a provisional restoration or a sculpted mockup (Fig. 6). The incisal plane was approved by the patient for tongue comfort and length. With the trial incisal edge in place, teeth No. 22-24 were prepared for porcelain veneers without local anesthesia. Reduction grooves in the trial incisal edge, presence of the trial incisal edge on the contralateral teeth, and placement of the reduction matrix from the diagnostic wax-up ensured conservative tooth reduction to maintain enamel for predictable adhesive restoration. Teeth No. 22-24 were provisionalized by relining the composite resin shells with the same resin, matching the level of the trial incisal edge on the adjacent incisors. Teeth No. 25-27 were prepared for porcelain veneers and provisionalized to the level of the provisional restorations of teeth No. 22-24. All other planned restorations were prepared and full-arch impressions were obtained using custom trays. The full-coverage provisional shells were relined intraorally with acrylic resin (Snap, Parkell, Inc.) and the partial veneer provisional shells relined with Charisma.

The anterior provisional restorations were bonded in 3 tooth segments. Impressions of teeth No. 8 and 24, and the adjacent provisional restorations generated casts to verify that the length and contour of the final restorations would match the provisional restorations. The provisional posterior teeth restorations were placed without cement. Full mouth equilibration created even posterior tooth contacts in CR closure to 20 µm ribbon (Accufilm, Parkell, Inc.). Smooth anterior guidance on the canines and central incisors excluded the posterior teeth. The provisional posterior teeth restorations were removed and bilateral triple tray impressions with the anterior teeth in contact were obtained; these impressions made it possible to verify the posterior porcelain occlusion on the full arch casts. The posterior full coverage provisional shells were cemented and the partial veneer provisional bonded. A full mouth series of X-rays taken at this time showed dense compacted lamina dura around the intruded teeth and confirmed the healthy dentition and periodontium that was seen on the panoramic X-ray provided by the orthodontist at the diagnosis stage (Fig. 7). Next, the periodontist placed a connective tissue graft on tooth No. 8 with the provisional restoration in place. To determine the patient’s comfort with lip support, normality of pronunciation, and approval
of esthetic exposure, the provisional restorations were tested over a 10-week period. A digital caliper recorded the intraoral mesiodistal width of the tooth No. 24 provisional restoration at 5.43 mm (Fig. 8). Video images of the patient’s provisional restorations during speech and smiling were recorded with a hand-held camera and downloaded into editing software (Windows Moviemaker, Microsoft). Single frame exposures of the provisional restoration exposure (taken with lips in repose, smiling, and during speech) were isolated, and the height and width of tooth No. 24 were measured using the digital caliper (Fig. 9). The ratio of the frame image width to the actual width of tooth No. 24 was 1.16 (6.30 mm/5.43 mm). For the provisional restoration in tooth No. 24, the maximum exposure in the frame image was 7.05 mm during speech and 3.11 mm with the lips in repose. Since the video image was enlarged by a ratio of 1.16, the actual maximum exposure of this provisional restoration was 6.07 mm during speech and 2.68 mm with lips in repose.

Casts of the provisional restorations were mounted on a semiadjustable articulator, with a facebow, CR and protrusive records, and a stick bite parallel to the interpupillary line to confirm correct cast orientation. Full arch master die casts were cross-mounted against the provisional casts. Lithium disilicate all-porcelain restorations (IPS e.maxPress, Ivoclar Vivadent, Inc.) were fabricated, etched, silanated, and bonded to the acid-etched teeth (Fig. 10). The tooth preparation/provisional restoration casts and
the triple tray casts of the posterior teeth provided verification checks for porcelain contours, incisal length, and occlusion that minimized adjustments after bonding. All restorations were equilibrated to achieve even contact on closure in centric relation to 20 µm Accufilm. Canine guidance was established in lateral excursions and central incisor guidance in protrusive excursion. For nocturnal bruxing protection, a full arch maxillary bite splint with even CR contacts on all teeth—and anterior guidance on the canines alone—was delivered (Fig. 11). The completed case demonstrated a dramatic esthetic improvement that was also comfortable, due to the replicated contours and occlusion of the tested provisional restorations (Fig. 12).

### Discussion

To solve the patient’s esthetic and structural problems, the dental team planned an extensive dental rehabilitation involving a conservative approach with orthodontics followed by full and partial coverage bonded porcelain restorations. Mini-implants provided absolute anchorage for significant intrusion movement that reduced excessive gingival exposure. Although orthognathic surgery, (LeFort I maxillary impaction technique), would have shortened the treatment time, it also would have increased the possibility of greater morbidity and sensory deficit in the lip; in addition, orthodontic treatment still would have been required to correct tooth rotation problems. A post-orthodontic anterior open occlusal relationship can be treated by reducing the occlusal vertical dimension with posterior tooth equilibration and autorotation of the mandible; however, these steps would not have resolved the esthetic deficit or protected the worn teeth. An interdisciplinary solution was needed to provide optimal treatment.

For a patient with an equilibrated dentition at the correct vertical dimension of occlusion, the Pankey-Mann-Schuyler sequence—performed during one or a series of appointments—can provide comprehensive restoration. In the present case, the second and third molars were equilibrated in conjunction with the placement of all provisional restorations to establish therapeutic occlusion and correct the esthetic deficit simultaneously. The patient did not demonstrate a speech deficit after orthodontics despite the significantly altered anterior tooth relationship. Because the gradual orthodontic displacement of the anterior teeth may have led to accommodation of the tongue and lips, phonetic tests cannot be the sole guide for incisal edge placement. Over time, it was confirmed that the mandibular incisal plane of the provisional restorations was placed correctly for esthetics, comfort when eating, clear pronunciation of sibilant sounds, CR contact of anterior teeth without fremitus, and smooth anterior guidance against the maxillary provisional restorations.

Complex cases include so many variables that visual assessment alone is inadequate for treatment planning or evaluating the final restoration. Obtaining a predictable result requires objective criteria for each aspect of an interdisciplinary case. The trial incisal edge was measured on the cast to recreate normal tooth proportion, an objective goal for the restorative process that was then customized intraorally. The trial incisal edge was evaluated for speech, lip support, and esthetic exposure; at that point, it was corrected rapidly prior to its use as a reduction guide. Digital videography provides a noninvasive recording and objective measurement of the teeth’s esthetic exposure. Frame-by-frame evaluation of the lip (and its relation to the provisional restoration) can take place without the physical intervention of a ruler or caliper; at the same time, the incisal plane and tooth arrangement are evaluated as well. In the present case, the patient readily accepted the improved esthetics and had

### Table. The range of mandibular incisor exposure in the dental literature.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Gender (years)</th>
<th>Lip posture</th>
<th>Mandibular incisor vertical exposure (mm)</th>
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<tbody>
<tr>
<td>Hartmann &amp; Muller18</td>
<td>Both (60-86)</td>
<td>At rest</td>
<td>1.60</td>
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<tr>
<td></td>
<td>Both (21-33)</td>
<td>At rest</td>
<td>0.40</td>
</tr>
<tr>
<td>Al-Wazzan19</td>
<td>Both (56-60)</td>
<td>At rest</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>Both (20-25)</td>
<td>At rest</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>Male (all ages)</td>
<td>At rest</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
<td>Female (all ages)</td>
<td>At rest</td>
<td>0.78</td>
</tr>
<tr>
<td>Vig &amp; Brundo20</td>
<td>Both (&gt;60)</td>
<td>At rest</td>
<td>2.95</td>
</tr>
<tr>
<td></td>
<td>Both (≥29)</td>
<td>At rest</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Male (all ages)</td>
<td>At rest</td>
<td>1.23</td>
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<tr>
<td></td>
<td>Female (all ages)</td>
<td>At rest</td>
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</tr>
<tr>
<td>Al-Habahbeh et al21</td>
<td>Male (all ages)</td>
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<td>1.09</td>
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<td></td>
<td>Female (all ages)</td>
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<td></td>
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<tr>
<td>da Motta et al22</td>
<td>Male (12-15)</td>
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<td></td>
<td>Male (≥51)</td>
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<td></td>
<td>Female (≥51)</td>
<td>At rest</td>
<td>2.22</td>
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<tr>
<td>van der Geld et al23</td>
<td>Male (20-25)</td>
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<td></td>
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<td></td>
<td>Male (50-55)</td>
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<td>1.50</td>
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<tr>
<td>van der Geld et al27</td>
<td>Male (35-55)</td>
<td>Speech</td>
<td>6.60</td>
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<tr>
<td></td>
<td>Male (35-55)</td>
<td>Spontaneous smile</td>
<td>3.90</td>
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no problem with lip support or phonetics. This patient had a very active lip and the amount of her mandibular incisor esthetic exposure was at the high end range of natural teeth norms (Table).

The literature describes a broad range of esthetic exposure values, which creates a general guideline only. Patients can have active or inactive lips, displaying different amounts of a provisional restoration with a correct incisal plane. Roe et al found a wide range of upper lip mobility measurements.38 Esthetic exposure is only one variable that influences placement of the incisal plane. If the patient does not accept the height of the provisional mandibular incisor restoration, the dentist must determine an objective range of normal exposure so that the provisional restoration can be altered to stay within this range. If the patient wants an excessive or deficient amount of esthetic exposure, the effect on the maxillary arch must be discussed.

It is important to analyze the entire range of esthetic exposure for the mandibular incisors, from the lips at repose through and occlusal planes, and the buccal corridor. Clinical information can be compared with data from natural teeth studied in the dental literature for the age and sex of the patient. A hand-held digital video camera should be a practical part of any dental procedure affecting phonetics and the esthetic zone.

Conclusion

Comprehensive restoration is a profound benefit to patients, as multiple problems can be solved by using a planned approach. In current treatment philosophy, preservation of natural tooth structure, optimal prosthetic contours, and esthetics are priorities in any dental restoration. Multiple guidelines for mandibular incisor restorations and the incisal plane must be used to create the best balance of function, speech, and esthetics. Each aspect of an interdisciplinary case must be controlled with objective criteria for a predictable result. A bonded trial incisal edge and the use of digital videography are simple techniques that facilitate these goals.

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References


Operative (Restorative) Dentistry  Comprehensive restoration and mandibular incisor esthetic exposure


Manufacturers
Cosmedent, Chicago, IL
800.621.6729, www.cosmedent.com

Heraeus-Kulzer, South Bend, IN
800.435.1785, www.heraeus-dental-us.com

Ivoclar Vivadent, Inc., Amherst, NY
800.533.6825, www.ivoclarvivadent.com

Microsoft, Redmond, WA
425.882.8090, www.microsoft.com

Parkell, Inc., Edgewood, NY
800.243.7446, www.parkell.com

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