



# DIAGNOSTIC MOCK-UPS AS AN OBJECTIVE TOOL FOR PREDICTABLE OUTCOMES WITH PORCELAIN LAMINATE VENEERS IN ESTHETICALLY DEMANDING PATIENTS: A CLINICAL REPORT

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This clinical report demonstrates how a clinician can objectively overcome some of the barriers associated with providing patients with predictable esthetics, in a mutually satisfactory manner. Two such barriers are identified and discussed. The first is related to psychology and patient attitude to treatment. The second is related to the actual clinical procedure. A direct mock-up technique is described which serves as an effective communication tool between the dentist, patient, and dental laboratory technician. (J Prosthet Dent 2008;99:333-339)

Historically, many authors have identified barriers to patients receiving and accepting dental treatment.<sup>1-3</sup> It has been suggested that the psychological status, as well as the patient's attitude, has bearing on the course of dental treatment.<sup>1-3</sup> Recently, the American College of Prosthodontics (ACP) recommended the use of a classification system by McGarry et al<sup>4</sup> for evaluating the difficulty in treating the dentate patient.<sup>4</sup> In this classification system, the occlusal scheme and state of the existing dentition have a bearing on perceived difficulty for dental treatment. A Class I patient is ideal or minimally compromised in terms of difficulty to treat, while a Class IV patient is severely compromised. It is proposed that the psychological status of the patient can also affect perceived difficulty for dental treatment. Esthetic concerns or challenges raise the classification in complexity by 1 or more levels in Class I and II patients. McGarry et al<sup>4</sup> identified a specific group as "refractory patients" in the Class IV category. These are patients who present with chronic complaints following appropriate treatment. It is

therefore evident that the psyche and attitude of patients towards treatment can affect the outcome of dental treatment.

Provisional restorations serve as an excellent tool in evaluating the esthetic needs of patients.<sup>5,6</sup> Some patients demand a high level of restorative dentistry to achieve esthetics and function. Elective restorative dentistry should not be undertaken without a clear understanding of the patient's expectations and the limitations of restorative therapy. The final result should be visualized and realized before an irreversible procedure is performed.<sup>6,7</sup> The use of mounted diagnostic casts, diagnostic arrangements, and provisional restorations is well documented and ensures a predictable end result.<sup>7,8</sup> Patient approval is more likely to follow. More recent and sophisticated methods have integrated additive direct diagnostic mock-up procedures to compensate for tooth aging or severe loss of tooth substance. A direct mock-up may be defined as the fabrication of an acrylic resin template directly intraorally using autopolymerizing acrylic resin

molded on the unprepared tooth surfaces with a silicone matrix. This approach allows for more enamel preservation and, as a consequence, more predictable bonding, biomechanics, and esthetics.<sup>8,9</sup>

When porcelain laminate veneers are the selected treatment option to restore the esthetics and function, the mock-up is an objective and effective tool for communication between the dentist, patient, and laboratory technician. In the authors' opinion, this method is a necessity when treating patients with high esthetic demands. Unlimited time allocated for the evaluation period with mock-ups before any irreversible procedure is performed renders this technique safe and reliable. The mock-up technique allows 3-dimensional visualization of the result intraorally over a period of time. This is, therefore, preferred to a 2-dimensional chairside image modification software that is currently available. This article describes how a series of diagnostic mock-ups are used to evaluate the esthetic demands and provide restorations that are acceptable to an exacting patient.

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## CLINICAL REPORT

A healthy 21-year old woman presented at the University of Southern California School of Dentistry (Oral Health Center) with complaints concerning her existing acrylic resin veneer provisional restorations (Fig. 1). The patient was concerned that the definitive restorations that the previous dentist was planning to provide would replicate the form and color of her existing provisional restoration. Evaluation of the patient's dental history revealed that the previous dentist attempted to set the esthetic parameters for the definitive restorations with the use of a mock-up and provisional restorations, without success. The maxillary anterior teeth were previously prepared for porcelain laminate veneers. The dissatisfied patient was then referred to the primary author for restoration of the maxillary anterior teeth. A history of unsuccessful, extensive orthodontic treatment was confirmed by photographs (Fig. 2). The orthodontic treatment was considered to have failed as the large open contacts in the maxillary anterior dentition were not closed.

The patient complaint stemmed from the shape of the overcontoured provisional restorations, as well as the asymmetry and lack of harmony between the maxillary central incisors. The cant<sup>10</sup> (maxillary central incisor crown angulation) in the midline was also a feature of the smile with which the patient was displeased. It has been shown that lay people, orthodontists, and general dentists are able to identify a discrepancy in the cant in the maxilla of 2 mm or more.<sup>10</sup> The patient in this clinical report was significantly more discerning than expected, as the cant in the midline was estimated at 1 mm. This finding was an indication that the patient should be classified as exacting.<sup>2</sup> The history also indicated no desire to pursue further orthodontic treatment.

The first 2 appointments with the patient consisted of data collection and documentation. The physical

limitations to a successful outcome were noted. A large portion of these appointments included attempting to assess if the patient psyche would allow a successful treatment outcome. The patient was categorized as Class III according to McGarry et al.<sup>4</sup> This classification was largely based on a combination of physiological and psychological needs of the patient. It was decided that although the patient was exacting, her dental needs could be realized with the use of mock-up and provisional restorations as an objective communication tool. A large aspect of the negative conditioning and attitude towards dental treatment was linked to prior improper treatment planning. The dental history clearly demonstrated that although the patient was esthetically demanding, she was not a refractory patient. As these teeth were previously prepared, it was decided that a satisfactory outcome

would be achieved if this patient was treated with porcelain laminate veneers to restore the maxillary anterior teeth.

Other treatment options, which included orthodontic tooth movement prior to restoration, were discussed and rejected by the patient. Complete coverage restorations were not considered a treatment option as they are less conservative than veneers. The limitations of treatment were discussed with the patient. She was made aware of the large spaces between the lateral incisors and canines and the restorative challenge associated with the spacing (Fig. 2). Attention was also drawn to the gingival zenith in relation to the maxillary lateral incisors. The apical and mesial position of the gingival margin of the right maxillary lateral incisor presented another potential restorative challenge (Fig. 3). The asymmetry in the



**1** Preoperative photograph.



**2** Tooth preparations by previous dentist showing large open contacts between maxillary lateral incisors and canines.

gingival zenith between the maxillary laterals also was of concern. However, in the natural dentition, maxillary lateral incisors display a large variation in size compared to the central incisors. They are often bilaterally asymmetrical, with wider mesio-distal variation in their size than the central incisors.<sup>11-14</sup> Also, the gingival margins of the lateral incisors are often misaligned and unevenly displayed.<sup>15</sup> As long as the asymmetry between the lateral incisors is balanced and does not create visual tension, it can be an acceptable element of a harmonious esthetic restoration. Based on these concepts, it was decided that a satisfactory result would be achievable for the patient within the constraints created by tooth and gingival margin positions.

When evaluating the patient's incisal relationship, it was found that the edge-to-edge position of the laterals and canines further complicated the prospect of restoration (Fig. 2). As the patient had already committed to restorative treatment, she was highly motivated to proceed, having been fully briefed on the limitations of dental treatment. Based on the diagnostic data and initial esthetic evaluation, a diagnostic wax pattern, which was created freehand, served as a baseline for the initial diagnostic evaluation for the patient. The diagnostic cast with wax pattern was converted to a stone cast (GC Fujirock EP; GC America, Alsip, Ill) for improved visualization (Fig. 3). An impression of the diagnostic cast was made with a light-bodied addition-reaction silicone material with relatively low shore hardness (Elite Double 22; Zhermack, Eatontown, NJ) to avoid fracture of the wax pattern. The impression material was vacuum-mixed and poured onto the boxed diagnostic cast. The impression was separated from the cast for evaluation of detail reproduction. A vacuum-mixed type IV stone (GC Fujirock EP; GC America) was poured into the silicone mold (or impression) and separated after setting. In the first stage of the



**3** Stone cast of first diagnostic arrangement.

diagnostic approach, recognition of the patient's personality assisted the technician in defining a preliminary restorative goal. The dental laboratory technician was present at the initial patient interview. Direct communication between the technician and the patient ensures that no information is lost. In the opinion of the authors, the role of the technician is critical in obtaining an optimal result. The technician is responsible for creating an appropriate tooth arrangement for the patient. It follows that direct contact with the patient would only facilitate information transfer to the technician by visualization and communication.

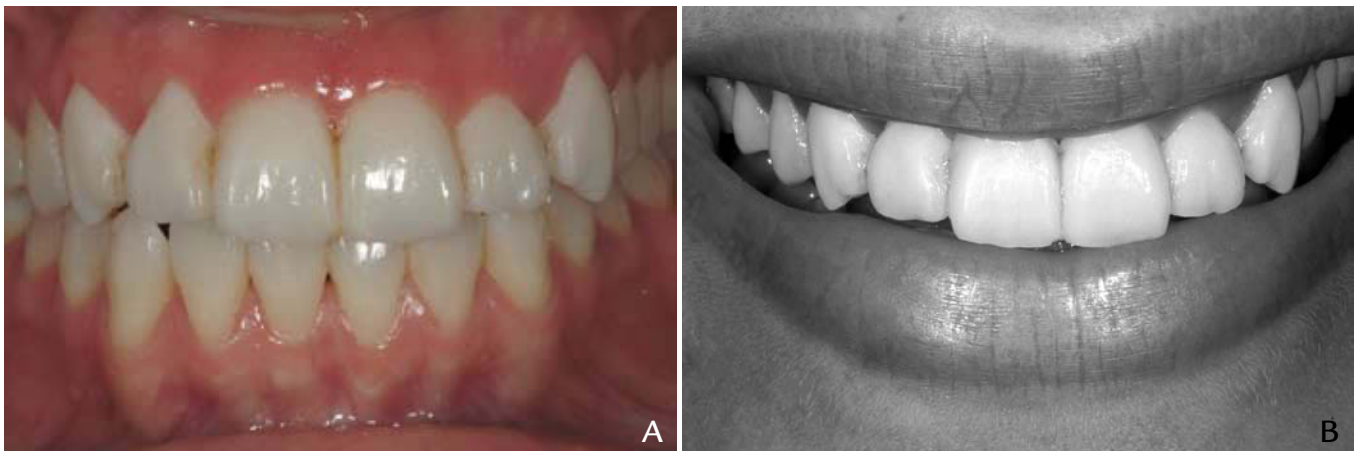
Figure 4 demonstrates the sequential steps in translating the initial diagnostic arrangement into a diagnostic direct mock-up over the existing preparations. This technique is almost identical to the one defined earlier in this article, except that an acrylic resin template was directly fabricated on the prepared teeth. The teeth and the soft tissues were insulated with petroleum jelly (Vaseline; Unilever, Greenwich, Conn) to prevent damage caused by heat generated during the exothermic reaction of acrylic resin. The silicone index (Platinum 85; Zhermack), which was made on the cast (Fig. 3), was filled with acrylic resin (New Outline; Microstar, Lawrenceville, Ga) and adapted to maxillary anterior tooth preparations with finger pressure until the material was fully polymerized (Fig. 4, A). Irriga-

tion was used to cool the acrylic resin during the exothermic stage. Square wax ropes (Coltene/Whaledent, Inc, Cuyahoga Falls, Ohio) were adapted to the palatal aspect of the maxillary anterior teeth to block palatal, interdental undercuts to control the flow of unpolymerized acrylic resin (Fig. 4, B). Excess polymerized acrylic resin "flash" was removed with a blade. Figure 4, C, shows an intraoral anterior view of the mock-up immediately after removal of the silicone index. A thin layer of acrylic resin flash is visible on gingival tissues and was removed with a blade (#10 surgical blade; Patterson Dental; St. Paul, Minn) (Fig. 4, D).

The mock-up was enhanced with light-polymerizing stains (Kolor Plus; Kerr Corp, Orange, Calif) to characterize the acrylic resin interdentally. An unfilled resin with a minimal oxygen-inhibited layer acting as liquid glazing resin (Skin Glaze; Microstar) was used to smooth the surface. The brown interdental staining increased the "separation effect" of the teeth, while the grey incisal surface staining allowed simulation of translucency which would be incorporated into the definitive porcelain bonded restorations. The smooth glossy surface produced by the glaze improved the surface reflectivity and patient's comfort. The latter is improved as a rough and porous surface is prone to plaque retention, staining, and can aggravate the patient's tongue. An additional polymerization cycle through a layer



**4** A, Silicone index adapted to preparations. B, Excess polymerized acrylic resin. C, Intraoral anterior view of mock-up. D, Removal of excess polymerized resin with blade.



**5** A, Intraoral anterior view of mock-up after staining and glazing. B, Patient smiling with mock-up.

of glycerin jelly (K-Y Jelly; Personal Products Co, Skillman, NJ) was necessary to obtain a highly glossy surface (Fig. 5, A). This is achieved by eliminating the oxygen inhibition layer. The glazing resin was polymerized for 20 seconds at an intensity of 1000 mW/cm<sup>2</sup> (Allegro High-Intensity LED; Den-Mat, Santa Maria, Calif), followed by the application of an air-blocking bar-

rier (K-Y Jelly; Personal Products Co) and 10 seconds of additional light exposure with the same light unit to polymerize the oxygen-inhibition layer.

Although the patient initially seemed satisfied with the outcome of the direct mock-up on the prepared teeth, she was encouraged to wear the mock-up for a week to obtain input from close family and friends (Fig. 5,

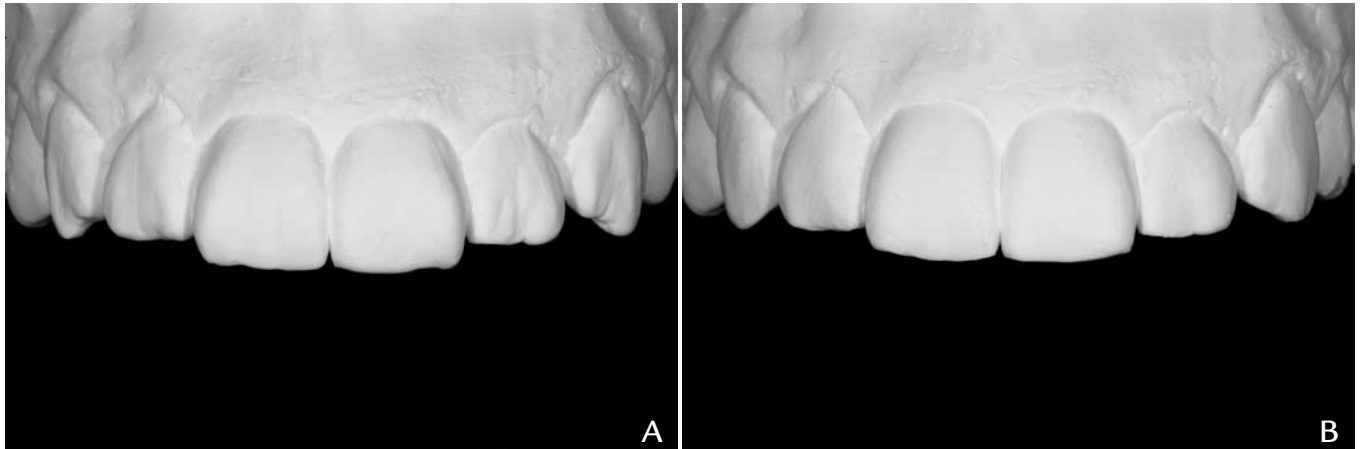
B). The mock-up was fixed onto the teeth as a result of intimate adaptation to the preparations from polymerization shrinkage. The patient was instructed on maintenance of interproximal gingival health with the aid of dental floss (Super Floss; Oral-B, S Boston, Mass). At the next appointment the patient remained satisfied with the restorations as a whole; how-

ever, she requested some modifications to the mock-up. She expressed her desire for the teeth to have a “softer look,” with less interproximal staining. A “softer look” can be defined as teeth with less prominent and defined facial transitional line angles. The diagnostic arrangement was modified accordingly and duplicated in dental

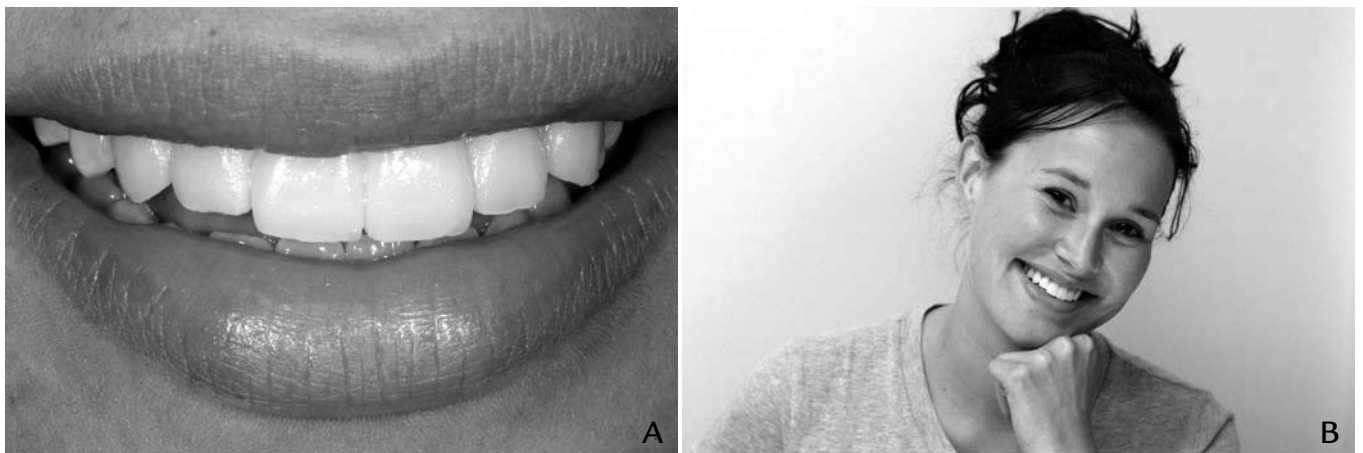
stone (Fig. 6). Translating the new diagnostic arrangement into the second direct mock-up on the existing preparations culminated in the patient’s full approval (Fig. 7). Only at this point was it appropriate to continue with tooth preparation. The appropriate tooth reduction was verified with the use of a silicone index (Platinum 85;

Zhermack) made from the modified diagnostic waxing (Fig. 8).

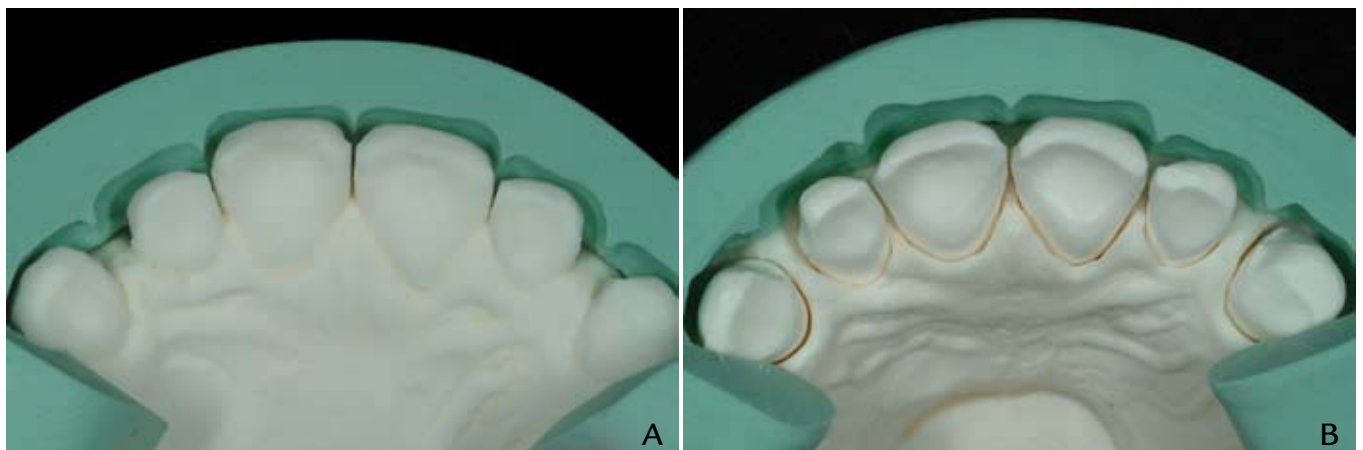
At this point, the clinician realized the patient’s esthetic needs in a systematic and objective manner. Such diagnostic commitment may seem exaggerated; however, it offers maximum predictability of the treatment outcome, resulting in a high prob-



**6** Stone cast of modified diagnostic arrangement to achieve “softer look.”



**7** A. Second (definitive) mock-up with “softer look.” B, Patient is satisfied with definitive mock-up.



**8** A, Relationship between silicone index made from definitive diagnostic arrangement with stone cast of preparative veneer preparations, highlighting underreduced facial areas. B, Definitive preparation with adequate facial reduction to provide dental laboratory technician with sufficient space to achieve optimal esthetics.



**9** A, Intraoral anterior view of definitive restorations. B, Intraoral lateral view of definitive restorations. C, Patient smiling with definitive restorations. D, Patient is satisfied with definitive restorations.

ability of reestablishing the patient's confidence. This aspect of the relationship is invaluable when compared to the possible consequences of inadequately defined treatment objectives. It would be more costly to miss the esthetic target and have to remake the definitive restorations. It was appropriate to proceed with the fabrication of the definitive restorations at this point in time.

Figure 9 shows various views of the definitive restorations. All of the treatment objectives were met. The restorations were satisfactory in terms of form, phonetics, and function. Adequate vertical and horizontal overlap were established, with a mutually protective occlusion.<sup>16</sup> The contour modifications used to change the incisal edge position from edge to edge (preoperatively) to the current one involved adding bulk to the teeth facially and incisally. This allowed establishment of appropriate facial contours,

incisal length, and horizontal and vertical overlap. The detailed clinical and laboratory steps have been previously described and are beyond the scope of this article.<sup>6,8,17</sup> The porcelain laminate veneer restorations have now been in service for 1 year with no postoperative clinical complications.

### SUMMARY

This article demonstrates how a clinician can objectively remove some of the barriers associated with providing patients with predictable esthetics, in a mutually satisfactory manner.

Two such barriers were identified and discussed. The first is related to psychology and patient attitude to treatment. The second is related to the actual clinical procedure. It is important to understand each patient's psychological and social attitudes to dental treatment. The classifica-

tion system is an objective method of categorizing patients to determine whether their esthetic needs can be satisfied. The direct mock-up technique described is the second tool which facilitates predictable results, when treating patients with complicated esthetic needs. Close communication between the patient, dentist, and dental laboratory technician is essential for a smooth and predictable transition from the initial contact to insertion of the definitive restorations.

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## NOTEWORTHY ABSTRACTS OF THE CURRENT LITERATURE

### Multicenter retrospective analysis of wide-neck dental implants for single molar replacement

Levine RA, Ganeles J, Jaffin RA, Clem DS 3rd, Beagle JR, Keller GW.  
*Int J Oral Maxillofac Implants* 2007;22:736-42.

**Purpose:** To evaluate the predictability of Straumann wide-neck dental implants (6.5-mm prosthetic neck with a 4.8-mm endosseous sandblasted, large-grit, acid-etched-surface body) used for molar replacement.

**Materials and Methods:** Four hundred ninety-nine single-tooth implants were restored in molar sites in 410 patients (mean time of loading 23 months; range, 1 to 54 months) by 6 clinicians throughout the United States. Three hundred-fifty nine implants were placed in the mandible and 148 implants in the maxilla.

**Results:** The overall cumulative survival rate was 98.4% for all sites (8 failures). Survival rates of 99.2% for mandibular molars (3 failures) and 96.6% for maxillary molars (5 failures) were achieved. Survival rate of implants placed in conjunction with the bone-added osteotome procedure in the maxillary molars was 89%, with 5 of 45 procedures leading to failure.

**Discussion:** Minimal restorative problems were encountered. No cases of abutment loosening or fractures were observed for cemented restorations on solid abutments.

**Conclusion:** The data suggest that the Straumann solid-screw, wide-neck implants can be a satisfactory choice for molar single-tooth replacement.

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