Dynamic Documentation of the Smile and the 2D/3D Digital Smile Design Process

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Medical and dental histories, clinical examination, study models, and photographs provide the data for a proper diagnosis and the treatment plan for esthetic dentistry. However, they do not offer all the information necessary to analyze the smile and create harmony with the lips and face without excessive intraoral adjustments. Dentolabial parameters vary according to lip dynamics and are influenced by both a static posed smile and a smile in motion as captured in video. This article describes a documentation protocol using smartphone videos to improve the analysis, smile design decisions, and elaboration of a 2D smile frame that will guide the 3D digital smile design project. The use of dynamic documentation of the smile (DDS) allows esthetic rehabilitative planning from a facial perspective, improvement of communication with the patient, integration between the specialists, and the predictable quality of the treatments. Int J Periodontics Restorative Dent 2017;37:183–193. doi: 10.11607/prd.2911

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Esthetic dental rehabilitation has been faced with three great challenges: *(1)* relate the working models to the face, *(2)* interdisciplinary communication and planning, and *(3)* interaction with the patient. Drawing reference lines and forms on extra- and intraoral photographs has been used to broaden the diagnostic view and help the restorative team evaluate esthetics and function and make adequate clinical decisions.[1–3] Digital Smile Design (DSD) is a conceptual tool that allows esthetic rehabilitative planning from a facial perspective, improving communication between specialists and increasing the predictability of the treatments.[1]

There are parameters that guide smile evaluation and design, such as the midline, height, and curve of the smile and intra- and interdental proportion.[4–8] Although many studies have measured the static smile,[9–13] it is always difficult to capture the ideal frame in a photograph.[14] The beauty of a smile emanates from its motion and the dynamic integration of teeth, gingiva, lips, and face, so static photos are an inadequate basis for smile design. The perception of esthetics in motion is different than the static view. Each second of video footage covers approximately 29 frames, increasing the chance of finding the correct spontaneous moments for the smile design.

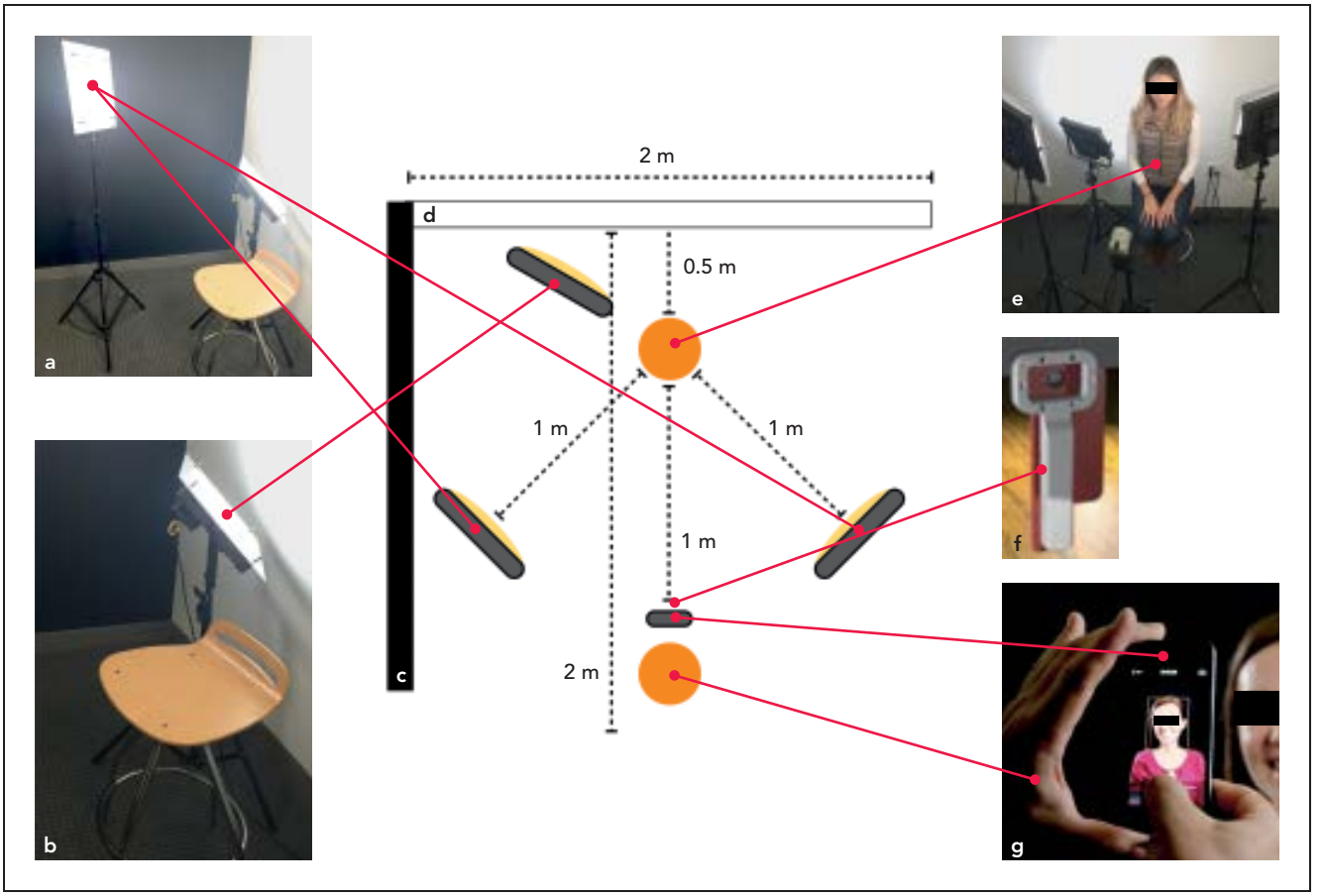

Fig 1 *Suggested studio for smartphone videos.* (a) *Two LED panels in front of the patient will generate the ideal light to create videos with sufficient quality.* (b) *An extra LED panel can be placed behind the patient when using a white background to remove the shadows.* (c, d) *A room with a black and a white wall used for backgrounds.* (e) *Patient approximately half a meter away from the wall.* (f) *An extra LED light attached to the phone to reduce intraoral shadows in the close-up images.* (g, h) *A smartphone or tablet used to film the patient. The device should not be too close to the patient to avoid large distortions.*

Dynamic video evaluations have been used in orthodontics for some years.[14–20] However, few studies of the smile in motion have been conducted in esthetic dentistry. The aim of this study was to describe the smartphone video protocol for making the photo documentation with snapshots of the video, and to show the advantages of using video documentation to facilitate and simplify the documentation process, improving facial analysis, smile design, team communication, treatment planning, and patient education.

Smartphone Video Protocol for DSD

Photographs taken with digital single lens reflex (DSLR) cameras are still the gold standard to fabricate beautiful documentation for lectures and publications. When it comes to image quality, smartphone cameras are not as good as DSLR cameras. However, they are adequate for smile design, treatment planning, patient education, and the digital workflow, allowing the team to deliver optimal routine dentistry on a daily basis.

The key to recording videos of acceptable quality with a smartphone is to have intense light coming from LED panels (Fig 1). When filming with the smartphone, the operator has to make sure ideal framing and zoom are adjusted to the face with ideal exposure and focus adjusted to the mouth (Fig 2). A monopod and a smartphone holder are used to stabilize the phone, and a glove box should be placed behind the patient to avoid head movement (Fig 3).

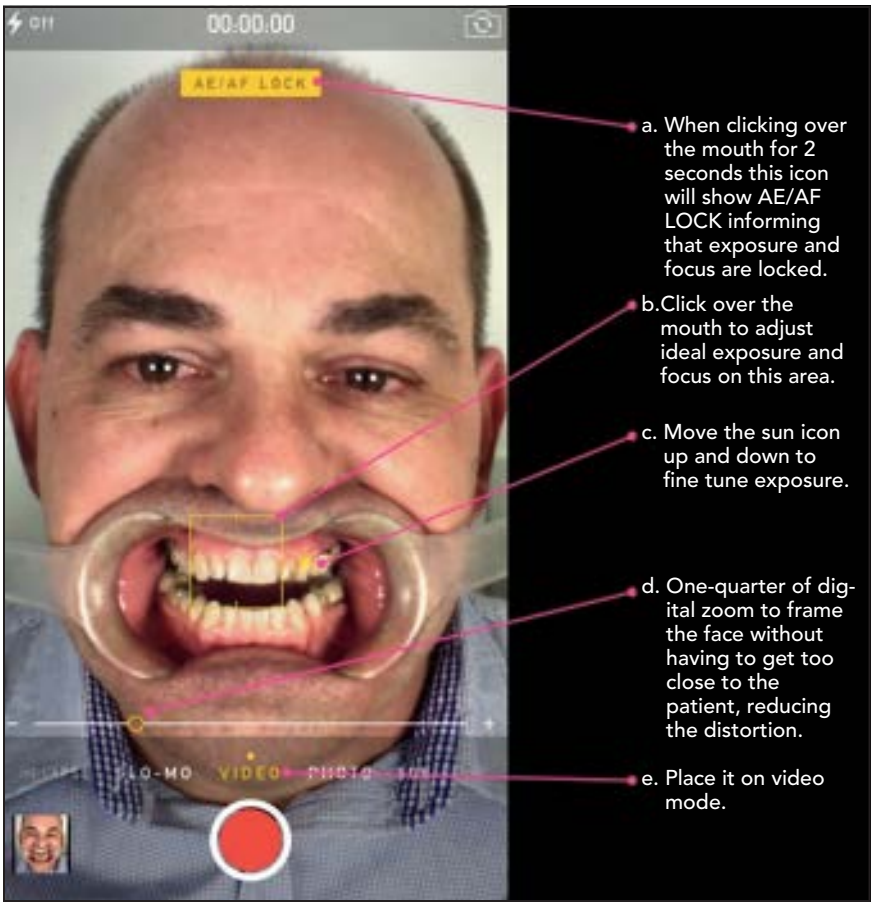

Fig 2 *Adjusting the smartphone.*

Fig 3 *Stabilization of the smartphone and the patient's head.*

Technical Videos

Four videos should be taken from specific angles for ideal development of the facially guided smile frame.

A facial frontal video should be recorded, including with and without retractor smiling (Fig 4). The key is to keep the camera and the patient's head still to create photos with and without retraction from similar distances, angles, and distortions. Both images then can be overlapped on the DSD process, linking the facial analysis to the intraoral analysis. The

Fig 4 *Facial frontal video.* (a) *Retracted.* (b) *Smiling.*

Fig 5 *Facial profile video.* (a) *Patient positioning.* (b) *At rest.* (c) *Smiling.*

camera should be level with the eyes slightly above the mouth, creating a natural smile curve. The closer the camera gets to the patient, the bigger the distortion of the image. To minimize this distortion, keeping a 1-meter distance and slightly zooming in digitally are recommended. In both frontal videos, the mouth should be open with the teeth apart for better visualization of the esthetic issues, the mandibular teeth, and drawings and simulation. The patient should bite on a jig on the molar area to keep the teeth at a similar distance in both photos.

A facial profile video (Fig 5) should be taken with the lips at rest and in a wide E smile. The key is to provide a total profile view. The reference should be the upper lip.

A 12 o'clock video (Fig 6) should also be taken from above the head at the most coronal angle that still allows visualization of the incisal edge of the six anterior maxillary teeth with the patient retracting the upper lip with both thumbs. This image should show the relationship between the facial midline, interpupillary line, intercommissural line, angles of the mandible, menton, arch form, and vermilion of the lower lip.

Finally, an anterior occlusal video (Fig 7) should be made without a mirror and perpendicular to the occlusal plan. The goal is to capture the maxillary teeth from second premolar to second premolar with the palatine raphe as straight line.

Complementary Videos

Four complementary videos should also be taken for facial, phonetic, functional, and structural analysis (Fig 8).

A facial interview (Fig 8a), a short interview of the patient with basic questions, can give important information about the patient's desires and chief complaint. This information is vital for the dental team to develop a strategy of communication to the patient and increase the patient's confidence. The following four basic questions should be asked: *(1)* Why are you seeking dental treatment? *(2)* What do you like and what do you dislike about your smile? *(3)* What are your expectations? *(4)* What do you consider as an ideal smile?

In a close-up 180-degree phonetics video (Fig 8b), the patient will count from zero to ten, pronouncing the important phonetic sounds (F, V, S), and give a regular smile and

Fig 6 *12 o'clock video.* (a) *Patient positioning.* (b) *Close-up view.*

Fig 7 *Anterior occlusal video.* (a) *Patient positioning.* (b) *Close-up view.*

a stretched E smile. As the smile design process is related to the speech process, dentists should include the phonetic analysis when designing new smiles. If better speech findings are needed, the video can be easily sent to a speech therapist for further analysis.

In an intraoral functional video (Fig 8c), taken with a retractor, the patient is asked to perform the functional excursive movements (protrusion and lateral movements). Both sides, working and nonworking, are filmed. Asking the patient to chew and do the functional

Fig 8 *Complementary videos.* (a) *Facial interview.* (b) *Close-up 180-degree phonetics.* (c) *Intraoral functional.* (d) *Intraoral structural.*

excursive movements provides insight into their envelope of function, clarifying some interferences that are difficult to capture in still photos.

An intraoral structural video (Fig 8d) is also taken with a retractor to visualize the occlusal surfaces of the maxillary and mandibular arches.

Specific moments of facial expression must be analyzed to understand the dentofacial disharmonies and make clinical decisions. For example, the lip rest position, the height of the smile line, the shapes of the lips, the integration of facial and dental midline, lip support, soft tissue display, buccal corridor, and facial profile can all appear distorted when only photos are considered. What may look good or bad in a static photo may seem the opposite when these elements are in motion. A common problem with the digital smile design is that the photos may be taken at the wrong angle. Video can capture a specific view with slightly different angles and can be transformed into photos by pausing the video and making a screen shot of the desired angle. This simplifies the documentation process and saves time. It also removes the responsibility of the photographer to snap the photo at the perfect moment, allowing a choice of the best recorded moment. The facial analysis through video should guide the smile design process that will be done over static images in two (2D) and three dimensions (3D).

DSD Technique

The main goal of the DSD technique on the computer is to adjust the photos from the three main views of DSD (12 o'clock, frontal, and occlusal) with one another using the digital ruler, and to add the lines and drawings that will create the smile frame based on the video analysis. This frame, together with

the conventional patient documentation (eg, medical history, dental history, clinical exam, perio chart, radiographs, models), completes the information needed to improve the decision-making process, interdisciplinary interaction, and treatment planning. The frame is not a definitive rule that needs to be matched at any cost, because beauty does not mean perfect symmetry. The idea is to develop a treatment plan that gets as close as possible to the frame creating the simplest, most straightforward, most conservative treatment possible. Analyzing the video should guide placement of the lines over the photos.

Creating the Facially Guided Smile Frame in Eight Steps

Step 1: The Digital Facebow

The facial midline may not match the dental midline. The idea is to discover if a dental midline shift and/or cant is present and select a position to start a smile decision. Discrepancies between dental and facial midline up to 2 or 3 mm were generally not noticed in a study that observed images limited to the perspective of the smile.[21] However when full-facial images were analyzed, a minor dental midline shift such as 1 mm could be seen in asymmetric faces depending on the direction of the shift. It could be concluded that extraoral facial structures such as the nose and chin can affect the perception of dental midline shift.[22]

Step 2: Smile Curve

The smile curve position and shape will depend on the facial and lips dynamic analysis through the video. The video is paused when necessary, and three photos are captured: real rest position, natural smile, and angled smile. In the first photo, the relationship between the upper lip and the incisal anterior maxillary edge is analyzed. The second one allows analysis of the relationship of the buccal corridors with the cheeks, which can be used to determine whether they should be changed by widening or narrowing the arch. In the angled smile photo, the length of the posterior teeth is analyzed in relation to the lower lip to determine the appropriate length and smile curve.

Step 3: Interdental Width Proportion

The authors recommend using the recurring esthetic dental (RED) proportion,[10] instead of the golden proportion, to determine the ideal width from the frontal perspective of the central and lateral incisors and canines to create natural and pleasant smiles. These proportions, from a frontal view, dictate that if the central incisors are *x*, the lateral incisors should be 0.7*x* and the canines 0.5*x*. Facial references, such as the inner part of the eyes and the interalar and intercommissural lines at rest, can be used to determine the outer edge of this ruler that refers to the distal of the canines. This ruler can be adapted to any tooth that seems to be in a harmonious position with the face, with the other lines suggesting the width of the remaining anterior teeth.

Step 4: Central Incisor Width/ Length Proportion

The ideal central incisor proportion should be around 80%.[23] The present authors usually work within the range of 70% to 90%. Since the incisal edge position and the width have already been determined, working with the central template will allow analysis of the relationship of the gingival margin to the other parameters.

Step 5: Gingival Curve

The gingival curve must be determined with the help of the video analysis. The gingival curve should be placed over the cervical aspect of the proposed new central incisor, and the posterior inclination of the curve will be determined to create a realistic relationship between the curve and the upper lip according to the posterior gingival display.

Step 6: Papillae Curve

The papillae curve should be slightly closer to the gingival curve, because the height of the papillae is usually 40% of the height of the crown.[24]

Step 7: Vermilion Curve

After the image is adjusted to the guidelines, the clinician can zoom in and analyze the relationship between the teeth, the arch curve, and the vermilion curve in the 12 o'clock view that will help determine the ideal buccal-palatal position of each maxillary anterior tooth (Fig 9).

Step 8: Arch Curve

Integrating the analysis of the occlusal photo with the facial frontal video helps determine if the arch is

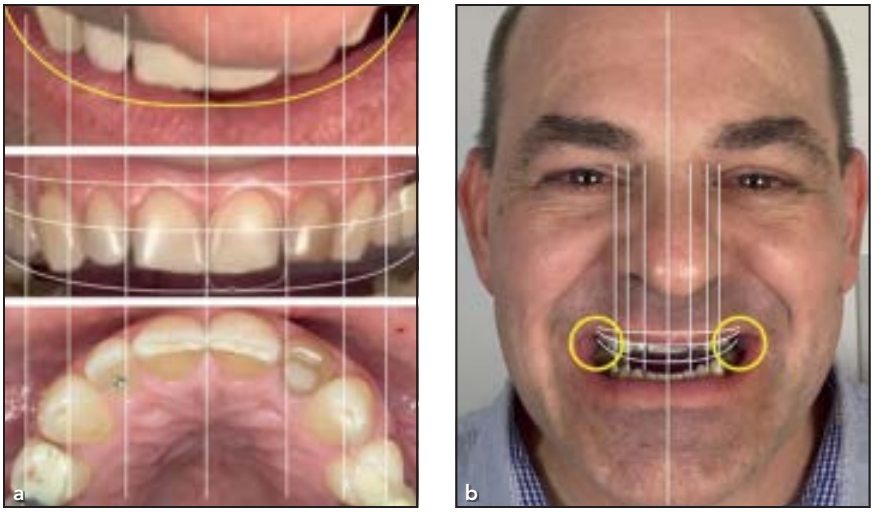

Fig 9 *Finished 2D digital smile design.* (a) *12 o'clock view* (top), *frontal view* (middle), *occlusal view* (bottom). (b) *Facially guided smile frame.*

Fig 10 *Three views of DSD (12 o'clock, frontal, and occlusal).* (a) *2D digital design.* (b) *Superimposition of digital design and model scans.* (c) *3D diagnostic virtual waxing.*

too narrow or too wide in relation to the face. This view is also key to analyzing space distribution, planning cases with crowding or diastemata, and checking spacing for implants. The curve can then be placed over the occlusal view to translate this observation and analyze the symmetry of the arch. Also from the occlusal view, the interdental proportion guide is overlaid to evaluate the space distribution.

The 2D smile frame can be translated into a 3D project, either through analog (conventional wax-up) or digital (3D digital wax-up on CAD software) means (Fig 10). Regardless of the 2D and 3D software used, the final 3D file (in STL format) will be exported to a printer to generate the physical model of the new design. This model can be used to fabricate a matrix for a mock-up and provisional and also guides for tooth preparation, crown lengthening, and implant placement (Fig 11). The presentation to the patient starts with the placement of the motivational mock-up followed by the photo/video session (Figs 12 and

Fig 11 *3D-printed model and vacuum tray.*

Fig 12 *The vacuum tray is trimmed following the gingival line to allow for an immediate esthetic mock-up.*

Fig 13 *Screenshots of smartphone videos: images of the patient without* (a) *and with* (b) *the mock-up for the motivational presentation.*

13). Next, the treatment plan is presented. If the patient approves the plan, the rehabilitative procedures may be performed in a completely digital flow, integrating the initial smile design project into orthodontic, periodontal, orthognathic surgery, guided implant surgery, and/or restorative procedures.

Discussion

Establishment of an esthetic rehabilitative treatment plan requires a correct diagnosis that identifies

and quantifies which elements of the smile need to be corrected or improved, and which must be maintained. Medical and dental history, clinical examinations, data from images, study models, and photographs have been used for this purpose. Although these sources of guidance provide relevant data for diagnosis, they do not offer all the information necessary for analyzing the smile. Dynamic records of the smile on video are fast and easy and allow an effective analysis of esthetics, phonetics, and function.

It is difficult to capture a photo at the ideal moment for smile analysis. Usually when the dentist asks the patient to give a full smile, the patient shows less than the real maximum height of the smile. The same can occur on the rest position analysis. A photo cannot guarantee that the moment captured is the realistic rest position.

Facial analysis based only on a photograph may provide incomplete and/or incorrect information. Tjan and Miller[9] evaluated static photographs of a posed smile and reported that 11% of the patients presented a high smile, as opposed to 21% of patients with an anterior high smile in a study with video recording.[18] Tarantili et al[17] also evaluated the smile on video and observed that the average duration of a spontaneous smile was 500 ms, which reinforces the difficulty of recording this moment in photographs. These data have contributed to an understanding of the findings of Maulik and Nanda,[18] who reported greater exposure of the posterior teeth and a gingival strip characterizing a high posterior smile in 42% of the patients evaluated on video. This high exposure of teeth and number of teeth visible in the smile tend to diminish with age, a fact confirmed in both photographic[12] and dynamic[20] evaluations. However, many other esthetic parameters that have been established in photographs have not yet been defined in videos.

Creating a photo protocol from videos can save significant time for the photographer (dentist/staff) and for the patient. An efficient and fast initial photo session will generate a positive feeling for the patient. It is much simpler to train the staff to take photos with smartphones than to train them to use sophisticated DSLR cameras and studios. With proper illumination, a good smartphone camera can be a useful tool that can generate enough quality images for the smile design and treatment planning process and for patient communication.

All the photographic facial documentation taken from videos allows the creation of a 2D smile frame completely integrated into the face. Photographs, videos, and drawings of the DSD protocol shared in the cloud have allowed members of the interdisciplinary team to access this information at any time. All the discussions, solutions, and decisions can be performed online, even in an asynchronous way, adding pieces of information or comments at any time, anywhere. In addition, technicians can evaluate their work by reviewing the videos of try-ins and finished cases to improve the results for patients.

Conclusions

The use of dynamic smile documentation associated with the DSD protocol will make diagnosis more efficient and treatment plans more consistent. It will also provide more logical and straightforward treatment sequences, reducing the risks and improving the final results.

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