SKYN Concept: A Digital Workflow for Full-Mouth Rehabilitation

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FUNCTION

Defining a New Occlusion: Clinical Phase

A female patient requested that both the esthetics and occlusion of her teeth be improved. An appointment was scheduled for transcutaneous electrical nerve stimulation (TENS) to aid in determining the new occlusion. Careful analysis of the occlusion confirmed that the vertical dimension of occlusion (VDO) was compromised due to erosion and wear of the posterior and anterior teeth (Fig 1).

The patient was not able to define the proper position of the jaw because of her proprioception. Typically, when the jaw is not in the most appropriate position, the nerves around the periodontal fibers inform the brain, and so the brain attempts to compensate by placing the jaw in the new position. However, this was not possible in this patient because most of her teeth were worn. As a result, the muscles were overworking and compensating for the tooth

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wear. This cycle is called *proprioception*. It was necessary to cease the patient's current proprioception and return the muscles to their original relaxed position in order to ensure correct positioning of the arches for an appropriate full-mouth rehabilitation. TENS is used to improve the proprioception of the patient. It relaxes the muscles and dispels them of built-up lactic acid while introducing oxygen and adenosine triphosphate (ATP), interrupting the former anaerobic cycle and recreating an aerobic cycle.[1]

The TENS unit was applied for 1 hour to the patient's cranial nerves V, VII, and XI to relax the paracervical muscles and the muscles of mastication (Figs 2a and 2b). The new occlusion was recorded vertically, anteroposteriorly, and transversally with a Myotronics K7 evaluation system (Bisico France). To record the bite, a magnet was placed on the buccal surface of the mandibular incisors and the physiologic movement of the jaw, including the rest position, habitual occlusion, trajectory of opening, and closing without proprioception, was registered with the software (Fig 2c). The new VDO was determined in function of the trajectory of opening and closing and in function of the rest position and the wear of the teeth of the patient. Bite registration was performed using polydimethyl polymethyl vinyl siloxane (Regidur, Bisico France) (Fig 3). Polyvinyl siloxane (PVS) impressions were taken and then given to the laboratory for producing the cast models and wax-up.

Defining a New Occlusion: Laboratory Phase

Cast models (FujiRock EP, GC) made from the PVS impressions in the laboratory served as a base for the creation of the maxillary and mandibular wax-up integrating esthetic (incisal edge) and function (palatal and occlusal surfaces). The wax-up (Renfert) was created integrating the occlusal surfaces of the premolars and molars as well as the palatal and lingual surfaces of the incisors and canines, with lengthening of the incisal edges of the anterior teeth (Fig 4). Transparent silicone was used on the wax-up to produce a template for the intraoral mock-up.

Fabricating the Mock-up

In the clinic, the composite resin mock-up was fabricated directly in the patient's mouth and remained for occlusion testing for 1 month. To fabricate the mock-up, the teeth were cleaned with pumice and then spot etching was performed on the enamel surfaces with 35% phosphoric acid. The teeth were then rinsed and dried. No preparation of the teeth was done. A bis-acryl resin was injected into the maxillary silicone template and it was pressed onto the patient's maxillary arch. Once the resin had cured (or polymerized depending on the type of resin), the silicone template was gently removed, the resin excesses were eliminated with dental tweezers, and all surfaces were polished. The same process was performed with the mandibular silicone template. Once the intraoral mock-up was completed, the new occlusal scheme was verified and adjusted.

Another 1-hour TENS session was performed so that the facial muscles would once again relax into their proper position newly supported by the mock-up. The occlusion was again tested in static and dynamic positions using articulating paper (Fig 5). The static position was verified by the patient biting on the mock-up to check the contact points between the maxillary and mandibular canine fossa. The dynamic occlusion was then tested through mastication. The patient chewed on the right side of her mouth, and the surface guidance on molars, premolars, and canines was verified by the clinician. If the surface guidance was not adequate, adjustments were made. The anterior guidance was carefully adjusted so canine guidance was observed and equilibrated on both sides. On the areas where an interference was observed during the canine guidance, the composite mock-up was adjusted accordingly. A composite mock-up allows perfect correction of occlusal guidance by adding or removing composite from the lingual concavity of the canines. Finally, occlusal equilibration was carefully performed so precise contacts and guidance were created for the patient. Additionally, the position of the incisal edge was inspected. Videos and photographs were taken, and the patient was consulted to be sure she was satisfied with the outcome.

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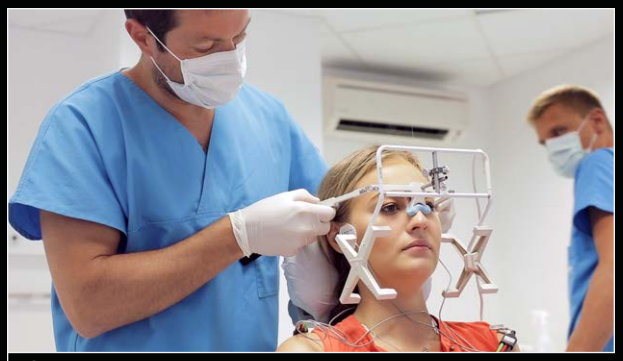
2a



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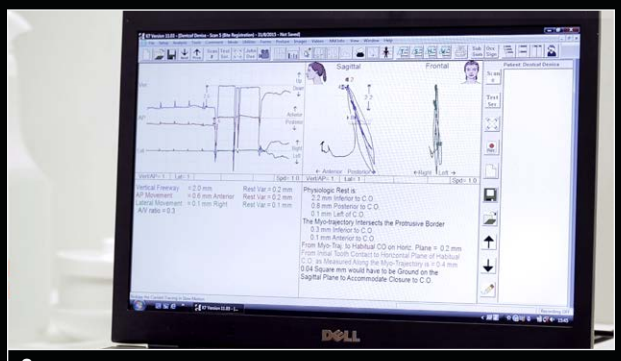

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Fig 1 Patient displays symptoms that affect function, including tooth wear, muscle tension, and pain.

Figs 2a and 2b TENs unit is applied and yhe headpiece is positioned. This is the receptor. Inside the mouth (on the mandibular incisors), a magnet (the transmitter) is placed. With this the physiologic moment of the jaw is registered and a graph produced.

Fig 2c Graph shows habitual occlusion, trajectory of opening and closing, and rest position after 1 hour of TENS. Using this information, the new position of the mandible is determined.

Fig 3 Bite registration requires no manual repositioning procedure.

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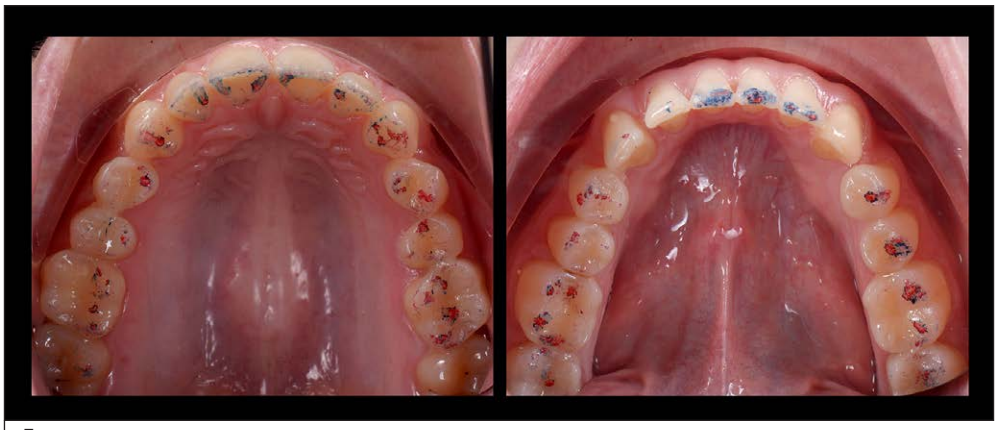

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Fig 4 Diagnostic wax-up.

Fig 5 Functional mock-up is transferred to the mouth and checked.

ESTHETICS

Digital Design

After the function was validated, the design of the esthetics phase was performed digitally. At this time the functional mock-up was completed in the patient's mouth. A standard photo-video documentation was used, following Digital Smile Design (DSD) protocol.[2] Video is important for selecting the emotional smile, followed by planning that is done on the photographs (Fig 6). The patient had natural beauty and her face was slightly asymmetric (Fig 7a). It was decided to preserve the asymmetry of her face by not using the bipupillary line as a reference, but rather vertical lines that connect the glabella with the philtrum (Fig 7b). The resulting perpendicular line became the reference for the occlusal plane. By this way the natural asymmetry of the face was preserved. DSD protocol was performed to determine the ideal width, length, and position of the future teeth (Fig 8). Soft tissue remodeling by gingivectomy was required to create the biologic conditions for the planned design.

Fig 6 The patient is photographed and videotaped using the same camera. Video is more relevant for smile design, as it can capture the emotional smile. Photography captures the social smile, in which the patient tends to conceal defects.

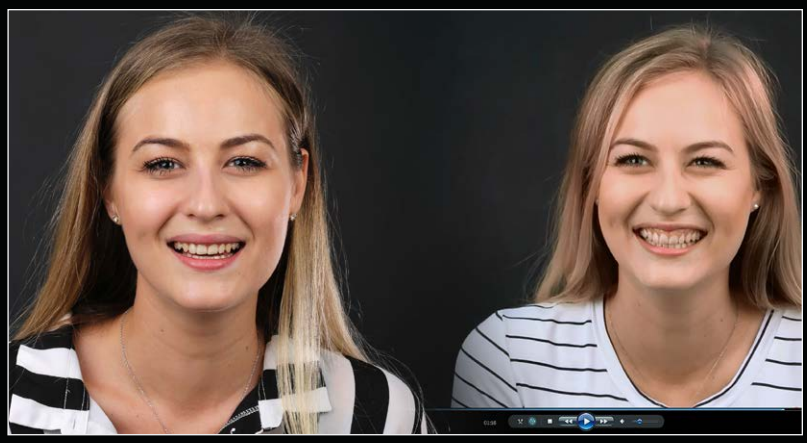


Fig 7a The patient's face is not symmetric. Beauty is many times built from asymmetry, and in this case it will be retained by not choosing the bipupillary line as a reference.

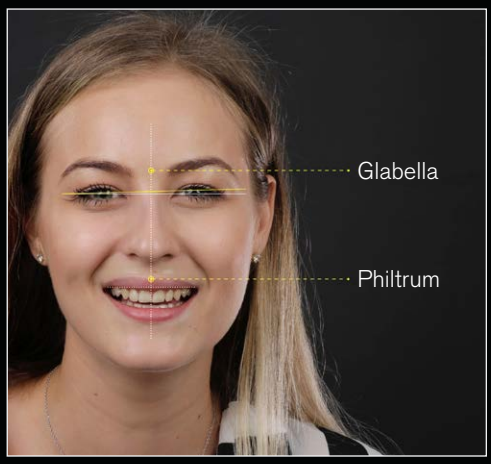


Fig 7b Vertical line from the glabella to the philtrum. Its perpendicular will be the horizontal reference for the new smile.

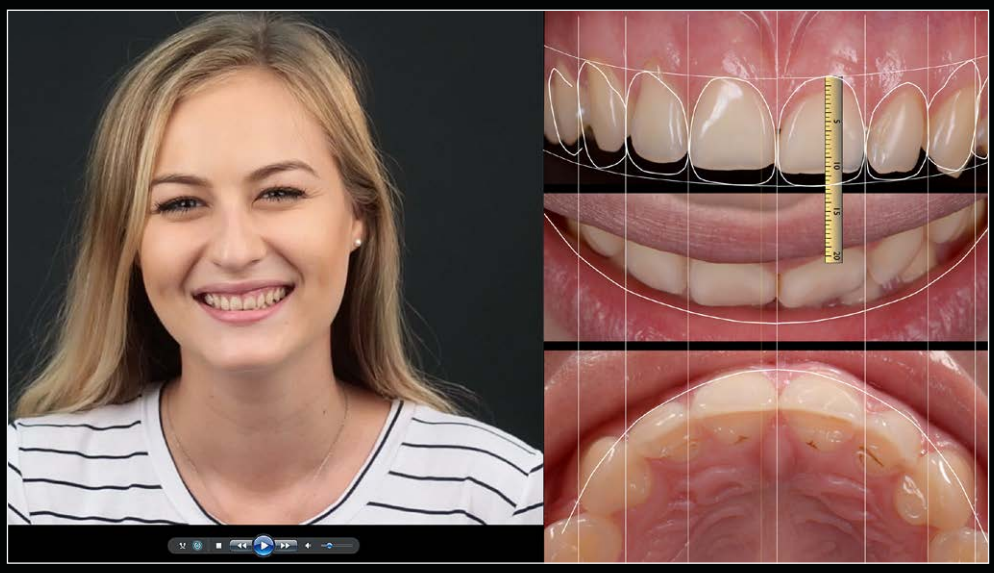


Fig 8 The video is frozen at relevant frames of the emotional smile, and a manually calibrated 3D view is used to design the future smile.

Fig 9a SKYN concept can copy any natural shape and transfer it to the mouth.

Fig 9b "Skyn" application is a real-time, intuitive and creative process that allows the dentist to design using natural morphology.

Fig 9c When placing "skyns" it is necessary to check for correct emergence profile and incisal edge position.

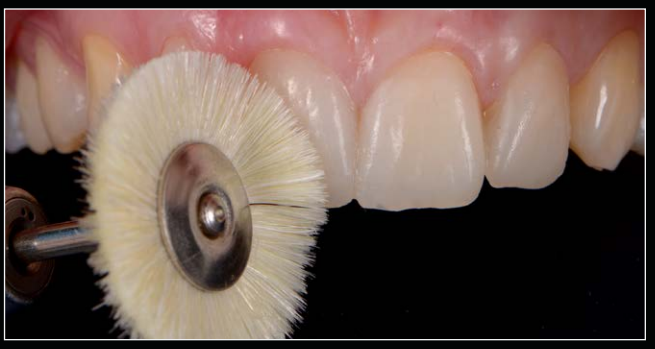


Fig 9d "Skyns" are relined with composite and polished.

Fig 9e *(above)* Final aspect of the anterior "skyns."

Fig 9f *(right)* The design is validated by the patient.

SKYN Concept: Selecting Natural Morphology

DSD provided the ideal proportions (width and length) of the future restorations. The shape and size of the future restorations were selected from different models of natural teeth. A PVS impression was taken from the facial surface of the selected tooth morphology. A thin layer of translucent composite resin (IPS Empress Direct, Trans 30, Ivoclar Vivadent) was applied into a PVS template to create the composite "skyns"—the thin composite veneers with a natural morphology (Figs 9a and 9b).[3,4] The "skyns" were then placed onto the teeth and relined directly using another nanohybrid composite (Empress Direct A1, Ivoclar Vivadent). During the composite "skyn" try-in, the following need to be checked: emergence profile, incisal edge position, gingival zenith, and tooth shape. "Skyns" were similarly produced for the posterior teeth Figs 9c to 9e). If the steps are performed in this sequence, "skyn" placement becomes an intuitively easy clinical procedure, with many advantages. After placement, videotaping the patient dynamically is recommended so the patient can best view and approve the design (Fig 9f).

Fig 10 Two CAD/CAM systems are used to fabricate the veneers.

Fig 11a Minimally invasive preparations.

Fig 11b Finalization and polishing of the preparation.

Fig 11c Minimal tooth reduction is performed.

10

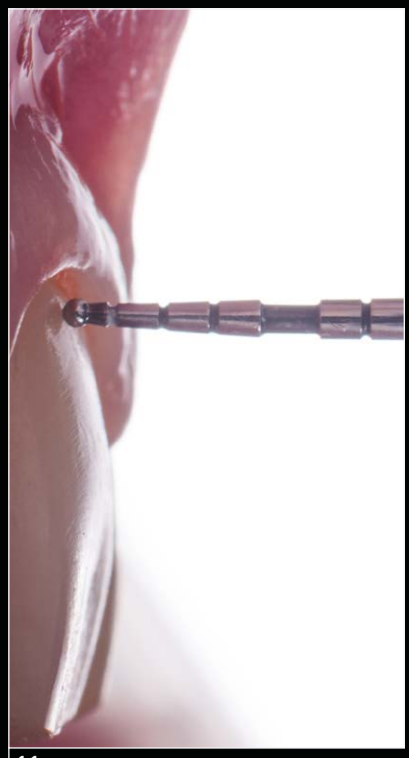
11a

11b

SKYN Concept: The Triple Scanning Technique

After the "skyns" are placed, it is possible to validate the three most important aspects of an esthetic rehabilitation: function, esthetics, and patient acceptance. Now it is possible to proceed with the scanning of the final design (Fig 10). Scan A is the first scan, which depicts the composite "skyns" placed directly on the patient's teeth.

The next step is the teeth preparation. The Aesthetic Pre-evaluative Temporary (APT) technique[5] **[Au: Added reference, OK?]** was selected for minimal selective reduction (Fig 11). All preparations were performed with the "skyn" in place to maximize enamel and tooth preservation. In this case, it was necessary to add volume to both the facial and palatal surfaces. In order to preserve as much tooth structure as possible, double veneers (one facial and another palatal veneer) were planned for the anterior teeth and minimal occlusal clearance for the posterior teeth. Once all the preparations were completed, they were digitally scanned (scan B). Additionally, a traditional PVS impression was taken to produce a cast as a control for the final restorations.



11c

Fig 12a Veneer thickness is minimal (0.3 to 0.5 mm).

Fig 12b 3D staining technique is used for characterization.

SKYN Concept: Milling and 3D Staining

The final restorations will be scan A (design) plus scan B (preparation). Since machining is not needed for design, it is necessary only to define the preparation margins and the copy margins. However, due to the axis of insertion in this case, it was only possible to mill the facial veneers. All restorations were milled using leucite-reinforced glass ceramic blocks (Empress CAD Multi, Ivoclar Vivadent). Once the restorations were milled, they were verified on the cast model and adjustments were made where necessary.

The third scan (scan C) was then done to produce the palatal veneers. The palatal veneers are fabricated from scan A (design) plus scan C (model with facial veneers). After milling, the restorations are stained using a 3D staining technique (Fig 12). 3D staining requires a specific sequence to create 3D optical illusions. Bonding was performed as recommended for leucite ceramic (hydrofluoric acid etching, followed by silanization [Monobond Plus, Ivoclar Vivadent] and luting with a light-cured resin cement [Variolink Esthetic System, Ivoclar Vivadent) on all prepared teeth (Fig 13). The beautiful natural results are shown in Figs 14 and 15.

Fig 13 Buccal and palatal veneers are cemented during the same appointment.

Fig 14a Final intraoral view.

Fig 14b Final occlusal views.

Fig 14c Final lateral views.

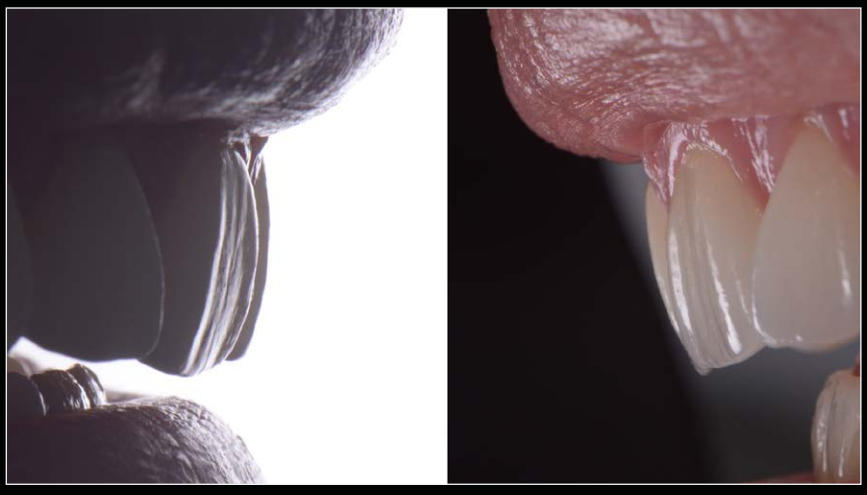


Fig 14d Lateral views. Note the texture and morphology obtained with the SKYN concept.

Figs 15a and 15b Final portraits.

CONCLUSION

SKYN is an innovative concept that is able to get more out of CAD/CAM systems than the classic workflow for which the machined are designed. Even though SKYN can work on all levels of complexity, for best results a systematic approach is recommended to simplify cases prior to treatment—as function and biology are tackled in this clinical case, prior to esthetics.

REFERENCES

1. Kasat V, Gupta A, Ladda R, Kathariya M, Saluja H, Farooqui AA. Transcutaneous electric nerve stimulation (TENS) in dentistry—A review. J Clin Exp Dent 2014;6:e562–e568.
2. Coachman C, Calamita M. Digital smile design: A tool for treatment planning and communication in esthetic dentistry. Quintessence Dent Technol 2012;35:103–111.
3. Kano P, Xavier C, Ferenca J, Van Dooren E, Silva NFR. Anatomical shell technique: An approach to improve the esthetic predictability of CAD/CAM restorations. Quintessence Dent Technol 2013;36:38–58.
4. Kano P, Baratieri LN, Decurcio R, Duarte S, Saito P, Ferencz J, Silva NFR. The anatomical shell technique: Mimicking nature. Quintessence Dent Technol 2014;37:94–112.
5. Gurel G, Morimoto S, Calamita MA, Coachman C, Sesma N. Clinical performance of porcelain laminate veneers: Outcomes of the aesthetic pre-evaluative temporary (APT) technique. Int J Periodontics Restorative Dent 2012;32:625–635.