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# Digital registration of peri-implant transmucosal portion and pontic area in the esthetic zone

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## ABSTRACT

**Aim** There is a general agreement on the importance of soft tissues conditioning to obtain optimal results in case of teeth replacement supported by dental implants in the esthetic zone. Soft tissue healing should be guided with temporary restorations which are useful to condition soft tissues, as they are relatively easy to modify "chair side" by adding or reducing pressure until a satisfactory soft tissue scalloping has been achieved. Once the desired result is obtained, it is very important to replicate this profile in the master model used for the fabrication of the final prosthesis. The aim of this paper is to describe a simple protocol developed by the authors.

**Materials and methods** The new technique for the registration of the trans-mucosal area is described and the steps for its replication with a digital workflow are illustrated through a case report. The final restoration was designed as a monolithic zirconia framework (produced with a milling machine) with feldspathic porcelain veneering limited to the buccal surface. The occlusal surface replicated the one of the provisional. The protocol included the digital duplicates of the emergence profile and the conditioned soft tissues.

**Results and conclusion** The protocol developed by the authors entails a totally digital workflow and results are more predictable.

KEYWORDS Dental implants; Esthetic zone; Intra-oral scanner; peri-implant tissue; pontic; Trans-mucosal tissue.

## INTRODUCTION

Implant-supported rehabilitations proved to be a safe and effective procedure to replace missing teeth. In the initial phase of dental implants era, the main concern was to achieve osseointegration as well as high implant survival and success rates. As soon as it was clear that dental implants performed very well in terms of survival and success, a significant amount of research was focused on the improvement of the esthetic results. Guidelines for implant placement have been established and bone augmentation procedures are considered mandatory when bone volumes do not allow a correct implant placement (1-2).

New materials for metal-free frameworks were developed as well as improved porcelains in order to achieve good esthetics.

In the last decade, the role of peri-implant tissues in the final esthetic result has been emphasized (the so-called pink esthetics). A lot of discussion has been carried out about soft tissue augmentation procedures (3-4).

Today, there is a general agreement on the importance of soft tissue conditioning for an optimal result of tooth replacement in the esthetic zone. Soft tissue healing should be guided with a provisional prosthesis until a satisfactory esthetic result is achieved. Temporary restorations are useful to condition soft tissues, as they are relatively easy to modify "chair side" by adding or removing pressure until a satisfactory soft tissue scalloping is obtained.

Although this process may be slow and time consuming, optimal emergence profiles can be obtained in this way. Once the desired result is achieved, it is very important to replicate this profile in the master model used for the fabrication of the final prosthesis. Implant transfer copings are usually round cylinders and do not allow to precisely replicate the trans-mucosal area. A very interesting technique was proposed by Hinds in 1997, which allows to fabricate individualized impression coping capable to

FIG. 1 Initial situation of the patient after the car accident and the first unit therapies which saved her life.

FIG. 2 Situation of the patient after two maxillofacial surgeries, one to reposition the maxillary bones and one for bone augmentation.

duplicate the conditioned transmucosal area (5).
In the last years, digital technology represent a fast-growing reality in the dental office and dental lab. The use of intraoral scanners allows precise duplication of implant position, as all manufacturers developed scan bodies with standardized shapes that can be easily recognized by the scanning machines. As it happens with conventional transfer copings, the scan-bodies are not effective in the reproduction of the trans-mucosal portion, because soft tissues tend to collapse immediately after the removal of the provisional restoration, as soft tissues have been conditioned and individualized during the provisional phase, and because in many esthetic cases the trans-mucosal portion is deeply extended and difficult to scan.
The aim of this paper is to describe a simple protocol developed by the authors in order to replicate the trans-mucosal area with a digital workflow.

## METHODS

The proposed technique for the registration of the trans-mucosal area includes the following steps.

1) Digital impression of the dental arch with scan bodies over implants.
2) Digital impression of the opposing arch.
3) Registration of the occlusal relationship.
4) Digital impression of the provisional restoration positioned on a polivinilsiloxane base.
5) Digital impression of the dental arch with the provisional restoration in situ.
6) Superimposition of impressions # 1,4,5 in a single file.
7) Modification of impression # 1, shaping the soft tissues according to the profile of the provisional registered in impression # 4.

A case is reported to describe the technique.
A 25-year old female patient was involved in a severe car accident which resulted in several fractures of arms and legs, rupture of the spleen, fracture of the nose, the maxilla, and the mandible, as well as the loss of teeth 1.1, 1.2, 1.3, and 1.4, including the supporting alveolar and basal maxillary bone (Fig. 1). She was initially treated in a "first aid surgical unit", but the maxillo-facial skeleton was badly repaired. The patient survived, but the final result was the complete displacement of both the maxillary and mandibular fragments, with loss of occlusion.
The clinical situation made an immediate rehabilitation with implant-supported prostheses impossible, both because of the severe bone loss in the maxilla and mandible, and because of the complete loss of correct intermaxillary relationship on the right side.
A team approach was used in order to achieve a prosthetically driven rehabilitation including orthodontics, maxillo-facial surgical procedures to repostion and to reconstruct the bone loss in the maxilla and the mandible, and, in a subsequent stage, implant placement and sequential prosthetic restoration.
The patient needed two further maxillofacial surgeries: the first one was aimed to reposition the right maxilla and mandible in a correct position from an occlusal point of view by means of two dento-alveolar osteotomies. The second surgery was aimed to reconstruct the alveolar bone in the maxilla and the mandible by means of autogenous bone blocks taken from the anterior iliac crest to create adequate bone volumes to allow implant placement in a prosthetically driven, ideal position (Fig. 2).
After these procedures, the patient was temporarily rehabilitated with a vacuform retainer including the missing teeth in the upper arch to provide sufficient esthetics without any pressure on the grafted area during healing (6).
Six months later, two Straumann BLT® implants with a sand-blasted, acid-etched, chemically activated surface (SLActive - Straumann Dental Implant System - Institut Straumann AG, Basel, CH) were placed in positions 1.1 and 1.3 (3.3 mm in diameter, 10 mm in length). The same vacuform retainer was used as provisional prosthesis (Fig. 3). Two implants of the same dimensions and brand were placed also in the previously fractured mandible in

FIG. 3 Situation aftert implant placement and their delivery of an implant supported provisional.

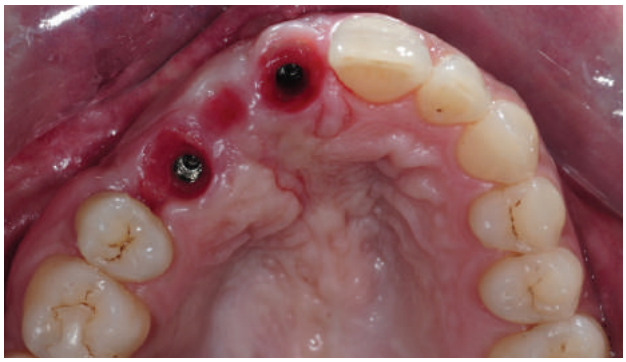

FIG. 4 Situation at the end of soft tissue conditioning.

position of 43-42.
Soft tissue augmentation was performed with free gingival grafts in order to re-establish the correct position of the muco-gingival line.
After a healing period of 12 weeks, an implant impression was taken with a digital workflow: the healing abutments were removed, the Scan Bodies provided by the manufacturer for intra-oral scan (Scan Body, Institut Straumann AG, Basel, CH) were secured to the implants and the digital implant impression of the upper arch was taken recording natural teeth, implants, periodontal, and peri-implant tissues.
The healing abutments were removed from lower arch implants, the Scan Bodies positioned, and the digital impression of the lower arch was then acquired in a second scan.
The scan bodies in both arches were removed and a third acquisition was performed on the vestibular side of both arches in occlusal contact. This acquisition allowed to perform a bite registration between the upper and lower scans. In the bite registration function, the software was designed so as to take in consideration only the landmarks needed for this purpose.
Once the intermaxillary relationship was established in the planning software, the abutments were chosen from the software library and the provisional restoration was designed. Emergence profiles were relatively narrow to avoid excessive pressure on the delicate soft tissues. The ovate pontic at the lateral upper incisor site was also designed to provide very gentle pressure. The project was then realized by milling a PolyMethyl Methacrylate (PMMA) block (Telio Cad, Ivoclar Vivadent Ag, Schaan, Liechtenstein) which was then individualized with laboratory resin (Nexco SR, Ivoclar Vivadent Ag, Schaan, Liechtenstein) and a fixed provisional prosthesis delivered to the patient.
Several modifications were performed on the provisional so as to shape the transmucosal portion with small resin increases (Gradia, GC Dental, Tokyo, Japan): the ovate pontic profile was augmented and the emergence profiles enlarged so as to imitate the natural teeth. The soft tissue conditioning phase lasted 3 months.
When the hard tissue healing and the soft tissue

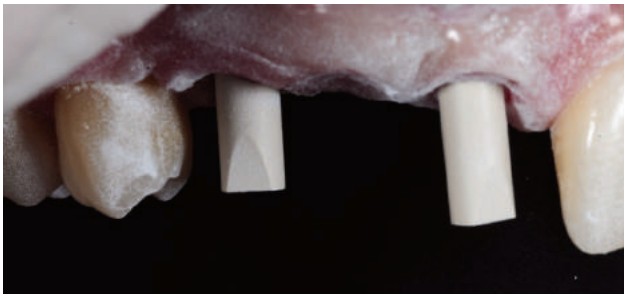

FIG. 5 Scan bodies in situ for the digital impression with opacizing powder.

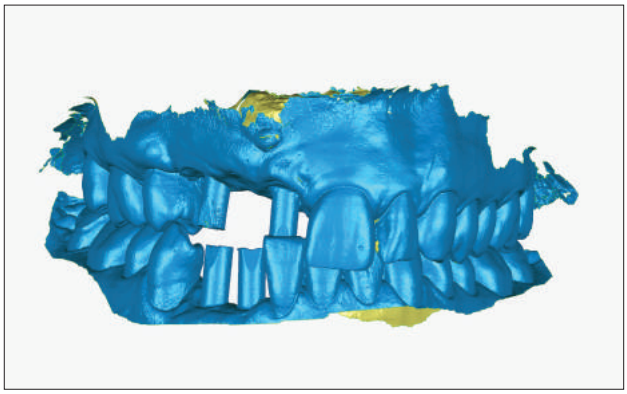

FIG. 6 Maxillary and mandibular scans in occlusion.

modeling phase were considered completed, the clinician performed digital impressions with an intraoral scanner. In this phase, a specific technique to register the transmucosal region was used.

- STEP 1: the temporary prosthesis was removed, the Scan Bodies provided by the manufacturer for intra-oral scan (Scan Body, Institut Straumann AG, Basel, CH) were secured to the implants, and the digital implant impression of the upper arch was taken recording natural teeth, implants, periodontal and peri-implant tissues (master scan). The scanner used for this case (True Definition Scan, 3M, Minnesota, USA) operates with contrast pattering powder in order to increase the speed of the impression, to facilitate data acquisition and accuracy (Fig. 4, 5).
- STEPS 2 and 3: the opposing arch and the inter-

maxillary relationships were recorded (Fig. 6).
- STEP 4: two implant analogues were secured to the provisional restoration and embebbed in a small base made with Polivinilsiloxane (Zeta Labor Titanium – Zhermack Spa, Badia Polesine, Italy). The provisional was then scanned outside the mouth with a small amount of opacizing powder (Fig. 7).
- STEP 5: another intra-oral scan was taken with the provisional repositioned onto the implants (Fig. 8). All scans were sent to the dental lab (Apulia Digital Lab, Bari, Italy).
- STEP 6: the dental lab processed the master scan with the Geomagic Studio 12 software (3D systems, Rock Hill, South Carolina, USA). The scan with the provisional prosthesis secured to the implant was superimposed to the master scan. The file of the provisionals on the polivinilsiloxane base was then imported. Superimpositions were relatively easy, since there was a huge number of points in common between the three scans (Fig. 9, 10).
  The modeling tool in the software allowed to remove the fixed provisional from the file, and the reproduction of the transmucosal profiles as well as the conditioned ovate pontic area (Fig. 11).
- STEP 7: the obtained file was then imported in the 3 shape software (3Shape Dental System, 3 Shape A/S, Copenaghen K, Denmark) for the design of the framework of the final prosthesis (Fig. 12).

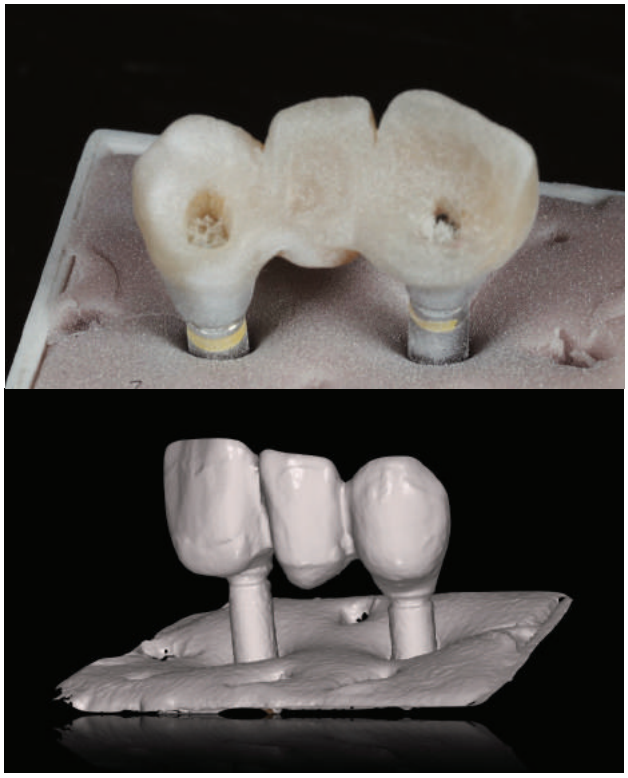

FIG. 7 Scan of the provisional prosthesis.

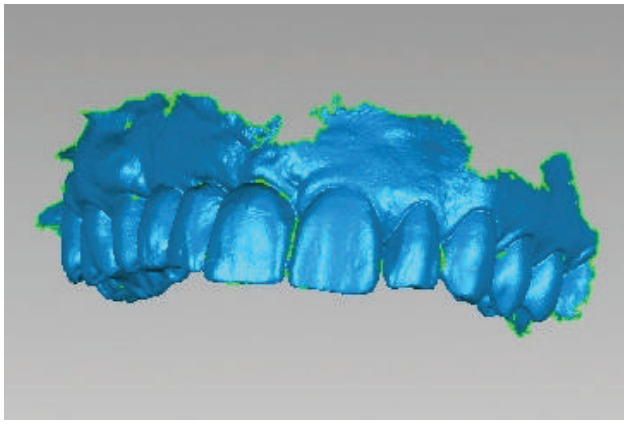

FIG. 8 Scan of the maxillary arch with the provisional in situ.

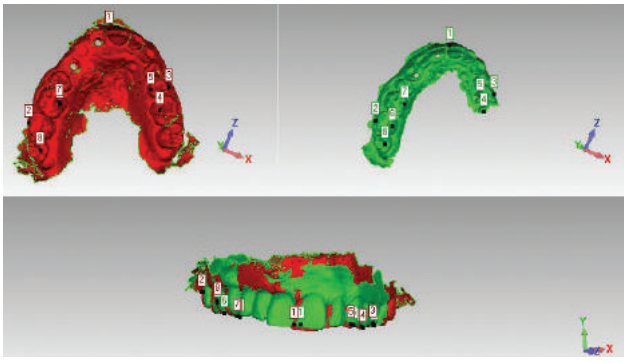

FIG. 9 Superimposition of the master scan with the auxiliary scan with the provisional in situ.

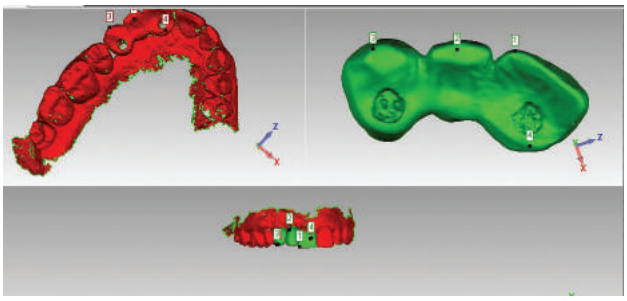

FIG.10 Superimposition of the master scan with the scan of the provisional restoration.

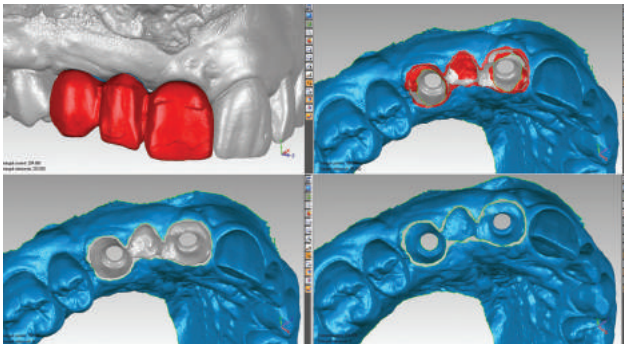

FIG. 11 Reproduction of the conditioned soft tissues by digital carving of the maxillary master scan.

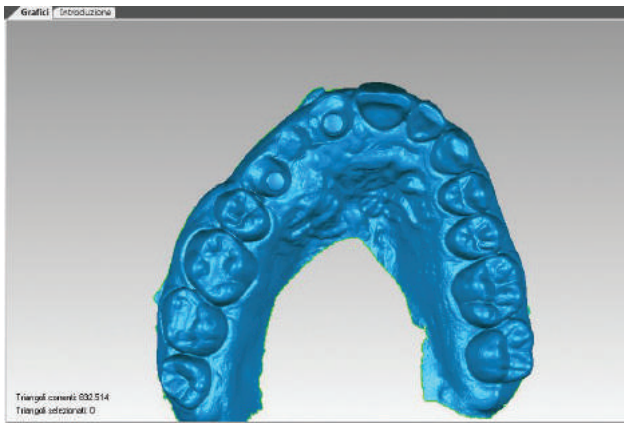

FIG. 12 The maxillary master scan with the exact reproduction of the soft tissues.

FIG. 12 The final rehabilitation.

## RESULTS

The final restoration was designed as a monolithic zirconia framework with feldspathic porcelain veneering limited to the buccal surface (7).
The zirconia framework was produced with a milling machine (Zenotec Select, Wieland Dental, Pforzheim, Germany) from disks of yttrium-stabilized zirconia (Sagemax Zr; Sagemax Bioceramics Inc) obtained from powder by cold isostatic pressing (Tosoh Corporation, Tokyo, Japan). The occlusal surface was copied by the provisional that was successfully worn by the patient for 3 months and demonstrated very good function.
The Sheffield test was used during clinical try-in and intraoral periapical radiographs were made to evaluate the passivity of the frameworks (8).
The occlusal contacts were evaluated in centric occlusion and during the excursive movements. Feldspathic porcelain (E-max Ceram; Ivoclar Vivadent AG, Schaan, Liechtenstein) was then veneered on the vestibular aspect and the prosthesis was cemented to the titanium abutments (Variobase, Institut Straumann AG, Basel, Switzerland) with resin cement (Panavia F; Kuraray, Tokyo, Japan).

The prosthesis was delivered to the patient and showed excellent adaptation to her soft tissues (Figure 13).
One month after delivery, the patient was recalled, the prostheses inspected, and since no problems were experienced, the prosthetic screws were tightened to 35 Ncm and their access holes filled with polytetrafluoroethylene (PTFE) tape (800 Golden Band; AW Chesterton Co); they were then sealed with composite resin (Tetric EvoCeram Bulk Fill; Ivoclar Vivadent AG).

## DISCUSSION

Digital impressions could be considered very accurate as regards the position and the morphology of implants and teeth, but not precise for the transmucosal portion, as the scan bodies cannot be customized and adapted to the conditioned soft tissues. Furthermore, the soft tissue may collapse after the removal of the provisional restoration, especially in cases when the transmucosal portion is very deep. Some authors tried to replicate the soft tissues with the digital impression with a different procedure: they scanned the provisional in situ, set the scan in pause mode, unscrewed the provisional restoration and scanned the subgingival part outside the mouth (9).
The protocol developed by the authors included duplicates of the emergence profile and the conditioned soft tissues in a totally digital workflow in a more predictable way.

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