

# FULL DIGITAL WORKFLOW FOR ANTERIOR IMMEDIATE IMPLANT PLACEMENT: IMPLEMENTING GUIDED SURGERY AND ONE-TIME ABUTMENT CONCEPT

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Stavros **PELEKANOS**   
DDS, Dr. Med. Dent.  
Practice limited to prosthodontics  
and implant surgery  
Athens (Greece)

Panagiotis **NTOVAS**   
DDS, MSC  
Athens (Greece)

**T**ooth extraction is always followed by loss of vital hard and soft tissues, which can make the forthcoming esthetic rehabilitation a challenge. A biologic orientated treatment strategy has to be followed in order to maintain hard and soft tissue volume.

Immediate implant placement, combined with socket seal surgery and socket preservation, can optimize soft tissue conditions and compensate dimensional changes in the alveolar ridge. Furthermore, the placement of a permanent abutment at the time of surgery can significantly reduce both peri-implant bone and soft tissue alterations.

Digital technology can be a valuable tool for planning the treatment, assisting implant placement, providing an accurate soft tissue transfer and fabricating restorations, by mirroring the nearby teeth.

The aim of the present article is to introduce a step-by-step protocol, in order to achieve anterior esthetics with immediate implant placement, implementing a full digital workflow.

**KEYWORDS:** Single implant, Digital workflow, Immediate implant, Computer-aided surgery, One-time abutment, Esthetic rehabilitation, Socket preservation

## INTRODUCTION

Restoring a single tooth in the anterior maxilla with a dental implant, is probably one of the most challenging procedures in implant dentistry [1]. Extensive knowledge of soft and hard tissue management, pre-surgical treatment planning and precise execution are required for predictable results [2, 3].

Tooth extraction is always followed by loss of vital hard and soft tissues resulting in a shift both in horizontal and vertical dimensions [4].

Atraumatic tooth extraction is of paramount importance, in order to protect the thin buccal bone. Immediate implant placement, into fresh extraction sockets, avoiding flap elevation, along with socket preservation and free gingival soft tissue graft, can assist in the preservation of the initial, bone and soft tissue volume, reducing the need for further soft or hard tissue augmentation [5, 6]. The aforementioned management of the post extraction socket is complemented by the definitive use of an intermediate abutment after implant placement [7, 8]. The use of this one-time abutment, leads to a decrease bone loss, to an increased soft tissue stability and facilitates further prosthetic steps [9]. A digital workflow can be a valuable tool, not only in order to perform a precise virtual treatment plan, but also to transfer it to the patient [10]. Digital technology can assist in the analysis of the smile, implementing esthetic proportions with a high accuracy, and in the simulation of the final esthetic outcome. Digital wax-up can contribute significantly by reducing the asymmetry between the restoration and the rest of the dentition, as the dimension, the shape and the anatomy of patient's teeth, can be transferred with a high accuracy using mirroring tools [11].

Combining the data derived for the CBCT, the operative situation and the diagnostic wax-up, a virtual representation of the patient can be achieved; based on this combination, a complete surgical planning can be performed.

Computer guided surgery is an important tool, especially for the immediate implants in the anterior

zone, as an accurate placement of the implant, based on the diagnostic wax-up is of major importance [12].

Intraoral scanners can perform an accurate transfer of the soft tissue, as they have been shaped by the provisional restoration [9, 10, 13]. The scanned data and the information derived from the diagnostic wax up can be effectively combined leading to a predictable fabrication of the final restoration [9, 10, 14].

The aim of the present article is to introduce a step-by-step protocol, in order to achieve anterior esthetics with immediate implant placement, connective tissue grafting, one-time intermediate abutment, combined with a full digital workflow.

## CLINICAL REPORT

A 32-year-old man presented, complaining about pain, mobility and discoloration of his maxillary left central incisor. His medical history was, in general, unremarkable. Maxillary left central incisor had an existing root canal treatment and a composite resin restoration due to a dental trauma that had occurred 10 years earlier.

Initial patient's smile is presented in *figure 1*. Close-up photos of the maxillary left central incisor are presented in *figures 2 and 3*.

The tooth had grade II mobility, as it had an increased buccolingual movement.

Patient reported discomfort on tooth percussion and palpation of the soft tissues.

Radiographic examination revealed the pre-existing root canal treatment along with crack lines and extensive resorption of the root and the buccal plate of the alveolar ridge (*fig. 4a and b*).

Based on the clinical findings and on radiographic examination, a root fracture was diagnosed and a hopeless prognosis was given to the tooth [15].

An initial smile design was performed, by mirroring the shape of the sound maxillary right incisor (*fig. 5*) Afterwards, a digital wax-up was performed mirroring the maxillary right incisor. The digital wax-up combined with the data derived

## CLINICAL CASE



1. INITIAL PATIENT'S SMILE PRESENTED FROM DIFFERENT PERSPECTIVES.



2. INITIAL FRONTAL VIEW.



3. INITIAL PALATAL VIEW.



4A. PERIAPICAL RADIOGRAPH OF THE MAXILLARY RIGHT CENTRAL INCISOR.



B. CROSS-SECTIONAL CBCT IMAGES.

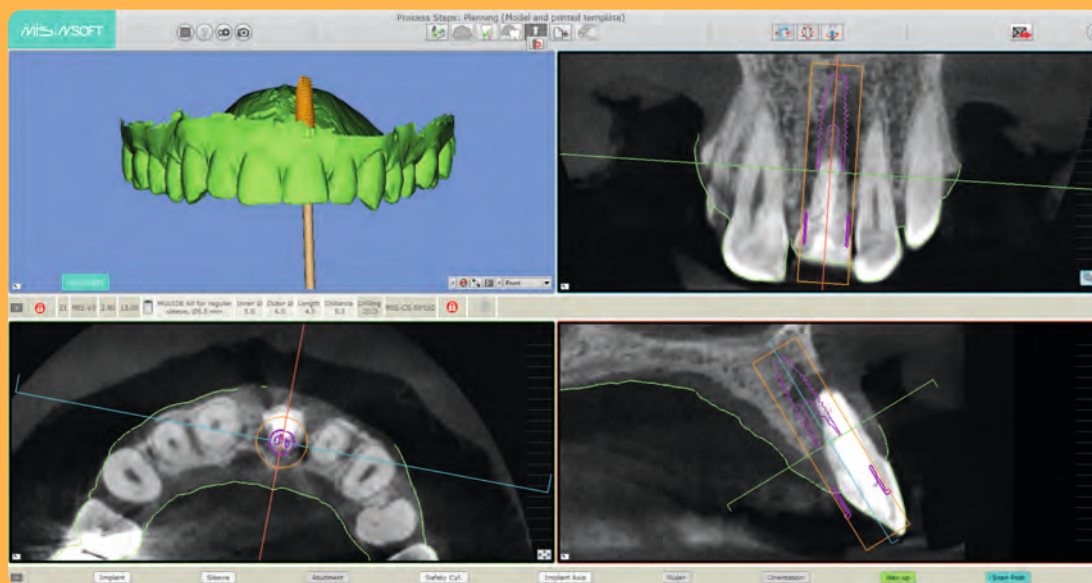
## CLINICAL CASE (CONTINUED)



5. DESIGN OF THE SMILE MIRRORING THE SHAPE OF THE RIGHT CENTRAL INCISOR.

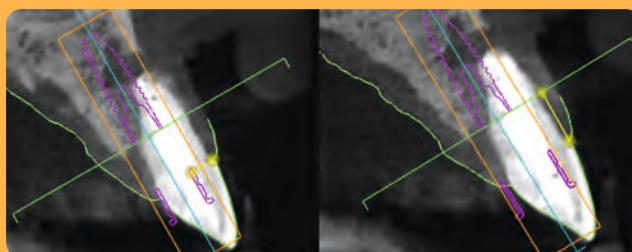


6. VIRTUAL PLANNING OF IMPLANT'S POSITION (MSOFT).



7. VIRTUAL PLANNING OF IMPLANT'S POSITION COMBINING THE CBCT WITH THE DIAGNOSTIC WAX-UP (MSOFT).

8. DESIRED POSITION OF THE IMPLANT BASED ON THE CLINICAL CROWN AS IT WAS DERIVED FROM THE DIGITAL DIAGNOSTIC WAX-UP (MSOFT).





9. ATRAUMATIC EXTRACTION OF THE LEFT MAXILLARY CENTRAL INCISOR.



10. EXTRACTION OF THE RESIDUAL ROOT'S REMNANT DUE TO PRE-EXISTING ROOT FRACTURE.



11. MEASURING RESIDUAL BUCCAL PLATE'S HEIGHT.



12. FULLY GUIDED IMPLANT PLACEMENT IMPLEMENTING MGUIDE SYSTEM (MIS).

from the CBCT, in order to perform virtual surgical planning using MGuide software (MIS) (fig. 6 and 7). A 3.3x12 implant, with a narrow apical body and cylindrical tapered shape-innovative hybrid design (V3, MIS, Israel) was selected. The implant was designed to be placed almost 5mm below the level of the cervical line of the desired clinical crown, as it was derived by the diagnostic wax-up and 3mm behind it (palatal) (fig. 8).

Based on the surgical planning, a surgical guide was 3D-printed.

The central incisor was extracted in an atraumatic way, in 2 pieces due to the pre-existing root fracture. (fig. 9 and 10). The height of the residual

buccal plate was measured after the extraction (fig. 11).

After the removal of the granulation tissue, the surgical guide was fitted and the implant was placed fully guided through the surgical guide based on the pre-surgical virtual planning (fig. 12).

Immediately, after implant's insertion, the definitive intermediate abutment (Connect abutment, MIS) was fitted and a cover screw was placed on it (fig. 13 and 14).

The buccal aspect and the rest of the peri-implant space was filled with a combination 50-50 of allograft (Maxgraft, Botiss) and DBBM (Cerabone, Botiss) (fig. 15).

## CLINICAL CASE (CONTINUED)



13. PLACEMENT OF THE DEFINITIVE INTERMEDIATE ABUTMENT (CONNECT, MIS).



14. PLACEMENT OF THE COVER SCREW ON THE DEFINITIVE INTERMEDIATE ABUTMENT.



15. FILLING OF THE PERI-IMPLANT SPACE WITH A MIXTURE OF 50-50 OF ALLOGRAFT (MAXGRAFT, BOTISS) AND DBBM (CERABONE PLUS, BOTISS).



16. FREE MUCOSAL GRAFT HARVESTED FROM THE PALATE.

Afterwards, a free mucosal graft was harvested from palate according to the dimensions of the socket, along with a desired extension into the buccal mucosa [2, 3, 16]. The graft was partially de-epithelized and inserted in the previously prepared buccal tunnel (*fig. 16 and 17*). The stabilization of the graft was achieved with interrupted sutures (*fig. 18*).

A provisional resin-bonded fixed dental prostheses was placed. The prostheses had been slightly under-contoured compared to the desired emergence profile (*fig. 19*) [17, 18].

After 6 months, the second stage surgery was performed in a special manner de-epithelializing the grafted site leaving the papillae intact, in order

to improve the esthetic integration between the grafted site and the proximal soft tissue without leaving any scar tissue (*fig. 20 to 22*).

At the same time, an intraoral scan was performed, utilizing a scan-body, on the definitive intermediate abutment level which was previously final-torqued to 30N/cm (*fig. 23*).

In the same appointment, an implant supported provisional restoration was fabricated (*fig. 24*).

In *figures 25 and 26*, the final emergence profile as it has been shaped by the provisional restoration can be appreciated.

A zirconia restoration (IPS, e.max, ZirCAD Prime, Ivoclar Vivadent) was milled based on the initial



17. PREPARING FREE MUCOSAL PARTIALLY DE-EPITHELIALIZED GRAFT FOR ITS INSERTION TO THE PREVIOUSLY PREPARED BUCCAL TUNNEL.



18. STABILIZATION OF THE GRAFT IMPLEMENTING INTERRUPTED SUTURES IN AN EXACT APPROXIMATION WITH WOUND MARGINS.



19. PROVISIONAL RESIN-BONDED FIXED DENTAL PROSTHESES WITH A DESIGN BASED TO THE DESIRED EMERGENCE PROFILE.



20. FRONTAL VIEW 6 MONTHS AFTER THE INITIAL SURGERY.



21. OCCLUSAL VIEW 6 MONTHS AFTER THE INITIAL SURGERY.



22. SUPERFICIAL EXCISION OVER THE GRAFTED SITE FOR A BETTER ESTHETIC INTEGRATION BETWEEN THE GRAFTED SITE AND THE PROXIMAL SOFT TISSUE.

## CLINICAL CASE (CONTINUED)



23. FINAL IMPRESSION UTILIZING THE OPTICAL CAMERA FOR AN INTRAORAL SCAN-BODY ON INTERMEDIATE ABUTMENT'S LEVEL.



24. IMPLANT SUPPORTED FIXED SCREWED PROVISIONAL RESTORATION.



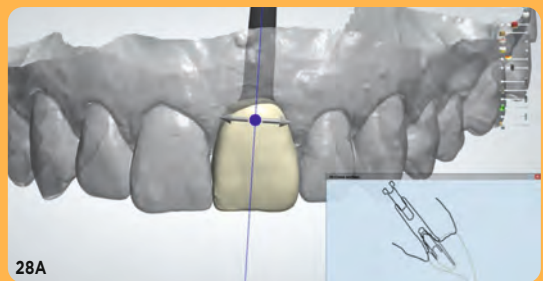
25. THE EMERGENCE PROFILE, AS IT HAS BEEN SHAPED BY THE PROVISIONAL RESTORATION. OCCLUSAL VIEW.



26. THE EMERGENCE PROFILE, AS IT HAS BEEN SHAPED BY THE PROVISIONAL RESTORATION. FRONTAL VIEW.



27. THE EMERGENCE PROFILE ALONG WITH THE TI-BASE ON THE DIGITAL MODEL.



28A

28A. DESIGNING OF THE FINAL RESTORATION WITH THE WORKFLOW.  
B. FINAL DESIGN OF THE FINAL IMPLANT RESTORATION WITH THE WORKFLOW.



B



29. FRONTAL VIEW AFTER THE PLACEMENT OF THE FINAL RESTORATION.  
30. PERIAPICAL RADIOGRAPH AFTER THE PLACEMENT OF THE FINAL RESTORATION.

digital wax-up and was only buccally veneered (fig. 27 and 28).

A hybrid-abutment-crown utilizing a ti-base was screwed over the definitive intermediate abutment (fig. 29 and 30) [19, 20].

## DISCUSSION

Concerning the anterior zone, when an immediate implant loading is not feasible, the use of a temporary resin bonded fixed dental prosthesis can contribute to the post-surgical contouring of the soft tissue providing patient's comfort [21].

Shaping the transmucosal part of the provisional restoration is essential in order to establish a natural emergence profile. A correct emergence profile is of paramount importance in order to accomplish the desired esthetic results and to establish the circumstances which will promote the health of the peri-implant tissue [7, 22, 23].

The optimal three-dimensional position of the implant is also critical for the final esthetics and soft tissue stability [7, 22, 23].

Based on the proposed workflow, implants have to be placed in a prosthetically favorable position which at the same time promote soft tissue esthetics and stability via the appropriate restoration. According to the aforementioned principle, implants have to be placed 4.0 mm or some times more below the zenith

of the desired clinical crown as it has been defined by the digital diagnostic wax-up.

Ideally implant's neck has to be placed at least 2.0 mm more palatal, than the expected buccally marginal part of the future crown. The aforementioned dimension can be increased depending on the depth of the implant.

For screw-retained restorations, it is also important that the implant's position be palatal, as it is required in order to ensure that the screw access will be placed in the cingulum [7, 22].

It is beneficial for both the provisional and the definitive restorations to be screw retained, in order to avoid the adverse effect of cementation, that can lead to an excess of the cement and/or an extra gap between the restorations and the abutments, increasing the risk for biological complications [19].

A critical step of the presented workflow is the definitive placement of an intermediate abutment at the same time with implant placement. The use of a one-time placed definitive abutment enables the formation of a connective tissue integration and an attached zone of junctional epithelium providing a seal between the oral environment and the alveolar bone, which is important for the long-term success of implant-supported restorations. This protocol often referred to as "one-time abutment", seems to be superior to repeated abutment placements, as it can contribute to less soft tissue shifts and less bone resorption [7, 8, 24].

Further techniques have also been proposed, in order to restore implants with one-time abutment concept, without the use of an intermediate abutment. However, based on these protocols, implants have to be restored directly using the definitive restoration without the implementation of a provisional restoration [25].

Implants can be placed with different duration after tooth extraction or immediately in fresh extraction sockets. A high survival rate of implants immediately placed, into fresh extraction sites, has been reported in the scientific literature [26, 27]. According to some studies placing of the implant immediately after tooth extraction can enhance hard and soft tissue preservation, reducing the necessity for other surgical interventions such as ridge augmentation. However, it is not adopted by another part of the scientific literature.

Bone augmentation along with soft tissue grafts at the time of immediate implant placement constitute an important step in order to compensate alveolar ridge reduction and to improve final esthetics and patient's satisfaction [28].

In the present clinical case, the peri-implant space was filled with bone graft and soft tissue augmented using a combination of a soft tissue graft consisting of epithelized and subepithelial connective tissue. This type of graft combines the socket seal technique that is performed using a free gingival graft and the connective tissue graft assisting ridge preservation, and at the same time, thickening the buccal soft tissue providing the conditions for the development of the appropriate contour of the peri-implant soft tissue [16].

According to the authors of the present article, it is beneficial that after the maturation of the graft, a superficial excision over the site that have been grafted with the free gingival graft, to be performed, in order to achieve a better esthetic integration, among the grafted site and the proximal soft tissue. Nowadays, the CAD/CAM fabrication of implant-supported restorations can be considered as the new standard, as it provides the utilization of the available materials taking advantage of the unlimited

design opportunities regarding the emergence profile, the angulation and the dimensions of the designed restorations leading to restorations with industrial quality [9, 10].

Also, digital technology gives us the opportunity to obtain information from the rest of the dentition and improving the adaptation of the restorations. Especially, in clinical scenarios, as in the case that has been presented in the article; when the contralateral tooth maintains its shape in a proper function, digital technology gives us the opportunity to copy exactly that tooth implementing mirroring tools [11].

Zirconia based all ceramic implant supported crowns fabricated from an anatomically milled zirconia framework, veneered with feldspathic ceramic, seems to be a valid treatment for single anterior crowns with less aesthetic problems compared to metal-ceramic implant supported restorations [29].

Intraoral scanning can offer a high level of accuracy, especially for single tooth implants. Intraoral scanning can facilitate impression taking during implant surgery or at the same time with implant exposure [9, 10].

The placement of the provisional restoration instead of a standard healing abutment, at the time of implant exposure, leads soft tissue to heal towards an optimal individualized 3d geometry. The emergence profile, as it has been elaborated from the provisional restoration, can also be scanned using the intraoral scanner, either directly by scanning the soft tissue immediately after the removal of the provisional restoration or by scanning also the area of the provisional restoration that comes in contact with the peri-implant soft tissue [9, 10].

Despite successful results and lack of complications in the presented clinical case report, further research is needed regarding the long-term horizontal bone loss of the augmented buccal plate, when it is performed simultaneously with immediate implant placement.

## CONCLUSION

Immediate implant placement, combined with socket seal surgery and socket preservation, can optimize soft tissue conditions and compensate dimensional changes in the alveolar ridge.

A workflow that combines the biologically advantages of the orientated management of soft and hard post-extraction tissue with the one-time

abutment concept and the capabilities that the ongoing integration of the digital technology can provide was demonstrated.

The presented digital workflow for immediate implant placement can lead to predictable esthetics and function when a single anterior tooth has to be restored with a dental implant offering the potential for further enhancements and simplification. ■

## CORRESPONDENCE

s.pelekanos@athenasmile.gr, ntovas@gmail.com

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