CASE REPORT

Management of a Complex Case during COVID-19 Time Using One-day Digital Dentistry: A Case Report

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Abstract

Aim and objective: The aim of the present case report is to describe the digital management of an implant prosthetic rehabilitation performed by the use of different digital technologies, which allowed to successfully perform in 1 day both the surgical and the prosthetical stages with a minimally invasive approach and a high standard of care.

Background: Coronavirus disease-2019 (COVID-19) pandemic is affecting dental everyday practice. Clinicians have to reduce the number of patients per day and the time they spend in the dental office. Minimally invasive and digital approaches, with less possible exposure and interaction, are suggested to reduce the risk of infection.

Case description: The failure of a short-span implant prosthetic rehabilitation combined with pain and mobility of the involved teeth was the main complaint reported by a 78-year-old male patient, who asked an urgent appointment to solve the problem. An intraoral scanner allowed the clinician to immediately take a preliminary digital impression of the arch to be treated. The resulting 3D files were sent by e-mail to the dental technician who provided a digital wax-up for the computerized workflow. Computer-aided implantology (CAI) performed using an in-office cone-beam computed tomography (CBCT) allowed clinician to guide the surgical approach in a prosthetic manner. Such an integration inside a well-defined workflow was the key for a successful and rapid treatment.

Conclusion: By using new innovative digital technology, the treatment was completed in 1 day, reducing the risk of COVID-19 by limiting the number of appointments and reducing contacts in confined environments like the dental office and public transportations. It also helped to reduce materials production and people movement in the treatment of dental emergency.

Clinical significance: The possibility of performing an effective treatment saving time by using efficient technology and a minimally invasive procedure highlights the importance of digital planning in order to optimize every single step of the treatment. Digital workflow reduces also the movement of potentially infected materials from the office to the dental laboratory.

Keywords: Computer-aided implantology, COVID-19, Dental implantology, Dynamic navigation implantology, Guided implantology, Guided surgery navident.

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Introduction

During the pandemic outbreak of coronavirus disease-2019 (COVID-19), dental services have highly contributed to the national efforts to reduce the spread of COVID-19 and its impact on the population. More specifically, the COVID-19 has reshaped the working environment for health practitioners, especially dentists. Routine treatments have been suspended during the pandemic period and dentists had to reorganize urgent care and implement appropriate measures to avoid cross-infections. The priority was deemed to be protection for the patients and the doctors as well. With some minor differences between countries, minimizing the risks of transmission associated with dental procedures was mainly achieved by the following measures:[1–5]

- Stopping all unnecessary patient contact with dentists, allowing only dental emergencies to be treated.
- Reducing gatherings in waiting rooms, by reorganizing and rescheduling appointments. Increasing the use of remote consulting.
- Implementing environmental/surface disinfection (ESD) protocols in dental settings, and personal protective equipment (PPE) for dentists and staff.
- Modifying treatments and, when possible, minimizing risks associated with aerosol-generating procedures (AGPs).

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Coronavirus disease-2019 has strongly affected the dental business, not only in terms of potential risk of spreading the infection but also in terms of negative economic impact.

In nearly all countries, the lockdown measures reduced dental treatments to emergency procedures only, causing a dramatic reduction of earnings.

Finding the SARS-CoV-2 in the saliva of infected subjects (also asymptomatic ones) increased concern in the public opinion and in practitioners on its possible transmission in the dental setting due to the droplets spread by handpieces used during dental procedures. In a recent article, the New York Times listed the dentists and their staff as the workers who face the highest COVID-19 risk, since they can encounter COVID-19 infection daily and typically work in close proximity to one another and their patients.[3,6–10]

Dentists are currently facing increased costs for more efficient PPEs, ESD protocols and huge reduction of patients due to limitations in the circulation of people, the reduction in household's income due to closure of most of the working activities and/or employees' dismiss. All these factors will unfortunately persist for many months ahead; even if limitations in the circulation of people and in the working activities will slowly go back to "normality," nothing will be the same as before the pandemic. Consequently, reshaping of the activities in a dental setting will become paramount, with dentists trying both to reduce infection risk and to gain adequate incomes. This goal could be achieved mainly by reorganizing dental appointments in a different way and performing a wider number of procedures in the same visit, ideally to reduce management of clinical cases in a single visit. Such an approach would limit contacts not only between patients, practitioners, and staff but also between patients and patients in the waiting rooms, or between patients and other people, avoiding unnecessary use of public transportation related to multiple visits for dental treatments. Moreover, a lower number of visits will also decrease the overall costs and time needed for ESD (and PPEs).[11–20]

Coronavirus disease-2019 could be also considered as a challenge to make innovative choices toward a more rationale and efficient approach to solve dental problems. In that direction, the use of digital technologies could simplify and optimize procedures, also to reduce the risk of cross-infections; it could allow the clinician to reduce the number of the scheduled appointments, and to perform complex implant prosthetic treatments with minimally invasive procedures more rapidly, and ideally in one single visit.[11–23]

The aim of the present case report is to describe the digital management of an implant prosthetic rehabilitation of a patient who had lost a bridge in the upper arch and asked for an immediate rehabilitation by using different digital technologies, which allowed to successfully perform in 1 day both the surgical and the prosthetical stages with a minimally invasive approach and a high standard of care during the COVID-19 lockdown in Italy.

This case report will show how in many cases such a modern digital approach can be the best choice to perform complex treatments profitably in a single visit, while also minimizing the risk of contamination for practitioners, staff, and patients.

Case Description

A 78-year-old male patient referred to the dental office, requiring an urgent appointment on March 2020, 2 weeks after the lockdown measures in Italy.

He referred that his anterior short span bridge was unstable, painful during chewing, and it bled during brushing. He requested an appointment to solve the problem.

A return call with the clinician was scheduled after 30 minutes by the secretary.

Fig. 1: Orthopanoramic X-ray from patient records (date of execution May 13, 2019, time of scan: 13 seconds)

Before calling the patient, the dentist checked the patient's health status at the time of the last visit to the dental office (May 13, 2019) and his last orthopanoramic (Fig. 1).

During the telephone call between the dentist and the patient, it was possible to establish that the lost bridge consisted of seven ceramic crowns on four pillars (one implant at 1.4 site and four natural pillars at 1.2, 1.1, 2.1, and 2.2 sites), by taking a picture by the patient's smartphone.

The natural pillars supporting the bridge exhibited subgingival decays and they were unusable to support a new bridge.

The dentist explained to the patient that the quickest and safest solution during this period was the extraction of the residual teeth (1.2, 1.1, 2.1, and 2.2 sites) and the preparation of a removable provisional denture.

The patient was unwilling to accept this option due to an accentuated gag reflex, and asked for a fixed implant-supported prostheses, with a new definitive bridge to be placed at the end of the pandemic emergency.

After questioning to establish whether the health status of the patient had changed since his last appointment (no changes were noticed), the dentist explained that a preliminary cone-beam computed tomography (CBCT) scan would be necessary to determine if the desired plan was feasible. At this point, by referring to the previously acquired orthopanoramic, the dentist was able to confirm a provisional treatment plan to remove the residual roots, to retain the patient's existing implant, to insert three new implants in the 1.3, 1.1, and 2.1 area, and to use these four implants to support a fixed screw-retained provisional prosthesis.

The relative risks of early and delayed implant placement were discussed with the patient, and it was explained that in this case a minimum torque of 35 N cm per implant placed would be desired if the implants were to be immediately loaded. A quote for the provisional and final prostheses was provided.

A specific COVID-19 precheck triage was also carried out to elicit his current health status and history of contact and travels.

The decision was made to carry out all of the treatment, including manufacture and delivery of the fixed screwed provisional, in 1 day in order to minimize interaction and possible risk of infection.

The patient's availability for the following days was confirmed and after checking the availability of the lab technician, the secretary called the patient and gave him an appointment for 2 days later at 8.30 am.

At 7.30 am of the appointment day another phone triage was done, and good health status was again assessed.

At 8.15 am, the patient arrived in the office, bringing also routine diagnostic exams (including blood and coagulation tests) performed a few months before, showing no significant deviations from ordinary ranges. A record of his temperature was taken (36.5°C) and the patient was asked to wash his hands with a hand sanitizer.

A written informed consent was obtained from the patient after a detailed description of the proposed treatment was given.

The dental nurse provided him with medical protective equipment, asked the patient to gargle for 15 seconds followed by a rinse of 30 seconds with hydrogen peroxide, then a rinse of 60 seconds followed by a gargle of 15 seconds with chlorhexidine digluconate w/v 0.2%, prior to an examination of the oral cavity.

The lost bridge was disinfected and a temporary cement was used to maintain it in the correct position in the mouth for the time required to take the CBCT scan (this was important because the bridge was used as reference for prosthetically driven implant planning).

A CBCT scan was taken to evaluate the available bone and if there were any limitations to the proposed treatment.

The CBCT revealed that there was sufficient available bone to perform the treatment, and the patient received prophylactic antibiotic therapy with 2 g of augmentin (GlaxoSmithKline, London, UK).

An intraoral scanner (IOS) impression of both arches (upper arch with and without the failed bridge), with the occlusion, was carried out. The resulting stereolithographic (.stl) files were sent via mail to the lab technician with a prescription to prepare and print, using a 3D printer, a digital wax-up replicating the temporary bridge in terms of shape and occlusal contacts. The project was made by securing that the try-in was correspondent to the abutment of the remaining single implant, which was previously covered by the failed bridge. The digitally realized wax-up was screw retained above the implant by using a multiunit abutment (MUA) in order to move the implant-prosthetic junction well away from the soft tissues.

The DICOM images were uploaded into the Navident software (Claronav, Toronto, Ontario, Canada) to develop a prosthetic-driven implant plan, approximately 90 minutes after the patient's arrival at the dental office.

Following careful extractions of the remaining roots (at 1.2, 1.1, 2.1, and 2.2 sites) and proper surgical toilette of the sites, the implant placement procedure was started using a dynamic computer-aided implantology system (Claronav, Toronto, Ontario, Canada).

Implant Planning and Surgical Procedure

The Navident Trace and Place (TaP) protocol, which consists of three steps, was used: (1) Plan: creation of a virtual surgical plan on the basis of the volumetric Digital Imaging Communication in Medicine (DICOM) data acquired from a CBCT scan, (2) Trace: registration of the patient's jaw to CBCT. This is done by tracing radiopaque landmarks that get selected/marked on patient's CBCT, and (3) Place: navigated implant placement according to the plan.

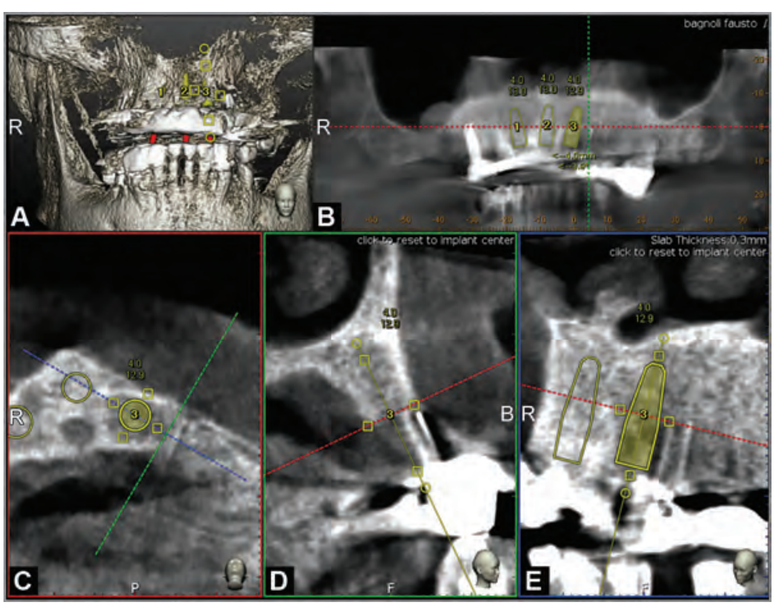
Plan

As previously mentioned, CBCT (Scanora 3Dx, Soredex, Tuusula, Finland) and an IOS scan (Medit i500, Medit Corp., Seoul, South Korea) were previously obtained, allowing an ideal virtual wax-up of teeth to be designed by the dental laboratory, using the patient's old collapsed bridge as wax-up. Both DICOM files from CBCT and STL files from the IOS were imported in the Navident software, matched and superimposed semi-automatically to residual teeth (or in toothless cases by using reference points in the wax-up) using the mesh-to-image registration tool provided.

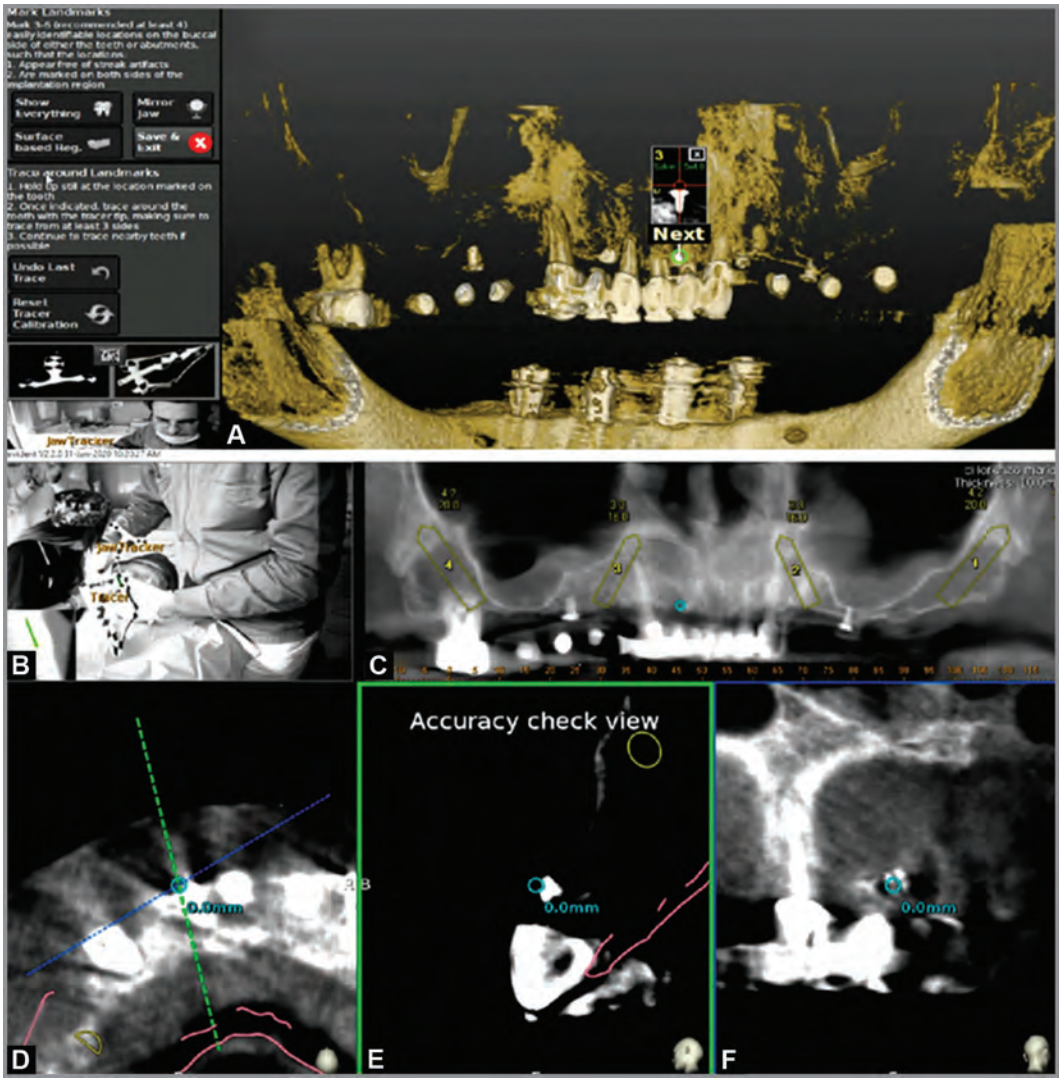
Implant placement was then prosthetically planned using digital wax-up (Fig. 2). As part of planning, surgeon selected three to six landmarks, teeth or abutments or roots or other anatomical landmarks, to be used as trigger points for tracing.

Trace

For the system's camera to track patient's jaw, an optical tracking tag was fixed to the patient's jaw where surgery was going to be performed. This required a HeadTracker for tracking by placing it directly on the patient's head (Fig. 3A). Tracing was then be performed starting at landmark locations. During tracing, surgeon



Figs 2A to E: Navident software showing implants planning along 3D (A); panoramic (B); axial (C); cross section (D); and sagittal (E) views



Figs 3A to F: Dynamic navigation TaP system and the correspondent view of the Navident software (A) showing the tracing progress to register points to the CBCT data. The surgeon (B) can verify the registration accuracy by touching with the tracer's ball tip on the patient's landmark (mini-screw in this case) and compare the physical location of the tip with its own on-screen representation: panoramic view (C), axial view (D), accuracy check view (E), cross-sectional view (F)

slided tracer's ball tip in full contact with each landmark surface (Fig. 3B).

After tracing all selected landmarks/teeth, the software automatically performed registration. Sampled trace points got superimposed with CBCT 3D rendering. Complete trace and registration process took an average of 1–2 minutes. Accuracy of trace registration was then assessed by touching with tracer's ball tip any patient's anatomical marker and confirming congruency between the touched marker and what was shown on the laptop screen (Figs 3C to F). If accuracy check was not satisfying, the tracing process could be immediately repeated.

Place

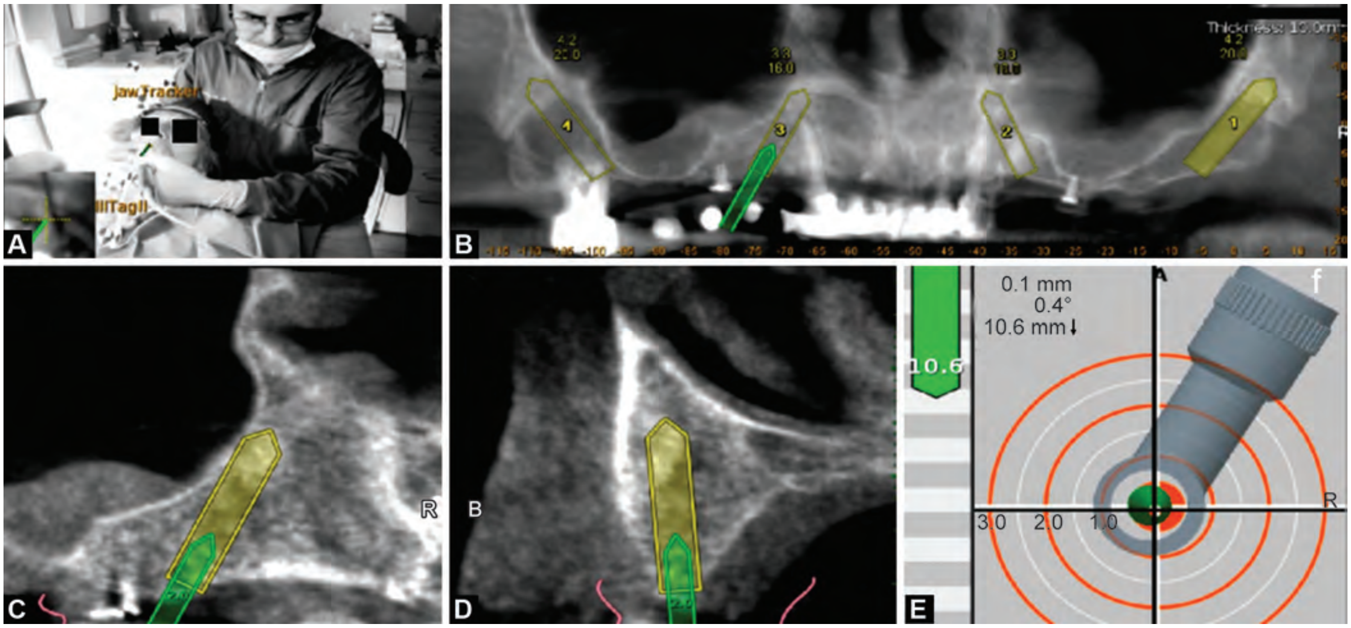
Handpiece drill axis and drill tip length were then calibrated using a metallic caliber; a second accuracy check was carried out in the same manner as for tracing. Once accuracy was confirmed, navigated implant placement could be carried out following the target view. This allowed clinician to verify, in real time, entry point, depth, and angulation of planned osteotomy as related to the plan. Other views that clinician could see on the screen enabled to follow the position of handpiece drill during osteotomy in coronal and sagittal views (Fig. 4).

Surgical treatment was performed by an experienced surgeon (LVS). Three implants were inserted in area 1.3, 1.1, and 2.2 with a flapless approach. After implant insertion (all implants resulted in a torque higher than 35 Ncm, indicating good primary stability), multiunit abutments (MUAs) were selected and tried.

The digital printed wax-up manufactured by the lab technician was screwed above the previously selected MUA abutment. The wax-up was linked to the new three implants by other abutments and then esthetic, phonetic, and occlusal assessments were carried out.

Four scan abutments were screwed above all implants, and an IOS impression was taken to prepare a provisional screwed prosthesis.

The four implants were covered by healing screws.



Figs 4A to E: Several views on the screen during surgery: (A) Tracker video stream; (B) Panoramic view; (C) Sagittal section view; (D) Cross-sectional view; (E) Depth indicator and target view

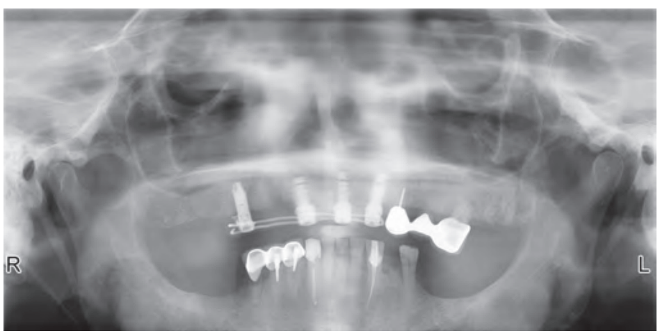


Fig. 5: Final panoramic X-ray with fixed implant-supported provisional bridge in place

In order to transfer further detail in respect of occlusion and gingival fit, the digitally printed wax-up was removed and rebased using the healing screws on the MUA: the overall procedure ended around 1 pm.

Prosthetic Finalization

Immediately after surgery, the patient remained in the surgical room and ice was applied externally to reduce postoperative inflammation. Patients was allowed to rest, and enjoy if needed some music or movies from a tablet. He was given some water to drink and some plain yoghurt as food.

Total 200 mg of ketoprofen (Ibifen, IBI, Aprilia, LT, Italy) was administered after the effect of anesthesia vanished. During this waiting time, the patient was intentionally kept inside the surgical room to limit any risks of contamination and contact in COVID-19 time. Patients had been previously informed and agreed on staying inside the office instead of going back home and then come back, to avoid risk of contamination and contact in public transportation.

After 5 hours (around 6 pm), the provisional prosthesis was screwed in to place, and an occlusal check was carried out and a low-dose digital orthopanoramic (Fig. 5) was taken after the prosthesis was screwed in (Fig. 6). No closed interactions occurred during these 5 hours between patient and dental staff, as the patient was in a separate room. During these 5 hours, the dental technician performed the following:

- Received stl files of the impressions were downloaded and imported in a CAD software.
- The former wax-up was merged with the new impressions.
- Implant positions were detected by overlapping the scan body positions with their own digital shape.
- The bridge was ultimated and milled.
- A resin model was printed to allow the following metal framework reinforcement.
- The printed bridge was relined above the framework and finished.

The patient and the dentist interacted for an estimated total time of 2 hours and 30 minutes, 90 minutes for the surgical steps (roots extraction, surgical toilette of the sockets, and computer-aided implant insertion) and 60 minutes for prosthetic steps (IOS preliminary impression, checking the wax-up, MUA connection, IOS final impression, prosthesis delivering, occlusal check).

At the end of the day, the patient appreciated the final functional and esthetic result. In order to limit the future appointments to the dental office, a memorandum was prepared for the patient (Table 1).

Postsurgical Protocol

After surgery, analgesia was achieved with 200 mg of ketoprofen for a maximum of three times daily according to the needs of the patient. The patient was instructed to rinse with 0.2% chlorhexidine digluconate mouthwash (Corsodyl, GlaxoSmithKline Consumer Healthcare, Brentford, United Kingdom) two times a day for 2 weeks, to follow a soft diet for 1 week, and to gently cleanse with a soft toothbrush, avoiding the use of floss in the surgical area for the 1st month.

The patient was followed through video calls after 24 hours, 48 hours, and once a week for 1 month for any significant clinical signs

Fig. 6: Clinical appearance of the immediate restoration

Table 1: Memorandum for the patient to be followed in the days after surgery

Memorandum
Day 1: Ketoprofen 200 mg tablet at 00:00 in the fed state (f.s.)
Ice pack 10 minutes on 10 minutes off
Diet: fresh liquid or semi-liquid
Day 2: Ketoprofen 200 mg tablet at 08:00–20:00 (f.s.) in case of pain
0.2% chlorhexidine digluconate mouthwash two times a day
Diet: liquid or semi-liquid
No ice pack
Phone-video call
Day 3: Ketoprofen 200 mg tablet as day 2
0.2% chlorhexidine digluconate mouthwash two times a day
Diet: soft
Phone-video call
Day 4: Ketoprofen 200 mg tablet as day 2
0.2% chlorhexidine digluconate mouthwash two times a day
Diet: soft
Day 5 to day 14: 0.2% chlorhexidine digluconate mouthwash two times a day
Diet: soft

and symptoms. He reported none and was satisfied and appreciated our care and effort.

Discussion

In the present work, the management of an implant prosthetic rehabilitation of a patient who had lost a bridge in the upper arch and asked for an immediate rehabilitation was reported by using different digital technologies, which allowed to successfully perform in 1 day both the surgical and the prosthetical stages with a minimally invasive approach (no bone grafting) and a high standard of care during the COVID-19 lockdown in Italy.

Implant surgery and the following prosthetic treatment typically represent a case of delayed treatment that would, under normal circumstances, definitely require more than a single appointment.

The custom of using multiple appointments is mainly dictated by the time required by dental labs to receive and process the materials from the dental office, and then to manufacture and deliver the requested products. However, technological improvements, not only operative ones but also in communication between dental offices and labs, enables a significant saving of time (and consequently costs) in the whole process. In COVID-19 times, limiting the number of appointments has the added benefit of reducing contacts in confined environments like the dental office. In order to limit the potential for infection spread and to reduce fear in the general public, it is paramount we play our part in countering public movement, especially in crowded environments (like public transport) by minimizing the number of appointments.

In the presented case, the digital equipment enabled the multiple steps adopted in implant surgery and prosthetic restoration to be carried out in a single visit (1 full day), reducing the potential risk of cross-contamination.

Moreover, such a workflow could also be adopted in routine treatments, especially when patients do not have time for multiple appointments or live far from the dental office and wish to avoid unnecessary time traveling.[24–29]

More precisely, the adopted workflow can be divided into the following steps:

First step: Analysis of the oral and general health status of the patient; consideration of his requests and evaluation of several options to solve the patient's needs (new or recent orthopanoramic or periapical radiographs are needed); explanation of the possible options in terms of the clinical procedures, timing, and costs.

Second step: IOS impressions to prepare a digital wax-up and a related scan prosthesis (to be evaluated in consideration of the span width) and several pictures to get the intra- and extraoral esthetic requirements.

Third step: A check of the digital wax-up to evaluate aesthetics, phonetics, and occlusion; acquisition of a CBCT scan to evaluate the feasibility of the proposed surgery and to facilitate surgical planning.

Fourth step: Surgical procedure, MUA screwing; IOS impressions to prepare a fixed provisional prosthesis; a silicon bite-check index to convey the correct information regarding occlusal height.

Fifth step: Placement of the fixed provisional and carrying out an occlusal check.

Sixth step: Postsurgical appointments with periapical radiographs to monitor healing.

In this case, all of these steps were performed in 1 day, whereas traditionally for many reasons they are performed on different visits.

It should be clear that the spread of the coronavirus will change the workflow in terms of the number of appointments and these should be reduced where possible to limit the chances of becoming infected and/or spreading the infection.

The first step could be done by telephone consultation with the patient, evaluating photographs of his oral status, reviewing radiographs already present in the dental office, determining his health status, and discussing possible solutions to the problem.

In the second step, the clinician could develop the treatment plan and arrange an appointment in which he can check the digital wax-up, proceed to the surgical treatment, take the impression, accept delivery of the provisional prosthesis a few hours later, and give the patient the right information for the postoperative period (a memorandum should be prepared).

Reducing the number of the appointments from six to two will result in the additional advantage of a reduction in treatment costs for the dentist, taking in to consideration a lessening of the need for repeated use of single-use devices, air and surface decontamination, and chair time costs.

To perform case like that one presented in this study, a CBCT, an IOS, and a system able to perform a computer-aided implantology were used. Indeed, the most relevant issue is the combination of all these technologies and their integration in a well-organized treatment plan. Remote consulting also played a significant role in reducing time the patient had to spend in the office. Probably, remote consulting could not be sufficient to give all the clinical information that could be obtained by a face-to-face visit, but in this case, it resulted a very efficient tool to assess most patient's postsurgical conditions. It served profitably in COVID-19 times, but its use will also significantly increase in the future, and more specific diagnostic tools will be developed for the purpose.

The CBCT allowed the clinician to immediately evaluate the residual bone volume where implants needed to be placed. At the same time, the availability of CBCT in the dental practice gave the opportunity not only to save time but also to reduce potential risks within the whole procedure.[4,13,29–31] Referring patients for CBCT scans, which has always been a common practice, is less recommended in COVID-19 times to limit human interactions, which has been reported as a major consideration in addressing the reduction of infection.

The IOS allowed the clinician to immediately take a preliminary digital impression of the arch to be treated. The resulting 3D files were sent by e-mail to the dental technician who provided a digital wax-up. The wax-up represented the ideal prosthetic outcome and it was uploaded to the planning software for the formulation of a prosthetically driven implant plan. Besides a considerable amount of time saved, the absence of any impression and/or plaster cast reduced the risk of cross-infections between the dental and laboratory teams. It also reduced the need for impression disinfection measures.[32,33]

In COVID-19 times, these advantages were highly appreciated by all people working in dental offices and labs.

As long as 20 years ago, computer-aided implantology (CAI) was scientifically proposed to clinicians to guide the surgical approach in a prosthetic manner. Additional aims were to reduce the invasiveness of implant surgeries, limit bone augmentation procedures, and take advantage of the residual bone of the jaw.

The CAI field has been improved during the last two decades and has resulted in the emergence of two main approaches: a static-guided CAI and a dynamic-guided CAI. The first one is represented by a system joining a virtual project by the use of a physical object represented by a surgical guide, used to perform both osteotomies and implants seating.

The dynamic computer-aided implantology (DCAI) can make this procedure faster as it doesn't require any radiographic device while taking the CBCT and it works without any surgical guide. In COVID-19 times, this is another advantage because making a conventional surgical guide takes more time since it must be delivered, checked, and precisely inserted. Moreover, the procedure of positioning a guide in multiple implant surgery is not easy and increases the risk of surface/aerosol contamination, which dentists should aim to limit and not increase in COVID-19 times.[24–29,34]

As described above, a postoperative digital impression was taken with an IOS, and then sent to the lab via e-mail. The dental lab is able to start the manufacture of the prosthesis almost immediately, allowing it to be delivered on the same day of the surgery. The advantage is not only saving time but simplifying the procedure and minimizing cross-contamination.[35–37]

With traditional techniques, a complex treatment such as one here described needs a lot of laboratory steps that make longer and more articulated all the technical procedures, to be completed in a single day.[38–46] This was only possible because all the digital devices present in the dental office allowed the clinician to reduce the necessary steps to complete the work. Moreover, the digital supplies helped to reduce material requirements and people movement.

A potential limitation of the presented workflow is the absence of the necessary technology in dental offices and/or labs. With the increasing use of digital technology in dentistry, the required devices to perform this "1-day digital dentistry" are becoming available and present in dental practices, being commercially available since years.

The minimally invasive approach allowed by CAI in order to limit bone augmentation procedures by using the residual bone of the jaw represents also a great advantage to minimize duration of the surgical procedure, number of appointments, costs, and patient morbidity. A more well-organized and profitable system of work will always be the key to a high-quality standard of care.

Conclusion

Digital technologies are promising innovative solutions to solve dental problems in pandemic times. In fact, they not only standardize treatments but also provide clinicians with the capability to reduce cross-infection risks. Moreover, digital technologies in general, and dynamic navigation specifically, empower clinicians to perform complex implant prosthetic treatments, not only in a minimally invasive way but also in one single visit.

The possibility of performing an effective treatment saving time by using efficient technology and minimally invasive procedure highlights the importance of digital planning in order to optimize every single step of the treatment.

The preservation of time involves the clinical side of the matter since the patient could receive an entire treatment without the need of several expositions to the potentially hazardous environment of the dental office.

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