prosthesis

Case Report

The Use of a Surgical Template for the Insertion of Dental Implants and Sinus Lift with the Summers Technique Based on Digital Planning: A Case Report

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Abstract: (1) Background: Computer-guided surgery is now established as the main technique for implant placement, reducing intraoperative complications and helping the clinician avoid damaging sensitive anatomical structures, such as, for example, the maxillary sinus. (2) Methods: A complex case is discussed to suggest how computer-aided surgery can merge with freehand surgery, as a surgical guide can make a freehand surgical procedure less complicated and more predictable. (3) Results: A surgical procedure was executed following digital planning, except for sites 1.5 and 2.5, where a mixed approach was adopted: they were initially prepared with a milling depth of 1 mm from the base of the maxillary sinus and were then finished using osteotomes, according to the technique described by Summers. Radiography confirmed the correct positioning of the implants and the sinus lift. (4) Conclusions: A mixed digital/analogical approach used in complex cases increases the accuracy of the results and reduces complications and treatment time. The presence of a correctly digitally planned surgical guide helps in the freehand approach and not only in the digital approach.

Keywords: digital dentistry; implantology; maxillary sinus floor elevation; atrophic posterior maxilla; computer-guided surgery

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Citation: Speroni, S.; Bosco, F.; Ferrini, F.; Pittari, L.; Nota, A.; Tecco, S. The Use of a Surgical Template for the Insertion of Dental Implants and Sinus Lift with the Summers Technique Based on Digital Planning: A Case Report. *Prosthesis* **2024**, *6*, 206–215. https://doi.org/10.3390/prosthesis6010016

Academic Editors: Marco Cicciu and Giuseppe Minervini

Received: 30 November 2023
Revised: 25 January 2024
Accepted: 6 February 2024
Published: 14 February 2024

1. Introduction

An accurate implant placement during surgical treatment is considered to be the desired goal in order to achieve optimal clinical results and reduce failures, complications, and side effects [1].

Different studies agree that increased accuracy can influence the correctness of clinical results in various prosthetic implant procedures [2]. The introduction of cone-beam computed tomography (CBCT), which provides imaging at a low radiation dose and at a relatively low cost, has increased the applicability and justification of three-dimensional (3D) pre-surgical planning.

Many authors also agree that computer-guided surgery could reduce intraoperative complications, helping the clinician avoid damaging sensitive anatomical structures, such as the mandibular nerve and the maxillary sinus. It also helps in the preservation of the proximity of the roots in partial edentulism [3,4].

The reduced invasiveness and duration of surgical procedures are additional benefits of computer-guided surgery, together with increased patient satisfaction and compliance [5].

A major advantage of this kind of procedure is the correct placement of the implant. The optimal angulation of the implant in complex prosthetic cases can promote more esthetically satisfactory results and more durable peri-implant tissue health [6]. Also, in orthodontic cases, computer-guided surgery guarantees the primary stability of implants [7]. Inaccuracies in implant positioning may result in complications such as the perforation of the inferior alveolar canal, the lingual plate, or the maxillary sinus.

A compromised prosthesis is also a possibility, which may lead to the transmission of unfavorable occlusal forces to the implant. For decades, before the advent of digital techniques, the use of resin surgical guides constructed following wax ups for freehand implant insertion was the solution for inserting implants in the correct positions.

Anyway, digital procedures have not completely replaced the use of freehand or mixed procedures, especially when used by expert operators who do not want to completely rely on digitally guided procedures.

Mixed techniques are widely described in the literature, with largely overlapping results at follow-up.

In any case, these are techniques which, as we will see later, should be recommended to expert hands with greater surgical knowledge.

The optimal positioning of implants can also reduce the costs of restorations, allowing for the use of standard abutments and avoiding expensive customized solutions.

A digital approach can also be optimal in surgical cases where the bone substance is not sufficient for implant placement, thus requiring additional procedures such as sinus augmentation. The aim of our case report is to validate the authors' theories and to suggest how computer-aided surgery can merge with freehand surgery in complex clinical cases in order to obtain a more favorable outcome. In these situations, the surgical guide can make the freehand surgical procedure less complicated and more predictable [8].

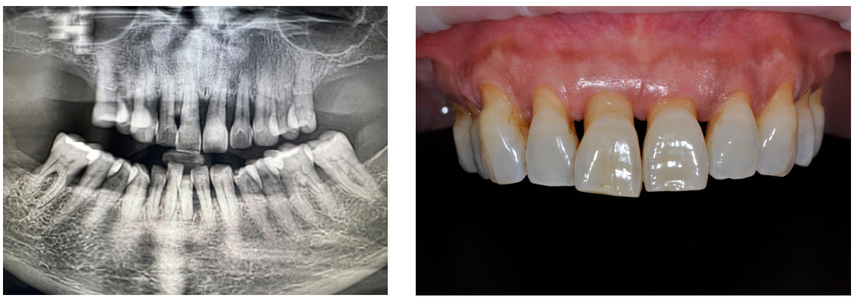
2. Materials and Methods

The present clinical case represents a surgical case with the use of a mixed computer-guided and freehand technique.

The protocol was approved by the Ethics Committee of the territory of Lombardy 1 (approval 38/INNT/2023).

The patient was treated at a private practice and signed consent forms for the clinical procedures and a consent form for the treatment of their personal data in the present paper.

The patient came to our clinic presenting with a complex situation in the upper arch, with a severe loss of bone tissue caused by aggressive periodontitis; the teeth presented a severe grade of mobility (Figure 1).



(**a**) (**b**)

Figure 1. Pre-operative records. (**a**) Initial orthopantomography; (**b**) photograph of the initial situation.

Different treatment options were discussed with the patient: the prosthetic implant option was considered more favorable and predictable compared to advanced periodontal therapy because of the severe mobility of the teeth.

Additionally, the patient expressed the desire to intervene with a fixed prosthetic implant treatment, avoiding, if possible, complex regenerative procedures with bone grafts: for these reasons, the most rapid and conservative option was chosen.

Provisionals were constructed and their insertion was planned after strategic extractions; implants were then positioned in place of elements 15-13-11-21-23-25, followed by prosthetic finalization with two cantilever elements in positions 16 and 26.

Cantilevers were chosen to avoid the sinus lift that would have been necessary in order to position implants in sites 16 and 26, where the bone was not sufficient.

2.1. Surgical Phase

Phase 1 consisted of strategic extractions in the locations where the implants would then be positioned, creating provisionals for the preserved teeth.

This was fundamental for the correct healing of the post-extractive alveolar socket in order to guarantee a successful positioning of the implant after tissue recovery.

The preparation of elements 14-11-21-24 as pillars permitted the construction of armored provisionals, made of acrylic resin, with ovate pontics on the intermediate elements [9].

The final refinement of the provisionals guided the correct recovery of the soft tissues (Figure 2).

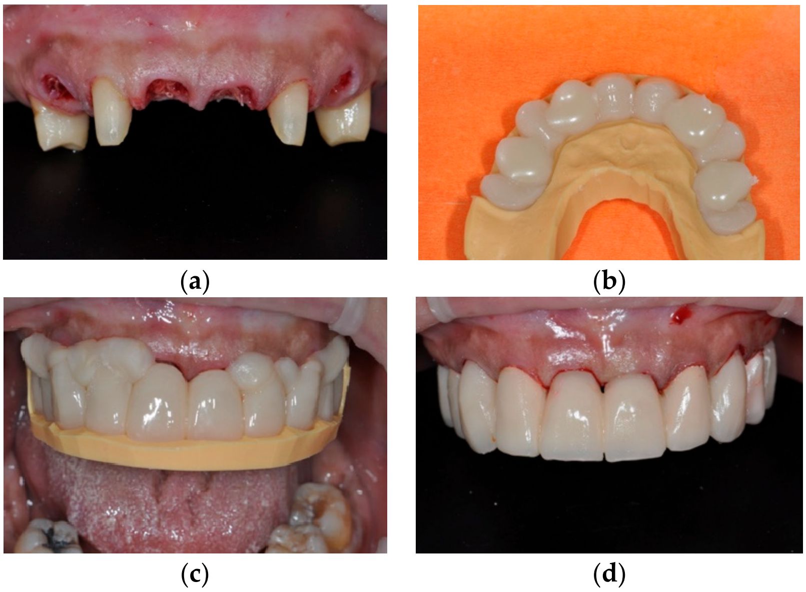


Figure 2. (**a**) Locations of strategic extractions; (**b**) provisionals; (**c**) relining provisionals with resin material; (**d**) positioning of provisionals.

2.2. Computer-Guided Surgical Planning

The aim of this phase was to prepare a surgical guide for the insertion of the implants in the planned sites.

Sites 15 and 25 were planned differently, with a mixed approach that considered both the surgical guide and a freehand technique to complete the implant site.

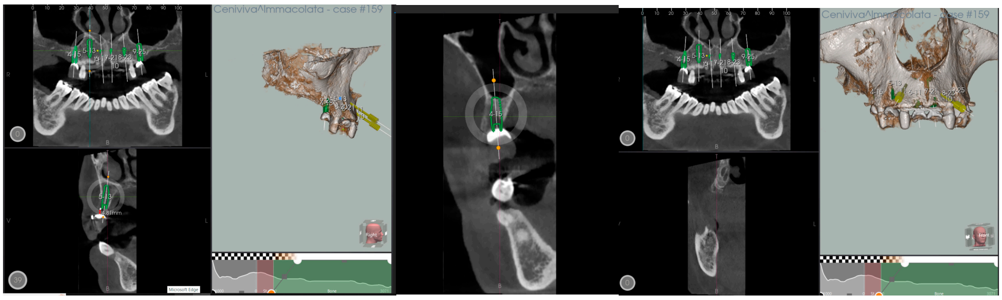
In these sites, the excessive pneumatization of the maxillary sinus called for a mixed digital/analogical planning of the implant site. The finishing of the site was carried out with a freehand approach, using the mini sinus lift technique described by Summers in the early 1990s [10].

A surgical guide was then constructed using a specialized software (Implant 3D, version 9.3.0).

The planning information was sent to the printer (cDLM EnvisionTEC 3D printer, EnvisionTEC, Gardena, CA, USA) in order to build the guide [6–8].

A sequence of burs for the preparation of the implant site was also selected, based on the diameters and sizes of the implants that had previously been chosen (Figure 3).

For implants in sites 15 and 25, the guide was used only initially in order to select the correct positions of the implants; subsequently, the site was finished by hand using osteotomes in order to perform a crestal sinus lift, a technique that is widely accepted and has predictable results, comparable to those of the lateral window technique [10].



(**a**)

(**b**)

Figure 3. (**a**) CT images that show the planned position for the implants; (**b**) construction of the surgical guide.

2.3. Surgical Phase: Insertion of the Implants

Following the exposure of the surgical site, in order to perform an open flap procedure, the teeth-supported surgical guide was positioned.

The guide was first stabilized using pivots that had been programmed with the surgical plan.

In cases where guided surgery is used, the protocol involves positioning the surgical guide by means of bone anchoring of the same using an open flap procedure with exposure of the alveolar process or using a flapless technique.

An open flap procedure was chosen in order to correct any alveolar defects found in the planning phase. It also allowed for better clinical control of the positioning of the neck of the implant in regard to the gingival margins [11].

The surgical procedure was executed following the correct planning of the milling sequence.

The sequence of drills was established in the programming phase.

Sites 15 and 25 were prepared with a milling depth of 1 mm from the base of the maxillary sinus.

Once the milling sequence was completed, the site was finished using osteotomes according to the technique described by Summers and 9 mm long implants were inserted.

The Summers technique is used, as its author recommended, when the implant must be deepened into the maxillary sinus by a few millimeters after breaking the base of the maxillary sinus with the use of osteotomes with increasing diameters based on the chosen implant diameter.

Starting from the lowest diameter through the osteotome and percussion, the base of the maxillary sinus is broken using the depth reference of the notches marked on the osteotome.

Once the base of the maxillary sinus has been broken, the bone residue formed is gently pushed inside the maxillary sinus with osteotomes so as to raise the membrane of the sinus.

The radiograph shows the correct positioning of the implants and the sinus lift (Figure 4).

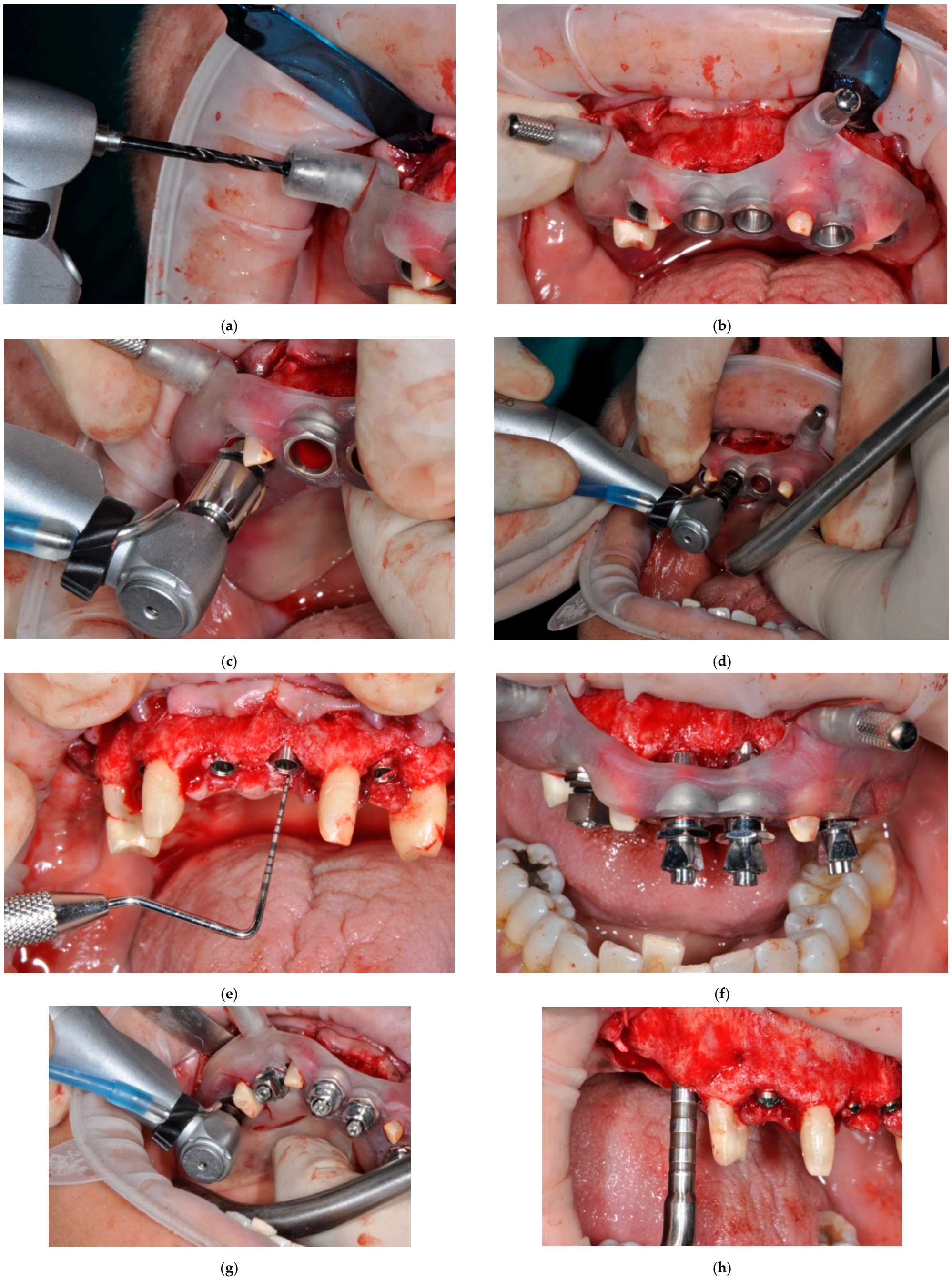
Three months after the implant insertion, healing screws were positioned at the reopening of the implants.

At the same time, a digital impression was taken in order to fabricate provisional crowns.

In the following weeks, definitive abutments were positioned and provisional crowns were inserted after removing the dental elements (Figure 5).

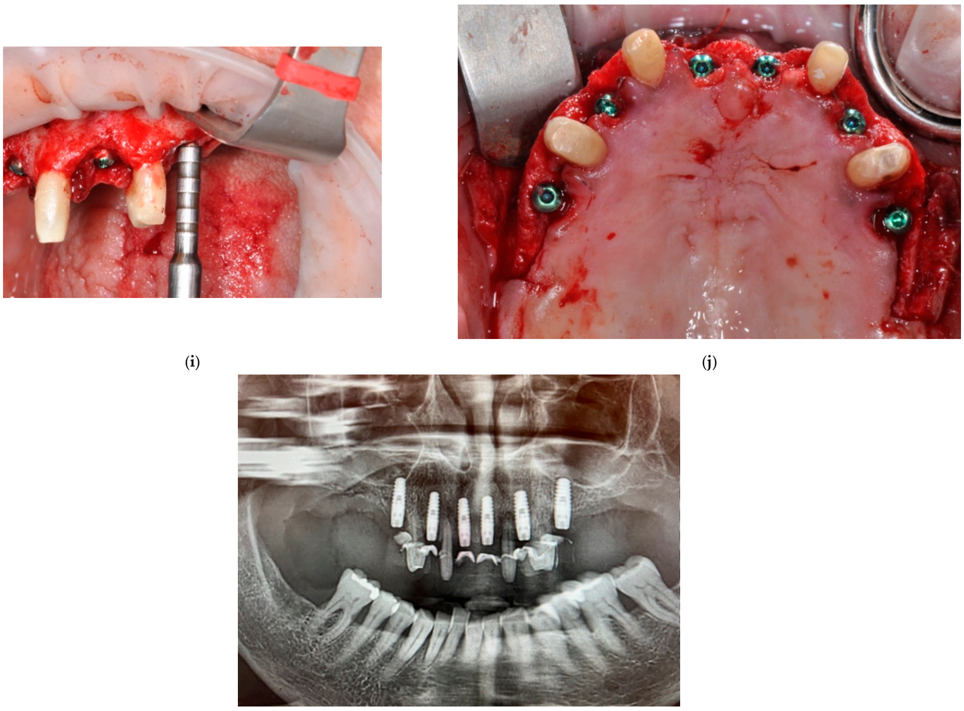
Subsequently, periodic checks were carried out. After 4 months, the complete healing of peri-implant soft tissues was noted, and the definitive elements were cemented.

After six months, radiographic control showed a correct osteointegration of the implants.



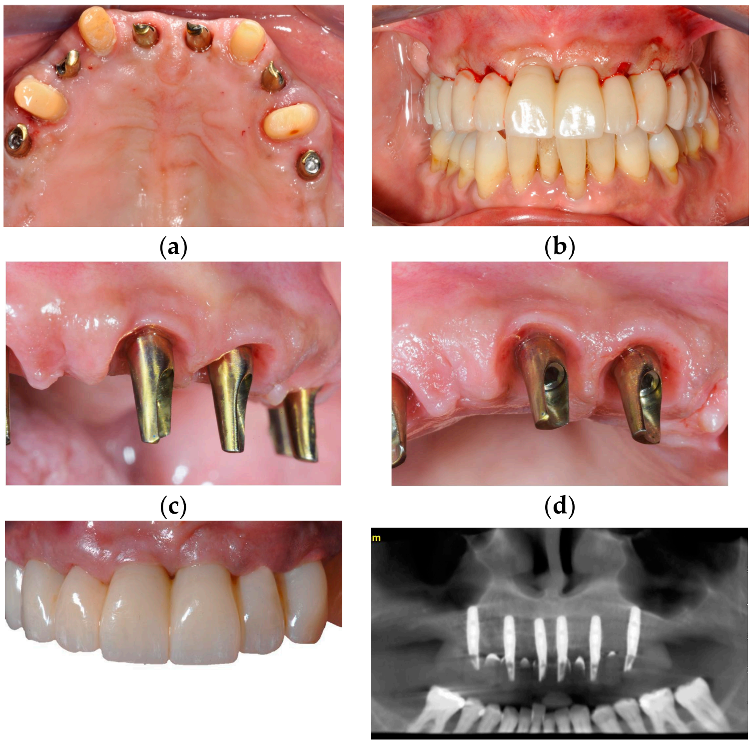
(a) (b) (c) (d) (e) (f) (g) (h)

Figure 4. *Cont*.



(i) (j) (k)

Figure 4. Implant positioning sequence and final radiograph. (**a**,**b**) Positioning of the guide; (**c**–**e**) implant insertion; (**f**) implant mounts; (**g**–**i**) preparation of posterior implant sites according to the Summers technique with osteotomes; (**j**) final result; (**k**) post-operative radiograph.



(**a**) (**b**) (**c**) (**d**) (**e**) (**f**)

Figure 5. Insertion of provisional and definitive crowns and control X-ray. (**a**) Insertion of definitive abutments. (**b**) Insertion of provisional crown and positioning ovate pontics in extraction sockets. (**c**,**d**) Soft tissue architecture healing. (**e**) Definitive crown after six months. (**f**) Control X-ray six months later.

3. Discussion

The implementation of digital techniques has greatly influenced progress in dentistry. Thanks to the development of CAD/CAM systems, the digital workflow is in constant growth and it is considered to be efficient in terms of timing [12–14].

Apart from decreasing the timing needed for planning and for surgical procedures, a complete digital workflow allows for the appropriate control of surgical steps, which favors an optimal end result, allowing for a one-stage plan of surgical as well as prosthetic rehabilitation [15].

Many studies show that implant positioning with a surgical guide guarantees an appropriate 3D positioning of the implants, favoring the correct mechanical properties of the implants (in terms of fatigue test) [16,17] as well as the esthetics of the final result.

Other studies affirm that digitally guided positioning is related to the correct management of interdental spaces, thus facilitating optimal oral hygiene [18,19].

It has also been demonstrated that the level of expertise of the first operator is correlated to the survival rate of the implants [12].

Lambert et al. [13] highlight how surgeons who had positioned fewer than 50 implants had a doubly high failure rate compared to more expert surgeons. One possible explanation for the poor outcomes of implants placed by inexperienced surgeons is that the frequency of problems such as excessive heat during drilling, failure to stabilize the implant, or lack of adequate planning may increase with less experience.

Therefore, a digitally planned guide could improve the outcomes of less expert surgeons, reducing possible problems, mostly in cases of treatment with multiple implants. In a recent study conducted on maxillary models, the accuracy of freehand implant surgery performed by an experienced operator was compared to static guided implant surgery performed by an inexperienced operator: at the apex of the implant, the accuracy of implant placement using a surgical guide was significantly higher than that of freehand implantation. The mean difference between the planned and actual implant positions at the apex was 0.68 mm for the experienced group using the freehand technique and 0.14 mm for the non-experienced group using the surgical guide technique [20].

Even more expert surgeons can obtain advantages from a digitally planned approach, not only during the positioning of implants, but also to facilitate a freehand surgical treatment, as in the present case, where sites 15 and 25 were initially prepared with a milling depth of 1 mm from the base of the maxillary sinus (following digital planning) and then finished with a freehand approach using osteotomes according to the technique described by Summers [10].

In the present clinical case, the accurate planning of prosthetic implant rehabilitation was an important prerequisite that allowed us to precisely plan the subsequent sinus lift procedure that preceded the positioning of the implants. This approach is fully presented in the present clinical case.

The sinus lift technique should always be planned basing on a prosthetically guided project in order to obtain an ideal 3D positioning of the implants.

The use of a surgical guide allows for the execution of a sinus lift procedure that is directly correlated with the prosthetic plan. The same surgical guide can then be used to position the implants in the same site.

This approach can mostly be useful in situations where an atrophic bone is present, because with digital programming, the surgical procedures can be directly linked to the final prosthetic plan.

As explained, in the present case, due to the pneumatization of the maxillary sinus, the site for two implants, 15 and 25, required an additional procedure consisting of a sinus lift performed following the technique described by Summers.

In general, a transalveolar sinus lift is usually recommended when the initial residual alveolar bone height (RBH) is more than 5 mm, while a lateral window sinus lift is suggested when the bone height is less than 5 mm [21–23].

The transalveolar approach for sinus floor elevation with subsequent placement of implants was first suggested by Tatum in 1986. Tatum used a "socket former" to create a "greenstick fracture" in the sinus floor [24].

Summers [10] later described a different transalveolar approach using a set of tapered osteotomes with increasing diameters. This concept was intended to increase the density of soft (type III and type IV) maxillary bone, resulting in better primary stability of the inserted dental implants. Bone tissue was conserved by this osteotome technique because there was no drilling. Adjacent bone was compressed by pushing and tapping as the sinus membrane was elevated. Then, autogenous, allogenic, or xenogenic grafts were added to increase the volume below the elevated sinus membrane [25].

In the literature, the transalveolar osteotomy approach for maxillary sinus augmentation has been observed to be related to the causes of failed implants [26,27]. But correlations between anatomic variations of maxillary sinus ostium and post-operative complications after sinus augmentation have also been noted for both conventional approaches [28].

Thus, digital planning and guided surgery allowed the surgeon to better focalize on bone quality and therefore on the last drill diameter, improving the primary stability of the implants, thus reducing implant failures.

A recent study [29] highlighted how the accuracy of digital protocols makes them reliable for rehabilitation in partially edentulous patients.

Another recent study [30] focused on the importance of choosing the right implant system to pair with the software system used for digital planning in order to ensure that the implant system chosen is supported by the software.

In this clinical case, digital planning allowed us to evaluate the quality of the bone and the length of the implants that needed to be positioned. The surgical guide created for the positioning of the implants was also used as a template for the correct inclination of the osteotome in the execution of the Summers technique.

So, one of the added advantages of the surgical guide was to give us the opportunity to execute the sinus lift in a more conservative way.

As digitally planned, the use of the surgical guide was preceded by numbing the area with local anesthesia and, after incisions were created in the gingiva in order to open the flap, since an open flap procedure was being executed, the tooth-supported surgical guide was fixed on the maxilla.

The surgical guide also allowed the surgeon to be quicker in the execution of the surgery.

In addition, using the same guide for both the sinus lift and the implant positioning allowed us to execute both surgeries in the same appointment.

Inexperienced surgeons can benefit from this technique as it allows them to plan the surgery in all of its phases.

As known in the literature, the perforation of the sinus membrane is a complication that can occur, so it is fundamental for the surgeon to use all precautions in order to avoid this. The use of a surgical guide permits them to establish the maximum depth that can be reached with the instruments.

In cases where the quantity of bone tissue guarantees good initial stability, the implants can be positioned during the same surgical procedure as the sinus augmentation.

In this case, as previously described, after the execution of the transalveolar sinus lift, 9 mm long implants were finally inserted. In conclusion, in the case described, the therapeutic approach can be considered a mixed implant treatment with digital/analogical support (freehand approach). The post-treatment radiograph confirmed the correct positioning of the implants and the sinus lift.

In this clinical case, the good outcome of the prosthetic rehabilitation confirms the accuracy of the diagnostic–therapeutic course that was followed.

Furthermore, the digital approach allowed for the surgery to be performed in a minimally invasive way, thus reducing the length of the procedures and the recovery time.

4. Conclusions

A mixed digital/analogical approach used in a complex case is described. The procedure led to increased accuracy in the result, as proved by the post-treatment radiograph and prosthetic rehabilitation. In this case, the presence of a correctly digitally planned surgical guide was fundamental. The guide also helped the surgeon in the freehand approach and not only in the digital approach.

Certainly, this particular surgical technique can be considered a valid aid in complex cases where the surgeon faces this type of surgery for the first time. In these cases, the use of surgical guides both analogically and digitally may be the best choice.

Author Contributions: Conceptualization, S.S., F.B., F.F., and S.T.; methodology, S.S., A.N., L.P., F.B. and S.T.; investigation, S.S.; data curation, S.S., F.B. and S.T.; writing—original draft preparation, S.S., F.B. and S.T.; writing—review and editing, S.S., F.B., F.F. and S.T.; supervision, F.B. and S.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The protocol was approved by the Ethics Committee of the territory of Lombardy 1 (approval 38/INNT/2023).

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study. Written informed consent was obtained from the patient(s) to publish this paper.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: We acknowledge Stefano Mummolo for his contribution to clinical surgical planning.

Conflicts of Interest: The authors declare no conflicts of interest.

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