Guided implant-prosthetic rehabilitation: a clinical case report

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Abstract

The advent of new assisted design software in combination with computed tomography (CT) has increased the possibility of rehabilitating edentulous jaws with implant-supported fixed prostheses, allowing flapless surgery and immediate loading even in the presence of critical bone volume. Aim: The aim of the present study is to demonstrate how the use of advanced technologies supported by specific software allows the design and execution of optimal implant surgery while going on to decrease what could be intra- and postoperative risks.

Keywords: All-on-six, Computer guided implant surgery, Flapless implant surgery, Dental implants, Computed Tomography, Virtual implant surgery planning.

Introduction

The advent of new assisted design software in combination with computed tomography (CT) has increased the possibility of rehabilitating edentulous jaws with implant-supported fixed prostheses, allowing flapless surgery and immediate loading even in the presence of critical bone volume [1]. CT-guided surgery has become even more accessible with the increased availability of virtual implant planning software [2]. In fact, computed tomography (CT) or cone-beam CT (CBCT) scans and three-dimensional surgical planning software allow the clinician to analyze the patient's anatomical structures and prosthetic parameters, while at the same time virtually visualizing the optimal position and direction of insertion of each implant [3].
Virtual prototyping makes it possible to: produce stereolitho-graphic models that, by transferring virtual planning to the surgical field, are particularly useful in the presence of edentulous portions lacking anatomical landmarks for surgery [4]; second, the direct transfer of implant position from the pre-surgical plane to the dental laboratory makes possible the pre-fabrication of an immediate-load fixed acrylic resin complete denture.
Thus, it becomes evident that the software-guided surgical-prosthetic protocol has several clinical advantages such as optimizing all available residual bone to avoid regenerative procedures, reducing the number of surgical procedures, decreasing the invasiveness of the surgery, and shortening the time between surgery and delivery of the prosthesis, minimizing the patient's postoperative discomfort, with good predictability of functional and aesthetic results [5] [6].
Therefore, flapless-guided surgery requires less time and at the same time allows reducing bleeding and post-surgical complications (trismus, swelling, hematoma).
In addition, a flapless approach maintains high osteogenic potential and blood supply to the underlying implants, allowing intimate contact between the periosteum and bone while preserving the integrity of the supra-periosteal plexus [7] [8].
The current work-flow for guided implant surgery incorporates new technologies such as intra-oral optical scanners, in-office CBCT, virtual implant planning software, and 3D printers. Which of these advanced modalities the practitioner chooses to use will depend on equipment availability and experience level [9].

Materials and Methods

The patient, a 52-year-old man in good general health, presents on objective examination having several edentulous areas at the level of the two arches, with greater impairment of function and aesthetics at the level of the upper jaw. His request is to regain optimal morpho-functional restoration by performing a fixed prosthetic solution; therefore, for this reason, an immediate-loaded implant-prosthetic rehabilitation of the upper maxilla was proposed to the patient according to the All-on-six technique.

Results

No implants were lost during the follow-up monitoring period; furthermore, no intra- and postoperative complications were recorded.

Conclusion

Through the use of guided technology, it is therefore possible to perform implant surgery with reduced number of implants with greater precision and safety realizing a durable result with a favorable prognosis.

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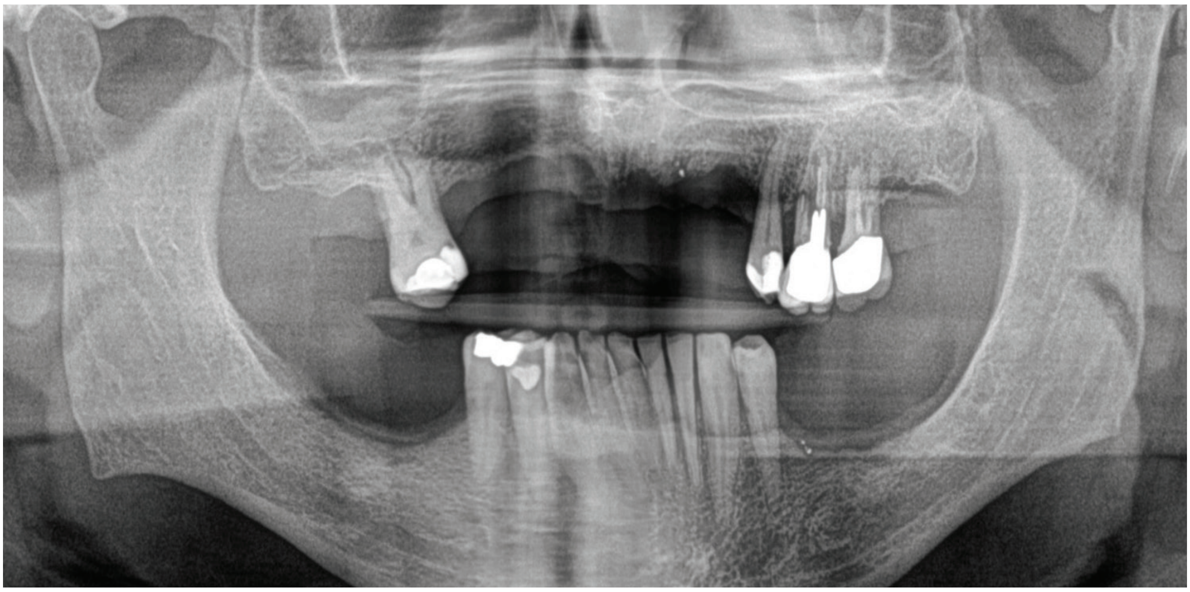

Figure 1. Pre-operative OPT.

CASE REPORT

A 52-year-old male patient presents for his first visit to the Department of Dentistry and Prosthodontics of the Vita-Salute San Raffaele Hospital directed by Prof. E.F. Gherlone. The patient presents good general health; however, following a thorough intra- and extra-oral objective examination, several areas of edentulousness in the four quadrants are evident, compromising proper masticatory function. A good state of impairment of the last remaining elements of the upper arch is also evident. In fact, the patient came to our attention with the desire to be able to regain optimal masticatory as well as esthetic function, with a request for a fixed prosthetic solution.

With the purpose of performing accurate morpho-functional restoration, the patient was proposed an immediate-loaded implant-prosthetic rehabilitation of the upper jaw according to the All-on-six technique.

Planning of the surgery was carried out through the use of CREA-3D Software (BioSAFin). Through the realized surgical protocol, four axial implants were planned at the level of the anterior area; the implants placed in place 12 and 22 having a diameter of 3.8 mm and a length of 6 mm; in place, instead, 14 and 24, having a diameter of 3.8mm and a length of 9 mm. In contrast, the two tilted implants placed at sites 16 and 26 were planned with a diameter of 3.8 mm and a total length of 15 mm.

Cross-sections were also performed at the level of the planned implant sites through the software; these allowed us to evaluate their position in relation to the bone structure, the relevant noble anatomical structures and the related prosthetic aspects. In order to have with greater clarity a visualization of the axes of implant insertion, an axial section was made.

The support of the CREA 3D software was of relevant importance as it allowed, through the use of the 3D function, a three-dimensional evaluation of the position of the implants, thus additionally assessing the parallelism of the EAs.

The surgery was performed under aseptic conditions under oral sedation with diazepam 0.25 mg/kg (Valium 5 mg, Roche) and under local anesthesia with 2% mepivacaine and adrenaline 1:100000 (Carbocaine, AstraZeneca, Milan, Italy). The implants were placed with a *flapless* technique.

FOLLOW-UP

Follow-up visits, aimed at clinical and radiographic examination, were performed one week after implant placement. Thereafter they were performed at three months, six months and then annually until a follow-up of one year was reached. The patient was adequately instructed, by a dental hygienist, in mechanical plaque control through the use of the electric or manual toothbrush, interproximal brushes, and Super Floss type floss (Oral B, Procter & Gamble, Cincinnati, OH, USA). Whereas, professional oral hygiene procedures were performed every three months following implant placement.

Parameters evaluated

Implants survival rate

Implant survival rate is based on the number of implants that were not lost or removed, throughout the follow-up period [9].

Marginal bone loss

Endoral radiographs, using the parallel cone technique, were taken after implant placement, at three, six, and 12 months. In order to assess the marginal bone trend, measurements were taken through the use of CREA-3D software (BioSAFin). First, the instrument was calibrated (pixels/mm), using the diameter of the implants as the unit. Next, changes in peri-implant marginal bone height relative to the most coronal portion of the implant fixture and the point of contact between the implant fixture and the marginal ridge itself were measured. To assess the trend of the bone, a line passing over the shoulder of the implant was considered as the reference point for measurement from which a straight line was drawn parallel to the long axis of the implant to the most coronal point at which the bone made contact with the fixture

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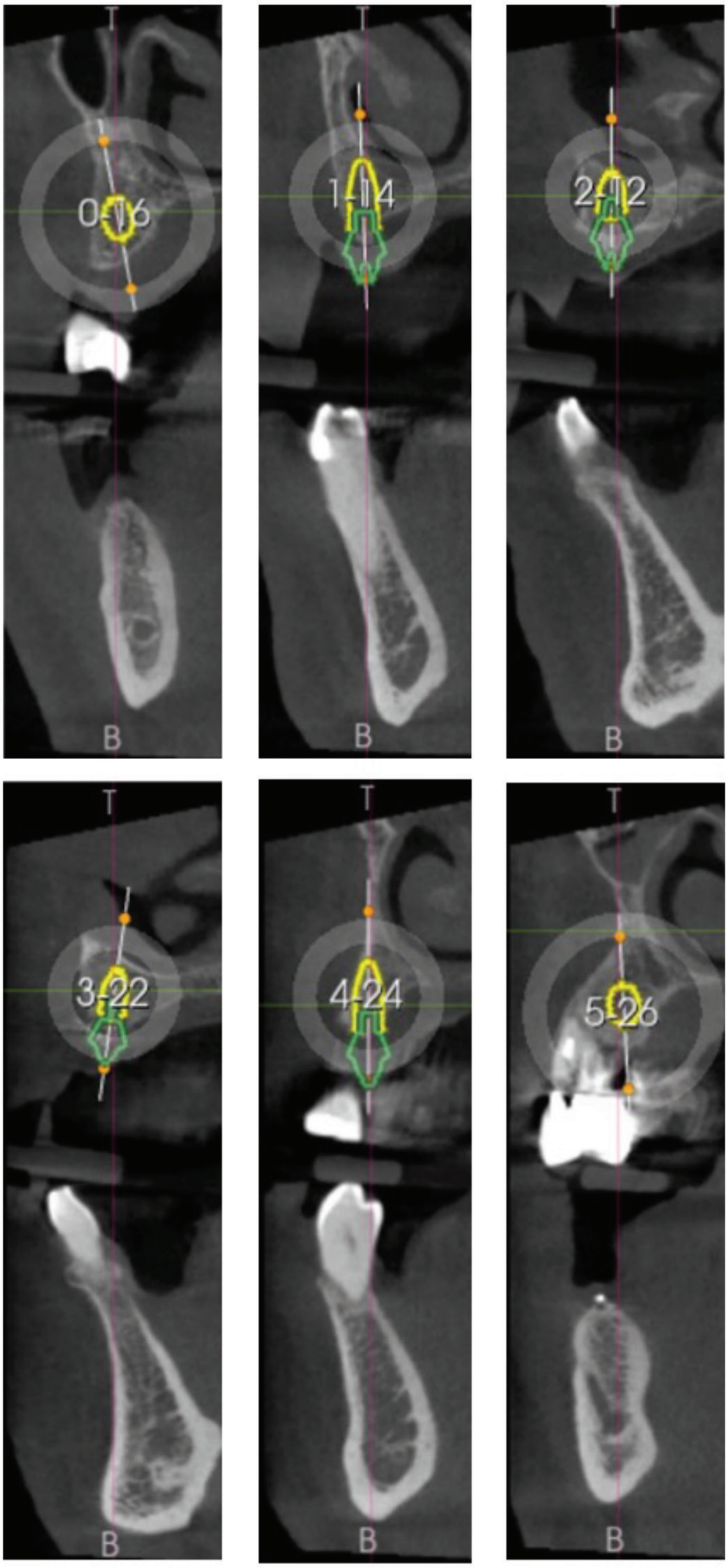

Figure 2. Cross-section at the site level of planned plants.

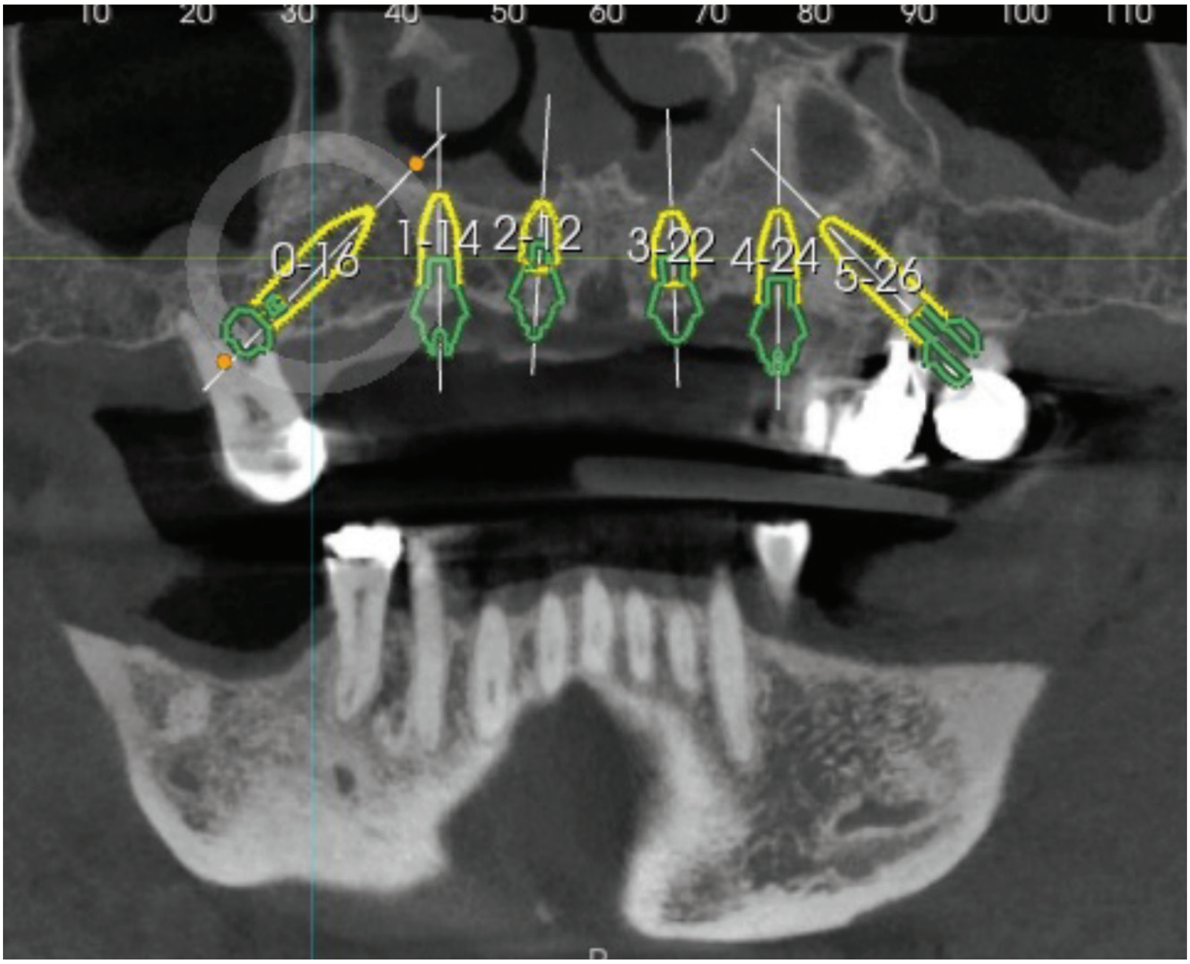

Figure 3. Planning the intervention using the CREA-3D BIOSAFIN Software.

Figure 4. Three-dimensional assessment of implant position and parallelism of EAs using CREA-3D BIOSAFIN Software.

both mesially and distally. The software automatically provided the distance between the two points measured in millimeters.

Then, to calculate the marginal bone level, a mesial measurement was taken, a distal measurement was taken, and then the average of the values of the mesial, distal portion, and the average between the two values of a single implant site was quantified.

RESULTS

Implants survival rate

The patient was monitored over one year after implant placement; what could be inferred was that no implants were lost, thus demonstrating a promising implant survival rate of approximately 99% [11]. Since 2010, several reviews, including systematic ones, have been written in order to evaluate the accuracy of flapless guided surgery in clinical trials. In general, it can be concluded that the implant survival rate ranges from 91% to 100%, thus having confirmation of the results obtained in this clinical case [12].

Marginal bone loss

Axial and tilted implants revealed minimal bone loss not relevant to implant stability [13].

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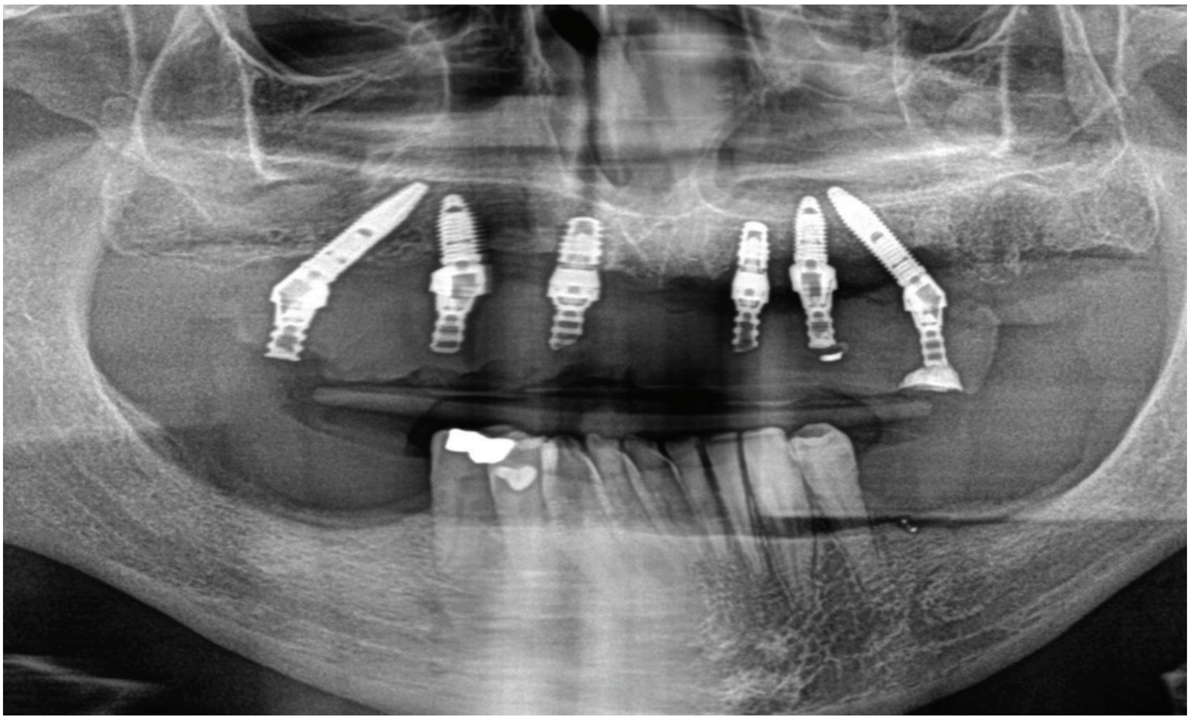

Figure 5. Radiography in the immediate postoperative period.

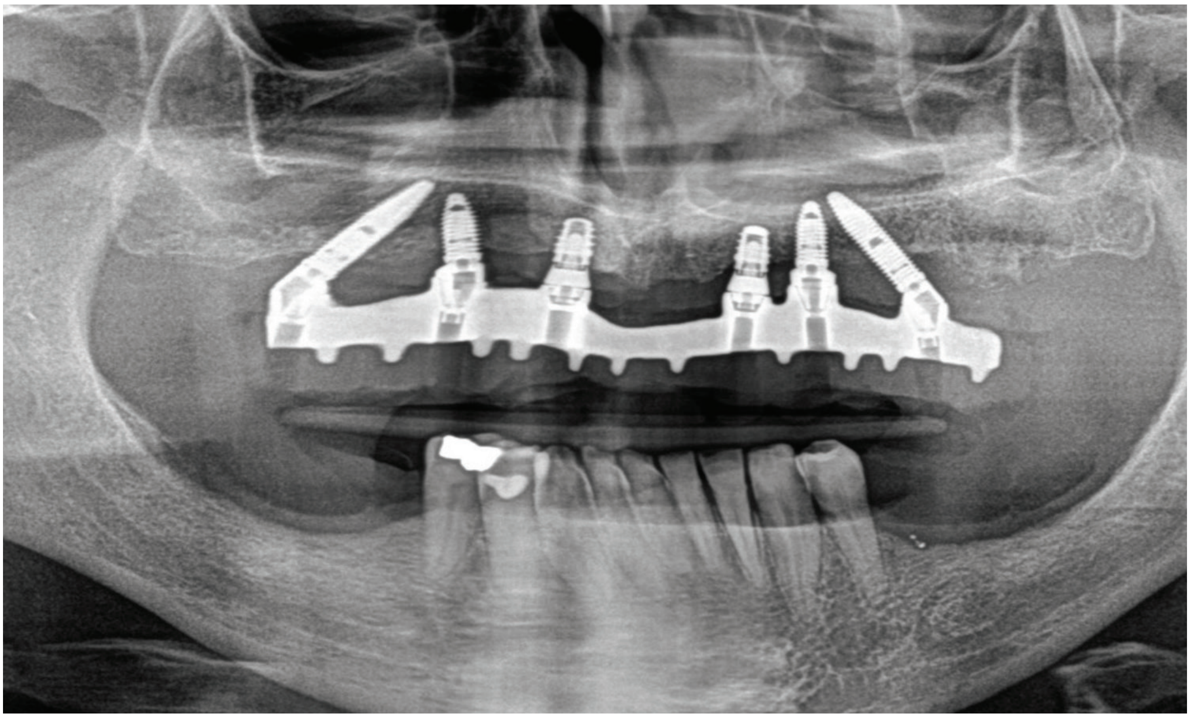

Figure 6. Postoperative radiography at one year.

MARGINAL BONE LOSS	Axial Implants in place 1.2 e 2.2	Axial Implants in place 1.4 e 2.4	Tilted implants
6 months (mm)	0.53 ± 0.76	0.61 ± 0.65	0.71 ± 0.69
1 year (mm)	0.85 ± 0.87	0.85 ± 0.88	0.90 ± 0.88

Discussion

Individually analyzed risk factors show that several preoperative factors could influence the accuracy of software-guided surgery.
One advantage in accuracy is having more than seven unrestored teeth to perform CBCT and surface scan matching. In addition, it was found that longer implants demonstrated more accurate guided placement of the same. There are also variables dependent on the operating system chosen, which could not be evaluated in this specific study because only one system was used [14] [15]. In fact, many factors would seem to influence the outcome of the surgical procedure; if the accuracy data from the current study are compared with the distances of the matching error, it can be concluded that the matching error (0.2 mm on average for an experienced user) is likely to have little influence on guided access, when compared with all surgical and technical factors [16]. Other studies have also shown that drills and sheaths possess some freedom of movement, and this could easily lead to lateral deviation of implants [17]. Last but not least, it should be emphasized that the user's own individual performance may have an influence on the accuracy of matching with an algorithm (ICP) and therefore extensive training is recommended. Matching errors should be reduced if the vestibular and lingual surfaces of CBCT scans aided with optical scans are used [18]. Therefore, to avoid further possible errors, it is recommended to separate the maxillary and mandibular dentition when performing any three-dimensional CBCT scan. Consequently, any scan can be used for computer-guided surgery [19]. The application of a guided surgery procedure such as the one described simplifies the possibility of transferring preoperative planning to the surgical field [20]. This study demonstrated such simplification, as all placed implants were screwable through direct straight occlusal access [21]. In addition, the patient benefits from lower morbidity due to less invasive surgical wounds and shorter operative times [21].
In contrast, this surgical timing advantage is counteracted by the complexity of time-consuming preoperative guided surgical planning [22].

Conclusions

Thus, computer-guided implant surgery based on scans performed with CBCT and intra-oral scans appears to be a viable surgical treatment option.
The protocol implemented has led to promising survival rates in the short term. However, even these guided surgery systems are not without minor errors that could affect their implant placement. It is therefore necessary for there to be an ongoing improvement of the software so as to reduce any deviations, and it is important to know these limitations so as to allow for increasing accuracy, regardless of multi-factorial agents that could alter the expected outcome.

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