ORIGINAL ARTICLE

DENTAL IMPLANT INSERTION – HOW TO PLAN AND PREDICT SUCCESS

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Abstract: For decades, implant placement protocols and implant loading protocols were addressed independently from one another. With the healing of the alveolar socket post-extraction, the implant placement protocol and the surgical technique are determining factors for selection of an appropriate implant loading protocol; these should be considered as codependent variables. *The objectives* of the study were to highlight factors influencing the implant placement and loading protocol. *Material and methods.* The retrospective study included patients presented for teeth extraction and oral rehabilitation treatment plan that included implant restorations between October 2020 and October 2022. Factors influencing implant placement and loading protocol were analyzed for each case. Representative cases were presented with details. *Results.* 10 clinical cases were included in the study, in which implanto-prosthetic treatment was performed using different insertion protocols. Three representative cases were presented. *Conclusions.* Implant insertion protocols are closely related to multiple factors, so the clinician nowadays must carefully decide the time elapsed from tooth extraction to the moment of dental implant insertion. The insertion protocol should be chosen only if the factors influencing that protocol led to the success of the implant-prosthetic treatment.

Keywords: insertion protocol, implant loading, dental implant.

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1. Introduction

Fixed dental prostheses supported by implants have become a well-documented and reliable treatment option. Excellent survival rates of both the multiple-unit prostheses and their supporting implants have been reported notably for conventional metal-ceramic restorations [1].

The ultimate goal of the clinician is to counteract the effect of tooth extraction on bone which begins the slow process of remodeling just after extraction [2].

All the contemporary treatment and fabrication concepts have aimed to minimize treatment durations and patient visits while maintaining optimal clinical and patient-related outcomes [3]. This quest for greater efficiency also has resulted in a diversification of implant placement and loading protocols. Contemporary options include immediate, early, or placement, as well as immediate, early, or conventional loading [4].

Reviews of the timing of dental implant placement suggest that immediate- and delayed-implant placement exhibit similar behavior when the survival rate and tissue remodeling are similar [5]. It has been suggested that tooth extraction procedure (in the least disruptive way possible) has a major effect on clinical outcomes, whereas the dental implant positioning may have just a minimal effect [6].

Numerous reviews have been published to classify these protocols and define their indications [7]. While both immediate / early placement and immediate / early loading can yield excellent results, they are subject to biological limitations and a need for careful patient selection and site assessment. Immediate or early placement requires a fair amount of residual bone for good primary stability of the implant [8].

Cone beam computerized tomography (CBCT) is a very suitable diagnostic instrument for the planning of prosthetic rehabilitation supported by implants; moreover, the comparison of the pre-operative and post-operative scans can be used for the analysis of three-dimensional changes of the peri-implant tissues [9].

For decades, implant placement protocols and implant loading protocols were addressed independently from one another. With the healing of the alveolar socket post-extraction, the implant placement protocol and the surgical technique are determining factors for selection of an appropriate implant loading protocol; these should be considered as codependent variables. Moreover, it is important that treatment planning should commence once the indication for tooth extraction has been confirmed, and the implant placement and loading protocol should both be planned prior to the extraction of the tooth [10].

In clinical practice the decision to place an implant following tooth extraction is usually determined by the attainment of specific soft and hard tissue characteristics of the healing socket. These events do not necessarily follow rigid time frames and may vary according to site and patient factors. To avoid time-based descriptions, this classification uses numeric descriptors—types 1 to 4—that reflect the hard and soft tissue changes observed:

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Type 1 - Implant placement immediately following tooth extraction and as part of the same surgical procedure;

Type 2 - Complete soft tissue coverage of the socket (typically 4 to 8 wk);

Type 3 - Substantial clinical and/or radiographic bone fill of the socket (typically 12 to 16 wk);

Type 4 - Healed site (typically more than 16 weeks) [11].

Regarding implant loading, Cochrane reviews are recognized as a gold standard in evidence-based health care. Recently, Esposito and coworkers published an updated version of their systematic review regarding different times for loading dental implants, and based it on the following definitions:

• Immediate loading was defined as implants in function within 1 week after their placement. No distinction was made between occlusal and nonocclusal loading.

• Early loading was defined as putting implants in function between 1 week and 2 months after placement.

• Conventional loading was defined as putting implants in function after 2 months [12].

The placement definitions established by the ITI Treatment Guide Vol.3 [13] and loading definitions establishedby the 4th ITI Consensus Conference [14]:

- Type 1A - Immediate placement + immediate restoration/loading
- Type 1B Immediate placement + early loading
- Type 1C Immediate placement + conventional loading
- Type 2A Early placement with soft tissue healing + immediate restoration/loading
- Type 2B Early placement with soft tissue healing + early loading
- Type 2C Early placement with soft tissue healing + conventional loading
- Type 3A Early placement with partial bone healing + immediate restoration/loading
- Type 3B Early placement with partial bone healing + early loading
- Type 3C Early placement with partial bone healing + conventional loading
- Type 4A Late placement + immediate restoration/loading
- Type 4B Late placement + early loading
- Type 4C Late placement + conventional loading [15].

Immediate implant placement has been a popular treatment concept for patients as well as for clinicians since it reduces the number of surgical interventions and the total treatment time. In addition, it was assumed for many years that the immediate insertion of an implant into a fresh extraction socket could counteract the three-dimensional alterations of the alveolar process because of tooth extraction. However, preclinical and clinical studies failed to show this, making it a potentially risky procedure from an aesthetic point of view. After all, considerable post-extraction

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bone remodelling may be expected, mainly at the buccal aspect often resulting in a deficient alveolar ridge. Given this, the immediate installation of an implant into a fresh extraction socket may lead to a lack of buccal convexity and even midfacial recession [16].

2. Material and methods

The retrospective study collected data from dental charts in a private practice setting in the period April - June 2021.

Inclusion and exclusion criteria

All patients who required extraction of teeth and subsequent implant placement presented in the period of October 2019-October 2020 in the dental clinic were consecutively enrolled according to the following inclusion criteria:

- Dental implants planned for replacement of the teeth.
- Periodontal probing pockets < 4 mm.
- Adjacent natural teeth were periodontally sound with no periodontal attachment loss.
- Adjacent teeth with healthy dental pulps, or if non-vital, had satisfactory endodontic status and were free of symptoms.

Patients were excluded if they smoked cigarettes.

Data obtained from dental charts were analyzed and presented according to a template.

Ethics approval for this study was granted by the University of Medicine and Pharmacy of Craiova (Ethics ID 52/29.01.2024) and was performed in accordance with the principles established in the Declaration of Helsinki.

3. Results

The study included 10 patients who required one or more teeth extraction and subsequent implant placement. All clinical cases in which implanto-prosthetic treatment was performed were included. The cases included anterior and posterior area edentulism, each with different local conditions for the implanto-prosthetic treatment. Different dental implant and prosthetic insertion protocols were used in these cases, offering different treatment modalities depending on the factors and indications specific to each case (Table 1).

Table 1. Distribution of patients according to the edentulism type by gender

Gender	Partial Edentulism type		Total
	Anterior	Posterior	
Female	1	3	4
Male	3	3	6
Total	4	6	10

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Case 1.

A 37-year-old man, non-smoker, with no history of systemic disease visited the dental clinic unhappy with the aesthetics in the frontal maxillary area. The intraoral and radiological examenination showed the congenital absence of tooth number 1.2 with the persistence of deciduous tooth number 5.2. After CBCT evaluation it was estabieshed that there is sufficient height and width of the alveolare ridge and satisfactory bone density (850 Hounsfield units) for placing an implant after the subsequent extraction of the deciduous tooth (Figure 1). Extraction of tooth 5.2 was easily performed and considering the CBCT findings it was decided that implant placement can be performed immediately after the extraction. Occlusal loading was carried out immediately with the help of a provisional crown made from the extracted tooth (tooth 5.2), without occlusal contact (Figure 2). The immediate insertion protocol in this case was of choice due to the ideal conditions present: non-smoking patient, good oral hygiene, absence of periodontal disease and satisfactory alveolar bone volume.

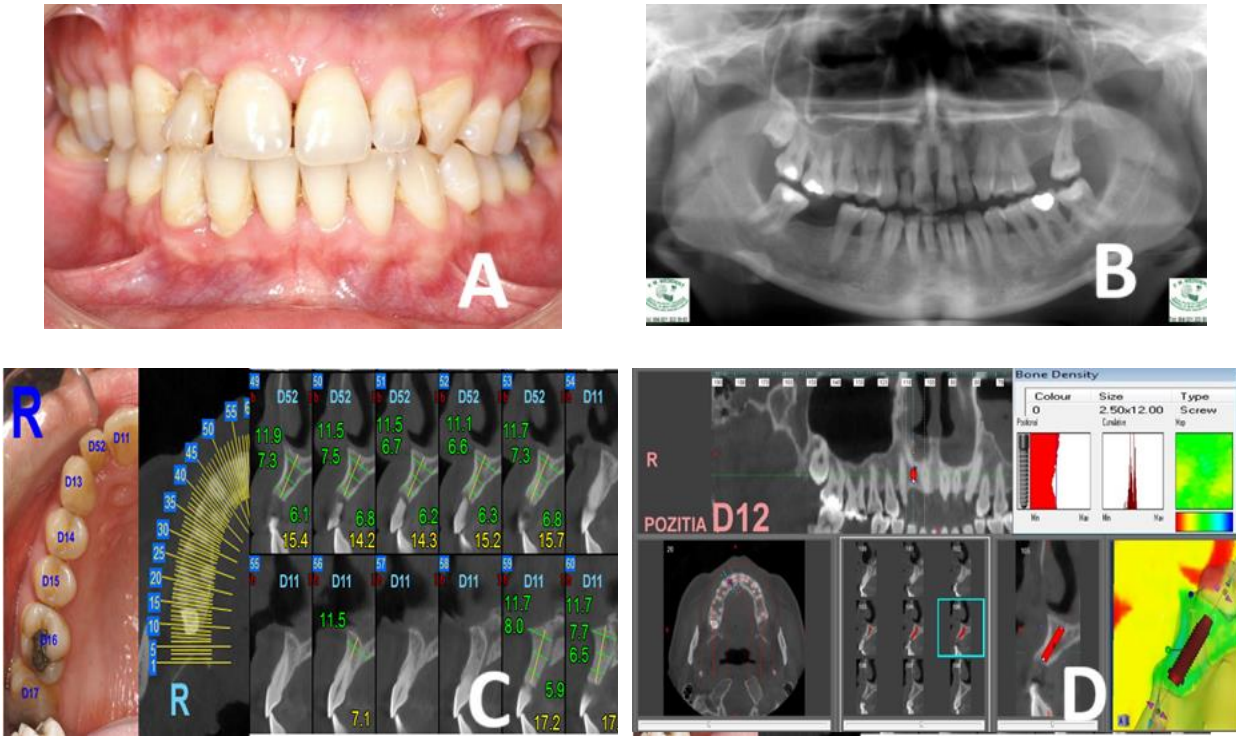

Figure 1. (A) Intraoral aspect (B) Initial panoramic x-ray (C) CBCT examination (D)3D simulation of implant placement

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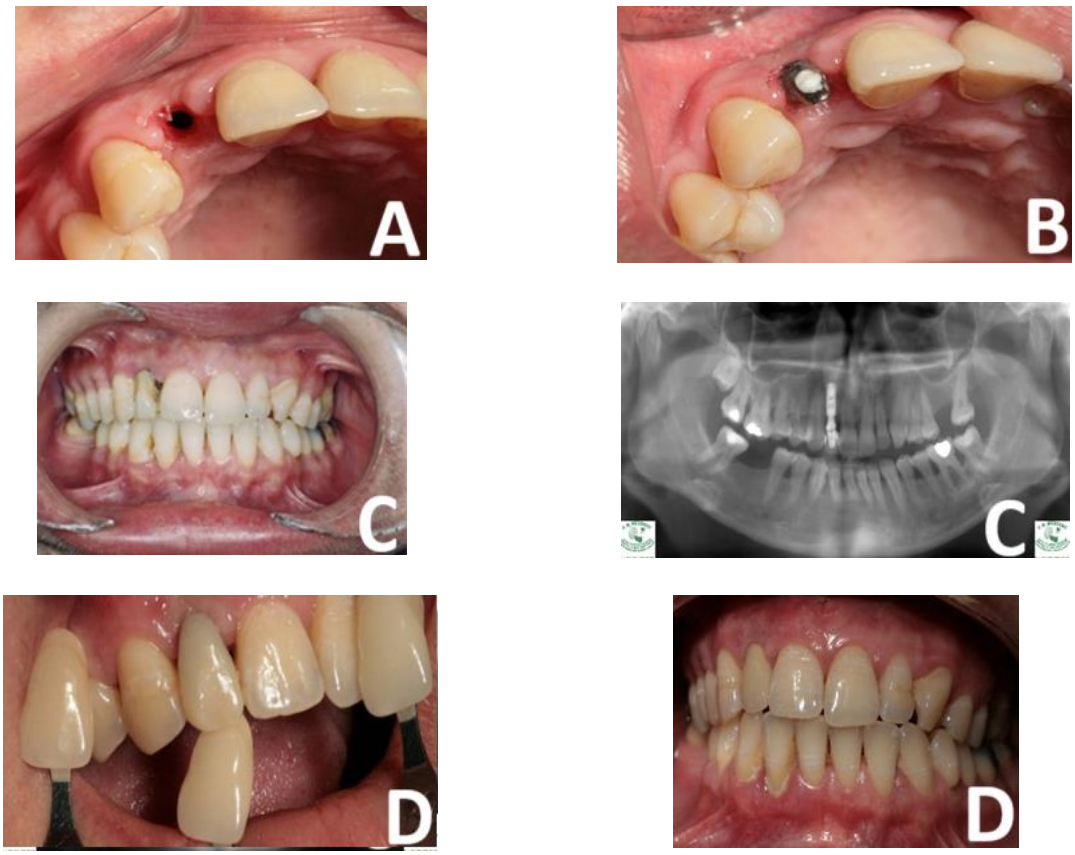

Figure 2. (A) Postextraction alveolus (B) Inserted implant with the prosthetic abutment (C) Provisional crown made from the extracted tooth 5.2 and the post-insertion radiological image (D) Choosing the color of the definitive crown and the cemented definitive Crown at the level of the implant abutment

Case 2.

A 43-year-old female pacient, non-smoker, with no history of systemic disease visited the dental clinicpresented with discomfort and pain after a bite on the left maxillary premolar. After clinical and radiological examination it was decided that extraction of tooth 2.4 was necessary (Figure 3). After one week of antibiotic treatment (Amoxicillin 500 mg every 8 hours), the ablation of the fixed prosthetic and then the extraction of tooth 2.4 was performed. The radiological examination showed the amount of remaining bone and enabled the planning of the positioning of the implants. The complete disappearance of the vestibular bone plate in the area of tooth 2.4 can be observed, this defect was remedied by the process of guided bone regeneration with the help of gelatinous A-PRF membranes (Figure 4.). After 2 months, in which healing of the local soft tissues took place, a surgical flap was performed and two "Bluesky Bio I Internal Hex" dental implants (Bredent TM,

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Germany) were inserted (Figure 5.). After a healing period of 4 months a gingival conformer will be fixed and the rest of the prosthetic stages will continue.

The type 2C insertion protocol was chosen in this case because the presence of local infectious processes requires a healing period, a period in which the cellular immunological response helps to achieve local healing.

Figure 3. Initial intraoral and panoramic x-ray aspect.

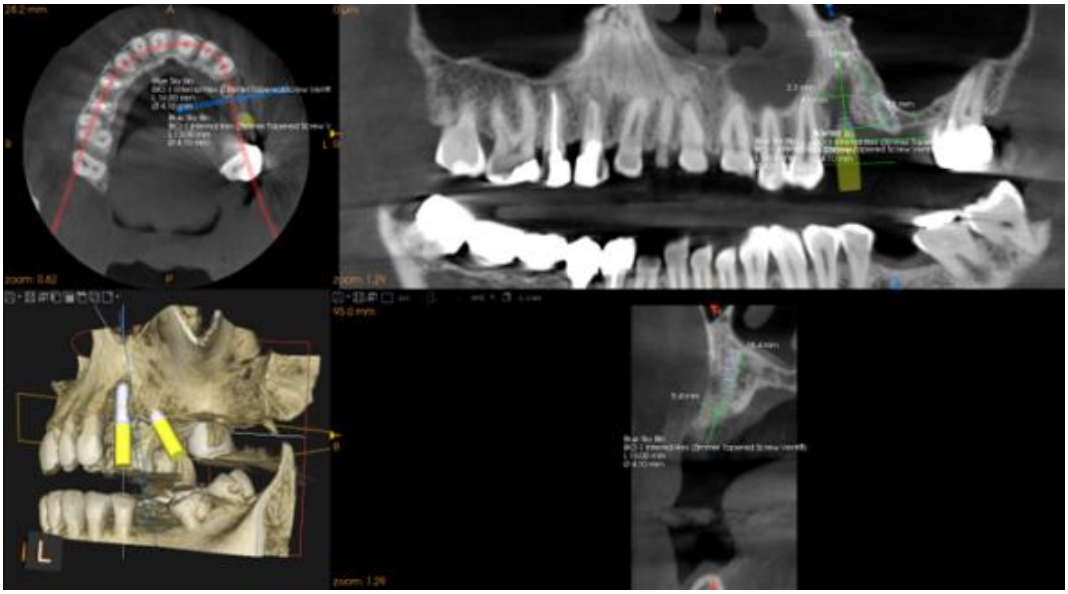

Figure 4. CBCT implant placement planning

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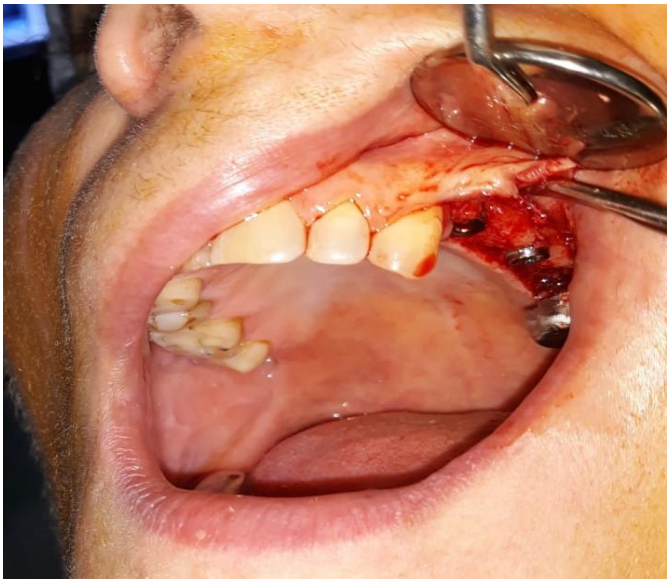

Figure 5. Implant placement

Clinical case number 2 had an insertion according to protocol type 2C (early insertion with gingival healing). The insertion protocol chosen in this case was given by the presence of infectious processes in the area of implant insertion. Although the patient wanted an esthetic rehabilitation as soon as possible, clinical signs of local infection prevented this. However, within the type 2 insertion protocol, the treatment time is much shorter compared to conventional implant placement protocol. This approach offers high aesthetic results and a low risk of recession of the gingival mucosa.

Case 3.

A 52-year-old female pacient, non-smoker, with no history of systemic disease visited the dental clinic presented with mobility of the right maxillary lateral incisor. During the clinical examination, a loosening of the corono-radicular device was observed. Upon CBCT examination a vertical fracture of the root of the lateral incisor was observed (Figure 6.). Thus, it was decided to perform the extraction of tooth 1.2. Considering the fact that the patient din does not smoke, had good oral hygiene, no periodontal disease, no signs of local infection were present and the CBCT analysis showed good volume of alveolare bone the decisins to perform an immediate insertion of a dental implant with immediate occlusal loading was taken (Figure 7).

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Figure 6. Initial intraoral and CBCT aspect.

Figure 7. Implant insertion and immediate loading of the implant.

Clinical case no. 3 presents an immediate insertion protocol, type 1A, with immediate occlusal loading. This case is similar to clinical case no. 1, but case no. 3 presents a thin vestibular cortex and tooth 1.2 is present with a vertical fracture. The lack of infection adjacent to tooth 1.2, the sufficient bone substrate, the gingival phenotype of adequate thickness, together with the patient's desire to restore the aesthetic function as quickly as possible were key factors in choosing the immediate insertion.

4. Discussions

Immediate implant placement has become widely accepted despite the controversial beginning. The primary advantages of immediate implant placement are a reduction in time and surgical episodes and preservation of the bone and gingival tissues [17]. One of the factors involved in the success of osseous integration and the long-term success of implants is the implant

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primary stability; it is defined as the biometric stability of the implant immediately after its placement within the bone. Primary stability is related to the mechanical engagement of the implant with the surrounding bone after implant insertion. Secondary stability depends on bone formation and remodeling at the implant-bone interface, and is influenced by the implant surface and wound-healing time [18].

The placement of implants in extraction sockets can be difficult. In addition, it can be difficult to secure primary stability and complete debridement of infected tissue [19].

There is a constant debate about the placement of implants using an immediate protocol versus the traditional or delayed placement protocol. A study by Assery et al showed a survival rate of 97.2% obtained after a 22- year follow-up indicates an excellent prognosis for an immediate implant placed in fresh sockets without bone augmentation procedures [20].

Other studies agree with these findings and have shown no statistically significant differences in the implant outcomes (risk of implant failure) between the early implant placement protocol and the immediate or the delayed implant placement protocols. However, it was found that the early implant placement protocol results in less marginal peri-implant bone loss compared with the immediate placement protocol. No other significant differences were found between the protocols. Significantly lower marginal peri-implant bone loss was found for implants placed according to the early placement protocol compared with those placed immediately into fresh extraction sockets. The greater marginal peri-implant bone loss in the immediate placement group may be attributed to the horizontal and vertical resorption of the extraction socket walls that begin immediately after tooth extraction. Implant placement protocols were also compared based on the peri-implant probing depth and peri-implant soft tissue level. No significant differences were found between the early and immediate placement protocols for these two variables, indicating that peri-implant health and soft tissue stability can be achieved using both implant placement protocols [21].

The study we carried out on the previously presented clinical cases shows the multitude of factors that must be taken into account when deciding the moment of implant insertion. Local anatomical conditions, factors related to the patient as well as the final three-dimensional position of the implant are key elements in the insertion of a dental implant in the dento-maxillary apparatus. Although the presented cases included only implant insertion according to type 1 and 2 insertion protocol, they show us a change in the direction of therapeutic conduct, thus, the cases where the patient has to wait as long as possible for the implant insertion are increasingly exceptional. Currently, great emphasis is placed on an oral rehabilitation as fast and as efficient as possible, so the vast majority of

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patients want the aesthetic results of the implant-prosthetic treatment in the shortest possible time. In 2 of the 3 cases presented in this report, the implants were immediately placed according to type I protocol.

Evaluations of the clinical performance of dental implants should include the function and appearance of the surrounding soft tissues or bone, as these are essential parameters for evaluating treatment outcomes and characterizing implant success.

The decision of implant insertion and the moment of its prosthetic loading has to take into consideration a series of factors that influence the subsequent evolution of the implanto-prosthetic restoration:

- Factors related to the patient: the patient's desire to restore the aesthetic function as quickly as possible, the absence of personal pathological history, poor dental hygiene, , the absence of tobacco smoking
- The periodontal factor
- No clinical sign of local infection
- Quantity and quality of alveolar bone
- The vestibular cortex of the alveolar process
- Inocclusion of the provisional crown
- Absence of post-insertion pain
- Primary stability
- Surgical and prosthetic techniques and implant design
- Final three-dimensional position of the implant

5. Conclusions

In conclusion, implant insertion protocols are closely related to multiple factors, so the clinician nowadays must carefully decide the time elapsed from tooth extraction to the moment of dental implant insertion. The insertion protocol should be chosen only if the factors influencing that protocol lead to the success of the implant-prosthetic treatment.

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Conflict of interest statement

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Data availability statement

Will be provided on request.

Ethics statement

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