Immediate loading of implants in the aesthetic zone: comparison between two placement timings

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Summary

***Aim of the study*. Implant rehabilitation delivered in accordance with the traditional protocol has proven to be highly predictable and acceptable (1). Nevertheless, the application of immediate loading on post-extraction implants, especially for aesthetic zones, has now considerably increased (2). The aim of this work is to illustrate the immediate loading of implants placed in the aesthetic zone through tapered design fixtures with microgeometry of a high degree of porosity inserted at the same time or 4-8 weeks from dental avulsion (TSA® Advance, Phibo®).**
***Materials and methods*. A total of 15 implant fixtures of which 8 at an interval of 4-8 weeks from extraction (type 2) and the remaining according to the immediate post-extraction technique (type 1) were positioned. All implants were prosthesized within 24 hours from the placement. Definitive crowns replaced provisional restorations after 20-24 weeks. After 4 and 12 months from implant insertion, the following parameters were assessed: X-ray image, pain, mobility or suppuration, soft tissue condition and aesthetic appearance.**
***Results.* Percentage of osseointegration was 93.75%, and 53.5% of the osseointegrated fixtures was type 2. No statistically significant difference between the mean ISQ values for implants of type 1 and 2 both in the post-operative period and after 12 months was evident, indicating that the timing of insertion did not affect the achievement of stability for the implant fixtures tested in our study. Immediate post-extraction implants showed a greater propensity for gingival recession and a peri-implant radiolucency greater than those placed at an interval of 4-8 weeks. The values obtained for the PES/WES and the subjective evaluation of the analyzed sample showed the considerable aesthetic value and the high level of satisfaction guaranteed by the implant technique illustrated.**
***Conclusion.* Although well-designed, high quality, randomized clinical trials are still needed as well as the requirement to establish a common, complete, and reproducible index for the evaluation of aesthetic outcome, immediate/early placement and loading of a single TSA® Advance, Phibo® may be considered a valuable and predictable option in terms of implant success as well as hard and soft tissue stability.**

Key words: immediate post-extraction implant, early post-extraction implant, immediate loading, aesthetic outcome assessment, non-functional loading.

Introduction

Implant rehabilitation delivered in accordance with the traditional protocol has proven to be highly predictable and acceptable. This protocol requires a 12 month healing period following tooth extraction with an additional undisturbed healing period of 6 and 3 months following implant placement, respectively for the upper and lower jaw (1). The application of these time intervals in implant rehabilitation for maxillary anterior areas presents patients with aesthetic and functional limitations.
In order to shorten the overall duration of treatment and to provide satisfactory aesthetic and functional results, researchers and clinicians have focused on reducing the time that has elapsed between tooth extraction, implant placement and prosthetic restoration delivery. For these reasons, immediate implant insertion into extraction sockets has become a common practice (2).
According to the literature, different terms are used to indicate the immediate implant placement technique. Clinicians have the opportunity to choose from different timing options as defined by the International Team for Implantology (ITI) Consensus Conferences of 2003 and 2008. In this study, we refer to immediate implant placement after tooth extraction (type 1 implants) and early implant placement after 4 to 8 weeks of soft tissue healing (type 2 implants) (3).

Immediate placement of implants in the fresh extraction sockets (type 1) is an increasingly popular treatment option. The main advantages are obvious: a reduction in wainting time and of number of necessary surgeries, patient satisfaction and possibility of exploiting the residual crestal bone (4, 5). These benefits may come at a cost: increased risk of infection, the need for bone augmentation procedures to solve the discreal between implant surface and alveolar bone, and significant risk of aesthetic complications (6). The main reasons for development of the mucosal recession is the presence of a thin gingival biotype, the lack of a facial bone wall to support the facial soft tissues and a facial malposition of the implant (7).
Following tooth avulsion, there is a series of biological processes that take place: bone reabsorption both vertically and horizontally, with a change in height and thickness of the alveolar bone; gingival collapse; migratory movements of the adjacent teeth; modification of the bony quality with a collapse of compact bone and the formation of alveolar bone marrow (8). During the first 4-8 weeks from tooth avulsion, the majority of the amount of bone resorption and gingival remodeling can be verified; further, the presence of an implant placed immediately does not allow for the preservation of the buccal bone wall that is subjected to a greater degree of resorption (4).
To overcome some of these potential risks, the early implant placement protocol (type 2) has been proposed, as it may share some of the advantages of immediate placement, while at the same time allowing primary healing after tooth extraction and thus achieving enough soft tissues in case there is a need for bone augmentation procedures and a reduction of the risk of infection during implant placement (9). Further, a correct three-dimensional implant position is easier to achieve, since the extraction socket already shows partial bone fill in the apical area; thus, a facial malposition can be avoided more easily (3).
As documented by retrospective and prospective studies, there is evidence that early placement (type 2) is associated with a lower frequency of mucosal recession compared to immediate placement (type 1) (10). This approach helps achieve aesthetic outcomes with high predictability as has been documented in retrospective and prospective clinical studies (11).
In the past decade, implants placed with an immediate or early protocol appeared to have a similar survival outcome. Recent experimental and clinical studies have aimed at a progressive shortening of the healing period for single-tooth implants with immediate loading in the aesthetic zone of the anterior maxilla (12).
In recent clinical studies, there is a range of 86-100% survival rate for single-tooth replacements installed according to a one-stage surgical procedure and immediate loading was recorded (12). At present, it appears that premature loading *per se* does not lead to fibrous tissue encapsulation; rather, it is due to an excessive amount of micromotion at the bone-implant interface during the healing phase, and the tolerated magnitude of the load is between 50 and 150 µm (13).
There are two different types of load: functional and non-functional. The term "functional" indicates full occlusal loading in at least centric occlusion, while "non functional" refers to restorations with no centric or eccentric contacts. The latter type is of fundamentally-relevant in the protocol of immediate loading in the aesthetic sector, because it allows shaping the soft tissues during the healing phase while at the same time reducing the risk of overloading (14).
The crucial factor for successful osseointegration is the stability of the implant during the healing phase, wich is the initial intimate contact between bone and implant surface to oppose the displacement induced by masticatory loads and any other forces.
To facilitate the immediate loading protocol, the implant stability at the time of placement is essential, but also implant surface modifications also have a significant role in measuring the success of osseointegration (7). In fact, a tapered shape is the most suitable for increasing the primary stability, by causing a progressive compression of the bone during insertion of the implant (15). Immediate loading combined with implants placed in extraction sockets is a method not yet considered EBD (Evidence-Based Dentistry), although it has already received confirmations in authoritative international acclaims (12).
This bimodal approach aims at combining the previously enlisted advantages of immediate post-extraction implants to the preservation of the peri-implant mucosa guaranteed by immediate loading (16). A recent review of the literature revealed a survival rate between 97.5 and 98% (17) for this type of implant. Anyway, in the frontal area the success of a single implant rehabilitation is not only determined by a high percentage of survival but also by an acceptable quality of survival (18). This includes the harmonic integration of the restoration provided with the adjacent elements, at both the dental and gingival level, as well as the maintenance of an adequate bone level and patient satisfaction (19). Although the literature shows a growing interest in aesthetic outcome assessment, there are still no universally accepted criteria of judgment for this type of parameter (20).
In this work, implant restorations in the aesthetic zone through tapered fixtures with microgeometry with high degree of porosity manufactured in a controlled manner under dual chemical action are described (TSA® Advance, Phibo®). Implant placement occurred either immediately or after 4-8 weeks from dental avulsion and all implants were prosthesized within 24 hours from the placement without functional occlusion.

Materials and methods

The present study describes the placement of 15 implants for a total of 10 patients rehabilitated (mean age: 47.4). Seven implants were inserted concurrently with avulsion while the remaining eight were placed in a delayed mode. The indications that led to dental avulsion included the loss of periodontal attachment, endodontic failure, root fracture and unstable deciduous teeth persistence. All implants were prosthesized within 24 hours from the placement. The selection of patients was carried out according to well-defined criteria (Tab. 1).
Among the specific contraindications for the immedi-

ate post-extraction implant placement, the following parameters were considered:

- presence of gingival recession ≥ 5 mm;
- presence of active infection;
- clinical and radiological evidence of a bone quantity < 3 mm in the apical area of the alveolus as it would make it difficult the to obtain primary stability.

Pre-operative therapy

Surgical protocol was preceded by the patient's oral cavity clinical examination where dentists focused on the analysis of soft tissues conditions, study of the occlusion and of the relationship between maxilla and mandible as well as performing an assessment of

Table 1. Inclusion/exclusion criteria.

INCLUSION CRITERIA	EXCLUSION CRITERIA
Age over 18 years	Systemic diseases
Single tooth or several teeth missing in the aesthetic area (maxilla= 1.5-2.5; mandible= 3.5-4.5)	Physical or mental disability they would reduce patient's compliance
ISQ ≥ 60	Parafunctions
	Smokers
	Patients with plaque and bleeding index ≥ 25%
	Presence of active infection

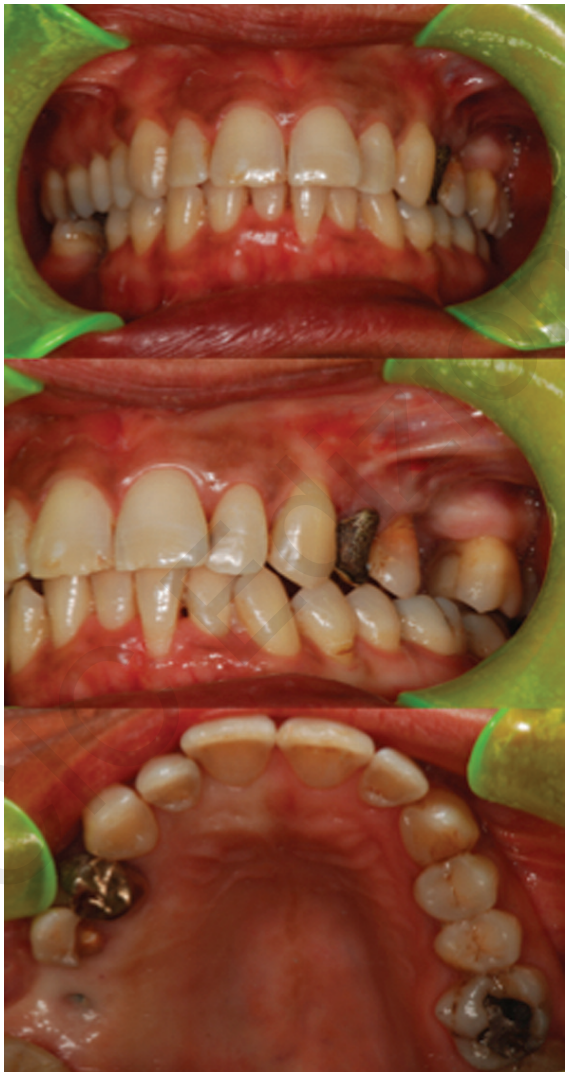


Figure 1.1. Pre-operative clinical situation for implants of type 1.

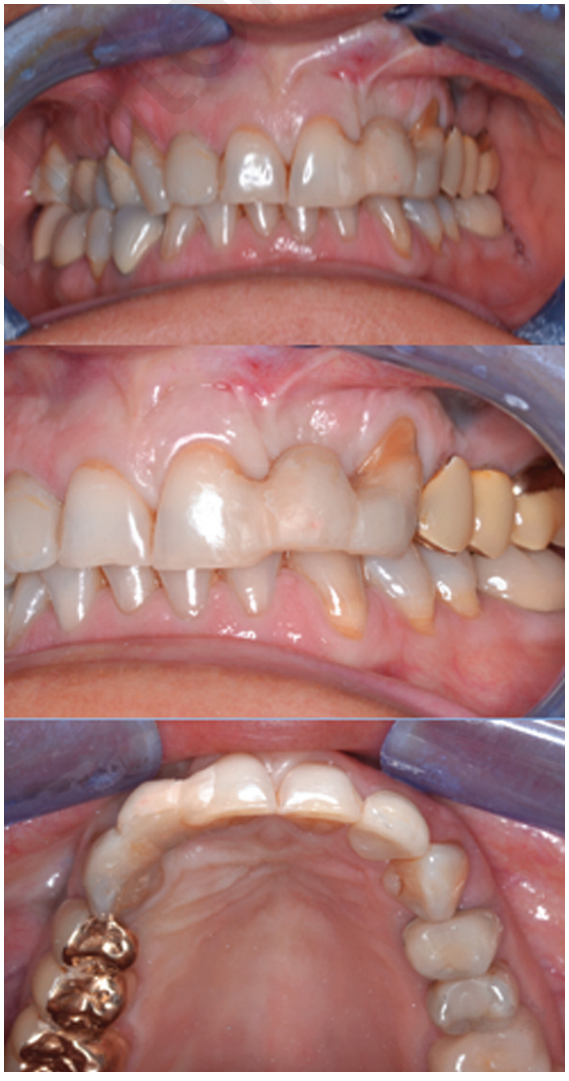


Figure 2.1. Pre-operative clinical situation for implants of type 2.

quality and quantity of bone in the area to be rehabilitated (Figs. 1.1, 2.1). Bone volume and implant fixtures dimensions were defined on orthopantomography and dentascan CT (Figs. 1.2, 2.2).

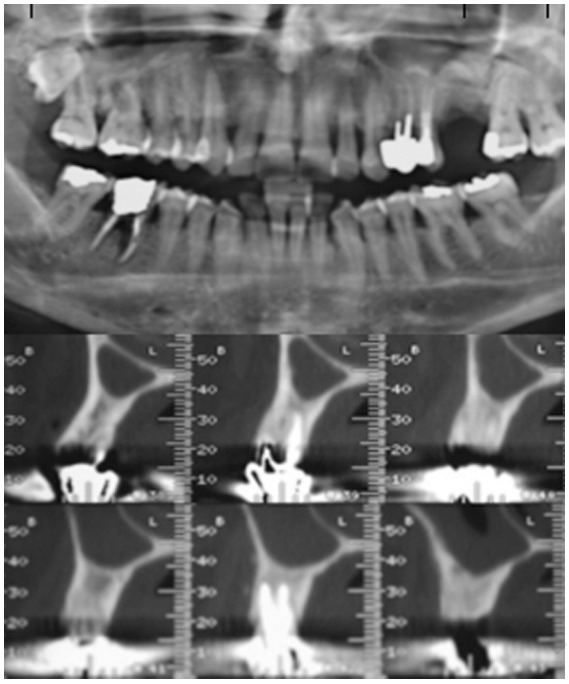


Figure 1.2. Pre-operative orthopantomography and Dentascan CT for implant of type 1.

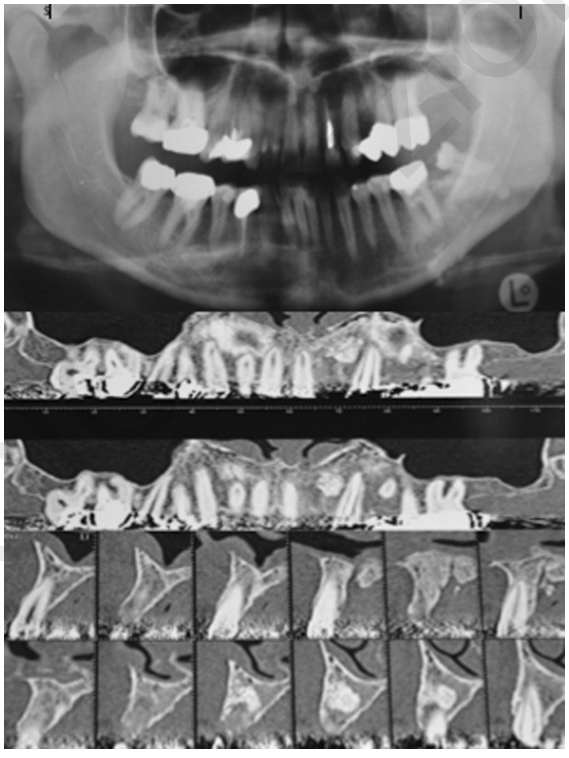


Figure 2.2. Pre-operative orthopantomography and Dentascan CT for implants of type 2.

In the present study the implants TSA ® Advance, Phibo ® were used.
The selected patients signed informed consent to medical treatment.
A dose of 1 g of penicillin and clavulanic acid one hour before surgery and then for 6 days every 12 hours were administered to the patients.
Surgical procedures were performed after rinses with pure chlorhexidine 0.2% for 60 seconds and plexic infiltration of local anesthetic with mepivacaine 2% and without epinephrine.

Surgical protocol

In cases of post-extraction implant rehabilitation, the extraction of the dental elements through a careful dislocation of the roots was first carried out. The avulsion was as atraumatic as possible and was followed by alveolar curettage and irrigation with saline solution to remove any granulation tissue that was possibly present (Fig. 1.3).
The insertion of implant fixtures took place after a crestal incision with inclusion of the interdental papilla of adjacent teeth and the subsequent preparation of a mucoperiosteal flap to expose the alveolar bone (Figs. 1.3, 2.3).
In two cases, a flapless implant insertion was preferred. The advantages of this technique include less bleeding, less swelling and the preservation of pre-existing soft tissue contours (21). The sequence of drilling was carried out depending upon the type of bone (according to Lekholm classification) and using instruments with increasing diameter starting with an initial bur of 1.8 mm (Figs. 1.3, 2.3).

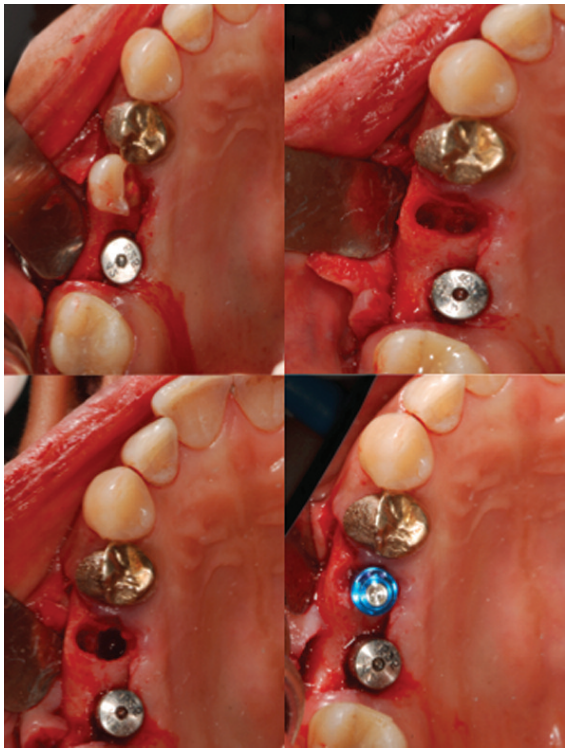


Figure 1.3. Surgical phase for implants of type 1.

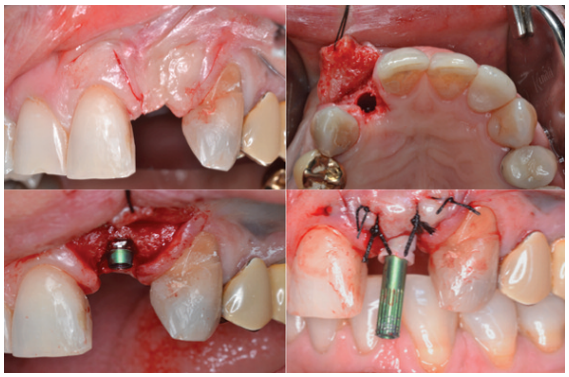


Figure 2.3. Surgical phase for implants of type 2

Bone quality was defined according to X-rays and through the drilling resistance at site preparation during the initial osteotomy. An under-preparation of the site, in order to increase the initial contact bone-fixture, was chosen in patients with bone type III while in the coronal third with bone type IV the drilling was solely conducted so that the implant would serve an element of compaction, protection and available bone condensation until final insertion. The implants were inserted using a motor device able to record the delivered torque (Figs. 1.3, 2.3). The insertion torque was 35 Ncm on average. A particular attention to crestal anatomy maintenance was placed, as it tends to preserve the parameters considered essential for the aesthetic treatment. In cases where a peri-implant bone defect ≥ 2 mm was detected, the gap was filled with a mixture of autologous and alloplastic bone, sometimes associated with resorbable membranes. The mucoperiosteal flap was carefully repositioned around the neck of the implant and then was sutured with silk 3/0 to obtain first intention healing. After wards, implant stability was assessed through analysis of resonance frequency (Ostell®, Integration Diagnostics, Goteborg). An ISQ ≥ 60 was defined valid for the following immediate loading. The implants with lower ISQ values were excluded from the immediate loading program.

Prosthetic protocol

The TSA® Advance, Phibo implant fixture used in this study had an internal hexagon connection. An abutment was added on each fixture to convert the connection from internal to external.
A plastic coif for provisional restoration stabilized on the fixture through a titanium laboratory screw was subsequently placed on the abutments (Figs. 1.3, 2.3).
The acrylic resin provisional restorations were holed on the occlusal surface so that they could lie on the respective plastic coifs leaving a space for the passage of the laboratory screw. The provisional restorations were then rebased with cold resin directly on the plastic coifs. The laboratory screw was subsequently unscrewed in order to remove the previously rebased provisional restorations to finish them extra-orally.
The provisional crowns were finally repositioned in the oral cavity of the patient through the use of a short screw (final clinical screw), which unlike the laboratory one, does not protrude from the occlusal surface (Figs. 1.4, 2.4). The head screw was covered with

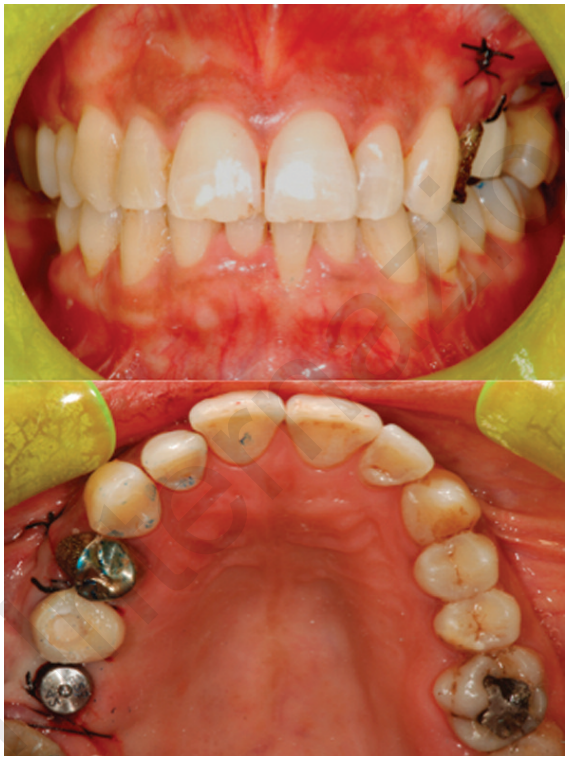


Figure 1.4. Post-operative clinical situation after provisional restoration placement (type 1)

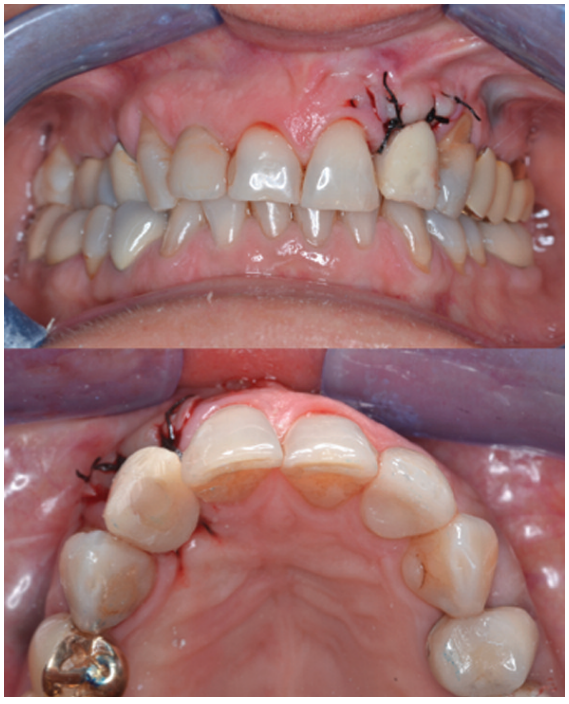


Figure 2.4. Post-operative clinical situation after provisional restoration placement (type 2)

light-curing composite resin. Functional contacts of provisional crowns were eliminated in both centric and protrusive occlusion and with laterality by interposing articulating paper of a thickness of 200 μm in order to have a non-functional immediate loading (22). Definitive crowns replaced the provisional restorations after 20-24 weeks (Figs. 1.5, 2.5).

Post-operative phase

In the post-operative phase, the patients were placed on an antibiotic regimen for six days and had to take analgesics as needed. They were also instructed to rinse the surgical area with 0.2% chlorhexidine three times per day for the first 2 weeks, then to brush for the next 6 weeks with a soft toothbrush, while maintaining normal oral hygiene in the remaining areas. Patients were also asked to adopt a soft diet and avoid mastication at the newly rehabilitated sites for 8 weeks.
Periapical radiographs were performed at the implant insertion and patients underwent the first control one week after surgery. They were recalled at 4 and 12 months and then annually. The following parameters were evaluated:

1. X-ray imaging: evaluation of the extent of peri-implant crestal bone resorption at 4 and 12 months after implant insertion (Figs. 1.5, 2.5);
2. No pain, mobility or suppuration;
3. Soft tissue conditions:
   - Probing pocket depth (PPD);
   - Bleeding index;
   - Gingival recession
4. Aesthetic appearance:
   - "Pink Esthetic Score/White Esthetic Score" (PET/WES) (23) at 12 months after implant insertion to evaluate the aesthetic result in an objective way;
   - -"Visual Analogic Scale" (VAS) (20) at 12 months after implant insertion to assess the level of satisfaction expressed by each patient.

Statistical analysis

Data are presented as means ± standard deviation. The comparison between average values was performed using the Student's *t* test (confidence interval was 95%, significance level was 0.05).

Results

A total of 15 implant fixtures of which 8 occurred at an interval of 4-8 weeks from extraction (type 2) and the remaining according to the immediate post-extraction technique (type 1) were positioned. The intervention was well tolerated by all patients.
Only one implant was not osseointegrated, while all the others showed clinical stability without signs of infection. The percentage of osseointegration was

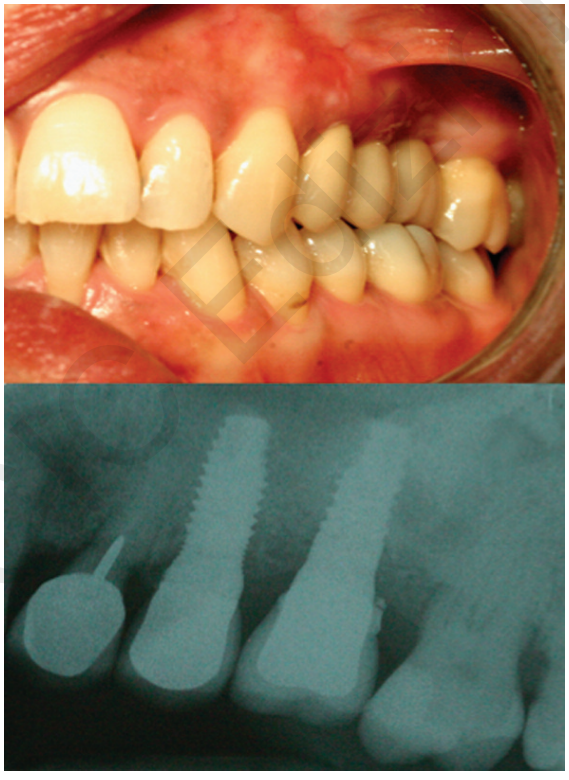


Figure 1.5. Clinical and radiographic situation after one year (type 1).

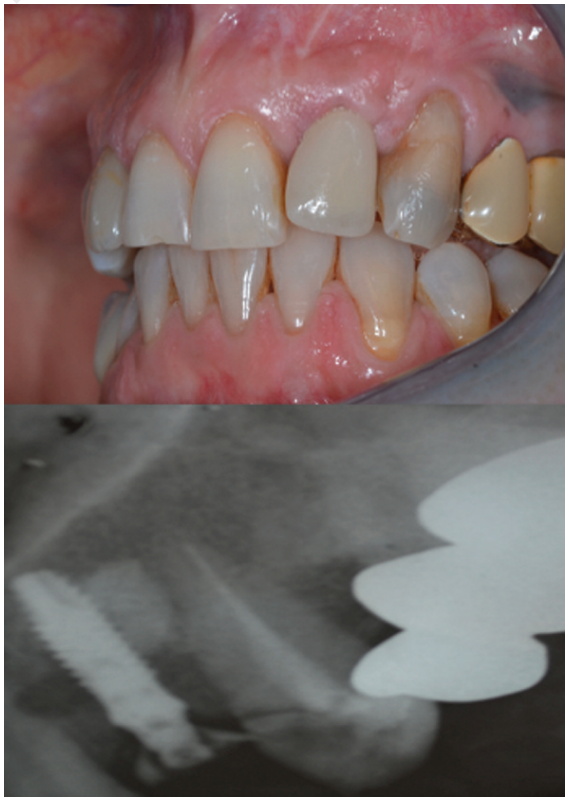
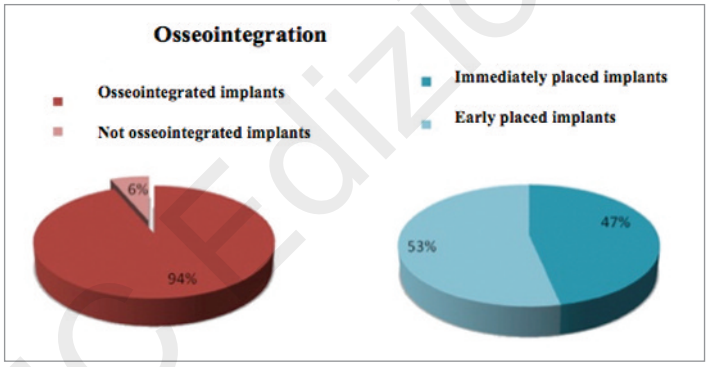


Figure 2.5. Clinical and radiographic situation after one year (type 2).

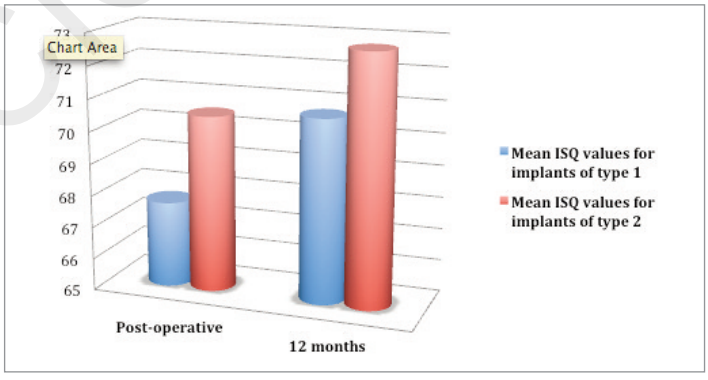
93.75%, while 53.5% of the osseointegrated fixtures were of type 2 (Graph 1).
In two cases, a peri-implant gap > 2 mm that had been filled with heterologous material was detected.
The average values for primary and secondary stability at 4 and 12 months amounted to 68.93 ± 4.11 and 71.8 ± 4.13. The mean value and standard deviation for ISQ of implants of type 1 and 2 (Graph 2) in the immediately post-operative (67.68 ± 4.47; 70.5 ± 3.46) and at 12 months (70.71 ± 3.9 ; 72.75 ± 4.3) did not show a statistically significant difference (post-operative p = 0.23; 12 months p = 0.36).
An aesthetically satisfactory rehabilitation implies the presence of healthy and stable peri-implant tissues. For this reason in this study a particular attention was given to the analysis of the following parameters at 4 and 12 months:

- Probing pocket depth (PPD): no statistically significant difference between the mean values of probing depth at 4 and 12 months for implants of types 1 (2.8 ± 0.3; 2.5 ± 0.2) and 2 (2.6 ± 0.4; 2.4 ± 0.3) emerged (Graphs. 3, 4).
- Peri-implant bone resorption: mean value ± standard deviation calculated for implants of type 1 and 2 at four months, amounting respectively to 0.14 ± 0.314 and 0.187 ± 0.09, showed an almost significant difference (t = 1.988; p = 0.060) (Graph 3). A difference that was not due to chance was recorded at 12 months between the averages and standard deviations of the same implants, respectively of 0.12 ± 0.414 and 0.275 ± 0.07 (t = 2.76; p = 0.016) (Graph 4). Therefore, there was a probability of less than 1.6% that the observed discrepancy was due to chance. Finally, the difference between the averages of bone loss calculated for the whole implants at 4 and 12 months did not reject the null hypothesis (p = 0.054) (Graphs 5, 6).
- Bleeding index (O 'Leary): no bleeding on probing was observed.
- Gingival recession: if the difference between the average values of gingival recession calculated at four months between implants of type 1 and 2 (0.942 ± 0.35; 0.35 ± 0.562) (Fig. 5, Graph. 3) was attributable to chance, the same was not observed at 12 months (0.39 ± 1.285; 0.837 ± 0.36) with a p = 0.039 (Graph 4). However, the average increase of gingival recession assessed on all the fixtures (0.306 mm) after 12 months from the insertion was not statistically significant (Graphs 7, 8).
- Correlation between periodontal biotype and the level of gingival recession: in both comparisons at 4 and at 12 months between the mean values of gingival recession in relation to periodontal biotype, the null hypothesis (H0) could be rejected (4 months p = 0.033; 12 months p = 0.014) (Graph. 9).

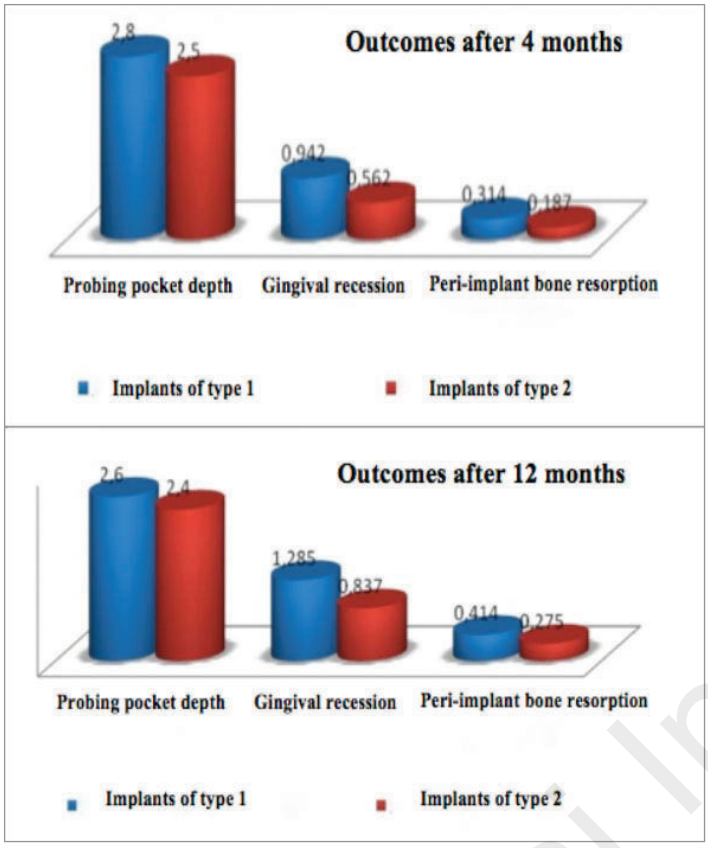
The aesthetic outcome for post-extraction implants of type 1 and 2 was analyzed both from a clinical point of view using the "Pink Esthetic Score/White Esthetic Score" (PET/WES) (Tab. 2), and in first person.
In a range between 0 and 10, the average values of PES/WES amounted respectively to 8.6 ± 1.3 and 8.4 ± 1.3 for the whole osseointegrated fixtures and no statistically significant difference between implants of types 1 and 2 were observed (Tab. 3).
The patients expressed a high level of satisfaction about the treatment (86%), as emerged from a "Visual Analogic Scale" (VAS) questionnaire compiled one year after implant placement.



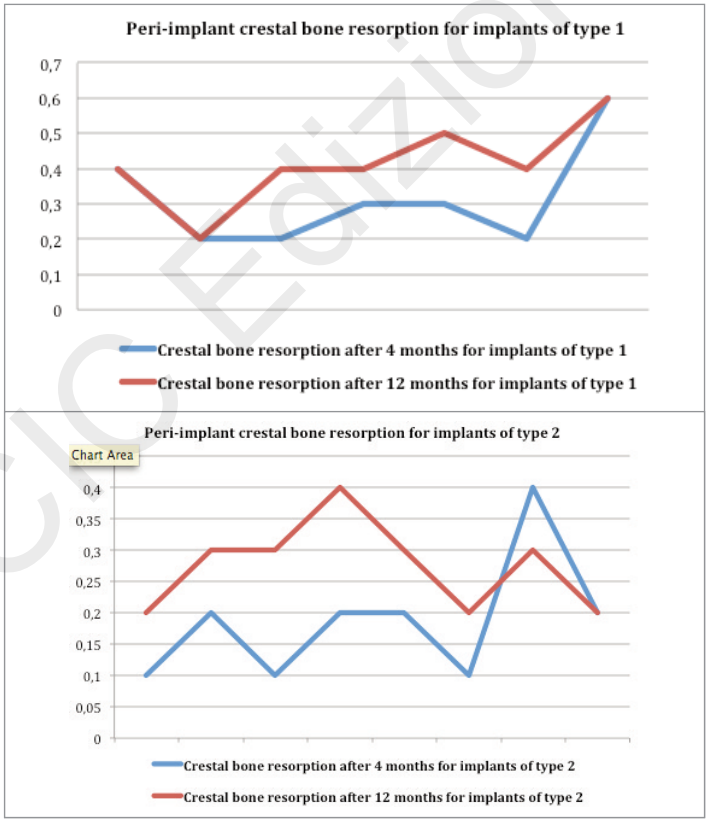
Graphic 1. Percentage of osseointegration.



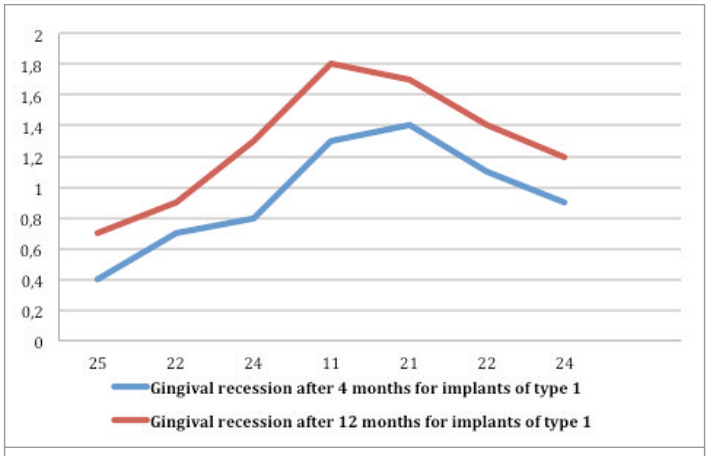
Graphic 2. Mean values ± standard deviation for ISQ of implants of types 1 and 2.

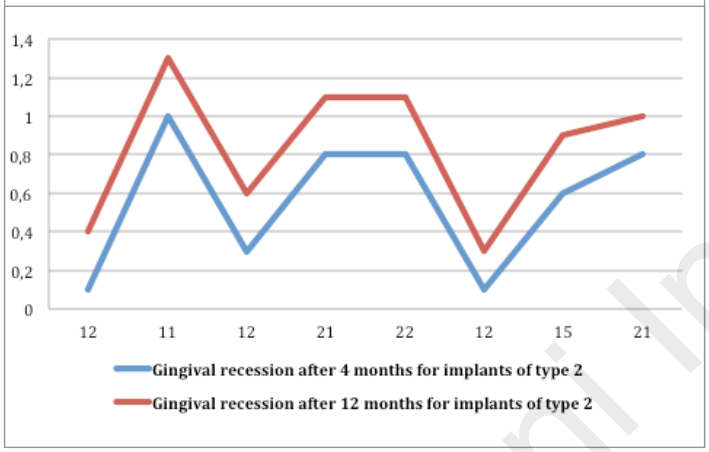


Graphics 3, 4. Probing pocket depth, gingival recession and peri-implant bone resorption for implants of type 1 and 2.

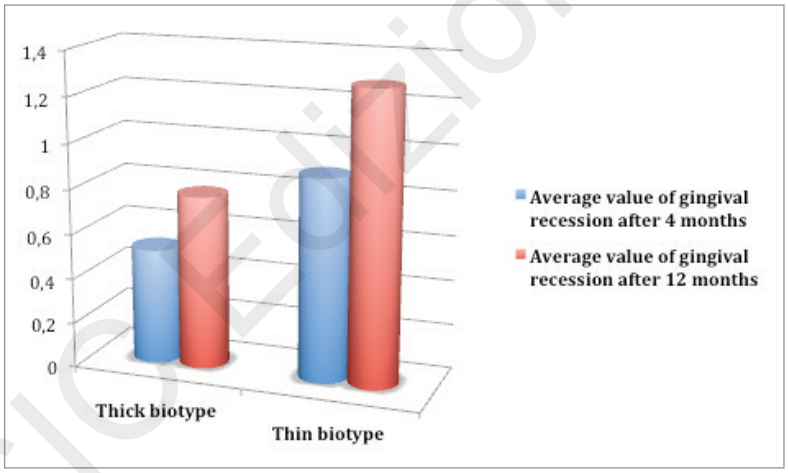


Graphics 5, 6. Crestal bone resorption for implants of type 1 and 2 after 4 and 12 months.





Graphics 7, 8. Gingival recession for implants of type 1 and 2 after 4 and 12 months.



Graphic 9. Correlation between periodontal biotype and gingival recession.

Discussion

Several studies have documented the successful implementation of post-extraction implant placement in combination with an immediate loading protocol (24, 25). The data about their survival outcomes refer especially to implants of type 1 or those inserted at the same time of teeth avulsion. Only a limited number of retrospective studies, and an even smaller amount of prospective studies focused on a comparison between the insertion types 1 and 2 (26). The survival rates are between 90% and 99% in the first case and between 90% and 100% in the second (27). Our study aimed to assess the success of immediate loading in post-extraction implantation of type 1 and 2 after one year from insertion, trough tapered design fixtures with microgeometry of a high degree of porosity.

In the present study, the percentage of osseointegration was 93.75%, confirming the usefulness of the adopted post-extraction technique with this type of implant fixtures trough tapered design fixtures with microgeometry with a high degree of porosity (TSA® Advance, Phibo®). The specific analysis on the timing of insertion showed survival

Table 2. Pink Esthetic Score/White Esthetic Score (PES/WES).

Pink Esthetic Score (PES)				
Variable		Score		
		0	1	2
Mesial papilla	Shape versus reference tooth	Absent	Incomplete	Complete
Distal papilla	Shape versus reference tooth	Absent	Incomplete	Complete
Curvature of facial mucosa	Natural matching versus reference tooth	Unnatural	Fairly natural	Natural
Level of facial mucosa	Level versus reference tooth	Major discrepancy (>2mm)	Minor discrepancy (1-2 mm)	No discrepancy (<1 mm)
Root convexity, soft tissue color and texture	Color and texture versus reference tooth	Obvious difference	Moderate difference	No difference
White Esthetic Score (WES)				
Tooth form	Shape versus reference tooth	Obvious difference	Moderate difference	No difference
Tooth volume/outline	Volume versus reference tooth	Obvious difference	Moderate difference	No difference
Color	Color versus reference tooth	Obvious difference	Moderate difference	No difference
Surface texture	Texture versus reference tooth	Obvious difference	Moderate difference	No difference
Translucency and caracterization	Transluncency versus reference tooth	Obvious difference	Moderate difference	No difference

Table 3. Aesthetic outcome for implants of type 1 and 2.

PES	Mesial papilla	Distal papilla	Curvature of facial mucosa	Level of facial mucosa	Root convexity, soft tissue color and texture	Total PES (Max 10)
Mean	1,9	1,9	1,7	1,6	1,6	8,6
SD	0,31	0,31	0,48	0,51	0,52	1,3
WES	**Tooth form**	**Tooth volume/outline**	**Color**	**Surface texture**	**Translucency and caracterization**	**Total WES**
Mean	1,7	1,6	1,5	1,8	1,8	8,4
SD	0,48	0,51	0,52	0,42	0,42	1,3

Pink Esthetic Score/White Esthetic Score

rates of 100% and 87.5% in favour of type 2 implants. Immediate implant placement was slightly less favourable than early implant placement after 4 to 8 weeks.

Only one implant was not osseointegrated and the failure occurred in a patient with a history of periodontitis. An increase in the rate of failure was also reported from Polizzi (28) and Evian (29) et al. in patients with a history of periodontal disease.

In this work, primary stability was measured by resonance frequency analysis (Osstell). The mean values and standard deviations for primary and secondary stability were 68.93 ± 4.11 and 71.8 ± 4.13. The similarity may be due to three factors:

- High insertion torque;
- Under-preparation of the site;
- Microdesign of high degree of porosity and a tapered design that increases the effective surface of the implant.

No statistically significant difference between the mean ISQ values for implants of type 1 and 2 both in the post-operative period and after 12 months, was recorded reflecting the fact that the timing of insertion did not

affect the achievement of stability of the implant fixtures tested in our study. Although the osseointegration of immediate post-extraction implants is widely reported in literature, the aesthetic outcome regarding soft tissues is not well documented (18). The aesthetic parameters analyzed in our study were the following: probing pocket depth, bleeding index, gingival recession and peri-implant crestal bone resorption.

Several aids are considered valid in determining marginal peri-implant mucosa stability and, consequently, in increasing the aesthetic valence of the post-extraction implants. Among these, the possibility of the insertion of the implant fixture both on the bucco-palatal and apical-coronal plane is included (30).

In order to ensure the best aesthetic outcome, the implants tested in this study were placed with the major axis palatally inclined to avoid damaging the vestibular wall with harmful ischemic diseases and compressions to maintain of its morphology.

The apical-coronal position or depth of implant placement may also be an important factor in determining the stability of the peri-implant mucosa. In clinical practice, immediate implants are placed with the shoulder of the implant slightly apical (1-2 mm) to the buccal marginal bone crest in order to prevent gingival recession. During the healing period, the buccal crestal bone undergoes resorptive and modeling changes characterized by a combination of bone fill within the original peri-implant defect, resorption of the buccal plate of bone of approximately 50% of the original width and approximately 1 mm loss of crestal bone height.

Nevertheless, an average gingival recession of 0.74 ± 0.39 at four months and 1.046 ± 0.43 at one year was observed, which is in line with the results described in the literature.

The comparison between the average values of gingival recession for implants of type 1 and 2 prevented the rejection of the null hypothesis at four months but not at one year. Indeed, after 12 months from implant positioning, there was a difference between the timing of insertion that was unlikely due to chance (probability estimated at 3.9%).

It can be concluded that the implants inserted contextually to dental avulsion show a greater propensity to gingival recession compared to those inserted at a distance of 4-8 weeks. Moreover, this susceptibility to recession occurs with greater evidence in the follow-up to a year. The extent of gingival recession was closely related to the patient's periodontal biotype (31), i.e. gingival thickness in bucco-palatal direction, classified into thin and thick. Several authors argue that a thin biotype usually associated with fine-looking and elongated crowns is friable and thus often subject to gingival recession following mechanical and/or surgical manipulation (31). This statement is confirmed by the results obtained in our study in which the greatest amount of recession was recorded in patients with a thin biotype, both at 4 and at 12 months from implants insertion. The discrepancy between these values and those observed in patients with thick biotype was attributable to chance with a probability of 3.3% at 4 months and 1.4% at one year.

Ultimately, the stability of the soft tissue depends on the integrity of the underlying bone tissues. Recent experimental and clinical studies have shown that healing of extraction sites is characterized by bone formation within the socket and dimensional variation of the marginal ridges due to physiological resorption and bone remodeling. These studies have shown that immediate post-extraction implants are not able to prevent vertical and horizontal bone resorption, which takes place physiologically after dental avulsion (32).

In this work, the difference between the mean values of crestal bone resorption for implants of type 1 and 2, respectively of 0.414 ± 0.12 and 0.275 ± 0.07, was statistically significant after 12 months from insertion ($p = 0.016$). Therefore, immediate implant placement did not prevent the crestal bone resorption but showed a peri-implant radiolucency, which was larger than those of early implants.

In this study, the aesthetic evaluation of the inserted implants was expressed by two objective indexes also taking into account the level of satisfaction expressed by the patient. The objective assessment of the aesthetic result was achieved by the "Pink Esthetic Score/White Esthetic Score" (PET / WES), introduced by Belser et al. (23).

This is an index that separately analyzes the peri-implant soft tissue and the prosthetic restoration in relation to five different parameters, giving each a minimum score of 0 and a maximum of 2. It provides a reproducible assessment over time, for monitoring long-term alterations occurred at the examined rehabilitations.

Some parameters used for PES include the mesial papilla, distal papilla, curvature of facial mucosa, level of facial mucosa and root convexity, soft tissue color, and texture while the WES focuses on the visible part of the implant crown emerging from the peri-implant mucosa (tooth form, volume, color, surface texture, translucency, and characterization).

The subjective aesthetic evaluation, or the patient's opinion about the aesthetic result, was recorded using a visual analog scale (VAS) inserted into a special questionnaire. The range of response ranged from 0 (complete dissatisfaction) to 100 (completely satisfied).

The obtained values for the PES/WES, respectively of 8.6 ± 1.3 and 8.4 ± 1.3, and the subjective evaluation of the analyzed sample, which averaged 86%, indicate the considerable aesthetic valence and the high level of satisfaction guaranteed by the implant technique illustrated. However, the difference between the mean values PES/WES (PES $p = 0.66$; p WES = 1.0), as well as between the mean rates of satisfaction reported by patients ($p = 0.61$), for implants of type 1 and 2 was not statistically significant.

Conclusions

Within the limitations of the present study, implant survival rates, aesthetic outcomes, patient satisfaction, and minimal events of complication seem to validate the approach described as a reliable means to immediately rehabilitate single sites of the aesthetic zone.

The specific analysis on the timing of insertion showed better results for implants placed after 4-8 weeks from extraction than implants placed immediately.
Based on this study, it can be stated that an early approach is also related to a low risk for the development of mucosal recession on the facial aspect and to a reduced crestal bone resorption compared to the immediate one.
Furthermore, immediate loading did not alter the implant osseointegration but rather allowed the proper shaping of peri-implant soft tissues during the healing phase which increases patient satisfaction.
Although well-designed, high quality, randomized clinical trials are still needed as well as the requirement to establish a common, complete, and reproducible index for the evaluation of aesthetic outcome, immediate/early placement and loading of a single TSA® Advance, Phibo® may be considered a valuable and predictable option in terms of implant success as well as hard and soft tissue stability.

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