

Original Research Article

Immediate extraction-implantation and provisionalization (IIP): Esthetic evaluation of IIP surgical protocols via the Pink Esthetic Score: a retrospective cross-sectional study of 39 implants

Sylviane Coiffic^{*} , Hugues Soulas, Julien Hamon

Rennes 1 University, Université de Rennes, Rennes, France

(Received: 4 June 2023, accepted: 21 October 2024)

Keywords:

Dental implant /
tooth extraction /
oral surgery /
esthetic surgery /
immediate dental
replacement

Abstract – A general protocol has been accepted by the scientific community for using the extraction immediate implantation and provisionalization (EIIP), in the replacement a compromised tooth in the antero-maxillary region, but the multiplicity of biomaterials used leads to diversity of application of the protocol. The aims of this study were to compare the Pink esthetic Score (PES) according to the EIIP protocol, evaluate abutment visibility according to surgical protocol, and assess whether the type of tooth rehabilitated had an impact on PES or abutment visibility. A retrospective study evaluating the PES of 39 implants in 3 treatment units compared the esthetic results of surgical techniques (xenogeneic graft, alloplastic, PRF, connective tissue graft, membrane) after the crown had been in use for at least 3 weeks. When indicated, EIIP treatment appears to be the treatment's choice for the management of compromised teeth in the antero-maxillary region, whatever the biomaterial used in the protocol (xenogeneic graft, platelet-rich fibrin, connective tissue graft, membrane, alloplastic substitute). Each of the PES observed was rated as "acceptable", and no statistical differences were found in the study between biomaterials, tooth situation (central or lateral) or abutment visibility.

Introduction

Immediate implant placement with immediate provisionalization enables a successful implant restoration with optimal esthetics results from the combination of a visually pleasing prosthesis and healthy, harmoniously scalloped peri-implant soft tissues.

Understanding the implication of implants in the gingivo-osseous complex allows us to better control the predictable risks and to manage the physiological/biological balance of aesthetic reconstructions in the antero-maxillary region.

Its primary objectives are to shorten treatment times, interventions and the psychological impact of edentulism, and to maintain the gingivo-osseous relationships that guarantee long-term aesthetic results. This procedure is therefore intended as a first-line therapeutic choice when replacing a compromised tooth in the antero-maxillary sector when all primary conditions are met [1].

In 2014, a consensus established recommendations when performing immediate implant extraction in aesthetic areas according to Chen and Buser [2]. A standardized EIIP protocol

has thus been commonly accepted in the scientific literature and has demonstrated its value through excellent long-term success rates [3].

The main aim of this study was to evaluate the aesthetic outcome of EIIP protocols using the Pink Esthetic Score.

Materials and method

A multicenter retrospective observational cross-sectional study was carried out.

Ethical principles

Following a favorable notice from Rennes' University Hospital Ethics Committee (notice 21.152), and in accordance with the ethical principles set out in the 2002 Declaration of Helsinki, data collection began.

Study design

Logos® software was used in the 3 care units to identify patients meeting the inclusion criteria.

* Correspondence: sylvianecoiffic@gmail.com

Table I. Distribution of the population according to the surgical management adopted.

Soft tissues / Hard tissues	Xenograft (Bio-Oss®)	Alloplastic substitute (Guidor® easy graft crystal+)
CTG	21	
PRF	6	
PRF + Membrane (Creos®)	4	
None		8

Consent was obtained after clear information had been provided on the use of the data collected.

All data were anonymized, and a random number was assigned to each implant studied in an Excel® anonymization table grouping all patients included in the study. This enabled structured and comparable data to be acquired between patients.

Study objectives

The primary objective was to compare aesthetic integration via the Pink Esthetic Score (PES) according to the surgical protocol of hard and soft tissue management during immediate extraction-implantation and provisionalization (EIIP) after the crown in use had been in place for at least 3 weeks.

This study also had three secondary objectives: to evaluate abutment visibility according to the surgical protocol, to assess whether the type of tooth rehabilitated had an impact on PES or abutment visibility and evaluate the patient's aesthetic perception.

Inclusion and exclusion criteria

Patients were included in the study if they had the following characteristics:

Inclusion criteria:

- Patient from one of 3 care units: Centre de Soins Dentaires du CHU de Rennes, Dr. LIMBOUR's practice in Cesson-Sévigné, Dr. MURDEN's practice in Changé.
- EIIP protocol performed in the maxillary incisal sector (11, 12, 21 or 22) as a single unit, according to the principles described by Chen and Buser [2].
- Flapless atraumatic surgery without sutures if PRF, connective tissue or a membrane was used.
- Buccal bone thickness >1mm radiographically.
- Implants ranging from 3.5 × 11.5 mm to 4.3 × 15 mm.
- Initial stability of 35 Ncm measured by a Torque Wrench.
- Jumping gap <4 mm.
- Implant placed at least 1.5 years previously.
- Implant-supported crown in use for at least 3 weeks.

Exclusion criteria:

- Other uncompensated edentulism.
- Active periodontal disease.

- Plural restoration.
- Unweaned exogenesis.
- Unbalanced general pathology.
- Previous dental crowding.
- Certain medications that can cause gingival hyperplasia.
- Implant placed without EIIP protocol.

Study population

29 patients were included in the study, for a total of 39 implants. The population included 17 women (20 implants) and 12 men (19 implants).

The population ranged in age from 21 to 64, with a mean age of 40.5.

The implants were placed by a variety of practitioners, all following the indications and recommendations of the immediate extraction-implantation technique, but using variable surgical methods regarding hard and soft tissue management.

Different combinations of surgical management were studied and summarized in the appended table (Tab. I).

Aesthetic assessment tools

For each patient, a standardized oral photograph was taken; using lateral flash, focal length F22, ISO100, shutter speed 1/125. In addition, for the lateral incisors, a photo orthogonal to the reconstructed crown was presented in order to better visualize the papilla.

As the evaluation reported by patients is subjective, it is not sufficient on its own to properly judge aesthetics from an academic point of view, so an examination of the result using an objective index is necessary.

Thus, the Pink Esthetic Score introduced by Fürhauser in 2005 [4] seemed the most reliable, in order to evaluate the aesthetic rendering according to the different surgical procedures through the 7 variables he described. An 8th variable was added concerning the implant abutment visibility, with the following values:

- 0: Abutment directly visible.
- 1: Abutment visible through transparency.
- 2: Invisible abutment.

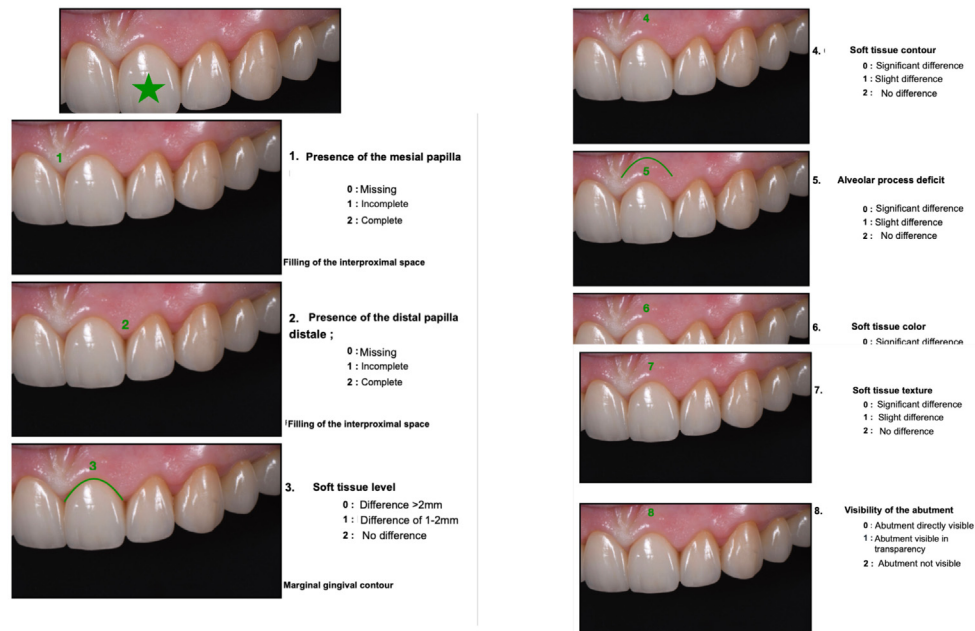


Fig. 1. PES assessment model.

Finally, each patient was asked to rate his or her level of aesthetic satisfaction from among the following choices:

- Very satisfied.
- Satisfied.
- Unsatisfied.

PES data collection

Data collection was initiated using the management software used in all 3 treatment units, i.e. Logos®.

Each photograph of the implant restoration in use was assigned a random number between 1 and 39, in order to anonymize them. These photographss were rated by 33 independent assessors, all qualified dentists and general practitioners, using the Pink Esthetic Score.

The 39 anonymized photos were indexed in a Google Form and then submitted to the evaluators, who had the following template at their disposal:

Statistical analysis

Variables are presented as [mean±standard deviation]. Comparison between all groups was ensured by the application of a non-parametric Kruskal-Wallis test. The comparison between two groups was ensured by the application of Mann Whitney tests. The scores obtained were statistically analyzed, with a significance threshold set at $p < 0.05$.

The database was created using Microsoft Excel®, and analyses and figures were produced using Stata v.13 (Stata Corp LLC, TX, USA) and GraphPad Prism 5 (GraphPad, MA, USA).

Results

A total of 39 implants were loaded for 29 patients (Tab. I).

The evaluation form containing all the implants selected was submitted to the 33 evaluators for analysis of the PES according to the 8 criteria mentioned above. A PES score out of 14 (>11: excellent, 8–11: acceptable, <8: poor) was given by each assessor for each implant.

Visibility of the implant abutment was scored out of 2 (0: abutment directly visible, 1: abutment visible through transparency, 2: abutment invisible).

PES and abutment visibility comparison by surgical protocol

21 implants were assigned to the xenograft (BioOss®) and CTG group, 6 implants to the xenograft (BioOss®) and PRF group, 4 implants to the PRF xenograft (BioOss®) resorbable membrane (Creos®) group and finally 8 implants assigned to the alloplastic apposition group (Fig. 1, Tab. II).

There was no significant difference between the protocols in terms of the Pink Esthetic Score obtained on the implants.

There were no significant differences in implant abutment visibility according to surgical protocol.

Comparison of PES and abutment visibility by tooth type

28 implants were placed in the central incisor position (11 and 21) and 11 in the lateral position (12 and 22) (Tab. III, Tab. IV).

There were no differences either between surgical protocols or between the different types of teeth assessed.

Table II. PES and abutment visibility results table according to surgical protocol.

	Alloplastic graft	CTG + Xenograft	PRF + Xenograft	PRF + Xenograft + Membrane	<i>p</i>
	<i>n</i> = 8	<i>n</i> = 21	<i>n</i> = 6	<i>n</i> = 4	
Pink Esthetic Score	8.83±1.43	9.6±1.57	9.39±1.78	9±3.25	0.75
Abutment's visibility	1.58±0.31	1.76±0.28	1.88±0.11	1.82±0.18	0.14

Table III. PES results and abutment visibility by tooth type.

Tooth	11	12	21	22	<i>p</i>
	<i>n</i> = 13	<i>n</i> = 4	<i>n</i> = 15	<i>n</i> = 7	
Pink Esthetic Score	9.2±1.58	9.23±1.35	9.18±2.16	10.07±1.31	0.76
Abutment's visibility	1.78±0.28	1.84±0.12	1.71±0.29	1.69±0.3	0.77

Table IV. PES results and abutment visibility by tooth type.

Tooth	Central	Lateral	<i>p</i>
	<i>n</i> = 28	<i>n</i> = 11	
Pink Esthetic Score	9.19±1.88	9.77±1.33	0.36
Abutment's visibility	1.74±0.28	1.75±0.25	0.81

Patients' aesthetic perception

95% of patients who underwent this protocol were very satisfied with the aesthetic result.

The remaining 5% were satisfied.

Exemple of a case (Fig. 2)

Traumatic injury causing the fracture of the left central incisor 21 (a.), remanent of the third apical of the root (b.), atraumatic extraction of the fragment (c.), palatal drilling (d.), implant placement and bone grafting (e.), radiography post-operative (f.), polishing of the provisional crown (g.), post-operative esthetic outcome (h. And i.), and final result with the definitive emax crown (j.)

Discussion

Benefits of EIIP

Since 1998, when Wöhrle first demonstrated the success of immediate implant placement and provisionalization of maxillary anterior implants without major bone defects, numerous studies have confirmed the viability of these treatments [5,6]. It is effective in optimizing esthetic success while preserving pre-existing bone and gingival architecture.

The immediate extraction-implantation technique reduces the need for soft-tissue interventions and limits hard-tissue resorption, which is systematic and significant during the

first 6 months, with a loss of 40% of the height and 60% of the thickness of the alveolus [7]. Two-thirds of which is resorbed within the first three months [8]. In the literature, 43% horizontal resorption is observed in the case of simple extraction, compared with 15% in the case of EII associated with a xenograft and collagen matrix after 4 months of healing [9].

EIIP prevents and/or reduces the risk of pro-inflammatory micro-movements around the implant and the aggregation and maturation of dental plaque in the implant-parodont gap, and limits bone compression resulting from implantation, as in this operative technique drilling is performed slightly palatal to the alveolus, to preserve the vestibular crestal bone [10].

Osteolysis occurs when the implants are loaded, via bone reshaping, probably linked to the creation of a new epithelial-conjunctive attachment. This leads to apical migration of the underlying soft tissues, which can result in an unaesthetic result. There is much speculation as to the origin of this osteolysis. It could be due to biological, mechanical or occlusal imbalances.

These disturbances have been recognized by various authors [11,12]. A distinction is made between:

- Bacterial infiltration along the implant-abutment junction [13].
- Micromovements of the abutment in relation to the implant [13].
- Occlusal stresses [14,15].
- Repeated unscrewing and screwing of the abutment [16].

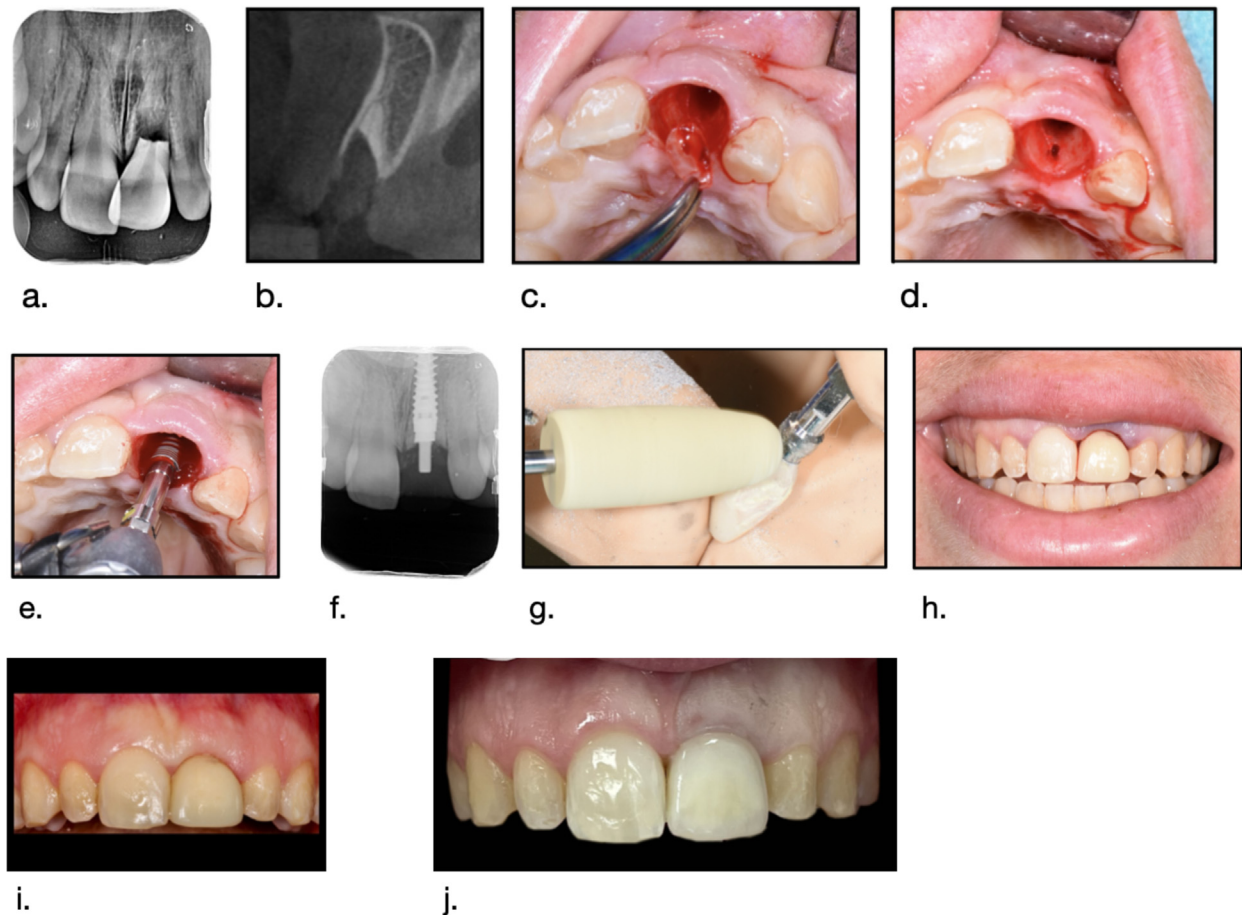


Fig. 2. Example of a case of EIIIP.

The biological benefit/risk ratio is thus based on a balance of loading constraints [15]. EIIIP appears to be favorable to this balance, as it reduces the number of interventions and, what's more, micromovements and stresses on the implant and soft tissues.

With regard to soft-tissue management, the placement of a provisional crown is essential to fill the gap in the antero-maxillary region, which can be a source of aesthetic concern, and will also serve as a healing guide.

Several authors have reported that the use of a provisional crown with immediate cosmetic loading enabled regeneration of the mesial and distal papillae in 91% of cases, compared to 70% with delayed loading [17]. On average, an additional 1mm of marginal vestibular gingiva was preserved [18].

In the vestibulo-palatal region, the provisional crown must be slightly under-contoured to avoid soft tissue ischemia, which could lead to recession [19]. It must be undersized to avoid any static or dynamic occlusal forces on the osseointegrating implant.

It has been shown that, to obtain an ad integrum papillary volume, a distance of less than 5mm must be maintained between the alveolar apex and the contact point of the provisional crown [20]. The EIIIP protocol therefore preserves the pre-existing periodontal architecture [21] (Fig. 3).

General EIIIP protocol

To ensure successful management, a 2014 consensus by Chen and Buser has been widely accepted in the scientific literature regarding the EIIIP protocol [2]:

- The presence of a thick bone and gingival morphotype,
- An intact vestibular crest,
- Absence of infection,
- Ideal implant positioning (emergence opposite the cingulum), as advocated by a consensus by Nickenig *et al.* in 2014 [22],
- Non-functional crown, stabilizing the soft tissue.

This protocol requires:

- Careful assessment of the initial situation via clinical and radiographic examination.
- Atraumatic extraction of the residual tooth, with preservation ad integrum of the vestibular alveolar wall [2]. If a full-thickness flap is raised, the blood supply is disrupted and subsequent bone loss results in gingival recession, which is why flapless surgery was advocated [23]. Although a more recent study found no significant difference between the two mucosal access techniques for EIIIP [24].

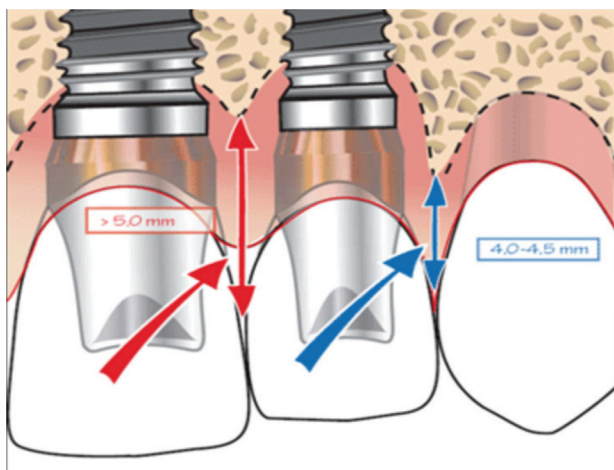


Fig. 3. Diagram illustrating the distance required between the alveolar apex and the contact point to restore a complete papilla [21].

- Slightly palatal drilling to maintain periodontal integrity, clinical studies have shown that the implant should not be placed too close to the vestibular crest of the alveolus, in order to limit resorption [25,26].
- Implant loading without heating the recipient bone, with the implant head positioned approximately 0.5 to 1 mm below the vestibular alveolar crest and 2 mm palatal to the crest of the alveolar crest, in an optimal three-dimensional position [27,28], in accordance with existing consensus such as that of the European Association of Dental Implantologists (EDI) [22].
- Placement of a provisional abutment if the implant's primary stability is greater than or equal to 35 Ncm torque [29,30].
- Gap filling if the gap is between 1 and 4 mm: this "jumping gap" is the space between the inner surface of the buccal alveolar wall and the implant surface. In a recent study, a gap of less than 4 mm is considered favorable if biomaterials are added to fill it. Ultimately, a good bone-implant interface improves stability and aesthetic results [31–33].
- Immediate cosmetic treatment with a transitional crown under occlusion for 3 months [34].

For all the cases in this study, the consensus and requirements described above and accepted in the scientific literature were respected.

Putting the study protocols into perspective

Although the application of this commonly accepted EIIP protocol was respected for all 39 implants in this study, different soft and hard tissue management approaches were used and are therefore discussed and compared.

As described above, filling of the bone gap is necessary.

In this study, 31 implant gaps were filled with xenograft bone (BioOss®), as the literature recommends filling the gap between the implant body and the extraction socket bone walls with xenograft allografts or bone substitutes [35,36]. In a study published in 2023, cone-beam computed tomography

(CBCT) measurements revealed that adding xenograft, compared with no xenograft, resulted in a 0.2 mm increase in horizontal space filling in EIIP [37]. The use of xenografts can therefore improve aesthetic results by preserving the volume and contour of the alveolar ridge beneath prosthetic restorations [38].

A series of studies by Chu *et al.* and Saito *et al.* demonstrated that gap grafting with xenograft with immediate placement of a provisional prosthesis had a positive impact on the location and dimension of the vestibular mucosa [39,40].

For the remaining 8 implants in this study, the other biomaterial used for gap filling was Easy-graft Crystal+ (Guidor®), biphasic (60% HA + 40% β -TCP) and partially resorbable. This alloplastic substitute benefits from increased structural porosity, enabling bone neoformation.

These data are also corroborated at soft tissue level, showing minimal loss of soft tissue contour after 6 months. Immediate implants with alloplastic substitutes achieved higher bone density and marginal bone levels than immediate implants alone [41].

Ultimately, xenografts and synthetic materials proved to be effective grafting materials [42].

A 2022 study compared the same biomaterials used in EII, finding no statistical difference [43].

Here, PES appears to show a difference in favor of CTG and xenogeneic grafting, which is not statistically significant with regard to the aesthetic results of the different methods of bone filling in EIIP.

Interestingly, a 2022 meta-analysis found 54% more horizontal vestibular bone resorption after gap-filling with bone substitute during the EII protocol, and also a higher risk of minor complications, mainly peri-implant mucositis and post-operative pain [44].

Finally, during implant placement, if no crestal preservation is performed, the need for guided bone regeneration is ten times higher [45].

With regard to soft tissue management, the majority of cases have involved buried connective tissue grafting (21 implants). In fact, several studies have demonstrated the benefits of placing connective tissue grafts (CTG) after implant insertion, particularly when the implant is placed immediately. It is relevant to note that this applies to all tissue phenotypes [46,47].

The use of a membrane acts as a physical barrier, enabling the appositioned bone substitute to be maintained, as well as selective colonization of the clot by desmodont cells. The use of xenografts is recommended, unlike alloplastic material, which can be used on its own, as was the case for 8 implants in this study [48–50].

The randomized clinical trial conducted by da Silva *et al.* shows that in natural dentition, when an increase in soft tissue volume is desired (height/thickness of keratinized tissue), CTG is recommended [51]. Traditionally, and as in all cases of CTG in this study, the palate was the preferred site for connective tissue harvesting due to the abundance of tissue and its relatively easy access [52].

In the present study, 10 cases received PRF (Platelet Rich Fibrin) apposition during soft tissue management. This autogenous membrane, introduced by Dr. Joseph Choukroun and colleagues in 2001, is an autogenous platelet concentrate forming a fibrin clot from a venous blood sample taken pre-operatively. Its use in combination with an immediate implant procedure can be considered a safe, effective and predictable treatment option for the rehabilitation of infected sockets after extraction [53], which, despite the loss of information during data collection, concerns several cases in this study. In addition to guided bone regeneration, it can serve as a reliable and straightforward adjuvant for immediate implantation in an infected socket, achieving a stable osteogenic effect with a good aesthetic result [54].

A number of studies have been carried out on soft tissue management. They show that the reduction in recession, increase in keratinized tissue and gingival thickness are significantly higher when a connective graft is used than when PRF is used.

Nevertheless, a quantity-effect relationship has been demonstrated in these recent studies. It has been shown that if four layers of PRF are superimposed, coverage is the same as when using a short-term buried connective graft, and the use of four layers results in significantly higher coverage than when only one or two layers of PRF are used [55,56].

Despite the autogenic similarity of these contributions, it is interesting to argue that the indications for each (PRF and CTG) are not identical, indeed the former is more often described as a contribution enabling scar improvement and capable of stimulating osteogenesis and angiogenesis in the bony environment, while the latter serves as a biological matrix and enables remodeling of the marginal gingival architecture.

Despite significant advances in periodontal and peri-implant regeneration treatments over the past 20 years, the results of these therapies remain unpredictable, and the literature remains scarce on the relationship of PRF to immediate implants.

Evaluation of abutment visibility in relation to different surgical procedures revealed a better esthetic result when using combined PRF and xenogeneic bone (1.88/2) compared to alloplastic grafting alone (1.58/2), yet the p-value study showed no statistically significant difference between the results.

In this EIIP protocol, not only surgical management is essential, but also the correct choice of implant system. This criterion has not been studied, but it is interesting to note that the shape of the implant abutment plays a crucial role in aesthetic integration, and the majority of implants in the study are Nobel Active®, providing good primary fixity. Several recent studies have looked for a way to limit the size and location of the inflammatory hiatus in the connection of the two implant parts. To this end, the use of a platform-switching connection (abutment platform narrower than implant platform) would be favorable with regard to the EIIP technique [57].

Putting the Pink Esthetic Score into perspective

When choosing an esthetic index to compare the results of surgical protocols, the Pink Esthetic Score (PES) introduced by Furhauser in 2005 has established itself as a benchmark for assessing peri-implant soft-tissue integration. It is considered a reliable, reproducible index and is the most commonly used in the literature [4].

The fact that no significant difference was found between the PES, considered acceptable, for the different surgical protocols helps to justify the therapeutic choices made by dentists pre-operatively. In this way, analysis of the initial soft and hard tissue situation enabled the correct indication for surgical management to be established in each of the 3 care units.

Furthermore, it has been shown that patient satisfaction is generally particularly high when implants are loaded immediately [58]. In fact, the emotional shock of an antero-maxillary edentulism induces a deterioration in quality of life, expressed by a low percentage of the OHRQoL (Oral health related quality of life) index according to Khan's 2018 study [59].

Although it is not possible to directly compare mean PES scores between different studies [4], Cosyn *et al.* reported a mean PES of 10.48 ± 2.47 . The cases in the present study achieve a comparable threshold of aesthetic success via PES, suggesting a similarity [60].

In a study evaluating 45 early-placed antero-maxillary implants, the mean total PES of 7.8 ± 0.88 (range: 6 to 9) testifies to an overall favorable condition of the peri-implant soft tissues. The two PES variables – soft tissue curvature (1.9 ± 0.29) and gingival festoon (1.8 ± 0.42) – had the highest mean values, while the combined alveolar process deficit/soft tissue color and texture variable (1.2 ± 0.53) proved the most difficult to fully satisfy. Mean scores were 1.6 ± 0.5 for the mesial papilla and 1.3 ± 0.5 for the distal papilla [61].

In contrast to the 2009 study, the variables in the present study that were most difficult to satisfy in their entirety concerned the indexes of mesial and distal papillae and gingival festoon. The index most often noted as being close to the maximum for all procedures was the visibility of the implant abutment, thus marking the overall success of the hard and soft tissue thickness procedures. It should be noted that the different EIIP surgical procedures showed no significant statistical difference (Fig. 4).

A study by Mastrangelo *et al.* on 115 cases of EIIP reveals a difference according to surgical protocols, in fact after 3 years, the mean PES score, evaluated, was significantly higher in the group that received at least a gap xenograft (9.7 vs. 8.14; $p = 0.001$). This means that sites treated with the addition of a bone substitute achieved better esthetics than sites rehabilitated by implant placement alone [62].

Jan Cosyn also carried out a retrospective study comparing the use of autogenous versus xenogeneic grafts in the EIIP protocol and found a PES of 9.65 for the xenogeneic graft, comparable to our study. The autogenous graft showed inferior soft tissue aesthetics (SEP: 9.00; $p = 0.045$). Interestingly, the distal papillae were found to be shorter after both techniques ($p = 0.009$) [63].

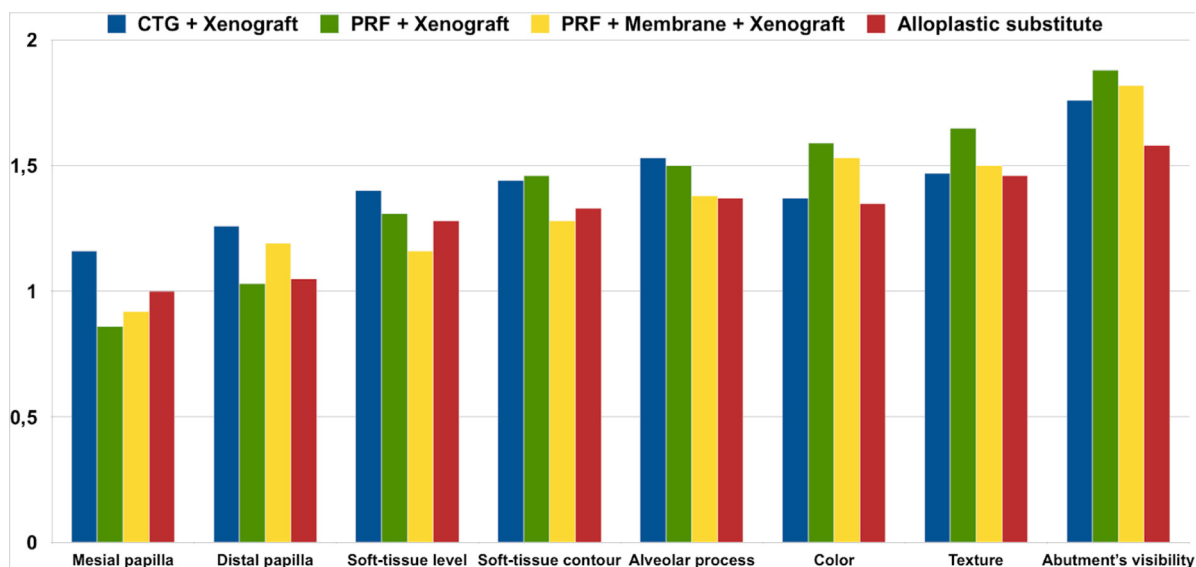


Fig. 4. Histogram of means of the PES variables according to the different surgical protocols.

Several studies have compared the PES index with the EIIP protocol. In the de Angelis study, for example, the use of an organic bovine bone substitute (Endobon®) with a resorbable collagen membrane (OsseoGuard®) in the defects around the post-extraction implant significantly improved the aesthetic result assessed by the PES. [64].

In a 2020 study comparing the PES of cases that had received a xenogeneic substitute (BioOss®) and a collagen membrane to a group that had had no external contribution during an EII procedure, the mean PES for each group was 8.2, with a range of 4.4 to 13.4. There was therefore no difference in PES between the groups either ($p=0.794$) [65].

With regard to the type of tooth rehabilitated, the location (lateral or central incisor) had no difference in results on abutment visibility or PES according to the different surgical management protocols, respectively 1.74/2 and 9.19/14 for the central incisor and 1.75/2 and 9.77/14 for the lateral incisor.

Overall, the scores obtained from the PES are “acceptable” for a professional via the PES, yet 95% of patients are very satisfied, proving that the aesthetic perception and level of requirement between the two groups of observers is not the same. It would be interesting to assess patients’ aesthetic perception based on the same aesthetic index used for professionals, in order to compare them.

In the literature, implants placed immediately and early (4-8 weeks) to replace a single compromised tooth in the anterior maxilla have shown similar ridge dimensional changes, as well as acceptable clinical and aesthetic results in the short term (one-year follow-up) [66].

According to Buser and Chen’s meta-analysis of EII, Immediate (type 1) implant placement is, however, associated with greater variability of results and a higher frequency of recession greater than 1mm of the vestibular mucosa compared with early (type 2 and type 3) implant placement [2].

Bias analysis

Several biases were identified during the course of this retrospective multicenter study. Firstly, there was an information bias, mainly observed during data collection.

Due to the large number of operators involved, data were not collected in the same way or as exhaustively for all patient files. Certain criteria could therefore not be studied due to the lack of comparability between patients due to the lack of information (for example, consultation time, surgical material such as the use of Piezotome® or Benex®, causes of extraction...).

The collection of medical data did not establish whether or not autogenous bone had been harvested during implant drilling, and therefore whether or not autogenous bone had been added during gap filling, which can have a fairly significant impact on bone remodeling, as autogenous bone is osteo-inductive and could therefore potentiate aesthetic results over the long term.

Another bias relates to the multiplicity of operators, which compromises the implementation of a standardized protocol and therefore the reproducibility of the surgical techniques studied, and moreover the expected aesthetic results [67].

There is also a selection bias, as our study included patients from 3 care units. Thus, the therapies proposed, the materials used and the follow-up carried out were dependent on the different operators and equipment in the various care units. It might therefore be interesting to compare the results obtained in a single-center study.

The other selection bias is that the different groups are not strictly comparable in terms of quantity. These results must be interpreted with caution, given the small number of cases included in this study. It would be interesting to conduct this study on a larger scale and prospectively, in order to increase the level of evidence.

Finally, an assessment bias needs to be taken into account, as PES was graded on a simple standardized photograph, whereas it is an aesthetic index that needs to be apprehended in all three spatial dimensions to be fully considered. In fact, it is difficult to assess the variable concerning the alveolar process deficit or the soft tissue texture deficit. It might be interesting to reproduce the study with the help of a 3D digital impression, in order to assess volume as well. Nevertheless, it has been described in several studies, notably on the detection of caries or malignant oral cancers, that a photographic assessment was more accurate than a visual interpretation [68,69].

Conclusion

Achieving optimal gingival esthetics around anterior single-tooth implants, reproducing the smile in a natural way, is a demanding task.

A tooth with a complicated fracture, root resorption or recurrent endodontic lesion is a compromised tooth.

The aesthetic result cannot be considered to depend solely on the surgical aspect.

After all, the pink of the gums is only halfway there if we confine ourselves to aesthetics. It is therefore important to focus on the prosthetic aspect too, and in particular on the notion of emergence profile at the interface of surgery and implant prosthesis. However, the patient's aesthetic validation must remain the primary objective of successful rehabilitation in the antero-maxillary sector.

The results of this study have shown that variants of today's hard and soft tissue management protocols are equivalent in terms of esthetic outcome, if the indication and inclusion/exclusion criteria are respected prior to therapeutic management.

Each of the materials used in the immediate implant extraction and provisionalization described in the study achieved an average Pink Esthetic Score of 9.35, which is considered "acceptable" ($11 > \text{PES} > 8$) in the scientific literature.

It would be interesting to conduct this study on a larger scale and on a single-center basis in order to increase the level of evidence and reduce the biases encountered in this study.

Funding

This article did not receive any specific funding.

Conflicts of interest

The authors declare no conflicts of interest in regards to this article.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [Coiffic.S], upon reasonable request.

Ethics approval

Ethics approval from Rennes' University Hospital Ethics Committee (notice 21.152), and in accordance with the ethical principles set out in the 2002 Declaration of 63 Helsinki.

Informed consent

Informed consent was signed by all patients.

References

1. Kois JC, Kan JY. Predictable peri-implant gingival aesthetics: surgical and prosthodontic rationales. Practical procedures and aesthetic dentistry. PubMed 2002;13:691–692.
2. Chen ST, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla – a systematic review. Int J Oral Maxillofac Implants 2014;29:186–215.
3. Al-Sawai AA, Labib H. Success of immediate loading implants compared to conventionally-loaded implants: a literature review. J Invest Clin Dent 2015;7:217–224.
4. Fürhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clinical Oral Implants Res 2005;16:639–644.
5. Wöhrle PS. Single-tooth replacement in the aesthetic zone with immediate provisionalization: fourteen consecutive case reports. Practical periodontics and aesthetic dentistry. PubMed 1999; 10: 1107–1114; quiz 1116.
6. Kan JYK, Kitichai Rungcharassaeng, Lozada J. Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. Int J of Oral and maxillofacial implants. PubMed 2003; 18: 31–39.
7. Casap N, Zeltser C, Wexler A, Tarazi E, Zeltser R. Immediate placement of dental implants into debrided infected dentoalveolar sockets. J Oral Maxillofac Surg 2007; 65: 384–392.
8. Shropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. J Prosthetic Dent 2004; 91: 92.
9. Clementini M, Agostinelli A, Castelluzzo W, Cugnata F, Vignoletti F, De Sanctis M. The effect of immediate implant placement on alveolar ridge preservation compared to spontaneous healing after tooth extraction: radiographic results of a randomized controlled clinical trial. J Clin Periodontol 2019. <https://doi.org/10.1111/jcpe.13125>
10. Ikar M, Grobecker-Karl T, Karl M, Steiner C. Mechanical stress during implant surgery and its effects on marginal bone: a literature review. Quintessence International (Berlin, Germany: 1985) 2020; 51: 142–150.
11. Weber HP, Cochran DL. The soft tissue response to osseointegrated dental implants. J Prosthetic Dent 1998; 79: 79–89.
12. Anitua E, Alkhraisat MH, Eguia A. On peri-implant bone loss theories: trying to piece together the Jigsaw. Cureus 2023. <https://doi.org/10.7759/cureus.33237>
13. Ericsson I, Persson LG, Berglundh T, Marinello CP, Lindhe J, Klinge B. Different types of inflammatory reactions in peri-implant soft tissues. J Clin Periodontol 2005; 22: 255–261.

14. Miyata T, Kobayashi Y, Araki H, Ohto T, Shin K. The influence of controlled occlusal overload on peri-implant tissue. Part 4: A histologic study in monkeys. *Int J Oral Maxillofac Implants* 2002; 17: 384–390.
15. Isidor F. Influence of forces on peri-implant bone. *Clin Oral Implants Res* 2006; 17: 8–18.
16. Abrahamsson I, Berglundh T, Wennstrom J, Lindhe J. The peri-implant hard and soft tissues at different implant systems. A comparative study in the dog. *Clin Oral Implants Res* 1996; 7: 212–219.
17. Lindeboom JAH, Tjiook Y, Kroon FHM. Immediate placement of implants in periapical infected sites: a prospective randomized study in 50 patients. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontology* 2006; 101: 705–710.
18. Block MS, Mercante DE, Lirette D, Mohamed W, Ryser M, Castellon P. Prospective evaluation of immediate and delayed provisional single tooth restorations. *J Oral Maxillofac Surg* 2009; 67: 89–107.
19. Chu SJ, Salama M, Salama H, Garber D, Saito H, Sarnachiaro GO, *et al.* The dual-zone therapeutic concept of managing immediate implant placement and provisional restoration in anterior extraction sockets. *PubMed* 2012; 33: 524–532, 534.
20. Tarnow DP, Wagner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol* 1992; 63: 995–996.
21. Boutillier B. Théorie et pratique de la mise en charge immédiate - QUINTESSENCE INTERNATIONAL — 2912550467 [Internet. 2007 [cité 30 mai 2023]. Disponible sur: http://www.remede.org/librairie-medicale/livre_3861_268.html. ISBN:10:2912550467
22. Nickenig HJ, Zoller JE, Rothamel D. Avoiding implant malpositioning [Internet. 2014. Disponible sur: https://bdizedi.org/wp-content/uploads/pdf/GuidelinesEuropeanConsensusConference/guidelines_2014_avoiding_implant_malpositioning.pdf
23. Pennel BM, King KO, Wilderman MN, Barron JM. Repair of the alveolar process following osseous surgery. *J Periodontol* 1967;38:426–431.
24. Covani U, Cornellini R, Barone A. Buccal bone augmentation around immediate implants with and without flap elevation: a modified approach. *Int J Oral Maxillofac Implants* 2008; 23:841–846.
25. Kan JYK, Roe P, Rungcharassaeng K, Patel RD, Waki T, Lozada JL, *et al.* Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: a cone beam computed tomography study. *PubMed* 2011; 26:873–876.
26. Seyssens L, Eghbali A, Cosyn J. A 10-year prospective study on single immediate implants. *J Clin Periodontol* 2020; 47:1248–1258.
27. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. *Int J Oral Maxillofac Implants* 2004; 19: 43–61.
28. Caneva M, Salata LA, De Souza SS, Baffone G, Lang NP, Botticelli D. Influence of implant positioning in extraction sockets on osseointegration: histomorphometric analyses in dogs. *Clin Oral Implants Res* 2010; 21: 43–49.
29. Douglas de Oliveira DW, Lages FS, Lanza LA, Gomes AM, Queiroz TP, Costa F de O. Dental implants with immediate loading using insertion Torque of 30 Ncm. *Implant Dentistry* 2016; 25:675–683.
30. Esposito M, Grusovin MG, Maghaireh H, Worthington HV. Interventions for replacing missing teeth: different times for loading dental implants. *Cochrane Database Syst Rev* 2013. <https://doi.org/10.1002/14651858.CD003878.pub5>
31. Capelli M, Testori T, Galli F, Zuffetti F, Motroni A, Weinstein R, *et al.* Implant-buccal plate distance as diagnostic parameter: a prospective cohort study on implant placement in fresh extraction sockets. *J Periodontol* 2013; 84: 1768–1774.
32. Babbush CA. Immediate implant placement in fresh extraction sites. *Dent Implantol Update* 2006; 17: 89–93.
33. Ferrus J, Cecchinato D, Pjetursson EB, Lang NP, Sanz M, Lindhe J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. *Clin Oral Implants Res* 2010; 21: 22–29.
34. Crespi R, Capparé P, Crespi G, Gastaldi G, Romanos G, Gherlone E. Tissue remodeling in immediate versus delayed prosthetic restoration in fresh socket implants in the esthetic zone: four-year follow-up. *Int J Periodont Restorat Dent* 2018; 38: s97–103.
35. Al Qabbani A, Al Kawas S, Enezei H, Razak NHA, Al Bayatti SW, Samsudin AR, *et al.* Biomechanical and radiological assessment of immediate implants for alveolar ridge preservation. *Dent Res J* 2018; 15: 420–429.
36. Al Qabbani A, Al Kawas S, A. Razak NH, Al Bayatti SW, Enezei HH, Samsudin AR, *et al.* Three-dimensional radiological assessment of alveolar bone volume preservation using bovine bone xenograft. *J Craniofac Surg* 2018;29:e203–e209.
37. Fettouh AIA, Ghallab NA, Ghaffar KA, Mina NA, Abdelmalak MS, Abdelrahman AAG, *et al.* Bone dimensional changes after flapless immediate implant placement with and without bone grafting: randomized clinical trial. *Clin Implant Dent Related Res* 2023. <https://doi.org/10.1111/cid.13178>
38. Schlee M, Esposito M. Aesthetic and patient preference using a bone substitute to preserve extraction sockets under pontics. A cross-sectional survey. *Eur J Oral Implantol*. 2009;2:209.
39. Chu S, Salama M, Garber D, Salama H, Sarnachiaro G, Sarnachiaro E, *et al.* Flapless postextraction socket implant placement, part 2: the effects of bone grafting and provisional restoration on peri-implant soft tissue height and thickness—a retrospective study. *Int J Periodont Restorat Dent* 2015; 35: 803–809.
40. Saito H, Chu S, Reynolds M, Tarnow D. Provisional restorations used in immediate implant placement provide a platform to promote peri-implant soft tissue healing: a pilot study. *Int J Periodont Restorat Dent* 2016;36:47–52.
41. Attia AM, Azim Abozaid FA, Edrees M, Ibrahim I. Evaluation of immediate dental implant augmented with biphasic calcium phosphate coated by polylactide — co-glycolide versus to immediate dental implant only. *Int J Dent Oral Health*. 2017;3:45–54.
42. Jyothirmayee K, Goutam M, Batra N, Bagrecha N, Deshmukh P, Malik S. A comparison of xenograft graft material and synthetic bioactive glass allograft in immediate dental implant patients. *J Pharmacy Bioallied Sci* 2022; 14: 980.
43. Tomar N, Dahiya S, Sharma PK, Ipe Sabu K, Anuj Singh Parihar, Mandal A, *et al.* A comparative clinical evaluation of effectiveness of platelet-rich plasma, synthetic allograft, and bioresorbable xenograft during immediate implant placement. *Cureus* 2022. <https://doi.org/10.7759/cureus.32121>
44. Seyssens L, Eekhout C, Cosyn J. Immediate implant placement with or without socket grafting: a systematic review and meta-analysis. *Clin Implant Dent Related Res*. 2022. <https://doi.org/10.1111/cid.13079>

45. Avila-Ortiz G, Elangovan S, Kramer KWO, Blanchette D, Dawson DV. Effect of alveolar ridge preservation after tooth extraction. *J Dental Res*. 2014;93:950–958.
46. Zucchelli G, Mazzotti C, Mounssif I, Mele M, Stefanini M, Montebugnoli L. A novel surgical-prosthetic approach for soft tissue dehiscence coverage around single implant. *Clin Oral Implants Res*. 2012. <https://doi.org/10.1111/clr.12003>
47. Grunder U. Crestal ridge width changes when placing implants at the time of tooth extraction with and without soft tissue augmentation after a healing period of 6 months: report of 24 consecutive cases. *Int J Periodontics Restorative Dentistry*. PubMed. 2011;31:9–17.
48. Leventis M, Fairbairn P, Kakar A, Leventis AD, Margaritis V, Lückerrath W, *et al.* Minimally Invasive Alveolar Ridge Preservation Utilizing an in situ hardening β -tricalcium phosphate bone substitute: a multicenter case series. *Int J Dent* 2016;2016: 1–12.
49. Saito H, Couso-Queiruga E, Shiao HJ, Stühr S, Prasad H, Allareddy T, *et al.* Evaluation of poly lactic-co-glycolic acid-coated β -tricalcium phosphate for alveolar ridge preservation: a multicenter randomized controlled trial. *J Periodontol* 2020; 92:524–435.
50. Kakar A, Rao BHS, Hegde S, Deshpande N, Lindner A, Nagursky H, *et al.* Ridge preservation using an in situ hardening biphasic calcium phosphate (β -TCP/HA) bone graft substitute—a clinical, radiological, and histological study. *Int J Implant Dent* 2017; 3. <https://doi.org/10.1186/s40729-017-0086-2>
51. Carrera TMI, Machado LM, Soares MTR, Passos GP, Oliveira GJP de, Ribeiro Júnior NV, *et al.* Root coverage with platelet-rich fibrin or connective tissue graft: a split-mouth randomized trial. *Br Oral Res* 2023; 37: e084. <https://doi.org/10.1590/1807-3107bor-2023.vol37.0084>
52. Reiser GM, Bruno JD, Mahan PE, Larkin LH. The subepithelial connective tissue graft palatal donor site: anatomic considerations for surgeons. 1996; 16: 130–137.
53. Del Fabbro M, Boggian C, Taschieri S. Immediate implant placement into fresh extraction sites with chronic periapical pathologic features combined with plasma rich in growth factors: preliminary results of single-cohort study. *J Oral Maxillofac Surg* 2009; 67: 2476–2484.
54. Fang J, Xin XR, Li W, Wang HC, Huixin Lv, Zhou Y. Immediate implant placement in combination with platelet rich-fibrin into extraction sites with periapical infection in the esthetic zone: a case report and review of literature. *World J Clin Cases* 2021; 9: 960–969.
55. Culhaoglu R, Taner L, Guler B. Evaluation of the effect of dose-dependent platelet-rich fibrin membrane on treatment of gingival recession: a randomized, controlled clinical trial. *J Appl Oral Sci* 2018; 26: e 20170278.
56. Tavelli L, Asa'ad F, Acunzo R, Pagni G, Consonni D, Rasperini G. Minimizing patient morbidity following palatal gingival harvesting: a randomized controlled clinical study. *Int J Periodont Restorat Dent*. 2018; 38: e127–e134.
57. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. *Int J Periodontics Restorative Dent* 2006; 26: 9–17.
58. Yeung CA. Effect of implant rehabilitation on oral health-related quality of life with three different implant strategies. *evidence-based dentistry* 2020; 21: 92–93.
59. Khan SU, Ghani F, Nazir Z. The effect of some missing teeth on a subjects' oral health related quality of life. *Pak J Med Sci* 2018 25;34(6). <https://doi.org/10.12669/pjms.346.15706>
60. Cosyn J, Eghbali A, De Bruyn H, Colls K, Cleymaet R, De Rouck T. Immediate single-tooth implants in the anterior maxilla: 3-year results of a case series on hard and soft tissue response and aesthetics. *J Clin Periodontol* 2011; 38: 746–753.
61. Belser UC, Grütter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using pink and white esthetic scores. *J Periodontol* 2009; 80: 140–151.
62. Mastrangelo F, Gastaldi G, Vinci R, Troiano G, Tettamanti L, Gherlone E, *et al.* Immediate postextractive implants with and without bone graft. *Implant Dentistry* 2018; 27: 638–645.
63. Cosyn J, Eghbali A, Hanselaer L, De Rouck T, Wyn I, Sabzevar MM, *et al.* Four modalities of single implant treatment in the anterior maxilla: a clinical, radiographic, and aesthetic evaluation. *Clin Implant Dent Related Res* 2012; 15: 517–530.
64. Angelis ND, Felice P, Pellegrino G, Camurati A, Gambino P, Esposito M. Guided bone regeneration with and without a bone substitute at single post-extractive implants: 1-year post-loading results from a pragmatic multicentre randomised controlled trial. *Eur J Oral Implantol* 2011; 4: 313–325.
65. Jacobs B, Zadeh H, De Kok I, Cooper L. A Randomized Controlled Trial Evaluating Grafting the Facial Gap at Immediately Placed Implants. *The International Journal of Periodontics & Restorative Dentistry*. 2020; 40: 383–92. <https://doi.org/10.11607/prd.3774>
66. Arora H, Ivanovski S. Immediate and early implant placement in single-tooth gaps in the anterior maxilla: A prospective study on ridge dimensional, clinical, and aesthetic changes. *Clinical Oral Implants Research* 2018;29:1143–54. <https://doi.org/10.1111/clr.13378>
67. Chrcanovic B, Kisch J, Albrektsson T, Wennerberg A. Impact of different surgeons on dental implant failure. *Int J Prosthodont* 2017; 30: 445–454.
68. Boye U, Walsh T, Pretty IA, Tickle M. Comparison of photographic and visual assessment of occlusal caries with histology as the reference standard. *BMC Oral Health* 2012; 12. <https://doi.org/10.1186/1472-6831-12-10>»po
69. Walsh T, Warnakulasuriya S, Lingen MW, Kerr AR, Ogden GR, Glenny AM, *et al.* Clinical assessment for the detection of oral cavity cancer and potentially malignant disorders in apparently healthy adults. *Cochrane Database Syst Rev* 2021; 2021. <https://doi.org/10.1002/14651858.CD010173.pub3>

Cite this article as: Coiffic S, Soulas H, Hamon J. 2024. Immediate extraction-implantation and provisionalization (IIP): Esthetic evaluation of IIP surgical protocols via the Pink Esthetic Score: a retrospective cross-sectional study of 39 implants. *J Oral Med Oral Surg*. 30, 24. <https://doi.org/10.1051/mcb/2024034>