

The Impact of Buccal Bone Defects and Immediate Placement on the Esthetic Outcome of Maxillary Anterior Single-Tooth Implants

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This study aimed to evaluate the impact of buccal bone defects and immediate placement on the esthetic outcome of maxillary anterior single-tooth implants. The archives of the Department of Dental Implants & Tissue Regeneration at Hygeia Hospital during a 5-year period (2010–2014) were retrospectively analyzed, in search of patients treated with a single-tooth implant after extraction of a maxillary incisor. The status of the buccal bone plate and the time of implant placement were recorded. The pink esthetic score (PES) of each case was evaluated, with a maximum score of 14. In total, 91 patients were included in the study. The mean PES was 10.5. The outcome was considered satisfactory (PES \geq 8) in 89% and (almost) perfect (PES \geq 12) in 35% of the cases. Immediate implant placement had no impact on PES ($P > .05$), even though it demonstrated slightly greater variability. On the other hand, buccal bone defects had a negative effect on PES ($P < .0001$). In conclusion, a satisfactory esthetic outcome can be achieved in single-tooth implants in the anterior maxilla. The presence of buccal bone defects is considered a negative prognostic factor, whereas immediate implant placement does not affect the esthetic outcome.

Key Words: *peri-implant soft tissue, pink esthetic score, anterior maxilla, dental implant*

INTRODUCTION

Dental implant placement is a predictable method of treating partially or fully edentulous patients. Even though their survival is high, implant-supported restorations are not always considered esthetically successful. The first criteria for dental implants' success is focused on osseointegration and not on esthetics.^{1,2}

The increasing clinical experience in implants in the anterior maxilla showed that esthetic success is mainly dependent on the architecture of the peri-implant soft tissues.³ Moreover, patients' requests for symmetrical and harmonious results prove that the contralateral natural teeth are the ultimate reference for single implants in the anterior maxilla.⁴ Various indexes have been introduced for the objective evaluation of the clinical image of peri-implant soft tissues.^{5–7}

Bone resorption that occurs after the extraction of the anterior maxillary teeth frequently hinders the effort for esthetic results and makes bone regeneration techniques necessary.⁸ On the other hand, immediate implant placement requires great skill and experience.^{9,10}

The aim of this retrospective study was to evaluate the impact of buccal bone defects and immediate implant placement on the esthetic outcome of maxillary anterior single-tooth implants.

MATERIALS AND METHODS

The records of patients treated during a 5-year period (2010–2014) at the Department of Dental Implants & Tissue Regeneration, at Hygeia Hospital, Athens, Greece, were retrospectively reviewed. Data studied included age, gender, site of implant placement, treatment method, outcome, and follow-up. The patients for the study were included based on the following inclusion criteria:

- poor prognosis of a maxillary central or lateral incisor needing extraction,
- restoration with a single dental implant,
- conventional (not immediate) loading, and
- at least 6 months' follow-up period postloading with the final prostheses.

The present study attempts to evaluate the impact of surgical and not prosthetic parameters on the final outcome. Immediate loading was considered a prosthetic confounding variable, and as a result, all of these cases were excluded. Two surgical parameters were recorded in each case:

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FIGURE 1. Left central incisor restoration with a single dental implant. Evaluation of pink esthetic score: 12 (mesial papilla: 1, distal papilla: 2, soft tissue level: 2, soft tissue contour: 2, alveolar process deficiency: 2, soft tissue color: 1, and soft tissue texture: 2).

1. The status of the buccal bone plate (intact or bone defect) after extraction and curettage, which is considered an objective surgical finding.
2. The time of implant placement (immediate or late, 3–5 months after the extraction), which was decided by the surgeon (VP and DZ) intraoperatively and was independent of the status of the buccal bone plate. The only factor that defined it was the ability or not to correctly place the dental implant in the right 3-dimensional space, as described by Buser et al.¹¹

After the evaluation of the above parameters, 4 groups of patients were formed:

- Group A: intact buccal bone plate and late implant placement
- Group B: intact buccal bone plate and immediate implant placement
- Group C: buccal bone defect and late implant placement
- Group D: buccal bone defect and immediate implant placement

In every case, bone regeneration techniques were performed. Specifically:

- Group A: In the extraction phase, alveolar ridge preservation was performed and in the implant-placing phase; if part of the collar or threads were exposed, guided bone regeneration (GBR) was performed.
- Group B: In the extraction and immediate placement phase, the space between the buccal plate and the implant was always filled with bone graft.
- Group C: In the extraction phase, GBR was performed, and in the implant-placing phase, if part of the collar or threads were exposed, GBR was performed again.
- Group D: In the extraction and immediate placement phase, GBR was performed.

In the above procedures, various bone grafts (autografts, allografts, and bone substitutes) were used, as well as

resorbable or not resorbable membranes. Moreover, different flaps were used for primary closure, sometimes in combination with soft tissue grafts.

Photographs of all included patients, taken at least 6 months after placing the final prostheses, were collected. To evaluate the difference in the esthetic outcome between the 4 groups, these photographs were assessed according to the pink esthetic score (PES), as described by Fürhauser et al,⁵ by 2 of the study authors (GK and IZ). This index is an easy, reliable, and objective tool to evaluate only the peri-implant soft tissues and not the quality of the final prostheses. The PES is composed of 7 variables:

1. Mesial papilla
2. Distal papilla
3. Soft tissue level
4. Soft tissue contour
5. Alveolar process deficiency
6. Soft tissue color
7. Soft tissue texture

Each variable is assigned a score of 0–2, with 2 being the best and 0 worst. The papillae are evaluated for completeness (2), incompleteness (1), or absence (0). The remaining variables are compared with the contralateral tooth as a reference. The highest possible score of 14 was awarded to peri-implant soft tissues that perfectly matched the contralateral natural tooth. In case of disagreement, the photographs were reevaluated with the presence of all 4 authors. In keeping with Cosyn et al,⁴ the threshold for clinical acceptance was arbitrarily set at 8. A score of 12 or more was considered (almost) perfect. An example of PES evaluation of a clinical case is presented in Figure 1.

Student *t* test was performed between the PES of the 4 groups using freeware software (<http://www.physics.csbsju.edu>) with *P* < .05 as the threshold of significance.

RESULTS

Ninety-one patients, 48 male and 43 female (1.1:1 ratio), 18–65 years old (mean age, 38.4 years) were included in the study. In these patients, 91 dental implants were placed, osseointegrated, and loaded successfully. The mean PES was 10.5 (range, 6–14). The outcome was considered satisfactory (PES ≥ 8) in 89% and (almost) perfect (PES ≥ 12) in 35% of the cases. The mean PES and the percentages of satisfactory and perfect results in every group are presented in Table 1.

The impact of buccal bone defects on PES

Buccal bone defects had a negative effect on PES, as shown by the comparison between group A+B (intact buccal bone plate) and group C+D (bone defect), independently of the time of implant placement (*P* < .0001; Table 2). A statistically significant difference was also detected after separately comparing groups A and C (late placement) and groups B and D (immediate placement; *P* = .006 and *P* = .003, respectively).

The impact of immediate placement on PES

Immediate implant placement had no impact on PES, as shown by the comparison between group A+C (late placement) and

TABLE 1
Mean PES and percentages of satisfactory and perfect results in every group*

	Number of Cases	PES (Range)	Satisfactory Cases (%)		Perfect Cases (%)
			Yes	No	
Group A	20	11.4 (8–14)	20 (100%)	0 (0%)	12 (60%)
Group B	26	11.3 (7–14)	24 (92%)	2 (8%)	13 (50%)
Group C	22	9.6 (6–12)	18 (82%)	4 (18%)	4 (18%)
Group D	23	9.5 (6–12)	19 (83%)	4 (17%)	3 (13%)
Total	91	10.5 (6–14)	81 (89%)	10 (11%)	32 (35%)

*PES indicates pink esthetic score. Satisfactory cases: PES \geq 8. Perfect cases: PES \geq 12.

group B+D (bone defect), independently of the status of the buccal bone plate ($P > .05$; Table 3). A statistically significant difference was not detected even after separately comparing groups A and B (intact bone plate) and groups C and D (bone defect; $P > .05$). Nonetheless, immediate implant placement demonstrated slightly greater variability in scores, as shown by standard deviation.

DISCUSSION

The restoration of single teeth in the esthetic zone is considered a clinical challenge. In the anterior maxilla, osseointegration and function are not the only demands. Success lies in the creation of an esthetic result in harmony with the neighboring natural teeth. Surgical technique has a great effect on the architecture of the peri-implant soft tissues.¹¹

The PES in literature reports of single-tooth implant restorations in the anterior maxilla usually ranges between 9.5 and 11.5,^{4,5,8,10,12–19} in agreement with the present study. On the other hand, there are a few studies reporting considerably higher^{20–22} or lower values.^{23–25} Unfortunately, there is not a generally accepted threshold for the characterization of a successful clinical result. Cosyn et al⁴ proposed that the outcome should be considered satisfactory if PES \geq 8 and (almost) perfect if PES \geq 12. The results of the present study are in agreement with most of the literature reports using the same arbitrary system.^{4,10,14,18,24} Nonetheless, the rate of perfect cases in the present study is slightly higher than reported.^{4,10,14,18,23,24} The clinical challenge of single implants in the anterior maxilla is supported by the fact that

less than one third of cases are considered (almost) perfect. The high rate of satisfactory and perfect cases in the current study is attributed to the strict compliance with the guidelines for right positioning of the implant in the 3-dimensional space, as described by Buser et al¹¹ and to the bone regeneration techniques performed in each case, as described in the “Materials and Methods” section. The retrospective analysis of the bone regeneration techniques showed a lot of variations in the type of bone grafts, the type of membrane, and the type of flap used. These variations in combination with the rather small number of cases in each group of the presented study did not allow further statistical analysis.

An intact buccal plate is the best support for the soft tissues.¹¹ Bone defects hinder the efforts for successful esthetic outcome, as shown by the present study (Table 2). Bone defects are also related to recession and exposure of the abutment of the implant.¹¹ These cases require more complicated bone regeneration techniques, and the final outcome is characterized by lower PES.^{8,16,18} Furthermore, wider flap elevation is mandatory, resulting in greater bone resorption.¹⁸

Immediate placement in the anterior maxilla is recommended only for experienced surgeons.²⁵ The difficulty lies in placing the implant correctly in the comfort zone¹¹ while achieving primary stability. If the above are ensured and any bone defects are treated, the final outcome is not compromised,^{14,25,26} in agreement with the present study as well. On the other hand, immediate placement is sometimes related to buccal recession.^{14,27} It is speculated that the attempt to complete all necessary surgical interventions in 1 stage may render these cases quite unpredictable, as shown by the

TABLE 2
Comparison of PES and percentages of satisfactory and perfect cases between group A+B (intact buccal bone plate) and group C+D (bone defect)†

	Number of Cases	PES (Range)	Satisfactory Cases (%)		Perfect Cases (%)
			Yes	No	
Group A+B (intact bone plate)	46	11.3 (7–14)*	44 (96%)	2 (4%)	25 (54%)
Group C+D (bone defect)	45	9.6 (6–12)*	37 (82%)	8 (18%)	7 (16%)
Total	91	10.5 (6–14)	81 (89%)	10 (11%)	32 (35%)

†PES indicates pink esthetic score. Satisfactory cases: PES \geq 8. Perfect cases: PES \geq 12.

* $P < .0001$.

TABLE 3

Comparison of PES and percentages of satisfactory and perfect cases between group A+C (late placement) and group B+D (immediate placement)[†]

	Number of Cases	PES (Range)	Satisfactory Cases (%)		Perfect Cases (%)
			Yes	No	
Group A+C (late placement)	42	10.5 (6–14)*	38 (90%)	4 (10%)	16 (38%)
Group B+D (immediate placement)	49	10.4 (6–14)*	43 (88%)	6 (12%)	16 (33%)
Total	91	10.5 (6–14)	81 (89%)	10 (11%)	32 (35%)

[†]PES indicates pink esthetic score. Satisfactory cases: PES ≥ 8. Perfect cases: PES ≥ 12.

*P > .05.

slightly greater variability in scores. Furthermore, grafting narrow defects between the buccal bone plate and the implant may not be necessary,²⁸ but the results of the present study suggest a possible positive effect on the final esthetic outcome.

CONCLUSION

Satisfactory esthetic outcome can be achieved in single-tooth implants in the anterior maxilla. The presence of buccal bone defects is considered a negative prognostic factor. On the other hand, immediate implant placement does not affect the esthetic outcome, if performed by skilled clinicians.

ABBREVIATIONS

GBR: guided bone regeneration
 PES: pink esthetic score

REFERENCES

- Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants.* 1986;1:11–25.
- Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. *J Prosthet Dent.* 1989;62:567–572.
- Cooper LF. Objective criteria: guiding and evaluating dental implant esthetics. *J Esthet Restor Dent.* 2008;20:195–205.
- Cosyn J, Eghbali A, De Bruyn H, Dierens M, De Rouck T. Single implant treatment in healing versus healed sites of the anterior maxilla: an aesthetic evaluation. *Clin Implant Dent Relat Res.* 2012;14:517–526.
- 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. *Clin Oral Implants Res.* 2005;16:639–644.
- Meijer HJ, Stellingsma K, Meijndert L, Raghoobar GM. A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues—the Implant Crown Aesthetic Index. *Clin Oral Implants Res.* 2005;16:645–649.
- 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.
- Cosyn J, Eghbali A, Hanselaer L, et al. Four modalities of single implant treatment in the anterior maxilla: a clinical, radiographic, and aesthetic evaluation. *Clin Implant Dent Relat Res.* 2013;15:517–530.
- De Rouck T, Collys K, Cosyn J. Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization: a review. *Int J Oral Maxillofac Implants.* 2008;23:897–904.

- Cosyn J, Eghbali A, De Bruyn H, Collys 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.
- 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.
- Lai HC, Zhang ZY, Wang F, Zhuang LF, Liu X, Pu YP. Evaluation of soft-tissue alteration around implant-supported single-tooth restoration in the anterior maxilla: the pink esthetic score. *Clin Oral Implants Res.* 2008;19:560–564.
- Luo Z, Zeng R, Luo Z, Chen Z. Single implants in the esthetic zone: analysis of recent peri-implant soft tissue alterations and patient satisfaction: a photographic study. *Int J Oral Maxillofac Implants.* 2011;26:578–586.
- Raes F, Cosyn J, Crommelinck E, Coessens P, De Bruyn H. Immediate and conventional single implant treatment in the anterior maxilla: 1-year results of a case series on hard and soft tissue response and aesthetics. *J Clin Periodontol.* 2011;38:385–394.
- Cutrim ES, Peruzzo DC, Benatti B. Evaluation of soft tissues around single tooth implants in the anterior maxilla restored with cemented and screw-retained crowns. *J Oral Implantol.* 2012;38:700–705.
- Hof M, Pommer B, Ambros H, Jesch P, Vogl S, Zechner W. Does timing of implant placement affect implant therapy outcome in the aesthetic zone? A clinical, radiological, aesthetic, and patient-based evaluation. *Clin Implant Dent Relat Res.* 2015;17:1188–1199.
- Hof M, Pommer B, Strbac GD, Sütö D, Watzek G, Zechner W. Esthetic evaluation of single-tooth implants in the anterior maxilla following autologous bone augmentation. *Clin Oral Implants Res.* 2013;24:88–93.
- Boardman N, Darby I, Chen S. A retrospective evaluation of aesthetic outcomes for single-tooth implants in the anterior maxilla. *Clin Oral Implants Res.* 2016;27:443–451.
- Noelken R, Neffe BA, Kunkel M, Wagner W. Maintenance of marginal bone support and soft tissue esthetics at immediately provision-alized OsseoSpeed implants placed into extraction sites: 2-year results. *Clin Oral Implants Res.* 2014;25:214–220.
- Felice P, Soardi E, Piattelli M, Pistilli R, Jacotti M, Esposito M. Immediate non-occlusal loading of immediate post-extractive versus delayed placement of single implants in preserved sockets of the anterior maxilla: 4-month post-loading results from a pragmatic multicentre randomised controlled trial. *Eur J Oral Implantol.* 2011;4:329–344.
- Fürhauser R, Mailath-Pokorny G, Haas R, Busenlechner D, Watzek G, Pommer B. Esthetics of flapless single-tooth implants in the anterior maxilla using guided surgery: association of three-dimensional accuracy and Pink Esthetic Score. *Clin Implant Dent Relat Res.* 2014;17:427–433.
- Perelli M, Abundo R, Corrente G, Saccone C, Zambelli M. Implant-supported prostheses esthetic outcomes after socket preservation technique. *J Craniofac Surg.* 2015;26:729–730.
- Dierens M, de Bruecker E, Vandeweghe S, Kisch J, de Bruyn H, Cosyn J. Alterations in soft tissue levels and aesthetics over a 16-22 year period following single implant treatment in periodontally-healthy patients: a retrospective case series. *J Clin Periodontol.* 2013;40:311–318.
- Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Esthetic outcome and tissue stability of maxillary anterior single-tooth implants following reconstruction with mandibular block grafts: a 5-year prospective study. *Int J Oral Maxillofac Implants.* 2013;28:270–280.
- Rieder D, Eggert J, Krafft T, Weber HP, Wichmann MG, Heckmann

SM. Impact of placement and restoration timing on single-implant esthetic outcome: a randomized clinical trial. *Clin Oral Implants Res*. 2016;27:e80–e86.

26. den Hartog L, Slater JJ, Vissink A, Meijer HJ, Raghoobar GM. Treatment outcome of immediate, early and conventional single-tooth implants in the aesthetic zone: a systematic review to survival, bone level, soft-tissue, aesthetics and patient satisfaction. *J Clin Periodontol*. 2008;35:1073–1086.

27. 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.

28. Botticelli D, Berglundh T, Lindhe J. Resolution of bone defects of varying dimension and configuration in the marginal portion of the peri-implant bone: an experimental study in the dog. *J Clin Periodontol*. 2004;31:309–317.