



The Health of The Peri-Implant Phenotype after Immediate Insertion and Loading of One-Piece and Two-Piece Dental Implants in the Anterior Region. A Clinical and Cone-Beam Computed Tomographic Study

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Abstract

Objective This study aimed to provide an inclusive comparison between the peri-implant phenotype of immediately placed in fresh extraction socket one-piece and two-piece implants with immediate loading in the anterior region.

Materials and Methods Twenty-two patients with a mean age of 36 ± 4.6 (4 males and 18 females) were *randomly* allocated to the one-piece and the two-piece groups. Each patient had one immediate implant placement with immediate loading by provisional restorations. Gingival Index, Peri-implant Probing depth, Papilla Presence Index, and, Implant Quality Score were recorded at 3, 6, 9 months, and 18 months. Cone beam computerized tomography is utilized to assess peri-implant bone for 1 year.

Statistical analysis A two-sample *t*-test was used to compare the two groups.

Results Both groups showed similar clinical presentations. For group two, Gingival Index, Papilla Presence Index, Peri-implant Index, Implant Quality Score, and peri-implant bone level showed statistically significant improvement. Group one showed a non-significant increase in bone density.

Conclusions The peri-implant phenotype showed more predictable treatment outcomes in the context of health and esthetics in two-pieces than in one-piece.

Keywords

- ▶ extraction socket
- ▶ one-piece dental implants
- ▶ esthetics
- ▶ peri-implant phenotype

Introduction

The peri-implant phenotype can be defined as the morphologic and dimensional features characterizing the clinical presentation of the tissues that surround and support osseointegrated implants.^{1,2} The peri-implant phenotype encompasses a soft tissue component, constituted by the peri-implant keratinized mucosa width, mucosal thickness, and the supracrestal tissue height, and an osseous compo-

nent, characterized by the peri-implant bone thickness. This definition does not only apply to buccal and facial sites but also lingual and palatal peri-implant locations. Like the periodontal phenotype, the peri-implant phenotype is site-specific and may change over time. When an unrepairable tooth is removed, it should be immediately restored to its hallmark³ as well as granted to establish long-term function and esthetics.⁴ Immediately after tooth extraction, many techniques have been used to preserve or augment the

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extraction defects.^{5,6} Dimensional bone and soft tissue alterations post-extraction in esthetic sites are of particular clinical relevance.⁷ It has been documented that placement of implants into fresh extraction sockets with a bone-to-implant gap of 2 mm or less would prevent remodeling and hence maintain the original shape of the ridge.⁸ Immediate loading of implants has been defined as a situation where the superstructure is connected to the fixtures no later than 72 h after surgery.⁹ The main advantage of this approach include the preservation of the alveolar bone by implant and sculpting of the peri-implant mucosa by immediate provisionalization,¹⁰ preserving soft-tissue morphology, shorter treatment time, better immediate esthetics.¹¹ As a result, this procedure has some drawbacks. There is a risk of mucosal recession, and a skilled operator is required.^{10,12} One-piece implants were developed to incorporate the transmucosal abutment as an integral part of the implant and thus eliminate the structural weakness built into two-piece implants.¹³ One-piece implants have many advantages, including strong unibody design, no split components, single-stage surgery with either a flap or flapless approach, and simple restorative techniques. Absence of micro gap, micro infiltration, absence of pumping effect,¹⁴ use of small diameter prosthetics, and laboratory simplification could enhance the health and maturation of soft tissues during the healing phase and provide economic sustainability.^{13,15}

The absence of an implant/abutment interface microgap at the bone crest in one-piece implants was associated with reduced peri-implant inflammatory cell accumulation and minimal bone loss.¹⁶ The long-term preservation of crestal bone height around osseointegrated implants is often used as a primary success criterion for different implant systems. Radiographic evaluation of bone forms a very important and viable means of detecting the health and stability of peri-implant hard tissue.^{17,18} A decrease in marginal bone levels indicates that the implant is loosening its bony anchorage.¹⁹

Immediate loading, defined as loading within 48 hours, was found to have a significant effect on early marginal bone loss.²⁰ The increase in marginal bone loss may be caused by load concentrated at the crestal bone because of micro-mobility of early loaded non-integrated implants.²¹

This study aimed to evaluate the peri-implant phenotype health after immediate insertion with immediate loading of one-piece and two-piece dental implants in the anterior region.

Patients and Methods

The study included 22 patients of both sexes (4 males and 18 females) ranging in age from 20 to 50 years. Patients were recruited from the outpatient clinic at the Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University, the Department of Oral Medicine, Periodontology, Oral Diagnosis, and Oral Radiology. All selected patients were indicated for immediate dental implant surgery due to the presence of non-restorable teeth. The ethics committee approved the study code 601/146. Every patient signed an informed consent form

Grouping and Intervention

There are two groups: group 1, a one-piece group, and group 2, a two-piece group. Group 1 included 11 patients ranging in age from 20 to 42 years old with a mean age of 34.3 ± 4.6 , who received immediate loaded implant placement using one-piece implants. Group 2: included 11 patients ranging in age from 30 to 38 years old with a mean age of 36 ± 2 , who received immediate loaded implant placement using two-piece implants. ROOTT implants, Great Portland Street, London, United Kingdom, were employed in both groups.

Criteria for Eligibility

Patients had to be between the ages of 20 and 50 years, be free of any chronic systemic conditions, have good oral hygiene, be nonsmokers, and have an unrepairable tooth with intact labial bone.

Exclusion Criteria

Patients undergoing chemotherapy or radiotherapy, as well as those who abuse alcohol or drugs, were excluded. Patients with parafunctional habits such as bruxism, clenching, lip, or fingernail biting, pregnant or breastfeeding, and patients who had an active tooth infection were also ruled out.

Preoperative Work Up

Clinical Assessment

Name, gender, age, medical, and dental histories were all documented in the patient's biographic data. A clinical examination was performed, and a complete periodontal chart was kept. To create optimum plaque management and periodontal therapy, all patients received oral hygiene instructions and started periodontal therapy.

Radiographic Evaluation

Preoperative CBCT scans were taken for assessment of the degree of bone resorption around afflicted teeth. Bone height, width, density, mesiodistal space, and inter-arch relationship also were filled.

Surgical procedures: Surgery was conducted under local anesthesia and strict aseptic conditions. All implant placements were achieved flapless, sequential drilling with copious irrigation was performed until the planned dimensions were obtained, depending on radiographic measurements. The gap between the implant and the walls of the prepared socket was measured, and a bone graft was placed if needed. Patients were evaluated clinically at 3, 6, 9, and 18 months postoperatively. After the atraumatic removal of the entire root, the socket was debrided gently and irrigated; after that, the pilot drill was used to prepare the implant bed, and the implant was guided to the palatal bone to gain greater bone anchorage. Nonfunctional provisional restoration at the visit of surgery or within 48 hours was attached to the fixtures. The definitive prosthesis was placed 4 months after surgery ▶ **Fig. 1-5.**



Fig. 1 Clinical image of remaining root indicated for extraction and has been replaced with two-piece implant.



Fig. 2 Clinical image of remaining root indicated for extraction and has been replaced with one-piece implant.



Fig. 3 Clinical image of two-piece implant.

Postoperative Workup

Clinical evaluation included the Gingival Index, Peri-implant, and probing depth. Papilla Presence Index and Implant Quality Score *The ICOI Pisa Implant Quality of Health Scale* were recorded at 3, 6, 9, and 18 months. Radiographic evaluation of the peri-implant bone level and density were monitored at baseline, 3 months, 6 months, 9, and 12 months. The DICOM files were imported in 3D slicer open software



Fig. 4 Clinical image of one-piece implant.

the peri-implant area was segmented and computed using the fast grow cut methods and segment statistics the procedures were tuned to segment the peri-implant bone defects the mask was set to default and local seed to zero the area and density are indicated in **Fig. 6**.

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov–Smirnov and Shapiro–Wilk tests). Age data showed normal (parametric) distribution gingival index showed nonnormal (nonparametric) distribution. Data are presented as median, range, mean and standard deviation (SD) values. For nonparametric data, the Mann–Whitney *U* test was used to compare the two groups. Friedman's test was used to study the changes within each group. Dunn's test was used for pair-wise comparisons when Friedman's test was significant. The significance level was set at $P \leq 0.05$.

Results

The changes in gingival index scores recorded showed a higher significant mean value at different intervals in the one-piece group than in the two-piece group. T0 ($p=0.00$), T1 ($p=0.00$), T2 ($p=0.003$), and T3 ($p=0.00$). In the one-piece group, they showed a significantly higher value at 6 months, and in the two-piece group, they showed a significantly higher value at 3 months. The changes in peri-implant probing depth showed a higher significant mean value at different intervals in the one-piece group than in the two-piece group ($p=0.0012$). No significant difference was recorded intra-groups. The Papilla Presence Index showed significant changes between groups at 3 months $p=0.001$; 6 months, $p=0.002$; 9 months and 18 months, $p=0.00$, but within each group, there was no significant difference.

The changes in marginal bone level were recorded at baseline, 3 months, 6 months, and 9 months. The differences between the two groups according to an independent *t*-test showed, the one-piece group had a significantly lower buccal



Fig. 5 Clinical image of two-piece implant after installation of definitive restoration (A). (B) Clinical photo of one-piece after installation of definitive restoration.

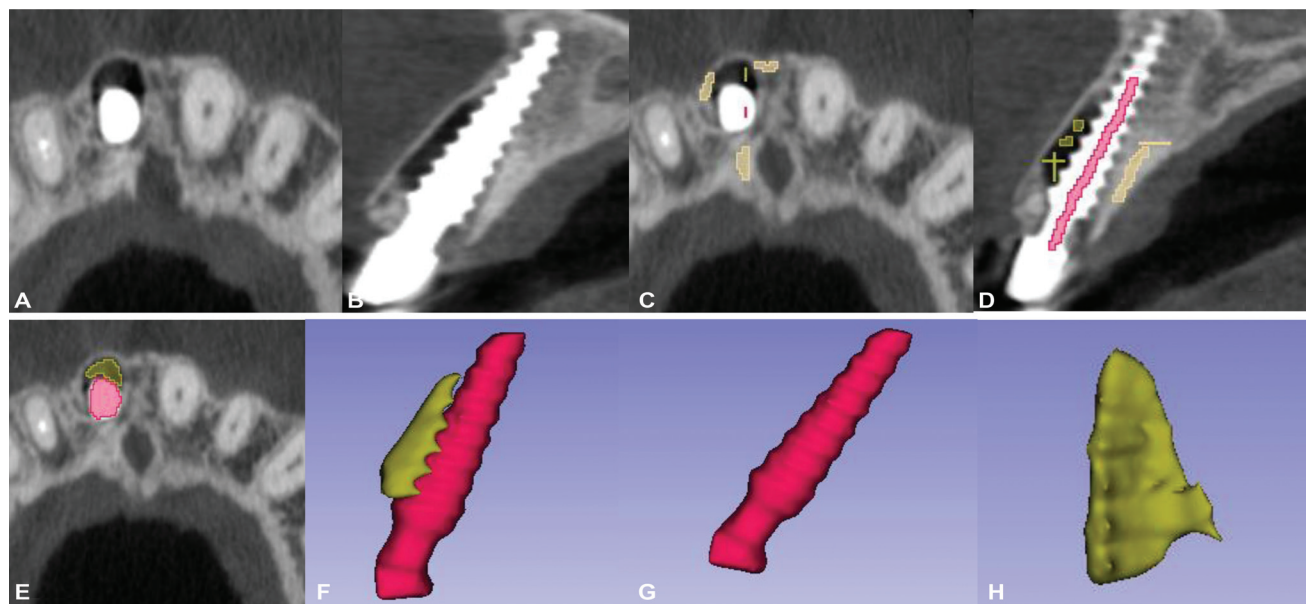


Fig. 6 A, B Sync axial and sagittal plane of CBCT cropped and threshold adjusted. C, D Paint selected area with different color. E Axial view of initial segmentation (preview). F The fixture and the peri-implant bone defect was segmented. G and H Fixture and area denoting bone defects was isolated.

crestal bone level than the two-piece group. They revealed a substantial drop in buccal crestal bone level in 3 months in the one-piece group, but no significant difference in the two-piece group over the same time. The one-piece group had a significantly higher decrease in buccal and palatal marginal bone thickness than the two-piece group ($p = 0.0036$ and $p = 0.022$, respectively) ▶ **Table 1**.

The changes in bone density showed no significance at different intervals between the two groups, as well as there was no significant difference within each group. The implant quality scale: scale 1 showed 100% of the two-piece group that was successful, while only 50% of the cases received one-piece implants were recorded as scale 1, while the remainder of cases showed 25% scale 2 and 25% scale 3.

Discussion

The esthetic, stability, and quality of immediate implant treatments are influenced by the health and morphologic changes in bone and soft tissue following immediate implant with immediate restoration in the aesthetic area. Because the identification of the role of many challenges and the interaction of component risk factors contributing to peri-implant tissue health have never been carried out in numerical values, a great number of studies have been conducted to examine each contributing component. The main effects of the parameters could be in the hands of the operator. As a patient-based demand, the choice of immediate implantation and immediate provisionalization was confirmed as a sound treatment and established a high success rate. The

Table 1 Comparison of the difference in buccal and palatal bone thickness in both groups at each interval and overall, throughout the study (independent *t*-test)

Time	Group		Buccal			Palatal
			Crestal	Apex	6 mm from the apex	
T0-T1	One piece	Mean	-1.05	0.00	-0.51	-0.08
		SD	0.63	0.00	0.39	0.05
	Two pieces	Mean	-0.91	-0.45	-0.79	0.25
		SD	0.50	0.21	0.56	0.14
	T		0.55	6.768	1.298	7.019
P		0.588 ns	0.00*	0.210 ns	0.00*	
T1-T2	One piece	Mean	0.03	-0.01	-0.12	-0.13
		SD	0.19	0.01	0.04	0.06
	Two pieces	Mean	-0.15	-0.20	-0.03	0.45
		SD	0.08	0.08	0.01	0.24
	T		2.761	7.45	6.90	7.414
P		0.012*	0.00*	0.00*	0.00*	
T2-T3	One piece	Mean	-0.15	0.00	0.00	-0.10
		SD	0.05	0.00	0.00	0.09
	Two pieces	Mean	-0.10	0.10	-0.10	-0.90
		SD	0.04	0.04	0.04	0.42
	T		7.452	7.66	7.90	7.36
P		0.00*	0.00*	0.00*	0.00*	
T0-T3	One piece	Mean	-0.13	-0.01	-0.12	-0.23
		SD	0.05	0.02	0.04	0.13
	Two pieces	Mean	-0.4	-0.4	-0.2	-0.6
		SD	-0.25	-0.10	-0.13	-0.45
	T		3.349	12.09	1.86	2.497
p-Value		0.0036*	0.00*	0.079^{ns}	0.022*	

Significance level $p \leq 0.05$, * significant, ns = non-significant.

selection of a one-piece or two-piece implant is critical in the setting of health and post-operative issues, this is a particularly concerning immediate implant therapy

A bone thickness of more than 2 mm leads to significantly less bone loss after implant uncovering.²² The concept of "critical bone thickness" showed that a minimum thickness of 1.5 mm was needed to avoid further physiological bone remodeling and to have less pathologic bone loss. A 2 mm threshold can be used to differentiate between thin and thick peri-implant bone thickness (2 mm: thin; 2 mm: thick), as well as to indicate bone augmentation. A thin bone morphology around an implant may accompany a more aggressive bone resorption pattern due to disturbance of the surrounding blood supply.²³ Peri-implant bone thickness is critical for the long-term stability of soft tissues and ridge contour. For the long-term stability of soft tissues and ridge contour, the peri-implant bone thickness should be increased. Increased bone thickness can lead to better esthetic stability outcomes. Dental implants were placed immediately in fresh extraction sockets during the mean observation period of 2 years, and none of the implants failed or presented an acute infection or

peri-implantitis. All implants presented enough peri-implant keratinized soft tissue, low rates of probing depth (mean 2.25 mm), and the presence of the preimplant bone level was stable, with a mean bone loss over 2 years after loading of 0.83 mm.¹³ When comparing the present results to those from a prior study, the change in bone height of two-piece was 0.2 ± 0.08 and in one piece it was -1.41 ± 0.08 over the observation period. Both studies, with different placement modalities and protocols, showed comparable outcomes. In group one, the gingival index showed significant changes over the observation period and significantly differed from group two.

Peri-implant probing depth in one-piece showed at 3 months a significantly greater increase of 3.75 ± 1.72 than in the two-piece group of 1.5 ± 0.71 . Both groups showed no difference (mean 0 ± 0) overall, throughout the study. This was compatible with a healthy peri-implant tissue.^{24,25}

The papilla presence index showed a statistically significant difference between groups one and two. The two-piece group showed higher scores during the observation time. Many factors affecting papilla height could explain the

majority of the variance observed in changes over time, including the relationship between the mid-facial mucosal level,²⁶ and the buccal bone crest level and thickness,²⁷ the implant platform level, and the first bone implant contact level.²⁸ In contrast, dental implant papilla (DIP) height varies according to the phenotype²⁹ the distance from the contact point to the proximal bone crest,³⁰ implant-adjacent tooth distance,³¹ the distance between two adjacent implants,³² and the loading protocols.³³ According to the current findings, most cases of one-piece and two-piece showed optimal conditions in terms of soft and hard tissues at the time of crown loading baseline time point. However, with time, the papilla presence index in one piece group decreased statistically significantly. Other studies showed papilla loss was significantly higher with a delayed protocol of implant placement compared with immediate or immediate-delayed protocols.³⁴ The current study's follow-up was satisfactory when compared to other investigations into peri-implant soft tissue stability.

Changes in bone density are a good predictor of an implant's health and biological stability.³⁵ The one-piece group had a slightly higher percent growth in bone density, but there was no statistically significant difference between the two groups ($p = 0.222$). The texture parameters assessed in images showed an association with peak insertion torque, resonance frequency analysis measurements, and histologic bone-to-implant contact BIC, indicating that bone health is more than just bone mineral content expressed as a gray value.^{36,37} The gray tone is correlated with the density of bone: the higher the mean value of gray levels, the denser the bone. The coefficient of variation SD and mean gray value ratio is correlated with the uniformity of the radiographic representation.

The implant quality scale: *The ICOI Pisa Implant Quality of Health Scale* can be used as a tool for an assessment of peri-implant tissue health.³⁸ This study showed that one-piece group, recorded a score of 1 in 50% of the cases, in comparison to 25% for each of scores 2 and 3, while the two-piece group recorded a score of 1 in 100% of the cases. This difference was statistically significant ($p = 0.018$). This finding was working in with a higher rate of technical complications for the one-piece compared to the two-piece implant system.

Limitations and prospects: The full factorial study can be used to effectively figure out relationships and hypotheses. A small number of variables that could have influenced the peri-implant phenotype were investigated.

Conclusion

Two-piece immediate implants were much superior to one-piece implants in terms of immediate loading. To optimize both the timing and the techniques of the immediate implant, a full factorial study is required.

Conflict of Interest
None declared.

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