Bioesthetic outcome of immediate versus early implant placement for anterior implant supported single tooth. (Randomized Clinical Trial)

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Abstract

Statement of problem: **Providing a definitive anterior implant placement restoration with proper esthetic and peri implant soft tissue contour are important for both immediate and early implant placement.**
Purpose: Bioesthetic outcome of immediate versus early implant placement for anterior implant supported single tooth restoration used customized healing abutments in split mouth technique.
***Material and method*: Twenty-four implants were placed in twelve patients age range between 20 and 40 years, one on each side to replace non restorable teeth in the maxillary anterior region in a split mouth technique. Extraction of one side was done for early implant placement after 4 weeks the other was extracted and both implants were inserted one side as immediate where the other is early implant placement. Customized healing abutments were fabricated using cervico mold and connected to both dental implants. After 3 month defentive crowns were inserted for both sides. The periodontal probing depth and bleeding index at 3, 6 and 12 months were evaluated. Also, pink and white esthetic score (PES-WES) was evaluated at 3,6 and 12 months after implant placement**
***Results*: The frequency percentage of probing depth decreased significantly from 3 month until 12 month after crown insertion for of immediate implant placement. When comparing between the two approaches, there was no significant difference between them. On the other hand the mean of bleeding index of both approaches are decreased significantly during 12 month period which there is insignificant difference between them. The individual parameters of PES showed significant difference between the two groups regarding soft tissue level and soft tissue curvature at the different intervals. Where the early implant placement (EIP) with customized healing abutment showed better pink esthetic score (PES) than immediate implant placement (IIP) with customized healing abutment while the white esthetic score (WES) showed no significant difference.**
***Conclusion*: Both together EIP and IIP were associated with proper periodontal health with no significant difference between them. Concerning the early implant placement that was associated with better PES than immediate implant placement while the WES showed no difference between both.**
***Clinical implication*: The use of cervico device for construction of customized healing abutments prepares soft tissue for the prosthetic stage preserving its contours and eliminating the need for reopening surgery for immediate as well as for early implant placement.**

Keywords: Customized healing abutment, emergence profile, immediate placement, soft tissue management.

Introduction

Esthetics is of most importance while rehabilitating maxillary anterior region with dental implants. The anterior esthetics are influenced by several variables, including the patient's smile line, the location of the dental implant, the biotype of the periodontium, the form of the tooth, the position of the neighboring teeth, the bone structure of the

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implant site, and the timing of implant placement. Additional difficulties arise during implant implantation because of the great visibility and patient expectations. The accelerated bone remodeling especially in the maxillary anterior region make the preservation of peri-implant tissue and contour crucial (1,2).

After tooth extraction, immediate implant placement various clinical approaches to minimize bone loss and enhance implant success was followed, thus favoring less invasive procedures. Minimally invasive tooth extraction, avoiding unnecessary flap release, minimizes tissue disruption and conserves alveolar bone. Further reduction in bone loss can be achieved through early implant placement, typically 4-8 weeks post-extraction, allowing soft tissue healing and facilitate accurate bone defect assessment (3,4,5).

Regardless of implant placement timing and according to the clinical situation, provisional restoration is crucial. As it can provide immediate aesthetics and function while the implant integrates as it preserves soft tissue contours simplifying subsequent treatment stages (6,7). Once achieving secondary stability indicating complete integration, the final prosthesis can be manufactured, benefiting from preserved soft tissue contours for more predictable results. Adequate primary stability, exceeding 35 N cm or an implant stability quotient above 70, is crucial for the desired outcome (8). Implementing comprehensive and less invasive approaches addresses post-tooth extraction bone loss, enhancing implant success for optimal aesthetic and functional outcomes.

Customized healing abutments, offer a promising solution. They protect and preserve alveolar contours, eliminate the need for a second reopening surgery and provisional restorations, and expedite the soft tissue conditioning phase for natural-like restorations (9). This approach provides a simplified chairside technique for customizing healing abutments, particularly useful for immediate implants and early implant placement in anterior region. The aim is to maintain soft tissue contours and reduce the number of clinical steps, presenting a valuable alternative to traditional methods (10). The aim of the study was to evaluate the soft tissue contour between early and immediate implant placement using customized healing abutment.

The null hypothesis was no significant difference between both technique of implant placement.

Materials and method

The present study was conducted as a prospective, double-blinded, balanced, randomized controlled clinical trial with a parallel-group design. Ethical approval was obtained under the number IRB2023-H0113D-P-0494 from the ethical committee in the Faculty of Dentistry, Beirut Arab University. Twenty-four dental implants were placed in twelve participants indicated for bilateral immediate and early implant placement in the esthetic zone of the maxillary dental arch. They were selected from those attended to the Department of Prosthodontics, Faculty of Dentistry, Beirut Arab University, Lebanon. Clinical procedures and possible complications were explained to the participants, who signed an informed consent considering the 1975 Declaration of Helsinki, revised in 2013.(11)

Sample size was calculated by using a software program (G*Power version 3.1.9.2; Heinrich Heine University Düsseldorf) based on the results of a study evaluating the marginal bone level The significance level was set to 95% with a power of 80%. A random allocation sequence was generated by using an online software program (Research Randomizer). (12).

The inclusion criteria were patients within 2 to 40 years with unrestorable bilateral teeth with a harmonious gingival contour, having a thick gingival phenotype and at least 4 mm of bone apical to the root apex and 2mm labial plate of bone of the unrestorable tooth to be extracted and absence of any periapical radiolucency (Figure 1) (13). Any patient suffering from medical disorders interfering with osseointegration or soft tissue healing, active oral infections or periodontal disease, presence of dehiscence or fenestration defects related to the tooth to be extracted, poor oral hygiene, and heavy smokers was excluded from the study (14).

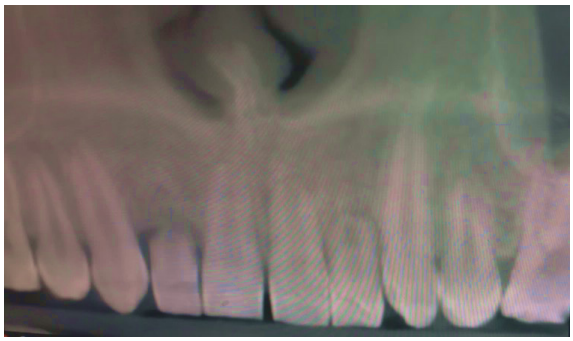

Figure 1. Panoramic view of CBCT of patient

Bench scan (**Medit T-710 Tabletop Scanner)** of cast and preoperative CBCT (3D Accuitomol 170) was made for each participant for construction of CAD CAM surgical guide. The implant was planned to engage the palatal wall, avoid pressure on the labial plate of the bone, and be 1-mm apical to the crest. A fully guided tooth-supported surgical guide was designed and then printed in clear acrylic resin (Dental SG Resin; Formlabs) by using a 3D printer (Form2; Formlabs).

After surgical guide printing, the tooth was extracted and essix retainer is placed until after 4 weeks the contalateral side tooth was extracted and implant placed (IDI implant *Implants Diffusion International* 23/25) for both sides following implant placement protocol using fully guided CAD CAM surgical guide (15).

Directly after early and immediate implant placement, a customized healing abutment was fabricated using cervico kit. The selection was made intraorally using a special handle to place the indicator over the restorable area. Utilise the anatomical shape tab from the same group as per the anterior tooth missing. The anterior suitable stock healing abutment directly screwed on the implant analog and was fixed at the corresponding well of the silicone mold, and the custom healing abutment was fabricated with nano-hybrid flowable resin (3M™ Filtek™ Supreme Flowable Composite) (Figure 2 a,b,c). Minor selective grinding, finishing, and polishing were made when necessary to achieve a smooth, lustrous tissue contact surface, and screwed to the implants at both sides (16) (Figure 3).

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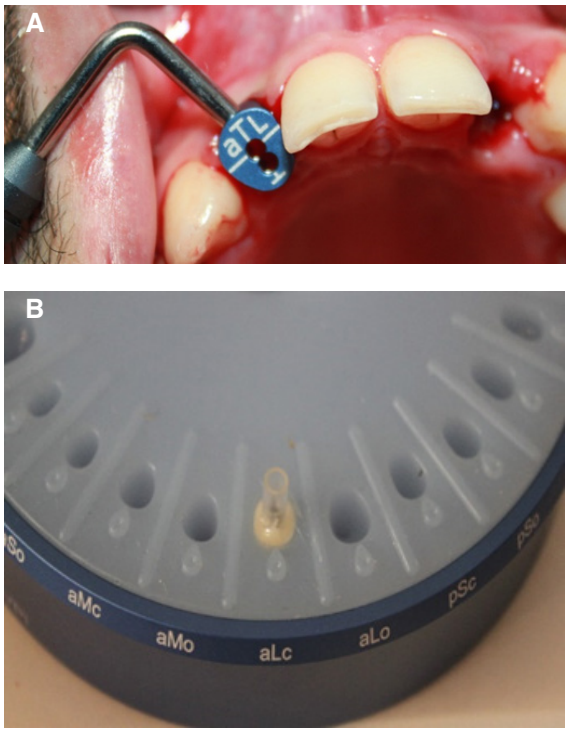

Figure 2. A) Intraoral view of proper selection of stock abutment. B) Custom made healing abutment fabrication. C) custom made healing abutment.

Figure 3. intra oral view of custom made healing abutment after insertion.

The prosthetic procedures for definitive restorations were performed 3 months after implant placement. The healing abutment was removed (Figure 4) scan body placed in position and a digital implant-level impression was made using intraoral scanner (Medit I 700 3D scanners) (17) (Figs. 5, 6)

Figure 4. Soft tissue healing after removal of custom-made provisional crowns.

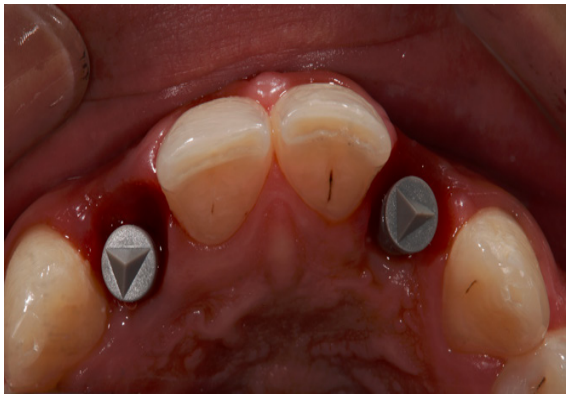

Figure 5. Bilaterally attached scan bodies to the implants.

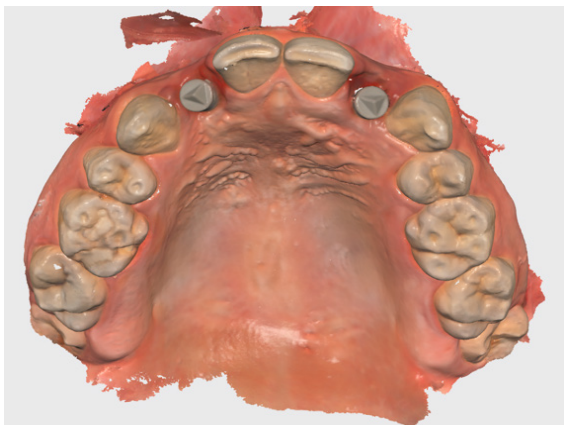

Figure 6. Virtual view of scan bodies after scanning.

The designed restoration using exocade for the design (Figure 7) was milled from a super translucent multilayered zirconia (KATANA Zirconia STML; Kuraray Noritake). The milled restoration was cemented on the Ti-base with a resin cement (RelyX Unicem; 3M ESPE). Then, the definitive restoration was connected into the implant, and the Ti-base screw was tightened to 20 Ncm according to the manufacturer's instructions. The screw access channel was sealed with the sterilized PTFE and photopolymerized composite resin (Filtek Supreme Ultra; 3M ESPE). The definitive restoration was evaluated for centric and eccentric occlusal contacts and then finished and polished (Figure 8).

Figure 7. Virtual crowns designed using exocad software.

Figure 8. Final definitive crowns after screwing intraorally.

Peri-implant probing depth (PD) is the measurement of the distance between the gingival margin and the deepest part of the sulcus. The depth of the peri-implant sulcus was assessed using a graded plastic autoclavable periodontal probe. Furthermore, it was measured on the day when the final restoration was placed, in addition to the intervals specified before. The probe was positioned in alignment with the elongated orientation of the implant and inserted with little pressure into the sulcus around the implant. Measurements was taken at labial and palatal for each implant. Probing depths of 1 mm or less was recorded as 1 mm, whereas depths surpassing 1 mm but less than 2 mm will be recorded as 2 mm, and so on (18).

Modified Sulcus Bleeding Index (BI): A score of 0-3 was assigned to each labial and palatal surface of the implant then the average for each implant was calculated according to the following criteria: Score 0: No bleeding when a periodontal probe is passed along the gingival margin adjacent to the implant. Score 1: Isolated bleeding spots visible. Score 2: Blood forms a confluent red line on margin. Score 3: Heavy or profuse bleeding (19).

The PES-WES of each definitive restoration was evaluated at 3, 6 and 12 months after implant placement. PES was assessed based on 5 parameters: mesial and distal papillae, soft tissue level, soft tissue curvature, root convexity. The parameters of PES were scored 0, 1, or 2 when there was obvious, minor, or no discrepancy with the contralateral tooth if present or digitally designed tooth (20). The WES was assessed based on 5 parameters; tooth outline, volume, shade, texture, and translucency. The parameters of WES were scored 0, 1, or 2 when there was obvious, minor, no discrepancy with the contralateral tooth if present or digitally designed tooth (21). The PES-WES was evaluated by using intraoral photographs made with a digital camera (EOS 1300D; Canon) with a macro lens (105 mm f/2.8 EX DG OS HSM; Sigma). The assessment was completed in 2 sessions a week apart by an experienced prosthodontist and periodontist. The scores of the 2 evaluators were correlated, and when differences were present, the evaluators discussed them. The statistical tests were performed by using a software package (IBM SPSS Statistics, v20.0; IBM Corp). The Shapiro-Wilk test of normality was used to verify the normal distribution of collected data. The total PES-WES and PD and BI were described as mean and standard deviation (SD) and analyzed by using the student t test. The scores of the PES and WES parameters were expressed in frequency and percentage. The PES and WES parameters were analyzed by using the chi square test with the application of the Fisher exact.

Results

Table 1 and Table 2 the frequency percentage of probing depth decreased significantly from 3 month until 12 month after crown insertion for of immediate implant placement. When comparing between the two approaches, there was no significant difference between them. On the other hand the mean of bleeding index of both approaches are decreased significantly during 12 month period which there is insignificant difference between them (Table 3). For the results of PES showed in Table 4 and 5 and graph there was significant difference of frequency percentage of STL

Table 1. Frequency (percentage) of Probing depth parameters; labial, palatal at 6- and 12-month intervals

		Immediate implant placement (n=12)				**Early implant placement (n=12)**			
Score		1(mm)	2(mm)	3(mm)	P	1(mm)	2(mm)	3(mm)	P
Labial	3 m	0(0.0%)	0(0.0%)	12(100%)	0.09175171	2(16.6%)	8(66.6%)	2(16.6%)	0.0902425
	6 m	2(16.6%)	8(66.6%)	2(16.6%)	0.03708995	2(16.6%)	9(75%)	1(8.3%)	0.0432152
	12m	5(41.6%)	4(33.3%)	3(25%)	0.08975157	4(33.3%)	5(41.6%)	3(25%)	0.0838247
Palatal	3 m	0 (0.0%)	3(25%)	9(75%)	0.083772234	3(25%)	7(33.3%)	2(16.6%)	0.083772234
	6 m	0 (0.0%)	4(33.3%)	8(66.7%)	0.09024257	4(33.3%)	5(41.6%)	3(25%)	0.073940983
	12m	1(8.33%)	5(41.6%)	6(50%)	0.06365874	5(41.6%)	5(41.6%)	2(16.6%)	0.05393278

3m:3 month 6m: 6montth 12m: 12 month

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Table 2. Pairwise comparison regarding probing depth (mm) within each group.

Group	Compared to	P value	
		Immediate implant placement	Early implant placement
3 months	6 months	0.00001*	0.359649
	12 months	0.000039*	0.387351
6 months	12 months	0.290364	0.5

*significant at 5% level

Table 3. Modified Sulcus Bleeding Index results at 3 and 6 month

	Group				
	Early		Immediate		P value
	Mean	Standard Deviation	Mean	Standard Deviation	
Labial at 3 months	0.58	0.51	0.50	0.52	0.682
Palatal at 3 months	0.67	0.49	0.58	0.51	0.673
Labial at 6 months	0.53	0.49	0.52	0.48	0.672
Palatal at 6 months	0.51	0.67	0.51	0.58	0.657
Labial at 12 months	0.54	0.52	0.52	0.49	0.680
Palatal at 12 months	0.50	0.54	0.49	0.53	0.684

Table 4. Pairwise comparison regarding bleeding index within each group.

Group	Compared to	P value	
		Immediate implant placement	Early implant placement
3 months	6 months	0.8389	0.9229
	12 months	0.8509	0.9236
6 months	12 months	0.9618	1.00

Table 5. Frequency (percentage) of 5 PES parameters in immediate implant placement and early implant placement at 3,6 and 12 months

		Immediate n=12				Early n=12			
Score		0	1	2	P	0	1	2	P
Mp	3 m	0(0.0%)	0(0.0%)	12 (100%)	0.241481755	0(0.0%)	4(33.3%)	8(66.7%)	0.112701665
	6 m	0(0.0%)	0 (0.0%)	12 (100%)	0.241481755	0 (0.0%)	4(33.3%)	8(66.7%)	0.112701665
	12m	0(0.0%)	11(91.7%)	1 (8.3%)	0.241481755	0(0.0%)	5(41.6%)	7(58.3%)	0.094248664
Dp	3 m	0(0.0%)	10(83.3%)	2 (16.7%)	0.211324865	0 (0.0%)	4(33.3%)	8(66.7%)	0.112701665
	6 m	0(0.0%)	10(83.3%)	2 (16.7%)	0.211324865	0 (0.0%)	3(25%)	9(75%)	0.143126786
	12m	0(0.0%)	0 (0.0%)	12 (100%)	0.241481755	0 (0.0%)	1(8.3%)	11(91.7%)	0.211324865
STL	3m	0(0.0%)	10(83.3%)	2 (16.7%)	0.211324865	0 (0.0%)	4(33.3%)	8(66.7%)	0.112701665
	6 m	0(0.0%)	10(83.3%)	2 (16.7%)	0.211324865	2(16.6%)	4(33.3%)	8(66.6%)	0.066367646
	12m	0(0.0%)	11(91.7%)	1 (8.3%)	0.241481755	1(8.3%)	5(41.6%)	8(66.6%)	0.043821628*
STC	3m	0(0.0%)	3(25%)	9(75%)	0.143126786	3(25%)	4(33.3%)	5(41.6%)	0.09175171
	6 m	0(0.0%)	3(25%)	9(75%)	0.143126786	3(25%)	4(33.3%)	5(41.6%)	0.09175171
	12m	0(0.0%)	4(33.3%)	8(66.7%)	0.112701665	1(8.3%)	5(41.6%)	8(66.6%)	0.033821628*
RC	3m	0(0.0%)	2(16.7%)	10(83.3%)	0.177748307	0(0.0%)	4(33.3%)	8(66.7%)	0.112701665
	6 m	0(0.0%)	2 (16.7%)	10(83.3%)	0.177748307	0 (0.0%)	4(33.3%)	8(66.7%)	0.112701665
	12m	0(0.0%)	1(8.3%)	11(91.7%)	0.211324865	0 (0.0%)	4(33.3%)	8(66.7%)	0.022701665*

Mesial and distal papillae, soft tissue level, soft tissue curvature, and root convexity

**Statistically significant difference at p value<0.05, different superscript lowercase letters denote statistically significant difference between follow up points*

and STC and RC parameter during 12 months for both immediate and early implant placement. On the other hand, there was insignificant difference of frequency percentage of all WES parameter for both immediate and early implant placement during 12 month (Table 6). When comparing between the two parameters (Table 7) showed that there was significant difference of frequency percentage of STL between immediate and early implant placement at 6 and 12 month.

Discussion

The null hypothesis regarding the esthetic outcomes was not rejected. Evaluating the probing depth, a slight difference in data but no significant difference between immediate and early implant placement as well as bleeding index because proper contour of crown in all aspects done after customized healing abutment resulted in healthy gingiva with no plaque accumulation and no bleeding. The two different implant placements with customized healing abutments show statistical differences in terms of PES values. However, the individual parameters of PES showed significant difference between the two groups regarding STL, STC and RC at the different intervals while the early implant with customized healing abutment showed better than immediate implant with customized healing abutment that the utilization of customized healing abutments in the early implant phase, particularly in the anterior region, has shown promising outcomes. Customized healing abutments aid in guiding peri-implant tissue healing, maintaining tissue stability, and preserving soft tissue contours. These abutments have been observed to prevent hard and soft tissue collapse, contributing to successful long-term outcomes without significant bone loss and support and prevent papilla collapse while helping protect the integrity of the buccal and lingual wall. This is similar to Puisys, et al 2022(22) where the study resulted in excellent esthetic outcomes with PES >12 after 1-year follow-up. Also, Groenendijk, et al 2020(23) conducted that PES in early implant placement remained the safest method to prevent unaesthetic appearance, and width of keratinized gingiva (≥3 mm) was a significant factor to achieve implant esthetic results. The use of a custom made

Table 6. Frequency (percentage) of 5 WES parameters at 3,6 and 12-month intervals

Score	Time	Immediate n=12			p-value	Early n=12			P-value
		0	1	2		0	1	2	
Outline	3m	0(0.0%)	0(0.0%)	12(100%)	0.34148175	0(0.0%)	0(0.0%)	12(100%)	0.34148175
	6 m	0 (0.0%)	0 (0.0%)	12(100%)	0.34148175	0(0.0%)	0 (0.0%)	12(100%)	0.34148175
	12 m	0 (0.0%)	0(0.0%)	12(100%)	0.34148175	0(0.0%)	0(0.0%)	12(100%)	0.34148175
Volume	3m	0(0.0%)	0(0.0%)	12(100%)	0.34148175	0(0.0%)	0(0.0%)	12(100%)	0.34148175
	6 m	0 (0.0%)	7(58.3%)	5 (41.7%)	0.21270166	0(0.0%)	6 (50%)	6 (50%)	0.19424866
	12 m	0 (0.0%)	5(41.7%)	7 (58.3%)	0.19424866	0(0.0%)	5(41.7%)	7 (58.3%)	0.19424866
Shade	3m	0 (0.0%)	0 (0.0%)	12(100%)	0.34148175	0(0.0%)	0 (0.0%)	12(100%)	0.34148175
	6 m	0 (0.0%)	5(41.7%)	7 (58.3%)	0.19424866	0(0.0%)	5(41.7%)	7 (58.3%)	0.19424866
	12 m	0 (0.0%)	6 (50%)	6 (50%)	0.19424866	1(8.3%)	5(14.7%)	6 (50%)	0.15456459
Texture	3m	0 (0.0%)	0 (0.0%)	12(100%)	0.34148175	0(0.0%)	0 (0.0%)	12(100%)	0.34148175
	6 m	2 (16.7%)	5(41.7%)	5 (41.7%)	0.11754935	2(16.7%)	5(41.7%)	5 (41.7%)	0.11754935
	12m	0 (0.0%)	6 (50%)	6 (50%)	0.19424866	1(8.3%)	5(14.7%)	6 (50%)	0.15456459

Table 7. Mean ±standard deviation of PES, WES, immediate implant placement (n=12) and early implant placement (n=12) at different intervals

	6 months			12 months		
Parameter	Immediate	Early	P value	immediate	Early	P value
PES	13.00 ± 0.30	10.00 ± 1.00	<.001	12.58 ±0.51	10.58 ±1.00	<.001
WES	9.50 ± 1.00	9.00 ± 1.00	0.234	9 ±0.60	7.67 ±0.65	002

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healing abutment helps prevent hard and soft tissue collapse, promoting tissue regeneration and preventing bone loss.

In a comprehensive analysis of dental implant outcomes, significant insights have emerged regarding the esthetic and health implications of immediate versus early implant placements. According to Patel et al. 2024 (24), the Pink Esthetic Score (PES) results highlighted a statistically significant difference favouring early implant placement at both 6- and 12-months post-procedure. This implies that, customized healing abutments in early implant placement in the anterior region help maintain socket volume, support soft tissue, and mimic natural emergence profile, aiding in optimal restorative outcomes. This is the crucial aspect for replacement of front teeth.

Further examination into specific PES parameters by Amid et al. 2024(25) showed that a statistically significant difference was obtained for soft tissue curvature (STC) and root convexity (RC) at definite time events. The results assume great value, since this study demonstrates that when implants are early placed, better esthetic alignment of roots is obtained, simulating their configuration. Additionally, Pitman et al. 2023 (26) gave a report of a significant texture finding at the 6-month interval, which reported a significantly perceived surface smoothness and texture at the site of the implant placed immediately.

On the contrary, at the 6-month interval, there were no significant differences between the two groups for the White Esthetic Score (WES). It pointed out that the implant crown matched the color of the natural tooth evenly between the two groups. However, a notable shift was observed by Lops, et al. 2023 (27)who showed significant with improvement in color match of adjacent teeth taking into account follow-up in 12 months, in favour of the immediate placement group.

Conclusion

There was significant difference of frequency percentage of gingival health between immediate and early implant placement during twelve month of crowns delivery. The early implant placement was associated with pink esthetics than immediate implant placement.

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